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Pre-Impoundment Water Quality Study for the Mancos Project

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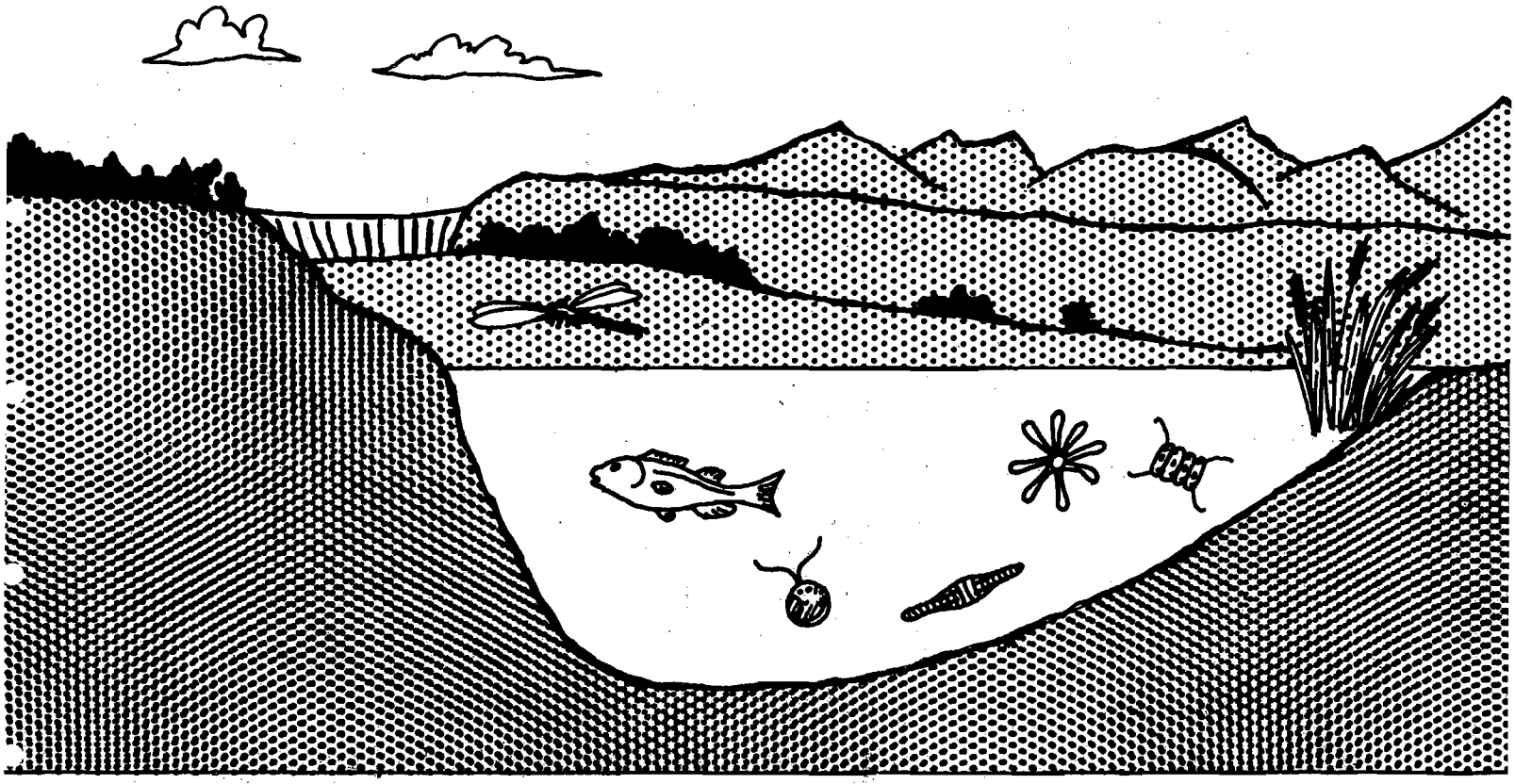

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Introduction

The U.S. Bureau of Reclamation is currently in the process of evaluating a number of water development projects in Southwest Colorado. As a part of the planning process the Bureau has conducted a water quality investigation, in cooperation with the UWRL, of the stream segments that will be affected by each project. The data collected in this study were used to evaluate the water quality of each stream segment with respect to various beneficial uses of water (agriculture, raw municipal water supply, protection of the aquatic biota) and will provide a baseline by which to assess the impact of each project. In addition, these data will be used in the process of site location, design and operation planning for reservoirs and other project features.

This report includes only the results of the water quality study of the Mancos River, associated with the Mancos Project.[1] Water quality data were collected during the period from May, 1977, through August, 1978. One sample was collected and analyzed during each month except during June, 1977, in which two samples were collected from some sites. The concentration of 49 water quality constituents was determined for each sample at the UWRL.

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[1]Other projects included in this study are: the Dolores Project, the Animas La Plata Project, the Dominguez Project, the West Divide Project, the McElmo Creek Project and the San Miguel Project. The results of the water quality study for each project are contained in individual reports.

Methods

Bottles to be used for sample collection were prepared at the UWRL and sent to Colorado for sample collection via Greyhound bus. Three sample bottles were used for each station. Water to be analyzed for non-metallic constituents (plus calcium and magnesium) were collected in half gallon Nalgene bottles. Two 500 ml polyethylene bottles were used for the collection of samples to be analyzed for metals. One of these was reserved for the analyses of "total" metals and the other reserved for the analyses of "dissolved" metals. All sample bottles were prepared prior to shipment using a rinse with dilute HCl followed by three rinses with high quality distilled water. Prior to shipment, 1.5 ml of 50 percent HNO_3 was added to each sample bottle reserved for the analyses of "total" metals.

In Colorado the staff of the USBR or of the consulting firm cf A and S Consultants, Inc. collected samples from each water quality station. Samples were packed in ice for the return trip to the UWRL and shipped via Greyhound bus. Samples usually arrived in Logan the following afternoon and analyses were begun immediately. Occasionally, samples were held in transit longer due to inclement weather.

Upon receipt at the UWRL a portion of the sample reserved for the analyses of non-metallic constituents and the entire sample reserved for the analyses of dissolved metals was filtered through a 0.45 μ "Millipore" filter. Where necessary samples were filtered through a GF/C glass fiber filter prior to filtration through the Millipore filter. Aliquots to be

used for the analyses of total Kjeldahl nitrogen, dissolved metals, cyanide and NO_3/NO_2 were preserved as outlined in Table 2.

Immediately following sample coding and pre-treatment (filtration and/or preservation), analyses were performed for total phosphorus, orthophosphate, alkalinity, cyanide, nitrate and nitrite. On some occasions the analyses of nitrate/nitrite and cyanide were postponed until the following day. When this was necessary the samples for NO_3/NO_2 and cyanide were preserved.

The analyses of calcium, total hardness, sulfate, chloride, total dissolved solids, total Kjeldahl nitrogen, hexavalent chromium and fluoride were completed within seven days using the methods listed in Table 1.

