SURFACE-WATER AND SUSPENDED-SEDIMENT INFLOW AND OUTFLOW FOR NUTRIA RESERVOIR NO. 3, ZUNI INDIAN RESERVATION, NEW MEXICO, MARCH 1994 TO SEPTEMBER 1995

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 98-4083

Prepared in cooperation with the

PUEBLO OF ZUNI

USGS
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By Allen C. Gellis

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Albuquerque, New Mexico
1998

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
inch	2.54	centimeter
foot	0.3048	meter
mile	1.609	kilometer
acre	0.4047	hectare
square mile	2.590	square kilometer
cubic foot	0.02832	cubic meter
acre-foot	0.001233	cubic hectometer
cubic foot per second	0.02832	cubic meter per second
pound per cubic foot	16.02	kilogram per cubic meter
ton, short	907.2	kilogram
ton per acre-foot	0.0007357	megagram per cubic meter

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F = 9/5\ (°C) + 32$$

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

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Abstract

Surface-water and suspended-sediment inflow to and outflow from Nutria Reservoir No. 3 on the Zuni Indian Reservation, western New Mexico, were calculated. The period of study was March 3, 1994, to September 30, 1995. Total runoff into Nutria Reservoir No. 3 during the study period was 6,812 acre-feet.

During the study period, 24,310 tons of suspended sediment was transported into Nutria Reservoir No. 3, and 259 tons of suspended sediment was transported out of Nutria Reservoir No. 3. Runoff during the study period, recorded at an upstream gage with 25 years of record, was 137 percent higher than that for a 19-month period similar to the study period. This may indicate that suspended-sediment loads transported into Nutria Reservoir No. 3 also were larger than average. Based on the difference between inflow and outflow of suspended sediment, 24,050 tons of suspended sediment was deposited in Nutria Reservoir No. 3. From March 1994 to May 1994 the spillway elevation of Nutria Reservoir No. 3 was raised to allow water to be diverted into an adjacent reservoir, Nutria Reservoir No. 4. This flow and sediment transported into Nutria Reservoir No. 4 were not recorded. If the elevation of the spillway had not been raised, suspended-sediment loads recorded downstream from Nutria Reservoir No. 3 would have been larger and the calculated amount of sediment deposited in Nutria Reservoir would have been smaller.

Of the total suspended-sediment load entering Nutria Reservoir No. 3 during the study period, 94 percent was transported by an arroyo, Garcia Draw. Garcia Draw drains only 15 percent of the total drainage area of Nutria Reservoir No. 3 and contributed less than 5 percent of the total surface runoff to the reservoir.

The average annual amount of sediment deposited in Nutria Reservoir No. 3 during the study was 15,355 tons. By using a dry-weight density of 99.4 pounds per cubic foot for the deposited sediment, the annual volume of sediment deposited in Nutria Reservoir No. 3 is 7.09 acre-feet per year. This number is smaller than the previously reported sedimentation rate of 15.0 acre-feet per year obtained from past surveys. The capacity of Nutria Reservoir No. 3 in 1993 was 191 acre-feet. By using the calculated average sedimentation rate of 7.09 acre-feet per year, Nutria Reservoir No. 3 could be completely filled approximately 27 years after the 1993 survey.

INTRODUCTION

Nutria Reservoir No. 3 is located on the Zuni Indian Reservation, western New Mexico. The reservoir was formed in 1934 by the construction of a dam on the Rio Nutria (fig. 1) (Rossillon and Lewandowski, 1969). The dam was reinforced in 1937. The original reservoir storage capacity of Nutria Reservoir No. 3 in 1934 was 1,076 acre-feet (Rossillon and Lewandowski, 1969). Surveys by the U.S. Army Corps of Engineers in 1993 showed a loss in storage capacity of 82 percent (Easterling and Associates and Resource Consultants and Engineers, 1995) (table 1) due to sedimentation.

Purpose and Scope

An investigation of wetland dynamics in the upper Rio Nutria watershed on the Zuni Indian Reservation was conducted in cooperation with the Pueblo of Zuni. Wetlands on the reservation, especially in the upper Rio Nutria watershed, were

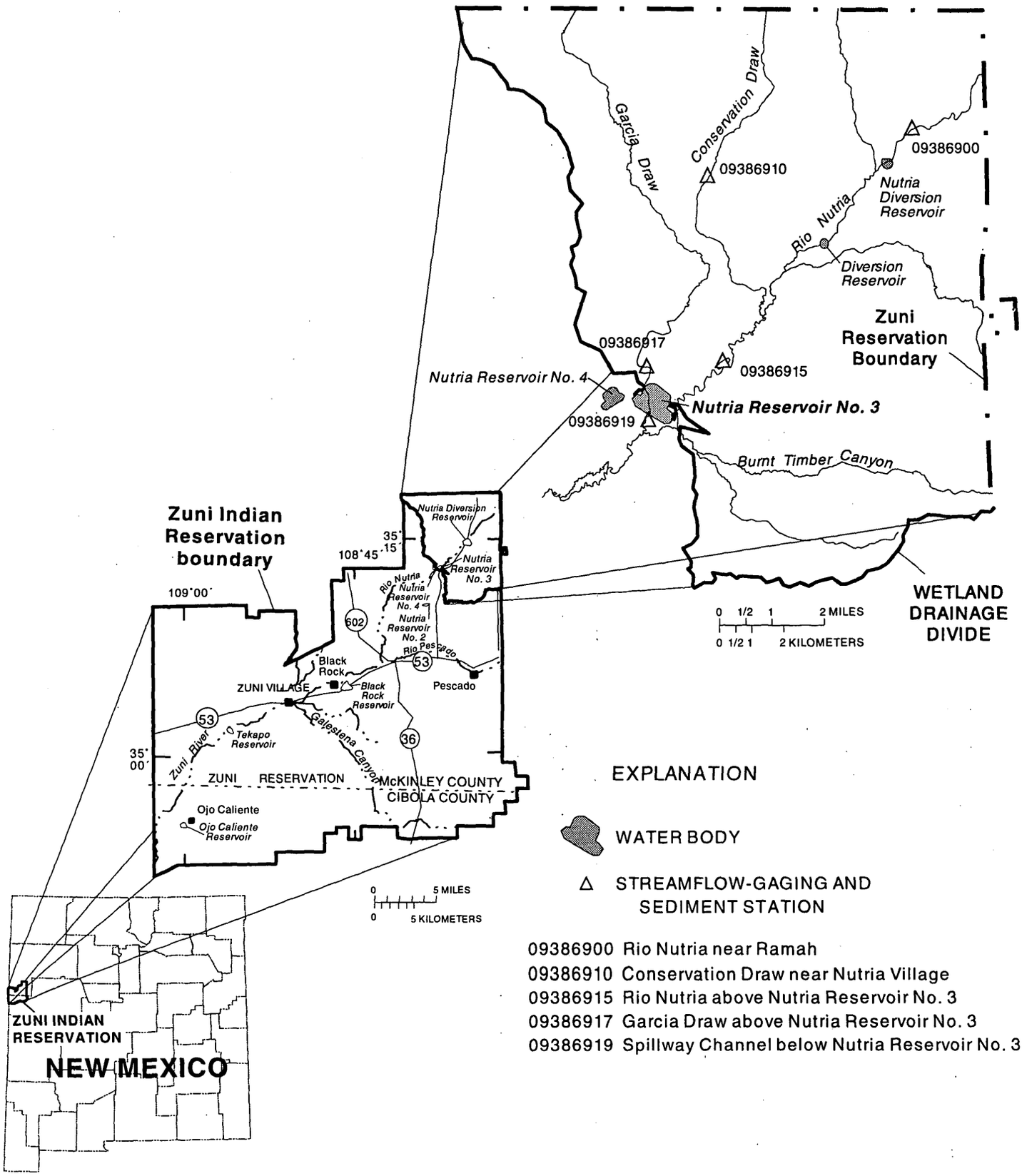

Figure 1.--Location of Zuni Indian Reservation, Nutria Reservoir No. 3, and streamflow-gaging and sediment stations.

thought to be degrading at a rapid rate from sedimentation. This report describes the interpretation of data collected from March 3, 1994, to September 30, 1995, for surface-water and suspended-sediment inflow to and outflow from Nutria Reservoir No. 3. The report was prepared in cooperation with the Pueblo of Zuni.

