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CHERRY CREEK BASIN WATER QUALITY AUTHORITY
1988 ANNUAL REPORT SUMMARY

Prepared for the
Water Quality Control Commission
Colorado Department of Health
Denver, Colorado

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On Behalf of:

Cherry Creek Basin Water Quality Authority
Englewood, Colorado

Project No. 4460-4405

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CHERRY CREEK BASIN WATER QUALITY AUTHORITY
ORGANIZATIONAL RESPONSIBILITIES-MONITORING PROGRAM

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I. BACKGROUND AND LEGISLATION

The Clean Lakes Study of Cherry Creek Reservoir, published by the Denver Regional Council of Governments (DRCOG, 1984), conducted in 1982 identified eutrophication of the Reservoir as negatively impacting the beneficial uses of the Reservoir. The Clean Lakes Study identified phosphorus as the major nutrient causing algal productivity and eutrophication. Based on the Clean Lakes Study, the Colorado Water Quality Control Commission (CWQCC) established an in-reservoir total phosphorus standard of 0.035 mg/L to maintain the chlorophyll-a levels in Cherry Creek Reservoir at concentrations averaging no higher than 15 µg/L (0.015 mg/L) as acceptable average values for the "growing season" (that is, applicable only during the months of July through September).

During 1985, the local governments (cities and counties and special districts), private interests, and representatives of the State and Federal Government developed a strategy to meet the applicable growing-season phosphorus and chlorophyll-a standards in Cherry Creek Reservoir. The control strategy was outlined in the Cherry Creek Basin Water Quality Management Master Plan (DRCOG, 1985a; 1985b).

The Cherry Creek Basin Master Plan was approved by the Colorado Water Quality Control Commission in 1985. Parts of the plan were adopted as the "Regulations for Control of Water Quality in Cherry Creek Reservoir" (Section 4.2.0, 5C.C.R.3.8.11) on November 6, 1985, and became effective on December 30, 1985. The Master Plan was approved by the USEPA Region VIII office as the 208 Management plan for the Cherry Creek basin.

In 1985, an inter-governmental agreement was executed by the local governments within the Cherry Creek basin to form the Cherry Creek Basin Authority (Authority). The Authority was created for the purpose of

coordinating the approach and implementing the tasks to protect and preserve the water-quality of waters of Cherry Creek basin while allowing economic development to occur.

In addition, this inter-governmental agreement committed each governmental entity to provide $15,000 for the initial year 1986. Subsequent actions have committed each governmental entity to provide $15,000 for each successive year (calendar years 1987 and 1988) to insure the continual operation of the Authority. For calendar year 1988, each local government (cities, counties and special districts) contributed $15,000 and the 1988 budget was as follows:

Program Component	Amount
Legislative	$22,000
Finance/Administration/Contingency	113,000
Technical Review	2,000
Best Management Practices	
a. General	5,500
b. Tri-County (On-Site Disposal Study)	25,000
Monitoring	
a. In-Situ, Inc. (Ponds, Streams and Reservoir)	110,000
b. CSU (Meridian/Inverness Study)	6,000
c. CDM/Riverside (In-Lake Study)	60,000
Total 1988 Budget	$343,500

During the summer and fall of 1987, the authority participated in hearings of the State of Colorado Legislature's Water and Water Quality Interim Subcommittee, at their request. Following discussions and hearings, the intergovernmental agreement identified the need for the Authority to have legislation enacted that would grant the Authority additional powers. The Subcommittee agreed to sponsor the Cherry Creek Basin Authority Legislation for the 1988 General Assembly (HB-1029). The Cherry Creek Basin Authority's proposed Legislation was introduced during the 1988 session of the Colorado legislature.

The Authority worked closely with sponsors, legislators and special interest groups throughout the 1988 session in order to obtain favorable votes from several legislative committees and, ultimately, the House and Senate. The Legislation created the Cherry Creek Basin Water Quality

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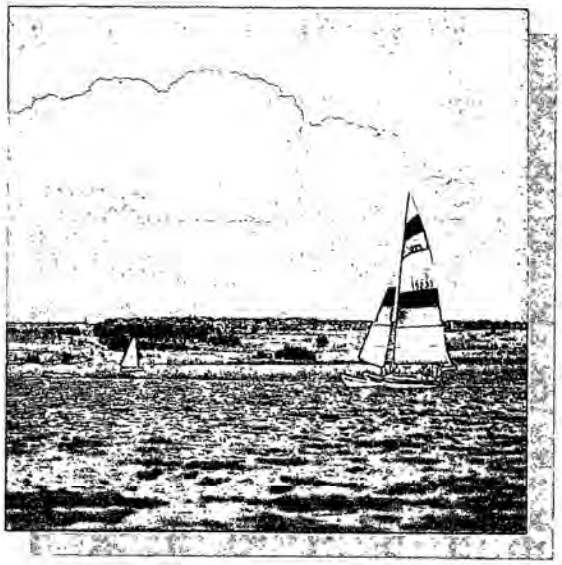
ıe Master Plan during the 1988

HELPING YOU ENJOY CHERRY CREEK



Your purchase of a 1989 Cherry Creek Basin decal will help in the effort to control algae growth in Cherry Creek Reservoir.

It may take years but actions are being taken to slow the aging and decay of the Reservoir so that you can enjoy it longer.

That's why the money from the decal program is necessary—so scientists and engineers can come up with effective ways to restore Cherry Creek Reservoir.

Cherry Creek is a valuable asset to the Denver metro area, with more than 1 million visitors each year who enjoy swimming, boating, sailing, fishing and passive recreation.

reporting period. In addition, a requirement of the "Regulations for Control of Water Quality in Cherry Creek Reservoir" (Section 4.2.8, 5C.C.R.3.8.11) is an annual report on the status of the Cherry Creek Basin Master Plan. This 1988 Annual Report Summary is completed to fulfill this requirement. All the collected monitoring data and more technical analyses are contained in the full technical supplement to this report summary. This latter report can be obtained upon request (In-Situ, Inc., 1988).

III. SUMMARY OF PROGRESS

Substantial progress has been made during the 1988 water year (October 1, 1987 through September 30, 1988) towards protecting the surface-water quality of the Cherry Creek basin. Progress since 1988 has been provided in previous annual reports to the CWQCC by Richard P. Arber and Associates, Inc. (1986) and by In-Situ, Inc. (1987b).

The following items are provided as a summary of progress and of issues that have occurred during the past annual period (the 1988 water year):

A. 1988 Monitoring Program

In order to complement recent historical data for assessing nutrient-related impacts on the biological quality of Cherry Creek Reservoir, the Authority approved a continuing multifaceted monitoring program to be conducted during calendar year 1988 (In-Situ, Inc., 1986, as amended). The overall program included the following general monitoring components:

(1) Phosphorus removal rates in wet and/or dry drainage-detention ponds,

(2) Phosphorus-loading rates contributed by small basins from various land uses,

(3) Reservoir inflows and outflows and their associated water-quality characteristics (storm events and ambient conditions),

(4) In-reservoir phosphorus, nitrogen, and biota,

(5) Reservoir bottom-sediment/water interactions influence on selected water-quality variables, and

(6) Phosphorus contributions to the reservoir from precipitation.

Both ambient and storm-event samples were collected within the monitoring program. Where applicable, these data are compared with historical data to develop data trends. A sample-inventory summary for the 1988 water-year data is given in Table S-1, and the various sites are described in Table S-2 and are located on Plate 1.

During the 1988 water-year period, 20 storm events occurred in the Cherry Creek basin based upon precipitation data collected either at the USACOE rain gage located at the Cherry Creek Dam or at the non-recording rain gage located at the Inverness Business Park. Of these storms, 15 were sampled at one or more of the pond or reservoir-inflow sites. The 5 storms which were not sampled were either storms with low wintertime snowmelt runoff or very localized summer thunderstorms. Four runoff events (generally during warming periods in the wintertime) were sampled although only minimal amounts of precipitation were recorded. The largest precipitation event, a 4-day storm of between 3 and 4 inches was recorded in mid-May 1988 (In-Situ,Inc., 1988, Appendix F). The next largest storm events occurred during June 26-27, August 4, August 17-18, and September 12-13, 1988. The numbers of storm-related samples reflect the higher-than-normal annual precipitation occurring during the 1988 water-year period (23.3 inches), compared to a normal annual average (1951-80 period) estimated at 14.3 inches. However, only a single, relatively small storm occurred during July 1988, and the total precipitation during this month was below normal.

1. Small-Basin/Detention-Pond Monitoring

During 1987 and 1988, the Authority monitored two ponds, located in the Inverness Office Park area and the Clarke Farms residential development near Parker. The pond-inflow sites concurrently serve as small-basin drainage monitoring for differing land uses and results are reported in the Annual Report (In-Situ, Inc. 1988). Specifically, Inverness pond inflow site I-1 concurrently serves to

TABLE S-1

CHERRY CREEK MONITORING-PROGRAM SAMPLING INVENTORY SUMMARY
1988 Water Year

Small-Basin/Detention-Pond Sites:

Site[2]	Description	Number of Samples: Ambient	Storm-Event	Total
C-1	Pond inflow, residential	1	15	16
C-2	Pond inflow, residential	-	12	12
C-3	Pond outflow	3	22/1[1]	25
I-1	Pond inflow, commercial	2	15	17
I-2	Pond inflow, undeveloped	-	9	9
I-3	Pond outflow	2	15	17
	Totals	8	88/1	96

Reservoir Inflow/Outflow and Composite-Precipitation Sites:

Site[2]	Description	Number of Samples: Ambient	Storm-Event	Total
CC	Cherry Creek inflow	6	11	17
SP	Shop Creek	5	20	25
QA	Quincy Avenue	6	15	21
CT	Cottonwood Creek	6	14	20
CO	Cherry Creek outflow	-	8	8
PC	Composite precipitation	-	17	17
	Totals	23	85	108

In-Reservoir Sites:

Site[2]	Description	Number of Surveys	Number of Samples
SB	Swim beach area	16	32/1[1]
MR	Main reservoir	16	32
IF	Cherry Creek inflow area	15	30/1[1]
	Totals	47	94/2

Benthic Respirometer:

	Number of Water Samples	Number of Sediment Samples
First Test (5/16-17), Sites IF and SB	34[3]/26/2[1]	7
Second Test (8/24-25), Sites IF and SB	32[3]/18	8
Totals	66/44/2	15

1) Sample split or duplicate.
2) See Plate 1 for sampling locations and Table S-2 for site descriptions.
3) Field analyses only (total of 66); 44 of those were associated with samples sent for laboratory analyses.

