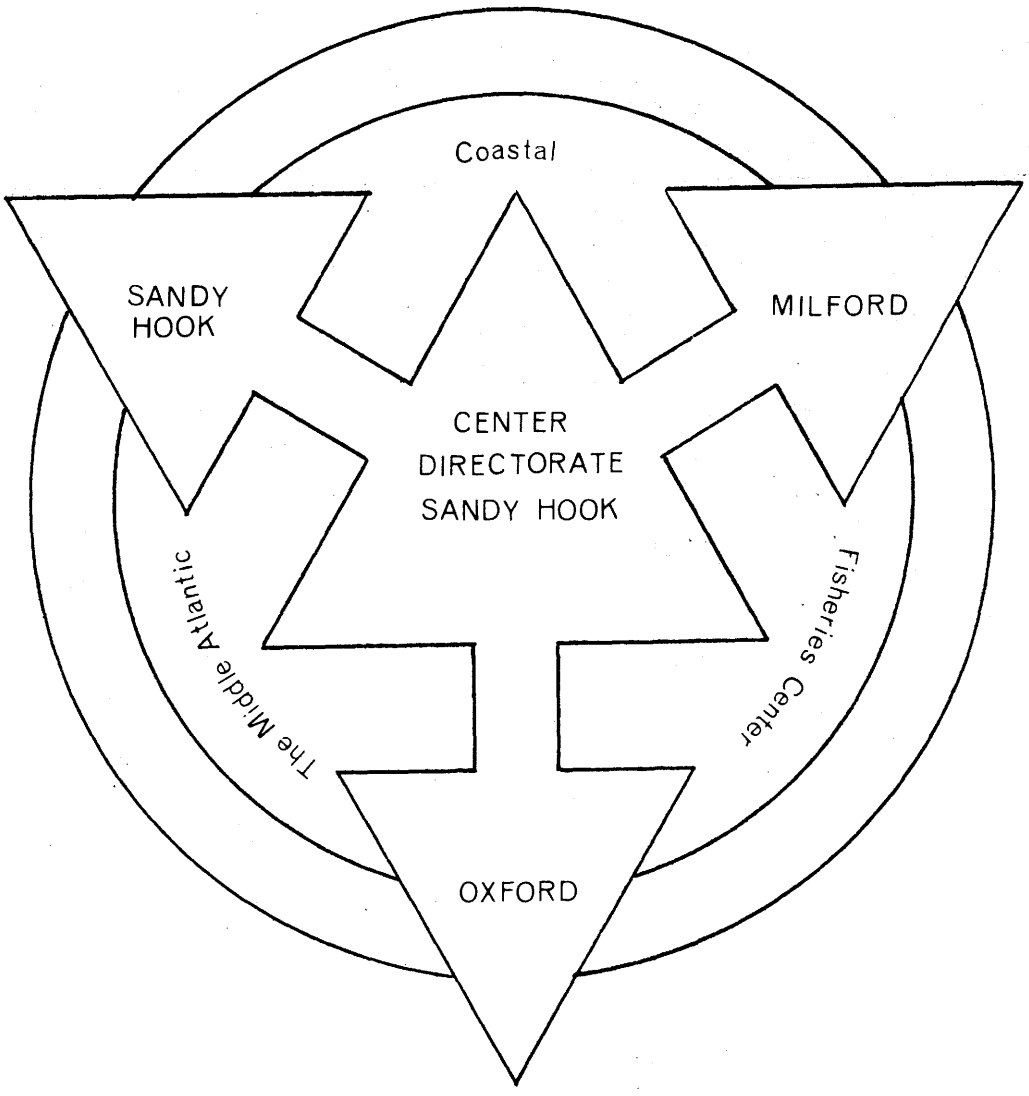
TRACE METALS IN MARINE BIOTA AND SEDIMENTS COLLECTED FROM OFFSHORE WATERS OF NEW YORK BIGHT

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region

MIDDLE ATLANTIC COASTAL FISHERIES CENTER



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MIDDLE ATLANTIC COASTAL FISHERIES CENTER
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INTRODUCTION

For nearly a century, solid waste materials from the New York Metropolitan Region have been disposed by dumping in designated areas within the New York Bight. Certain investigators have examined the deleterious impact, as well as the sources, chemical nature, and disposal practices of these materials (Gross, 1969, 1970; Pearce, 1970; Sandy Hook Laboratory, 1972).

Recently, an alternate dumping site in relatively deep waters compared to the present dumping areas has been proposed. See Figure 1 for location of the current and proposed deep water dump sites. Baseline studies of the environmental conditions at this station should be made to assess the impact of solid waste disposal at this site. In the present study, the baseline conditions for trace metals were examined for both bottom sediments and the indigenous species of fish in the areas. The samples were examined for cadmium, chromium, copper, lead, nickel, silver, and zinc.

METHODS

Sample Collection and Preparation

Whole fish, tissues and organs of fish were taken on board ship, packaged in plastic bags, and frozen until analysis. At the laboratory, the fish samples from each station were pooled by grinding with an electric blendor using glass jars and stainless steel cutting blades.

Bottom sediment samples were obtained with a Smith-McIntyre dredge. Plastic tubes 1-3/4 inches in diameter were inserted to the depth of the grab, then capped and frozen until analysis. At the laboratory the top 1-1/2 inches of sediment were removed from the plastic tubes and dried at 60°C for 48 hours. If possible, the dried samples were ground into a homogenous sample using a glass mortar and pestle.