Table 1.--Volume and sedimentation rate for Nutria Reservoir No. 3

Volume (acre-feet)	1934	[1]1993
Volume (acre-feet)	[2]1,076	191
Decrease from original volume (acre-feet)	NA	885
Decrease from original volume in 1934 (percent)	NA	82
Elapsed time (years)	NA	25
Mean sedimentation rate (acre-feet per year)	NA	15.0 (1934-93)

[1]Easterling and Associates and Resource Consultants and Engineers (1995)
[2]Original reservoir storage capacity (Rossillon and Lewandowski (1969)

Description of the Study Area

The 408,400-acre Zuni Indian Reservation (fig. 1) is located in the southern portion of the Colorado Plateau physiographic province in western New Mexico. Landform features are flat-topped and gently sloping mesas, dissected by intermittent and ephemeral streams. Elevations on the reservation range from 6,000 to 7,700 feet above sea level. The climate of the Zuni Indian Reservation is semiarid. The average annual rainfall reported at Black Rock (fig. 1) is 12.2 inches. Three major vegetation zones are present in the study area: sage from about 6,100 to 6,700 feet; piñon-juniper from about 6,500 to 7,200 feet; and ponderosa pine higher than 6,900 feet above sea level. Primary land uses are sheep and cattle grazing in the valley bottoms and irrigation and dry-land farming. The population in 1990 was 8,996.

Nutria Reservoir No. 3 is connected to an off-site reservoir, Nutria Reservoir No. 4, by a diversion channel. Nutria Reservoir No. 4 receives most of its inflow from Nutria Reservoir No. 3. The drainage area of Nutria Reservoir No. 3 at the spillway is 149 square miles. The upper reaches of the Rio Nutria drain the Zuni Mountains, which reach elevations of 8,400 feet. Flow is intermittent in the Rio Nutria, and runoff occurs during spring snowmelt and high-precipitation events. Tributaries to the Rio Nutria are arroyos, which are channels incised into alluvium that have only ephemeral flow.

METHODS OF INVESTIGATION

To measure the inflow and outflow of surface water and calculate suspended-sediment concentration to and from Nutria Reservoir No. 3, two U.S. Geological Survey (USGS) streamflow-gaging stations were installed upstream (March 1994) and one was installed downstream (December 1993) from Nutria Reservoir No. 3 (fig. 1). The two stations measuring inflow to Nutria Reservoir No. 3 are Rio Nutria above Nutria Reservoir No. 3 (station 09386915) and Garcia Draw above Nutria Reservoir No. 3 (station 09386917) (fig. 1). Flow is intermittent in the Rio Nutria above Nutria Reservoir No. 3 and is ephemeral in Garcia Draw. The streamflow-gaging station downstream from Reservoir No. 3 is Spillway Channel below Nutria Reservoir No. 3 (station 09386919).

Two other USGS streamflow-gaging stations located in upstream portions of the Rio Nutria Basin were used to quantify streamflow and suspended-sediment concentration. These stations are Rio Nutria near Ramah (09386900) and Conservation Draw near Nutria Village (09386910) (fig. 1). The Rio Nutria near Ramah station has been in operation since 1970. The station on Conservation Draw has been in operation since 1992.

When flow was present at each station, monthly measurements of streamflow and surface water (stage) were made; during periods of high flow more frequent measurements were made. A rating curve was developed from the relation of stage and streamflow and used to estimate streamflow when only stage was known (Kennedy, 1984). Stage values were obtained from automatic digital recorders installed at each station using a 15-minute recording interval. These 15-minute data were then used to compute mean daily streamflows.

Sediment collection at each station was limited to suspended sediment; bed load was not collected. When flow was present, suspended-sediment samples were routinely collected two times a week at each station; during high flows, when suspended-sediment transport rates were assumed to be highest, samples were collected more frequently. Conventional U.S. Series depth-integrating DH-48 samplers were used to collect samples of suspended sediment at various points in the cross section using the equal-width increment method (Edwards and Glysson, 1988).

All streamflow-gaging stations were instrumented with an automatic pump sampler. Pump samplers were used in addition to the DH-48 samplers because they could collect suspended sediment during flash-flood runoff events or at times when personnel could not reach the station. The automatic pump sampler is a portable device capable of collecting 24 separate, sequential water-sediment samples from a single point in the streamflow. The pump sampler is activated by stage and collects samples at set time intervals when streamflow exceeds a predetermined stage. The samplers have a peristaltic pump system that transports the sample from the stream to the sample bottle. Before and after sampling, the sampler automatically clears the suction line.

Suspended-sediment samples from the DH-48 sampler and the automatic pump sampler were brought to the laboratory for determination of suspended-sediment concentration by the evaporation method (Guy, 1969). In the evaporation method, sediment is allowed to settle in the bottom of the sample bottle and the supernatant liquid is decanted. The sediment is washed into an evaporating dish, dried in an oven, and later weighed.

The concentration of suspended sediment is equal to the ratio of the dry weight of sediment to the volume of the water-sediment mixture. This concentration is computed as a weight-to-weight ratio and is expressed in parts per million (ppm). A conversion factor is used to convert ppm to milligrams per liter (mg/L) using the assumptions that water density is equal to 1,000 grams per milliliter plus or minus 0.005; that temperature is 0.0 to 290 °C; that specific gravity of suspended sediment is 2.65; and that dissolved-solids concentration is less than 10,000 ppm (Guy, 1969). For concentrations less than 15,900 ppm, the conversion factor is one.

Because suspended-sediment concentrations vary with streamflow, all concentration values need to be considered as instantaneous and representative of only that streamflow at that given location and time. Based on the author's experience, streams with low suspended-sediment concentration at low flows may not be as well mixed as streams with high suspended-sediment concentration at high flows. Samples of suspended sediment collected at a point by automatic pump samplers need to be calibrated with depth-integrated samples collected at that point to assure that they are representative of the concentration in the flow. The closer the calibration is to 1, the better the sediment is mixed with the flow. The standard technique of simultaneously collecting suspended-sediment samples by depth integrating and by automatic pump sampler was not done in this study. Flow in other arroyos in New Mexico, such as the Rio Puerco, is observed to be turbulent during high flow and is well mixed. Automatic suspended-sediment samples taken at the USGS station Rio Puerco near Bernardo (08353000) are representative of the channel cross section (Dave Funderburg, U.S. Geological Survey, oral commun., 1997). The arroyos studied for this project, such as Garcia Draw and Conservation Draw, are assumed to also be turbulent and well mixed during high flow; however, the Rio Nutria may not be as well mixed because of low flow. Flow in arroyos such as Garcia Draw has large suspended-sediment concentrations and may be well mixed.

Instantaneous streamflow and suspended-sediment concentration are used to develop suspended-sediment transport curves when suspended-sediment samples are not available. The instantaneous suspended-sediment discharge rate (the rate at which a dry weight of sediment passes through a section of stream) was computed using instantaneous streamflow, suspended-sediment concentration, and a conversion factor. The formula to calculate the suspended-sediment discharge rate (Porterfield, 1972) is:

$$Qs = Qw\ Cs\ k \qquad (1)$$

where Qs = suspended-sediment discharge rate, in tons per day;

Qw = instantaneous streamflow, in cubic feet per second;

Cs = suspended-sediment concentration, in milligrams per liter; and

k = conversion factor of 0.0027.

SURFACE-WATER AND SUSPENDED-SEDIMENT INFLOW AND OUTFLOW

Precipitation

Total rainfall measured during the study from February 28, 1994, to September 30, 1995, at the National Oceanic and Atmospheric Agency (NOAA) rain gage in Zuni Village was 21.96 inches and for calendar year 1994 was 14.38 inches. Average annual rainfall at the NOAA rain gage for its 1950-94 period of record is 12.40 inches.

Runoff and Suspended Sediment

Runoff was intermittent at all gaging stations during the study period. Streamflow and suspended-sediment data determined for gaging stations used in this study are presented in table 2 (tables 2-4 are in the back of the report). At Conservation Draw, only one runoff event was recorded for suspended sediment, from September 11 to 13, 1994. During this event, suspended-sediment samples were collected on September 13; suspended-sediment concentrations and loads were estimated for September 11 and 12. During this event, total runoff was 15.3 acre-feet, total suspended-sediment load was 450 tons, and mean sediment concentration, obtained by dividing total suspended-sediment load by total runoff, was 29.4 tons per acre-foot.

