PHASE 2 Technical Memorandum for Red and Assiniboine Ammonia Criteria Study

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To: City of Winnipeg Project Management Committee
Study Team Members

Subject: **Fish Behaviour Technical Memorandum # FB 01**

Biological and Environmental Data from Experimental Gillnetting in the Vicinity of the NEWPCC Outfall, March, 1999

August, 1999

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1.0 OBJECTIVE OF STUDY

The objective of the March, 1999 fish behaviour investigation was to determine the distribution of fish in relation to the ammonia gradient in the vicinity of the NEWPCC outfall.

2.0 STUDY AREA

Gillnetting and water sampling were conducted at seven sites in the vicinity of the NEWPCC outfall (Figure 1) between 16 and 23 March, 1999. Water sampling was conducted at one additional site, adjacent to the outfall. A control site was located upstream of the outfall, approximately 150 m upstream of an abandoned railway bridge (Figure 2). Four sites were located immediately downstream of the NEWPCC discharge outlet; the first site was approximately 15 m out from the outfall (water sampling only), the second site was approximately 85 m downstream of the outfall, the third was approximately 66.5 m downstream of the centre-line of the Kildonan Settlers Bridge (Chief Peguis Trail), and the fourth was approximately 100 m upstream of a small tributary (Figure 2).

3.0 METHODS

3.1 POSITIONING

A Fieldranger Model 6000 Ahip chain@ was used to map the location of water sampling and gillnetting sites on a 1:5555 scale map (1 mm = approximately 5.5 m) overlaid with a 20 m UTM grid (NAD 83) provided by Tetr*ES* Consultants. The Universal Transverse Mercator (UTM) position (datum) of each site was derived from the map and recorded in an Excel database.

3.2 WATER SAMPLING

In conjunction with gillnetting, water depth, pH, water temperature, dissolved oxygen, total ammonia, and water velocity were measured at each sampling location. Only pH, water temperature, dissolved oxygen, and total ammonia were measured adjacent to the outfall.

Water depth was measured with a weighted, graduated rope to the nearest centimeter; pH was measured with a hand-held meter (OAKTON pH Wand); water temperature and dissolved oxygen were measured with a multi-parameter meter (Horiba); total ammonia was measured using a Palintest photometer; and, water velocity was measured with a current meter (Price Model 622AA). Unionized ammonia (mg/L) was calculated using the following equation:

$$NH_3 \text{ (mg } NH_3\text{/L)} = \text{total ammonia (mg/L)}/(10^{(0.09018+(2729.92/273.16+\text{temperature (EC)})-\text{pH})} + 1)$$

3.3 FISH DISTRIBUTION AND ABUNDANCE

Fishing was conducted at seven sites in the vicinity of the NEWPCC outfall, using ›standard experimental‹ gangs (Figure 1). Sites 1 - 4 were fished at the surface and at the bottom. Each gang consisted of six, 25 yard (22.9 m) long by 6 feet (1.8 m) deep twisted nylon panels of 1.5, 2, 3, 3.75, 4.25, and 5" (38, 51, 76, 95, 108, and 127 mm) stretched mesh. Each gill net was fished for one to three overnight sets per site (Table 1).

3.3.1 Biological Data

All fish captured were enumerated by species and measured for fork length (" 1 mm) and round weight (" 25 g), and examined to determine sex, state of maturity, and presence of DELTs (Deformity, Erosion, Lesion, and/or Tumour).

Ageing structures (pectoral fin rays) were taken from goldeye (*Hiodon alosoides*), mooneye (*Hiodon tergisus*), northern pike (*Esox lucius*), and white sucker (*Catostomus commersoni*) and archived for future analysis.

Stomachs from goldeye, mooneye, northern pike, and white sucker were collected and fixed with 10 % formalin. All stomach contents were archived for future analysis, except for the contents from three northern pike, which were identified.

4.0 RESULTS

4.1 WATER SAMPLING

A summary of the on-site measurements taken during sampling in the vicinity of the NEWPCC outfall is presented in Table 2. The concentration of total ammonia was highest in the surface waters immediately adjacent to the outfall, ranging from 5.70 mg/L to 0.20 mg/L. Generally, total ammonia was higher at nearshore sampling locations along the right bank (facing upstream) and declined with increasing distance downstream of the outfall.

