Lake Lowell Agricultural Return Drains

Follow Up Pesticide Residue Evaluation

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Introduction

In 2014, the Idaho State Department of Agriculture (ISDA) conducted water quality monitoring for pesticide residues on four agricultural return drains that discharge into Lake Lowell (Figure 1). The original study, conducted by ISDA in 2010, indicated that these four agricultural drains transport large quantities of sediment and pesticide residues into Lake Lowell. The majority of acreage serviced by these drains consists of irrigated agriculture and they transport irrigation return waste water along with canal spill water into Lake Lowell. The four drains monitored in 2014 were Highland Wasteway, Bernard Drain, Coulee Drain and Garland Drain, which were the same drains that ISDA evaluated in 2010 (Figure 1).

Lake Lowell is located within Canyon County, Idaho about 25 miles west of Boise and about five miles west of Nampa, Idaho. The Lake Lowell watershed is primarily in Canyon County, with a smaller portion in Ada County. The Lake Lowell drainage area is approximately 62 square miles (39,680 acres).

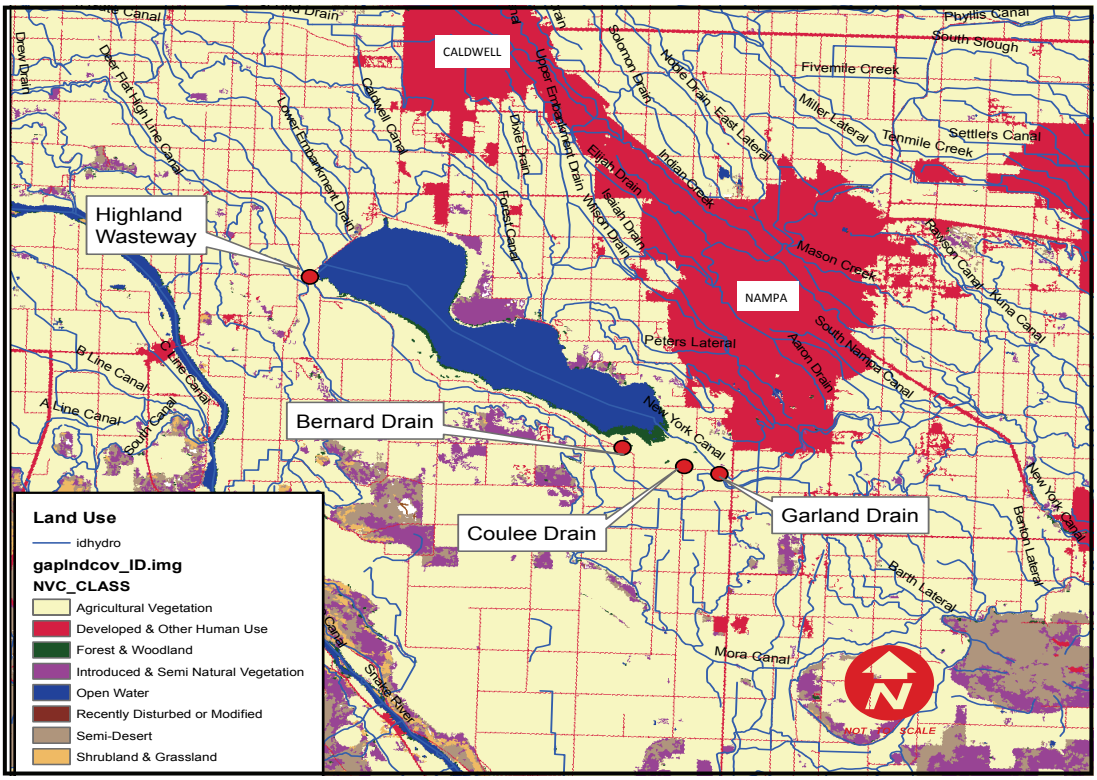

Figure 1. Drain monitoring locations on Lake Lowell.