Average annual runoff at Rio Nutria near Ramah during its period of record, water years 1970-95, was 5,170 acre-feet, and runoff for the study period (March 3, 1994, to September 30, 1995) was 13,402 acre-feet. The average total runoff for a 19-month period similar to the study period (March 1, 1994, to September 30, 1995) was 9,760 acre-feet. Therefore, the average total runoff during the study period was about 137 percent higher than that for the period of record for the same months. Because runoff during the study period was higher than average, suspended-sediment loads at this station also may have been higher than average.

There was a considerable loss of runoff of 51 percent (6,891 acre-feet) and suspended-sediment load of 8 percent (140 tons) between Rio Nutria near Ramah and Rio Nutria above Nutria Reservoir No. 3 (table 3). The decrease in surface-water runoff is due to storage of water in two diversion reservoirs used for irrigation that are located between the two stations (fig. 1). The decrease in suspended-sediment loads between the two gaging stations is a result of sediment deposition behind these two diversion reservoirs. The greater loss in runoff downstream compared to loss of sediment loads from the diversion reservoirs may be due to the addition of sediment from numerous tributary arroyos that drain in the 6.3 miles between the southernmost diversion reservoir and Nutria Reservoir No. 3 and that, when flowing, maintain large sediment concentrations.

Total surface-water flow entering Nutria Reservoir No. 3 for the study period, computed by adding the runoff at Rio Nutria above Nutria Reservoir No. 3 and the runoff at Garcia Draw above Nutria Reservoir No. 3, was 6,812 acre-feet. Total runoff measured at the Spillway Channel below Nutria Reservoir No. 3 was 2,244 acre-feet (table 3).

The total suspended-sediment load transported during the study period at Rio Nutria near Ramah was 1,650 tons. A peak flow recorded on March 5, 1995, at Rio Nutria near Ramah was 1,850 cubic feet per second, which was the peak flow of record.

The total suspended-sediment load transported into Nutria Reservoir No. 3, computed by adding the sediment loads for Rio Nutria above Nutria Reservoir No. 3 and Garcia Draw above Nutria Reservoir No. 3, was 24,310 tons (table 3). The total suspended-sediment load for the same period measured at the Spillway Channel below Nutria Reservoir No. 3 was 259 tons. The difference between suspended-sediment inflow and outflow is the amount of sediment deposited in Nutria Reservoir No. 3, or about 24,050 tons (table 3).

The mean sediment concentration for flows entering Nutria Reservoir No. 3 was 3.57 tons per acre-foot and for flow leaving the reservoir was 0.115 ton per acre-foot (table 3). A smaller sediment concentration was expected in the outflow and is a result of sediment dropping out of suspension.

Flow from Nutria Reservoir No. 3 was diverted to Nutria Reservoir No. 4 from March 1994 to May 1994. The diversion channel from Nutria Reservoir No. 3 into Nutria Reservoir No. 4 appears to have aggraded since it was constructed; consequently, a higher elevation of the water surface or a larger volume of water in Nutria Reservoir No. 3 was necessary for water to flow into Nutria Reservoir No. 4. To facilitate this flow into Nutria Reservoir No. 4, the Zuni Fish and Wildlife Department sandbagged the spillway channel at Nutria Reservoir No. 3, creating a higher spillway

elevation and more storage. The higher water elevation in Nutria Reservoir No. 3 caused water to flow into Nutria Reservoir No. 4. Flow into Nutria Reservoir No. 4 was not recorded, and suspended-sediment samples were not collected.

If the elevation of the spillway had not been raised, higher runoff and larger suspended-sediment loads would have been recorded at the spillway channel downstream from Nutria Reservoir No. 3. Therefore, a smaller amount of sediment deposition in Nutria Reservoir No. 3 would have been calculated.

Particle-Size Analysis

Particle-size analysis of suspended sediment consisted of determining the percentage of sediment finer than 0.062 millimeter (mm) by sieving the sample through a 0.062-mm sieve. Table 4 lists the results of particle-size analysis of suspended-sediment samples collected at the stations used in this study.

Sediment Transport

Two distinct stream types enter Nutria Reservoir No. 3: the intermittent streamflow of Rio Nutria and the ephemeral streamflow of Garcia Draw and other similar arroyos. Although Garcia Draw, which drains 15 percent of the total drainage area of Nutria Reservoir No. 3, contributed less than 5 percent of total runoff, it transported 94 percent of the total suspended-sediment load entering Nutria Reservoir No. 3 during the study period. The mean sediment concentration of Garcia Draw is 75.7 tons per acre-feet, which is 326 percent of the mean sediment concentration for Rio Nutria above Nutria Reservoir No. 3 (table 3).

Suspended-sediment transport curves also illustrate the larger suspended-sediment concentrations in Garcia Draw compared with the other drainages (fig. 2). The best-fit lines shown in the transport curves were derived from best-fit least-squares regression analysis. R^2 values for the transport curves range from 0.15 to 0.46 and illustrate the extreme range in observed values of suspended sediment relative to instantaneous streamflow. For example, at an instantaneous discharge of 10 cubic feet per second, the suspended-sediment concentration is 44 mg/L at Rio Nutria near Ramah, 72 mg/L at Rio Nutria above Nutria Reservoir No. 3, and 50 mg/L at the Spillway Channel below Nutria Reservoir No. 3 (fig. 2E). The suspended-sediment concentration at Garcia Draw above Nutria Reservoir No. 3 at 10 cubic feet per second is 43,600 mg/L, which is about three orders of magnitude higher than those at the other stations.

Sedimentation of Nutria Reservoir No. 3

The amount of suspended sediment deposited in Nutria Reservoir No. 3 during the study period, using data calculated for the streamflow-gaging stations, was estimated to be 24,050 tons (table 3). This amount does not include suspended sediment that may be transported into Nutria Reservoir No. 3 from ungaged areas, which are approximately 6 percent of the drainage area; the decrease in the amount of sediment that would have been deposited had water been allowed to flow over the spillway; or the contribution from bed load.

An average annual value of sediment deposited in the reservoir was calculated by obtaining a monthly average of sediment deposited from January through December and summing the values. The average annual sediment deposited in Nutria Reservoir No. 3 was 15,355 tons. This amount is considered a maximum value for the study period because streamflow and sediment diverted into Nutria Reservoir No. 4 were not measured.

Three samples of sediment deposited in Nutria Reservoir No. 3 were collected for analysis of dry-weight density; the three samples were collected near the dam, in the middle of Nutria Reservoir No. 3, and in an upstream reach. The average dry-weight density of the three samples was 99.4 pounds per cubic foot. By using the average annual amount of 15,355 tons of deposited sediment, the annual volume of deposited sediment is 7.09 acre-feet per year. The mean sedimentation rate previously reported for Nutria Reservoir from 1934 to 1993 was 15.0 acre-feet per year (table 1) (Rossillon and Lewandowski, 1969; Easterling and Associates and Resource Consultants and Engineers, 1995). This previously reported sedimentation rate, obtained from historical reservoir surveys, may be higher because it included the transport of bed material.

The capacity of Nutria Reservoir No. 3 in 1993 was 191 acre-feet (table 1). By using the average sedimentation rate of 7.09 acre-feet per year, which may be higher than average, the reservoir could be completely filled approximately 27 years after the 1993 survey.