4.2 FISH DISTRIBUTION AND ABUNDANCE

Common and scientific names and abbreviations for all fish species captured in the vicinity of the NEWPCC outfall are provided in Table 3. A total of 16 fish, from 4 species, were captured in gill nets set immediately downstream of the NEWPCC outfall (Table 4). All fish were caught in bottom sets. Northern pike was the most abundant species (n = 11), followed by white sucker, goldeye, and mooneye. The largest catch occurred at Net 1, with a total of 6 northern pike, 2 goldeye, 1 mooneye, and 1 white sucker.(Figure 2). Total catch declined with increasing distance downstream from the outfall (Figure 2). No fish were caught at the upstream control site.

TABLES AND FIGURES

Table 1. Summary of gillnet set information at sites in the vicinity of the NEWPCC outfall, March, 1999.

Site	Bank Set [1]	Date Set	Type	Time Set	Nearshore			Offshore			Time Pull	Duration (hours)	Comments
					Easting	Northing	Depth (m)	Easting	Northing	Depth (m)			
Net1	R	16-Mar-99	Surface	10:35	0636375	5534805	2.50	0636440	5534815	5.80	10:55	24.3	
Net2	R	16-Mar-99	Surface	11:02	0636470	5534940	3.80	0636525	5534940	6.50	10:40	23.6	
Net3	L	16-Mar-99	Surface	11:20	0636890	5534870	1.70	0636935	5534905	2.40	11:20	24.0	
Net4	L	16-Mar-99	Surface	17:15	0636595	5534255	5.05 [2]	0636535	5534273	5.05 [2]	15:00	21.8	
Net1	R	17-Mar-99	Bottom	10:55	0636375	5534805	2.50	0636440	5534815	5.80	11:15	24.3	
Net2	R	17-Mar-99	Bottom	10:40	0636470	5534940	3.80	0636525	5534940	6.50	10:15	23.6	
Net3	L	17-Mar-99	Bottom	11:20	0636890	5534870	1.70	0636935	5534905	2.40	12:05	24.8	
Net4	L	17-Mar-99	Bottom	15:30	0636595	5534255	5.05 [2]	0636535	5534273	5.05 [2]	17:00	25.5	
Net61	R	18-Mar-99	Bottom	15:25	0638969	5537729	2.50	-	-	5.00	13:40	22.3	Ice pushed net to R-bank
Net62	R	18-Mar-99	Bottom	15:00	0639713	5539400	2.25	-	-	1.25	12:05	21.1	Ice pushed net to R-bank
Net63	R	18-Mar-99	Bottom	14:15	0640390	5540123	2.00	-	-	2.50	11:20	21.1	
Net1	R	22-Mar-99	Bottom	10:55	0636375	5534805	2.50	0636440	5534815	5.80	11:50	24.9	
Net2	R	22-Mar-99	Bottom	10:40	0636470	5534940	3.80	0636525	5534940	6.50	11:38	25.0	
Net3	L	22-Mar-99	Bottom	11:05	0636890	5534870	1.70	0636935	5534905	2.40	13:32	26.5	

[1] codes for position: R - right; L - left

[2] depth measured from ice surface; ice thickness 0.75

Table 2. Summary of on-site measurements taken during sampling in the vicinity of the NEWPCC plume, March, 1999.