TABLE S-2

CHERRY CREEK BASIN AND RESERVOIR
MONITORING SITES

ISI Code[1]	Station/Site Number[4]	Site Description
I-1	06712940	Cottonwood Creek at Inverness above Pond
I-2	06712945	Undeveloped Watershed at Inverness above Pond
I-3	06712950	Cottonwood Creek at Inverness below Pond
C-1	06712270	Main Tributary Inflow, Clarke Farms Pond #3
C-2	06712275	Side Tributary Inflow, Clarke Farms Pond #3
C-3	06712280	Outflow, Clarke Farms Pond #3
CC	06712500	Cherry Creek near Melvin
SP	06712855	Cherry Creek Trib. #1 (Shop Creek) near Aurora
QA	06712860	Quincy Avenue Storm Drain near Aurora
CT	06712960	Cottonwood Creek near Cherry Creek Lake
CO	06713000	Cherry Creek below Cherry Creek Lake
PC	(3 sites):	Cherry Creek Basin Precipitation Composite:
(CR)	393926104502400	Cherry Creek Reservoir Site (USACOE)
(QR)	393802104494900	Quincy Avenue Site (QA)
(TR)	393729104505600	Cottonwood Creek Site (CT)
IR[3]	393410104512900	Inverness Nonrecording Precipitation Gage
SB[2]	393848104505601	Cherry Creek Reservoir near Swim Beach
MR[2]	393846104513201	Cherry Creek Reservoir near Dam
IF[2]	393815104503501	Cherry Creek Reservoir near Inflow

1) See location map (Plate 1).
2) Vertical-profile designations: xx-1 = mid-euphotic zone; xx-2 = near bottom.
3) A recording precipitation gage at the Stonegate Center Wastewater Treatment Plant was returned to its manufacturer during 1988 due to poor field performance.
4) Either 8-digit USGS downstream station number or 15-digit latitude-longitude number.

monitor a drainage characterized by undeveloped and commercial development; whereas, pond-inflow site I-2 monitors a relatively undeveloped area. The Inverness pond is a "wet" pond and serves as a water hazard for the Inverness golf course. This pond (Inverness Pond No. 4) is located on Cottonwood Creek and has a weir spillway downstream. Major inflows and outflows of the pond are monitored. Of the approximately 4.2 square miles (mi^2) of drainage area at the discharge end of the pond, approximately 4.1 mi^2 are monitored at 2 inflow locations. This pond has been monitored since late April 1987.

The second pond is located at Clarke Farms residential subdivision, and the monitoring sites consist of 2 inflow points and 1 outflow point. Land uses associated with the small-basin inflows to this detention pond (designated a Clarke Farms Pond No. 3) consist of largely undeveloped (site C-1) and residential (site C-2) areas. Clarke Farms Pond No. 3 is generally an "extended dry" pond, in that a water-quality standpipe permits water levels in the pond to drop between storm events and allows the pond to drain. An area of approximately 0.46 mi^2 is drained by Clarke Farms Pond No. 3. This pond has been monitored since mid-October 1987.

Based upon the analysis of data collected to date at the 2 ponds monitored in this program, it is concluded that a "wet" pond similar to Inverness Pond No. 4, would remove approximately 20 percent of the total phosphorus entering the pond on an annual basis. Removal efficiencies of total phosphorus from runoff generated by individual major storm events may be as much as 35 percent but would probably average slightly over 20 percent. During low-flow conditions, it appears that Inverness Pond No. 4 may actually increase phosphorus loadings to Cottonwood Creek downstream over those contributed upstream, probably due to resuspension of settled sediment or re-solution of phosphorus from pond sediments. This release of phosphorus by the pond is relatively small compared to its annual phosphorus removal from inflows.

Analyses of data at Clarke Farms Pond No. 3 for the period October 1987 through September 1988 indicated average total phosphorus removal over the 12-month period to be about 72 percent under the leaky pond case and about 39 percent for the non-leaky case (In-Situ, Inc., 1988). Storm total phosphorus removal rates for the same period ranged from 45 to 85 percent for the leaky case. If the water-quality stand pipe was assumed representative of 100 percent of the outflow (non-leaky case), then the storm total phosphorus removal rates was estimated to average about 50 percent.

2. Colorado State University (CSU) Monitoring Study

During 1987 and 1988, the Authority shared costs with Inverness and Meridian on a CSU water-quality monitoring program on the Inverness and Meridian Office Parks. Initial study results for 1987 were given in Sanders and Showalter (1987). Preliminary study conclusions based upon data collected by CSU between 1987 and June 1988 are as follows:

- The variability of the water-quality data at the different sampling sites is high. Hence, at very low loadings during typical base flow conditions, it is very difficult to determine differences in base flow loadings at different points. Even if base flow loadings could be better determined, the overall effects of the base flows are minor when compared to storm events.

- The total annual phosphorus load from Inverness during base flows is approximately 23 lbs and from Meridian is 9 lbs. This is not significantly greater than base-flow loadings from the undeveloped site between Inverness and Meridian.

- Construction activities contribute large amounts of phosphorus during storm events even with erosion control measures in place. Construction activity along a stream channel contributes

relatively large amounts of phosphorus to the stream even during base flows.

- Based upon CSU data, rainfall contributes an estimated 405 lbs of phosphorus to Inverness and Meridian each year. CSU estimates that 140 lbs of phosphorus per year are contributed by automobile emissions on I-25 adjacent to the two business parks.

3. Reservoir Inflow/Outflow Monitoring

Inflows of the major tributaries into Cherry Creek Reservoir and outflows from the Reservoir have been monitored at the following 4 reservoir-inflow and 1 reservoir-outflow sites (Plate S-1 and Table S-2):

- Cherry Creek near Melvin,
- Shop Creek (also referred to as "Cherry Creek Tributary #1"),
- Quincy Avenue Storm Drain,
- Cottonwood Creek, and
- Cherry Creek below Cherry Creek Lake.

These 5 inflow/outflow monitoring sites were included in a previous monitoring program conducted by the U.S. Geological Survey (USGS) for the 1982-through-1986 calendar years (In-Situ, Inc. 1987a). Recent reservoir inflow/outflow data collected from April through September 1987 were discussed in In-Situ, Inc. (1987b). A total of 83 tributary inflow samples and 8 reservoir-outflow samples were collected during the 1988 water year (Table S-1).

Daily discharges for Shop Creek, Cottonwood Creek, the Quincy Avenue storm drain and Cherry Creek have been tabulated by monitoring site for the 1988 water year. The sum of measured reservoir inflows for these 4 tributaries totaled about 8,960 ac-ft for the 1988 water year. Reservoir outflow for this same period measured by the Corps

of Engineers totaled nearly 16,500 ac-ft and measured by the U.S. Geological Survey (USGS) totaled about 17,500 ac-ft (In-Situ, Inc., 1988, Appendix L). This difference between the summation of tributary inflows and reservoir outflow has yet to be resolved, but is probably the result of the poor measurements in Cherry Creek (site CC) because of the shifting sand channel. Communication with the USGS related to the station indicates that historically the gaging of flows at this station has been difficult. The general policy of the USGS is to not adjust measured discharges or balance inflows and outflows at Cherry Creek Reservoir. This report also follows that policy. The aggregated 1988 water-year nutrient loadings to Cherry Creek Reservoir for the four inflow sites totaled an estimated 9,520 lbs of phosphorus and 72,200 lbs of nitrogen. Outflow nutrient loadings for 1988 water year were an estimated 4,340 lbs of total phosphorus and over 43,200 lbs of total nitrogen. This means that an estimated one-half of the inflow loadings of total phosphorus and total nitrogen during the 1988 water year have been retained in the reservoir and may be available as an internal nutrient-loading source in the future.

Precipitation (wet fallout and dry fallout) on Cherry Creek Reservoir also contributes phosphorus from the atmosphere. Three bulk samplers collect both wet and dry fall-out from the atmosphere. The phosphorus concentrations and total precipitation values measured by these collectors, and data statistics are based upon the 17 precipitation samples. During the 1988 water-year period, an estimated 23.3 inches of precipitation fell directly on the reservoir. The average total phosphorus concentration of this precipitation was 0.42 mg/L. The resultant loading to the reservoir surface area of 850 ac for the period was an estimated 1880 lbs of total phosphorus.

4. In-Reservoir Monitoring

To aid in assessing areal patterns as well as time-related changes in water-quality and biological conditions in Cherry Creek

Reservoir, three in-reservoir locations have been sampled -- one site each in the main body, the swim beach, and the Cherry Creek inflow arm areas (Plate 1) during the 1988 water-year period. In-reservoir sampling surveys are conducted by boat during open-water conditions or by augering through the ice during the winter period. At each site, two sets of water-quality samples are collected for each survey; one set is obtained from the middle of the euphotic zone (the depth of which is estimated using a secchi disk) and a second set is obtained near the reservoir bottom.

Total phosphorus concentrations for the 1988 water year in the reservoir at all depths and all locations averaged about 0.063 mg/L. Chlorophyll-a values during this annual period averaged about 23 µg/L. The relatively high average chlorophyll-a value for the 1988 water year was due primarily to high growing season chlorophyll-a values in July and August 1988 (48.8 and 32.3 µg/L, respectively), based upon two surveys for each month at 3 sampling sites.

Changes in chlorophyll-a values vary seasonally as well as annually. Environmental factors which contribute to these variations include daylight-length, solar radiation with absorption and scattering, temperature, thermal structure and nutrient availability. Although responses of phytoplankton populations to such factors are generally well recognized, their interaction often discourages a clear-cut cause-and-effect rationale (Reynolds, 1984; Wetzel, 1983). Chlorophyll-a values commonly reach their peak when physical conditions (i.e. nutrients, water temperature and light) are most favorable towards promoting algal growth in a given reservoir.