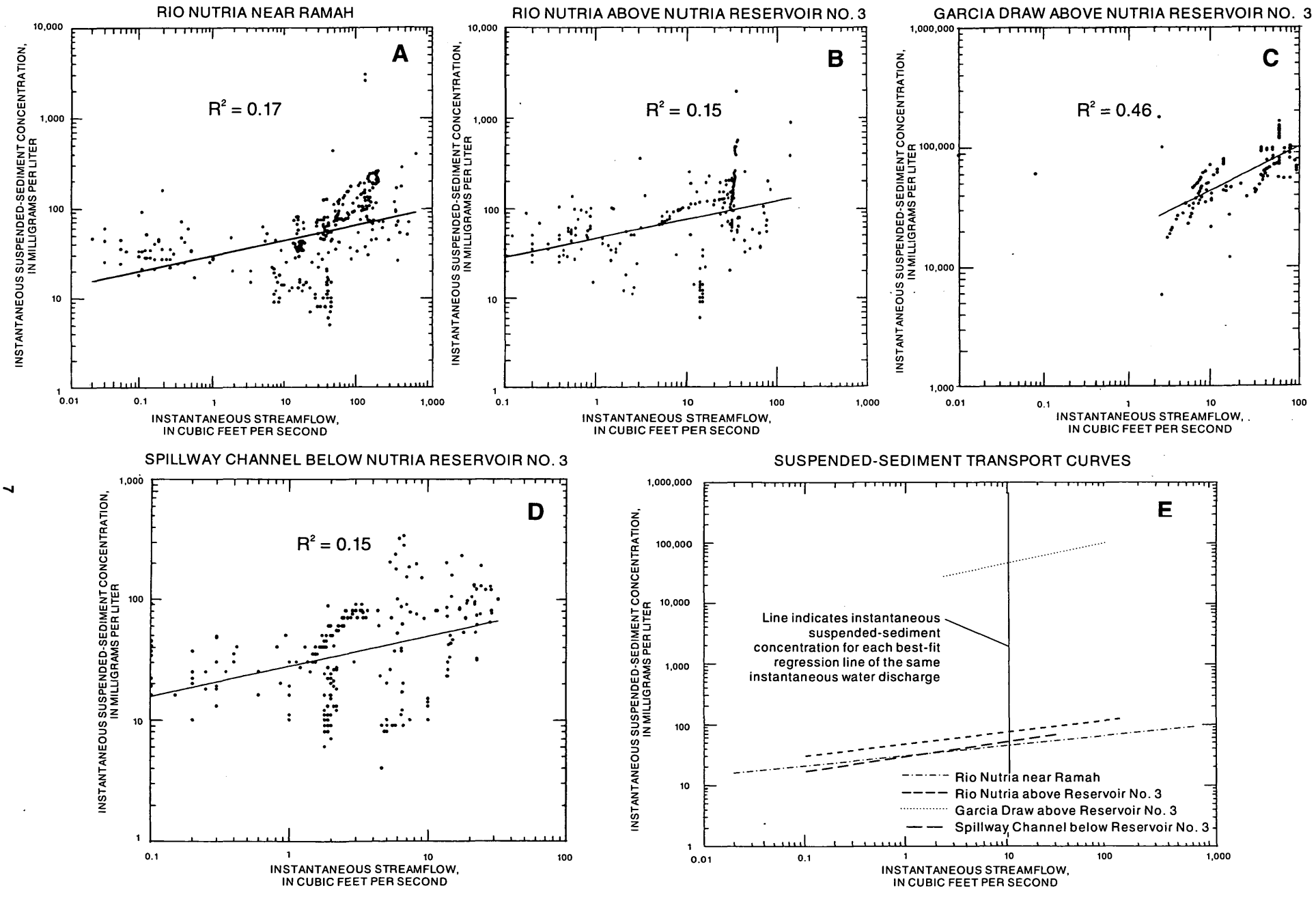

Figure 2.--Suspended-sediment transport curves for (A) Rio Nutria near Ramah; (B) Rio Nutria above Nutria Reservoir No. 3; (C) Garcia Draw above Nutria Reservoir No. 3; (D) Spillway Channel below Nutria Reservoir No. 3; and (E) plot of best-fit regression lines for all stations.

SUMMARY

Surface-water and suspended-sediment inflow to and outflow from Nutria Reservoir No. 3 were measured from March 3, 1994, to September 30, 1995. Two streamflow-gaging stations were installed upstream from Nutria Reservoir No. 3 and one station was installed downstream. During the study period, runoff measured at one of the upstream streamflow-gaging stations, Rio Nutria near Ramah, was 13,402 acre-feet. Based on long-term (water years 1970-95) records at this station, this runoff was about 137 percent higher than that for a similar 19-month period and may indicate that suspended-sediment loads transported into Nutria Reservoir No. 3 also were higher than average.

One of the gaged drainages into Nutria Reservoir No. 3 is an ephemeral arroyo, Garcia Draw. Although Garcia Draw drains only 15 percent of the total drainage area upstream from Nutria Reservoir No. 3, it transported 94 percent of the total suspended-sediment load entering the reservoir. At an instantaneous discharge of 10 cubic feet per second, suspended-sediment concentrations in Garcia Draw were about three orders of magnitude higher than those at the other drainages.

During the study period 24,050 tons of suspended sediment was deposited in Nutria Reservoir No. 3. Because streamflow and sediment entering Nutria Reservoir No. 4, a reservoir receiving diverted water from Nutria Reservoir No. 3, were not measured, the calculated amount of sediment deposited in Nutria Reservoir No. 3 is considered a maximum value for the study period.

The capacity of Nutria Reservoir No. 3 in 1993 was 191 acre-feet. By using the calculated average sedimentation rate of 7.09 acre-feet per year, which may be higher than average, Nutria Reservoir No. 3 could be completely filled approximately 27 years after the 1993 survey.

REFERENCES

Easterling and Associates and Resource Consultants and Engineers, 1995, Zuni River feasibility study of sediment transport: Easterling and Associates, Albuquerque, N. Mex., and Resource Consultants and Engineers, Fort Collins, Colo., report prepared for the U.S. Army Corps of Engineers, Albuquerque District, appendix, variously paged.

Edwards, T.K., and Glysson, G.D., 1988, Field methods for measurement of fluvial sediment: U.S. Geological Survey Open-File Report 86-531, 118 p.

Guy, H.P., 1969, Laboratory theory and methods for sediment analysis: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. C1, 58 p.

Kennedy, E.J., 1984, Discharge ratings at gaging stations: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A10, 58 p.

Porterfield, George, 1972, Computation of fluvial-sediment discharge: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. C3, 66 p.

Rossillon, E.C., and Lewandowski, E.R., 1969, Examination of dams and appurtenant facilities for Bureau of Indian Affairs--Zuni Reservation of New Mexico: Bureau of Reclamation, Report to the Chief Engineer, Appendix VI.

Table 2.--Streamflow and suspended-sediment data for samples collected at streamflow-gaging stations in the Nutria Reservoir No. 3 Basin, water years 1994 and 1995

[Streamflow-gaging stations shown in figure 1. ft^3/s, cubic feet per second; mg/L, milligrams per liter]

Date	Time	Stream-flow, instan-taneous (ft^3/s)	Suspended-sediment concentration (mg/L)
09386917 Garcia Draw above Nutria Reservoir No. 3			
Water year October 1993 to September 1994			
May 12	1843	14	46,900
May 12	1848	14	43,100
May 12	1908	9.5	36,900
May 12	1918	9.5	35,800
May 12	1938	8.1	34,700
May 12	1948	6.7	33,700
May 12	2008	5.2	32,300
May 12	2048	4.4	28,000
May 12	2108	3.8	26,700
May 12	2128	3.7	24,800
May 12	2248	3.3	21,100
May 12	2318	3.2	20,100
May 12	2348	3.1	18,800
May 13	0018	2.9	17,500
May 13	0218	2.5	5,790
Aug. 19	1200	0.08	60,000
Sept. 6	2233	0.01	86,000
Sept. 6	2243	13	79,200
Sept. 6	2253	13	75,400
Sept. 6	2303	13	72,300
Sept. 6	2323	11	64,900
Sept. 6	2333	11	61,300
Sept. 6	2343	10	58,100
Sept. 7	0001	9.3	21,500
Sept. 7	0013	8.7	50,200
Sept. 7	0033	8.3	49,400
Sept. 7	0053	7.3	47,100
Sept. 7	0113	7.1	45,100
Sept. 7	0133	6.9	42,600
Sept. 7	0153	6.7	40,800
Sept. 7	0223	6.2	37,400
Sept. 7	0253	5.8	33,800
Sept. 7	0323	5.7	30,700
Sept. 7	0353	5.5	27,800
Sept. 7	0423	5.3	26,000
Sept. 7	0523	5	22,900
Sept. 11	0316	49	79,400
Sept. 11	0326	90	76,700
Sept. 11	0341	93	69,200
Sept. 11	0351	93	69,400
Sept. 11	0411	94	68,500
Sept. 11	0421	94	66,500
Sept. 11	0431	94	63,500
Sept. 11	0511	79	55,200
Sept. 11	0531	67	54,800
Sept. 11	0551	58	56,000
Sept. 11	0611	43	56,600
Sept. 11	0631	38	56,500
Sept. 11	0731	21	49,100
Sept. 11	0801	16	46,500
Sept. 11	0831	13	43,900
Sept. 11	0901	9.5	41,100
Sept. 11	0931	8.3	43,900
Sept. 11	1001	7.3	38,300
Sept. 11	1101	6.9	36,000
Sept. 12	855	4.7	33,800
Sept. 13	1458	2.5	99,500
Sept. 13	1542	36	98,200
Sept. 13	1552	36	95,300
Sept. 13	1557	68	89,000
Sept. 13	1617	78	80,900
Sept. 13	1627	78	89,200
Sept. 13	1637	78	96,400
Sept. 13	1657	79	102,000