The data obtained for each water quality station during this study was subjected to statistical analysis to determine the means, maximum, minimum, range, standard deviation and coefficient of variation for each constituent. In addition the water quality data for each station was compared to the proposed Colorado Water Quality Standards for agricultural use, raw water supply and the protection of the aquatic biota (Appendix A). This analysis was based on the number of times in which the concentration of a constituent exceeded the proposed standard for that constituent with respect to the number of times a detectable concentration of the constituent was analyzed (Appendix D). In Tables 6 and 7 the comparison is made on the basis of the total number of samples analyzed since for most constituents if the concentration is below the detection limit of analyses it is below the proposed standards. For some metals (cadmium, mercury, silver, copper and zinc) the proposed standards for the protection of the

Table 1. Analytical methods used in water quality survey.[1]

Analysis	Units/Sensitivity	Method
Non Metallic Constituents		
Total hardness	1 mg/l as $CaCO_3$	EDTA Titrimetric. *S.M.* p. 202
pH		pH electrode. *S.M.* p. 460
Total alkalinity	1 mg/l as $CaCO_3$	Potentiometric. *S.M.* p. 278
Carbonate hardness	1 mg/l as $CaCO_3$	Calculated from $CaCO_3$
Bicarbonate hardness	1 mg/l as $CaCO_3$	Calculated from $CaCO_3$
Total dissolved solids	1 mg/l	Gravimetric. *S.M.* p. 82
Chloride, dissolved	mg/l, 2 place	Titrimetric ($HgNO_3$) *S.M.* p. 304
Sulfate, dissolved	mg/l, 2 place	Turbidimetric ($BaCl_2$) *S.M.* p. 496
Fluoride, dissolved	mg/l, 2 place	Ion selective electrode *S.M.* p. 391
Cyanide, total	mg/l, 2 place	Ion selective electrode *S.M.* p. 372
Phosphorus, total	mg/l, 2 place	Persulfate digestion *S.M.* p. 466
Phosphate, ortho	mg/l, 2 place	Ascorbic acid *S.M.* p. 481
Nitrogen, total organic	mg/l, 2 place	Kjeldahl. *S.M.* p. 437
Nitrate	mg/l, 2 place	Cadmium reduction (automated) *S.M.* p. 620
Metallic Constituents		
Aluminum, total; dissolved	µg/l, 3 place	Atomic absorption (AA) *S.M.* p. 152
Arsenic, total; dissolved	µg/l, 3 place	Atomic Absorption (Vapor generation) *S.M.* p. 159

Table 1. Continued.

Analysis	Units/Sensitivity	Method
Barium, dissolved[2]	µg/l, 2 place	Atomic absorption *S.M.* p. 152
Boron, dissolved	mg/l, 2 place	Carmine. *S.M.* p. 290
Calcium	mg/l, 2 place	Titrimetric (EDTA) *S.M.* p. 189
Cadmium, total; dissolved	µg/l, 3 place	Atomic absorption (Flameless) EPA p. 78
Chromium, dissolved[2]	µg/l, 3 place	Atomic absorption (Flameless) EPA p. 78
Chromium, hexavalent	µg/l, 3 place	Colorimetric, *S.M.* p. 192
Copper, total; dissolved	µg/l, 3 place	Atomic absorption *S.M.* p. 148
Iron, total; dissolved	µg/l, 3 place	Atomic absorption *S.M.* p. 148
Lead, total; dissolved	µg/l, 3 place	Atomic absorption (Flameless) EPA p. 78
Magnesium, dissolved	mg/l, 2 place	Calculated from calcium and total hardness
Manganese, total; dissolved	µg/l, 3 place	Atomic absorption *S.M.* p. 148
Mercury, total; dissolved	µg/l, 3 place	Atomic absorption (Cold vapor) *S.M.* p. 56
Molybdenum, total; dissolved	µg/l, 3 place	Atomic absorption (Flameless) EPA p. 78
Nickel, total; dissolved	µg/l, 3 place	Atomic absorption (Flameless) EPA p. 78
Potassium, dissolved	mg/l, 2 place	Flame photometric, *S.M.* p. 234
Selenium, total; dissolved	µg/l, 2 place	Atomic absorption (Vapor generation) *S.M.* p. 159
Silver, total; dissolved	µg/l, 3 place	Atomic absorption (Flameless) EPA p. 78

Table 1. Continued.

Analysis	Units/Sensitivity	Method
Sodium, dissolved	mg/l, 2 place	Flame photometric, *S.M.* p. 250
Zinc, total; dissolved	µg/l, 3 place	Atomic absorption, *S.M.* p. 148

[1]Sources of analytical methods:

S.M. = *Standard Methods for Examination of Water and Wastewater.* 14th Ed. (1975). APHA.

EPA = USEPA (1976a). *Methods for Chemical Analysis of Water and Wastes.*

[2]These analysis were not included in original contract. Analysis of these constituents began in January, 1978.

Table 2. Methods of storage and preservation of samples used in the water quality survey.

Constitutent	Preservative	Storage
Metals[1]	3 ml 50% "mercury free" HNO_3/l	Several months (refrigerated)
TKN	0.8 ml conc. H_2SO_4/l	Max. of 7 days in dark amber glass bottle (refrigerated)
NO_3-NO_2	1 drop chloroform per 12 ml vials	Max. of 2 days in stoppered vials (refrigerated)
CN^-	pH adjusted to 12 with ionic strength adjuster	Up to 24 hours (refrigerated)

[1]Sample bottles (500 ml) for "total metals" contained 1.5 ml HNO_3 when shipped to field.

aquatic biota are below the detection limits of analyses. Since there may have been instances in which the concentration of one of these metals was less than the detection limit of analysis but still greater than the proposed standard for the protection of the aquatic biota, the comparisons for these metals with the proposed standards in Tables 6 and 7 are enclosed in parenthesis.

Results

The water quality data obtained during this study are presented in Appendix B. Statistical analyses of these data, including the mean, standard deviation and coefficient of variance for each parameter are presented in Appendix C.

This water quality study included 17 sampling periods (one each month, except for June, 1977, in which two samples were collected from some sites). No samples for the Mancos River were received during June, July or August, 1977, and August, 1978. In addition, 16 analyses were omitted because a sample bottle was cracked in transit during the December, 1977, sampling round. Finally, 8 analyses were omitted at the UWRL.

In order to check the reliability of these analyses, an ion balance was computed for each sample analyzed. The error in each ion balance was computed as follows:

$$\% \text{ error} = \frac{|\Sigma M^{+n} - \Sigma M^{-n}|}{\Sigma M^{+n} - \Sigma M^{-n}} \times 100 \qquad (1)$$

The ion balance calculations for each sampling period are presented in Table 4. The frequency distribution of errors in the ion balances was calculated for each water quality station (Table 5 and Figure 1). The error in the ion balances for this station was less than 10 percent during 50 percent of the sampling periods in which all the analyses required for the ion balance calculations were completed. For three samples the ion balances were over 20 percent. For two of the samples (3/21/78 and 5/18/78) an erratic endpoint was noted in the alkalinity titration. In addition, both of these

Table 3. Mancos River water quality study - missing parameter values.[a]

Sampling Round	Analyses not performed	Reason for Omission
1	Hex. chromium, Boron	Analysis omitted
2-5	All	No samples sent
7	All	No samples sent
8	Hex. chromium	Analysis omitted
9	All non-metallic constituents, plus calcium and hex. chormium	Sample bottle broke in transit
12	Dissolved nickel	Analysis omitted
15	Selenium (total; diss); Arsenic (total; diss.)	Analysis omitted
17	All	No samples received

[a]When total hardness was not determined, magnesium concentration could not be caluclated. When alkalinity was not determined, inorganic carbon species (HCO_3^-, $CO_3^=$) could not be determined.

Table 4. Ion balance calculations for the Mancos water quality survey.

MANCOS PROJECT

STATION 161 MANCOS RIVER

	5/25/77	6/15 *	6/30 *	7/19 *	8/24 *	9/21	10/19 *	11/15	12/13 *	1/18/78	2/15	3/21	4/18	5/18	6/16	7/19	8/24 *
CA	612.0	0.0	0.0	0.0	0.0	250.0	0.0	354.0	0.0	239.0	328.0	215.0	64.0	65.0	152.0	207.0	0.0
MG	327.0	0.0	0.0	0.0	0.0	77.0	0.0	177.0	0.0	107.0	130.0	69.0	21.0	1.0	21.0	93.0	0.0
NA	500.0	470.0	0.0	0.0	0.0	59.0	0.0	268.0	316.0	147.0	212.0	127.0	34.0	9.0	30.0	121.0	0.0
K	11.0	0.0	0.0	0.0	0.0	11.0	0.0	0.6	8.0	2.9	2.4	4.0	1.0	14.1	4.0	6.0	0.0
HCO3	185.0	0.0	0.0	0.0	0.0	76.0	0.0	152.0	0.0	142.0	225.0	983.0	95.0	308.0	236.0	191.0	0.0
CO3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0	0.0	0.0	0.0	0.0	0.0
CL	69.0	0.0	0.0	0.0	0.0	6.0	0.0	29.0	0.0	17.0	26.0	24.0	10.0	-1.0	5.0	14.0	0.0
SO4	415.0	0.0	0.0	0.0	0.0	615.0	0.0	2204.0	0.0	1046.0	1549.0	759.0	129.0	114.0	516.0	833.0	0.0
STDS	2119.0	470.0	0.0	0.0	0.0	1296.0	0.0	3184.6	324.0	1780.9	2472.4	2217.0	361.6	511.1	964.0	1415.0	0.0
MTDS	5612.0	0.0	0.0	0.0	0.0	1435.0	0.0	2908.0	0.0	1693.0	2338.0	1486.0	339.0	260.0	716.0	1563.0	0.0
SC	79.469	20.445	0.000	0.000	0.000	21.657	0.000	43.826	13.951	28.937	36.304	22.265	6.441	4.078	10.981	23.345	0.000
SA	14.287	0.000	0.000	0.000	0.000	10.714	0.000	69.745	0.000	25.897	37.484	36.759	5.041	6.553	15.479	24.556	0.000
ADIFF	65.182	20.445	0.000	0.000	0.000	2.943	0.000	5.919	13.951	3.039	1.139	14.491	1.400	2.456	4.499	2.634	0.000
ERR(%)	69.523	100.000	0.000	0.000	0.000	7.289	0.000	6.326	100.000	5.543	1.543	24.549	12.196	35.331	17.002	6.456	0.000