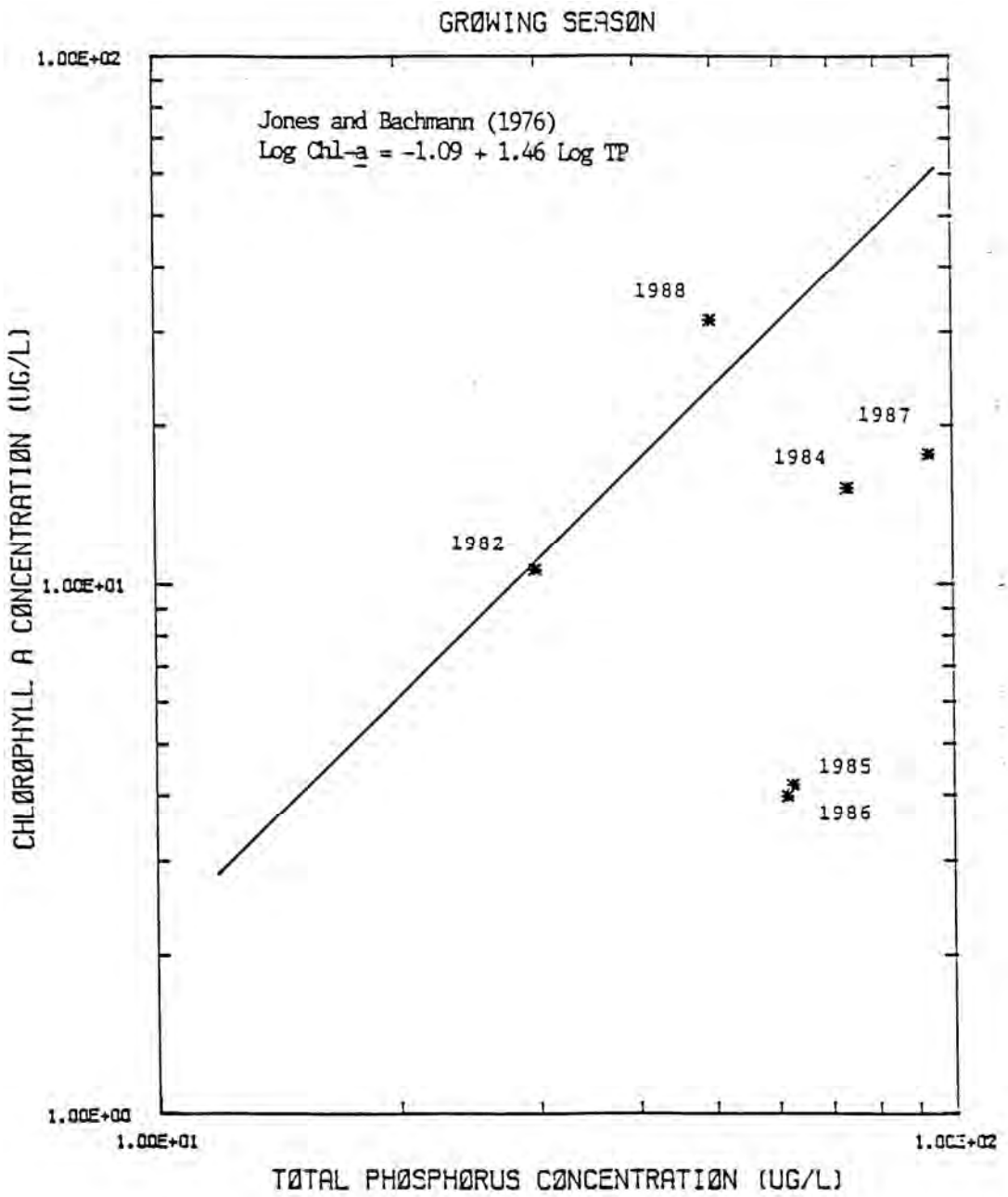
Fluctuations in numbers of individual phytoplankton species are generally due to available physical conditions and each species' particular niche or dominance in the phytoplankton community. Peaks of various species often correspond with replacement of one assemblage by the next (Reynolds, 1984).

Overall, fluctuations in biomass (chlorophyll-a) values will reflect the availability/favorability of nutrient levels and other physical factors in the reservoir. A lag time for nutrient uptake and consequent blooms is generally seen in phytoplankton populations. Over time, chlorophyll a can be used as an indicator for variations in nutrient species. Figure S-1 shows how the average 1988 growing-season (July-through-September) total phosphorus and chlorophyll-a values compared to previous years in the Cherry Creek Reservoir. For the first time since 1982, the growing-season values of total phosphorus and chlorophyll a during the 1988 water year plotted higher than these values predicted by the Jones-Bachmann (1976) relationship (Figure S-1).

Two benthic respirometer studies were conducted at the in-reservoir swim-beach (SB) and inflow (IF) sites (Plate 1). A benthic respirometer is used to measure over time the chemical fluxes between (to or from) the underlying sediments and the water. The purpose is to estimate the flux of nutrients between the reservoir water and the bottom sediments. These two studies were performed on May 16-17 and August 24-25, 1988. Average loading of total phosphorus and total nitrogen to the reservoir water from the sediments was 87 lbs/day and 1370 lb/day, respectively. Although total phosphorus loads from the sediments are significant compared to precipitation (5.2 lb/day) and tributary inflows (26 lb/day) and may account for the large algae blooms during times when relatively low tributary inflows occur, these loads from the sedimets should be used with caution when comparing daily estimates from inflows to 2 survey values from the benthic respirometer.

The following summarizes the findings and conclusions drawn from the monitoring data collected for the 1988 water-year period:

(1) Both "wet" and "extended dry" drainage/water-quality ponds reduce total phosphorus loads during storm events, but the "wet" pond may not substantially reduce total phosphorus downstream over the long



Jul-Sep Values of Chlorophyll-a vs. Total Phosphorus, Cherry Creek Reservoir	
Project No. 4460-4405	Fig. S-1

term. That is, phosphorus deposited in the wet-pond bottom during storm events is released back to the stream thereby increasing its load during low flows. Results from wet-pond monitoring indicate that this type of pond may remove between 20 and 35 percent of total phosphorus during relatively large storm events. However, phosphorus removal by the Inverness wet pond averaged 20 percent over 1988 water-year period. In comparison, results from an extended dry pond at Clarke Farms, assuming that 80 percent of the outflow seeped through the bottom of the pond, indicate that average total phosphorus removal rates may exceed 70 percent.

(2) Small-basin (that is, drainage areas generally less than several square miles) contributions of total phosphorus and total nitrogen loads in the Cherry Creek basin appear to be typical of similar small basins reported in the scientific literature for other parts of the U.S.

(3) The average in-reservoir total phosphorus concentration during the 1988 growing-season (July-through-September) period was 0.050 mg/L, which is higher than the standard of 0.035 mg/L. The average chlorophyll-a concentration during the same period was nearly 32 µg/L, which is about twice the growing-season goal of 15 µg/L. These average values were lower and higher, respectively (0.095 mg/L total phosphorus and 8.3 µg/L chlorophyll-a) than comparable values for the previously monitored (1987) growing-season period. Analysis of water-quality and biological data from Cherry Creek Reservoir since 1982 continues to indicate that the originally-applied Jones-Bachmann relationship between total phosphorus concentrations and chlorophyll-a values generally overpredicts chlorophyll-a values for given levels of total phosphorus. The 1988 year to date, as with the three previous years, has been characterized by greater-than-normal ("normal" considered by the National Weather Service to be the 1961-through 1980 period for climatological data) precipitation and more resultant runoff than for the 1982 base year, on which the standards were based. The

above-normal runoff has resulted in greater-than-average reservoir releases. Preliminary results, therefore, indicate that reservoir flow releases may reduce the build-up of algae and hence improve reservoir quality. On the other hand, the month of July 1988 exhibited below-normal precipitation, which may well have affected the relative high chlorophyll-a values in July and early August. Also, because eutrophication is related to algae production, and chlorophyll-a is directly correlated with algae growth, a critical evaluation of the total-phosphorus/chlorophyll-a relationship appears appropriate.

(4) Annual loads of total phosphorus and total nitrogen to Cherry Creek Reservoir from bulk precipitation and inflows during the 1988 water year can be estimated with some reliability, based upon the monitoring of major tributaries. The preliminary nature of results of the benthic-respirometer studies makes conclusions on loads from the reservoir bottom sediments tentative. However, these bottom sediments may contribute relatively significant amounts to the annual total phosphorus and total nitrogen loadings, with inflows and bulk precipitation contributing relatively smaller amounts. Ground water also may contribute some total phosphorus and total nitrogen to Cherry Creek Reservoir, but this component has not been included in the ongoing monitoring program. This indicates that, even with stringent in-basin controls on phosphorus, in-reservoir sources of phosphorus also may need to be addressed if the eutrophication process is to be slowed.

(5) The percent of dissolved phosphorus versus total phosphorus continues to appear to be increasing over time (In-Situ, Inc., 1987b). Recent data indicate a higher percentage of total phosphorus is in dissolved form, even though total-phosphorus concentrations appear to be decreasing at several monitoring sites. Ponds designed to remove suspended phosphorus may not be effective in decreasing dissolved-phosphorus concentrations.

B. Shop Creek Project

A major drainage/water-quality control project for Shop Creek is being constructed by the Authority and the City of Aurora. An intergovernmental agreement has been approved and signed by the Authority and Aurora to share the costs of the Shop Creek project (Appendix B). The Authority has agreed to pay for the allocated water-quality costs, totaling about $464,000, and Aurora will pay for the drainage improvements at approximately $585,000. This is the first major basin project, as outlined in the Master Plan, to be constructed. The Authority considers it to be a prototype project. Water quality will be improved by controlling in-channel erosion and settling out urban-related stormwater sediments in the detention pond. The Shop Creek project has a detention pond, followed by rapid infiltration via a sand filter. After filtration, the water will flow into a wetlands area. The wetlands are being constructed to provide additional phosphorus removal. Construction of the designed project began on October 10, 1988. This project has a goal of removing a minimum of 50 percent of the phosphorus loading transported by Shop Creek, in order to improve the quality of Cherry Creek Reservoir.

The project specifically is as follows: The project involves improvements to a 3000-foot long reach of Shop Creek between Parker Road and the Perimeter Road around Cherry Creek Reservoir. The project is planned to meet two specific objectives. The development of the alternative described in the report by Muller Engineering and others (1987) has required that four key design issues be evaluated and considered -- hydraulics, water quality, aesthetics, and a budget of approximately $1 million. The project includes a detention pond containing a permanent pool with a volume of 4 ac-ft and a storm-flow detention volume of 8 ac-ft. The detention-pond dam is designed to be constructed of a natural-appearing soil-cement mixture and will detain and then slowly release storm-runoff downstream into Shop Creek and eventually Cherry Creek Reservoir. This flow-detention process will allow for the settling out of sediments. Total phosphorus will be removed from the permanent pool, fed by base flows, and from the stormflow pool.

The stream channel between the pond and the Perimeter Road (downstream) will be stabilized by the construction of five drop structures constructed according to the design with a soil-cement mix patterned in an aesthetic oval shape. The channel between each set of structures will be relatively flat-sloped, promoting slow-moving, braided stream patterns which will be planted with suitable vegetative species to develop wetland habitats. The channel then will achieve a stable flow regime and the wetlands will remove additional phosphorus.

Erosion-protection drop structures will be constructed of a soil-cement mix at the outlet of the culvert under Parker Road and on the downstream edge of the Perimeter Road. The project is estimated to cost nearly $1.049 million, which includes acquisition of 4.25 acres of land for the detention pond.

C. Best Management Practices and Nonpoint-Source Pollution

The primary methods established to date for the control of nonpoint-source pollution, (i.e., phosphorus in storm runoff) are best management practices (BMPs) associated with erosion control in newly developing areas and along stream channels. Several land-use entities in the Cherry Creek basin (including the Towns of Castle Rock and Parker, the City of Aurora, Greenwood Village, and Arapahoe County) have all enacted BMP ordinances that require hay bales, rock drains, and other facilities to minimize sediment-laden flows from discharging to major drainageways. Hence, all development within these land-use entities have included these types of erosion-control measures. Douglas County, the other major land-use entity in the basin, has drafted its model ordinance which will come before the Board of County Commissioners in early 1989. This practice of erosion control, which is readily addressed, is judged to provide the most significant impact to control phosphorus loadings into the Cherry Creek Reservoir that the Authority can provide.