Table 2.--Streamflow and suspended-sediment data for samples collected at streamflow-gaging stations in the Nutria Reservoir No. 3 Basin, water years 1994 and 1995--Continued

Date	Time	Stream-flow, instan-taneous (ft^3/s)	Suspended-sediment concentration (mg/L)
09386917 Garcia Draw above Nutria Reservoir No. 3			
Water year October 1993 to September 1994			
Sept. 13	1717	79	97,600
Sept. 13	1737	68	96,600
Sept. 13	1756	49	93,800
Sept. 13	1757	49	97,900
Sept. 13	1809	42	95,800
Sept. 13	1814	42	94,400
Sept. 13	1819	42	93,200
Sept. 13	1824	36	92,600
Sept. 13	1829	36	91,700
Sept. 13	2109	9.1	70,900
Sept. 13	2129	8.1	62,800
Sept. 13	2159	7.5	60,900
Sept. 13	2229	7.1	55,500
Sept. 13	2259	6.9	52,900
Sept. 13	2329	6.6	50,400
Sept. 13	2359	6.4	49,400
Sept. 14	0059	6	47,500
Sept. 14	0159	5.7	45,900
Sept. 20	1715	2.3	178,000
Sept. 20	1720	59	163,000
Sept. 20	1725	59	150,000
Sept. 20	1730	59	144,000
Sept. 20	1735	59	142,000
Sept. 20	1745	59	141,000
Sept. 20	1755	59	139,000
Sept. 20	1805	59	135,000
Sept. 20	1815	59	128,000
Sept. 20	1825	59	122,000
Sept. 20	1835	59	117,000
Sept. 20	1855	59	120,000
Sept. 20	1915	59	120,000
Sept. 20	1935	59	118,000
Water year October 1994 to September 1995			
Oct. 14	2031	24.6	38,800
Oct. 14	2036	30.4	44,400
Oct. 14	2041	37.5	52,700
Oct. 14	2046	45.3	67,400
Oct. 14	2051	49.8	83,800
Oct. 14	2101	59.2	80,800
Oct. 14	2111	59.2	76,200
Oct. 14	2121	59.2	72,000
Oct. 14	2131	58.9	72,200
Oct. 14	2141	55.6	72,500
Oct. 14	2151	51.4	71,400
Oct. 14	2211	42.7	65,900
Oct. 14	2231	36.1	58,100
Oct. 26	0043	42.0	77,800
Oct. 26	0053	41.1	64,800
Oct. 26	0058	40.6	60,000
Oct. 26	0108	38.8	63,100
Oct. 26	0126	34.5	48,600
Oct. 26	0138	31.9	43,500
Oct. 26	0143	30.8	41,700
Oct. 26	0925	15.5	12,000
Oct. 26	0953	15.2	27,200
09386915 Rio Nutria above Nutria Reservoir No. 3			
Water year October 1993 to September 1994			
Mar. 8	1008	15	34
Mar. 8	1116	16	22
Mar. 9	1510	30	20
Mar. 10	1510	14	15
Mar. 14	1318	2.9	24
Mar. 17	1125	2.7	13
Mar. 17	1301	2.6	11
Mar. 21	1246	14	14
Mar. 21	1247	14	6
Mar. 21	1347	14	14
Mar. 21	1407	14	10
Mar. 21	1419	14	21
Mar. 21	1427	14	12

Table 2.--Streamflow and suspended-sediment data for samples collected at streamflow-gaging stations in the Nutria Reservoir No. 3 Basin, water years 1994 and 1995--Continued

Date	Time	Streamflow, instantaneous (ft^3/s)	Suspended-sediment concentration (mg/L)
09386915 Rio Nutria above Nutria Reservoir No. 3			
Water year October 1993 to September 1994			
Mar. 21	1447	14	12
Mar. 21	1507	14	10
Mar. 21	1527	15	11
Mar. 21	1547	15	29
Mar. 21	1607	15	12
Mar. 21	1627	15	10
Mar. 21	1647	15	9
Mar. 21	1707	15	11
Mar. 21	1727	15	14
Mar. 21	1747	14	13
Mar. 21	1817	14	13
Mar. 21	1847	14	9
Mar. 21	1947	14	13
Mar. 21	2047	14	21
Mar. 22	0049	12	14
Mar. 24	1231	2.2	54
Mar. 24	1307	2.2	18
Mar. 24	1358	2.1	12
Mar. 28	1358	1.5	34
Mar. 28	1456	1.4	38
Mar. 31	1122	1.2	46
Mar. 31	1215	1.2	40
Apr. 4	1333	0.88	59
Apr. 7	1030	0.88	81
Apr. 11	1431	1.7	35
Apr. 11	1525	1.7	32
Apr. 14	1106	1.5	26
Apr. 14	1153	1.5	34
Apr. 18	1555	0.82	47
Apr. 18	1610	0.82	56
Apr. 21	1026	0.64	75
Apr. 25	1304	0.54	54
Apr. 25	1321	0.54	57
May 2	1431	0.88	63
May 5	1023	0.54	43
May 9	1020	0.24	68
May 12	0934	0.4	103
May 16	1131	0.49	29
Water year October 1994 to September 1995			
Oct. 26	1125	0.55	135
Nov. 10	1216	0.12	49
Nov. 12	2318	31	109
Nov. 12	2338	32	133
Nov. 12	2358	33	44
Nov. 13	0018	33	127
Nov. 13	0038	33	182
Nov. 13	0058	33	104
Nov. 13	0118	32	140
Nov. 13	0138	32	93
Nov. 13	0158	31	55
Nov. 13	0228	30	65
Nov. 13	0358	26	114
Nov. 13	0858	16	190
Nov. 13	1258	11	186
Nov. 14	1130	1.6	97
Nov. 14	1233	1.5	100
Nov. 17	1150	0.4	29
Nov. 28	1109	0.32	25
Dec. 5	1149	0.54	52
Dec. 7	1024	32	63
Dec. 7	1035	32	210
Dec. 7	1055	32	199
Dec. 7	1115	32	123
Dec. 7	1117	32	117
Dec. 7	1119	32	72
Dec. 7	1135	32	60
Dec. 7	1155	32	131
Dec. 7	1215	32	67
Dec. 7	1255	32	211
Dec. 7	1315	32	132

Table 2.--Streamflow and suspended-sediment data for samples collected at streamflow-gaging stations in the Nutria Reservoir No. 3 Basin, water years 1994 and 1995--Continued

Date	Time	Stream-flow, instan-taneous (ft^3/s)	Suspended-sediment concentration (mg/L)
09386915 Rio Nutria above Nutria Reservoir No. 3 Water year October 1994 to September 1995			
Dec. 7	1335	31	94
Dec. 7	1355	30	100
Dec. 7	1415	29	128
Dec. 7	1505	25	100
Dec. 7	1535	23	150
Dec. 7	1635	20	108
Dec. 7	1735	18	226
Dec. 8	1040	3.6	137
Dec. 8	1233	3.1	353
Dec. 12	1050	0.6	27
Dec. 15	1023	0.44	34
Dec. 22	1040	0.17	88
Dec. 27	1026	0.44	30
Jan. 10	1206	0.59	97
Jan. 20	1528	0.95	15
Feb. 15	1833	36	556
Feb. 15	1853	36	531
Feb. 15	1913	35	1,936
Feb. 15	1933	35	471
Feb. 15	2003	34	467
Feb. 15	2033	34	452
Feb. 15	2133	34	425
Feb. 15	2233	35	384
Feb. 16	1430	34	256
Feb. 16	1450	34	220
Feb. 16	1510	34	213
Feb. 16	1530	34	217
Feb. 16	1550	34	206
Feb. 16	1610	34	225
Feb. 16	1630	34	203
Feb. 16	1650	34	198
Feb. 16	1710	34	191
Feb. 16	1730	33	186
Feb. 16	1750	33	182
Feb. 16	1810	33	184
Feb. 16	1830	33	175
Feb. 16	1900	33	169
Feb. 16	1930	33	156
Feb. 16	2030	33	147
Feb. 16	2130	33	140
Feb. 17	1330	30	148
Feb. 18	1506	27	89
Feb. 19	1506	23	85
Feb. 20	1506	24	63
Feb. 21	1219	33	92
Feb. 22	0819	36	56
Feb. 22	1219	37	78
Feb. 22	1619	37	76
Feb. 23	0419	36	53
Feb. 23	1219	38	78
Feb. 23	1619	38	77
Feb. 23	2019	37	62
Feb. 27	1128	54	57
Feb. 27	2328	44	43
Feb. 28	1128	50	35
Feb. 28	2328	44	32
Mar. 1	1128	66	36
Mar. 1	2328	86	159
Mar. 2	1128	80	197
Mar. 2	2328	71	103
Mar. 3	1038	73	87
Mar. 3	2238	64	52
Mar. 4	1038	77	72
Mar. 4	2238	77	54
Mar. 5	1038	76	63
Mar. 5	2238	66	37
Mar. 6	1038	141	376
Mar. 6	2238	142	878
Mar. 13	1520	34	397
Mar. 14	1520	28	70