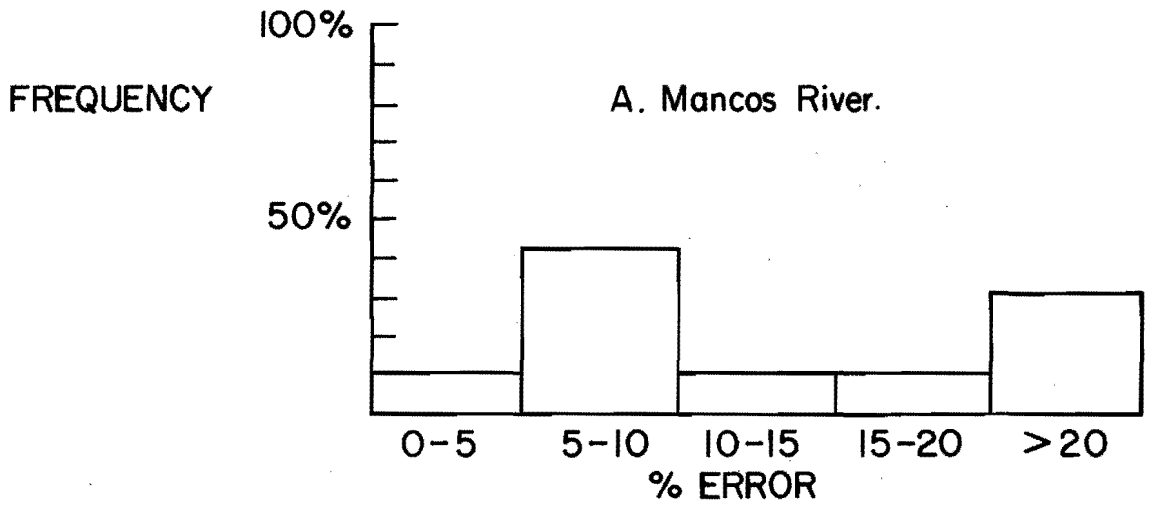
STDS = Sum of the constituents (mg/ℓ)
MTDS = Laboratory measured TDS (mg/ℓ)
SC = Sum of cations (meq/ℓ)
SA = Sum of anions (meq/ℓ)
ADIFF = Absolute difference between SC and SA (meq/ℓ)
ERR(%) = (ADIFF)/(SC + SA) x 100
* = Indicated date where one or more constituents have not been recorded.
– = Indicates that the concentration was below detection limit.

Table 5. Frequency distribution in the errors in the ion balances for the Mancos River.

Station 16: Mancos River

Err(%)	Number	% of total
0 - 5	1	10
5 - 10	4	40
10 - 15	1	10
15 - 20	1	10
>20	3	30
Missing Data	7	
Total	17	

Figure 2. Frequency distribution of errors in ion balance for the Mancos water quality study.



samples were noted as being "extremely turbid." These observations indicate that the suspended matter (probably clay) in the samples reacted as "alkalinity" and resulted in an unreasonable ion balance. Clays can absorb cations (i.e., hydrogen ions added in the alkalinity titration), so such an explanation may be reasonable. In both cases the sum of anions term was much greater than the sum of cations term, adding support to this explanation.

Discussion

The water quality of the Mancos River is extremely variable, as characterized by a range in TDS concentration from 339 mg/1 to 5,612 mg/1 (mean = 1,831 mg/1). The TDS was below 500 mg/1 only during the spring of 1978. The concentration of sulfates and total hardness was correspondingly high. Sulfate concentration ranged from 114 to 2,204 mg/1 (mean = 837 mg/1), and the total hardness ranged from 167 to 2,887 mg/1 as $CaCO_3$ (mean = 1,047 mg/1).

The concentration of several heavy metals exceeded the proposed Colorado Water Quality Standards for raw water supply, although none exceeded the proposed standards during more than half of the sampling periods. Specifically, the concentrations of barium, total cadmium, total chromium, total lead, total mercury and total selenium exceeded the proposed standards during one or more occasions. The concentration of these metals usually exceeded the proposed standards during March through May of 1978, reflecting the increase in suspended solids concentration usually associated with spring runoff. In addition to these metals, the concentrations of sulfate, magnesium, and dissolved manganese exceeded the proposed water supply standards throughout most of this study. The rationale for standards for these constituents is not direct toxicity but undesirable effects associated with their presence. Manganese in water supplies may cause an undesirable taste and result in the staining of sinks and laundry (EPA, 1976). Sulfate in high concentrations has a cathartic effect on some people, particularly those not accustomed to high concentrations of sulfate in their water supply (EPA, 1976). Magnesium also has a cathartic effect when present in high

Table 6. Constituents that exceede the proposed Colorado River Quality Standards in the Mancos River.[1]

Parameter (All metals "total" unless specified)	Water Use: Class II Water Supply N/T[2]	%	Agriculture N/T[2]	%	Aquatic Biota N/T[2]	%
Aluminum (dissolved)	-	-	-	-	11/11	100
Barium	2/10	20	-	-	-	-
Cadmium[3]	1/11	9	1/11	9	(2/11)	(18)
Chromium	2/10	20	0/10	0	0/10	0
Copper[3]	0/11	0	0/11	9	(6/11)	(55)
Iron (total)	-	-	-	-	5/11	45
Lead	1/10	10	1/10	10	1/10	10
Magnesium	3/11	27	-	-	-	-
Manganese (dissolved)	5/11	45	-	-	-	-
Manganese (total)	-	-	4/11	36	1/11	9
Mercury[3]	1/11	9	-	-	(9/11)	(82)
Nickel	-	-	1/11	9	2/11	18
Selenium	1/11	9	0/11	0	0/12	0
Silver[3]	0/11	0	-	-	(2/11)	(18)
Zinc[3]	0/11	0	0/11	0	(4/11)	(36)
Total Cyanide	0/11	0	0/11	0	6/11	55
Sulfate	8/11	73	-	-	-	-

(1) Proposed Colorado Water Quality Standards in Appendix A.

(2) N/T = number of samples exceeding standard compared with the number of samples analyzed.

(3) Parenthesis indicate that the proposed standard was below the detection limit of analyses.

concentrations. Finally, the Mancos River is extremely hard. This level of hardness (ave. > 1,000 mg/l as $CaCO_3$) is undesirable since very hard waters tend to cause scaling in pipes and require more soap for cleaning than do soft waters. No undesirable health effects have been associated with high total hardness, per se.

The high TDS of this river may be undesirable with respect to its use for irrigation water. Except during the spring of 1978 the TDS of the Mancos River was over 1,000 mg/l. The use of water having a TDS of 1,000 - 2,000 mg/l for irrigation may have adverse effects on many crops (NAS, 1972). The effects of using this water for irrigation would depend on the concentration of specific ions (especially sodium), the types of soils being cultivated, specific crops being irrigated and the intensity of irrigation. As noted in Table 6, the standards for several toxic metals were exceeded during this study. As noted earlier, those metals usually exceeded the proposed standards during the spring. During the irrigation season the concentrations of these metals were usually below the proposed standards.

