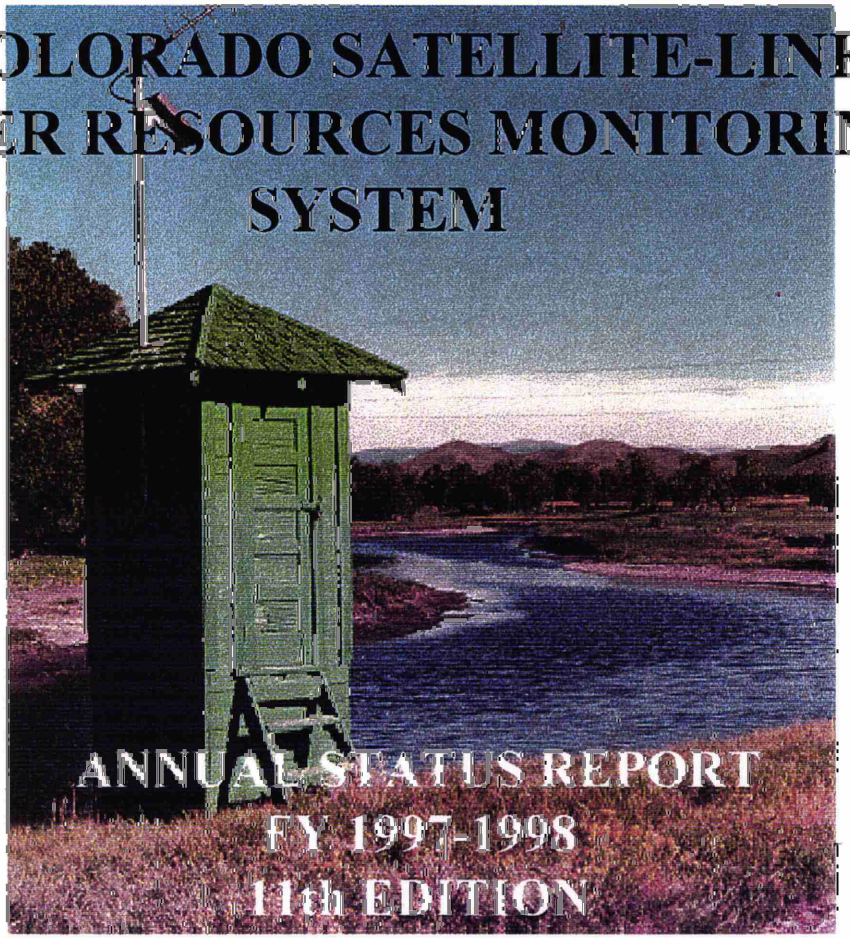
THE COLORADO SATELLITE-LINKED WATER RESOURCES MONITORING SYSTEM



Office of the State Engineer
Division of Water Resources

Prepared by The Hydrographic Branch

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INTRODUCTION

The satellite-linked monitoring system (SMS) provides the Division of Water Resources, other state and federal entities, and the water user community with access to real-time and historic stream-flow data from gaging stations across the State of Colorado. These data and software systems provide for more effective water rights administration, water resource management, computerized hydrologic records development, and flood warning.

The State Engineer's Office (SEO) began operating the SMS in 1985. The Colorado Water Resources and Power Development Authority provided initial funding for this project pursuant to Section 37-95-107(5), C.R.S. (1983), by enactment of Senate Joint Resolution No. 20. This system has become one of the most important and integral tools for the administration and management of Colorado's water resources, not only for the Division of Water Resources, but for the entire water user community.

Initially, the State of Colorado operated 150 remote gaging stations linked to the SMS. The Water Resources and Power Development Authority funded an additional expansion of forty stations and an upgrade to the central computer system in 1991. Through that expansion and additional stations funded by various cooperating entities, the Division of Water Resources now operates 298 satellite gaging stations linked to the SMS. Federal agencies, water conservancy districts, municipalities, and private entities own other stations in Colorado and neighboring states. The Division collects and uses the data from 252 of these stations operated by others.

The Colorado satellite-linked water resource monitoring system received national merit awards in 1985 and 1986. The National Society of Professional Engineers selected the system as one of ten outstanding national engineering achievements for 1985. The Council of State Governments selected the system as one of the eight top innovative programs instituted by state government in the nation for 1986.

The Satellite Monitoring System provides the primary input data for the Colorado River Decision Support System (CRDSS). This system was developed by the Division of Water Resources and the Colorado Water Conservation Board. It allows Water Commissioners and DWR engineers to more effectively administer and manage the Colorado River and its tributaries. CRDSS is also being used on the South Platte River.

The Colorado Water Conservation Board's construction fund continues to pay for the replacement of old Data Collection Platforms. A total of $120,000 was obtained for FY 98-99. Most of these funds are being used to replace fifteen satellite installations with new electronic equipment. The rest of the funding is for a gaging station renovation program.

I. PROGRAM DESCRIPTION

The Satellite Monitoring System (SMS) allows the Division of Water Resources to collect, process, store, and distribute any kind of environmental data transmitted from remote locations. The data set of interest to the Division is the water level at rivers, streams, diversion structures, and reservoirs. The SMS converts these raw water level values into several "products" of use to various "clients". The "products" range from raw data passed on to other computer systems to the official Hydrographic Records of mean daily stream flows. Our "clients" include Division of Water Resources personnel and other water users wanting real-time administrative data, computer systems performing other analyses, and the varied user community of state and federal agencies, municipalities, canal companies, attorneys, and consulting engineers needing access to real-time and historic stream flow data.

A. System Configuration

The Satellite Monitoring System consists of four primary sub-systems: 1) the remote station data measurement, collection, and transmission hardware; 2) the satellite communication links and transmission receive hardware; 3) the computer hardware and software systems; and 4) the computer communication hardware and software

The remote equipment at remote stream, diversion, or reservoir gaging stations includes the on-site sensors, the Data Collection Platform (DCP) and radio transmitter electronics, the power supply, and the radio antenna. The sensor may be either a float operating in a stilling well hydraulically connected to the stream or reservoir, a manometer or other type of pressure transducer, or a direct discharge meter. Often a temperature sensor and other meteorological sensors are also present. The DCP is a programmable device that collects, processes, and stores data from up to 16 sensors. It also controls the timing of the radio transmissions. Most sites are powered by 12 volt batteries re-charged by solar panels. If available, 120 volt AC power is converted to 12 volt DC current for some sites. An environmentally secure enclosure protects the equipment from extreme weather and unauthorized access.

The communications link for data transmissions from the DCPs is a Geostationary Orbital Environmental Satellite (GOES). This is a federal satellite operated by the National Oceanic and Atmospheric Administration-National Environmental Satellite, Data, and Information Service (NOAA-NESDIS). A GOES satellite is in an equatorial, geostationary orbit 22,500 miles in space. The Division of Water Resources originally installed a Direct Readout Ground Station (DRGS) to receive this data directly from the GOES satellite. NOAA receives all transmissions at a facility at Wallops Island, Virginia then re-transmits the data over one channel to a domestic communications satellite visible from all of North America. This satellite (DOMSAT) broadcasts back to earth with much more power than the GOES system. The more powerful signal allows us to use a much smaller antenna (1.8 meters) and much simpler electronics. Since the DOMSAT multiplexes all data on one channel we can receive data from any remote site without additional electronics. We still use the DRGS as a backup system. NOAA does not charge for these services.

The DCP's collect data measurements at 15-minute, 30-minute, or 60-minute intervals as needed. In most cases they store 8-hours of data and transmit at 4-hour intervals in the standard transmission mode. This provides replicate data in case of a missed transmission. When the DCPs detect that stream flow conditions exceed programmed levels, they transmit random messages, providing real-time alarm warnings.

The main computer is a Digital Equipment Corporation (DEC) VAX 4000-300. This system gathers data from the DRGS electronics and the DOMSAT receive system running on a PC. Real-time software automatically processes, converts, and stores the incoming data. The conversion calculations use the most up-to-date hydrographic shifts, as determined by actual measurements, to reflect changes in the stream channel characteristics. The system processes meteorological information in a similar manner. Every

morning the system reads the previous day's data and calculates mean values, minimums, maximums, and other statistics, placing the results in a separate data base. To preserve the integrity of the data, we do not edit the original real-time data. A DWR developed system extracts a subset of the original data for editing and hydrologic record development. The DWR hydrographers also use this system to manually enter and edit stations not included in the GOES-linked system. Only authorized users can edit the data. Other programs allow users to access data and to control the system. The central computer hardware is located in the Centennial Building at the Office of the State Engineer.

We support several methods of communications access and data dissemination. Using a PC and a modem, users anywhere in the world, with proper authorization can access our system. In 1995 the DWR installed new high speed (28,800 baud) modems. This provides our users with a better level of service through much higher data transfer rates. Many users now connect to the system through the Internet, the "Information Superhighway". This technology also connects the SMS to other independent systems.

The Division operates a system called WATERTALK that lets users retrieve up-to-date stream flow information from key gaging stations throughout the state by using a touch-tone telephone. WATERTALK uses a computer generated voice synthesizer. This system is very popular with both the public and the Division water commissioners. The telephone number for WATERTALK is 303-831-7135. Originally we dedicated 4 telephone lines to this program. Presently there are six telephone lines available to this program. The last page of this report shows the current list of stations available on Watertalk.

Another method used to provide stream flow data from the satellite stream flow monitoring system to the public is posting hydrographs to our home page on the internet (http://www.dnr.state.co.us/water/flow/). The hydrograph displays the last ten days of dayfile data graphically. Two hundred eighty five stations are plotted every three hours giving users of World Wide Web a good snap shot of water conditions throughout the state.

The last method of data dissemination is the Alarm system. This is another computer voice synthesized device that alerts the Denver office of the National Weather Service to potential flood conditions. Random alarm messages from the DCPs cause software on the main computer to dial the Weather Service. When they answer their telephone the system tells them the station name and the water level. This program is of great assistance during high run-off season.

B. System Operations

One of the most important technical aspects of the Satellite Monitoring program is to assure the highest possible rate of data capture and system availability. In years past, problems inherent in the GOES system and our DRGS prevented us from receiving 100% of DCP transmissions. NOAA launched new satellites in 1994, 1996 and 1997. That, in conjunction with the DOMSAT system, has improved the overall reliability of the DCP/satellite link.

Occasionally, local power outages at the Division's Denver office have created short term gaps in data reception and the availability of the system to users. In 1995 we purchased and installed uninterruptible power supplies for all the computer systems involved in data collection, data processing, and communications. While these power supplies will not keep the systems operating for more than 20 minutes, approximately 90% of the power outages we have experienced over 10 years have been less than 10 minutes in duration. This will help increase the availability and reliability of the Satellite Monitoring System. Our data reception is now better than 98%.

Maintaining data base integrity is an important operations goal. Real-time data are of no value unless the data are accurate. We expend considerable effort to ensure that the remote hardware and sensors remain in calibration. Other entities operate nearly 46% of the stations in the state's monitoring

network. They generally are not using the data to make real-time decisions. This difference in the use of data makes our efforts to keep the equipment calibrated more difficult. Those entities more concerned with historic data do not have the sense of immediacy as the DWR with its interest in water administration. Over time, improved communication has alleviated this problem.

Typically, hydrographers visit stations at two to four week intervals. They make on-site flow measurements and any necessary adjustments to the equipment. The system compares in-coming data to allowable data ranges for each station and flags outside of range data accordingly. The software that calculates mean values and other statistics does not use these flagged values. Each day the computer reports the number of "data quality" flags for each station.

The system diagnostic report helps in monitoring the operation of the remote data collection hardware. This computer generated report tabulates the transmission characteristics and a data base analysis for each station for the previous day. The report lists the number of received, scheduled, and missed transmissions, any message length errors, transmission time errors, errors in transmission quality including power (EIRP) and frequency, any deficiency in remote power supplies, and the number of missing values and parity errors for each station. We can detect remote equipment operating problems before they produce fatal errors.

The Division of Water Resources is responsible for system maintenance. Field personnel from each Division received training from Division of Water Resources personnel in the operation and maintenance of the system hardware. Training is directed at system diagnostics, hardware calibration, and basic repairs. Each Division is supplied with a minimum of two sets of replacement hardware. If a component malfunctions and cannot be repaired in the field, it is replaced and sent to our repair facility in Denver. If we cannot repair it, it is then returned to the manufacturer for repair.

We are using monies obtained from the Colorado Water Conservation Board's construction fund to renovate gauging stations and replace 15 DCPs per year. Many of the DCPs in the field are approaching fifteen years of use, and are nearing the end of their useful life. $120,000 was obtained for these purposes in fiscal year 97-98. This office is still developing a source of funds for these purposes on an on-going basis.

Communications with NOAA-NESDIS, other GOES users, and the Colorado user community is essential. NOAA-NESDIS coordinates the activities of the national GOES user group. Meetings are held three times a year to discuss GOES operations, future system improvements, system utility, and to facilitate communications between users. These meetings have proven to be beneficial.

