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Prepared in cooperation with the Colorado River Basin
Salinity Control Forum

Results of Water-Quality Monitoring during May 2007–May 2008 in Selected Sub-basins near Manila, Utah to Evaluate the Effect of Irrigation Improvements on Dissolved-Solids Loads Discharged to Flaming Gorge Reservoir

Administrative Report 2008

U.S. Department of the Interior
U.S. Geological Survey

Executive Summary

The Manila/Washam Salinity Project (MWSP) is an effort by the Natural Resources Conservation Service (NRCS) to reduce the transport of dissolved solids to Flaming Gorge Reservoir (FGR) from the agricultural areas surrounding Manila, Utah. This project, which is currently (2008) in the second year of implementation, includes piping on-farm delivery of irrigation water and converting flood irrigation to sprinkler irrigation. The U.S. Geological Survey (USGS) is monitoring the amount of dissolved solids being discharged from the project area to provide data that can be used in assessing the effectiveness of the MWSP in reducing dissolved-solids loads to FGR.

Birch Spring Draw (BSD) (fig. 1, table 1) drains most of Lucerne Valley, which contains much of the agricultural land near Manila and where the largest impacts from the MWSP are projected to occur. Discharge and the specific conductance of streamflow in BSD (located in the MWSP area) have been continuously monitored since May 11, 2007. These values and dissolved-solids concentrations determined from water samples have been used to calculate the dissolved-solids load discharged from BSD. Other water samples collected, and water-quality measurements made, within the MSWP area were used to develop a relation between the dissolved-solids load from BSD and the net dissolved-solids load discharged from the entire MWSP area.

From May 12, 2007 to May 11, 2008 (referred to as the 2007-08 reporting period), there were 3,160 acre-feet of water, containing approximately 10,900 tons of dissolved solids, discharged to FGR from BSD. The dissolved-solids load discharged during this period was 52 percent less than the load discharged during July 1, 2004 to June 30, 2005 (referred to as the 2004-05 reporting period). In particular, dissolved-solids loads were substantially smaller during the winter months of 2007-08 than during the winter months of 2004-05.

During the 2007-08 reporting period, the

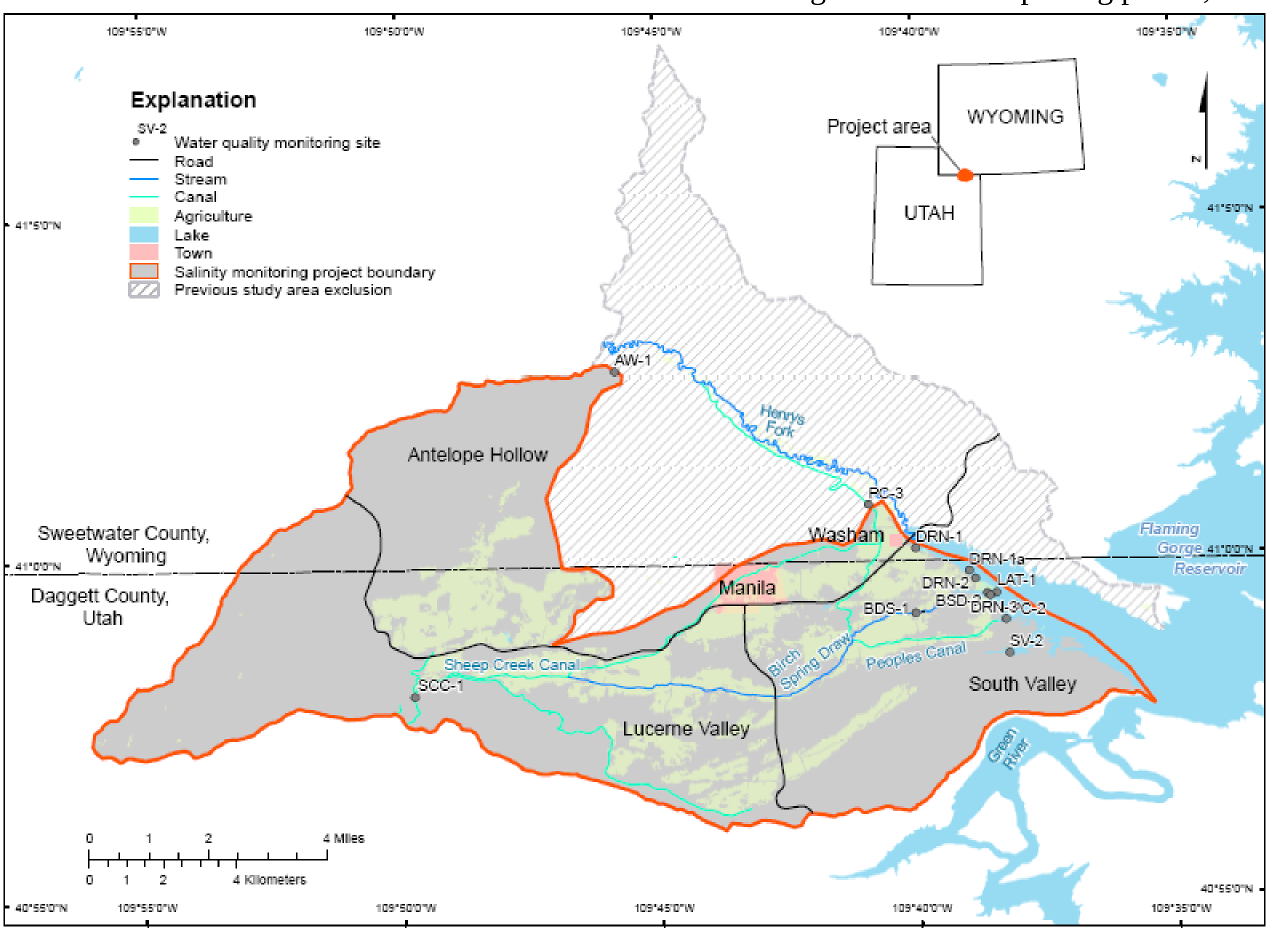

Figure 1. Map showing location of water-quality monitoring sites in the Manila/Washam Salinity Project area.

net dissolved-solids load[1] discharged from the entire MWSP area into Henrys Fork and FGR was about 19,500 tons. The dissolved-solids load discharged during this period was about 50 percent less than during the 2004–05 reporting period. A substantial portion of the difference in dissolved-solids loads for 2004-05 and 2007-08 may be attributable to greatly reduced flow in Peoples Canal and much less water distributed to agricultural areas in the lower Lucerne Valley during 2007.