The proposed standards for the protection of the aquatic biota were exceeded by several constituents. The standards for dissolved aluminum, total mercury, total copper, and total cyanide were exceeded during over half the sampling periods. The standards for total cadmium, total iron, total lead, total manganese, total nickel, total silver and total zinc were exceeded on one or more occasions.

APPENDIX A

Proposed Colorado Water Quality Standards

Table A-1 Proposed Colorado water quality standards: Class II water supply.

Parameter	Standard
Physical	
D.O. (mg/ℓ)[1]	Aerobic[2]
pH	5.0-9.0
Suspended solids and turbidity	[3]
Temperature	X
TDS (mg/ℓ)	Y
Biological	
Algae[4]	Free of toxic and objectionable algae
Fecal coliforms (#/100 mℓ)	1,000
Inorganics	
Ammonia (mg/ℓ as N)	0.5
Total residual chlorine (mg/ℓ)	X
Cyanide (mg/ℓ)	0.2
Fluoride (mg/ℓ)	[5]
Nitrate (mg/ℓ as N)	10
Nitrite (mg/ℓ as N)	1.0
Sulfide as H_2S (mg/ℓ)	0.05
Boron (mg/ℓ)	X
Chloride (mg/ℓ)	250
Magnesium (mg/ℓ)	125
Sodium adsorbtion ratio	X
Sulfate (mg/ℓ)	250
Phosphorus (mg/ℓ as P)	Bioassay[6]
Toxic Metals (mg/ℓ)	
Aluminum	X
Arsenic	0.05
Barium	1.0
Beryllium	X
Cadmium	0.01
Chromium	0.05
Copper	1.0
Iron	0.3 (soluble)
Lead	0.05
Manganese	0.05 (soluble)
Mercury	0.002
Molybdenum	Y
Nickel	X

X = numerical limit generally not needed for protection of classified use.

Y = limit may be required but there is insufficient data for setting a general standard.

Table A-1 Continued.

Parameter	Standards
Toxic Metals (mg/ℓ)	
Selenium	0.01
Silver	0.05
Thallium	X
Zinc	5.0
Organics[7] ($\frac{\mu g}{\ell}$)	
Chlorinated pesticides[8]	
Aldrin[9]	Y
Chlordane[9]	Y
Dieldrin[8]	Y
DDT[9]	Y
Endrin	0.2
Heptachlor[9]	Y
Lindane	4
Methoxychlor	Y
Mirex	100
Toxaphene	5
Organophosphate pesticides[8]	
Demeton	Y
Endosulfan	Y
Guthion	Y
Malathion	Y
Parathion	Y
Chlorophenoxy Herbicides	
2, 4-D	100
2, 4, 5-TP	10
PCB's[10]	Y
Phenol	1
Radiological[11] (pCi/ℓ)	
Alpha[11, 12]	15
Beta[11, 12]	50
Cesium 134	80
Plutonium	15
Radium 226 and 228[12, 13]	5
Strontium 90[12, 13]	8
Thorium 230 and 232	60
Tritium	20,000
Uranium (total, mg/ℓ)	5

[1]Where dissolved oxygen levels less than the standard occur naturally, a discharge shall not cause a further reduction in dissolved oxygen in receiving water.

[2]An effluent shall be regulated to maintain aerobic conditions, and a guideline of 2.0 mg/ℓ dissolved oxygen in an effluent should be maintained, unless demonstrated otherwise.

[3]Suspended solid levels will be controlled by Effluent Limitations and Basic Standards.

[4]Free from objectionable and toxic algae. It has been well established that heavy growth of some strains of blue-green algae, upon death and degradation, may release one or more substances which are toxic to humans and many other animals. Although no fixed numbers can be recommended at this time, it is clear that streams, lakes and reservoirs should not be permitted to bear heavy growth of algal blooms, nor allow these blooms to disintegrate. Every effort should be made to control algal growths to levels that are not hazardous.

[5]Fluoride limits vary from 2.4 mg/ℓ at 12.0 C and below, to 1.4 mg/ℓ between 26.3 C and 32.5 C, based upon the annual average of the maximum daily air temperature (see *National Interim Primary Drinking Water Regulations* for specific limitations).

[6]Phosphorus standards are to be determined by an algal bioassay using the method described in the latest edition of *Standard Methods for the Examination of Water and Wastewater*.

[7]All organics, not on this partial list, are covered under Basic Standards, Section 3.1., 1978 Colorado Water Quality Standards.

[8]Numerical limits in tables based on experimental evidence of toxicity. No point source discharges of organic pesticides shall be permitted to state waters.

[9]The persistence, bioaccumulation potential, and carcinogenicity of these organic compounds cautions human exposure to a minimum (EPA).

[10]Every reasonable effort should be made to minimize human exposure (EPA).

[11]Concentrations given are maximum permissible concentrations above naturally occurring or "background" concentrations except where otherwise noted.

[12]If Alpha or Beta are measured in excess of 15 or 50 pCi/ℓ respectively, it will be necessary to determine by specific analysis the particular radionuclide or radionuclides responsible for the elevated level. Particular radionuclides should not exceed the limit given in the table. If an elevated level of Alpha or Beta emissions is caused by radionuclides, the Division should be consulted.

[13]Maximum permissible concentrations including naturally occurring or background contributions.

Table 4-2 Proposed Colorado water quality standards (non-metallic): Protection of Aquatic Biota.

Parameter	Cold Water Biota	Warm Water Biota
Physical		
D.O. (mg/ℓ)[1]	6.0 7.0 (spawning)[2]	5.0
pH	6.5 - 9.0	6.5 - 9.0
Suspended solids and turbidity	[3]	[3]
Temperature (°C)	Maximum 20°C w/ 3° increase[4]	Maximum 30°C w/ 3° increase[4]
TDS (mg/ℓ)	Y	Y
Biological		
Algae[5]	Free from objectionable and toxic algae	Same as Cold Water
Fecal coliforms	X	X
Inorganics		
Ammonia (mg/ℓ as N)	0.02 unionized	0.10 unionized
Total residual chlorine (mg/ℓ)	0.002	0.01
Cyanide (mg/ℓ)	0.005	0.005
Fluoride (mg/ℓ)	X	X
Nitrate (mg/ℓ as N)	X	X
Nitrite (mg/ℓ as N)	0.05	0.5
Sulfide as H_2S (mg/ℓ)	0.002 undissociated	0.002 undissociated
Boron (mg/ℓ)	X	X
Chloride (mg/ℓ)	X	X
Magnesium (mg/ℓ)	X	X
Sodium adsorbtion ratio	X	X
Sulfate (mg/ℓ)	X	X
Phosphorus (mg/ℓ as P)	Bioassay[6]	Bioassay[6]
Organics[7] ($\frac{\mu g}{\ell}$)		
Chlorinated Pesticides[8]		
Aldrin[9]	0.003	0.003
Chlordane	0.01	0.01
Dieldrin[9]	0.003	0.003
DDT	0.001	0.001
Endrin	0.004	0.004
Heptachlor	0.001	0.001
Lindane	0.01	0.01
Methoxychlor	0.03	0.03
Mirex	0.001	0.001
Toxaphene	0.005	0.005

Table A-2 Continued.

Parameter	Cold Water Biota	Warm Water Biota
Organophosphate Pesticides[8]		
Demeton	1	1
Endosulfan	0.003	0.003
Guthion	0.01	0.01
Malathion	1	1
Parathion	0.04	0.04
Chlorophenoxy Herbicides		
2, 4-D	Y	Y
2, 4, 5-TP	Y	Y
PCB's	0.001	0.001
Phenols	1	1
Radiological[10] in (pCi/ℓ)		
Alpha (excluding uranium and radium[11])	15	15
Beta (excluding Sr^{90} [11]	50	50
Cesium 134	80	80
Plutonium 238, 239, and 240	15	15
Radium 226 and 228	5	5
Strantium 90[12]	8	8
Thorium 230 and 232	60	60
Tritium	20,000	20,000
Uranium (total)[13]	--	--

X = numerical limit generally not needed for protection of classified use.

