Idaho State Department of Agriculture
Division of Agricultural Resources

Lake Lowell Irrigation Return Drains Water Quality Monitoring Results

April 2002 through October 2002

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ISDA Technical Report Summary W-6 **March 2003**

Introduction

At the request of the Canyon Soil Conservation District (SCD) the Idaho State Department of Agriculture (ISDA) conducted water quality monitoring on three irrigation return drains that discharge into Lake Lowell. Lake Lowell is located within Hydrological Unit Code (HUC) 17050114 within Canyon County, Idaho. Lake Lowell is listed for Total Maximum Daily Load (TMDL) development in 2006. The listed pollutants of concern are low dissolved oxygen concentrations and excessive nutrients.

Originally four drains were identified for monitoring but permission was only granted to access three of the sites (Figure 1).

Keith Griswold formerly of the Idaho Soil Conservation Commission (SCC) Caldwell Idaho selected three sites for this study (Figure 1). Monitoring commenced in late April 2002 and continued through the irrigation season (October 2002). Samples were collected twice a month and analyzed for total suspended solids (TSS), total phosphorus (TP), ortho-phosphorus (OP), and nitrate + nitrite (NO_3+NO_2-N). On-site field parameters for dissolved oxygen, conductivity, total dissolved solids, pH, and discharge were measured during each sampling round.

The first site was located at the large diversion at the confluence of the Deer Flat Highline Canal and the Mora Canal that spills irrigation water into Lake Lowell (DM-1). The two other sites (LS-1 and LS-2) drained acreage south of Lake Lowell and entered Lake Lowell from the south side and were accessed from Lake Shore Drive (Figure 1).

Lake Lowell is 14.5 square miles and contains 28 miles of shoreline. Lake Lowell is approximately 9,000 acres at full pool and is fed by water out of the Boise River through the New York Canal. Water level is primarily regulated by irrigation water releases. The reservoir has the capacity to irrigate 200,000 acres.

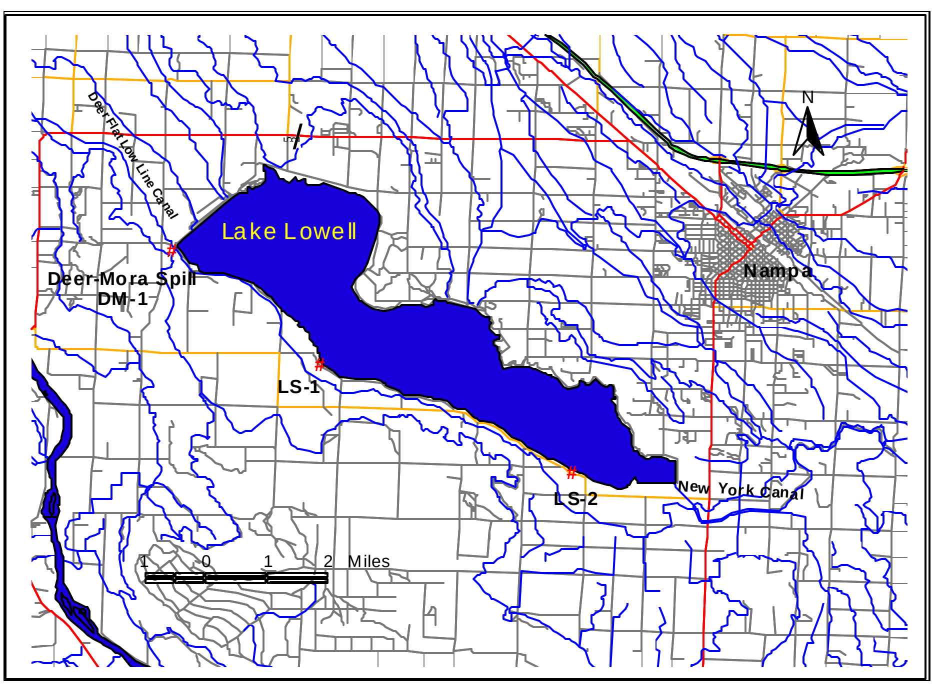

Figure 1. Lake Lowell Drain Monitoring Sites

Program Objectives

ISDA worked in cooperation with the Canyon County Soil Conservation District, Idaho Soil Conservation Commission (SCC) and the Natural Resources Conservation Service (NRCS) to evaluate the following objectives:

- Evaluate the water quality and loading rates for drainages entering Lake Lowell.
- Determine which areas contribute the greatest level of pollutant loading.
- Relate pollutant loading to areas that may require BMP implementation to reduce loading into Lake Lowell.
- Provide pre-BMP (background) water quality data for data comparison after implementation.