The monitoring system continues to operate with only two full-time employees paid by the appropriations for the program, a Systems Analyst/Program Manager and a Senior Telecommunications/Electronic Specialist. The Systems Analyst/Program Manager's responsibilities include the coordination of daily operations, network development, system enhancement, control and management of system access by the user community, software modification, and ADP training. The Senior Tele./Elect. Specialist's responsibilities include installation, preventative maintenance and repair of the system hardware.

Essential additional support is provided by other staff of the Division of Water Resources. The SMS is managed by the Chief of the Hydrographic Branch. His responsibilities include overall management of the program, integration of the SMS into the hydrographic program of the DWR, maintaining communications with the user community, interagency/intra-agency coordination, user fee development, budget management and program direction. Working under the Hydrographic Branch Chief is a computer programmer/operator. The responsibilities of this computer operator include operation of the receive site and central computer, data base management, and data backup. Also, part-time support for western slope preventative maintenance and repair is provided by the Division Engineer's Office for Water Division Three.

Overall guidance and direction are provided by the State Engineer and an Assistant State Engineer. Systems operation and maintenance support is provided by the hydrographic staffs of each of the seven Division offices.

C. System Software

The Satellite Monitoring System software package consists of a series of programs that provide for data reception, data processing, data conversions, data archiving, and data retrieval in various formats. Software tools are also provided for system diagnostics.

System users can access the real-time daily data and calculated means, minimums, and maximums through the Dayfile and Archive programs. Division of Water Resources personnel control the setup and maintenance of individual stations and the overall system through various other programs.

The Division has internally developed additional systems to supplement the basic satellite software. The record system was created to facilitate the development of hydrologic records. It uses the real-time data to produce the official hydrographic stream flow record for the Division of Water Resources. Editing is done on a separate working file duplicated from the original data base. In this fashion, the integrity of the real-time data is maintained. This is necessary since administrative decisions are based on the evaluation of real-time data.

DOMSAT Receive Station (DRS)

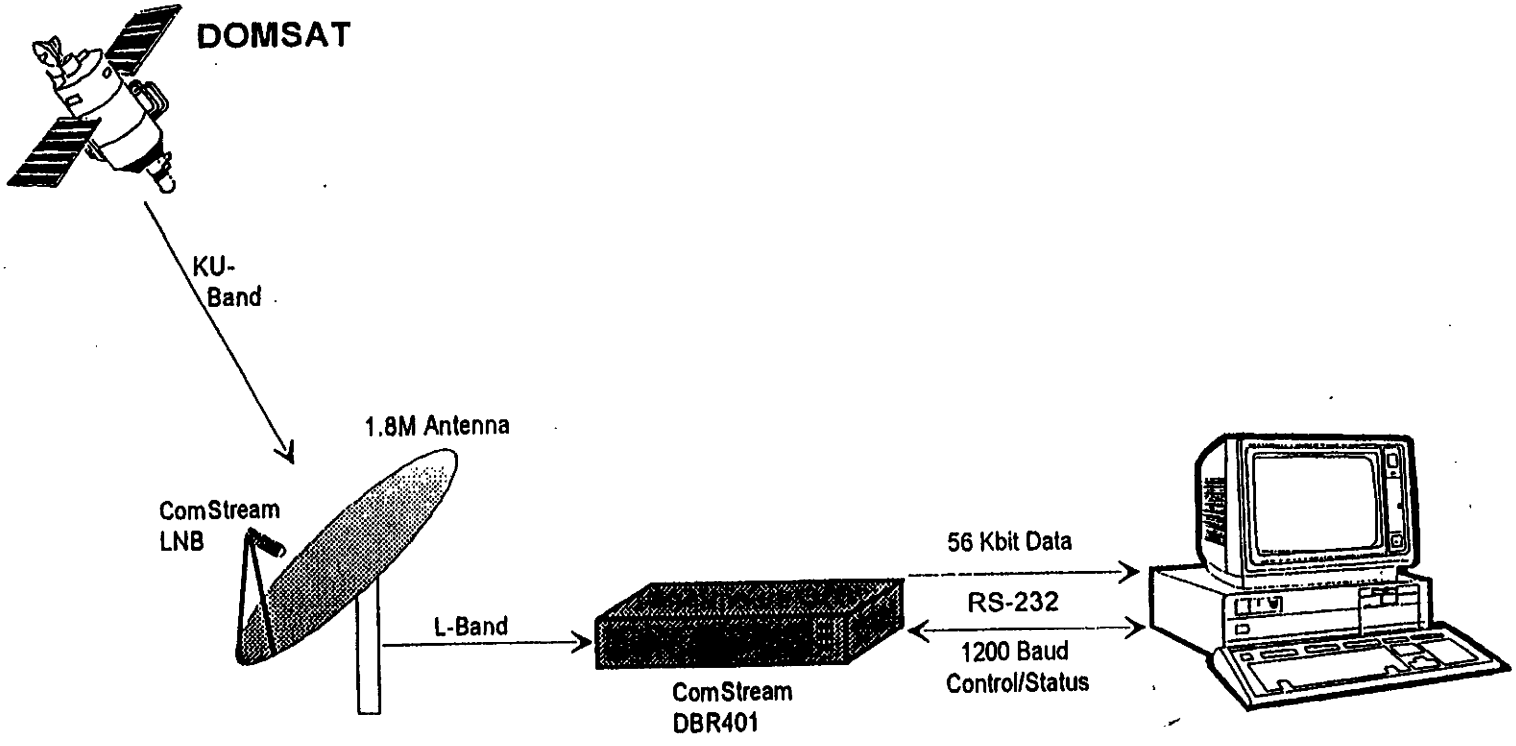

FIGURE 1

NOAA Sponsored Data Collection System (DCS)

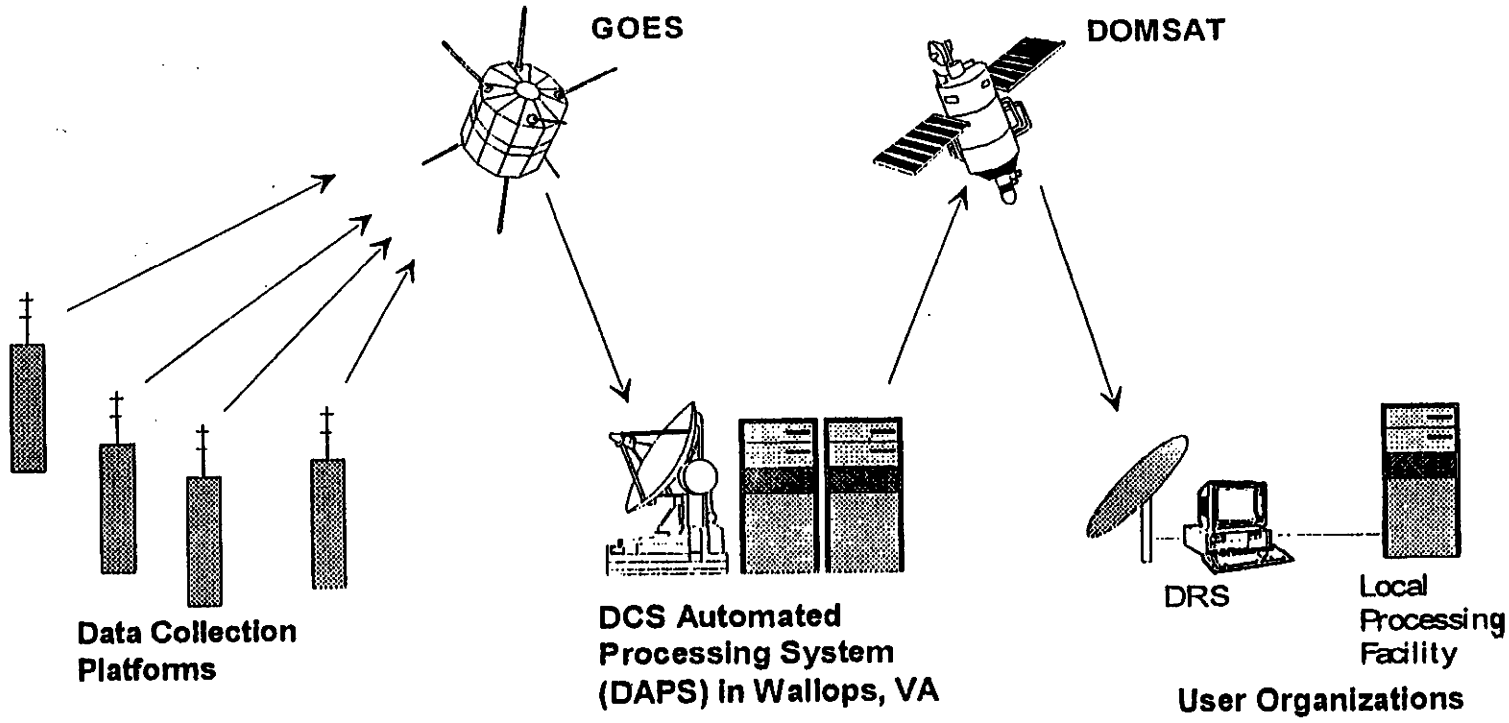

FIGURE 2

Stations Operated by the State of Colorado

Office of the State Engineer

Division 1 South Platte River Basin

1. ALVA B. ADAMS TUNNEL AT EAST PORTAL, NEAR ESTES PARK
2. BIG THOMPSON AT MOUTH, NEAR LA SALLE
3. BIG THOMPSON RIVER ABOVE LAKE ESTES
4. BIG THOMPSON RIVER AT DRAKE, NORTH FORK
5. BIG THOMPSON RIVER AT HILLSBOURGH DIVERSION.
6. BIG THOMPSON RIVER BELOW LAKE ESTES
7. BIG THOMPSON RIVER NEAR DRAKE, AT CANYON MOUTH
8. BIJOU CANAL
9. BOREAS PASS DITCH AT BOREAS PASS NR COMO
10. BOULDER CREEK NEAR ORODELL, CO, BOULDER COUNTY
11. BOULDER CREEK, SOUTH DIVERSION NR ELDORADO SPRINGS
12. BUCKHORN CREEK NEAR MASONVILLE, CO.
13. BURLINGTON-WELLINGTON CANAL AT HEADGATE
14. BUTTON ROCK RESERVOIR
15. CACHE LA POUDRE AT CANYON MOUTH, NEAR FORT COLLINS
16. CACHE LA POUDRE NEAR GREELEY, COLORADO, WELD COUNTY
17. CANAL # 3
18. CHARLES HANSEN FEEDER CANAL BELOW BIG THOMPSON SIPHON
19. CHARLES HANSEN FEEDER CANAL WASTEWAY TO BIG THOMPSON
20. CHEESMAN RESERVOIR
21. CLEAR CREEK AT LAWSON
22. DILLE TUNNEL NEAR DRAKE,CO.
23. EVANS # 2 DITCH
24. FORT MORGAN CANAL HEADGATE NR WIGGINS, COLORADO
25. GRAND RIVER DITCH AT LA POUDRE PASS
26. GREELEY LOVELAND DIVERSION AT LOVELAND, COLORADO
27. HARMONY NO. 1 DITCH AT HEADGATE, NEAR CROOK
28. HOOSIER PASS TUNNEL AT MONTGOMERY RES., NEAR ALMA
29. LARAMIE POUDRE TUNNEL
30. LARAMIE RIVER NEAR GLENDEVY, COLORADO
31. LARIMER AND WELD IRRIGATION COMPANY
32. LEFT HAND DIVERSION NEAR WARD COLORADO
33. LITTLE DRY CREEK NEAR GREENWOOD VILLAGE
34. LITTLE THOMPSON RIVER AT CANYON MOUTH NR. BERTHOUD
35. LOWER PLATTE AND BEAVER CANAL
36. MARYS LAKE AT ESTES PARK
37. METRO SEWER EFFLUENT AT DENVER, COLORADO
38. MIDDLE BOULDER CREEK AT NEDERLAND, CO.
39. MOFFAT WATER TUNNEL, GILPIN COUNTY, COLORADO
40. NEW CACHE LA POUDRE CANAL @25' NEAR TIMNATH
41. NORTH FORK SOUTH PLATTE RIVER AT BAILEY, COLORADO
42. NORTH STERLING CANAL AT HEADGATE, MORGAN COUNTY
43. OLYMPUS DAM AT LAKE ESTES
44. OLYMPUS TUNNEL (ESTES FOOTHILLS CANAL) AT LAKE ESTES
45. PAWNEE DITCH AT HEADGATE, NEAR MESSEX, COLORADO
46. RALSTON CREEK, ABOVE RALSTON RES., NEAR GOLDEN, COLO
47. RIVERSIDE CANAL AT RESERVOIR INLET GAGE, WELD COUNTY
48. ROBERTS TUNNEL AT EAST PORTAL NEAR GRANT, CO
49. S. BOULDER CK. B. GROSS RES. NR. COAL CK., CO.
50. S. PLATTE RIVER BELOW STRONTIA SPRINGS
51. SAINT VRAIN CREEK AT LYONS, BOULDER COUNTY
52. SAND CREEK AT COLORADO-WYOMING STATE LINE
53. SOUTH BOULDER CREEK ABOVE GROSS RES. AT PINECLIFFE

Stations Operated by the State of Colorado

Office of the State Engineer

Division 1 South Platte River Basin (continued)