Y = limit may be required but there is insufficient data for setting a general standard.

[1]Where dissolved oxygen levels less than the standard occur naturally a discharge shall not cause a further reduction in dissolved oxygen in receiving water.

[2]A 7 mg/ℓ standard, during periods of spawning of coldwater fish, shall be set on a case by case basis as defined in the NPDES permit for those dischargers whose effluent would affect fish spawning.

[3]Suspended solid levels will be controlled by Effluent Limitations and Basic Standards.

[4]Temperature shall maintain a normal pattern of diurnal and seasonal fluctuations with no abrupt changes and shall have no increase in temperature of a magnitude, rate and duration deemed deleterious to the resident aquatic life. Generally, a maximum 3°C increase over a minimum of a 4-hour period, lasting for 12 hours maximum, is deemed acceptable for discharges fluctuating in volume or temperature. Where temperature increases cannot be maintained within this range using BMP, BATEA, and BPWITT control measures, the Division will determine whether the resulting temperature increases preclude an Aquatic Life classification.

[5]Free from objectionable and toxic algae. It has been well established that heavy growth of some strains of blue-green algae, upon death and degradation, may release one or more substances which are toxic to humans and many other animals. Although no fixed numbers can be recommended at this time, it is clear that streams lakes and reservoirs should not be permitted to bear heavy growth of algal blooms, nor allow these blooms to disintegrate. Every effort should be made to control algal growths to levels that are not hazardous.

[6]Phosphorus standards are to be determined by an algal bioassay using the method described in the latest edition of *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association.

[7]All organics, not on this partial list, are covered under Basic Standards, Section 3.1., 1978 Colorado Water Quality Standards.

[8]Numerical limits in tables based on experimental evidence of toxicity. No point source discharges of organic pesticides shall be permitted to state waters.

[9]Aldrin and dieldrin in combination should not exceed 0.000003 mg/ℓ.

[10]Concentrations given are maximum permissible concentrations above naturally occurring or "background" concentrations except where otherwise noted.

[11]If Alpha or Beta are measured in excess of 15 of 50 pCi/ℓ respectively, it will be necessary to determine by specific analysis the particular radionuclide or radionuclides responsible for the elevated level. Particular radionuclides should not exceed the limit given in the table. If an elevated level of Alpha or Beta emissions is caused by radionuclides, the Division should be consulted.

[12]Maximum permissible concentrations including naturally occurring or background contribution.

[13]See Uranium in Table A-3 for aquatic life limitations.

Table A-3 Proposed Colorado water quality standards (metallic): Protection of Aquatic Biota.

Parameter	Water Hardness[1] - Cold and Warm Water Biota				
	0-100	100-200	200-300	300-400	over 400
Toxic Metals[2] (mg/ℓ)					
Aluminum (soluble)	0.1	0.1	0.1	0.1	0.1
Arsenic	0.05	0.05	0.05	0.05	0.05
Barium	X	X	X	X	X
Beryllium	0.01	0.3	0.6	0.9	1.1
Cadmium	0.004	0.001	0.005	0.01	0.015
Chromium	0.1	0.1	0.1	0.1	0.1
Copper	0.01	0.01	0.01	0.02	0.04
Iron	1.0	1.0	1.0	1.0	1.0
Lead[3]	0.004	0.025	0.050	0.100	0.150
Manganese	1.0	1.0	1.0	1.0	1.0
Mercury	0.00005	0.00005	0.00005	0.00005	0.00005
Molybdenum	X	X	X	X	X
Nickel	0.05	0.10	0.20	0.30	0.40
Selenium	0.05	0.05	0.05	0.05	0.05
Silver	0.00010	0.00010	0.00015	0.00020	0.00025
Thallium	0.15	0.15	0.15	0.15	0.15
Uranium	0.03	0.2	0.4	0.8	1.4
Zinc	0.05	0.05	0.10	0.30	0.60

X = numerical limit generally not needed for protection of classified use.

[1]Concentrations of total alkalinity or other chelating agents attributable to municipal, industrial or other discharges or agriculatural practices should not alter the total alkalinity or other chelating agents of the receiving water by more than 20 percent. Where the complexing capacity of the receiving water is altered by more than 20 percent or where chelating agents are released to the receiving water which are not naturally characteristic of that water, specific effluent limitations on pertinent parameters will be established. In no case shall instream modification or alteration of total alkalinity or other chelating agents be permitted without Commission authorization.

[2]Bioassay procedures may be used to establish criteria or standards for a particular situation. Requirements for bioassay procedures outlined in Section 3.1.10, Colorado Water Quality Standards, May 2. 1978.

[3]For bioassay lead concentration is based on soluble lead measurements (*i.e.* non-filterable lead using a 0.45 micron filter).

Table A-4 Proposed Colorado water quality standards: Agricultural Use.

Parameter	Standard
Physical	
D.O. (mg/ℓ)[1]	Aerobic[2]
pH	X
Suspended solids and turbidity	[3]
Temperature	X
TDS (mg/ℓ)	Y
Biological	
Algae[4]	Free of toxic and objectionable algae
Fecal coliforms (#/100 mℓ)	1,000
Inorganics	
Ammonia (mg/ℓ as N)	X
Total residual chlorine (mg/ℓ)	X
Cyanide (mg/ℓ)	0.2
Fluoride (mg/ℓ)	X
Nitrate (mg/ℓ as N)	100[5]
Nitrite (mg/ℓ as N)	10[5]
Sulfide as H_2S (mg/ℓ)	X
Boron (mg/ℓ)[2]	0.75
Chloride (mg/ℓ)	X
Magnesium (mg/ℓ)	X
Sodium adsorbtion ratio	X
Sulfate (mg/ℓ)	X
Phosphorus (mg/ℓ as P)	X
Toxic Metals (mg/ℓ)	
Aluminum	X
Arsenic	0.1
Barium	X
Beryllium	0.1
Cadmium	0.01
Chromium	0.0
Copper	0.2
Iron	X
Lead	0.1
Manganese	0.2
Mercury	X
Molybdenum	Y
Nickel	0.2

X = numerical limit generally not needed for protection of classified use.

Y = limit may be required but there is insufficient data for setting a general standard.

Table A-4 Continued.

Parameter	Standard
Toxic Metals (mg/ℓ)	
Selenium	0.02
Silver	X
Thallium	X
Zinc	2.0
Organics[6], ($\frac{\mu g}{\ell}$)	
Chlorinated Pesticides[7]	
Aldrin[8]	Y
Chlordane[8]	Y
Dieldrin[8]	Y
DDT[8]	Y
Endrin	Y
Heptachlor[8]	Y
Lindane	Y
Methoxychlor	Y
Mirex	Y
Toxaphene	Y
Organophosphate Pesticides[7]	
Demeton	Y
Endosulfan	Y
Guthion	Y
Malathion	Y
Parathion	Y
Chlorophenoxy Herbicides	
2, 4-D	Y
2, 4, 5-TP	Y
PCB's[9]	Y
Phenol	Y
Radiological[10] (pCi/ℓ)	
Alpha[11, 12]	15
Beta[11, 12]	50
Cesium	80
Plutonium	15
Radium 226, and 228[12]	5
Strontium 90[12]	8
Thorium 230 and 232	60
Tritium	20,000
Uranium (total, mg/ℓ)	5

[1]Where dissolved oxygen levels, less than the standard, occur naturally, a discharge shall not cause a further reduction in dissolved oxygen in receiving water.

[2]An effluent shall be regulated to maintain aerobic conditions, and a guideline of 2.0 mg/ℓ dissolved oxygen in an effluent should be maintained, unless demonstrated otherwise.

[3]Suspended solid levels will be controlled by Effluent Limitations and Basic Standards.

[4]Free from objectionable and toxic algae. It has been well established that heavy growth of some strains of blut-green algae, upon death and degradation, may release one or more substances which are toxic to humans and many other animals. Although no fixed numbers can be recommended at this time, it is clear that streams, lakes and reservoirs should not be permitted to bear heavy growth of algal blooms, or allow these blooms to disintegrate. Every effort should be made to control algal growths to levels that are not hazardous.