Land Use

Of the three drainages DM-1 has the largest proportion of agricultural lands (12,236 acres) followed by LS-2 (2,442 acres) and LS-1 (1,831 acres). Table 1 shows the breakdown of acreage based on irrigation practices.

Table 1. Acreage in study area based on land use and irrigation practices.

Land Use	DM-1	LS-1	LS-2
Surface Irrigated	4,104.5	1,509.5	2,401
Sprinkler Irrigated	7,536.1	192	17.4
Irrigated Pasture	119.9	130	23.7
CRP	475.6	0	0
Total Acreage	12,236.1	1,831.5	2,442.1

LS-1 and LS-2 drainages are dominated by surface irrigation techniques with 82% and 92% of the acreage respectively. Only 33% of the acreage within the DM-1 drainage is surface irrigated while 62% of the acreage is under sprinkler irrigation.

Results

Total Suspended Solids (TSS)

The three drains monitored during this program discharged a total of 8,302 tons of TSS into Lake Lowell during the irrigation season. DM-1, LS-1 and LS-2 contributed 3,167, 3,242, and 1,893 tons of TSS respectively. The bulk of the load recorded at station DM-1 was primarily due to the high discharge rate (64.1 cfs) not the concentration (111.5 mg/L). The TSS loads at LS-1 and LS-2 drains were based on high concentrations of TSS and low discharge rates Table 2.

Table 2. TSS load, mean concentrations and discharge

Measurements	DM-1	LS-1	LS-2
Load (Tons)	3,167	3,242	1,893
Concentration (mg/L)	111.5	871.6	816.4
Discharge (CFS)	64.1	8.4	5.47

The land use information, indicates that the two drainages that have the lowest percentage of sprinkler irrigated acreage (LS-1 and LS-2) have the highest concentration of TSS discharging into Lake Lowell (Figure 2).

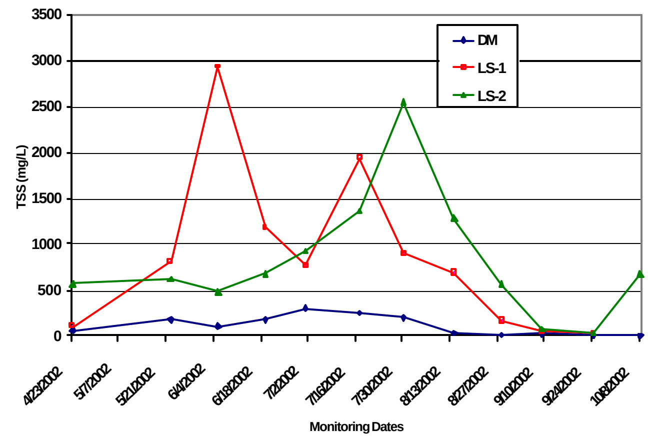

Figure 2. TSS concentrations (mg/L)

The use of sprinkler irrigation is evident when calculating sediment loss per acre. DM-1 with 62% of the acreage under sprinkler irrigation had TSS losses of 0.26 tons/acre. LS-1 and LS-2, which have 18% and 8% of the acreage under sprinkler irrigation show losses of 1.7 tons/acre and 0.77 tons/acre, respectively.

Using simple regression (R^2) it appears that discharge does not have a strong relationship with TSS at station LS-1 ($R^2 = 0.30$) or at station DM-1 ($R^2 = 0.31$). A somewhat stronger relationship was observed at station LS-2 ($R^2 = 0.62$). LS-2 drain is deeply incised with unstable exposed sidewalls. As discharge increases bank erosion and sloughing are readily observed and may account for the higher R^2 value.