54. SOUTH BOULDER CREEK NEAR ELDORADO SPRINGS, COLORADO
55. SOUTH PLATTE RIVE BELOW ANTERO RESERVOIR
56. SOUTH PLATTE RIVER AT COOPER BRIDGE, NEAR BALZAC, CO
57. SOUTH PLATTE RIVER AT FORT MORGAN
58. SOUTH PLATTE RIVER AT HENDERSON TEST
59. SOUTH PLATTE RIVER AT JULESBURG, CO. LEFT CHAN. #4
60. SOUTH PLATTE RIVER AT JULESBURG, CO. RIGHT CHAN. #2
61. SOUTH PLATTE RIVER AT JULESBURG-CHANNEL 1
62. SOUTH PLATTE RIVER AT WATERTON, CO.
63. SOUTH PLATTE RIVER BELOW 11-MILE RES., NEAR LAKE GEORGE
64. SOUTH PLATTE RIVER NEAR KERSEY, CO
65. SOUTH PLATTE RIVER NEAR WELDONA, CO.
66. SOUTH SAINT VRAIN CREEK AT WARD
67. ST. VRAIN CREEK NEAR PLATTEVILLE, AT THE MOUTH
68. STERLING NO 1 DITCH NR STERLING COLO
69. TEST PLATFORM FOR DIV1 IN GREELEY
70. TOWN OF LYON'S DIVERSION
71. USBR POWER PLANT AT BIG THOMPSON CANYON MOUTH
72. WESTERN MUTUAL DITCH AKA HEWES COOK
73. WILSON SUPPLY CANAL NEAR EATON RESERVOIR, COLORADO

Division 2 Arkansas River Basin

1. AMITY CANAL
2. APISHIPAH CREEK NEAR FOWLER, CO
3. ARKANSAS RIVER AT SALIDA, CO.
4. ARKANSAS RIVER ABOVE PUEBLO, CO.
5. ARKANSAS RIVER AT CANON CITY
6. ARKANSAS RIVER AT GRANADA
7. ARKANSAS RIVER AT GRANITE, CO.
8. ARKANSAS RIVER AT LA JUNTA
9. ARKANSAS RIVER AT LAS ANIMAS, CO.
10. ARKANSAS RIVER AT PORTLAND, CO.
11. ARKANSAS RIVER BELOW CATLIN DAM NEAR FOWLER, CO.
12. ARKANSAS RIVER BELOW JOHN MARTIN RESERVOIR, CO.
13. ARKANSAS RIVER NEAR AVONDALE, CO.
14. ARKANSAS RIVER NEAR CARLTON @ X-Y DITCH DAM
15. ARKANSAS RIVER NEAR NEPESTA, CO.
16. ARKANSAS RIVER NEAR ROCKY FORD, COLORADO
17. ARKANSAS RIVER NEAR WELLSVILLE
18. BUSK-IVANHOE TUNNEL, COLORADO
19. CATLIN CANAL BELOW CATLIN DAM, NEAR FOWLER, CO.
20. CHALK CREEK AT MOUTH NEAR NATHROP
21. CHARLES H. BOUSTEAD TUNNEL, COLORADO
22. CHEYENNE CREEK NEAR COLORADO,KANSAS STATELINE,CO.
23. CLEAR CREEK ABOVE CLEAR CREEK RESERVOIR, CO.
24. CLEAR CREEK DAM
25. COLORADO CANAL AT MILE 3.8, NEAR BOONE, CO.
26. COLUMBINE DITCH, COLORADO
27. CONSOLIDATED DITCH NEAR RIVERDALE, CO.
28. COTTONWOOD CREEK NEAR BUENA VISTA, CO

Stations Operated by the State of Colorado

Office of the State Engineer

Division 2 Arkansas River Basin (continued)

29. CROOKED ARROYO NEAR SWINK CO.
30. CUCHARAS RESERVOIR
31. CUCHARAS RIVER BELOW CUCHARAS RESERVOIR
32. CUCHARAS RIVER NEAR LA VETA, AT BOYD RANCH
33. DIVISION 2 TEST STATION
34. EWING DITCH, COLORADO
35. FORT LYON CANAL, COLORADO
36. FT. LYON STORAGE CANAL
37. GRAPE CREEK NEAR WESTCLIFFE, CO
38. HOLBROOK CANAL AT MILE 3.4, NEAR ROCKY FORD
39. HOMESTAKE TUNNEL
40. HORSE CREEK AT HIGHWAY 194
41. HUERFANO RIVER AT BADITO, NEAR WALSENBURG, CO.
42. HUERFANO RIVER AT MANZANARES CROSSING NEAR REDWING
43. JOHN MARTIN RESERVOIR AT CADDOA, COLORADO
44. KICKING BIRD CANAL
45. LAKE CREEK BELOW TWIN LAKES
46. LAKE FORK CREEK ABOVE TURQUOISE RESERVOIR, COLORADO
47. LAKE FORK CREEK BELOW SUGAR LOAF
48. LAMAR CANAL CO.
49. LARKSPUR DITCH AT MARSHALL PASS, COLORADO
50. LUNING ARROYO NEAR MODEL, CO
51. NINE MILE CANAL AT NINE MILE DAM NEAR HIGBEE, CO.
52. OXFORD FARMERS DITCH COMPANY
53. PUEBLO RESERVOIR NEAR PUEBLO, COLORADO
54. PUEBLO WATER WORKS DIVERSION
55. PURGATOIRE RIVER AT MADRID
56. PURGATOIRE RIVER AT NINEMILE DAM, NEAR HIGBEE
57. PURGATOIRE RIVER BELOW TRINIDAD RESERVOIR, CO.
58. PURGATOIRE RIVER NEAR LAS ANIMAS, COLORADO
59. PURGATOIRE RIVER NEAR THATCHER, COLORADO
60. ROCKY FORD HIGHLINE CANAL AT MILE 4.9 NEAR BOONE, CO
61. SOUTH ARKANSAS RIVER AT SALIDA, CO.
62. TIMPAS CREEK NEAR ROCKY FORD CO.
63. TWIN LAKES TUNNEL, COLORADO
64. WURTZ DITCH NEAR TENNESSEE PASS, CO
65. WURTZ EXTENSION DITCH NEAR TENNESSEE PASS, CO.

Division 3 Rio Grande River Basin

1. ALAMOSA CREEK ABOVE TERRACE RESERVOIR,CO CONEJOS CTY
2. ALAMOSA CREEK BELOW TERRACE RESERVOIR
3. BEAVER CREEK BELOW BEAVER CREEK RESERVOIR
4. BEAVER RESERVOIR
5. CLOSED BASIN PROJECT CANAL NEAR ALAMOSA, CO
6. CONEJOS RIVER BELOW PLATORO RESERVOIR, CO CONEJOS CO
7. CONEJOS RIVER NEAR LASAUSES - NORTH CHANNEL
8. CONEJOS RIVER NEAR MOGOTE
9. CONTINENTAL RESERVOIR NEAR CREEDE, CO.
10. DON LA FONT DITCH NO. 2 AT PIEDRA PASS, CO
11. LAJARA CREEK AT GALLEGOS RANCH NEAR CAPULIN, CO.

Stations Operated by the State of Colorado

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Division 3 Rio Grande River Basin (continued)

12. LOS PINOS RIVER NEAR ORTIZ
13. MEDANO CREEK AT GREAT SAND DUNES NATIONAL MONUMENT
14. MOUNTAIN HOME RESERVOIR IN COSTILLA COUNTY,COLORADO
15. NORTH CLEAR CREEK BELOW CONTINENTAL RESERVOIR,CO
16. NORTON DRAIN DITCH NEAR LASAUSES, CO.
17. PINOS CREEK NEAR DEL NORTE, CO
18. RIO GRANDE AT MONTE VISTA, CO
19. RIO GRANDE AT THIRTY MILE BRIDGE
20. RIO GRANDE CANAL NEAR DEL NORTE, CO.
21. RIO GRANDE NEAR DEL NORTE
22. RIO GRANDE NEAR LOBATOS, CO.
23. RIO GRANDE RESERVOIR NEAR CREEDE,CO
24. RIO GRANDE RIVER ABOVE THE MOUTH OF TRINCHERA CREEK
25. RIO GRANDE RIVER AT ALAMOSA, COLORADO
26. RIO GRANDE RIVER AT COUNTY LINE, CO.
27. RIO GRANDE RIVER NEAR CERRO, NM.
28. SAGUACHE CREEK NEAR SAGUACHE
29. SAN ANTONIO RIVER AT ORTIZ
30. SAN ANTONIO RIVER NEAR MANASSA, CO
31. SAND CREEK AT GREAT SAND DUNES NAT. MON.
32. SANGRE DE CRISTO CREEK NEAR FT. GARLAND
33. SOUTH CHANNEL CONEJOS RIVER NEAR LASAUSES, CO.
34. SOUTH CHANNEL NORTON DRAIN DITCH NEAR LA SAUSES, CO
35. SOUTH FORK OF THE RIO GRANDE RIVER AT SOUTH FORK
36. TABOR DITCH AT SPRING CREEK PASS,CO
37. TARBELL DITCH NEAR COCHETOPA PASS, CO
38. TERRACE RESERVOIR IN CONEJOS COUNTY, COLORADO
39. TRINCHERA CREEK AB. TURNER'S RANCH CO
40. TRINCHERA CREEK BELOW SMITH RESERVOIR, CO
41. UTE CREEK NEAR FORT GARLAND
42. WEMINUCHE PASS DITCH AT WEMINUCHE PASS, CO
43. WILLIAMS CREEK-SQUAW PASS DITCH AT SQUAW PASS, CO

Division 4 Gunnison River Basin

1. CIMARRON RIVER NEAR CIMARRON, CO - GUNNISON COUNTY
2. DALLAS CREEK NEAR RIDGWAY,CO - OURAY COUNTY
3. GUNNISON BELOW REDLANDS DIVERSION DAM
4. GUNNISON RIVER BELOW E. PORTAL GUNNISON TUNNEL
5. KANNAH CK AT JUNIATA ENLARGED DIVERSION
6. MUDDY CREEK ABOVE PAONIA RESERVOIR, CO - GUNNISON CO
7. MUDDY CREEK BELOW PAONIA RESERVOIR
8. REDLANDS CANAL NR GRAND JUNCTION, CO
9. SOUTH CANAL NR MONTROSE, CO - MONTROSE COUNTY
10. SURFACE CREEK AT CEDAREDGE, COLORADO, DELTA COUNTY
11. SURFACE CREEK NEAR CEDAREDGE
12. TAYLOR PARK RESERVOIR ELEVATION AND CONTENT
13. TEST 4
14. TROUT LAKE (LEVEL & ALARM) - TROUT LAKE, CO
15. TROUT LAKE (OUTFLOW) - TROUT LAKE, CO
16. UNCOMPAHGRE R. nr RIDGWAY, CO - OURAY COUNTY
17. UNCOMPAHGRE RIVER NR OLATHE, CO

Stations Operated by the State of Colorado

Office of the State Engineer

Division 5 **Colorado River Basin**

1. BLUE RIVER @ HIGHWAY 9 BRIDGE BLW BRECKENRIDGE, CO
2. BLUE RIVER AT FARMERS CORNER, BELOW SWAN RIVER
3. BLUE RIVER BELOW DILLON, CO SUMMIT COUNTY
4. BLUE RIVER BELOW GREEN MOUNTAIN RESERVOIR
5. COLORADO RIVER BELOW GRANBY RESERVOIR
6. COLORADO RIVER NEAR DOTSERO
7. COLORADO RIVER NEAR GRANBY,CO GRAND COUNTY
8. DILLON RESERVOIR SUMMIT COUNTY
9. EAGLE RIVER BELOW GYPSUM
10. FRYINGPAN RIVER NEAR RUEDI, CO EAGLE COUNTY
11. FRYINGPAN RIVER NEAR THOMASVILLE
12. GOVERMENT HIGHLINE CANAL
13. GRANBY RESERVOIR
14. GRAND VALLEY CANAL
15. GRASS VALLEY CANAL
16. GREEN MOUNTAIN RESERVOIR SUMMIT COUNTY
17. ORCHARD MESA IRRIGATION DISTRICT ABOVE PALISADE
18. OWENS CREEK
19. PLATEAU CREEK NEAR CAMEO
20. RIFLE CREEK BELOW RIFLE GAP RESERVOIR
21. RIFLE GAP RESERVOIR
22. ROARING FORK RIVER BELOW MAROON CREEK NEAR ASPEN, CO
23. SHADOW MOUNTAIN RESERVOIR GRAND COUNTY CO
24. SNAKE RIVER AT KEYSTONE SKI AREA, CO.
25. SNOWMASS CREEK
26. TENMILE CREEK BELOW NORTH TENMILE CREEK, AT FRISCO
27. THOMPSON CREEK FEEDER CANAL NEAR HAYSTACK, CO
28. VIDLER TUNNEL, WEST PORTAL
29. WEST DIVIDE CREEK NEAR RAVEN, CO
30. WILLIAMS FORK BELOW WILLIAMS FORK RESERVOIR
31. WILLIAMS FORK CREEK BELOW WF RESERVOIR
32. WILLOW CREEK BELOW WILLOW CREEK RESERVOIR
33. WILLOW CREEK PUMP CANAL
34. WILLOW CREEK RESERVOIR GRAND COUNTY CO