An update of the best management practices (BMPs) for the entities located in the Cherry Creek basin is given in Table S-3. All of the entities which

TABLE S-3

SUMMARY OF BEST MANAGEMENT PRACTICES (BMP) FOR THE CHERRY CREEK BASIN WATER QUALITY AUTHORITY

Entity	Status	Contact Individual	Contact Phone
Arapahoe County	Kiowa Engineers was retained by the County to revise procedures for preparing Erosion Control Plan in accordance with goals of the model ordinance. The study has been completed and the report was revised most recently on April 8, 1988.		
	Arapahoe County has had a regulation requirement for grading operations to have an approved erosion and sediment-control plan as a precondition of obtaining a grading permit (see In-Situ, Inc., 1988, Appendix P). This was adopted in September 1985.	Dave Peterson	795-4640
Aurora, City of	The City of Aurora's Best Management Practices ordinance was adopted in June 1987. An accompanying design manual is in draft form and was printed and distributed in December 1987. Ordinance provisions are being enforced for all new developments.	Darryl Hogan	695-7380
Castle Rock, Town of	The Best Management Practices for the Town of Castle Rock were adopted in March 1987. The revised BMPs have been changed to refer to the Cherry Creek basin only.	Dave Elliott	688-8795
Douglas County	A Model Ordinance has been drafted by Jerry Fifield on behalf of the Douglas County Engineering Department and Douglas County Planning Department. Also, an Addendum to the Storm Drainage Design and Technical Criteria manual is in the process of being distributed.	Julio G. Iturreria Planning Department Fred Koch Engineering Department	660-7460 660-7490

TABLE S-3
(Continued)

SUMMARY OF BEST MANAGEMENT PRACTICES (BMP) FOR
THE CHERRY CREEK BASIN WATER QUALITY AUTHORITY

Entity	Status	Contact	
		Individual	Phone
Greenwood, Village of	The Resolution for Best Management Practices in the Cherry Creek basin was adopted September 9, 1986.	Earl Smith	773-0352
Parker, Town of	The Town of Parker's Best Management Practices for the Cherry Creek basin were adopted by resolution in 1984 and were revised in 1986.	Frank Jaeger	841-4627

Source: Updated from In-Situ, Inc. (1987b).

are listed and have their respective model ordinances adopted have submitted a checklist to demonstrate consistency of their regulations with the Cherry Creek basin model ordinance. Table S-4 is a summary of questionnaire data submitted by entities in the basin related to current grading and storm-runoff control projects.

Based upon the responses to this survey questionnaire, a total of 50 grading projects, 49 storm-runoff (erosion-control) projects and 11 detention-pond projects are currently underway or already constructed.

During 1987 and 1988 the Authority has supported a study by the Tri-County Health Department on phosphorus contributions from on-site sewage disposal systems. The Authority funded Phase I of this study in 1987. The first phase provided a preliminary assessment, based on the available technical literature of current and future phosphorus loadings to Cherry Creek Reservoir from septic systems. This assessment was based solely upon existing data relative to basin soils, geology, hydrology and did not include any onsite field investigations or laboratory testing.

The Phase I study concluded that the existing 3200 onsite sewage systems in the Cherry Creek basin were not a significant source of phosphorus, because the soils and geology of the area in conjunction with Tri-County's existing septic regulations were believed to achieve a high level of phosphorus removal. Based upon the available data, it was concluded that the current total phosphorus loading to the reservoir from onsite sewage systems was less than the allocated 450 pounds per year (lbs/yr). The Phase I study also identified BMP's that could minimize phosphorus contributions from onsite systems. Design criteria were included which could improve an onsite system's ability to remove or retain phosphorus on a long-term basis.

On August 8, 1988, Tri-County entered into a contract with the Authority to perform Phase II of the septic study. The septic study will actually measure phosphorus concentrations of new septic systems in the Cherry Creek basin. One septic system has been identified which meets the selection criteria presented in the work plan. The homeowners tentatively have

TABLE S-4

SUMMARY OF OVERLOT GRADING AND
STORM-RUNOFF CONTROL PROJECTS AND PONDS

Reporting Entity	Grading # Projects	Grading Acres	Storm-Runoff Control # Projects	Storm-Runoff Control Acres	Number of Detention Ponds
Arapahoe County	36[6]	334	38[6]	354	0
Arapahoe Water & Sanitation District	4[1]	21.1	4[1]	21.1	1
City of Aurora	--	-0-	--	-0-	0
Town of Castle Rock	2[8]	267	2[8]	267	0
Douglas County	3[7]	63	1[7]	55	0
City of Greenwood Village	3[9]	13	2[9]	12	2
Inverness Water & Sanitation District	--	55	--	--	1[2]
Meridian Metropolitan District	--	-0-	--	-0-	3[3]
Town of Parker	2[5]	200	2[5]	200	3[4]
Stonegate Center Metropolitan Dist.	--	-0-	--	-0-	1
TOTALS	50	953	49	909	11

1) Southeast corner of Arapaho Road and Havana Avenue (4.0 ac), Jordan Park Office/Warehouse (3.02 ac), Big O Tire Distribution Center (8.12 ac), and Beta West Hanger/Office (6.0 ac).
2) Inverness Pond #4.
3) Meridian Office Park Ponds #3, #11, and #16 (constructed prior to 1987).
4) Clarke Farms, Villages of Parker, and Stroh Ranch.
5) Villages of Parker (25 ac), Stroh Ranch (175 ac).
6) See In-Situ, Inc. (1988, Appendix P) for detailed listing of Arapahoe County grading permits and erosion-control plans. Several of these are not located in the Cherry Creek basin.
7) The Pinery (55 ac), Lundlick/Clark/Winslow Gravel Mining (4 ac), and State Highway 83 improvements (4.5 ac).
8) Founders Village #9 (107 ac); Founders Village #13 (160 ac).
9) Overall at Cherry Creek #3 (9.75 ac); Three Bears Day Care (2.3 ac); single-family home (1 ac).

agreed to allow the monitoring equipment to be installed on their property. Assuming that the homeowner's cooperate, the monitoring equipment should be installed prior to the end the year. The homes would be occupied by the end of the year, at which time sampling could begin.

Until such time as additional information becomes available, the continuing interim recommendation is that DRCOG's average estimated septic-system effluent concentration of 0.058 mg/L to be used as a basis for projecting phosphorus loadings from onsite sewage-disposal systems. Based upon the Phase I results of this study (In-Situ, Inc. 1987b, Appendix M), it is believed that some interim changes are needed on how onsite sewage-disposal systems are regulated in the Cherry Creek basin. However, this need for change is not based upon a belief that the phosphorus allocations are being or soon will be exceeded. Instead, the Phase I study identified several BMPs that appear to minimize phosphorus contributions from onsite systems. It is believed to be in the best interest of the Cherry Creek basin to implement these BMPs prior to reaching the 450 lbs/yr allocation goal for total phosphorus from onsite systems.

In summary, it is not recommended that the additional BMPs identified in the Phase I study (In-Situ, Inc. 1987b, Appendix M) be implemented until a documented need is identified for additional action in the Cherry Creek basin or until further study warrants that a given BMP is worthwhile. This recommendation is made, because the conclusions reached in the Phase I study are professional judgments based principally upon a review of the relevant literature and because the field and laboratory investigations (Phase II) currently planned should provide more definitive site-specific data (In-Situ, Inc., 1988, Appendix O).

D. Evaluation of In-Reservoir Control Options

On behalf of the Authority, the consulting firm of Camp, Dresser and McKee, Inc. (CDM, 1988) in association with Riverside Technology, Inc. recently completed a preliminary study evaluating in-reservoir control options to reduce the total phosphorus and chlorophyll-a concentrations. The

preliminary results of this study indicate that the following reservoir-control options might be appropriate measures:

- Artificial circulation/destratification and hypolimnetic aeration will probably not be effective in Cherry Creek Reservoir. These techniques are applicable in situations where definable strata form within the water column. Cherry Creek Reservoir is particularly susceptible to wind-induced mixing and turbulence from power-boating, and stratification of the reservoir has not been identified as a problem.

- Algae/macrophyte harvesting and introduction of grass carp also probably will not be recommended for Cherry Creek Reservoir. These options would be appropriate in instances where an over-abundance of rooted-algae or aquatic macrophytes exist within the reservoir system. Factors such as wave action, light-limitation, and cold winters, present in this situation, tend to limit these nuisance organisms.

- Physical/chemical treatment of reservoir water to remove phosphorus and to filter algal populations probably will not be effective, because a large amount of the phosphorus is derived from sediments and inflow which would not be treated by this system, and the reproduction time of algal populations is quite short.

- Reservoir flushing/hypolimnetic discharge might be effective but also would require several thousand acre-feet of water during Cherry Creek Reservoir's growing season. Even though the Reservoir inflows may have increased in recent years, significant flushing over the short-term without supplemental flows is unlikely.

- Sediment removal could provide substantial reduction in total phosphorus derived from resuspension of bottom sediments. Draining and refilling the reservoir likely would require several years, however, and floating dredge operation may be difficult, given the

presence of underwater debris and entanglements. Required storage areas for collection and dewatering of removed bottom sediments are significant and would have to be designed to minimize the impact on reservoir-related park and recreation activities.

- Aeration could be useful in maintaining oxygen at depth during late summer and early fall periods and for under-ice conditions. This may be useful in preventing future winter-period fish kills. The aeration piping grids could provide some limited habitat structure for fishes but could present snags to fishermen. They also would be subject to damage and fouling.

- Phosphorus precipitation and inactivation could be effective in removing phosphorus from the water column.

- Biomanipulation may be possible as a means of controlling algal blooms. It would require, however, removal of gizzard shad and the subsequent stocking of adult-size walleyes. The likely result would be a put-and-take fishery for the Reservoir.

- Algicides use should be viewed as treatment of a symptom and not as a cure. The side effects of algicides may include accumulation of copper, destruction of non-target organisms, and dissolved-oxygen depletion. Algicides may be effective on limited occasions during high algae growth and in conjunction with other measures.

- Constructed wetlands, although not an in-reservoir control, could be used to further reduce influent phosphorus loadings. The wetlands also would trap suspended sediment transported by tributary inflows and, therefore, should be designed for sediment removal in addition to periodic harvesting of wetlands biomass.

The most effective strategy for achieving water-quality goals in Cherry Creek Reservoir will probably include both in-basin control measures to reduce phosphorus loading and in-reservoir measures to reduce algal growth.

The goal should be to force a phosphorus limitation - a goal that is complicated not only by influent phosphorus loads but also internal loads that are made readily available by resuspension of bottom sediments. Although light penetration and nitrogen appear to be significant limiting factors, problematic blue-green algae are capable of fixing atmospheric nitrogen and competing at very low light levels.

Realizing that sediment transport and nutrient loadings are problems in any reservoir system, the goal of any water-quality control strategy should be to (1) reduce nutrient and sediment loads using programs that are economical and efficient and (2) realize that treatment to remove nutrients and rejuvenate the reservoir are likely to be necessary in any reservoir system, particularly in a terminal storage reservoir.

This is already the case for Cherry Creek Reservoir. Even if controllable nutrient loadings were completely eliminated in the basin, the Reservoir appears to have sufficient in-reservoir nutrients to feed the eutrophication process, and hence the degradation of the Reservoir, for many years to come. Because the chlorophyll-a standard has been exceeded in this system, the only real solution to water quality enhancement is nutrient inactivation or removal from the Reservoir.

Phosphorus which is internal to the reservoir is contained both within the water column and resuspendible bottom sediments. Periodic flushing may assist in reducing both of these forms. Unfortunately, the hydrologic history of the Reservoir does not hold well for this technique. It may be, however, that continued development in the basin will increase the ambient tributary inflows to a point where periodic discharges from the Reservoir are more frequent.