Pesticides of Concern

ISDA defines a pesticide of concern (POC) as any pesticide that is detected at a concentration that is greater than or equal to fifty percent (≥50%) of an established Environmental Protection Agency (EPA) Aquatic Life Benchmark (http://www.epa.gov/oppefed1/ecorisk_ders/aquatic_life_benchmark.htm). These benchmarks were developed based on concentrations of pesticides and their acute and chronic effects on fish and aquatic invertebrates and acute effects on vascular and nonvascular plants. Acute toxicity of a pesticide refers to the effects from a single dose or repeated exposure over a short period of time (i.e. a few hours or a day). Chronic toxicity is the ability of a substance to cause adverse health effects resulting from long-term or repeated low levels of exposure.

Overall Results

The four Lake Lowell drains monitored in 2014 had a total of 284 total detections of 29 pesticide compounds. The overall detections consisted of 231 herbicides, 42 insecticides, five fungicide detections, and six desethyl atrazine detections, which is a degradate of the herbicide atrazine. The data collected by ISDA in 2010 yielded a total of 260 pesticide detections of 26 pesticide compounds. The overall detections in 2010 consisted of 212 herbicide detections, 42 insecticide detections, and six desethyl atrazine detections (Figure 2).

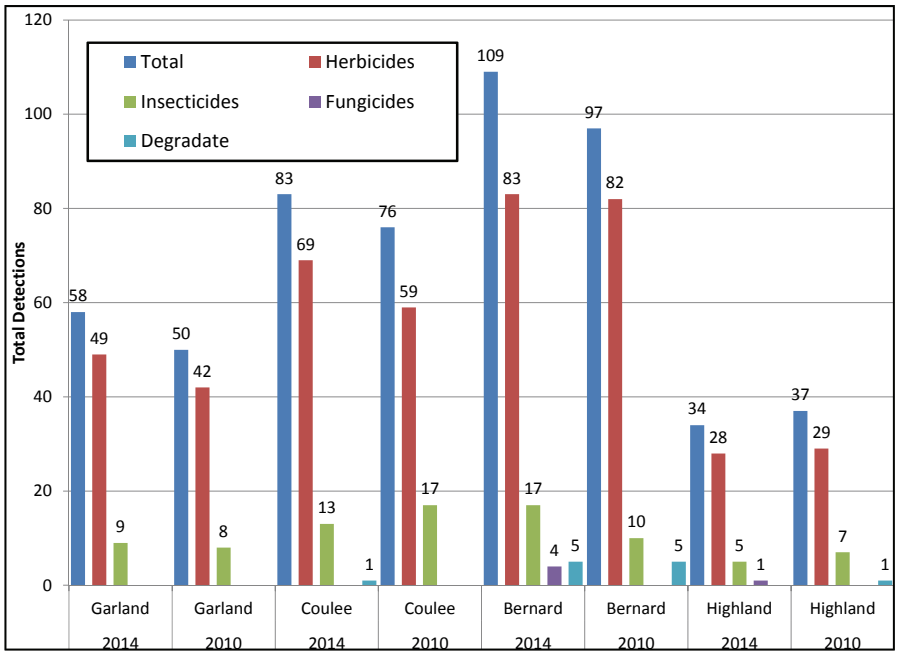

Figure 2. Overall pesticide detections for 2014 and 2010.

Of the 284 detections in 2014, 231 were herbicide detections. The general use pesticides (GUP) with the greatest number of detections were the herbicides, pendimethalin (38), metolachlor (36), 2,4-D (29), and Bromacil (21) (Table 1). Of these general use herbicides metolachlor has the lowest concentration (1ppb) for chronic effects on invertebrates. The herbicides that are highly soluble in water are 2,4-D (moderate), metolachlor (high), and bromacil (very high) and can move off-site with irrigation water or storm events. Pendimethalin has a very strong absorbance to soil and moves off-site with soil loss during irrigation and weather events.

There was a total of 42 insecticide detections in 2014 (Table 1), which was equal to the number of insecticide detections in 2010. The organophosphate insecticide, chlorpyrifos, was detected 24 times and all 24 detections met ISDA's criteria for a POC (≥50% of an EPA Aquatic Benchmark). Chlorpyrifos is a restricted use insecticide and is highly toxic to both fish and aquatic invertebrates. Chlorpyrifos binds tightly to soils and is primarily transported via erosion during irrigation or weather events. Dimethoate and methomyl both had four detections and have a high to moderate toxic effect on aquatic species. Methomyl is a restricted use pesticide, while dimethoate is a general use insecticide. Both insecticides are highly soluble in water and are transported via irrigation water runoff or weather events runoff.