Division 6 **White & Yampa River Basin**

1. ELK RIVER NEAR MILNER
2. ILLINOIS RIVER NEAR RAND, COLORADO
3. MICHIGAN RIVER NEAR GOULD, COLORADO
4. MICHIGAN RIVER NEAR MEADOW CREEK RESERVOIR, COLORADO
5. NORTH PLATTE RIVER NEAR NORTHGATE, COLORADO
6. WILLOW CREEK BELOW STEAMBOAT LAKE
7. YAMCOLO RESERVOIR ELEVATION ABOVE YAMPA, CO
8. YAMPA RIVER ABOVE STAGECOACH RESERVOIR
9. YAMPA RIVER BELOW CRAIG

Stations Operated by the State of Colorado

Office of the State Engineer

Division 7 **Dolores & San Juan River Basins**

1. ANIMAS RIVER AT HOWARDSVILLE, CO
2. AZOTEA OUTLET TUNNEL NEAR CHAMA,NEW MEXICO
3. CASCADE CANAL ABOVE ELECTRA LAKE
4. CHERRY CREEK AT THE MOUTH NEAR RED MESA, CO.
5. DOLORES RIVER AT DOLORES, CO
6. DOLORES RIVER BELOW MCPHEE RESERVOIR,CO.
7. DOLORES TUNNEL OUTLET NEAR DOLORES,CO.
8. ENTERPRISE DITCH NEAR THE COLORADO-NEW MEXICO STATELINE
9. FLORIDA CANAL
10. FLORIDA RIVER ABOVE LEMON RESERVOIR
11. FLORIDA RIVER BELOW LEMON RESERVOIR,CO.
12. HAY GULCH ABOVE RED MESA WARD RESERVOIR
13. HERMOSA CREEK NEAR HERMOSA
14. JACKSON GULCH RESERVOIR INLET CANAL
15. LA PLATA AND CHERRY CREEK DITCH NEAR HESPERUS,CO.
16. LA PLATA RIVER AT HESPERUS
17. LA PLATA RIVER AT THE COLORADO/NEW MEXICO LINE
18. LA PLATA RIVER NEAR FARMINGTON, NM.
19. LITTLE NAVAJO RIVER BELOW LITTLE OSO DIVERSION DAM
20. LITTLE OSO DIVERSION NEAR CHROMO, CO
21. LONE PINE CANAL AT GREAT CUT DIKE NR DOLORES,CO.
22. LONG HOLLOW AT THE MOUTH NEAR RED MESA, CO.
23. LOST CANYON CREEK NEAR DOLORES, CO
24. MANCOS RIVER NEAR MANCOS
25. NAVAJO RIVER AT BANDED PEAKS RANCH NEAR CHROMO,CO.
26. NAVAJO RIVER BELOW OSO DIVERSION DAM NEAR CHROMO, CO
27. PINE RIDGE DITCH NEAR HESPERUS, CO
28. PINE RIVER BELOW VALLECITO RESERVOIR NEAR BAYFIELD
29. PIONEER DITCH AT THE COLORADO-NEW MEXICO STATELINE
30. RIO BLANCO BELOW BLANCO DIVERSION DAM NEAR PAGOSA
31. TOWAOC CANAL, EAST AND WEST METER READOUTS

Stations Operated by Other Entities
and
Monitored by the Division of Water Resources

Division 1 South Platte River Basin

	Entity	
1.	COE	BEAR CREEK AT MORRISON, COLORADO
2.	COE	BEAR CREEK AT SHERIDAN, COLORADO
3.	USGS	BUFFALO CR. AT MOUTH AT BUFFALO CREEK, CO.
4.	COE	CHATFIELD RESERVOIR
5.	USGS	CHERRY CREEK NEAR PARKER, CO.
6.	COE	CLEAR CREEK AT DERBY
7.	AURO	DIXON FLUME ON HOLLTHUSEN GULCH
8.	AURO	FOUR MILE AT HIGH CREEK
9.	AURO	FOUR MILE CREEK NEAR HARTSEL, CO
10.	AURO	FRENCH CREEK ABOVE CONFLUENCE WITH MICHIGAN CREEK
11.	USGS	GENEVA CREEK NEAR GRANT, COLORADO
12.	NCWCD	HANSEN FEEDER CANAL LOVELAND TURNOUT
13.	NCWCD	HANSEN SUPPLY CANAL 20' PARSHAL TO POUDRE RIVER
14.	NCWCD	HORSETOOTH RESERVOIR ELEVATION AND DISCHARGE
15.	AURO	JEFFERSON CREEK BELOW SYNDER CREEK
16.	AURO	JEFFERSON CREEK NEAR JEFFERSON
17.	AURO	MICHIGAN CREEK ABOVE JEFFERSON, COLORADO
18.	COSP	MID FORK SO. PLATTE ABOVE MONTGOMERY RES NR ALMA CO
19.	COSP	MID. FORK SO.PLATTE BELOW MONTGOMERY RESERVOIR
20.	AURO	MIDDLE FORK AT PRINCE
21.	AURO	MIDDLE FORK SANTA MARIA, CO
22.	USGS	NORTH FORK OF SAINT VRAIN CREEK, NEAR ALLENSPARK, CO
23.	AURO	OHLER GULCH NEAR JEFFERSON, COLORADO
24.	USGS	PRECIPITATION AT BUFFALO CR. AT MORRISON CR.
25.	USGS	PRECIPITATION AT SPRING CREEK @ LONG SCRAGGY RANCH
26.	AURO	ROCK CREEK ABOVE CONFLUENCE WITH TARRYALL CREEK
27.	AURO	SCHATTINGER FLUME ABOVE CONFLUENCE W/ MICHIGAN CRK.
28.	COE	SOUTH PLATTE RIVER AT DENVER, COLORADO
29.	AURO	SOUTH FORK PLATTE ABOVE ANTERO
30.	COE	SOUTH PLATTE RIVER ABOVE ELEVENMILE RESERVOIR
31.	AURO	SOUTH PLATTE RIVER ABOVE SPINNEY RESERVOIR
32.	COE	SOUTH PLATTE RIVER AT HENDERSON, CO.
33.	USGS	SOUTH PLATTE RIVER BELOW UNION ST. BRIDGE
34.	AURO	SPRING BRANCH ABOVE CONFLUENCE
35.	USGS	SPRING CR. ABOVE MOUTH NR. SOUTH PLATTE, CO.
36.	NCWCD	ST. VRAIN SUPPLY CANAL AT 15 FT. P.F. NR LYONS, CO
37.	AURO	TARRYALL CREEK AT BORDEN DITCH
38.	AURO	TARRYALL CREEK AT US 285 NR COMO, COLORADO
39.	AURO	TROUT CREEK AT CONFLUENCE
40.	AURO	TROUT CREEK NEAR GARO

Stations Operated by Other Entities
and
Monitored by the Division of Water Resources

Division 2 Arkansas River Basin

	Entity	
1.	USGS	ARKANSAS RIVER AT GARDEN CITY, KANSAS
2.	USGS	ARKANSAS RIVER AT LAMAR
3.	USGS	ARKANSAS RIVER AT PARKDALE, CO
4.	USGS	ARKANSAS RIVER AT SYRACUSE, KANSAS
5.	USGS	ARKANSAS RIVER NEAR COOLIDGE KANSAS
6.	USGS	ARKANSAS RIVER NEAR NATHROP, CO.
7.	USGS	BEAVER CREEK ABOVE HIGHWAY 115, NEAR PENROSE, CO.
8.	USGS	BEAVER CREEK ABOVE UPPER BEAVER CEMETERY
9.	COSP	BEAVER CREEK NEAR PORTLAND
10.	COSP	BOB CREEK AT COLORADO CANAL
12.	COSP	FOUNTAIN CREEK AT COLORADO SPRINGS, CO.
13.	COSP	FOUNTAIN CREEK AT MOUTH, PUEBLO, CO
14.	COSP	FOUNTAIN CREEK AT PUEBLO, CO
15.	COSP	FOUNTAIN CREEK NEAR FOUNTAIN, CO.
16.	USGS	FOUNTAIN CREEK NEAR PINON, COLORADO
17.	COSP	FOUNTAIN CREEK NEAR SECURITY, CO
18.	USGS	FOUR MILE CREEK NEAR CANON CITY, CO.
19.	USGS	FRONTIER DITCH, KANSAS
20.	USGS	HUERFANO RIVER RIVER NEAR BOONE, CO.
21.	COSP	LAKE CREEK ABOVE TWIN LAKES RESERVOIR, CO
22.	COSP	LAKE HENRY RESERVOIR CONTENT AND OUTFLOW
23.	NWS	LEADVILLE 2SW, CO
24.	COSP	MEREDITH RESERVOIR INFLOW NEAR ORDWAY
25.	COSP	MEREDITH RESERVOIR OUTFLOW
26.	COSP	MERRIDITH RESERVOIR CONTENT
27.	USGS	MONUMENT CREEK AT PIKEVIEW
28.	USGS	PURGATOIRE RIVER AT ROCK CROSSING NEAR TIMPAS, CO.
29.	COE	PURGATOIRE RIVER AT TRINIDAD, CO
30.	AURO	ROCKY FORD DITCH NEAR MANZANOLA
31.	COSP	ROSEMONT RESERVOIR NEAR PUEBLO
32.	USGS	ST. CHARLES R. AT VINELAND, CO
33.	COSP	SUGAR CITY FLUME, SUGAR CITY, CO
34.	USGS	TELLER RESERVOIR NEAR STONE CITY, CO.

Stations Operated by Other Entities and Monitored by the Division of Water Resources

Division 3 Rio Grande River Basin

	Entity	
1.	USGS	COSTILLA CREEK NEAR COSTILLA, NM
2.	USGS	COSTILLA RESERVOIR NEAR COSTILLA, NM
3.	NMEX	PLATORO RESERVOIR
4.	COE	RIO CHAMA ABOVE ABIQUIU DAM
5.	COE	RIO CHAMA BELOW ABIQUIU DAM
6.	NMEX	RIO CHAMA BELOW EL VADO, N. MEXICO
7.	COE	RIO CHAMA NEAR CHAMITA, NM
8.	COE	RIO GRANDE AT EMBUDO, NM
9.	COE	RIO GRANDE AT OTAWI BRIDGE NR SAN ILDEFONSO, NM
10.	NMEX	RIO GRANDE BELOW OLD FORT QUITMAN, TX.
11.	USGS	RIO GRANDE NEAR WAGON WHEEL GAP, CO.
12.	NWS	RIO GRANDE RESERVIOR WEATHER STATION
13.	COE	RIO GRANDE RIVER AT ALBUQUERQUE, NM

Division 4 Gunnison River Basin

1.	NWS	BLUE MESA RESERVOIR, GUNNISON COUNTY, COLO.
2.	USGS	COCHETOPA CREEK BELOW ROCK CREEK NEAR PARLIN, CO.
3.	NWS	CRESTED BUTTE, CO (CLIMATALOGICAL)
4.	NWS	DOLORES RIVER NEAR BEDROCK, CO - MONTROSE COUNTY
5.	NWS	EAST RIVER AT ALMONT
6.	USGS	EAST RIVER BELOW CEMENT CREEK
7.	NWS	GUNNISON RIVER AT DELTA
8.	USGS	GUNNISON RIVER NEAR GRAND JUNCTION
9.	USGS	GUNNISON RIVER NEAR GUNNISON
10.	NWS	GUNNISON RIVER NEAR SOMERSET - NORTH FORK
11.	USGS	LAKE FORK AT GATEVIEW, COLORADO.
12.	NWS	OURAY, CO (CLIMATALOGICAL)
13.	USGS	PAONIA RESERVOIR NR BARDINE, CO
14.	NWS	PAONIA, CO (CLIMATOLOGICAL)
15.	USGS	RIDGWAY RESERVOIR, OURAY COUNTY
16.	USGS	SAN MIGUEL RIVER AT BROOKS BRIDGE NEAR NUCLA, CO
17.	USGS	SAN MIGUEL RIVER AT URIVAN, CO MONTROSE COUNTY
18.	NWS	SARGENTS, CO (CLIMATALOGICAL)
19.	USGS	SILVERJACK RESERVOIR NR CIMARRON, CO
20.	USGS	SLATE RIVER NEAR CRESTED BUTTE
21.	NWS	TAYLOR PARK RESERVOIR, GUNNISON COUNTY, COLO
22.	NWS	TAYLOR RIVER AT ALMONT
23.	USGS	TAYLOR RIVER AT TAYLOR PARK RESERVOIR (INFLOW)
24.	USGS	TOMICHI CREEK AT GR UNNISON, COLORADO

Stations Operated by Other Entities and Monitored by the Division of Water Resources

	Entity	
25.	USGS	UNCOMPAHGRE RIVER AT COLONA
26.	USGS	UNCOMPAHGRE RIVER AT DELTA, CO.
27.	USGS	UNCOMPAHGRE RIVER BELOW RIDGWAY RESERVOIR