Purpose of Assessment

There are about 11,000 acres of agricultural land in the MWSP area, located in the northern portion of Daggett County, Utah, and the southern portion of Sweetwater County, Wyoming (fig.1). The MWSP plan calls for about 7,780 acres of land currently using flood irrigation methods to be converted to gravity pressure sprinkler irrigation systems within the next 2 to 4 years (Natural Resources Conservation Service, 2006). The NRCS estimated that the dissolved-solids load discharged from the MWSP area would be reduced by 1,600 tons during 2007 as a result of irrigation improvements. Irrigation improvements resulting from the MWSP during 2008 to 2011 are projected to reduce the annual discharge of dissolved-solids to FGR by an additional 4,800 tons per year. Hence, the projected total reduction in dissolved solids discharged to FGR by 2012 as a result of the MWSP is 20,800 tons per year (Natural Resources Conservation Service, 2006). As part of the project implementation, and in support of future projects, the USGS is monitoring water quality in discharge from BSD and selected drains and seeps in the MWSP area to observe changes that occur during MWSP implementation.

[1] The term ‘net dissolved-solids load’ in this report refers to the difference between the outflow of dissolved solids from the MWSP area to Flaming Gorge Reservoir and the inflow of dissolved solids to the MWSP area from two irrigation canals: Sheep Creek Canal that enters from the west and Peoples Canal that enters from the north.

Assessment Methods

A streamflow and water-quality monitoring station was installed near the outflow of BSD on May 11, 2007 (site BSD-2 [USGS site 09230300], fig. 1). Discharge, specific conductance, and water temperature have been continuously monitored since the station was installed. These values have been reported provisionally in near real-time on the worldwide web at URL http://waterdata.usgs.gov/ut/nwis/rt. Additionally, quality-assured and approved daily mean discharge, specific-conductance, and water temperature values for the 2007 water year have been reported on the worldwide web at URL http://wdr.water.usgs.gov/wy2007/pdfs/09230300.2007.pdf. Monthly site visits have been made to this gage to maintain and calibrate the instrumentation. In addition, monthly water-quality samples have been collected at site BSD-2 to define the relation between dissolved-solids concentration and specific conductance (table 2, fig. 2). Dissolved-solids loads were computed using the following equation:

$$Load = (Conc)(Streamflow)(CF) \qquad (1)$$

Where

Load is the dissolved-solids load in tons,

Conc is the dissolved-solids[2] concentration,

Streamflow is in cubic feet per second, and

CF is a correction factor[3] used to adjust the load to a specific time interval.

[2] A site-specific coefficient, derived from the relation of specific conductance and dissolved-solids concentration was determined and used to estimate dissolved-solids concentration from specific-conductance values when necessary.
[3] The constant used in this study to calculate daily dissolved-solids loads was 0.002697 and the constant used to calculate 15-minute loads was 0.0000281.

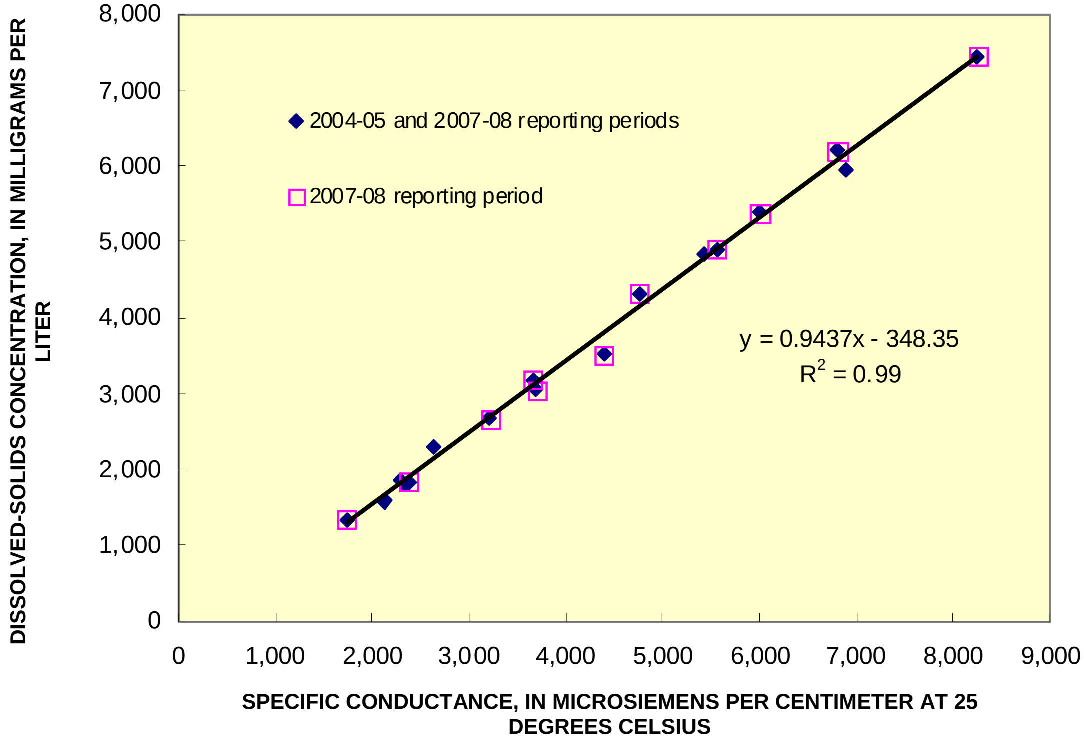

Figure 2. The relation of dissolved-solids concentration in water samples collected at or near site BSD-2 to the specific conductance of those water samples. (Data for the 2004–05 reporting period are from Gerner and others, 2007.)

Dissolved-solids loads in BSD during the 2007-08 reporting period were calculated based on 15-minute data, and then those values were aggregated to determine daily loads.

Many drains and seeps in Lucerne and South Valleys discharge dissolved solids to FGR, and the outflow from Antelope Hollow discharges dissolved solids to Henrys Fork, which in turn discharges to FGR. On a monthly basis, discharge and specific conductance were measured and water samples were collected to determine the dissolved-solids concentration (as residue on evaporation at 180^{o} Celsius) in water from the major drains and seeps. Results from these periodic measurements were used to calculate dissolved-solids loads and define a relation between the dissolved-solids load discharged in streamflow at site BSD-2 and the net dissolved-solids load discharged to Henrys Fork and FGR from all the monitored seeps, drains, and streams (table 3, fig. 3). This relation and the continuous data collected at site BSD-2 were used to estimate the net dissolved-solids load discharged from Lucerne and South Valleys and Antelope Hollow during the 2007-08 reporting period.