Table 1. Pesticides detected, type of pesticide, trade names, and number of detects.

Pesticide	Type	*Trade Name	# Detects	Pesticide	Type	*Trade Name	# Detects
2,4-D	H	Weedar 64	29	dichlorvos	I	Card-O-Vap 8	3
2,4-DB	H	2,4-DB200	1	dimethoate	I	Cygon	4
acephate	I	Orthene 97	2	diuron	H	Karmex	14
acetachlor	H	Gaurdian	1	EPTC	H	Eptam	6
alachlor	H	Lasso	6	ethalfluralin	H	Sonalan	12
atrazine	H	Aatrex	13	hexazinone	H	Velpar	4
azoxystrobin	F	Heritage	5	linuron	H	Lorox	4
bentazon	H	Basagran	1	malathion	I	Fyfanon	2
bromacil	H	Hyvar X	21	metribuzin	H	Sencor	4
bromoxynil	H	Buctril	13	methomyl	I	Lannate	4
chlorantraniliprole	I	VoliamExpress	2	metolachlor	H	Dual	36
chlorpyrifos	I	Lorsban	24	oxamyl	I	Vydate L	1
dacthal	H	Dacthal W-75	1	oxyfluorfen	H	Goal	1
desethyl atrazine	D	NA	6	pendimethalin	H	Prowl	38
				terbacil	H	Sinbar	21

H = Herbicides, I = Insecticides, F = Fungicides, D = Degradate of atrazine. Insecticides are in Red.

*** Other trade names may apply**

Individual Drain Results

Garland Drain

Garland Drain empties into the New York Canal just upstream of Lake Shore Drive and just downstream of the New York Canal's final check gates (Photo 1). There were a total of 58 pesticide detections with 49 herbicide detections and nine insecticide detections (Table 2). The pesticides highlighted in red are considered a pesticide of concern by ISDA. The insecticides chlorpyrifos, dichlorvos, dimethoate, and malathion all had concentration that were ≥50% or greater than an established EPA Aquatic Benchmark. The herbicide linuron had two detections that exceed the aquatic benchmark for chronic invertebrates.

Photo 1. Garland Drain

Table 2.

Pesticides Detected	Pesticide Type	Number of Detections	Highest Detection	Fish Acute	Fish Chronic	Inverts Acute	Inverts Chronic	Non Vasc. Acute	Vascular Acute
2,4-D	H	6	1.3	12,075	14,200	12,500	16,050	3,880	13.1
alachlor	H	3	0.48	900	187	1,250	110	1.64	2.3
atrazine	H	3	0.054	2,650		360	60	<1	0.001
bromacil	H	6	0.089	18,000	3,000	60,500	8,200	6.8	45
bromoxynil	H	4	0.14	26.5	18	48	2.5	51	—
chlorpyrifos	I	4	0.028	0.9	0.57	0.05	0.04	140	—
			0.053	0.9	0.57	0.05	0.04	140	—
			0.029	0.9	0.57	0.05	0.04	140	—
			0.68	0.9	0.57	0.05	0.04	140	—
dichlorvos	I	1	0.055	91.5	5.2	0.035	0.0058	14,000	
dimethoate	I	3	0.27	3,100	430	21.5	0.5	84	—
diuron	H	2	0.054	200	26	80	200	2.4	15
EPTC	H	2	0.19	7,000	—	3,245	810	1,400	5,600
ethalfluralin	H	3	0.19	16	0.4	30	24	25	—
hexazinone	H	2	0.099	137,000	17,000	75,800	20,000	7	37.4
linuron	H	2	0.54	1,500	5.58	60	0.09	13.7	2.5
			0.053	1,500	5.58	60	0.09	13.7	2.5
malathion	I	1	0.076	16.4	8.6	0.3	0.035	2,400	—
metolachlor	H	7	0.45	1,600	1,000	550	1	8	21
pendimethalin	H	7	0.95	69	6.3	140	14.5	5.2	12.5
terbacil	H	2	0.18	23,100	1,200	32,500	640	11	140

Coulee Drain

Coulee Drain is located approximately 1.5 miles west of the New York Canal on Lake Shore Drive. This drain returns primarily tail waters from irrigation activities and transports large loads of sediment back into Lake Lowell (Photo 2). There were a total of 83 pesticide detections with 69 herbicides, 13 insecticides and one desethyl atrazine. The pesticides in red (Table 3) are considered pesticides of concern by ISDA. The insecticide chlorpyrifos had nine POC detections while the insecticide malathion had one. The herbicide metolachlor had one detection (1.1 ppb) that exceeded the aquatic benchmark for chronic invertebrate concentration.