Division 5 Colorado River Basin

1.	NWS	BRECKENRIDGE 5S, CO (CLIMATOLOGY)
2.	BOR	CHAPMAN CONTROL HOUSE
3.	NCWCD	COLORADO RIVER ABOVE WINDY GAP
4.	NCWCD	COLORADO RIVER AT K BARGER DITCH NEAR KREMMLING
5.	NWS	COLORADO RIVER BELOW GLENWOOD SPRINGS
6.	NCWCD	COLORADO RIVER BELOW WINDY GAP AT CHIMNEY ROCK, CO.
7.	USGS	COLORADO RIVER NEAR CAMEO
8.	USGS	COLORADO RIVER NEAR COLORADO-UTAH STATE LINE
9.	USGS	COLORADO RIVER NEAR DE BEQUE, CO
10.	USGS	COLORADO RIVER NEAR KREMMLING
11.	USGS	COLORADO RIVER NEAR PALISADE
12.	NCWCD	COLORADO RIVER NEAR PARSHALL
13.	NWS	CRYSTAL RIVER ABOVE AVALANCHE CREEK NEAR REDSTONE
14.	NWS	DILLON 1 E, CO (CLIMATOLOGY)
15.	USGS	EAGLE RIVER AT AVON, CO
16.	NWS	EAGLE RIVER AT RED CLIFF, COLORADO
17.	USGS	EAGLE RIVER NEAR MINTURN, CO
18.	USGS	EAST ELK CR. ABV BOILER CR NR NEW CASTLE, CO
19.	NCWCD	FRASER RIVER NEAR GRANDBY
20.	USGS	FRENCH CREEK GULCH
21.	USGS	GORE CREEK AT MOUTH NEAR MINTURN
22.	NWS	GRAND LAKE, CO (CLIMATOLOGY)
23.	COSP	HOMESTAKE CREEK AT GOLD PARK CAMPGROUND, CO.
24.	COSP	HOMESTAKE RESERVOIR
25.	COSP	HOOSIER PASS TUNNEL AT INLET (NORTH PORTAL)
26.	USGS	HUNTER CREEK NEAR ASPEN, CO
27.	USGS	LAKE CREEK NEAR EDWARDS, CO.
28.	BOR	LINCOLN CREEK BELOW GRIZZLY RESERVOIR
29.	USGS	MAIN ELK CREEK NR NEW CASTLE, CO.
30.	NWS	MEREDITH, CO (CLIMATOLOGY)
31.	BOR	MORMON CONTROL HOUSE
32.	USGS	MUDDY CREEK ABOVE ANTELOPE CREEK
33.	USGS	MUDDY CRK BLW WOLFORD MTN RESER NR KREMMLING
34.	USGS	PINEY RIVER NEAR STATE BRIDGE COLORADO

Stations Operated by Other Entities and Monitored by the Division of Water Resources

Division 5 Colorado River Basin (cont.)

	Entity	
35.	USGS	ROARING FORK R ABV DIFFICULT CR NR ASPEN, CO
36.	NWS	ROARING FORK RIVER ABOVE ASPEN
37.	BOR	ROARING FORK RIVER ABOVE LOST MAN CREEK
38.	USGS	ROARING FORK RIVER AT GLENWOOD SPRINGS
39.	USGS	ROCK CREEK AT CRATER, CO
40.	NWS	RUEDI RESERVOIR NEAR BASALT CO
41.	NCWCD	TROUBLESOME CREEK NEAR KREMMLING.
42.	COSP	UPPER BLUE RESERVOIR NEAR BRECKENRIDGE, CO
43.	NWS	WINTER PARK, CO (CLIMATOLOGY)
44.	USGS	WOLFORD MOUNTAIN RESERVOIR

Division 6 White & Yampa River Basins

1.	USGS	ELK HEAD CREEK ABOVE LONG GULCH
2.	USGS	ELK HEAD CREEK BELOW MAYNARD GULCH
3.	USGS	FISHCREEK NEAR STEAMBOAT SPRINGS, CO.
4.	NWS	GREEN RIVER NEAR JENSEN, UTAH
5.	NWS	LITTLE SNAKE RIVER NEAR DIXON, WY
6.	NWS	LITTLE SNAKE RIVER NEAR LILY, CO
7.	USGS	LITTLE SNAKE RIVER NEAR SLATER, CO.
8.	USGS	NORTH FORK WHITE RIVER AT BUFORD
9.	USGS	SLATER FORK NEAR SLATER, CO.
10.	USGS	SOUTH FORK WHITE RIVER AT BUFORD
11.	USGS	WHITE RIVER BELOW BOISE CREEK NEAR RANGLEY
12.	USGS	WHITE RIVER BELOW MEEKER CO
13.	NWS	WHITE RIVER NEAR MEEKER
14.	USGS	WILLIAMS FORK NEAR HAMILTON CO
15.	USGS	YAMPA RIVER ABOVE LITTLE SNAKE RIVER NR MAYBELL CO
16.	USGS	YAMPA RIVER AT DEERLODGE PARK CO
17.	USGS	YAMPA RIVER AT STEAMBOAT SPRINGS
18.	USGS	YAMPA RIVER BELOW STAGECOACH RESERVOIR
19.	USGS	YAMPA RIVER NEAR MAYBEL
20.	USGS	YAMPA RIVER NEAR OAK CREEK, COLORADO

Stations Operated by Other Entities
and
Monitored by the Division of Water Resources

Division 7 Dolores & San Juan River Basins

	Entity	
1.	NWS	ANIMAS RIVER AT DURANGO
2.	USGS	ANIMAS RIVER BELOW SILVERTON, CO.
3.	USGS	ANIMAS RIVER NEAR CEDAR HILL, NM .
4.	NWS	DOLORES RIVER BELOW RICO, CO
5.	USGS	DOLORES RIVER NEAR SLICKROCK, CO
6.	USGS	LEMON RESERVOIR NEAR DURANGO, CO.
7.	USGS	PIEDRA RIVER NEAR ARBOLES, CO
8.	USGS	SAN JUAN RIVER AT FARMINGTON, NM.
9.	NWS	SAN JUAN RIVER AT PAGOSA SPRINGS, CO
10.	USGS	SAN JUAN RIVER NEAR CARRACAS, CO
11.	USGS	VALLECITO CREEK NEAR BAYFIELD
12.	NWS	VALLECITO RESERVOIR, CO.

Entity Abbreviation Legend

AURO	City of Aurora
BOR:	Bureau of Reclamation
COE:	Army Corp of Engineers
COSP;	City of Colorado Springs
NCWCD:	Northern Colorado Water Conservancy District
NMEX	State of New Mexico
NWS:	National Weather Service
USGS:	United States Geological Survey

II. SYSTEM APPLICATION

A. Water Rights Administration

The primary utility of the Colorado satellite-linked monitoring system is for water rights administration. The availability of real-time data from a network of key gaging stations in each major river basin in Colorado provides an overview of the hydrologic conditions of the basin that was previously not available. By evaluating real-time data for upstream stations, downstream flow conditions can typically be predicted 24 to 48 hours in advance. This becomes an essential planning tool in the hands of the Division Engineers and Water Commissioners. The "river call" can be adjusted more precisely to satisfy as many water rights as possible. Access to real-time data makes it possible to adjust the "river call" to match dynamic hydrologic conditions. If additional water supplies are available, more junior rights can be satisfied. On the other hand, if water supplies decrease, then water use can be curtailed to protect senior rights.

The administration of water rights in Colorado is becoming increasingly more complex due to increased demands, implementation of augmentation plans, water exchanges, transmountain diversions, and minimum stream flow requirements. For example, the number of water rights increased by 23% from 1982 to 1988, from 102,028 to 124,994. This increase in the number of water rights has continued to the present. Plans for water rights transfers approved by the water courts are becoming increasingly complex. This is especially evident where agricultural water rights are transferred to municipal use.

There is considerable interest in monitoring transmountain diversions, both by western slope water users and the eastern slope entities diverting the water. Transmountain diversion water is administered under different laws than water originating in the basin. In general, this water may be claimed for reuse by the diverter until it is totally consumed. Forty transmountain diversions are monitored by the system.

Water exchanges between water users are becoming increasingly frequent. These exchanges can provide for more effective utilization of available water resources in high demand river basins, but can be difficult to administer. The satellite-linked monitoring system has proven to be an integral component in monitoring and accounting of these exchanges.

Many municipalities and major irrigation companies have reservoir storage rights. Generally, these entities can call for release of stored water on demand. The Division Engineer must be able to delineate the natural flow from the storage release while in the stream. He then must track the release and ensure that the proper delivery is made. The system has demonstrated to be effective in this area.

The utility of the system in the administration of interstate compacts is an especially important application. The State Engineer has the responsibility to deliver defined amounts of water under the terms of the various interstate compacts, but not to over-deliver and deprive Colorado of its entitlement. Fifteen stations incorporated in the statewide monitoring network are utilized for the effective administration of these interstate compacts.

The majority of the large, senior water rights in Colorado belong to irrigation companies. These rights are often the calling right in the administration of a water district. The direct diversion rights exercised can affect significantly the hydrology of the river. Twenty-one major irrigation diversions are monitored by the system.

Water rights have been acquired by federal and state agencies to guarantee minimum stream flow for both the recreational and fisheries benefits. The availability of real-time data is essential in ensuring that these minimum stream flows are maintained.

B. Hydrologic Records Development

Specialized software programs provide for the processing of raw hydrologic data on a real-time basis. Conversions such as stage-discharge relationships and shift applications are performed on a real-time basis as the data transmissions are received. Mean daily values are computed automatically each day for the previous day. Data values that fall outside of user defined normal or expected ranges are flagged appropriately. Flagged data values are not utilized in computing mean daily values. Missing values can be added and invalid data values corrected by the respective hydrographer for that station using data editing functions. The records development software was significantly modified to allow for progressive records development. Computations are carried out by the computer alleviating the chance for human error.

Data can be retrieved and displayed in various formats including the standardized U. S. Geological Survey-Water Resources Division annual report format adopted by the Colorado Division of Water Resources for publication purposes. An advantage of real-time hydrologic data collection is in being able to monitor the station for on-going valid data collection. If a sensor or recorder fails, the hydrographer is immediately aware of the problem and can take corrective action before losing a significant amount of data.

It is essential to understand that real-time records can be different from the final record for a given station. This can be the result of editing raw data values because of sensor calibration errors, sensor malfunctions, analog-to-digital conversion errors, or parity errors. Discharge conversions can be modified by the entering of more current rating tables and shifts. Corrections to the data are sometimes necessary to compensate for hydrologic effects such as icing. Human error can also result in invalid data. The final record for those gauging stations operated by non-state entities, such as the U. S. Geological Survey-Water Resources Division, is the responsibility of that entity. Modifications to the real-time records for these stations are accepted by the state of Colorado.

C. Water Resources Accounting

Currently, the satellite-linked monitoring system is being utilized for accounting for the Colorado River Decision Support System (CRDSS), the Colorado-Big Thompson Project, the Dolores Project, and the Fryingpan-Arkansas Project Winter Water Storage. The ability to input real-time data into these accounting programs allows for current and on-going tabulations. Since the computations are performed on a computer, the accuracy is increased significantly.

D. Dam Safety

Dam safety monitoring has developed in recent years into a major issue. Numerous on-site parameters are of interest to the State Engineer in assessing stability of a dam. At this time, the system monitors forty reservoirs in Colorado. Currently, the parameters monitored are limited to inflow, outflow, and stage elevation. These data do, however, provide a basis for evaluating current operating conditions as compared to specific operating instructions. The installation and operation of additional sensor types could provide essential data on internal hydraulic pressure, vertical and horizontal movement, and seepage rates.

E. Automated Flood Warning System

The Office of the State Engineer, Division of Water Resources, in cooperation with the National Weather Service-Central Forecast Office (NWS-CFO) in Denver, operates a statewide flood warning system utilizing 92 stream gaging stations that are part of the Colorado satellite-linked water resources monitoring network operated by the State Engineer. The NWS-CFO, which operates on a 24-hour basis, is alerted to changing flow conditions. If conditions warrant, either a flood WATCH or a flood WARNING is issued.

Table 1 lists the incorporated stream gaging stations with the designated alert levels used to flag high water conditions. A synopsis of how the system operates follows:

1. Remote Data Collection/Data Transmission

Stream stage levels are measured and recorded every fifteen minutes for transmission at standard 4-hour intervals. If stage alert levels are surpassed, emergency transmissions are made at random intervals of from 2-10 minutes. All transmissions are sent via the Geostationary Operational Environmental Satellite (GOES). Transmissions are received and processed at the receive site located in Denver operated by the State Engineer.

2. Flagging High Water Levels

Data are screened in an automated fashion by the system's central computer to flag high water levels. The central computer automatically contacts the NWS-CFO by phone giving a voice-synthesized message that relays pertinent information. The transmission is not completed until the message is received and verified. A file is generated in the computer that lists all stations reporting high water levels during the last hour.