Site	Position[1]	Location[2]		Date	Sample Time	Water Depth (m)	Sample Depth (m)	Water Temperature (°C)	pH	Dissolved Oxygen (mg/L)	Total Ammonia (mg/L)	Unionized Ammonia[3] (mg/L)	Velocity/Depth (m/s) (m)
Outfall	RBN	E0636385	N5534730	16-Mar-99	13:35	-	0.10	1.6	8.17	9.20	5.70	0.078	-
Net1	RBN	E0636390	N5534820	16-Mar-99	13:20	2.50	0.10	1.0	8.19	8.96	1.66	0.023	0.10 / 1.80
Net1	RBO	E0636445	N5534825	16-Mar-99	13:25	5.80	0.10	1.1	8.60	8.80	0.66	0.023	
Net1	RBO	E0636445	N5534825	16-Mar-99	13:30	5.80	3.00	0.9	8.56	9.58	1.22	0.038	0.26 / 3.50
Net2	RBN	E0636505	N5534958	16-Mar-99	13:40	3.80	0.10	1.0	8.41	9.57	1.92	0.043	-
Net2	RBN	E0636505	N5534958	16-Mar-99	13:45	3.80	3.50	0.9	8.32	9.33	1.66	0.030	0.12 / 2.60
Net3	LBN	E0636925	N5534865	16-Mar-99	13:15	1.70	0.50	0.7	8.16	8.68	0.55	0.007	0.27 / 1.20
Net3	LBO	E0636935	N5534905	16-Mar-99	12:50	2.40	0.10	0.5	8.41	8.65	0.53	0.011	-
Net3	LBO	E0636935	N5534905	16-Mar-99	12:55	2.40	1.90	0.8	8.49	8.72	0.47	0.012	0.37 / 1.60
Net3	RBN	E0636940	N5535020	16-Mar-99	13:10	3.10	0.10	0.5	8.45	8.80	0.80	0.019	0.36 / 2.00
Net4	LBN	E0636595	N5534255	16-Mar-99	17:30	5.05 [4]	0.85 [4]	0.3	-	8.77	0.21	-	0.41 / 3.00 [4]
Outfall	RBN	E0636385	N5534730	17-Mar-99	pm	-	0.10	-	7.64	-	5.30	-	-
Net1	RBN	E0636390	N5534820	17-Mar-99	14:55	1.25	0.10	0.6	7.88	8.99	1.82	0.012	-
Net1	RBO	E0636445	N5534825	17-Mar-99	14:50	4.50	0.10	0.6	7.87	8.83	2.44	0.016	-
Net1	RBO	E0636445	N5534825	17-Mar-99	14:45	4.50	4.30	0.5	7.85	10.13	1.66	0.010	-
Net2	RBN	E0636505	N5534730	17-Mar-99	15:30	3.00	0.10	0.7	7.89	9.02	1.92	0.013	-
Net2	RBN	E0636505	N5534730	17-Mar-99	15:25	3.00	2.80	0.8	7.88	9.64	1.92	0.013	-
Net3	LBN	E0636925	N5534865	17-Mar-99	pm	1.60	0.10	0.2	8.04	8.75	0.41	0.004	-
Net3	LBO	E0636935	N5534905	17-Mar-99	pm	2.40	0.10	0.4	8.03	8.73	0.29	0.003	-
Net3	LBO	E0636935	N5534905	17-Mar-99	pm	2.40	1.50	0.3	7.88	9.11	0.50	0.003	-
Net3	RBN	E0636940	N5535020	17-Mar-99	pm	2.40	0.10	0.2	8.04	8.65	0.61	0.006	-
Net4	LBN	E0636595	N5534255	17-Mar-99	pm	5.05 [4]	0.85 [4]	0.1	7.84	8.93	0.32	0.002	-
Net61	MID	E0638969	N5537729	18-Mar-99	15:49	5.00	0.10	-	7.79	-	0.71	-	0.27 / 2.50
Net62	MID	E0639713	N5539400	18-Mar-99	15:08	1.25	0.10	-	7.93	-	0.44	-	0.37 / 0.50
Net63	MID	E0640390	N5540123	18-Mar-99	14:25	2.50	0.10	-	7.97	-	0.41	-	0.31 / 1.50
Net61	LBN	-	-	19-Mar-99	13:51	3.30	0.10	0.7	7.77	8.87	0.38	0.002	-
Net61	MID	-	-	19-Mar-99	14:04	5.00	0.10	0.6	7.81	8.87	0.31	0.002	-
Net61	RBN	E0638969	N5537729	19-Mar-99	14:28	2.20	0.10	0.6	7.79	9.79	0.44	0.002	-
Net62	MID	E0639713	N5539400	19-Mar-99	12:18	-	0.10	0.4	7.73	8.91	0.23	0.001	-
Net63	MID	E0640390	N5540123	19-Mar-99	10:45	3.10	0.10	0.5	7.82	8.84	0.44	0.002	-
Outfall	RBN	E0636385	N5534730	22-Mar-99	11:18	-	0.10	0.8	7.97	9.05	0.20	0.002	-
Net1	RBN	E0636385	N5534820	22-Mar-99	11:51	3.25	0.10	0.8	7.93	9.97	0.96	0.007	-
Net1	RBN	E0636390	N5534820	22-Mar-99	11:45	3.25	3.00	0.7	7.92	10.07	1.02	0.007	-
Net1	RBO	E0636445	N5534825	22-Mar-99	11:35	5.00	0.10	0.5	7.97	9.11	0.46	0.004	-
Net1	RBO	E0636445	N5534825	22-Mar-99	11:27	5.00	4.50	0.2	8.03	10.27	0.38	0.003	-

Table 2. (continued)