Total Phosphorus (TP)

The load of total phosphorus that entered Lake Lowell, during the 2002 irrigation season was 10.8 tons. On average 88% of the phosphorus entering Lake Lowell was in the particulate form. The same general trends observed for the TSS data were also observed for the TP data. DM-1, LS-1 and LS-2 contributed 5, 3.1, and 2.7 tons of TP respectively. As with the TSS data LS-1 and LS-2 had the highest average TP concentrations but much lower discharge rates (Table 3).

Table 3. TP load, mean concentration and discharge

Measurements	DM-1	LS-1	LS-2
Load (Tons)	5	3.1	2.7
Concentration (mg/L)	0.17	0.89	1.07
Discharge (CFS)	64.1	8.4	5.47

The concentrations of TP at LS-1 and LS-2 are higher when dominated by surface irrigated systems (Figure 3). Using total tons TSS and TP transported, the ratio developed indicates that for every ton of TSS lost 2.6 lbs of TP is discharged into Lake Lowell.

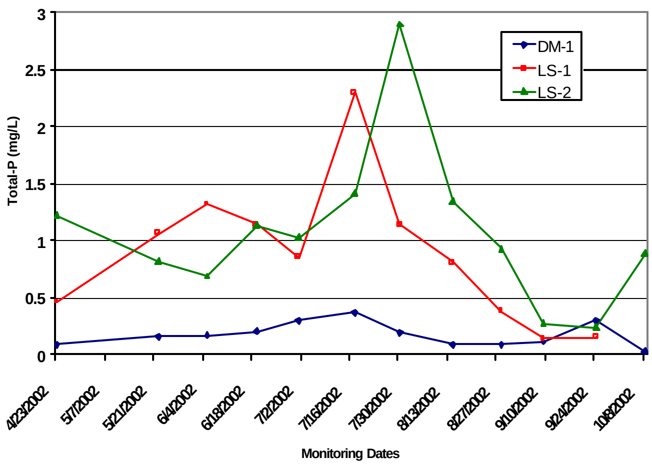

Figure 3. Irrigation Season TP concentrations.

The Environmental Protection Agency (EPA) Quality Criteria for Water (EPA 1986) indicates that phosphorus concentrations should not exceed 0.05 mg/L for streams entering lakes or reservoirs. Using this criteria, which may not apply to Lake Lowell, Table 4 lists the possible phosphorus reductions that may be needed within these drainages.

Table 4. Possible reductions to meet potential TP criteria

	DM-1	LS-1	LS-2
Average measured concentration (mg/L)	0.17	.89	1.07
EPA criteria concentration (mg/L)	0.05	0.05	0.05
Reduction to meet	71%	94%	95%

Nitrate + Nitrite as Nitrogen

The total load of Nitrogen (NO3 + NO2-N) that entered Lake Lowell during the irrigation season was 10.3 tons. Unlike phosphorus, nitrogen has a tendency to move through shallow ground water and enters these drains along with irrigation return water. Nitrogen can also be lost overland due to excessive irrigation that enters tail water ditches and migrates into the drains. The effects of shallow ground water (increased nitrate level) can be observed at station LS-2 on the last sampling date (October 8, 2002) after the irrigation water had been shut off (Figure 4).