3. Hydrologic Conditions Assessment

The NWS-CFO Official-In-Charge (OIC) immediately accesses by computer terminal the satellite monitoring system data base to further evaluate overall upstream and downstream flow conditions for the effected watershed. Sophisticated software including color graphics capability allows the user to effectively evaluate the data. The OIC follows up by consulting with the NWS regional offices of Pueblo, Grand Junction, Colorado Springs, and Alamosa. Radar coverage is utilized to identify and determine the intensity of precipitation events. The appropriate county sheriff offices and official spotters are contacted for verification of hydrologic conditions.

4. Watch/Warning Dissemination

If flooding is considered a possibility, a WATCH is issued. If flooding is considered to be imminent, a WARNING is issued. The National Warning System (NAWAS), utilizing the Colorado State Highway Patrol and the Colorado Division of Disaster Emergency Services (DODES) communications networks, is utilized to contact the various law enforcement agencies and county emergency preparedness offices. These agencies in turn provide a "fanout" to secondary points of contact including hospitals, schools, etc. Public announcements are made over the National Weather Service designated VHF-FM radio frequencies, known as the National Weather Radio (NWR), and through the news media via the Automation of Field Operations and Services (AFOS) national weather

wire. In the Denver metropolitan area, the Metropolitan Emergency Telephone System (METS) is utilized.

It is important to comprehend inherent limitations of the satellite monitoring system relative to its utilization as a warning system. There are no absolute safeguards against false alarms. Sensor malfunctions are an obvious cause for such false alarms. However, the computer can be programmed to ignore data values that are not plausible. For example, stage values greater than 10 to 15 feet are not physically possible at most stream gaging stations. In the event of a flash flood in a narrow, confined canyon, the remote data collection hardware would be washed away. This is especially the case for a station operating downstream of a failed dam. Ice jams on a river can cause the upstream stage to increase and consequently provide invalid discharge conversions. There is always a time lapse from the time a hydrologic event occurs to when the system identifies that it has occurred and when a random (emergency) transmission is sent. If an event occurs at 1410 hours, the system is not aware of the condition until 1415 hours since the DCP is programmed to activate at even 15-minute intervals to record a data measurement. The DCP then computes a transmit interval utilizing a random number generator. This interval is between 2 and 10 minutes. If a 6-minute interval is utilized, the random transmission will be made at 1421 hours. The elapsed time from event occurrence to transmission of data is 11 minutes. Scenarios could be given which would give a minimum elapse time of two minutes or a maximum elapse time of 24 minutes. In addition, a random transmission occurring on channel 118 has approximately a 20% chance (with current channel load levels) of not being received due to interference with another random transmission being sent at the same time.

TABLE 1

SATELLITE MONITORING SYSTEM
FLOOD WARNING NETWORK

DIVISION 1 South Platte River Basin		CODE	VALUE	DISCHARGE
1.	BEAR CREEK AT MORRISON	GAGE_HT	5.5	1500
2.	BEAR CREEK AT SHERIDAN	GAGE_HT	6.5	2600
3.	BIG THOMPSON RIVER AT DRAKE, NORTH FORK	GAGE_HT	5.5	600
4.	BIG THOMPSON RIVER NEAR DRAKE	GAGE_HT	5	3000
5.	BUCKHORN CREEK NEAR MASONVILLE	GAGE_HT	5.5	2000
6.	CACHE LA POUDRE AT CANYON MOUTH	GAGE_HT	6.5	4000
7.	CACHE LA POUDRE NEAR GREELEY	GAGE_HT	7	3000
8.	CLEAR CREEK AT LAWSON	GAGE_HT	6	1500
9.	NORTH FORK SOUTH PLATTE RIVER AT BAILEY	GAGE_HT	1.9	1290
10.	SAINT VRAIN CREEK AT LYONS	GAGE_HT	6	3500
11.	SO. PLATTE RIVER AT DENVER	GAGE_HT	7.86	9000
12.	SOUTH PLATTE RIVER AT HENDERSON	STAGE	6	8000
13.	SOUTH PLATTE RIVER AT WATERTON	GAGE_HT	5	3500
14.	SOUTH PLATTE RIVER NEAR KERSEY	GAGE_HT	7	8000
15.	SOUTH PLATTE RIVER NEAR WELDONA	GAGE_HT	7	8000
DIVISION 2 Arkansas River Basin				
1.	ARKANSAS RIVER AT CATLIN DAM NEAR FOWLER	GAGE_HT	6.7	5000
2.	ARKANSAS RIVER NEAR AVONDALE	GAGE_HT	5.7	5000
3.	ARKANSAS RIVER NEAR WELLSVILLE	GAGE_HT	7.9	4000
4.	FOUNTAIN CREEK NEAR PINON	GAGE_HT	7.8	4000
5.	PURGATOIRE RIVER NEAR LAS ANIMAS	GAGE_HT	8	1500
6.	PURGATOIRE RIVER NEAR THATCHER	GAGE_HT	11.3	1200
DIVISION 3 Rio Grande River Basin				
1.	ALAMOSA CREEK ABOVE TERRACE RESERVOIR	GAGE_HT	3.52	2000
2.	ALAMOSA CREEK BELOW TERRACE RESERVOIR	GAGE_HT	5.5	1280
3.	CONEJOS RIVER NEAR LASAUSES	GAGE_HT	6.7	1600
4.	CONEJOS RIVER NEAR MOGOTE	GAGE_HT	5.96	2500
5.	LAJARA CREEK AT GALLEGOS RANCH	GAGE_HT	5.41	350
6.	LOS PINOS RIVER NEAR ORTIZ	GAGE_HT	5.93	1650
7.	NORTH CLEAR CREEK BELOW CONTINENTAL RES.	GAGE_HT	3.5	550
8.	PINOS CREEK NEAR DEL NORTE	GAGE_HT	3.04	500
9.	RIO GRANDE AT MONTE VISTA	GAGE_HT	7.49	4200
10.	RIO GRANDE AT THIRTY MILE BRIDGE	GAGE_HT	4.75	6000
11.	RIO GRANDE NEAR DEL NORTE	GAGE_HT	5.6	7800
12.	RIO GRANDE RIVER AT ALAMOSA	GAGE_HT	7.91	5000
13.	RIO GRANDE RIVER AT COUNTY LINE	GAGE_HT	10.3	2400
14.	SAGUACHE CREEK NEAR SAGUACHE	GAGE_HT	4	600
15.	SAN ANTONIO RIVER AT ORTIZ	GAGE_HT	5	900
16.	SAN ANTONIO RIVER NEAR MANASSA	GAGE_HT	7	800
17.	SANGRE DE CRISTO CREEK NEAR FT. GARLAND	GAGE_HT	4.96	350
18.	SOUTH FORK OF THE RIO GRANDE RIVER	GAGE_HT	6.22	2500
19.	TRINCHERA CREEK AB. TURNER'S RANCH	GAGE_HT	3	250
20.	UTE CREEK NEAR FORT GARLAND	GAGE_HT	3.5	250

SATELLITE MONITORING SYSTEM
FLOOD WARNING NETWORK (continued)

DIVISION 4 Gunnison River Basin

		CODE	VALUE	DISCHARGE
1.	CIMARRON RIVER NEAR CIMARRON	GAGE_HT	4.15	1450
2.	EAST RIVER AT ALMONT	GAGE_HT	6	3000
3.	GUNNISON RIVER AT DELTA	GAGE_HT	9.75	18500
4.	GUNNISON RIVER BELOW E. PORTAL	GAGE_HT	9.55	9000
5.	GUNNISON RIVER NEAR SOMERSET –N. FORK	GAGE_HT	7.1	7000
6.	MUDDY CREEK ABOVE PAONIA RESERVOIR	GAGE_HT	9.57	1800
7.	MUDDY CREEK BELOW PAONIA RESERVOIR	GAGE_HT	8.08	2680
8.	REDLANDS CANAL NR GRAND JUNCTION	GAGE_HT	8	875
9.	SAN MIGUEL RIVER NR. PLACERVILLE	GAGE_HT	5.75	2100
10.	SURFACE CREEK AT CEDAREDGE	GAGE_HT	3.15	550
11.	SURFACE CREEK NEAR CEDAREDGE	GAGE_HT	3.4	630
12.	UNCOMPAHGRE R. nr RIDGWAY	GAGE_HT	4.9	3000
13.	UNCOMPAHGRE RIVER NR OLATHE	GAGE_HT	9.95	2000

DIVISION 5 Colorado River Basin

1.	BLUE RIVER AT FARMERS CORNER	GAGE_HT	6.6	1500
2.	BLUE RIVER BELOW DILLON	GAGE_HT	3.8	2000
3.	BLUE RIVER BELOW GREEN MOUNTAIN RES.	GAGE_HT	9.1	6000
4.	COLORADO RIVER NEAR CAMEO	GAGE_HT	10	23000
5.	COLORADO RIVER NEAR DOTSERO	GAGE_HT	11.5	16100
6.	COLORADO RIVER NEAR KREMMLING	GAGE_HT	10	18000
7.	CRYSTAL RIVER ABOVE AVALANCHE CREEK	GAGE_HT	4.75	2500
8.	EAGLE RIVER BELOW GYPSUM	GAGE_HT	8	5800
9.	FRYINGPAN RIVER NEAR RUEDI EAGLE	GAGE_HT	3.2	1300
10.	FRYINGPAN RIVER NEAR THOMASVILLE	GAGE_HT	4	1250
11.	GORE CREEK AT MOUTH NEAR MINTURN	GAGE_HT	9	1180
12.	MUDDY CRK BLW WOLFORD MTN RES.	GAGE_HT	8	2000
13.	PLATEAU CREEK NEAR CAMEO	GAGE_HT	7.4	4200
14.	RIFLE GAP RESERVOIR	GH_1	4.2	175
15.	ROARING FORK RIVER ABOVE ASPEN	GAGE_HT	4.5	1000
16.	WILLIAMS FORK BELOW WILLIAMS FORK RES.	GH_1	6	1300
17.	WILLIAMS FORK CREEK BELOW WF RESERVOIR	GAGE_HT	5.9	3000
18.	WILLOW CREEK BELOW WILLOW CREEK RES.	GAGE_HT	5.3	2300

DIVISION 6 Yampa & White River Basins

1.	ELK HEAD CREEK ABOVE LONG GULCH	GAGE_HT	7	1880
2.	ELK HEAD CREEK BELOW MAYNARD GULCH	GAGE_HT	6.5	2280
3.	ELK RIVER NEAR MILNER	GAGE_HT	6	4800
4.	ILLINOIS RIVER NEAR RAND	GAGE_HT	4	565
5.	LITTLE SNAKE RIVER NEAR DIXON, WY	GAGE_HT	9	4440
6.	YAMPA RIVER NEAR MAYBEL	GAGE_HT	11	16000

DIVISION 7 Dolores & San Juan River Basins

1.	ANIMAS RIVER AT DURANGO	GAGE_HT	6	6000
2.	DOLORES RIVER AT DOLORES	GAGE_HT	7	6500
3.	DOLORES RIVER NEAR RICO	GAGE_HT	5	1400
4.	FLORIDA RIVER ABOVE LEMON RESERVOIR	GAGE_HT	3.9	1200
5.	FLORIDA RIVER BELOW LEMON RES.	GAGE_HT	5	1000
6.	LA PLATA RIVER AT HESPERUS	GAGE_HT	3.88	500

SATELLITE MONITORING SYSTEM
FLOOD WARNING NETWORK (continued)

DIVISION 7 Dolores & San Juan River Basins	CODE	VALUE	DISCHARGE
7. LA PLATA RIVER AT CO./NM. STATELINE	GAGE_HT	5.57	800
8. LOST CANYON CREEK DOLORES	GAGE_HT	7.3	500
9. MANCOS RIVER NEAR MANCOS	GAGE_HT	6	1500
10. NAVAJO RIVER AT BANDED PEAKS RANCH	GAGE_HT	3.25	1500
11. NAVAJO RIVER BELOW OSO DIVERSION DAM	GAGE_HT	4.8	2000
12. RIO BLANCO BELOW BLANCO DIVERSION DAM	GAGE_HT	4.37	1200
13. SAN JUAN RIVER AT PAGOSA SPRINGS	GAGE_HT	7.5	5000
14. VALLECITO CREEK NEAR BAYFIELD	GAGE_HT	3.43	1500

III. OPERATING BUDGET

SATELLITE MONITORING SYSTEM
FY 97-98

		Budget	Actual	Proposed FY-98-99
I.	Personnel Costs	$ 128,000	$ 127,886	$ 132,000
II.	Operating Costs			
	A. Computer Operation and Maint.	$ 4,000	$ 3,675	$ 4,000
	B. Required Maintenance	50,000	49,942	48,000
	C. Telecommunications	35,000	29,675	30,000
	D. Travel and Training	10,000	15,204	18,000
	E. Other	5,000	2,336	4,000
	Sub-Total	$ **104,000**	$ **100,832**	$ **104,000**
III.	Capital Outlay	$ 40,000	$ 44,562	$ 35,000
	Total	**$ 272,000**	**$ 273,280**	**$ 271,000**

Notes:

1. The Total Budget of $ 271,000 for Fiscal Year 98-99 is based upon estimated appropriations of $ 220,000, User Fee collections totaling $ 50,000 and Interest earned of $1,000.