In summary, forcing a phosphorus limitation should be the long-term goal. The possible control components may not provide a long-term reduction of phosphorus and chlorophyll-a concentrations in the Reservoir but may address the problem of algae growth.

E. Point Sources of Pollution

The Authority is responsible for reviewing all site applications for wastewater works to ensure conformance with the Cherry Creek Basin Master Plan (DRCOG, 1985a; 1985b). The following recent site applications have been approved in the Cherry Creek basin since September 1987:

- Expansion of the Arapahoe Water & Sanitation District's Lone Tree Wastewater Treatment Plant, approved in June 1988 for a 0.8 million gallons per day (MGD) capacity using a variation of activated sludge treatment called SBR (segmental batch reactor).
- Town of Parker, amendment to a new land-application site.
- Denver Southeast Suburban Water & Sanitation District wastewater treatment plant expansion to 1.0 MGD using advanced waste treatment and rapid-infiltration wells.
- Cottonwood Water & Sanitation District plant expansion to 0.5 MGD using extended-aeration activated sludge treatment was approved in October 1987.

These recent site applications are consistent with the Cherry Creek Master Plan (DRCOG, 1985a) and none exceeds the approved wastewater flows or phosphorus allocations given in the Master Plan.

The "Regulations for Control of Water Quality in Cherry Creek Reservoir" established annual phosphorus allocations based upon existing wastewater treatment capacities plus the next planned expansion of facility (Table S-5). At present, most dischargers are required by their NPDES permits to monitor for phosphorus and to meet phosphorus restrictions in their effluent. Many dischargers employ "slow-rate" land application of treated wastewater effluents. In order to monitor phosphorus concentrations from the land-application sites, several dischargers have installed vacuum lysimeters below their land-application areas in order to withdraw leachate samples for phosphorus analyses. Some of these vacuum-lysimeter installations have had difficulty in obtaining enough leachate in a sample to monitor for phosphorus even after storm events, possibly due to slow percolation and small amounts of leachate being applied over large areas.

TABLE S-5

STATUS OF PHOSPHORUS LOADINGS IN THE CHERRY CREEK BASIN
1988 Water Year

Wastewater Facility	Present Wastewater Flow (MGD)[1]	Present Annual Phosphorus Loading (lbs/yr)	Furture Allowed Phosphorus Loading (lbs/yr)[3]
Arapahoe	0.34	66.4	354
Cottonwood	0.16	1.6	213
Denver Southeast	0.43	292	365[2]
Inverness	0.24	0	68
Meridian	0.0073	0.25	114
Parker	0.35	6.2	533
Stonegate	0	0	53
Castle Rock (Mitchell Creek)	0.14	--[4]	128
Castle Rock (Cherry Creek)[5]	0	0	21
Castle Rock (McMurdo Gulch)[5]	0	0	64
Castle Rock (Newlin Gulch)[5]	0	0	86
Rampart Range[5]	0	0	160
Totals	1.43	366	2,159

1) Maximum monthly mean value, based upon data for the period 10/1/87-9/30/88.
2) The present facility at Denver Southeast Suburban Water and Sanitation District may generate up to 365 pounds (lbs) of phosphorus annually. The 365-lb phosphorus allocation is temporary and will be reduced to 213 lbs of phosphorus in 1990 or when Denver Southeast completes construction of a final build-out 1.4 MGD facility, whichever occurs first.
3) Richard P. Arber & Associates (1986)
4) No sampling results reported.
5) Not yet constructed.

Source: Updated from Richard P. Arber & Associates (1986) and In-Situ, Inc. (1987b).

Ideally, the actual phosphorus loading occurring in the basin from point-source dischargers would be calculated using the phosphorus levels detected in the samples obtained from the land-application areas minus background levels. Soils in the basin commonly contain significant amounts of phosphorus, and thus phosphorus may be leached from the soil during watering. Obviously, phosphorus within the soil and groundwater should not be included as part of the sample results reported for an NPDES permit. Estimated phosphorus loadings from the existing treatment facilities were based upon a recent survey by the Authority of each discharger. Table S-5 presents the status of the calculated phosphorus loadings based upon the existing reported flows through each treatment facility. The future allowed phosphorus loadings as established in the Master Plan (DRCOG, 1985a) also are shown in Table S-5 for comparison purposes.

F. Oversight Committee

In late 1987, the Authority established an "Oversight Committee", a panel of technical water-quality experts to provide guidance to the Authority's monitoring and data-analysis programs. Under the chairmanship of Mr. Patrick F. Mulhern of Beardsley-Miller, the Committee currently consists of Dr. Robert C. Averett of the U.S. Geological Survey, Mr. John Anderson of the U.S. Army Corps of Engineers, Mr. R. Dennis Anderson of the Colorado Department of Health, and Mr. Ben Urbonas of the Urban Drainage and Flood Control District. The Committee has been advising the Authority on aspects of monitoring, technical procedures, reservoir modeling and data interpretation. The Authority is grateful that each of these individuals has agreed to provide his time and expertise.

CREDITS

Preparation of the Cherry Creek Basin Water Quality Authority's 1988 Annual Report Summary to the State of Colorado's Water Quality Control Commission was under the general supervision of Dr. Timothy D. Steele, Water Resources Manager and Associate of In-Situ, Inc. The report summary was written by Drs. Steele and James R. Kunkel, with assistance from Ms. Sue Z. Wemmert

APPENDIX A

Cherry Creek Basin Water Quality Authority Legislation

(9) "Special district" means any district created pursuant to article 1 of title 32, C.R.S., which has the power to provide sanitation services or water and sanitation services and has wastewater treatment facilities within the boundaries of the authority.

(10) "Wastewater treatment facility" means a facility providing wastewater treatment services which has a designed capacity to receive sewage for treating, neutralizing, stabilizing, and reducing pollutants contained therein prior to the disposal or discharge of the treated sewage. "Wastewater treatment facility" does not include any pretreatment facilities, lift stations, interceptor lines, or other transmission facilities to transmit sewage effluent outside the boundaries of the authority.

25-8.5-103. Creation and organization. The Cherry Creek basin water quality authority is hereby created. The authority shall be a quasi-municipal corporation and political subdivision of the state, with the powers provided in this article.

25-8.5-104. Boundaries of the authority. (1) The boundaries of the authority shall be determined by the authority, subject to the following:

(a) The boundaries shall be limited to the drainage basin of Cherry Creek from its headwaters to the dam at Cherry Creek reservoir, which the general assembly hereby finds to be:

(I) Arapahoe county: Portions of sections thirty-five and thirty-six, township four south, range sixty-seven west of the sixth principal meridian; a portion of section thirty-one, township four south, range sixty-six west of the sixth principal meridian; portions of sections one, two, three, ten, fifteen, twenty-two, twenty-three, twenty-seven, and thirty-four, and all of sections eleven, twelve, thirteen, fourteen, twenty-four, twenty-five, twenty-six, thirty-five and thirty-six, township five south, range sixty-seven west of the sixth principal meridian; all of sections seven, seventeen, eighteen, nineteen, twenty, twenty-one, twenty-two, twenty-five, twenty-six, twenty-seven, twenty-eight, twenty-nine, thirty, thirty-one, thirty-two, thirty-three, thirty-four, thirty-five, thirty-six and portions of sections five, six, eight, nine, fourteen, fifteen, sixteen, twenty-three and twenty-four, township five south, range sixty-six west of the sixth principal meridian; all of section thirty-one and portions of sections nineteen, twenty-nine, thirty, and thirty-two, township five south, range sixty-five west of the sixth principal meridian;

township ten south, range sixty-five west of the sixth principal meridian; portions of sections five, six, seven, eight, seventeen, eighteen, nineteen, twenty-nine, thirty, thirty-one, and all of sections one, two, three, four, nine, ten, eleven, twelve, thirteen, fourteen, fifteen, sixteen, twenty, twenty-one, twenty-two, twenty-three, twenty-four, twenty-five, twenty-six, twenty-seven, twenty-eight, thirty-two, thirty-three, thirty-four, thirty-five and thirty-six, township ten south, range sixty-six west of the sixth principal meridian; a portion of section one, township ten south range sixty-seven west of the sixth principal meridian;

(b) Lands may be included within the boundaries of the authority pursuant to section 25-8.5-119.

(c) Lands within the boundaries identified in paragraph (a) of this subsection (1) may be excluded from the authority pursuant to section 25-8.5-120.

(2) The authority shall maintain a current map, showing all lands that are included in the authority's boundaries.

25-8.5-105. Authority members. (1) The following governmental entities shall be members of the authority:

(a) Every county which has property within the authority's boundaries;

(b) Every municipality which has property within the authority's boundaries; and

(c) Every special district which includes in its service area property within the Cherry Creek basin and which owns and operates a wastewater treatment services facility in the Cherry Creek basin. For the purposes of this paragraph (c), wastewater treatment services shall mean a wastewater treatment facility with a designed capacity to receive more than two thousand gallons of sewage per day.

25-8.5-106. Board of directors. (1) The governing body of the authority shall be a board of directors which shall exercise and perform all powers, rights, privileges, and duties invested or imposed by this article.

(2) Each authority member shall appoint one representative and two alternates to serve on the board. Any county, municipality, or special district that provides wastewater treatment services by contract with another entity which is a member of the authority shall not be entitled to a separate member on the board.

(3) Directors shall be appointed for terms of two years. Notice of each appointment shall be given to the recording secretary for the authority.

(4) No director shall receive compensation as an employee of the authority. Reimbursement of actual expenses for directors shall not be considered compensation.

(5) An appointment to fill a vacancy on the board shall be made by the authority member for the remainder of the unexpired term.

(6) If a board member or designated alternate fails to attend two consecutive regular meetings of the board, the authority may submit a written request to the appointing authority member to have its representative attend the next regular meeting. If, following such request, said representative fails to attend the next regular board meeting, the board may appoint an interim representative from the authority member's jurisdiction to serve until the authority member appoints a new representative.

(7) An authority member, at its discretion, may remove from office any board member or designated alternate representing the authority member and appoint a successor.

(8) The board shall elect one of its members as chairman of the authority and one of its members as secretary-treasurer and shall appoint a recording secretary who may be a member of the board.

(9) The recording secretary shall keep, in a well-bound book, a record of all of the authority's meetings, resolutions, certificates, contracts, bonds given by employees or contractors, and all corporate acts which shall be open to inspection of all interested parties.

(10) The secretary-treasurer shall keep strict and accurate accounts of all money received by and disbursed for anc on behalf of the authority.

25-8.5-107. Voting. (1) Each authority member, through its designated director or designated alternate acting in the director's place, shall be entitled to one vote.

(2) Board action upon waste load allocations, site location, or site plans selected pursuant to section 25-8-702, discharge permits secured pursuant to section 25-8-501, amendments to the authority's wastewater management plan, and all budget and funding decisions shall require a vote of the following combinations of member votes:

(a) An affirmative vote of fifty percent of the counties which are members of the authority; and

(b) An affirmative vote of a majority of the municipalities which are members of the authority; and

(c) An affirmative vote of a majority of the special districts which are members of the authority.