Site	Position[1]	Location[2]		Date	Sample Time	Water Depth (m)	Sample Depth (m)	Water Temperature (°C)	pH	Dissolved Oxygen (mg/L)	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)	Velocity/Depth (m/s) (m)
Net2	RBN	E0636505	N5534730	22-Mar-99	12:06	3.00	0.10	0.9	7.94	9.47	0.88	0.007	-
Net2	RBN	E0636505	N5534730	22-Mar-99	12:00	3.00	2.50	0.8	7.82	9.88	1.06	0.006	-
Net3	LBN	E0636925	N5534865	22-Mar-99	12:21	1.60	0.10	0.4	7.94	9.93	0.32	0.002	-
Net3	MID	E0636950	N5534940	22-Mar-99	12:35	2.00	0.10	0.6	7.78	9.32	0.59	0.003	-
Net3	MID	E0636950	N5534940	22-Mar-99	12:29	2.00	1.75	0.4	7.75	9.77	0.66	0.003	-
Net3	RBN	E0636940	N5535020	22-Mar-99	12:42	1.75	0.10	0.7	7.73	9.60	0.83	0.004	-
Outfall	RBN	E0636385	N5534730	23-Mar-99	9:56	-	0.10	0.4	7.56	10.07	4.10	0.013	-
Net1	RBN	E0636390	N5534820	23-Mar-99	10:35	2.75	0.10	0.7	7.69	10.01	1.18	0.005	-
Net1	RBN	E0636390	N5534820	23-Mar-99	10:29	2.75	2.50	0.6	7.65	10.04	1.18	0.005	-
Net1	RBO	E0636445	N5534825	23-Mar-99	10:16	4.25	0.10	0.7	7.94	10.07	0.36	0.003	-
Net1	RBO	E0636445	N5534825	23-Mar-99	10:08	4.25	4.00	0.2	7.79	10.77	1.14	0.006	-
Net2	RBN	E0636505	N5534730	23-Mar-99	11:20	3.00	0.10	0.9	7.61	9.85	1.66	0.006	-
Net2	RBN	E0636505	N5534730	23-Mar-99	11:14	3.00	2.50	0.8	7.60	10.34	1.54	0.005	-
Net3	LBN	E0636925	N5534865	23-Mar-99	13:21	1.60	0.10	0.2	7.80	10.33	0.36	0.002	-
Net3	MID	E0636950	N5534940	23-Mar-99	13:15	2.25	0.10	0.3	7.75	10.34	0.63	0.003	-
Net3	MID	E0636950	N5534940	23-Mar-99	13:08	2.25	2.00	0.3	7.70	10.44	0.63	0.003	-
Net3	RBN	E0636940	N5535020	23-Mar-99	12:57	2.25	0.10	0.7	7.78	10.40	0.59	0.003	-

[1] codes for position: R - right; L - left; B - bank; N - nearshore (10-20 m); O - offshore (~50m); MID - mid-channel
[2] locations in zone 14U; measured in UTMs using NAD27
[3] calculated values
[4] depth measured from ice surface; ice thickness 0.75 m

Table 3. A list of fish species captured during gillnetting in the vicinity of the NEWPCC outfall, March, 1999.

Common Name	Scientific Name	Abbreviation
Goldeye	*Hiodon alosoides*	GOLD
Mooneye	*Hiodon tergisus*	MOON
Northern Pike	*Esox lucius*	NRPK
White Sucker	*Catostomus commersoni*	WHSC

Table 4. Fish caught immediately upstream and downstream of the NEWPCC outfall, March, 1999.

Site	Date Sampled	Fish Number	Mesh Size (inches)	Species	Length (mm)	Weight (g)	Sex [1]	Maturity [1]	DELTs [2]	Ageing Structure [3]	Stomach Contents [3]	Necropsy [4]
Net1	18-Mar-99	1006	5	NRPK	641	2300	F	2	X	X	-	-
Net1	18-Mar-99	1007	5	NRPK	630	2000	-	-	X	X	-	-
Net1	18-Mar-99	1008	5	NRPK	627	1950	-	-	-	X	-	-
Net1	18-Mar-99	1005	5	WHSC	462	1600	F	2	-	X	-	-
Net2	18-Mar-99	1000	5	NRPK	688	2300	-	-	X	-	-	-
Net2	18-Mar-99	1001	3.5	NRPK	678	2500	-	-	X	X	-	-
Net2	18-Mar-99	1002	2.5	NRPK	404	500	-	-	-	X	-	-
Net2	18-Mar-99	1003	2.5	NRPK	720	3500	F	2	-	X	-	-
Net2	18-Mar-99	1004	2.5	NRPK	709	3500	F	2	-	X	-	-
Net1	23-Mar-99	1015	3	GOLD	259	175	-	-	-	X	X	X
Net1	23-Mar-99	1016	3	GOLD	254	170	-	-	-	X	X	X
Net1	23-Mar-99	1017	1.5	MOON	175	60	-	-	-	X	X	X
Net1	23-Mar-99	1012	4	NRPK	525	1125	M	7	-	X	X	X
Net1	23-Mar-99	1013	4	NRPK	611	2050	F	2	-	X	X	X
Net1	23-Mar-99	1014	3	NRPK	680	2250	M	7	-	X	X	X
Net3	23-Mar-99	1018	4	WHSC	398	900	-	-	-	X	X	X