2. In addition to Satellite Monitoring Operation and Maintenance Funds listed above, funding amounting to $ 120,000 was received from the Colorado Water Conservation Board's Construction Funds. This money was allocated for Electronic Equipment Replacement and Gauging Station Renovation. These funds were spent as follows:

	Actual FY 97-98	Proposed FY 98-99
Electronic Equipment Replacement	$ 88,119	$ 85,000
Gauging Station Renovation	31,881	35,000
Total	**$120,000**	**$120,000**

3. An additional $ 120,000 was approved by Colorado Water Conservation Board for Fiscal Year 1998-99.

IV. FUNDING SOURCES

A. FY 97-98 FUNDING

Two hundred eighteen thousand nine hundred eight ($218,908) was appropriated from the General Fund for the operation of the satellite-linked monitoring system for FY 97-98. A total of $317,485 was approved for total program expenditures. The remaining $98,577 was to be collected from user fees, pursuant to Section 37-80-111.5 (c), C.R.S. (1985 Supplement).

In FY 97-98, user fees amounting to $52,024.64 were collected. Interest on cash funds amounted to $1,329. The following is a summary of the fees collected in FY 97-98:

City of Aurora	$8,697
Arkansas River Compact Commission	8,400
Dolores Water Conservancy District	6,500
Public Service Company	4,800
Aspen Consolidated Sanitation District	3,700
Pueblo Board of Water Works	2,400
Denver Water Department	2,400
Southwestern Water Conservancy District	2,400
State of Wyoming	1,550
Santa Maria Reservoir Company	1,200
Farmers Reservoir and Irrigation Company	1,200
Urban Drainage and Flood Control District	1,200
Metro Wastewater Reclamation District	1,200
Centennial Water & Sanitation District	1,200
City of Ft. Morgan	1,200
Clinton Ditch and Reservoir Co.	872
Town of Breckenridge	872
Colorado Division of Parks	800
Other Revenue	733.64
Rio Grande Canal Water Users Association	700
Total	$52,024.64

Total funds available for FY 97-98 amounted to $272,262. A summary of the funding is as follows:

General Fund Appropriation	$218,908
Users Fees	52,025
Interest on Cash Funds	1,329
Total	$272,262

Actual expenditures for FY 97-98 amounted to $273,280 leaving a fund balance of $20,255. The fund balance is an accumulation of un-spent year-end funds going back to FY 85-86. The amount of fees collected in any given year varies. Fees are also received throughout the fiscal year rather than at the beginning of the fiscal year. Efforts are made so as to not overspend against available funds.

V. WATERTALK LIST

DIVISION ONE

1 ADAMS TUNNEL
2 BEAR CREEK AT MORRISON
3 BEAR CREEK RESERVOIR
4 BEAR CREEK AT SHERIDAN
5 BIG THOMPSON AT MOUTH NEAR LASALLE
6 SOUTH BOULDER CREEK BELOW GROSS RESERVOIR
7 SOUTH BOULDER CREEK NEAR ELDORADO SPRINGS
8 BOULDER CREEK AT BOULDER
9 BOULDER CREEK NEAR ORODELL
10 BIG THOMPSON RIVER ABOVE LAKE ESTES
11 BIG THOMPSON RIVER BELOW LAKE ESTES
12 NORTH FORK, BIG THOMPSON RIVER, NEAR DRAKE
13 BIG THOMPSON RIVER, AT MOUTH OF CANYON
14 BURLINGTON CANAL
15 CHATFIELD RESERVOIR
16 CHEESMAN RESERVOIR
17 CHERRY CREEK RESERVOIR
18 CACHE LA POUDRE RIVER, AT FORT COLLINS
19 CACHE LA POUDRE AT CANYON MOUTH, FORT COLLINS
20 CACHE LA POUDRE NEAR GREELEY
21 CLEAR CREEK AT DERBY
22 CLEAR CREEK NEAR GOLDEN
23 CLEAR CREEK NEAR LAWSON
24 FOUR MILE CREEK, NEAR HARTSEL
25 FOUR MILE CREEK, AT HIGH CREEK
26 GRAND RIVER DITCH
27 HANSEN FEEDER CANAL WASTE WAY
28 HOOSIER PASS TUNNEL
29 JEFFERSON CREEK, NEAR JEFFERSON
30 LARAMIE POUDRE TUNNEL
31 LOWER LATHAM CANAL
32 MICHIGAN CREEK, ABOVE JEFFERSON
33 METRO SEWER EFFLUENT, AT DENVER
34 MIDDLE FORK, AT PRINCE
35 MIDDLE FORK, AT SANTA MARIA
36 MOFFAT TUNNEL
37 OHLER GULCH, NEAR JEFFERSON
38 OLYMPUS TUNNEL
39 SOUTH PLATTE RIVER, NEAR BALZAC
40 SOUTH PLATTE RIVER, BELOW CHEESMAN RESERVOIR
41 SOUTH PLATTE RIVER, AT DENVER
42 NORTH FORK, OF THE SOUTH PLATTE RIVER, AT GRANT
43 PLATTE RIVER, ABOVE ELEVENMILE RESERVOIR
44 SOUTH PLATTE RIVER, AT HENDERSON
45 SOUTH PLATTE RIVER, AT JULSBURG, LEFT CHANNEL
46 SOUTH PLATTE RIVER, AT JULSBURG, RIGHT CHANNEL
47 SOUTH PLATTE RIVER, NEAR KERSEY
48 SOUTH PLATTE RIVER, AT FORT LUPTON
49 SOUTH PLATTE RIVER, ABOVE SPINNEY RESERVOIR
50 SOUTH PLATTE RIVER, AT SOUTH PLATTE
51 SOUTH PLATTE RIVER, BELOW STRONTIA SPRINGS
52 SOUTH PLATTE RIVER, AT WATERTON
53 SOUTH PLATTE RIVER, NEAR WELDONA
54 RIVERSIDE CANAL
55 ROBERTS TUNNEL
56 SOUTH FORK PLATTE RIVER, ABOVE ANTERO RES.
57 NORTH STERLING CANAL
58 SAINT VRAIN CREEK AT LYONS
59 SAINT VRAIN CREEK AT MOUTH
60 TARRYALL CREEK, AT US 285, NEAR COMO
61 UNION DITCH, NEAR GILCREST
62 PLATTE RIVER, AT UNION AVENUE.
63 SOUTH PLATTE RIVER, BELOW ANTERO RESERVOIR.
64 FORT MORGAN CANAL HEAD GATE NEAR WIGGINS.
65 STERLING NUMBER 1 DITCH.
66 SOUTH SAINT VRAIN CREEK NEAR WARD COLORADO.
67 NORTH SAINT VRAIN CREEK NEAR ALLENS PARK.
68 SOUTH PLATTE RIVER BELOW CHATFIELD RESERVOIR.
69 SAND CREEK NEAR COLORADO-WYOMING STATE LINE.
70 BOREAS PASS.
71 BUTTON ROCK RESERVOIR.
72 BUCK HORN CREEK NEAR MASONVILLE.
73 LARAMIE RIVER NEAR GLENDEVY, COLORADO.
74 TARRYALL CREEK BELOW TARRYALL RESERVOIR.
75 HARMONY NUMBER 1 DITCH AT HEADGATE
76 PAWNEE DITCH AT HEADGATE NEAR MESSEX.
77 WILSON SUPPLY DITCH NEAR EATON RESERVOIR.
78 PLATTE RIVER NEAR LAKE GEORGE.
79 NORTH FORK OF THE SOUTH PLATTE RIVER AT BAILEY.
80 JEFFERSON CREEK BELOW SNYDER CREEK.
81 ROCK CREEK AT CONFLUENCE OF TARRYALL CREEK.
82 TARRYALL CREEK AT BORDEN DITCH.
83 GREELEY LOVELAND DIVERSION DAM.
84 BOULDER CREEK AT NORTH 75TH STREET.
85 LITTLE DRY CREEK NEAR GREENWOOD VILLAGE.
86 NEW CACHE LA POUDRE CANAL AT 25 NEAR TIMNATH.
87 CACHE LA POUDRE RIVER BELOW 25
88 OLYMPUS DAM AT ESTES PARK.
89 MARY'S LAKE NEAR ESTES PARK.
90 LARIMER AND WELD IRRIGATION DITCH.
91 CACHE LA POUDRE RIVER BELOW LARIMER AND WELD.
92 WESTERN MUTUAL DITCH A.K.A. HEWES COOK.
93 EVANS #2 DITCH.
94 MIDDLE BOULDER CREEK AT NEADERLAND.
95 SOUTH PLATTE RIVER AT FORT MORGAN.
96 LEFT HAND DIVERSION NEAR WARD COLORADO.
97 S. BOULDER CREEK ABOVE GROSS RESERVOIR
98 BIJOU CANAL.
99 RALSTON CREEK, ABOVE RALSTON RESERVOIR
100 SOUTH PLATTE RIVER CHANNEL 1
101 LOWER PLATTE AND BEAVER CANAL
102 TOWN OF LYONS DIVERSON
103 CANAL # 3
104 VIDLER TUNNEL NEAR ARGENTINE PASS
105 MIDDLE SAINT VRAIN AT PEACEFUL VALLEY
106 CHERRY CREEK NEAR PARKER
107 DILLE TUNNEL NEAR DRAKE
108 THOMPSON AT CANYON MOUTH NEAR BERTHOUD
109 BOULDER LARIMER DITCH
110 N. FORK CACHE LA POUDRE BELOW HALLIGAN RES.

DIVISION TWO

1 AMITY CANAL
2 ARKANSAS RIVER, NEAR AVONDALE
3 ARKANSAS RIVER, AT CATLIN DAM, NEAR FOWLER
4 ARKANSAS RIVER, NEAR COOLIDGE, KANSAS
5 ARKANSAS RIVER, AT GRANADA
6 ARKANSAS RIVER, BELOW JOHN MARTIN RESERVOIR
7 ARKANSAS RIVER, AT LA JUNTA
8 ARKANSAS RIVER, AT LAS ANIMAS
9 ARKANSAS RIVER, NEAR NEPESTA
10 ARKANSAS RIVER, AT PORTLAND
11 ARKANSAS RIVER, ABOVE PUEBLO
12 ARKANSAS RIVER, NEAR WELLSVILLE
13 BOB CREEK, AT CANAL
14 CHARLES H BOUSTEAD TUNNEL
15 BUSK IVANHOE TUNNEL
16 CROOKED ARROYO, NEAR SWINK
17 CATLIN CANAL, AT CATLIN DAM, NEAR FOWLER
18 CHEYENNE CREEK, NEAR KANSAS STATELINE
19 COLORADO CANAL, AT MILE 3.8, NEAR BOONE
20 COLUMBINE DITCH
21 EWING DITCH
22 FORT LYON STORAGE CANAL
23 FORT LYON CANAL
24 FOUNTAIN CREEK NEAR PINION
25 FRONTIER DITCH, KANSAS
26 LAKE HENRY RESERVOIR, CONTENT AND OUTFLOW

VI. WATERTALK LIST (cont.)

DIVISION TWO (cont.)

27 HOLBROOK CANAL AT MILE 3.4, NEAR ROCKY FORD
28 HOMESTAKE TUNNEL
29 HORSE CREEK AT HIGHWAY 194
30 JOHN MARTIN RESERVOIR, AT CADDOA
31 KICKING BIRD CANAL
32 LAKE CREEK BELOW TWIN LAKES
33 LAMAR CANAL
34 LARKSPUR DITCH, AT MARSHALL PASS
35 LAKE FORK CREEK, BELOW SUGARLOAF
36 LAKE FORK CREEK, ABOVE TURQUOISE RESERVOIR
37 MERRIDITH RESERVOIR INFLOW, NEAR ORDWAY
38 MERRIDITH RESERVOIR CONTENT AND OUTFLOW
39 OXFORD FARMERS DITCH COMPANY
40 PUEBLO RESERVOIR, NEAR PUEBLO
41 PUEBLO WATER WORKS DIVERSION
42 PURGATORIE RIVER, BELOW TRINIDAD RESERVOIR
43 PURGATORIE RIVER, NEAR LAS ANIMAS
44 PURGATORIE RIVER, AT MADRID
45 PURGATORIE RIVER, AT NINE MILE DAM, NEAR HIGBEE
46 PURGATORIE RIVER, NEAR THATCHER
47 ROCKY FORD HIGHLINE CANAL, MILE 4.9, NEAR BOONE
48 TIMPAS CREEK, NEAR ROCKY FORD
49 TWIN LAKES TUNNEL
50 WURTZ DITCH NEAR TENNESSEE PASS
51 CUCHARAS RIVER ABOVE CUCHARAS RES.
52 CUCHARAS RIVER BELOW CUCHARAS RES.
53 CUCHARAS RESERVOIR
54 CUCHARAS RESERVOIR SEEPAGE FLUME
55 FOUNTAIN CREEK AT COLORADO SPRINGS
56 FOUNTAIN CREEK NEAR SECURITY
57 FOUNTAIN CREEK NEAR FOUNTAIN
58 FOUNTAIN CREEK AT PUEBLO
59 ARKANSAS RIVER NEAR NATHROP
60 ARKANSAS RIVER NEAR PARK DALE
61 LAKE CREEK ABOVE TWIN LAKES.
62 FOUNTAIN CREEK AT MOUTH.
63 COTTON WOOD CREEK NEAR BUENA VISTA.
64 ARKANSAS RIVER AT CANYON CITY.
65 ARKANSAS RIVER AT GRANITE.
67 ARKANSAS RIVER AT SALIDA.
68 HUERFANO RIVER AT BADITO, NEAR WALSENBURG.
69 ARKANSAS RIVER AT NATHROP.
70 GRAPE CREEK NEAR WEST CLIFF.
71 CHALK CREEK AT MOUTH NEAR NATHROP.
72 SOUTH ARKANSAS RIVER AT SALIDA, CO.