Photo 2. Coulee Drain

Table 3.

Pesticides Detected	Pesticide Type	Number of Detections	Highest Detection	Fish Acute	Fish Chronic	Inverts Acute	Inverts Chronic	Non Vasc. Acute	Vascular Acute
2,4-D	H	11	1.7	12,075	14,200	12,500	16,050	3,880	13.1
acetachlor	H	1	0.34	190	130	4,100	22.1	1.43	3.4
alachlor	H	1	0.12	900	187	1,250	110	1.64	2.3
atrazine	H	5	0.036	2,650		360	60	<1	0.001
bromacil	H	7	0.34	18,000	3,000	60,500	8,200	6.8	45
bromoxynil	H	4	0.17	26.5	18	48	2.5	51	—
chlorantraniliprole	I	1	0.10	>601	110	4.9	4.5	1800	2000
chlorpyrifos	I	9	0.047	0.9	0.57	0.05	0.04	140	—
			0.033	0.9	0.57	0.05	0.04	140	—
			0.11	0.9	0.57	0.05	0.04	140	—
			0.68	0.9	0.57	0.05	0.04	140	—
			0.068	0.9	0.57	0.05	0.04	140	—
			0.15	0.9	0.57	0.05	0.04	140	—
			0.057	0.9	0.57	0.05	0.04	140	—
			0.031	0.9	0.57	0.05	0.04	140	—
			0.026	0.9	0.57	0.05	0.04	140	—
dacthal	H	1	0.097	15,000	—	13,500	—	>11,000	>11,000
desethyl atrazine	D	1	0.027	2,650		360	60	<1	0.001
dimethoate	I	1	0.16	3,100	430	21.5	0.5	84	—
diuron	H	5	0.18	200	26	80	200	2.4	15
ethalfluralin	H	4	0.13	16	0.4	30	24	25	—
EPTC	H	2	0.22	7,000	—	3,245	810	1,400	5,600
hexazinone	H	1	0.11	137,000	17,000	75,800	20,000	7	37.4
malathion	I	1	0.055	16.5	8.6	0.295	0.035	2400	>9630
methomyl	I	1	0.22	160	12	2.5	0.7	—	—
metolachlor	H	10	1.1	1,600	1,000	550	1	8	21
pendimethalin	H	10	0.68	69	6.3	140	14.5	5.2	12.5
terbacil	H	7	0.62	23,100	1,200	32,500	640	11	140

Bernard Drain

Bernard Drain (Photo 3) is located approximately three miles west of Coulee Drain and is a major drain for agricultural irrigation return water. Bernard Drain has a history of transporting heavy concentrations of sediment into Lake Lowell.

Photo 3. Bernard Drain

Bernard Drain had a total of 109 pesticide detections with 83 herbicide detections, 17 insecticide detections, four fungicide detections, and five desethyl atrazine detections (Table 4). There were a total of eight chlorpyrifos detections that were considered a POC by ISDA and two detections of the insecticide dichlorvos which were also a POC.

There were two POC herbicide detections (linuron and metolachlor) that were ≥50% of the chronic invertebrate benchmark (Table 4).

Table 4.