The area currently being monitored (fig. 1) is smaller than the area monitored during the initial study characterizing dissolved solids in water resources of agricultural lands near Manila (Gerner and others, 2007). The current study area excludes the Henrys Fork drainage between the Peoples Canal diversion and Washam where there is relatively little agricultural land. Monitoring dissolved-solids loads in inflow to this reach is difficult because the amount of dissolved solids added to Henrys Fork in this reach is small relative to the total load in the river, and the inflow is generally from small drains and seeps that are widely dispersed. The method used in this report to estimate net dissolved-solids loads is slightly different from that used in the previous report. Previously, a dissolved-solids load relation was established between the total load at three monitored sites and the net dissolved-solids

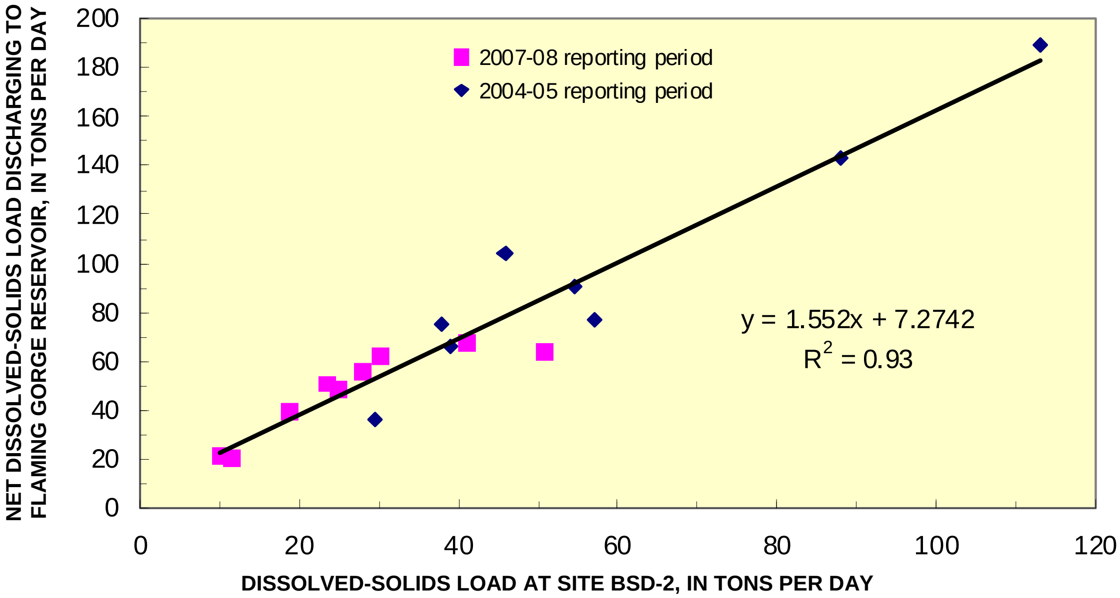

Figure 3. The relation of dissolved-solids load at water-quality site BSD-2 (USGS site 09230300) and the net dissolved-solids load discharged from the Manila/Washam Salinity Project area.

load discharged from the study area (Gerner and others, 2007). Currently, the net dissolved-solids load from the MWSP area is being predicted from dissolved solids discharged only at site BSD-2 (fig. 1).

Discharge and dissolved-solids loads in BSD are currently being monitored near the mouth of the drainage which is about 1 mile downstream of the 2004-05 monitoring site (site BSD-1, fig. 1). Because the monitoring site was moved, a relation was developed for dissolved-solids loads at the two locations using a second-order polynomial regression. This regression is based on data collected during the 2004-05 reporting period (Gerner and others, 2007) and is shown on figure 4. This relation was used to estimate the dissolved-solids load near site 09230300 during the 2004-05 reporting period, which allowed a comparison of the dissolved solids

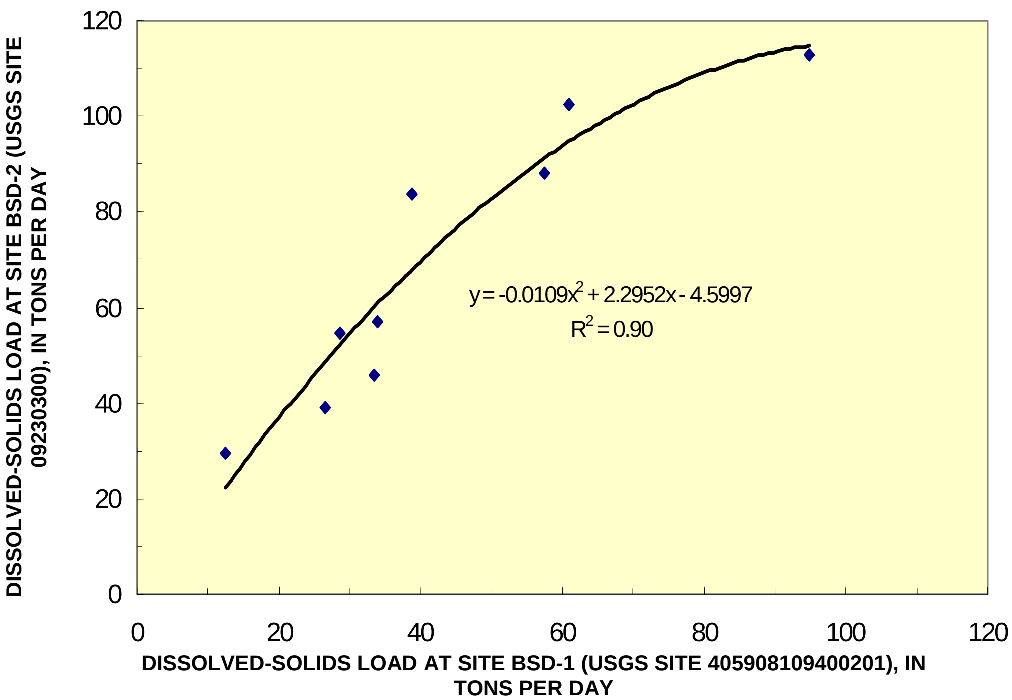

Figure 4. Relation of the dissolved-solids loads at site BSD-1 (USGS site 405908109400201) and site BSD-2 (USGS site 09230300) during the 2004-05 reporting period.

discharged from BSD and from the MWSP area during the 2004-05 and 2007-08 reporting periods to be made.

Monitoring results

Water-quality monitoring results for BSD are presented for the 2007-08 reporting period and compared to results from the 2004-2005 reporting period. The 2007-08 reporting period covers one year of operation beginning May 12, 2007. The results of monitoring at the BSD water-quality site and data collected at selected water-quality monitoring sites in the MWSP area were used to determine the net dissolved-solids load from the MWSP area for the 2007-08 reporting period.

Birch Spring Draw

During the 2007-08 reporting period, there were 3,160 acre-feet of runoff at site BSD-2 (USGS site 09230300). This water transported 10,900 tons of dissolved solids to FGR. The dissolved-solids load at site BSD-2 during this period was 52 percent less than during 2004–05. In particular, daily dissolved-solids loads were generally smaller during the winter months of 2007-08 than they were during the winter months of 2004-05 (fig. 5). Dissolved-solids loads in BSD were monitored infrequently during the winter of 2004-05, so some of the variation in daily load was probably not accounted for; however, for those days when measurements were made, the discharge and specific-conductance values were substantially larger than during 2007-08. During the 2007-08 reporting period, the dissolved-solids concentration in water at site BSD-2 (calculated from specific-conductance measurements) varied from 860 to 14,800 mg/L. Half of the concentrations during this period were between 2,090 and 4,550 mg/L, and the dissolved-solids concentration exceeded 6,180 mg/L only 10 percent of the time. The highest dissolved-solids concentration values were observed during February and March. The accuracy of the instrument measuring specific conductance during this period was confirmed but the source of the dissolved solids responsible for the elevated concentrations was not identified.