Table 2.--Streamflow and suspended-sediment data for samples collected at streamflow-gaging stations in the Nutria Reservoir No. 3 Basin, water years 1994 and 1995--Continued

Date	Time	Stream-flow, instan-taneous (ft^3/s)	Suspended-sediment concentration (mg/L)
09386900 Rio Nutria near Ramah Water year October 1993 to September 1994			
Feb. 28	1417	1.8	47
Mar. 3	1003	5	62
Mar. 3	1549	15	66
Mar. 3	1559	28	63
Mar. 3	1609	29	74
Mar. 3	2046	28	63
Mar. 3	2106	28	70
Mar. 3	2126	28	69
Mar. 3	2146	32	74
Mar. 3	2206	35	74
Mar. 3	2226	40	79
Mar. 3	2256	41	68
Mar. 3	2326	40	56
Mar. 3	2356	38	49
Mar. 4	0026	36	45
Mar. 4	0056	32	46
Mar. 4	1945	35	51
Mar. 14	1111	10	14
Mar. 14	1204	9.2	14
Mar. 17	1033	8.4	9
Mar. 20	0625	23	7
Mar. 20	0635	32	8
Mar. 20	0645	37	8
Mar. 20	0705	39	11
Mar. 20	0725	45	10
Mar. 20	0745	45	15
Mar. 20	0805	45	8
Mar. 20	0825	45	9
Mar. 20	0845	44	7
Mar. 20	0915	41	6
Mar. 20	0945	41	6
Mar. 20	1015	40	10
Mar. 20	1045	40	11
Mar. 20	1115	40	12
Mar. 20	1145	41	12
Mar. 20	1245	41	16
Mar. 20	1345	40	17
Mar. 20	1445	39	14
Mar. 20	1545	39	15
Mar. 20	1645	39	20
Mar. 20	1745	40	14
Mar. 20	1845	43	5
Mar. 21	0645	35	10
Mar. 21	0956	29	8
Mar. 21	1059	27	11
Mar. 21	1103	27	10
Mar. 24	1126	2.5	33
Mar. 28	1045	1	27
Mar. 28	1213	1	28
Mar. 31	1005	0.68	60
Mar. 31	1451	0.61	49
Apr. 4	1019	0.4	25
Apr. 4	1108	0.4	42
Apr. 7	0947	0.45	59
Apr. 11	0945	3.4	20
Apr. 11	1026	3.4	15
Apr. 14	1025	1.1	41
Apr. 18	1502	0.36	71
Apr. 18	1513	0.36	47
Apr. 21	0947	0.25	27
Apr. 25	1143	0.32	24
May 2	1351	0.55	17
May 5	1049	0.28	31
May 9	0935	0.19	35
May 12	0955	0.25	35
May 16	0953	1.9	20
May 19	1005	0.19	27
May 23	1020	0.22	27
May 25	1630	0.36	40
May 25	1634	0.36	41
Sept. 8	0926	0.06	33

Table 2.--Streamflow and suspended-sediment data for samples collected at streamflow-gaging stations in the Nutria Reservoir No. 3 Basin, water years 1994 and 1995--Continued

Date	Time	Stream-flow, instan-taneous (ft^3/s)	Suspended-sediment concentration (mg/L)
09386900 Rio Nutria near Ramah			
Water year October 1993 to September 1994			
Sept. 15	0933	0.05	24
Sept. 19	1400	0.05	35
Sept. 26	1055	0.03	25
Sept. 29	0929	0.02	46
Water year October 1994 to September 1995			
Oct. 3	1054	0.03	59
Oct. 6	1213	0.03	43
Oct. 13	1442	0.05	44
Oct. 17	0947	0.17	43
Oct. 24	1040	0.09	29
Oct. 27	0950	0.11	34
Oct. 28	1004	0.1	33
Oct. 31	0930	0.1	21
Nov. 7	1532	0.17	45
Nov. 10	1340	0.11	28
Nov. 12	0650	47	432
Nov. 12	0730	360	91
Nov. 14	0947	0.5	34
Nov. 14	1015	0.5	33
Nov. 17	1109	0.15	40
Nov. 21	0956	0.11	51
Nov. 28	1031	0.11	28
Dec. 5	1345	0.15	21
Dec. 6	0044	0.19	158
Dec. 6	0944	18	69
Dec. 6	0954	34	45
Dec. 6	1004	45	43
Dec. 6	1024	49	71
Dec. 6	1044	54	78
Dec. 6	1104	57	113
Dec. 6	1144	66	110
Dec. 6	1204	67	130
Dec. 6	1234	75	152
Dec. 6	1334	85	173
Dec. 6	1404	120	189
Dec. 6	1434	150	196
Dec. 6	1502	170	99
Dec. 6	1503	170	189
Dec. 6	1504	170	185
Dec. 6	1604	190	114
Dec. 6	1605	190	206
Dec. 6	1624	200	217
Dec. 6	1634	200	219
Dec. 6	1644	190	233
Dec. 6	1704	90	241
Dec. 6	1744	200	257
Dec. 6	1804	200	255
Dec. 6	1844	190	255
Dec. 6	1914	190	255
Dec. 6	1944	190	244
Dec. 6	2014	170	243
Dec. 6	2044	160	240
Dec. 6	2144	150	211
Dec. 6	2244	130	188
Dec. 6	2344	110	177
Dec. 7	0144	78	153
Dec. 7	0244	70	138
Dec. 7	0344	58	124
Dec. 7	0444	49	110
Dec. 7	1252	15	80
Dec. 7	1336	14	73
Dec. 12	0949	0.13	28
Dec. 15	1157	0.13	34
Dec. 20	1013	0.09	18
Dec. 27	1002	0.15	27
Jan. 9	1150	0.25	22
Jan. 20	1446	0.9	25
Jan. 26	1145	0.1	91
Feb. 6	1507	7.5	44
Feb. 6	1807	19	41

Table 2.--Streamflow and suspended-sediment data for samples collected at streamflow-gaging stations in the Nutria Reservoir No. 3 Basin, water years 1994 and 1995--Continued

Date	Time	Stream-flow, instan-taneous (ft^3/s)	Suspended-sediment concentration (mg/L)
09386900 Rio Nutria near Ramah Water year October 1994 to September 1995			
Feb. 6	1827	18	59
Feb. 6	1842	18	43
Feb. 6	1907	18	42
Feb. 6	1909	0.09	33
Feb. 6	1927	17	39
Feb. 6	2004	16	37
Feb. 6	2027	16	38
Feb. 6	2057	16	36
Feb. 6	2127	17	35
Feb. 6	2157	17	35
Feb. 6	2227	17	35
Feb. 6	2327	15	39
Feb. 7	0127	18	33
Feb. 7	1807	16	34
Feb. 7	2109	16	29
Feb. 8	0357	13	57
Feb. 8	1440	14	41
Feb. 8	1450	15	40
Feb. 8	1500	15	36
Feb. 8	1520	17	36
Feb. 8	1540	17	39
Feb. 8	1600	17	36
Feb. 8	1620	17	34
Feb. 8	1640	17	37
Feb. 8	1700	15	35
Feb. 8	1730	14	37
Feb. 8	2313	14	28
Feb. 8	2343	15	33
Feb. 9	0013	16	39
Feb. 9	0043	17	39
Feb. 9	0113	18	43
Feb. 9	0213	17	43
Feb. 9	0313	15	52
Feb. 9	1542	16	42
Feb. 9	1642	17	43
Feb. 9	1742	14	36
Feb. 9	2146	15	35
Feb. 9	2246	16	40
Feb. 14	1100	39	126
Feb. 14	1211	36	79
Feb. 14	1322	39	63
Feb. 14	1332	35	66
Feb. 14	1342	35	64
Feb. 14	1402	35	63
Feb. 14	1422	35	124
Feb. 14	1442	37	57
Feb. 14	1502	40	53
Feb. 14	1522	41	64
Feb. 14	1542	44	54
Feb. 14	1645	63	76
Feb. 14	1715	76	89
Feb. 14	1745	92	113
Feb. 14	1815	100	129
Feb. 14	1845	120	141
Feb. 14	1915	130	148
Feb. 14	2015	130	147
Feb. 14	2115	130	158
Feb. 15	1040	58	93
Feb. 15	1047	57	87
Feb. 15	1050	56	119
Feb. 15	1057	55	83
Feb. 15	1107	53	81
Feb. 15	1127	51	79
Feb. 15	1145	51	93
Feb. 15	1147	51	74
Feb. 15	1207	52	74
Feb. 15	1227	54	73
Feb. 15	1247	59	76
Feb. 15	1307	66	73
Feb. 15	1337	77	77