[1] definition of codes: F - female; M - male; 2,7 - fish maturing to spawn current year

[2] X - DELT noted (Deformity, Erosion, Lesion, and/or Tumour)

[3] X - ageing structure and stomach contents sampled and archived

[4] X - necropsy performed

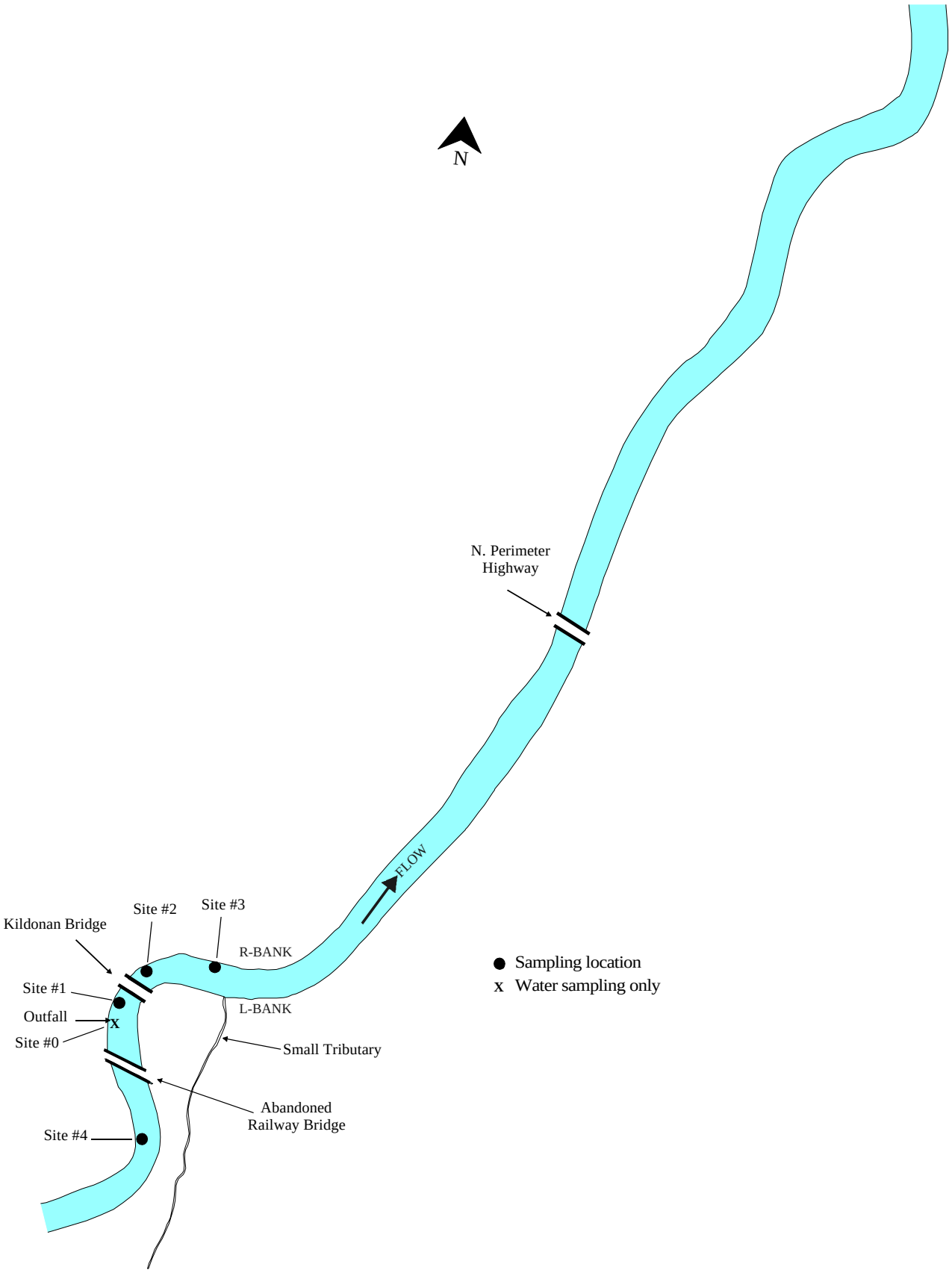

Figure 1. Sampling locations in the vicinity of the NEWPCC outfall, October, 1999.