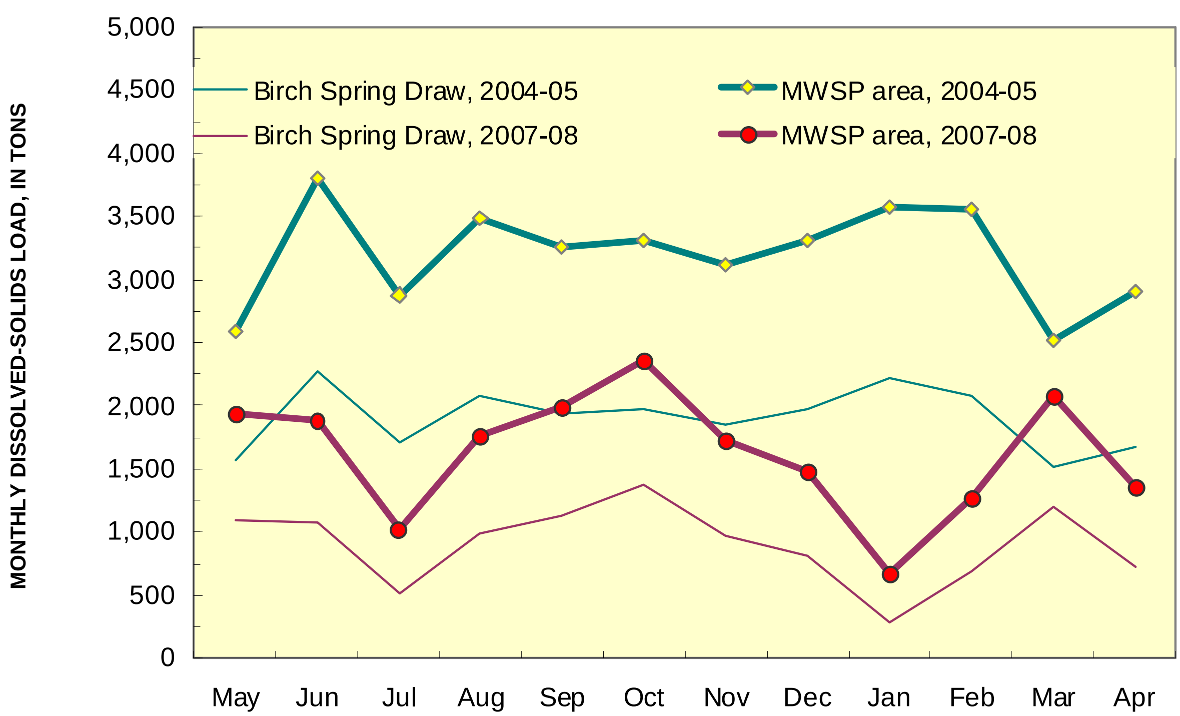

Figure 5. Monthly dissolved-solids loads in discharge at site BSD-2 (USGS site 09230300) and from the Manila/Washam Salinity Project area during the 2004-05 and 2007-08 reporting periods.

Dissolved Solids Discharged to Henrys Fork and Flaming Gorge Reservoir from the Manila/Washam Salinity Project Area

During the 2007-08 reporting period the net dissolved-solids load discharged from the MWSP area was 19,500 tons, about 50 percent less than during the 2004–05 reporting period. Daily dissolved-solids loads discharged during the winter were much smaller during 2007-08 than during 2004-05, possibly because of a much smaller amount of water distributed to the area during the 2007 irrigation season by Peoples Canal or as a result of less snowmelt runoff in the project area during the 2007-08 period (figs. 5 and 6). Peoples Canal, when full, transports as much as 40 ft^3/s, but there were no measurements of discharge in the canal during the 2007 irrigation season that exceeded 20 ft^3/s (fig. 6). Consequently, there probably was much less water applied to the agricultural land served by Peoples Canal during the 2007-08 reporting period than there was during the 2004-05 reporting period. This indicates that the amount and type of irrigation on lands served by Peoples Canal probably has a substantial impact on the net dissolved-solids load discharged from the MWSP area. In contrast to Peoples Canal, Sheep Creek Canal delivered a normal amount of water during the 2007 irrigation season. A relatively cool and wet spring during 2008 delayed the application of irrigation water in the study area, which resulted in fewer dissolved-solids in outflow from the MWSP area during April 2008.

Differing climatic conditions during 2004-05 and 2007-08 had a substantial influence on flow in the canals and drains, application of irrigation water, and on the daily dissolved-solids loads discharged from the MWSP area. During 2004-05, there were 170 days when the net dissolved-solids load discharged from the project area exceeded 100 tons per day; however, there were only 12 days during the 2007-08 reporting period when the net dissolved-solids load discharged from the project area exceeded 100 tons per day (fig. 7). Overall, the precipitation from July 2004 to June 2005 (9.51 inches) at Manila, Utah was normal, but the precipitation from May 2007 to April 2008 (5.7 inches) was substantially below normal (Western Regional Climate Center, 2008). Mean daily air temperatures at Manila were below normal during the 2004 summer but substantially above normal during the 2007 summer. Additional data collection at BSD-2 can be used to determine if the dissolved-solids load in BSD is sufficiently correlated to discharge so that dissolved-solids load values can be adjusted for changing flow conditions and trends in loads can be determined without some of the confounding effects of climate variability.