Table 2.--Streamflow and suspended-sediment data for samples collected at streamflow-gaging stations in the Nutria Reservoir No. 3 Basin, water years 1994 and 1995--Continued

Date	Time	Stream-flow, instan-taneous (ft^3/s)	Suspended-sediment concentration (mg/L)
09386900 Rio Nutria near Ramah Water year October 1994 to September 1995			
Feb. 15	1407	90	90
Feb. 15	1437	110	104
Feb. 15	1508	130	131
Feb. 15	1714	200	194
Feb. 15	1744	210	197
Feb. 15	1844	200	207
Feb. 15	1944	200	193
Feb. 15	2044	190	185
Feb. 15	2144	170	167
Feb. 15	2244	160	156
Feb. 15	2344	140	132
Feb. 16	0044	140	121
Feb. 16	1257	160	70
Feb. 16	1317	110	74
Feb. 16	1326	130	101
Feb. 16	1337	140	74
Feb. 16	1357	170	57
Feb. 16	1417	180	73
Feb. 16	1437	170	67
Feb. 16	1500	160	72
Feb. 16	1507	150	71
Feb. 16	1537	140	80
Feb. 16	1607	140	3,015
Feb. 16	1637	140	2,577
Feb. 16	1707	140	105
Feb. 16	1757	150	122
Feb. 16	1837	160	131
Feb. 16	1937	160	116
Feb. 16	2037	160	106
Feb. 16	2137	140	97
Feb. 16	2237	120	93
Feb. 16	2337	96	92
Feb. 17	0037	15	80
Feb. 17	1237	5.4	43
Feb. 17	1418	5.7	52
Feb. 17	2018	15	74
Feb. 18	0218	52	65
Feb. 18	1720	57	42
Feb. 18	2320	79	84
Feb. 19	0520	29	52
Feb. 19	1120	9.1	34
Feb. 19	1720	52	35
Feb. 20	1603	41	32
Feb. 20	2203	120	104
Feb. 21	0403	71	76
Feb. 21	1003	46	45
Feb. 23	1518	100	33
Feb. 23	2119	370	167
Feb. 24	0826	130	37
Feb. 24	1426	230	60
Feb. 24	2026	350	117
Feb. 25	0226	360	94
Feb. 25	0826	210	71
Feb. 25	1426	410	53
Feb. 25	2026	440	174
Feb. 26	2210	370	64
Feb. 27	0410	130	96
Feb. 27	1010	190	45
Feb. 27	1610	290	44
Feb. 27	2210	240	70
Feb. 28	0410	160	44
Feb. 28	1010	150	30
Feb. 28	1610	390	26
Feb. 28	2210	390	71
Mar. 1	0410	390	70
Mar. 1	1010	530	51
Mar. 1	1610	700	396
Mar. 1	2210	440	283
Mar. 3	1442	550	70
Mar. 5	1427	400	55
Mar. 6	0227	1,300	78

Table 2.--Streamflow and suspended-sediment data for samples collected at streamflow-gaging stations in the Nutria Reservoir No. 3 Basin, water years 1994 and 1995--Continued

Date	Time	Stream-flow, instan-taneous (ft^3/s)	Suspended-sediment concentration (mg/L)
09386900 Rio Nutria near Ramah Water year October 1994 to September 1995			
Mar. 6	2013	520	1,089
Mar. 7	2013	150	223
Mar. 8	0813	110	53
Mar. 8	2013	83	36
Mar. 9	0813	86	27
Mar. 20	1005	39	21
Mar. 20	2205	34	27
Mar. 21	1005	36	61
Mar. 21	2205	30	31
Mar. 22	1005	30	22
Mar. 22	2205	24	25
Mar. 23	1005	23	13
Mar. 23	2205	20	15
Mar. 24	1005	18	14
Mar. 24	2205	18	12
Mar. 25	1005	16	16
Mar. 25	2205	16	15
Mar. 26	1005	13	13
Mar. 26	2205	16	13
Mar. 27	1455	12	12
Mar. 29	0347	11	25
Mar. 29	2257	9.6	14
Mar. 30	1057	8.6	18
Mar. 30	2257	8.6	10
Mar. 31	1057	7.7	17
Mar. 31	2257	8.1	15
Apr. 1	2257	7.7	12
Apr. 2	1057	7.2	9
Apr. 2	2257	7.2	11
Apr. 3	1057	7.2	19
Apr. 4	1057	7.2	21
Apr. 4	2257	6.8	22
Apr. 5	1057	6.8	22

Date	Time	Stream-flow, instan-taneous (ft^3/s)	Suspended-sediment concentration (mg/L)
09386919 Spillway Channel below Nutria Reservoir No. 3 Water year October 1993 to September 1994			
Mar. 3	1114	0.87	20
Mar. 8	1340	2.1	41
Mar. 8	1418	2.1	19
Mar. 8	1445	2.1	26
Mar. 8	0218	2.1	21
Mar. 8	1418	2.2	18
Mar. 8	1418	2.2	26
Mar. 8	0218	2.2	12
Mar. 8	1418	2.2	27
Mar. 8	0218	2.2	13
Mar. 8	1418	2.1	13
Mar. 8	1432	2	20
Mar. 8	1454	2	22
Mar. 8	1553	2	16
Mar. 8	1554	2	11
Mar. 8	1607	2	9
Mar. 8	1608	2	24
Mar. 8	1615	2	15
Mar. 8	1615	1.9	11
Mar. 8	0415	1.9	13
Mar. 8	1615	1.9	9
Mar. 8	0415	1.9	8
Mar. 8	1210	1.8	24
Mar. 8	1352	1.8	9
Mar. 8	1355	1.8	10
Mar. 8	1514	1.8	12
Mar. 8	1516	1.8	24
Mar. 8	1521	1.8	16
Mar. 8	0321	1.8	9
Mar. 8	1520	1.8	12
Mar. 8	0321	1.8	6
Mar. 8	1520	1.8	8
Mar. 8	0320	1.9	10
Mar. 8	1520	1.8	11

Table 2.--Streamflow and suspended-sediment data for samples collected at streamflow-gaging stations in the Nutria Reservoir No. 3 Basin, water years 1994 and 1995--Continued