[5]In order to provide a reasonable margin of safety to allow for unusual situations such as extremely high water ingestion or nitrite formation in slurries, the NO_3-N plus NO_2-N content in drinking waters for livestock and poultry should be limited to 100 ppm or less, and the NO_2-N content alone be limited to 10 ppm or less.

[6]All organics, not on this partial list, are covered under Basic Standards, Section 3.1., 1978 Colorado Water Quality Standards.

[7]Numerical limits in tables based on experimental evidence of toxicity. No point source discharges of organic pesticides shall be permitted to state waters.

[8]The persistence, bioaccumulation potential, and carcinogenicity of these organic compounds cautions human exposeure to a minimum (EPA).

[9]Every reasonable effort should be made to minimize human exposure (EPA).

[10]Concentrations given are maximum permissible concentrations above naturally occurring or "background" concentrations except where otherwise noted.

[11]If Alpha or Beta are measured in excess of 15 or 50 pCi/ℓ respectively, it will be necessary to determine by specific analysis the particular radionuclide or radionuclides responsible for the elevated level. Particular radionuclides should not exceed the limit given in the table. If an elevated level of Alpha or Beta emissions is caused by radionuclides, the Division should be consulted.

[12]Maximum permissible concentrations including naturally occurring or background contributions.

Table A-5 Proposed Colorado water quality standards: Recreational Use.

Parameter	Standard	
	Class I (Primary Contact)	Class II (Secondary Contact)
Physical		
D.O.[1] ($\frac{mg}{\ell}$ D.O.)	Aerobic[2]	Aerobic[2]
pH	6.5-9.0	X
Suspended solids and turbidity	X	X
Temperature	X	X
TDS (mg/ℓ)	X	X
Biological		
Algae[4]	Free of objectionable and toxic algae	Free of objectionable and toxic algae
Fecal coliforms (#/100 mℓ)	200	1,000
Inorganics		
Ammonia ($\frac{mg}{\ell}$ as N)	X	X
Chloride (mg/ℓ)	X	X
Cyanide (mg/ℓ)	X	X
Fluoride (mg/ℓ)	X	X
NO_3 (mg/ℓ as N)	X	X
NO_2 (mg/ℓ as N)	X	X
Sulfide as H_2S (mg/ℓ)	X	X
Boron (mg/ℓ)[2]	X	X
Chloride (mg/ℓ)	X	X
Magnesium (mg/ℓ)	X	X
SAR	X	X
Sulfate (mg/ℓ)	X	X
Phosphorus (mg/ℓ as P)	Bioassay[5]	Bioassay[5]
Toxic Metals (mg/ℓ)		
Aluminum	X	X
Arsenic	X	X
Barium	X	X
Beryllium	X	X
Cadmium	X	X
Chromium	X	X
Copper	X	X
Iron	X	X
Lead	X	X
Manganese	X	X
Mercury	X	X
Molybdenum	X	X
Nickel	X	X
Selenium	X	X

Table A-5 Continued.

Parameter	Standard	
	Class I (Primary Contact)	Class II (Secondary Contact)
Toxic Metals (mg/ℓ)		
Silver	X	X
Thallium	X	X
Uranium	X	X
Zinc	X	X
Organics[6]		
Chlorinated Pesticides[7]		
Aldrin[8]	Y	Y
Chlordane[8]	Y	Y
Dieldrin[8]	Y	Y
DDT[8]	Y	Y
Endrin	Y	Y
Heptachlor[8]	Y	Y
Lindane	Y	Y
Methoxychlor	Y	Y
Mirex	Y	Y
Toxaphene	Y	Y
Organophosphate Pesticides[7]		
Demeton	Y	Y
Endosulfan	Y	Y
Guthion	Y	Y
Malathion	Y	Y
Parathion	Y	Y
Chlorophynoxy Herbicides		
2, 4-D	Y	Y
2, 4, 5-TP	Y	Y
PCB's[9]	Y	Y
Phenol	Y	Y
Radiological		
Alpha	X	X
Beta	X	X
Cesium 134	X	X
Plutonium 238, 239, and 240	X	X
Radium 226 and 228	X	X
Strantium	X	X
Thorium 230 and 232	X	X
Tritium	X	X
Uranium (total)	X	X

X = numerical limit generally not needed for protection of classified use.
Y = limit may be required but there is insufficient data for setting a general standard.

[1]Where dissolved oxygen levels, less than the standard, occur naturally, a discharge shall not cause a further reduction in dissolved oxygen in receiving water.

[2]An effluent shall be regulated to maintain aerobic conditions, and a guideline of 2.0 mg/ℓ dissolved oxygen in an effluent should be maintained, unless demonstrated otherwise.

[3]Suspsended solid levels will be controlled by Effluent Limitations and Basic Standards.

[4]Free from objectionable and toxic algae. It has been well established that heavy growth of some strains of blue-green algae, upon death and degradation, may release one or more substances which are toxic to humans and many other animals. Although no fixed numbers can be recommended at this time, it is clear that streams, lakes and reservoirs should not be permitted to bear heavy growth of algal blooms, nor allow these blooms to disintegrate. Every effort should be made to control algal growths to levels that are not hazardous.

[5]Phosphorus standards are to be determined by an algal bioassay using the method described in the latest edition of *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association.

[6]All organics, not on this partial list, are covered under Basic Standards, Section 3.1., 1978 Colorado Water Quality Standards.

[7]Numerical limits in tables based on experimental evidence of toxicity. No point source discharge of organic pesticides shall be permitted to state waters.

[8]The persistence, bioaccumulation potential, and carcinogenicity of these organic compounds cautions human exposure to a minimum (EPA).

[9]Every reasonable effort should be made to minimize human exposure (EPA).

APPENDIX B

Raw Water Quality Data

Table B-1. Water quality parameter codes.

A. METALLIC CONSTITUENTS
(µg/l unless noted)

101. Aluminium, Dissolved
102. Aluminium, Total
103. Barium, Dissolved
104. Barium, Total
105. Cadmium, Dissolved
106. Cadmium, Total
107. Calcium (mg/l)
108. Chromium, Hexavalent
109. Chromium, Total
110. Copper, Dissolved
111. Copper, Total
112. Hardness, Total
113. Iron, Dissolved
114. Iron, Total
115. Lead, Dissolved
116. Lead, Total
117. Magnesium (mg/l)
118. Manganese, Dissolved
119. Manganese, Total
120. Mercury, Dissolved
121. Mercury, Total
122. Molybdenum, Dissolved
123. Molybdenum, Total
124. Nickel, Dissolved
125. Nickel, Total
126. Potassium (mg/l)
127. Selenium, Dissolved
128. Selenium, Total
129. Silver, Dissolved
130. Silver, Total
131. Sodium (mg/l)
132. Zinc, Dissolved
133. Zinc, Total

B. NON-METALLIC CONSTITUENTS
(mg/l unless noted)

201. Alkalinity, Total
202. Arsenic, Dissolved (µg/l)
203. Arsenic, Total (µg/l)
204. Bicarbonate Hardness
205. Boron
206. Carbonate Hardness
207. Chloride
208. Cyanide
209. Fluoride
210. Nitrogen, Nitrate
211. Nitrogen, Nitrite
212. Nitrogen, Total Organic
213. Phosphorus, Ortho
214. Phosphorus, Total
215. Sulfate
216. Total Dissolved Solids

Table B-2. Water quality data for the Mancos project.