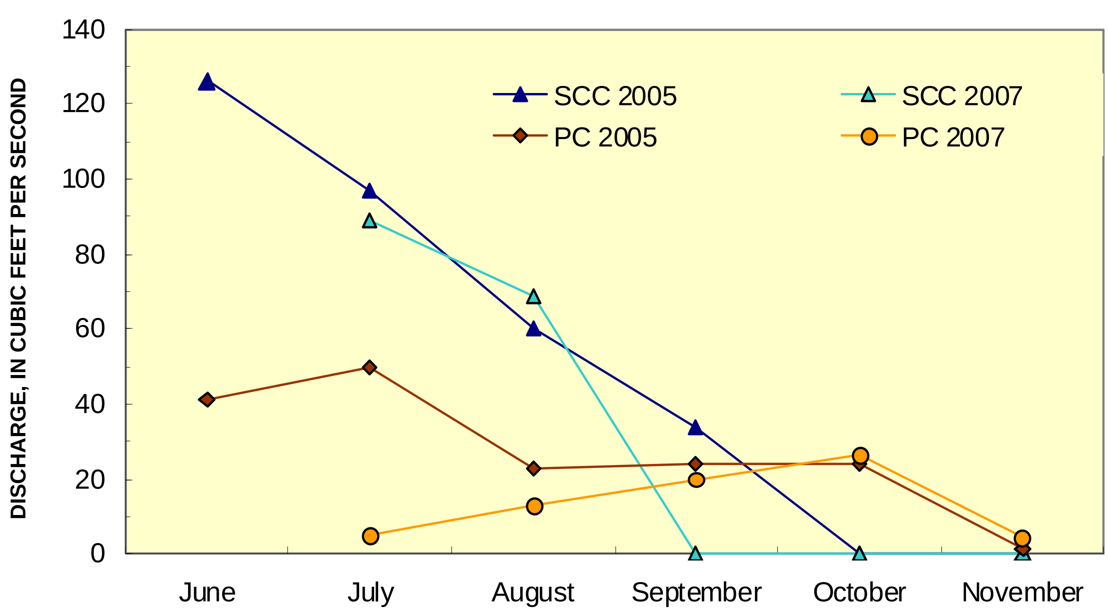

Figure 6. Instantaneous discharge measured in Sheep Creek Canal (SCC) and Peoples Canal (PC) in month indicated during 2005 and 2007.

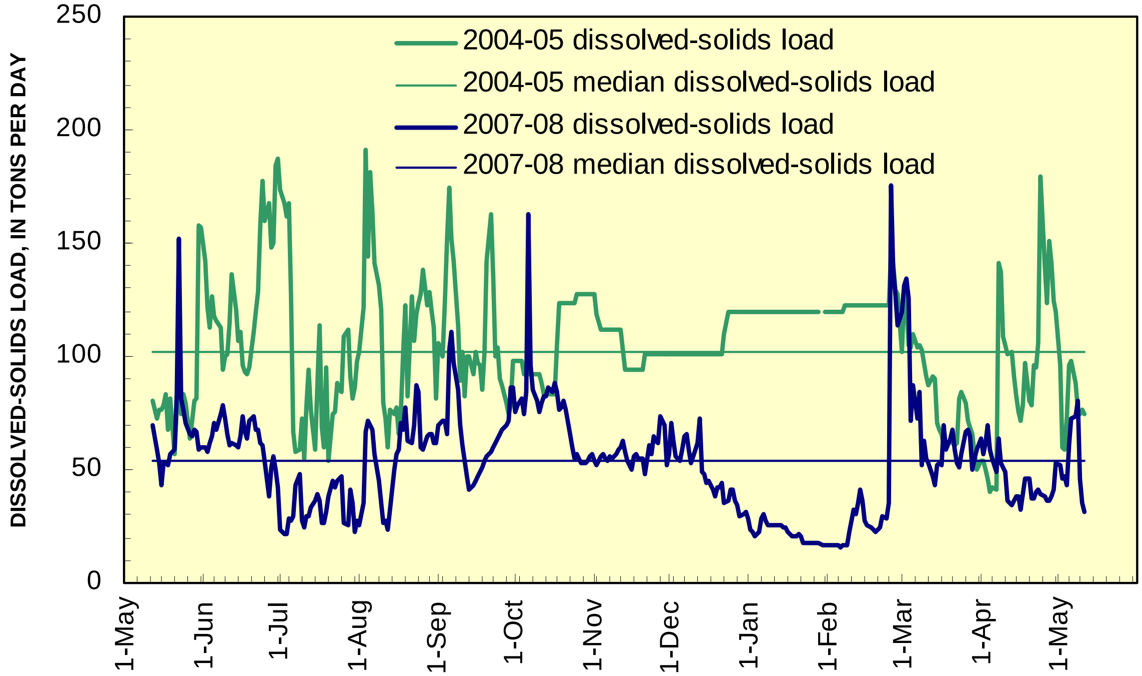

Figure 7. Daily dissolved-solids loads discharged from the Manila/Washam Salinity Project area during the 2004–05 and 2007–08 reporting periods.

References

Gerner, S.J., Spangler, L.E., Kimball, B.A., and Naftz, D.L., 2007, Characterization of dissolved solids in water resources of agricultural lands near Manila, Utah, 2004-05, U.S. Geological Survey Scientific Investigations Report 2006-5211, 36 p.

Natural Resources Conservation Service, 2006, Plan and environmental assessment: Manila - Washam Project area of the Colorado River Salinity Control Program–Final Draft: 112 p.

Western Regional Climate Center, 2008, Monthly total precipitation at Manila, Utah: Digital data accessed September 29, 2008 at http://www.wrcc.dri.edu/summary/Climsmut.html

Table 1. Monitoring sites in the Manila/Washam Salinity Project area.

[USGS, U.S. Geological Survey; ddmmss, degrees, minutes, seconds; FGNRA, Flaming Gorge National Recreation Area]

Site identifier	Site name	USGS site ID number	Latitude, ddmmss	Longitude, ddmmss	Site type
SCC-1	Sheep Creek Canal near Manila, Utah	405800109494601	405800	1094946	Canal
PC-2	Peoples Canal near mouth, near Manila, Utah	405902109381801	405902	1093818	Drain
PC-3	Peoples Canal at Washam, Wyoming	410044109405601	410044	1094056	Canal
AW-1	Antelope Wash at Co. Rd. 13 near Manila, Utah	410244109454901	410244	1094549	Drain
BSD-1	Birch Spring Draw near Manila, Utah	405925109383901	405925	1093839	Drain
BSD-2	Birch Spring Draw at FGNRA boundary, near Manila, Utah	09230300	405925	1093839	Drain
LAT-1	Lateral 1 near Manila, Utah	405926109382801	405926	1093828	Drain
SV-2	South Valley Canal at mouth, near Manila, Utah	405832109381401	405832	1093814	Drain
DRN-1	Drain No.1 near Manila, Utah	405945109390001	410005	1094002	Drain
DRN-1a	Drain 1a near Manila, Utah	405945109390002	405945	1093900	Drain
DRN-2	Drain 2 near Manila, Utah	405938109385301	405938	1093853	Drain
DRN-3	Drain 3 near Manila, Utah	405923109383601	405923	1093836	Drain

Table 2. Instantaneous discharge and properties of water samples collected from water-quality monitoring sites near Manila, Utah, May 2007–May 2008.
[FGNRA, Flaming Gorge National Recreation Area; hhmm, hours and minutes; —, no data or not computed; E, estimated]