DIVISION THREE

1 ALAMOSA CREEK, ABOVE TERRACE RESERVOIR
2 CLOSED BASIN PROJECT CANAL, NEAR ALAMOSA
3 CONEJOS RIVER, NEAR MOGOTE
4 CONEJOS RIVER, BELOW PLATORO RESERVOIR
5 CONTINENTAL RESERVOIR, NEAR CREEDE
6 LA JARA CREEK, AT GALLEGOS RANCH
7 LOS PINOS RIVER, NEAR ORTIZ
8 NORTH CHANNEL CONEJOS RIVER, NEAR LASAUSES
9 PLATORO RESERVOIR
10 RIO GRANDE RIVER, AT ALAMOSA
11 RIO GRANDE CANAL, NEAR DEL NORTE
12 RIO GRANDE, NEAR DEL NORTE
13 RIO GRANDE, NEAR LOBATOS
14 RIO GRANDE, AT THIRTY MILE BRIDGE
15 RIO GRANDE, AT MONTE VISTA
16 RIO GRANDE RESERVOIR
17 SOUTH FORK, RIO GRANDE RIVER, AT SOUTH FORK
18 RIO GRANDE RIVER, ABOVE TRINCHERA CREEK
19 SAGUACHE CREEK, NEAR SAGUACHE
20 SAN ANTONIO RIVER, AT ORTIZ
21 SOUTH CHANNEL, CONEJOS RIVER, NEAR LASAUSES
22 TABOR DITCH AT SPRING CREEK PASS
23 TERRACE RESERVOIR
24 MOUNTAIN HOME RESERVOIR.
25 TRINCHERA CREEK, ABOVE TURNERS RANCH.
26 UTE CREEK, NEAR FORT GARLAND.
27 BEAVER RESERVOIR.
28 NORTH CLEAR CREEK BELOW CONTINENTAL RES., CO.
29 SAND CREEK AT GREAT SAND DUNES NTL MONUMENT CO
30 ALAMOSA CREEK BELOW TERRACE RESERVOIR.
31 NORTON DRAIN DITCH NEAR LASAUSES.
32 PINOS CREEK NEAR DEL NORTE.
33 RIO GRANDE RIVER AT COUNTY LINE.
34 SANGRE DE CRISTO CREEK NEAR FORT GARLAND.
35 SAN ANTONIO RIVER NEAR MANASSA.
36 TRINCHERA CREEK BELOW SMITH RESERVOIR.
37 MEDANO CREEK AT GREAT SAND DUNES
38 TARBELL DITCH NEAR COCHETOPA PASS

DIVISION FOUR

1 BLUE MESA RESERVOIR, GUNNISON COUNTY
2 CIMARRON RIVER, NEAR CIMARRON, GUNNISON
3 DALLAS CREEK, NEAR RIDGEWAY, OURAY COUNTY
4 DOLORES RIVER, NEAR BEDROCK, MONTROSE COUNTY
5 EAST RIVER, AT ALMONT
6 GUNNISON RIVER, BELOW EAST PORTAL, GUNNISON R.
7 GUNNISON RIVER, AT DELTA, DELTA COUNTY
8 GUNNISON RIVER, NEAR GRAND JUNCTION
9 GUNNISON RIVER, NEAR GUNNISON COUNTY
10 MUDDY CREEK, ABOVE PAONIA RES. GUNNISON
11 MUDDY CREEK, BELOW PAONIA RES., GUNNISON
12 NORTH FORK, OF THE GUNNISON RIVER, SOMERSET
13 PAONIA RESERVOIR, NEAR BARDINE
14 REDLANDS CANAL, NEAR GRAND JUNCTION
15 RIDGWAY RESERVOIR, NEAR RIDGWAY, OURAY
16 KANNAH CREEK NEAR JUNIATA ENLARGEMENT
17 SAN MIGUEL RIVER, NEAR PLACERVILLE
18 SILVER JACK RESERVOIR, NEAR CIMARRON
19 SOUTH CANAL, NEAR MONTROSE, MONTROSE COUNTY
20 SURFACE CREEK, AT CEDAREDGE, DELTA COUNTY
21 SURFACE CREEK, NEAR CEDAREDGE, DELTA COUNTY
22 TAYLOR RIVER, AT ALMONT
23 TAYLOR PARK RESERVOIR, GUNNISON COUNTY
24 TROUT LAKE RESERVOIR, SAN MIGUEL COUNTY
25 TROUT LAKE RESERVOIR, OUT FLOW
26 UNCOMPAHGRE RIVER, AT COLONA, MONTROSE
27 UNCOMPAHGRE RIVER, BELOW RIDGEWAY RESERVOIR
28 UNCOMPAHGRE RIVER, NEAR RIDGEWAY, OURAY CTY
29 UNCOMPAHGRE RIVER, NEAR OLATHE, OURAY COUNTY.
30 TOMICHI CREEK NEAR GUNNISON.
31 LAKE FORK AT GATEVIEW, COLORADO.
32 GUNNISON RIVER BELOW REDLANDS DIVERSION DAM.
33 UNCOMPAHGRE RIVER AT DELTA.
34 EAST RIVER BELOW CEMENT CREEK.
35 COCHETOPA CREEK NEAR PARLIN.
36 SAN MIGUEL RIVER AT BROOKS BRIDGE.
37 SLATE RIVER NEAR CRESTED BUTTE.
38 SAN MIGUEL RIVER AT URIVAN.

DIVISION FIVE

1 BLUE RIVER, BELOW DILLON, SUMMIT COUNTY
2 BLUE RIVER, BELOW GREEN MTN RES., SUMMIT
3 COLORADO RIVER, NEAR CAMEO
4 COLORADO RIVER, NEAR DOTSERO, EAGLE COUNTY
5 COLORADO RIVER, BELOW GRANBY RES., GRAND CTY
6 COLORADO RIVER, BELOW GLENWOOD SPRINGS
7 COLORADO RIVER, NEAR KREMMLING
8 COLORADO RIVER, NEAR GRANBY, GRAND COUNTY
10 COLORADO RIVER, NEAR COLORADO UTAH STATE LINE
12 CRYSTAL RIVER, ABOVE AVALANCHE CREEK, REDSTONE
13 DILLON RESERVOIR, SUMMIT COUNTY
14 EAGLE RIVER, BELOW GYPSUM, EAGLE COUNTY

VI. WATERTALK LIST (cont.)

DIVISION FIVE (cont.)

15 EAGLE RIVER, AT RED CLIFF
16 FRASER RIVER, NEAR WINDY GAP
17 FRYINGPAN RIVER, NEAR RUEDI, EAGLE COUNTY
18 FRYINGPAN RIVER, NEAR THOMASVILLE, PITKIN COUNTY
19 GOVERNMENT HIGHLINE CANAL
20 GRANBY RESERVOIR
21 GRAND VALLEY CANAL
22 GREEN MOUNTAIN RESERVOIR, SUMMIT COUNTY
23 GRASS VALLEY CANAL
25 LINCOLN CREEK, BELOW GRIZZLY RESERVOIR
26 PINEY RIVER, NEAR STATE BRIDGE
27 PLATEAU CREEK, NEAR CAMEO
29 RIFLE GAP, BELOW GAP RESERVOIR
30 ROARING FORK RIVER, NEAR ASPEN
31 ROARING FORK RIVER, BELOW MAROON CREEK
32 ROARING FORK RIVER, AT GLENWOOD SPRINGS
33 ROARING FORK RIVER, ABOVE LOST MAN CREEK
34 RUEDI RESERVOIR, NEAR BASALT
35 SHADOW MOUNTAIN RESERVOIR, GRAND COUNTY
40 WILLOW CREEK PUMP CANAL, GRAND COUNTY
41 WILLIAMS FORK, BELOW WILLIAMS FK RES. GRAND CTY
42 WILLOW CREEK RESERVOIR, GRAND COUNTY
43 WILLOW CREEK, BELOW WILLOW CREEK RESERVOIR
44 WILLIAMS FORK RESERVOIR
45 COLORADO RIVER NEAR PALISADE
46 COLORADO RIVER AT B. KENNY-BARRIGER DITCH
47 MUDDY CREEK ABOVE ANTELOPE CREEK.
48 MUDDY CREEK NEAR KREMMLING
49 RIFLE GAP RESERVOIR.
50 COLORADO RIVER AT CHIMNEY ROCK.
51 COLORADO RIVER BELOW WINDY GAP.
52 COLORADO RIVER AT PARSHALL.
54 BLUE RIVER AT FARMERS CORNER
55 ORCHARD MESA IRRIGATION DIST. ABOVE PALISADE.
56 TENMILE CREEK BELOW NORTH TENMILE CREEK
57 GORE CREEK AT MOUTH NEAR MINTURN.
58 BLUE RIVER AT HI-WAY 9 BRIDGE B. BRECKENRIDGE.
59 EAGLE RIVER AT AVON

DIVISION SIX

1 YAMPA RIVER AT CRAIG.
2 ELK RIVER NEAR MILNER
3 YAMPA RIVER AT STEAMBOAT SPRINGS
4 ILLINOIS RIVER NEAR RAND
5 LITTLE SNAKE RIVER, NEAR DIXON, WYOMING
6 LITTLE SNAKE RIVER, NEAR LILY
7 ELK HEAD CREEK ABOVE LONG GULCH.
8 MICHIGAN CREEK, NEAR GOULD
9 NORTH PLATTE RIVER, NEAR NORTH GATE
10 ELK HEAD CREEK BELOW MAYNARD GULCH.
11 WHITE RIVER, NEAR MEEKER
12 YAMPA RIVER, NEAR MAYBELL
13 YAMPA RIVER, BELOW STAGE COACH RESERVOIR
14 YAMPA RIVER, ABOVE STAGE COACH RESERVOIR
15 YAMCOLO RESERVOIR
16 NORTH FORK OF THE WHITE RIVER AT BUFORD.
17 WILLOW CREEK, BELOW STEAMBOAT LAKE.
18 WHITE RIVER BELOW BOISE CREEK
19 SOUTH FORK OF THE WHITE RIVER AT BUFORD
20 PEARL LAKE
21 STEAM BOAT LAKE

DIVISION SEVEN

1 ANIMAS RIVER, NEAR CEDAR HILL, NEW MEXICO
2 ANIMAS RIVER, AT DURANGO
3 AZOTEA OUTLET TUNNEL, CHAMA, NEW MEXICO
4 CHERRY CREEK, AT MOUTH NEAR RED MESA
5 DOLORES RIVER, BELOW MCPHEE RESERVOIR
6 DOLORES RIVER, AT DOLORES, MONTEZUMA COUNTY
7 DOLORES RIVER, NEAR RICO
8 DOLORES TUNNEL OUTLET, NEAR DOLORES
9 FLORIDA RIVER, ABOVE LEMON RES., NEAR DURANGO
10 FLORIDA RIVER, BELOW LEMON RESERVOIR
11 LA PLATA RIVER, AT HESPERUS, LA PLATA COUNTY
12 LA PLATA RIVER, AT THE COLORADO NEW MEXICO LINE
13 LONG HOLLOW, AT THE MOUTH, NEAR RED MESA
14 LOST CANYON CREEK, DOLORES, MONTEZUMA COUNTY
15 LA PLATA AND CHERRY CREEK DITCH, NEAR HESPERUS
16 MANCOS RIVER, NEAR MANCOS
17 LONE PINE CANAL, AT GREAT CUT DIKE, NEAR DOLORES
18 NAVAJO RIVER, BELOW OSO DIVERSION DAM, CHROMO
19 PINE RIVER, BELOW VALLECITO RESERVOIR, BAYFIELD
20 RIO BLANCO, BELOW BLANCO DIVERSION DAM, PAGOSA
21 SAN JUAN RIVER, AT FARMINGTON, NEW MEXICO
22 SAN JUAN RIVER, AT PAGOSA SPRINGS
23 VALLECITO RESERVOIR
24 RIO BLANCO DIVERSION, NEAR PAGOSA SPRINGS.
25 DIVERSION NEAR CHROMO.
26 PIONEER DITCH AT STATE LINE.
27 ENTERPRISE DITCH AT STATE LINE.
28 HAY GULCH ABOVE RED MESA WARD RESERVOIR
29 U CANAL BELOW GREAT CUT DIKE, CO.
30 VALLECITO CREEK NEAR BAYFIELD.
31 FLORIDA CANAL.
32 PINE RIDGE DITCH NEAR HESPERUS.
33 JACKSON GULCH RESERVOIR, INLET CANAL.
34 NAVAJO RIVER AT BANDED PEAKS RANCH.

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