(3) All decisions of the board not enumerated in subsection (2) of this section shall be made and decided by a majority of the quorum.

(4) A director shall disqualify himself from voting on any issue in which he has a conflict of interest unless such director has disclosed such conflict of interest in compliance with section 18-8-308, C.R.S., in which case such disclosure shall cure the conflict. A director shall abstain from voting if the director would obtain a personal financial gain from the contract or services being voted upon by the authority.

25-8.5-108. Ex officio members. (1) Ex officio members shall be provided with notice of the authority meetings. Ex officio members shall not serve on the board. Ex officio members are not voting members. The following shall be considered ex officio members:

(a) Every soil conservation district of which more than two-thirds of its territory is included within the authority's boundaries;

(b) Any other governmental or quasi-governmental agency designated as an ex offico member by the authority.

25-8.5-109. Meetings. (1) The board shall fix the time and place at which its regular meetings shall be held and provide for the calling and holding of special meetings.

(2) Notice of the time and place designated for all regular meetings shall be posted at the office of the county clerk and recorder of each of the counties included within the authority. Such notices shall remain posted and shall be changed in the event that the time or place of such regular meetings is changed.

(3) Special meetings of the board shall be held at the call of the chairman or upon request of two board members. The authority shall inform all board members five calendar days before the special meeting and shall post notice in accordance with subsection (2) of this section at least three days before the special meeting of the date, time, and place of such special meeting and the purpose for which it is

called.

(4) All business of the board shall be conducted only during said regular or special meetings, and all said meetings shall be open to the public, but the board may hold executive sessions as provided in article 9 of title 29, C.R.S.

25-8.5-110. Powers of board - organization - administration. (1) The board has the following powers relating to carrying on the affairs of the authority:

(a) To organize, adopt bylaws and rules of procedure, and select a chairman and chairman pro tempore;

(b) To make and pass resolutions and orders which are necessary for the governance and management of the affairs of the authority, for the execution of the powers vested in the authority, and for carrying out the provisions of this article;

(c) To fix the location of the principal place of business of the authority and the location of all offices maintained under this article;

(d) To prescribe by resolution a system of business administration, to create any and all necessary offices, to establish the powers and duties and compensation of all employees, and to require and fix the amount of all official bonds necessary for the protection of the funds and property of the authority;

(e) To appoint and retain employees, agents, and consultants to make recommendations, coordinate authority activities, conduct routine business of the authority, and act on behalf of the authority under such conditions and restrictions as shall be fixed by the board;

(f) To prescribe a method of auditing and allowing or rejecting claims and demands and a method for the letting of contracts on a fair and competitive basis for the construction of works, structures, or equipment or for the performance or furnishing of such labor, materials, or supplies as may be required for the carrying out of any of the purposes of this article.

25-8.5-111. Powers of authority - general and financial. (1) In order to accomplish its purposes, the authority has the power to:

(a) Develop and implement, with such revisions as become necessary in light of changing conditions, plans for water quality controls for the reservoir, applicable drainage basin,

waters, and watershed;

(b) Conduct pilot studies and other studies that may be appropriate for the development of potential water quality control solutions;

(c) Develop and implement programs to provide credits, incentives, and rewards within the Cherry Creek basin plan for water quality control projects;

(d) Recommend the maximum loads of pollutants allowable to maintain the water quality standards and allocate, if delegated the power to pursuant to federal or state law, waste loads among both present and future sources of pollutants;

(e) Recommend erosion controls and urban runoff control standards;

(f) Recommend septic system maintenance programs;

(g) Incur debts, liabilities, and obligations;

(h) Have perpetual existence;

(i) Have and use a corporate seal;

(j) Sue and be a party to suits, actions, and proceedings;

(k) Enter into contracts and agreements affecting the affairs of the authority including, but not limited to, contracts with the United States and the state of Colorado and any of their agencies or instrumentalities, political subdivisions of the state of Colorado, corporations, and individuals;

(l) Acquire, hold, lease (as lessor or lessee), and otherwise dispose of and encumber real and personal property;

(m) Acquire, lease, rent, manage, operate, construct, and maintain water quality control facilities or improvements for drainage, nonpoint sources, or runoff within or without the authority;

(n) Establish rates, tolls, fees, charges, and penalties except on agricultural land for the functions, services, facilities, and programs of the authority; except that the total annual budgeted rates, tolls, fees, and charges for property owners shall not exceed thirty percent of the annual authority budget and shall not exceed the total annual budgeted fees to be paid by users of the Cherry Creek reservoir;

(o) Establish in cooperation with the department of natural resources fees for Cherry Creek reservoir users, which amounts shall be subject to the review and approval of the board of parks and outdoor recreation, which shall not unreasonably withhold approval. Said reservoir fees, including all users regardless of activity, however established, shall not in total exceed the amount that would be collected if the reservoir user fee was one dollar per reservoir user per year.

(p) (I) Levy and collect ad valorem taxes on and against all taxable property within the authority subject to the limitation that no mill levy for any fiscal year shall exceed one-half mill, however, ad valorem taxes greater than one-half mill can be levied by the authority if it is approved by the electors at an election held according to the procedures of part 8 of article 1 of title 32, C.R.S.

(II) No property tax shall be levied until the fees from the recreation users and the development fees are established.

(q) Issue and refund revenue and assessment bonds and pledge the revenues of the authority or assessments therefor to the payment thereof in the manner provided in part 4 of article 35 of title 31, C.R.S., and as provided in this article;

(r) Invest any moneys of the authority in any manner permitted by law;

(s) Review and approve water quality control projects of any entity other than the authority within the boundaries of the authority;

(t) Except that the authority shall not have the power to regulate agricultural nonpoint source activities; such agricultural nonpoint source activities shall be subject only to the provisions of section 25-8-205 (5);

(u) Have and exercise all rights and powers necessary or incidental to or implied from the specific powers granted to the authority by this article. Such specific powers shall not be considered as a limitation upon any power necessary or appropriate to carry out the purposes and intent of this article.

25-8.5-112. Power to issue bonds. To carry out the purposes of this article, the board is authorized to issue revenue or assessment bonds of the authority. Bonds shall bear interest at a rate such that the net effective interest rate of the issue of bonds does not exceed the maximum interest rate set forth in the resolution adopted by the board

authorizing the issuance of the bonds, payable semiannually, and shall be due and payable serially, either annually or semiannually, commencing not later than three years after date of issuance. The form and terms of said bonds, including provisions for their payment and redemption, shall be determined by the board. If the board so determines, such bonds may be redeemable prior to maturity upon payment of a premium not exceeding three percent of the principal thereof. Said bonds shall be executed in the name and on behalf of the authority, signed by the chairman of the board with the seal of the authority affixed thereto, and attested by the secretary of the board. Said bonds shall be in such denominations as the board shall determine, and the bonds and coupons shall bear the original or facsimile signature of the chairman of the board.

25-8.5-113. Revenue refunding bonds. Any revenue bonds issued by the authority may be refunded by the authority, or by any successor thereof, in the name of the authority, subject to the provisions concerning their payment and to any other contractual limitations in the proceedings authorizing their issuance or otherwise appertaining thereto, by the issuance of bonds to refund, pay, and discharge all or any part of such outstanding bonds, including any interest on the bonds in arrears or about to become due, for the purpose of avoiding or terminating any default in the payment of the interest on and principal of the bonds, of reducing interest costs or effecting other economies, or of modifying or eliminating restrictive contractual limitations appertaining to the issuance of additional bonds or to any system appertaining thereto or for any combination of such purposes. Refunding bonds may be delivered in exchange for the outstanding bonds refunded or may be sold as provided in this article for an original issue of bonds.

25-8.5-114. Use of proceeds of revenue refunding bonds. The proceeds of revenue refunding bonds shall either be immediately applied to the retirement of the bonds being refunded or be placed in escrow in any state or national bank within the state which is a member of the federal deposit insurance corporation to be applied to the payment of the bonds being refunded upon their presentation therefor; but, to the extent any incidental expenses have been capitalized, such refunding bond proceeds may be used to defray such expenses, and any accrued interest and any premium appertaining to a sale of refunding bonds may be applied to the payment of the interest thereon or the principal thereof, or both interest and principal, or may be deposited in a reserve therefor, as the board may determine. Any such escrow shall not necessarily be limited to proceeds of refunding bonds but may include other moneys available for its purpose. Any proceeds in escrow, pending such use, may be invested or reinvested in

any items permitted by the state of Colorado and bills, certificates of indebtedness, notes, or bonds which are direct obligations of, or the principal and interest of which obligations are unconditionally guaranteed by, the United States. Such proceeds and investments in escrow, together with any interest to be derived from any such investment, shall be in an amount at all times sufficient as to principal, interest, any prior redemption premium due, and any charges of the escrow agent payable therefrom to pay the bonds being refunded as they become due at their respective maturities or due at any designated prior redemption dates in connection with which the board shall exercise a prior redemption option. Any purchase of any refunding bond issued under this article shall in no manner be responsible for the application of the proceeds thereof by the authority or any of its officers, agents, or employees.

25-8.5-115. Facilities - comprehensive program. (1) The authority, acting by and through the board, may acquire, construct, lease, rent, improve, equip, relocate, maintain, and operate water quality control facilities, any project, or any part thereof for the benefit of the authority and the inhabitants thereof, after the board has made such preliminary studies and otherwise taken such action as it determines to be necessary or desirable.

(2) (a) The authority shall develop a comprehensive program for the water quality control facilities specified in subsection (1) of this section. A comprehensive program may consist of one project or more than one project.

(b) A hearing on the proposed comprehensive program shall be scheduled, and notice of the hearing shall be given by publication and posted in the office of the county clerk and recorder of each member county. Upon closure of the hearing, the board may either require changes to be made in the comprehensive program or the board may approve or reject the comprehensive program as prepared.

(c) If any substantial changes to the comprehensive program are ordered at any time, a further hearing shall be held pursuant to notice which shall be given by publication.

25-8.5-116. Coordination with drainage and flood control measures. (1) Any exercise by the authority of the powers granted by section 25-8.5-111 or 25-8.5-115 which affects drainage and flood control shall be consistent with and conform to the drainage and flood control program of the urban drainage and flood control district adopted pursuant to section 32-11-214, C.R.S., the resolutions, rules, regulations, and orders of the district issued pursuant to section 32-11-218 (1) (e), C.R.S., and any flood plain zoning

resolutions, rules, regulations, and orders of any public body having jurisdiction to adopt the same.

(2) Construction by the authority of drainage or water quality control facilities which might or will affect drainage or flood control within the boundaries of the urban drainage and flood control district shall not be undertaken until a proposal therefor has been presented to and approved by the board of directors of said district. Such proposal shall demonstrate compliance with the requirements of subsection (1) of this section, and the board shall apply the same standards of flood control and drainage criteria for approval thereof as it applies for review of proposals presented for approval pursuant to section 32-11-221, C.R.S. The provisions of section 32-11-221, C.R.S., shall apply to the presentation, consideration, and determination by said board of directors of any such proposal or modification thereof.