Site number	Site identifier	Site name	Date	Time, hhmm	Temperature, water, degrees Celsius	Discharge, instantaneous, cubic feet per second	Specific conductance, water, unfiltered, field, microsiemens per centimeter at 25 degrees Celsius	pH, water, unfiltered, laboratory, standard units	Calcium, water, filtered, milligrams per liter	Magnesium, water, filtered, milligrams per liter
405800109494601	SCC-1	Sheep Creek Canal near Manila, Utah	07/10/2007	1240	14.5	89	54	—	—	—
405800109494601	SCC-1	Sheep Creek Canal near Manila, Utah	08/13/2007	1200	18.5	69	60	—	—	—
405800109494601	SCC-1	Sheep Creek Canal near Manila, Utah	05/21/2008	1045	6.7	113	63	—	—	—
410044109405601	PC-3	Peoples Canal at Washam, Wyoming	07/10/2007	1800	23.8	4.8	1,190	—	—	—
410044109405601	PC-3	Peoples Canal at Washam, Wyoming	08/14/2007	1250	21.0	13	1,040	—	—	—
410044109405601	PC-3	Peoples Canal at Washam, Wyoming	09/27/2007	1740	14.7	20	1,210	—	—	—
410044109405601	PC-3	Peoples Canal at Washam, Wyoming	10/16/2007	1450	8.7	27	902	—	—	—
410044109405601	PC-3	Peoples Canal at Washam, Wyoming	11/07/2007	1710	4.7	2.6	840	—	—	—
410044109405601	PC-3	Peoples Canal at Washam, Wyoming	12/13/2007	1030	.1	.05	943	—	—	—
410044109405601	PC-3	Peoples Canal at Washam, Wyoming	05/20/2008	1810	18.4	39	463	—	—	—
09230300	BSD-2	Birch Spring Draw at FGNRA boundary, near Manila, Utah	06/12/2007	1500	22.3	7.7	2,370	—	—	—
09230300	BSD-2	Birch Spring Draw at FGNRA boundary, near Manila, Utah	07/10/2007	1525	23.7	1.2	4,390	—	—	—
09230300	BSD-2	Birch Spring Draw at FGNRA boundary, near Manila, Utah	08/13/2007	1430	24.1	1.4	3,210	—	—	—
09230300	BSD-2	Birch Spring Draw at FGNRA boundary, near Manila, Utah	09/27/2007	1410	13.5	4.7	3,690	—	—	—
09230300	BSD-2	Birch Spring Draw at FGNRA boundary, near Manila, Utah	10/16/2007	1350	9.0	14	1,740	—	—	—
09230300	BSD-2	Birch Spring Draw at FGNRA boundary, near Manila, Utah	11/07/2007	1350	6.1	3.5	3,660	7.9	243	144
09230300	BSD-2	Birch Spring Draw at FGNRA boundary, near Manila, Utah	12/12/2007	1230	-.1	2.1	5,560	7.7	380	243
09230300	BSD-2	Birch Spring Draw at FGNRA boundary, near Manila, Utah	01/14/2008	1150	-.1	.94	4,760	—	—	—
09230300	BSD-2	Birch Spring Draw at FGNRA boundary, near Manila, Utah	02/13/2008	1600	-.1	.93	8,250	—	—	—
09230300	BSD-2	Birch Spring Draw at FGNRA boundary, near Manila, Utah	03/18/2008	1320	5.0	1.4	6,800	7.9	364	286
09230300	BSD-2	Birch Spring Draw at FGNRA boundary, near Manila, Utah	04/10/2008	1515	10.4	1.7	6,000	—	—	—
09230300	BSD-2	Birch Spring Draw at FGNRA boundary, near Manila, Utah	05/20/2008	1545	22.7	4.3	2,840	—	—	—
405832109381401	SV-2	South Valley Canal at mouth, near Manila, Utah	07/11/2007	1010	15.0	3	1,360	—	—	—
405832109381401	SV-2	South Valley Canal at mouth, near Manila, Utah	08/14/2007	0945	16.6	2.1	1,460	—	—	—
405832109381401	SV-2	South Valley Canal at mouth, near Manila, Utah	09/27/2007	1720	14.7	2.2	1,370	—	—	—
405832109381401	SV-2	South Valley Canal at mouth, near Manila, Utah	10/16/2007	1720	14.7	2.2	1,370	—	—	—
405832109381401	SV-2	South Valley Canal at mouth, near Manila, Utah	11/07/2007	1640	6.0	.64	1,930	—	—	—
405832109381401	SV-2	South Valley Canal at mouth, near Manila, Utah	12/12/2007	1550	.1	1.1	2,190	—	—	—
405832109381401	SV-2	South Valley Canal at mouth, near Manila, Utah	02/13/2008	1215	1.0	.82	2,090	—	—	—
405832109381401	SV-2	South Valley Canal at mouth, near Manila, Utah	03/18/2008	1640	9.2	1.1	2,360	—	—	—
405832109381401	SV-2	South Valley Canal at mouth, near Manila, Utah	04/11/2008	0940	.2	1	2,170	—	—	—
405832109381401	SV-2	South Valley Canal at mouth, near Manila, Utah	05/20/2008	1240	20.3	.29	2,220	—	—	—
405902109381801	PC-2	Peoples Canal near mouth, near Manila, Utah	07/11/2007	0910	15.4	2.1	2,080	—	—	—
405902109381801	PC-2	Peoples Canal near mouth, near Manila, Utah	09/27/2007	1630	14.1	2.5	2,220	—	—	—
405902109381801	PC-2	Peoples Canal near mouth, near Manila, Utah	10/16/2007	1555	10.5	5.4	1,880	—	—	—
405902109381801	PC-2	Peoples Canal near mouth, near Manila, Utah	11/07/2007	1540	9.5	.51	2,750	—	—	—
405902109381801	PC-2	Peoples Canal near mouth, near Manila, Utah	12/12/2007	1500	4.1	.37	2,940	—	—	—
405902109381801	PC-2	Peoples Canal near mouth, near Manila, Utah	02/13/2008	1150	4.9	.08	3,110	—	—	—
405902109381801	PC-2	Peoples Canal near mouth, near Manila, Utah	03/18/2008	1530	7.5	.06	3,130	—	—	—
405902109381801	PC-2	Peoples Canal near mouth, near Manila, Utah	04/11/2008	0850	1.3	.08	3,220	—	—	—
405902109381801	PC-2	Peoples Canal near mouth, near Manila, Utah	05/20/2008	1200	15.8	1.3	1,900	—	—	—
405945109390002	DRN-1a	Drain No.1a near Manila, Utah	05/10/2007	1650	25.0	.02	6,310	—	—	—
405945109390002	DRN-1a	Drain No.1a near Manila, Utah	06/13/2007	1110	16.9	.04	4,080	—	—	—
405945109390002	DRN-1a	Drain No.1a near Manila, Utah	09/28/2007	0740	6.8	.24	2,920	—	—	—
405945109390002	DRN-1a	Drain No.1a near Manila, Utah	10/16/2007	1415	12.9	.05	3,760	—	—	—
405945109390002	DRN-1a	Drain No.1a near Manila, Utah	11/08/2007	0835	2.0	.04	4,340	—	—	—
405945109390002	DRN-1a	Drain No.1a near Manila, Utah	12/13/2007	1000	.1	.02	4,620	—	—	—
405945109390002	DRN-1a	Drain No.1a near Manila, Utah	04/10/2008	1650	10.2	.03	4,520	—	—	—
405945109390002	DRN-1a	Drain No.1a near Manila, Utah	05/20/2008	1315	21.6	.03	5,100	—	—	—
405938109385301	DRN-2	Drain No. 2 near Manila, Utah	05/10/2007	1640	18.8	4.3	2,980	—	—	—
405938109385301	DRN-2	Drain No. 2 near Manila, Utah	06/13/2007	1050	16.6	1.9	1,770	—	—	—
405938109385301	DRN-2	Drain No. 2 near Manila, Utah	07/10/2007	1630	14.8	.02	5,680	—	—	—
405938109385301	DRN-2	Drain No. 2 near Manila, Utah	09/28/2007	0840	8.7	4.9	2,380	—	—	—
405938109385301	DRN-2	Drain No. 2 near Manila, Utah	10/16/2007	1720	9.2	.49	3,440	—	—	—
405938109385301	DRN-2	Drain No. 2 near Manila, Utah	11/08/2007	0825	3.6	.19	3,850	—	—	—
405938109385301	DRN-2	Drain No. 2 near Manila, Utah	12/13/2007	0940	2.9	.07	4,190	—	—	—
405938109385301	DRN-2	Drain No. 2 near Manila, Utah	03/19/2008	0915	1.6	.05	5,170	—	—	—
405938109385301	DRN-2	Drain No. 2 near Manila, Utah	04/10/2008	1700	5.9	.04	5,300	—	—	—
405938109385301	DRN-2	Drain No. 2 near Manila, Utah	05/20/2008	1330	18.2	.41	3,340	—	—	—
410244109454901	AW-1	Antelope Wash at Co. Rd. 13 near Manila, Utah	06/13/2007	1250	18.8	1.9	3,690	—	—	—
410244109454901	AW-1	Antelope Wash at Co. Rd. 13 near Manila, Utah	07/10/2007	1840	21.1	1.2	3,670	—	—	—
410244109454901	AW-1	Antelope Wash at Co. Rd. 13 near Manila, Utah	08/14/2007	1345	18.2	2.2	3,840	—	—	—
410244109454901	AW-1	Antelope Wash at Co. Rd. 13 near Manila, Utah	09/27/2007	1855	13.2	2.2	3,860	—	—	—
410244109454901	AW-1	Antelope Wash at Co. Rd. 13 near Manila, Utah	11/08/2007	1130	4.7	2.1	4,100	—	—	—
410244109454901	AW-1	Antelope Wash at Co. Rd. 13 near Manila, Utah	12/13/2007	1115	-.1	1.5	4,310	—	—	—
410244109454901	AW-1	Antelope Wash at Co. Rd. 13 near Manila, Utah	02/13/2008	1400	2.1	1.4	3,930	—	—	—
410244109454901	AW-1	Antelope Wash at Co. Rd. 13 near Manila, Utah	03/19/2008	1020	1.1	1.9	3,750	—	—	—
410244109454901	AW-1	Antelope Wash at Co. Rd. 13 near Manila, Utah	04/10/2008	1810	7.9	1.6	3,870	—	—	—
410244109454901	AW-1	Antelope Wash at Co. Rd. 13 near Manila, Utah	05/20/2008	1709	21.0	.96	4,180	—	—	—