MANCOS PROJECT

STATION: 16: MANCOS RIVER

CODE	5/25/77	6/16	6/30	7/19	8/24	9/21	10/19	11/15	12/13	1/18/78	2/15	3/21	4/18	5/15	6/16	7/19	8/24
101	1527.					720.		429.	275.	410.	461.	272.	214.	186.	1040.	590.	
102	1527.					1000.		642.	275.	5966.	21990.	159990.	58761.	79300.	3010.	582.	
103								102.	150.	-100.	125.	207.	179.	-100.	-100.	-100.	
104								201.	150.	956.	389.	2791.	759.	1526.	533.	104.	
105	-3.					5.		9.	8.	-3.	-3.	-3.	-3.	3.	-3.	4.	
106	-3.					8.		4.	4.	7.	-3.	4.	21.	7.	5.	4.	
107	612.					250.		354.		239.	329.	218.	64.	65.	152.	207.	
108						-1.				-1.	-1.	-1.	3.	4.	3.	-1.	
109										-20.	-20.	96.	53.	29.	-20.	-20.	
110	-10.					-10.		-10.	-10.	-10.	70.	-10.	-10.	-10.	-10.	22.	
111	10.					36.		136.	-10.	44.	70.	297.	54.	164.	36.	29.	
112	2687.					943.		1622.		1042.	1359.	831.	208.	167.	467.	900.	
113	26.					42.		-21.	28.	22.	-21.	45.	65.	109.	31.	211.	
114	379.					300.		377.	119.	462.	1872.	1629.	5.	35339.	10374.	2600.	242.
115								-1.	3.	-1.	-1.	0.	-1.	-1.	-1.	-1.	
116								7.	3.	-1.	-1.	120.	3.	33.	-1.	6.	
117	327.					77.		177.		107.	130.	60.	21.	1.	21.	93.	
118	425.					11.		43.	71.	86.	54.	64.	13.	25.	12.	23.	
119	425.					32.		56.	71.	190.	110.	2829.	473.	494.	99.	86.	
120	0.6					-0.2		0.4	-0.2	0.4	0.7	0.4	0.4	-0.2	0.2	0.4	
121	0.6					-0.2		0.6	-0.2	0.4	0.7	0.5	2.5	0.3	0.5	0.8	
122	-5.					4.		33.	21.	17.	30.	7.	-5.	-5.	-5.	14.	
123	4.					13.		33.	21.	17.	33.	11.	321.	7.	-5.	57.	
124	17.					-6.		102.	-6.	14.	22.		-6.	-6.	-6.	-6.	
125	18.					62.		102.	20.	14.	22.	2749.	68.	129.	10.	-6.	
126	11.0					11.0		8.6	8.0	2.9	2.8	4.3	1.6	18.1	4.0	6.0	
127	-1.					1.		-1.	-1.	-1.	-1.	1.	-1.		-1.	-1.	
128	-1.					1.		-1.	-1.	14.	-1.	10.	-1.		-1.	6.	
129	-9.					-9.		9.	9.	-9.	-9.	-9.	-9.	-9.	-9.	-9.	
130	-9.					-9.		9.	9.	-9.	-9.	30.	-9.	10.	-9.	-9.	
131	500.					59.		269.	316.	187.	212.	129.	34.	9.	30.	121.	
132	54.					26.		20.	-5.	10.	15.	21.	-5.	-5.	9.	24.	
133	231.					240.		238.	561.	1031.	174.	890.	606.	526.	172.	175.	
201	185.					76.		152.		152.	225.	1022.	98.	306.	236.	141.	
202	-1.					-1.		-1.	-1.	-1.	-1.	-1.	-1.		-1.	-1.	
203	-1.					-1.		-1.	-1.	-1.	-1.	-1.	-1.		-1.	1.	
204	185.					76.		152.		152.	225.	965.	98.	306.	236.	141.	
205						0.49		0.34	-0.05	-0.05	-0.05	0.05	0.67	0.39	0.22	-0.05	
206												30.					
207	69.					8.		29.		17.	20.	24.	14.	-1.	5.	14.	
208	-1.01					-0.01		0.12		0.01	0.02	0.01	-0.01	-0.01	0.01	0.02	
209	0.16					0.19		0.14			0.16	0.02	-0.01	-0.01	-0.01	0.01	
210	0.04					0.15		0.10		0.47	0.64	0.74	0.13	0.20	0.15	0.05	
211	0.032					0.032		0.004		0.015	0.019	0.029	0.004	0.005	0.004	0.003	
212	1.0					0.6		0.9		1.9	2.7	1.3	-0.1	2.7	0.5	0.7	
213	-0.001					0.002		0.002	-0.001	0.003	0.001	0.005	0.006	0.006	0.002	0.020	
214	0.030					0.030		0.044	0.007	0.083	0.057	0.503	0.385	1.400	0.035	0.028	
215	415.					815.		2204.		1046.	1549.	758.	129.	114.	510.	633.	
216	5612.					1435.		2906.		1693.	2338.	1046.	339.	280.	716.	1553.	

APPENDIX C

Statistical Analyses of Water Quality Data

Table C-1. Statistical analysis of the water quality data for the Mancos project.

MANCOS PROJECT

STATION 16: MANCOS RIVER

CODE	CONSTITUENT	MEAN	VARIANCE	S.D.	C OF V	MAX	MIN	RANGE	N
	***** GROUP A: METALLIC CONSTITUENTS *****								
101	ALUMINIUM, DISSOLVED (UG/L)	612.0	.2570E+06	507.0	82.8	1640.	188.	1452.	11
102	ALUMINIUM, TOTAL (UG/L)	28428.9	.2634E+10	51326.1	180.5	159498.	275.	159221.	11
103	BARIUM, DISSOLVED (UG/L)	160.6	.1054E+04	32.5	20.2	207.	125.	82.	5
104	BARIUM, TOTAL (UG/L)	768.0	.7128E+06	844.3	109.9	2701.	154.	2547.	9
105	CADMIUM, DISSOLVED (UG/L)	5.8	.6700E+01	2.6	44.6	9.	3.	6.	5
106	CADMIUM, TOTAL (UG/L)	8.2	.2669E+02	5.2	62.8	21.	4.	17.	9
107	CALCIUM (MG/L)	248.9	.2548E+05	159.6	64.1	612.	64.	548.	10
108	CHROMIUM, HEXAVALENT (UG/L)	3.3	.3333E+00	0.6	17.5	4.	3.	1.	3
109	CHROMIUM, TOTAL (UG/L)	56.0	.8190E+03	28.6	51.1	86.	29.	57.	3
110	COPPER, DISSOLVED (UG/L)	46.0	.1152E+04	33.9	73.8	70.	22.	48.	2
111	COPPER, TOTAL (UG/L)	88.2	.7749E+04	88.0	99.8	297.	14.	283.	10
112	HARDNESS, TOTAL AS CACO3 (MG/L)	1047.2	.6267E+06	791.6	75.6	2887.	167.	2720.	10
113	IRON, DISSOLVED (UG/L)	64.3	.3974E+04	63.0	98.0	211.	22.	189.	9
114	IRON, TOTAL (UG/L)	19555.3	.2371E+10	48688.6	249.0	162925.	119.	162806.	11
115	LEAD, DISSOLVED (UG/L)	3.5	.5000E+00	0.7	20.2	4.	3.	1.	2
116	LEAD, TOTAL (UG/L)	28.7	.2132E+04	46.2	161.1	120.	3.	117.	6
117	MAGNESIUM (MG/L)	102.3	.9131E+04	95.6	93.4	327.	1.	326.	10
118	MANGANESE, DISSOLVED (UG/L)	75.5	.1410E+05	118.8	157.4	425.	11.	414.	11
119	MANGANESE, TOTAL (UG/L)	438.1	.6609E+06	812.9	185.6	2829.	32.	2797.	11
120	MERCURY, DISSOLVED (UG/L)	0.44	.2268E-01	0.15	34.42	0.7	0.2	0.5	8
121	MERCURY, TOTAL (UG/L)	0.74	.4626E+00	0.68	91.38	2.5	0.3	2.2	9
122	MOLYBDENUM, DISSOLVED (UG/L)	18.7	.9890E+02	9.9	53.1	33.	7.	26.	7
123	MOLYBDENUM, TOTAL (UG/L)	52.1	.9162E+04	95.7	183.7	321.	7.	314.	10
124	NICKEL, DISSOLVED (UG/L)	61.3	.7609E+04	87.2	142.4	192.	14.	178.	4
125	NICKEL, TOTAL (UG/L)	328.8	.7266E+06	852.4	259.3	2749.	10.	2739.	10
126	POTASSIUM (MG/L)	6.3	.1703E+02	4.1	65.2	14.	2.	13.	11
127	SELENIUM, DISSOLVED (UG/L)	1.0	0.	0.0	0.0	1.	1.	0.	2
128	SELENIUM, TOTAL (UG/L)	6.8	.3958E+02	6.3	93.2	14.	1.	13.	4
129	SILVER, DISSOLVED (UG/L)	9.0	0.	0.0	0.0	9.	9.	0.	2
130	SILVER, TOTAL (UG/L)	14.5	.1070E+03	10.3	71.3	30.	9.	21.	4
131	SODIUM (MG/L)	194.8	.2750E+05	165.8	85.2	500.	9.	491.	12
132	ZINC, DISSOLVED (UG/L)	22.4	.2014E+03	14.2	63.4	54.	9.	45.	8
133	ZINC, TOTAL (UG/L)	441.8	.9310E+05	305.1	69.1	1031.	174.	857.	11
	***** GROUP B: NON-METALLIC CONSTITUENTS *****								
201	ALKALINITY, TOTAL AS CACO3 (MG/L)	262.5	.7581E+05	275.3	104.9	1022.	76.	946.	10
202	ARSENIC, DISSOLVED (UG/L)	0.0	0.	0.0	0.0	0.	0.	0.	0
203	ARSENIC, TOTAL (UG/L)	45.3	.3544E+04	59.5	131.3	113.	1.	112.	3
204	BICARBONATE HARDNESS AS CACO3 (MG/L)	259.5	.7084E+05	266.2	102.6	992.	76.	916.	10
205	BORON (MG/L)	0.365	.4243E-01	0.206	56.434	0.67	0.08	0.59	6
206	CARBONATE AS CACO3 (MG/L)	61.0	0.	0.0	0.0	61.	61.	0.	1
207	CHLORIDE (MG/L)	22.9	.3636E+03	19.1	83.5	69.	5.	64.	9
208	CYANIDE (MG/L)	0.032	.1897E-02	0.044	137.529	0.12	0.01	0.11	6
209	FLUORIDE (MG/L)	0.113	.6067E-02	0.078	68.725	0.19	0.01	0.18	6
210	NITROGEN, NITRATE (MG/L)	0.270	.6322E-01	0.251	93.126	0.74	0.04	0.70	10
211	NITROGEN, NITRITE (MG/L)	0.0098	.9507E-04	0.0098	99.4920	0.032	0.002	0.030	10
212	NITROGEN, TOTAL ORGANIC (MG/L)	1.27	.7175E+00	0.85	66.87	2.7	0.5	2.2	9
213	PHOSPHORUS, ORTHO (MG/L)	0.0059	.6036E-04	0.0078	131.9305	0.026	0.001	0.025	9
214	PHOSPHORUS, TOTAL (MG/L)	0.2345	.1856E+00	0.4308	183.7478	1.440	0.004	1.436	11
215	SULFATE (MG/L)	837.3	.4150E+06	644.2	76.9	2204.	114.	2090.	10
216	TOTAL DISSOLVED SOLIDS (MG/L)	1831.8	.2443E+07	1562.9	85.3	5612.	280.	5332.	10