Pesticides Detected	Pesticide Type	Number of Detections	Highest Detection	Fish Acute	Fish Chronic	Inverts Acute	Inverts Chronic	Non Vasc. Acute	Vascular Acute
2,4-D	H	8	0.98	12,075	14,200	12,500	16,050	3,880	13.1
2,4-DB	H	1	0.31	1,000	—	7,500	—	932	—
acephate	I	2	0.64	416,000	5,760	550	150	>50,000	—
alachlor	H	2	0.092	900	187	1,250	110	1.64	2.3
atrazine	H	5	0.12	2,650		360	60	<1	0.001
azoxystrobin	F	4	0.063	235	147	130	44	49	3,400
bentazon	H	1	0.27	>50,000	—	>50,000	—	4,500	5,350
bromacil	H	8	0.85	18,000	3,000	60,500	8,200	6.8	45
bromoxynil	H	5	0.17	26.5	18	48	2.5	51	—
chlorantraniliprole	I	2	0.45	>601	110	4.9	4.5	1800	2000
chlorpyrifos	I	8	0.027	0.9	0.57	0.05	0.04	140	—
			0.092	0.9	0.57	0.05	0.04	140	—
			0.047	0.9	0.57	0.05	0.04	140	—
			0.079	0.9	0.57	0.05	0.04	140	—
			0.42	0.9	0.57	0.05	0.04	140	—
			0.048	0.9	0.57	0.05	0.04	140	—
			0.044	0.9	0.57	0.05	0.04	140	—
			0.032	0.9	0.57	0.05	0.04	140	—
desethyl atrazine	D	5	0.046	2,650		360	60	<1	0.001
dichlorvos	I	2	0.081	91.5	5.2	0.035	0.0058	14,000	
			0.11	91.5	5.2	0.035	0.0058	14,000	
diuron	H	10	0.21	200	26	80	200	2.4	15
ethalfluralin	H	4	0.081	16	0.4	30	24	25	—
EPTC	H	2	0.16	7,000	—	3,245	810	1,400	5,600
hexazinone	H	1	0.11	137,000	17,000	75,800	20,000	7	37.4
linuron	H	1	0.085	1,500	5.58	60	0.09	13.7	2.5
methomyl	I	3	0.14	160	12	2.5	0.7	—	—
metolachlor	H	11	0.89	1,600	1,000	550	1	8	21
metribuzin	H	4	0.24	21,000	3,000	2,100	1,290	8.7	130
oxyfluorfen	H	1	0.072	102	1.3	40	13	0.29	0.35
pendimethalin	H	12	0.32	69	6.3	140	14.5	5.2	12.5
terbacil	H	7	1.4	23,100	1,200	32,500	640	11	140

Highland Wasteway 3

The Highland Wasteway transports irrigation and irrigation waste water along the southern edge of Lake Lowell. At the wasteway diversion (Photo 4), water is either diverted into Lake Lowell or transported west through the Highline Canal. This site had the lowest total number of pesticide detections (34) with 29 herbicides, four insecticides and one fungicide (Table 5). There were three detections of the insecticide chlorpyrifos which were a POC, because they were ≥50% of both the acute and chronic benchmarks for invertebrates (Table 5).

Photo 4. Highland Wasteway

Table 5.

Pesticides Detected	Pesticide Type	Number of Detections	Highest Detection	Fish Acute	Fish Chronic	Inverts Acute	Inverts Chronic	Non Vasc. Acute	Vascular Acute
2,4-D	H	4	0.50	12,075	14,200	12,500	16,050	3,880	13.1
azoxystrobin	F	1	0.060	235	147	130	44	49	3,400
chlorpyrifos	I	3	0.029	0.9	0.57	0.05	0.04	140	—
			0.034	0.9	0.57	0.05	0.04	140	—
			0.036	0.9	0.57	0.05	0.04	140	—
ethalfluralin	H	1	0.054	16	0.4	30	24	25	—
linuron	H	1	0.11	1,500	5.58	60	0.09	13.7	2.5
methomyl	I	1	0.089	160	12	2.5	0.7	—	—
metolachlor	H	8	0.44	1,600	1,000	550	1	8	21
oxamyl	I	1	0.076	2,100	770	90	27	120	30,000
pendimethalin	H	9	0.62	69	6.3	140	14.5	5.2	12.5
terbacil	H	5	0.57	23,100	1,200	32,500	640	11	140