25-8.5-117. Transfer of powers. (1) Upon the adoption of the board of directors of the urban drainage and flood control district and the board of directors of the authority created herein of a joint resolution delegating the agreed-upon responsibility to the urban drainage and flood control district for carrying out and meeting, within the district's boundaries, the compliance requirements and the permitting requirements imposed with respect to storm water runoff quality by the federal "Water Quality Act of 1987" and any regulations and standards adopted pursuant thereto or pursuant to state law, all powers contained in this act to deal with water quality control and compliance relating to the agreed-upon aspects of storm water runoff and nonpoint sources of pollution, including financial powers and special assessment powers but not including ad valorem taxation powers, shall be transferred to the urban drainage and flood control district.

(2) Upon the transfer of powers as provided in subsection (1) of this section, any allocation of waste loads affecting storm water runoff or nonpoint sources of pollution proposed or adopted by the authority shall be effective only upon adoption thereof or concurrence therewith by the board of directors of the urban drainage and flood control district.

(3) If the urban drainage and flood control district accepts the responsibility and the transfer of powers as provided in subsection (1) of this section, after completion of a plan for water quality controls by the authority which involves storm drainage runoff or nonpoint sources and after commencement of implementation of such plan, the district shall be bound to carry out the plan as it relates to the storm water and nonpoint source powers transferred to it within the time requirements, if any, of the plan.

25-8.5-118. Power to levy special assessments. (1) The board, in the name of the authority, for the purpose of defraying all the cost of acquiring or constructing, or both, any project or facility authorized by this article, or any portion of the cost thereof not to be defrayed with moneys available therefor from its own funds, any special funds, or otherwise, also has the power under this article:

(a) To levy assessments against all or portions of the property within the authority and to provide for collection of the assessments pursuant to part 6 of article 20 of title 30, C.R.S.;

(b) To pledge the proceeds of any assessments levied under this article to the payment of assessment bonds and to create liens on such proceeds to secure such payments;

(c) To issue assessment bonds payable from the assessments, which assessment bonds shall constitute special obligations of the authority and shall not be a debt of the authority; and

(d) To make all contracts, to execute all instruments, and to do all things necessary or convenient in the exercise of the powers granted in this article or in the performance of the authority's duties or in order to secure the payment of its assessment bonds.

(2) The authority shall give notice, by publication once in a newspaper of general circulation in the authority, to the owners of the property to be assessed, which shall include:

(a) The kind of improvements proposed;

(b) The number of installments and the time in which the cost of the project will be payable;

(c) A description of the properties which will be assessed;

(d) The probable cost per acre or other unit basis which, in the judgment of the authority, reflects the benefits which accrue to the properties, except no benefit shall accrue to agricultural lands, to be assessed;

(e) The time, not less than thirty days after the publication, when a resolution authorizing the improvements will be considered;

(f) A map of the properties to be assessed, together with an estimate and schedule showing the approximate amounts to be assessed, and a statement that all resolutions and

proceedings are on file and may be seen and examined by any interested person at the office of the authority or other designated place at any time within said period of thirty days; and

(g) A statement that all complaints and objections by the owners of property to be assessed in writing concerning the proposed improvements will be heard and determined by the authority before final action thereon.

(3) The finding, by resolution, of the board that said improvements were ordered after notice given and after hearing held and that such proposal was properly initiated by the said authority shall be conclusive of the facts so stated in every court or other tribunal.

(4) Any resolution or order regarding the assessments or improvements may be modified, confirmed, or rescinded at any time prior to the passage of the resolution authorizing the improvements.

25-8.5-119. Inclusion of territory. (1) Any municipality, county, or special district, or any portion thereof, shall be eligible for inclusion upon resolution of its governing body requesting inclusion in the authority and describing the property to be included. The authority, by resolution, may include such property on such terms and conditions as may be determined appropriate by the board.

(2) Upon receipt of a resolution requesting inclusion, the board shall cause an investigation to be made within a reasonable time to determine whether or not the municipality, county, or special district, or portion thereof, may feasibly be included within the authority, whether the municipality, county, or special district has any property which is tributary to the basin, waters, or watersheds governed by the authority, and the terms and conditions upon which the municipality, county, or special district may be included within the authority. If it is determined that it is feasible to include the municipality, county, or special district, or portion thereof, in the authority, and the municipality, county, or special district has property tributary to the basin, waters, or watersheds governed by the authority, the board by resolution shall set the terms and conditions upon which the municipality, county, or special district, or portion thereof, may be included within the authority and shall give notice thereof to the municipality, county, or special district. If the board determines that the municipality, county, or special district, or portion thereof, cannot feasibly be included within the authority or otherwise determines that the municipality, county, or special district should not be included within the authority, the board shall

pass a resolution so stating and notifying the municipality, county, or special district of the action of the board. The board's determination that the county, municipality, or special district, or portion thereof, should not be included in the authority shall be conclusive.

(3) (a) If the governing body of the municipality, county, or special district desires to include the municipality, county, or special district, or portion thereof, within the authority upon the terms and conditions set forth by the board, the governing body shall adopt a resolution declaring that the public health, safety, and general welfare requires the inclusion of said municipality, county, or special district within the authority and that the governing body desires to have said municipality, county, or special district, or portion thereof, included therein upon the terms and conditions prescribed by the board. The governing body of such municipality, county, or special district, before final adoption of said resolution, shall hold a public hearing thereon, notice of which shall be given by publication in a newspaper of general circulation within such municipality, county, or special district, which shall be complete at least ten days before the hearing. Upon the final adoption of said resolution, the clerk of the governing body of such municipality, county, or special district shall forthwith transmit a certified copy of the resolution to the board and to the division of local government in the department of local affairs.

(b) After receipt of a copy of such resolution, the board shall pass and adopt a resolution including said municipality, county, or special district, or portion thereof, in the authority and shall cause a certified copy thereof to be transmitted to the division of local government and a certified copy to the governing body of the municipality, county, or special district.

(4) The director of said division, upon receipt of a certified copy of the resolution of the board, shall forthwith issue a certificate reciting that the municipality, county, or special district, or portion thereof, described in such resolution has been duly included within the authority according to the laws of the state of Colorado. The inclusion of such territory shall be deemec effective upon the date of the issuance of such certificate, and the validity of such inclusion shall not be contestable in any suit or proceeding which has not been commenced within thirty days from such date. The said division shall forthwith transmit to the governing body of such municipality, county, or special district and to the board five copies of such certificate, and the clerk of such governing body shall forthwith record a copy of the certificate in the office of the clerk and recorder of

each county in which such municipality, county, or special district, or portion thereof, is located and file a copy thereof with the county assessor of each such county. Additional copies of said certificate shall be issued by the division of local government upon request.

25-8.5-120. Exclusion of property. (1) Any owner of property within the boundaries of the authority may petition to be excluded from the authority.

(2) In order for such property to be excluded, the board shall determine that the property to be excluded does not receive wastewater treatment services or have an individual sewage disposal system located within the authority and either:

(a) Was improperly included within the authority; or

(b) Is not tributary to the basin, waters, or watersheds governed by the authority or will not benefit from projects or improvements provided by the authority.

(3) Any petition for exclusion shall specify the property to be excluded, and evidence that the property complies with the criteria of subsection (2) of this section.

(4) The authority shall provide notice of the date, time, and place of the authority's meeting to consider the petition for exclusion.

(5) The authority may approve, modify, or deny a petition for exclusion.

(6) If the authority approves a petition for exclusion of property, the authority shall file a copy of said resolution with the division of local government and with the county, municipality, or special district authority members which includes within its boundaries the excluded property, record a copy of the resolution in the office of the county clerk and recorder in the county in which said excluded property is located, and file a copy with the county assessor in such county.

SECTION 2. Safety clause. The general assembly hereby

finds, determines, and declares that this act is necessary for the immediate preservation of the public peace, health, and safety.

Carl B. Biedsoe
SPEAKER OF THE HOUSE
OF REPRESENTATIVES

Ted L. Strickland
PRESIDENT OF
THE SENATE

Lee C. Bahrych
CHIEF CLERK OF THE HOUSE
OF REPRESENTATIVES

Joan M. Albi
SECRETARY OF
THE SENATE

APPROVED April 28, 1988, at 2:35 pm

Roy Romer
GOVERNOR OF THE STATE OF COLORADO

APPENDIX B

Intergovernmental Agreement for the Share of Costs of the Shop Creek Water Quality Improvements Between the City of Aurora and the Cherry Creek Basin Water Quality Authority

INTERGOVERNMENTAL AGREEMENT FOR THE SHARE OF COSTS OF THE SHOP CREEK WATER QUALITY IMPROVEMENTS BETWEEN THE CITY OF AURORA AND THE CHERRY CREEK BASIN WATER QUALITY AUTHORITY

THIS AGREEMENT is made and entered into this 3rd day of October 1988, by and between the City of Aurora (AURORA), a home rule municipal corporation of the State of Colorado, and the Cherry Creek Basin Water Quality Authority (AUTHORITY), a quasi-municipal authority of the State of Colorado, organized pursuant to C.R.S. Section 25-8.5-101, et seq..

WHEREAS, the City Council of Aurora and the Board of Directors of the Authority hereby find that:

Water quality regulations for the Cherry Creek Basin promulgated by the Water Quality Control Commission of the State of Colorado require the removal of fifty percent of the phosphorous contained in the urban run-off projected to flow into Cherry Creek Reservoir.

Aurora and the Authority share a firm commitment to protect the health, safety, and welfare of all who enjoy the recreational facilities offered at Cherry Creek Reservoir by insuring a higher standard of quality for the water held therein.

To improve the water quality at Cherry Creek Reservoir by significantly reducing phosphorous pollution in the water flowing into the Reservoir, Aurora and the Authority desire to share the costs of construction of this prototype water quality improvement on Shop Creek, a primary source of urban run-off, and to determine the effectiveness of this prototype facility.

The people of the State of Colorado have authorized political subdivisions to exercise the powers and to cooperate in contract in matters set out in this Agreement through Colorado Constitution Article XIV, §18-2(a) and Article XX.

The General Assembly of the State of Colorado is authorized to encourage political subdivisions to cooperate and contract in matters set out in this Agreement through the enactment of C.R.S. § 29-1-201 and 203.

This Agreement is entered into pursuant to the Authority granted by the people of the State of Colorado and the General Assembly, and the subject matter and agreements contained herein are logical and foreseeable results of the state's enactment of the foregoing constitutional provisions and statutes.

WHEREAS, in view of the foregoing findings of the City Council of Aurora and the Board of Directors of the Authority, it is appropriate that this Intergovernmental Agreement be entered into.

NOW, THEREFORE, in consideration of the mutual promises, goals, and policies contained herein, Aurora and the Authority agree as follows:

1. Project description. This project, the construction of various drainage and water quality related improvements, including drainage way stabilization and erosion control on Shop Creek shall be known as the Shop Creek Project. The portion of Shop Creek to be improved shall range from its intersection with Parker Road, one-half mile south of Quincy Avenue, westward to its intersection with the southeast perimeter road of the Cherry Creek Reservoir State Recreation Area. The Shop Creek Project improvements are fully described in the Shop Creek Drainage Outfall System Plans, Project No. 6064, 1988, which is incorporated herein, and hereinafter referred to as the Shop Creek Project Plans. Pursuant to Colorado law, Aurora has received and analyzed a bid, which bid was awarded to Randall and Blake, Inc, (hereinafter the "bid") and fully incorporated herein.