Table 2. Instantaneous discharge and properties of water samples collected from water-quality monitoring sites near Manila, Utah, May 2007–May 2008.—Continued

[FGNRA, Flaming Gorge National Recreation Area; hhmm, hours and minutes; —, no data or not computed; E, estimated]

Site identifier	Date	Sodium, water, filtered, milligrams per liter	Potassium, water, filtered, milligrams per liter	Chloride, water, filtered, milligrams per liter	Sulfate, water, filtered, milligrams per liter	Silica, water, filtered, milligrams per liter	Alkalinity, water, filtered, incremental titration, field, milligrams per liter as calcium carbonate	Bicarbonate, water, filtered, incremental titration, field, milligrams per liter	Residue on evaporation, dried at 180 degrees Celsius, water, filtered, milligrams per liter	Residue, water, filtered, sum of constituents, milligrams per liter	Ratio of residue on evaporation, dried at 180 degrees Celsius to specific conductance	Ratio of dissolved-solids concentration from sum of constituents to residue on evaporation, dried at 180 degrees Celsius	Dissolved-solids load, in tons per day (rounded)
SCC-1	07/10/2007	—	—	—	—	—	—	—	—	—	—	—	7.9
SCC-1	08/13/2007	—	—	—	—	—	—	—	45	—	.75	—	8.4
SCC-1	05/21/2008	—	—	—	—	—	—	—	—	—	—	—	12
PC-3	07/10/2007	—	—	—	—	—	—	—	—	—	—	—	11
PC-3	08/14/2007	—	—	—	—	—	—	—	772	—	.74	—	27
PC-3	09/27/2007	—	—	—	—	—	—	—	—	—	—	—	48
PC-3	10/16/2007	—	—	—	—	—	—	—	661	—	.73	—	48
PC-3	11/07/2007	—	—	—	—	—	—	—	—	—	—	—	4.3
PC-3	12/13/2007	—	—	—	—	—	—	—	—	—	—	—	.1
PC-3	05/20/2008	—	—	—	—	—	—	—	326	—	.70	—	34
BSD-2	06/12/2007	—	—	—	—	—	—	—	1,840	—	.78	—	38
BSD-2	07/10/2007	—	—	—	—	—	—	—	3,520	—	.80	—	11
BSD-2	08/13/2007	—	—	—	—	—	—	—	2,670	—	.83	—	10
BSD-2	09/27/2007	—	—	—	—	—	—	—	3,230	—	.88	—	41
BSD-2	10/16/2007	—	—	59.5	659	—	—	—	1,340	—	.77	—	51
BSD-2	11/07/2007	368	11	166	1,610	12	304	360	3,180	2,730	.87	.86	30
BSD-2	12/12/2007	714	17	291	2,560	15	432	521	4,910	4,470	.88	.91	28
BSD-2	01/14/2008	—	—	—	—	—	—	—	4,320	—	.91	—	11
BSD-2	02/13/2008	—	—	698	3,650	—	—	—	7,450	—	.90	—	19
BSD-2	03/18/2008	1000	20	456	3,080	11	401	476	6,200	5,460	.91	.88	23
BSD-2	04/10/2008	—	—	—	—	—	—	—	5,380	—	.90	—	25
BSD-2	05/20/2008	—	—	—	—	—	—	—	2,270	—	.80	—	26
SV-2	07/11/2007	—	—	—	—	—	—	—	—	—	—	—	7.8
SV-2	08/14/2007	—	—	—	—	—	—	—	1,030	—	.71	—	5.8
SV-2	09/27/2007	—	—	—	—	—	—	—	—	—	—	—	5.8
SV-2	10/16/2007	—	—	—	—	—	—	—	—	—	—	—	5.8
SV-2	11/07/2007	—	—	—	—	—	—	—	—	—	—	—	2.4
SV-2	12/12/2007	—	—	—	—	—	—	—	1,560	—	.71	—	4.6
SV-2	02/13/2008	—	—	—	—	—	—	—	1,550	—	.74	—	3.4
SV-2	03/18/2008	—	—	—	—	—	—	—	—	—	—	—	5.0
SV-2	04/11/2008	—	—	—	—	—	—	—	—	—	—	—	4.2
SV-2	05/20/2008	—	—	—	—	—	—	—	—	—	—	—	1.2
PC-2	07/11/2007	—	—	—	—	—	—	—	1,700	—	.82	—	9.6
PC-2	09/27/2007	—	—	—	—	—	—	—	1,930	—	.87	—	13
PC-2	10/16/2007	—	—	—	—	—	—	—	1,610	—	.86	—	23
PC-2	11/07/2007	—	—	—	—	—	—	—	—	—	—	—	3.3
PC-2	12/12/2007	—	—	—	—	—	—	—	2,610	—	.89	—	2.6
PC-2	02/13/2008	—	—	—	—	—	—	—	2,820	—	.91	—	.6
PC-2	03/18/2008	—	—	—	—	—	—	—	—	—	—	—	.5
PC-2	04/11/2008	—	—	—	—	—	—	—	—	—	—	—	.6
PC-2	05/20/2008	—	—	—	—	—	—	—	1,560	—	.82	—	5.5
DRN-1a	05/10/2007	—	—	—	—	—	—	—	—	—	.88	—	.3