APPENDIX D

Comparison of Water Quality Data with the Proposed Colorado Water Quality Standards

Table D-1. Comparison of water quality data for the Mancos project with the proposed Colorado Water Quality Standards.

MANCOS PROJECT

STATION 161 MANCOS RIVER

CODE	CONSTITUENT	STANDARD	SOURCE	NUMBER EXCEEDING	NUMBER OF SAMPLES	PERCENT EXCEEDING
101	ALUMINUM, DISSOLVED (UG/L)	100.000	AB	11	11	100.00
104	BARIUM, TOTAL (UG/L)	1000.000	WS	2	9	22.22
106	CADMIUM, TOTAL (UG/L)	10.000	AG	1	9	11.11
		10.000	WS	1	9	11.11
		0.400	ABL1	0	9	0.00
		1.000	AB12	1	9	11.11
		5.000	AB23	1	9	11.11
		10.000	AB34	0	9	0.00
		15.000	ABG4	0	9	0.00
109	CHROMIUM, TOTAL (UG/L)	100.000	AG	0	3	0.00
		50.000	WS	2	3	66.67
		100.000	AB	0	3	0.00
111	COPPER, TOTAL (UG/L)	200.000	AG	1	10	10.00
		1000.000	WS	0	10	0.00
		10.000	ABL1	0	10	0.00
		10.000	AB12	1	10	10.00
		10.000	AB23	1	10	10.00
		20.000	AB34	0	10	0.00
		40.000	ABG4	4	10	40.00
113	IRON, DISSOLVED (UG/L)	300.000	WS	0	9	0.00
114	IRON, TOTAL (UG/L)	1000.000	AB	5	11	45.45
116	LEAD, TOTAL (UG/L)	100.000	AG	1	6	16.67
		50.000	WS	1	6	16.67
		4.000	ABL1	0	6	0.00
		25.000	AB12	1	6	16.67
		50.000	AB23	0	6	0.00
		100.000	AB34	0	6	0.00
		150.000	ABG4	0	6	0.00
117	MAGNESIUM (MG/L)	125.000	WS	3	10	30.00
118	MANGANESE, DISSOLVED (UG/L)	50.000	WS	5	11	45.45
119	MANGANESE, TOTAL (UG/L)	200.000	AG	4	11	36.36
		1000.000	AB	1	11	9.09
121	MERCURY, TOTAL (UG/L)	2.000	WS	1	9	11.11
		0.050	AB	9	9	100.00
125	NICKEL, TOTAL (UG/L)	200.000	AG	1	10	10.00
		50.000	ABL1	0	10	0.00
		100.000	AB12	1	10	10.00
		200.000	AB23	0	10	0.00
		300.000	AB34	0	10	0.00
		400.000	ABG4	1	10	10.00
128	SELENIUM, TOTAL (UG/L)	20.000	AG	0	4	0.00
		10.000	WS	1	4	25.00
		50.000	AB	0	4	0.00
130	SILVER, TOTAL (UG/L)	50.000	WS	0	4	0.00
		0.100	ABL1	0	4	0.00
		0.100	AB12	1	4	25.00
		0.150	AB23	0	4	0.00
		0.200	AB34	0	4	0.00
		0.250	ABG4	2	4	50.00
133	ZINC, TOTAL (UG/L)	2000.000	AG	0	11	0.00
		5000.000	WS	0	11	0.00
		50.000	ABL1	0	11	0.00
		50.000	AB12	1	11	9.09
		100.000	AB23	1	11	9.09
		300.000	AB34	0	11	0.00
		600.000	ABG4	2	11	18.18
202	ARSENIC, DISSOLVED (UG/L)	100.000	AG	0	0	0.00
		50.000	WS	0	0	0.00
		50.000	AB	0	0	0.00
205	BORON (MG/L)	750.000	AG	0	6	0.00
207	CHLORIDE (MG/L)	250.000	WS	0	9	0.00
208	CYANIDE (MG/L)	0.200	AG	0	6	0.00
		0.200	WS	0	6	0.00
		0.005	AB	6	6	100.00
209	FLUORIDE (MG/L)	2.400	WS	0	6	0.00
210	NITROGEN, NITRATE (MG/L)	100.000	AG	0	10	0.00
		10.000	WS	0	10	0.00
211	NITROGEN, NITRITE (MG/L)	10.000	AG	0	10	0.00
		1.000	WS	0	10	0.00
		0.050	ABC	0	10	0.00
		0.500	ABW	0	10	0.00
215	SULFATE (MG/L)	250.000	WS	8	10	80.00

SOURCE CODES: AB = AQUATIC BIOTA
ABC = AQUATIC BIOTA (COLD)
ABW = AQUATIC BIOTA (WARM)
ABL1 = AQUATIC BIOTA (TOTAL HARDNESS) LESS THAN 100)
AB12 = AQUATIC BIOTA (TOTAL HARDNESS) 100-200)
AB23 = AQUATIC BIOTA (TOTAL HARDNESS) 200-300)
AB34 = AQUATIC BIOTA (TOTAL HARDNESS) 300-400)
ABG4 = AQUATIC BIOTA (TOTAL HARDNESS) GREATER THAN 400)
AG = AGRICULTURE
WS = CLASS 2 RAW WATER SUPPLY

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