Date	Time	Streamflow, instantaneous (ft^3/s)	Suspended-sediment concentration (mg/L)
09386919 Spillway Channel below Nutria Reservoir No. 3			
Water year October 1993 to September 1994			
Mar. 8	0320	1.9	9
Mar. 8	1448	1.9	9
Mar. 8	1500	1.9	27
Mar. 8	1513	1.9	8
Mar. 8	1554	1.9	22
Mar. 8	0313	2	7
Mar. 8	1513	1.9	8
Mar. 8	0313	2	11
Mar. 8	1513	1.9	88
Mar. 8	0313	7.4	10
Mar. 8	1451	6.6	9
Mar. 8	1514	6.6	20
Mar. 8	1608	6.5	17
Mar. 8	1613	6.5	12
Mar. 8	0413	6.4	11
Mar. 8	1612	5	9
Mar. 8	0412	5.8	9
Mar. 8	1612	5	8
Mar. 8	0412	5.5	9
Mar. 8	1612	4.8	8
Mar. 8	1519	4.6	9
Mar. 8	1547	4.6	4
Mar. 8	1605	4.5	23
Mar. 8	1547	1.2	27
Mar. 8	1431	0.4	35
Apr. 1	1416	0.3	49
Apr. 2	0216	0.1	34
Apr. 2	1416	0.2	10
Apr. 3	1416	0.3	18
Apr. 4	1320	0.3	13
Apr. 4	1446	0.3	48
Apr. 5	0246	0.3	19
Apr. 5	1446	0.3	30
Apr. 6	1446	0.2	25
Apr. 7	0246	0.1	22
Apr. 7	1122	0.2	22
Apr. 7	1146	0.2	22
Apr. 8	1146	0.1	19
Apr. 8	2346	0.6	25
Apr. 9	1146	0.6	16
Apr. 9	2346	0.1	16
Apr. 10	1146	0.2	37
Apr. 11	1117	0.1	45
Apr. 11	1343	0.1	37
Apr. 12	1343	0.1	40
Apr. 13	0143	0.1	91
Apr. 13	1343	0.1	41
Water year October 1994 to September 1995			
Feb. 8	1410	6.4	37
Feb. 8	1420	6.4	39
Feb. 13	1046	1	30
Feb. 13	1055	1	11
Feb. 13	2255	1	16
Feb. 14	1055	1	19
Feb. 14	2255	0.94	50
Feb. 15	1055	19	70
Feb. 15	2255	19	69
Feb. 16	1000	23	31
Feb. 16	1047	23	61
Feb. 16	1109	22	120
Feb. 16	1121	22	32
Feb. 16	2304	22	53
Feb. 17	1009	22	90
Feb. 17	1018	22	95
Feb. 17	1104	22	95
Feb. 17	1113	22	94
Feb. 17	1120	22	128
Feb. 17	1500	22	131
Feb. 17	2320	3	90
Feb. 18	1120	19	97
Feb. 18	2320	19	92

Table 2.--Streamflow and suspended-sediment data for samples collected at streamflow-gaging stations in the Nutria Reservoir No. 3 Basin, water years 1994 and 1995--Concluded

Date	Time	Streamflow, instantaneous (ft^3/s)	Suspended-sediment concentration (mg/L)
09386919 Spillway Channel below Nutria Reservoir No. 3 Water year October 1994 to September 1995			
Feb. 19	1120	18	53
Feb. 20	1120	17	84
Feb. 20	2320	17	82
Feb. 23	1033	3.4	77
Feb. 23	2233	4.4	60
Feb. 24	1033	14	72
Feb. 24	2233	22	73
Feb. 25	1100	6.4	86
Feb. 25	2233	21	104
Feb. 26	1033	24	75
Feb. 26	2233	24	128
Feb. 27	1033	24	190
Feb. 27	2233	26	119
Feb. 28	1033	29	80
Feb. 28	2233	32	99
Mar. 1	2233	29	76
Mar. 2	1033	28	64
Mar. 2	2233	28	127
Mar. 3	1033	29	119
Mar. 13	1549	15	158
Mar. 14	1549	15	46
Mar. 14	2233	15	43
Mar. 15	0349	14	33
Mar. 15	1549	14	42
Mar. 16	0349	14	26
Mar. 16	1549	14	30
Mar. 17	0349	14	23
Mar. 17	1549	14	85
Mar. 18	1549	14	23
Mar. 19	0349	14	50
Mar. 20	1549	15	105
Mar. 27	1228	9.4	69
Mar. 28	1228	7.3	185
Mar. 29	0028	8.3	196
Mar. 29	1228	6.7	280
Mar. 30	1228	7	153
Mar. 31	1228	6.7	338
Apr. 1	0028	6.5	62
Apr. 1	1228	6.2	320
Apr. 2	0028	6	52
Apr. 2	1228	5.8	236
Apr. 3	0028	5.7	37
Apr. 3	1228	5.9	178
Apr. 4	0028	5.3	26
Apr. 4	1228	5.3	203
09386910 Conservation Draw near Nutria Village Water year October 1993 to September 1994			
Sept. 13	1414	23	15,300
Sept. 13	1419	23	16,800
Sept. 13	1424	23	16,000
Sept. 13	1429	23	16,000
Sept. 13	1434	22	14,900

Table 3.--Runoff and suspended-sediment loads calculated upstream and downstream from Nutria Reservoir No. 3, March 3, 1994, to September 30, 1995

Streamflow-gaging station number (fig. 1)	Station name	Drainage area (square miles)	Total runoff (acre-feet)	Total suspended-sediment load (tons)	Mean sediment concentration (tons/acre-foot)
		Upstream			
09386900	Rio Nutria near Ramah	71.4	13,402	1,650	0.123
09386910	Conservation Draw near Nutria Village[1]	2.5	15.3	450	29.4
09386915	Rio Nutria above Nutria Reservoir No. 3	118.0	6,511	1,510	0.232
09386917	Garcia Draw above Nutria Reservoir No. 3	23.5	301	22,800	75.7
		Downstream			
09386919	Spillway Channel below Nutria Reservoir No. 3	151.9	2,244	259	0.115

Total suspended sediment transported into Nutria Reservoir No. 3	24,310 tons
Total suspended sediment transported out of Nutria Reservoir No. 3	259 tons
Total suspended-sediment load deposited in Nutria Reservoir No. 3	24,050 tons
Total runoff entering Nutria Reservoir No. 3	6,812 acre-feet
Total runoff leaving Nutria Reservoir No. 3	2,244 acre-feet

[1]Suspended-sediment loads were only estimated for the period of September 9-13, 1994.

Table 4.--Particle-size data for suspended-sediment samples collected at streamflow-gaging stations in the Nutria Reservoir No. 3 Basin, water years 1994 and 1995

[ft^3/s, cubic feet per second; mg/L, milligrams per liter; mm, millimeters]

Date	Time	Streamflow, instantaneous (ft^3/s)	Suspended-sediment concentration (mg/L)	Sediment, suspended, sieve diameter (percent finer than 0.062 mm)
	09386917 Garcia Draw above Nutria Reservoir No. 3 Water year October 1993 to September 1994			
May 12	1833	2.8	64,480	95
May 12	1858	12	39,310	94
May 12	1928	8.2	34,770	98
May 12	2028	4.8	30,770	100
May 12	2218	3.4	22,970	100
May 13	0118	2.7	13,380	100
Aug. 20	2041	0.90	121,380	98.5
Aug. 20	2056	13	102,770	99.5
Aug. 20	2131	21	87,270	100
Aug. 20	2241	12	73,480	100
Aug. 21	0331	4.3	52,950	100
Aug. 21	0431	1.2	54,770	100
Sept. 6	2238	0.41	84,020	100
Sept. 6	2248	13	75,010	100
Sept. 6	2313	12	68,160	100
Sept. 6	2353	9.6	54,850	100
Sept. 11	0311	18	75,630	96
Sept. 11	0321	62	76,580	96
Sept. 11	0331	90	73,510	98
Sept. 11	0401	94	69,010	99
Sept. 11	0451	92	58,240	99
Sept. 11	0701	27	53,140	99
Sept. 13	1537	8.7	99,440	95
Sept. 13	1547	40	99,700	74
Sept. 13	1607	72	80,950	97

Table 4.--Particle-size data for suspended-sediment samples collected at streamflow-gaging stations in the Nutria Reservoir No. 3 Basin, water years 1994 and 1995--Concluded

Date	Time	Streamflow, instantaneous (ft^3/s)	Suspended-sediment concentration (mg/L)	Sediment, suspended, sieve diameter (percent finer than 0.062 mm)
	09386917 Garcia Draw above Nutria Reservoir No. 3 Water year October 1993 to September 1994			
Sept. 13	1647	78	101,120	95
Oct. 26	0038	41	74,070	88
Oct. 26	0048	42	70,320	83
Oct. 26	0118	36	52,230	84
	09386900 Rio Nutria near Ramah Water year October 1994 to September 1995			
Dec. 06	1124	63	85	85
Dec. 06	1304	81	164	97
Dec. 06	1603	200	201	97
Dec. 06	1724	200	250	97
Dec. 06	1824	210	240	98
Dec. 06	2114	160	220	98
Feb. 06	1717	14	44	93
Feb. 06	1957	13	38	91
Feb. 07	0027	12	37	95
	09386915 Rio Nutria above Nutria Reservoir No. 3 Water year October 1994 to September 1995			
Nov. 13	0285	29	79	96
Nov. 13	0458	24	144	98
Dec. 07	1235	32	82	97
Dec. 07	1435	27	101	97

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