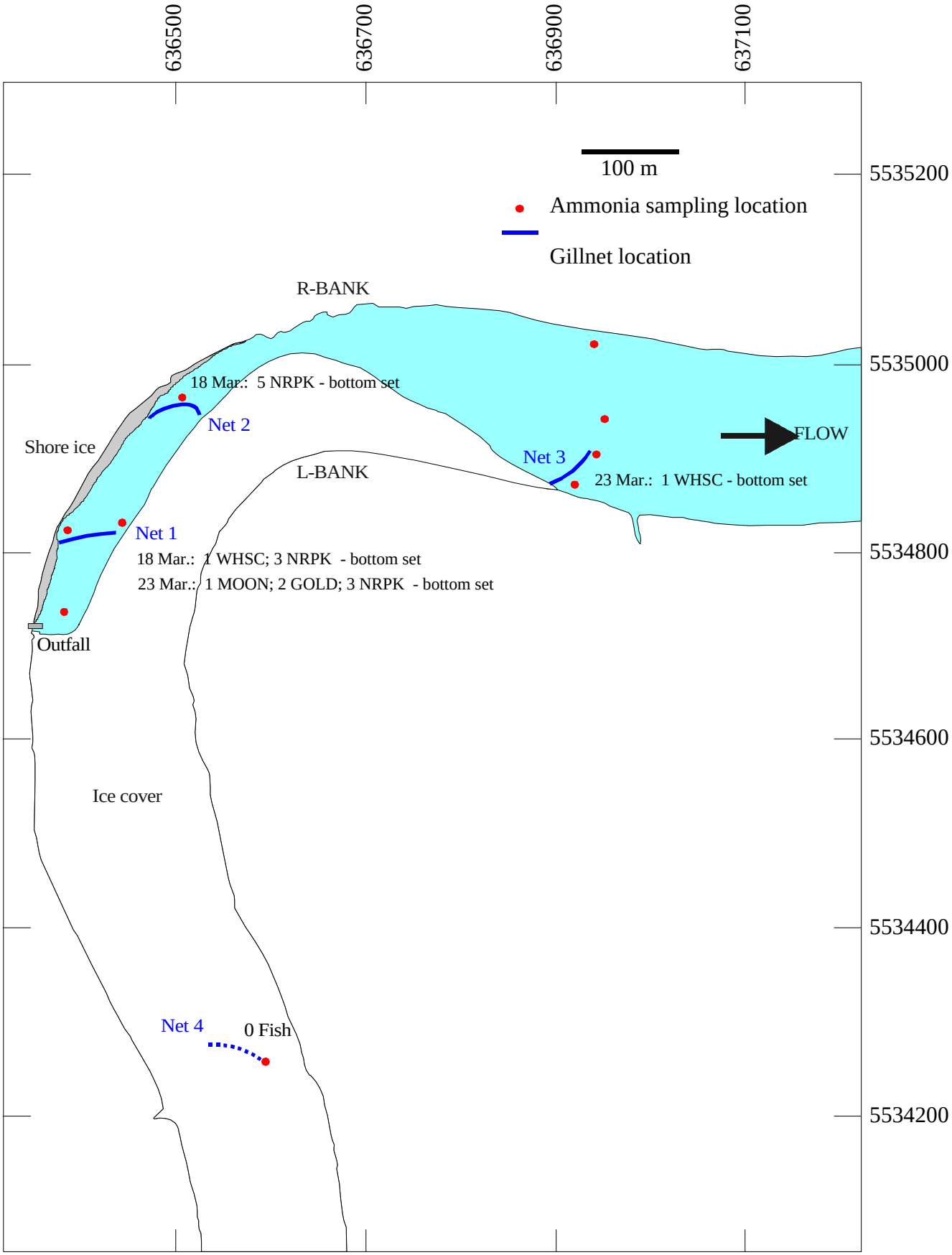

Figure 2. Gillnet and water sampling locations, and fish caught immediately upstream and downstream of the NEWPCC outfall, March, 1999 (see Table 3 for fish species codes) (grid in UTMs).