2. Responsibility for construction and contract administration. Aurora agrees to assume responsibility for the construction of the Shop Creek Project. All improvements shall be constructed in accordance with the standards set by the applicable ordinances, rules, and regulations of Aurora. As part of its responsibility, Aurora shall award and administer all contracts on this project in accordance with Aurora ordinances, rules, and regulations governing such matters.

3. Reimbursement of project costs. Aurora agrees to provide all initial funding for the Shop Creek Project, subject to this Agreement by the Authority. The Authority, subject to future appropriations being legally made by the Authority's Board of Directors for reimbursement of costs itemized in this Agreement, will reimburse Aurora for its share of all costs related to the construction of water quality related improvements at Shop Creek including, but not limited to, the proportionate costs of engineering design, rights-of-way, and construction monitoring. Aurora understands that the Authority does not currently have adequate funds to pay the reimbursement costs for the Shop Creek Project and that actual reimbursement is contingent upon the Authority collecting taxes and fees pursuant to C.R.S., Section 25-8.5-101, et seq., and the Authority's Board of Directors appropriating said revenues for this Agreement. The Authority has made good faith efforts to establish the taxes and fees, and Aurora understands in addition to the foregoing that payments by the Authority may not commence immediately. It is the intent of

the Authority, subject to future Boards of Directors of the Authority making legal and binding appropriations, that until Aurora is reimbursed pursuant to this Agreement the Authority should commit a minimum of thirty percent (30%) or more of each years approved and funded capital improvement budget to reimburse Aurora.

Project costs, including engineering, design and construction costs, for the Shop Creek Project total $1,048,872.45. A description of the water quality improvements and a calculation of their costs for Shop Creek Project of $463,987.21 is attached hereto as Exhibit A, and incorporated herein by this reference. Subject to the limitations of this Agreement, the Authority shall only pay Aurora for the actual costs of the Shop Creek Project water quality improvements which shall not exceed $463,987.21. If any grants, gifts or payments are made by any third parties for all or any portion of the water quality improvements of the Shop Creek Project, credit for those monies shall be attributed solely to the Authority, regardless of applicant or source, and reduce absolutely the amount to be reimbursed by the Authority. Upon completion of the Shop Creek Project, Aurora shall provide the Authority with as-built drawings of the Shop Creek Project and itemization of the actual costs for each aspect of water quality improvements of the Shop Creek Project.

4. Division of costs. The respective shares of Aurora and the Authority of the costs associated with the construction of water quality related improvements on Shop Creek are set forth in the attached Exhibit A. The division of costs set forth in Exhibit A represent a fair assessment of each party's responsibility for the Shop Creek improvements and, as such, may only be revised upon written agreement of the parties.

5. Change orders. Aurora agrees that any change order which will increase the Authority's total cost for the Shop Creek Project or alter, amend, or modify the water quality improvements of the Shop Creek Project must be approved by the Authority in writing prior to being put into effect.

6. Progress reports. Aurora agrees to submit monthly progress report to the Authority from its project manager. Aurora shall provide the Authority with notice of all progress meetings and allow the Authority to attend progress meetings with the project manager during the course of the construction. The progress reports shall indicate that all water quality-related improvements are being built according to design or modifications to the design approved pursuant to Section 5 herein.

7. Authority's right of access. Aurora shall permit the Authority, or its duly authorized agents and representatives, to enter the Shop Creek Project at all reasonable times for the

purposes of inspecting the Shop Creek Project to determine whether Aurora and the contractors are complying with the terms of this Agreement. Additionally, Aurora agrees that the Authority may have access to the Shop Creek Project in order to monitor the water quality, the effectiveness of the project and conduct maintenance.

8. Maintenance. Aurora is and shall be the owner of the Shop Creek Project. Aurora agrees to develop with the Authority a program for maintenance of the water quality related improvements of the Shop Creek Project, which program may be amended and modified from time to time based on their experience and operation of the Shop Creek Project. Aurora agrees to operate and maintain the Shop Creek Project, including maintenance necessary for the water quality improvements pursuant to the maintenance program, provided, however, subject to appropriations by future Boards of Directors of the Authority, the Authority may assist in maintenance including, but not limited, to maintenance costs. If the Authority undertakes the maintenance of water quality improvements for other similar nonpoint source structures in the Cherry Creek Basin, the Authority may, at the discretion of its Board of Directors, agree to maintain all or portions of the Shop Creek Project.

9. Payment of Claims. Aurora shall pay when due all claims for labor and material incurred by Aurora in the performance of their obligations under this Agreement and, in the event that any notice of intent to file a lien statement or a statement of lien or any attachment, garnishment, or action affecting title to real property is filed, served, or recorded against Aurora, the Authority, or the Shop Creek Project property or any portion thereof as a result of Aurora's actual or alleged failure to pay or discharge any obligation to any laborer or materials supplier, Aurora shall forthwith pay or discharge the same or cause the effect thereof to be removed from the Shop Creek Project Property.

10. Indemnification. Aurora shall indemnify and hold the Authority harmless from any and all liability, including, but not limited to, liability for injuries, death, damage or destruction to property, loss, or damage Aurora may suffer as a result of claims, demands, costs or judgments against Aurora arising out of or in any way connected with the Shop Creek Project or performance of their obligations under this Agreement and any and all costs, expenses, attorneys' fees, and liability incurred by Aurora in defending against such claims, regardless of whether a lawsuit is ever commenced or whether, if commenced, the same proceeds to judgment or not. Aurora agrees to defend at Aurora's own expense any claim or action brought against Aurora and the Authority pertaining to the Shop Creek Project wrongfully brought or filed.

11. Authority's liability. The Authority shall not be liable to Aurora or any other person or entity whatsoever for any death, injury or property damage suffered by said persons or entities caused by or resulting from any defect in the Shop Creek Project, nor shall the Authority be liable in any manner for any loss, injury, or damage incurred by Aurora or any other person or entity from the acts or attempted acts of theft, burglary, or vandalism committed by either identified or unidentified persons.

12. Designated Project Managers and Notices. The Authority and Aurora hereby designate the following individuals as their project managers for the Shop Creek Project. Any notices, demands, or other communications required or permitted to be given by any provisions of this Agreement shall be given in writing, delivered personally or sent by certified or registered mail, return receipt requested, postage prepaid, addressed as follows:

To Authority:	John Kempfer, Chairman Cherry Creek Basin Water Quality Authority c/o R.S. Wells Corp. 6200 South Syracuse Way Suite 150 Englewood, Colorado 80111
With copy to:	Ronda L. Sandquist McKenna, Conner & Cuneo 1670 Broadway, Suite 300 Denver, Colorado 80202
To Aurora:	City Manager's Office City of Aurora 1470 South Havana Aurora, Colorado 80012
With copy to:	Aurora City Attorney 1470 South Havana Aurora, Colorado 80012

or at such other addresses as said parties may hereafter or from time to time designate by written notice to the other party given in accordance with this section. Notice shall be considered given when actually delivered or mailed.

14. Time schedule. Aurora agrees to use its best efforts to commence the construction of these improvements in calendar year 1988, and to complete the project by July 1989.

SHOP CREEK DRAINAGE OUTFALL SYSTEM

CITY OF AURORA/CCBA COST SHARE
30-Aug-88

CONSTRUCTION COSTS:

BID ITEM NO.	DESCRIPTION	QUANTITY	UNITS	PROJECT TOTAL UNIT COST	PROJECT TOTAL TOTAL	RATIO	WATER QUALITY ASPECT QUANTITY	WATER QUALITY ASPECT TOTAL
4	EXCAVATION	59050	CY	$1.10	$64,955.00	0.57	33658.5	$37,024.35
5	REMOVE,STOCKPILE, REPLACE TOPSOIL	13213	CY	$2.48	$32,768.24	0.57	7531.41	$18,677.90
6	EXC. STRUCT.	9130	CY	$2.29	$20,907.70	0.36	3286.8	$7,526.77
9	INSTALL EMBANK.	33819	CY	$0.60	$32,291.40	0.57	30676.83	$18,406.10
20	F/I 8" UNDERDRAIN	627	LF	$22.20	$13,919.40	0.36	225.72	$5,010.98
21	F/I SOIL CEMENT	6370	CY	$19.81	$126,189.70	0.36	2293.2	$45,428.29
22	F/I OUTLET STRUCTURE	1	LS	$14,400.00	$14,400.00	1	1	$14,400.00
24	F/I DIP 8"	168	LF	$16.50	$2,772.00	0.36	60.48	$997.92
25	F/I DIP 12"	163	LF	$40.22	$6,555.86	0.36	58.68	$2,360.11
26	F/I SEED MIX 1	22.5	AC	$1,360.00	$30,600.00	0.59	13.275	$18,054.00
27	F/I SEED MIX 2	2	AC	$1,260.00	$2,520.00	1	2	$2,520.00
28	F/I RETENTION NET.	5693	SF	$0.15	$853.95	0.59	3358.87	$503.83
29	MULCHING	24.4	AC	$230.00	$5,612.00	0.59	14.396	$3,311.08
30	TRANS. WILLOWS	170	EA	$35.00	$5,950.00	1	170	$5,950.00
31	TRANS. CATTAILS	140	EA	$35.00	$4,900.00	1	140	$4,900.00
32	TRANS. CAT RHIZ.	1500	EA	$0.60	$900.00	1	1500	$900.00
47	SOIL CEMENT	1418	TON	$79.62	$112,901.16	0.36	510.48	$40,644.42
SUBTOTALS					$478,996.41			$226,615.75

ITEMS TO ALLOCATED BY RATIO OF COSTS:

1 MOBILIZATION	1 LS	$30,000.00	$30,000.00	0.33	0.33	$9,946.43
2 CLEARING AND GRUB	1 LS	$12,300.00	$12,300.00	0.33	0.33	$4,078.04
3 REMOVAL OF STRUCT.	1 LS	$26,400.00	$26,400.00	0.33	0.33	$8,752.86
7 CONTROL OF WATER	1 LS	$32,500.00	$32,500.00	0.33	0.33	$10,775.30
46 TRAFFIC CONTROL	1 LS	$500.00	$500.00	0.33	0.33	$165.77
SUBTOTALS			$101,200.00			$33,718.39

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TOTAL CONSTRUCTION COST TO BE ALLOCATED TO WATER QUALITY ASPECT: $260,334.14

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LAND ACQUISITION COSTS:

TOTAL $104,170.00

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COST SUMMARY	PROJECT	EROSION	WATER QUALITY
CONSTRUCTION	$683,509.00	$423,174.86	$260,334.14
CONTINGENCY	$34,175.45	$21,158.74	$13,016.71
ENGINEERING	$227,018.00	$140,551.64	$86,466.36
LAND	$104,170.00	$0.00	$104,170.00
TOTAL	$1,048,872.45	$584,885.24	$463,987.21

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