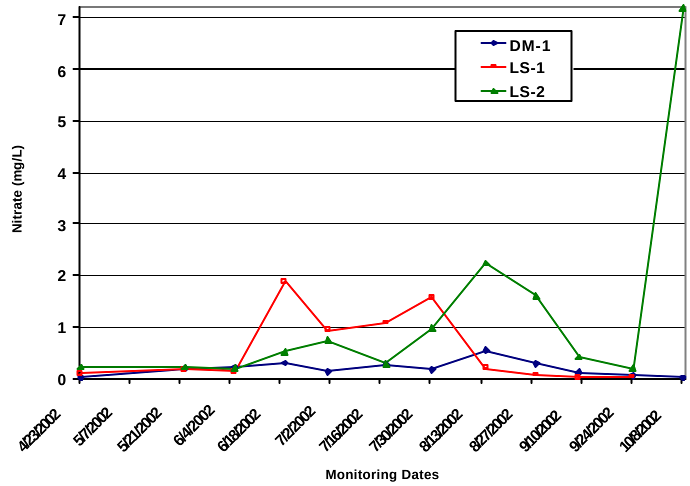

Figure 4. Irrigation Season Nitrate concentrations

Using the acreage data from Table 2 the pounds of nitrogen lost per acre during the irrigation season for each drainage is as follows: DM-1 0.88 lbs., LS-1 2.11 lbs., and LS-2 2.49 lbs.

Literature values indicate that $NO^3 + NO^2$-N should be limited to 0.30 mg/L or less to avoid degradation of water quality (Cline 1973). The largest reduction in nitrogen needed to meet the 0.30 mg/L criteria occurs within the drainages that are dominated by furrow or flood irrigation techniques (Table 5).

Table 5. Possible reductions to meet potential nitrate criteria

	DM-1	LS-1	LS-2
Average measured concentration (mg/L)	0.19	0.55	1.22
Literature Value (mg/L)	0.30	0.30	0.30
Estimated reductions for nitrate	0%	44%	75%

Conclusions

The three drains monitored during this program indicated heavy loading of sediment into Lake Lowell from agricultural practices. Along with the large sediment load (8,302 tons) the drains were major contributors of phosphorus (10.8 tons) and nitrogen (10.3 tons) during the irrigation season. A fourth drain that was identified but not monitored appeared visually (color and discharge) to contribute similar loads that were measured at site LS-2.

These excessive loads of sediment and nutrients may be having a negative impact on the water quality conditions of Lake Lowell. The excessive loadings may lead to eutrophication characterized by increases in phytoplankton biomass, macrophyte biomass, nuisance algae blooms, loss of water clarity and loss of oxygen in bottom waters. Lake Lowell is used as a primary contact body of water with swimming and water skiing during the summer months. Visual observations of the lake during the prime production period (summer months) show poor water clarity, surface algae scum along the shoreline and large macrophyte populations along portions of the south shore of the lake.

Sediment load from the drains, entering on the south side of Lake Lowell, appear to settle out in the shallow bay areas, along the shoreline, where the bulk of macrophyte growth occurs. The amount of nutrient rich sediment recycled or flushed from the system probably depends on the speed of drawdown during the irrigation season.

The data indicate that acreage currently under furrow or flood irrigation practices contribute the largest concentration of sediment, phosphorus, and nitrogen. Drains LS-1 and LS-2, which are dominated by surface irrigated methods, had average concentrations of TSS (871.6 mg/L, 816.4 mg/L), total phosphorus (0.89 mg/L, 1.07 mg/L) and nitrogen (0.55 mg/L, 1.22 mg/L) respectively. Approximately 62% of the acreage within the DM-1 drainage is under sprinkler irrigation. The total acreage within DM-1 (12,236 acres) is significantly larger than the two other drainages yet the concentration levels for TSS (111.5 mg/L), total phosphorus (0.17 mg/L) and nitrogen (0.19 mg/L) were considerably lower than the two drains that were dominated by surface irrigation.

Recommendations

The actual load reductions that may be required for Lake Lowell will be determined by DEQ during the sub basin assessment and the completed TMDL in 2006. Prior to the development of the TMDL ISDA recommends:

- The Canyon Soil Conservation District (SCD) work with local landowners, NRCS, SCC and ISDA to further identify loading sources within the Lake Lowell watershed.
- Evaluate on farm operations to determine the most effective placement for sediment reduction BMPs.
- BMPs should include conversion from furrow irrigation to sprinkler, nutrient management, sediment ponds and filter strips to reduce sediment loss to Lake Lowell.

References

Cline, C., 1973. The effects of forest fertilization of the Tahuya River, Kitsap Pennisula, Washington. Washington State Dept. of Ecology. 55p

USEPA. U.S. Environmental Protection Agency. 1987. Quality Criteria for Water. EPA publication 440/5-86-001. U.S. Gov. Printing Office, Washington D.C.