DRN-1a	06/13/2007	—	—	—	—	—	—	—	3,610	—	.88	—	.4
DRN-1a	09/28/2007	—	—	—	—	—	—	—	—	—	—	—	1.7
DRN-1a	10/16/2007	—	—	—	—	—	—	—	—	—	—	—	.4
DRN-1a	11/08/2007	—	—	—	—	—	—	—	—	—	—	—	.4
DRN-1a	12/13/2007	—	—	—	—	—	—	—	—	—	—	—	.2
DRN-1a	04/10/2008	—	—	—	—	—	—	—	—	—	—	—	.3
DRN-1a	05/20/2008	—	—	—	—	—	—	—	—	—	—	—	.4
DRN-2	05/10/2007	—	—	—	—	—	—	—	—	—	—	—	28
DRN-2	06/13/2007	—	—	—	—	—	—	—	1,450	—	.82	—	7.4
DRN-2	07/10/2007	—	—	—	—	—	—	—	5,140	—	.90	—	.3
DRN-2	09/28/2007	—	—	—	—	—	—	—	2,060	—	.87	—	27
DRN-2	10/16/2007	—	—	—	—	—	—	—	—	—	—	—	4.0
DRN-2	11/08/2007	—	—	—	—	—	—	—	—	—	—	—	1.8
DRN-2	12/13/2007	—	—	—	—	—	—	—	4,030	—	.96	—	.8
DRN-2	03/19/2008	—	—	—	—	—	—	—	—	—	—	—	.7
DRN-2	04/10/2008	—	—	—	—	—	—	—	5,040	—	.95	—	.5
DRN-2	05/20/2008	—	—	—	—	—	—	—	2,890	—	.87	—	3.2
AW-1	06/13/2007	—	—	—	—	—	—	—	—	—	—	—	19
AW-1	07/10/2007	—	—	—	—	—	—	—	—	—	—	—	12
AW-1	08/14/2007	—	—	—	—	—	—	—	3,950	—	1.03	—	23
AW-1	09/27/2007	—	—	—	—	—	—	—	—	—	—	—	24
AW-1	11/08/2007	—	—	—	—	—	—	—	—	—	—	—	24
AW-1	12/13/2007	—	—	—	—	—	—	—	—	—	—	—	18
AW-1	02/13/2008	—	—	—	—	—	—	—	3,970	—	1.01	—	15
AW-1	03/19/2008	—	—	—	—	—	—	—	—	—	—	—	19
AW-1	04/10/2008	—	—	—	—	—	—	—	—	—	—	—	17
AW-1	05/20/2008	—	—	—	—	—	—	—	—	—	—	—	11

Table 3. Dissolved-solids loads at water-quality monitoring sites near Manila, Utah.

[Data are from instantaneous measurements made in the month indicated; —, no measurement; <, less than]

Site identifier (see table 1)	Load, in tons per day (values are rounded)																			
	2004			2005						2007				2008						
	Jun/Jul	Aug	Sep	Oct	Nov	Jan	Feb	Apr	May/Jun	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Feb	Mar	Apr	May
Inflow sites																				
PC-3	109	50	50	51	3.9	0	0	20	29	—	11	26	51	51	4.4	.1	0	0	0	35
SCC-1	9.2	6.3	5.3	.5	0	0	0	.4	13	—	9.7	8.4	0	0	0	0	0	0	0	12
Outflow sites																				
BSD-2	113	39	57	88	46	38	55	30	102	38	11	10	41	51	30	28	19	23	25	26
PC-2	69	14	23	19	3.6	1.8	1.0	.6	33	—	9.6	12	13	23	3.3	2.6	.6	.5	.6	5.7
SV-2	27	11	1.3	30	8.3	5.2	7.5	2.8	2.2	—	7.8	5.8	5.8	5.8	2.4	4.6	3.4	5.0	4.2	1.2
DRN-1	15	1.8	.3	1.1	1.0	<.1	1.0	2.1	.5	—	0	.7	1.6	3.7	3.7	1.1	.7	.7	.34	1.6
DRN-1a	7.0	2.0	.8	1.2	.9	.2	.1	.3	2.1	.4	0	.3	1.7	.4	.4	.2	0	0	.3	.4
DRN-2	29	11	4.7	2.4	1.6	0.8	0.9	1.0	11	7.4	.3	1.6	27	4.0	1.8	.8	.9	.7	.5	3.2
DRN-3	8.8	.7	7.8	2.1	.5	<.1	.1	.5	<.1	—	<.1	1.5	.2	.1	.1	.1	—	.1	—	0
LAT-1	—	.3	3.2	1.4	.2	0	0	0	0.6	—	—	—	3.2	1.2	0	0	0	0	0	0
AW-1	37	42	33	46	46	29	25	20	15	19	12	23	24	24	24	18	15	20	18	11
Miscellaneous seeps	2.9	.5	1.0	3.5	.4	.1	.1	0	—	—	.4	.7	1.0	1.2	1.0	.7	.7	.7	.3	.5
SP-4	<.2	—	<.1	.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total inflow load	118	56	55	52	3.9	0	0	20	42	—	21	35	51	51	4.4	0.1	0	0	0	46
Total outflow load	308	121	131	195	106	75	90	55	166	—	41	54	118	114	66	54	37	48	47	49
Net outflow load[1]	190	65	76	143	102	75	90	35	124	—	20	20	68	64	62	54	37	48	47	2.9

[1]Outflow load minus the dissolved-solids loads at the inflow sites

Value calculated from measured discharge and dissolved-solids concentration

Value calculated from measured discharge and specific conductance

Estimated from adjacent values