Conclusions

In 2014, the insecticide chlorpyrifos had the highest number of detections for a pesticide of concern. All 24 detections were ≥50% of an established EPA Aquatic Benchmark for chronic and acute invertebrate benchmarks and some detections exceeded those criteria (Figure 2). The same pattern for chlorpyrifos detections was observed during ISDA's 2010 drain monitoring program. Bernard Drain had a two-fold increase in chlorpyrifos detections in 2014 (8) when compared to 2010 (4), while Coulee Drain had a slight decrease from 11 in 2010 to nine in 2014. Garland Drain and Highland Wasteway

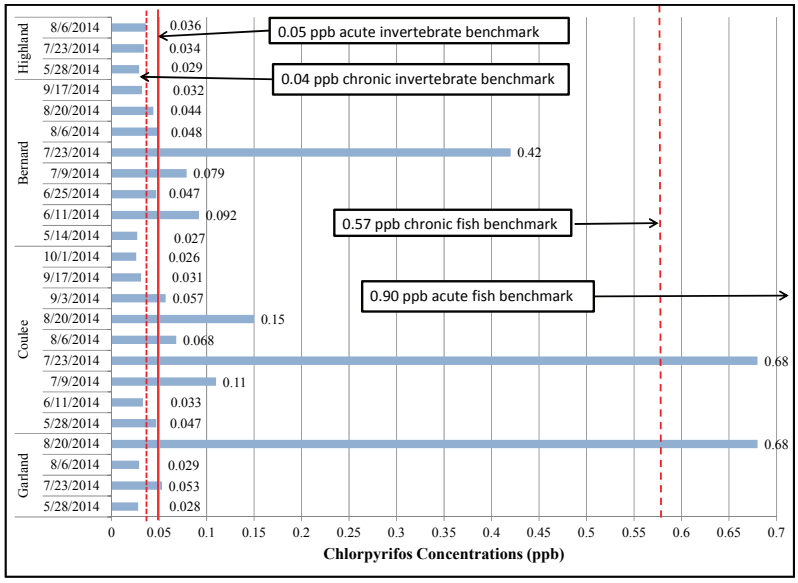

Figure 2. Chlorpyrifos detections and concentrations for Lake Lowell.

both showed a small decrease in chlorpyrifos detections with both Garland and Highland having five detections in 2010 and four and three detections, respectively in 2014. The effects of chlorpyrifos on the toxicity of sediment, that is deposited within the shallow littoral areas along Lake Lowell are unknown at this time.

Overall, there was a slight increase in pesticide detections when comparing 2014 (284) data to 2010 (260) data with an additional 19 detections of herbicides and five fungicide detections in 2014. The insecticide detections were identical at 42 and the degradate of atrazine (desethyl atrazine) were identical at six detections for both study years.

Recommendations

From 2010 to 2014, there appears to be little, if any, changes in management to reduce pesticide and sediment runoff from the agricultural fields within the study area. The two drains, Coulee and Bernard, deliver the majority of sediment along with pesticides into Lake Lowell. These two drains require constant maintenance to remove accumulated sediment to maintain proper drainage. For both drains, there appears to be sufficient acreage downstream of Lake Shore Drive to develop a series of sediment basins to reduce the load into Lake Lowell. The annual maintenance, conducted by the Boise Project Board of Control (Division 4) on these drains, could be transferred to the developed sediment ponds. The ponds placement could most likely be on U.S. Fish and Wildlife Service property within the refuge and would probably require some type of memorandum of understanding (MOU). Since Lake Lowell is under a Total Maximum Daily Load requirement, the installation of these sediment ponds would remove sediment, phosphorus and pesticide residues from Lake Lowell.

ISDA will continue to educate landowners and applicators about the potential impacts that pesticides can have on water quality and the environment. In 2015 ISDA hopes to conduct additional spatial monitoring on Coulee and Bernard Drains to evaluate or isolate the areas that may be contributing the bulk of sediment and pesticides into these drains. The following additional management recommendation should be considered:

⇒ Read and follow label directions; chlorpyrifos is a restricted use pesticide and has specific environmental hazard recommendations

⇒ Implement management strategies, including Integrated Pesticide Management (IPM), field scouting, selection of less toxic pesticides, irrigation water management.

⇒ Structural controls, including conservation buffers, vegetative filter strips, sediment basins, and pump back systems.

⇒ Avoid overspray and drift.

⇒ Never mix and load near any water source.