Chemical Analysis

Trace metal analyses of fish samples were carried out as follows: up to 10 g of sample were placed in 250 ml glass beakers and dried overnight at 100-115°C. Sufficient concentrated nitric acid was added to the dry samples to cover them and then the acid was evaporated by gentle boiling. About 3-6 ml of the concentrated nitric acid were added and again evaporated to dryness. This process was repeated until a fairly whitish residue was obtained, which usually required 4-6 acid additions. Samples were then filtered through Whatman No. 2 filter paper and brought to a 25 ml volume with 10% nitric acid.

Metal analyses of sediment were conducted as follows: 2.5 g of material were placed in a 250 ml beaker; to this were added 10 ml of concentrated nitric acid and 0.5 ml of 30% hydrogen peroxide. The acid and peroxide were evaporated to dryness by gentle boiling. To the dried sample the following were added: 25 ml of acid mixture, consisting of 80 ml of concentrated nitric acid, 20 ml of concentrated HCl and 300 ml of distilled water, 8 ml of 10% NH_4Cl, and 0.4 ml of calcium nitrate (11.8 g/100 ml of $Ca(NO_3)2.4\ H_2O$). This mixture was heated to a gentle boil for 15 minutes and cooled for five minutes or longer. Samples were then filtered through Whatman No. 2 filter paper and diluted to 100 ml with distilled water. The filtered samples of sediment and fish were analyzed directly on an atomic absorption spectrophotometer (Perkin Elmer Model 403).

RESULTS AND DISCUSSION

Marine Biota

The silver, cadmium, and chromium levels in the muscle and liver did not vary greatly in most of the fish examined. However, the copper, zinc and lead levels, varied substantially. Lead showed the greatest variation of all the elements tested (Table 1).

High levels of silver, cadmium, copper, and zinc encountered were in the liver of the deep sea slickhead, (Alepacephalus agassifi). The levels of these metals in the liver are several orders of magnitude greater than metal concentrations found in livers of windowpane flounder (Scophthalmus aquisus) collected at the present New York Bight sewage sludge and dredge spoils disposal sites (Greig, unpublished data). The levels of these metals in the liver of the slickhead were: cadmium - 13.9 ppm; copper - 28.6 ppm; silver - 1.12 ppm; and zinc - 271 ppm; all values are on a wet weight basis. Additional liver samples were taken from the deep sea grenadier (Nematonurus armatus), rattail (Nezumia bairdi), whiting (Merloccius bilinearus), and Halosaupsis macrochin (no common name). Trace metal levels in the livers of these fish were fairly similar to those found in livers of the windowpane flounder.

The level of cadmium found in the liver of the deep sea slickhead were unusually high at 13.9 ppm. Other marine animals such as oyster (Crassostrea virginica) and the digestive glands of channeled whelk (Busycon canaliculatum), which have the ability to concentrate metals, contained only 1-5 ppm and 10-15 ppm of cadmium, respectively for animals obtained from Long Island Sound (Greig, unpublished data).

For comparison with the present study the data of Windom, et al (1973), on cadmium, copper, and zinc levels in about 35 species of fish obtained from North Atlantic waters can be used. Cadmium levels in the livers of these fish generally were less than 1.7 ppm, although the liver of one species of fish contained 5 ppm. Cadmium levels in other organs and whole fish mainly were less than 1 ppm, although some species had levels as high as 2.6 ppm. Since these data were expressed on a dry weight basis the values presented here would have to be reduced by about one-fifth, assuming 80% moisture in the fish samples.

The highest cadmium level of 5 ppm dry weight found by these investigators would be about 1 ppm on a wet weight basis. Copper levels were in most cases less than 10 ppm in these fish. The copper level in liver of deep sea slickhead in our study was 28.6 ppm on a wet weight basis, which is more than triple the highest level of about 9 ppm on a wet weight basis, reported by Windom and coworkers. Copper concentrations in other species of fish obtained in the present study were similar to the levels in fish examined by Windom et al. (1973).

Zinc levels in North Atlantic fish were reported by Windom and coworkers to be in the range of 10-80 ppm on a dry weight basis. However, a high level of zinc at 397 ppm for the species Anchoa mitchelli was obtained. This level would be about 80 ppm on a wet weight basis. Zinc levels found in most fish in our study was in this same range.

Heavy Metals in Sediments

Sediment samples collected at stations shown in Table 2 were examined for chromium, copper, nickel, lead, and zinc. With one exception, the metal concentrations in sediments were quite similar for all stations sampled; the chromium, copper, nickel, and lead levels were in the range of 20-30 ppm, dry weight basis whereas zinc levels were 30-60 ppm. For the exception, which was the sediment collected at the station with the coordinates 39°32'N and 72°32'W, the values for the four metals were in the range of 3-8 ppm, and the zinc level was about 14 ppm.

The levels of chromium, copper, lead, and zinc in these sediments were about one half to one seventh lower than typically found at the present New York Metropolitan ocean sewage sludge and dredge spoils dumping areas. Surprisingly, the nickel levels in the majority of the above sediments were about the same magnitude as found at the present New York Ocean dumping areas.

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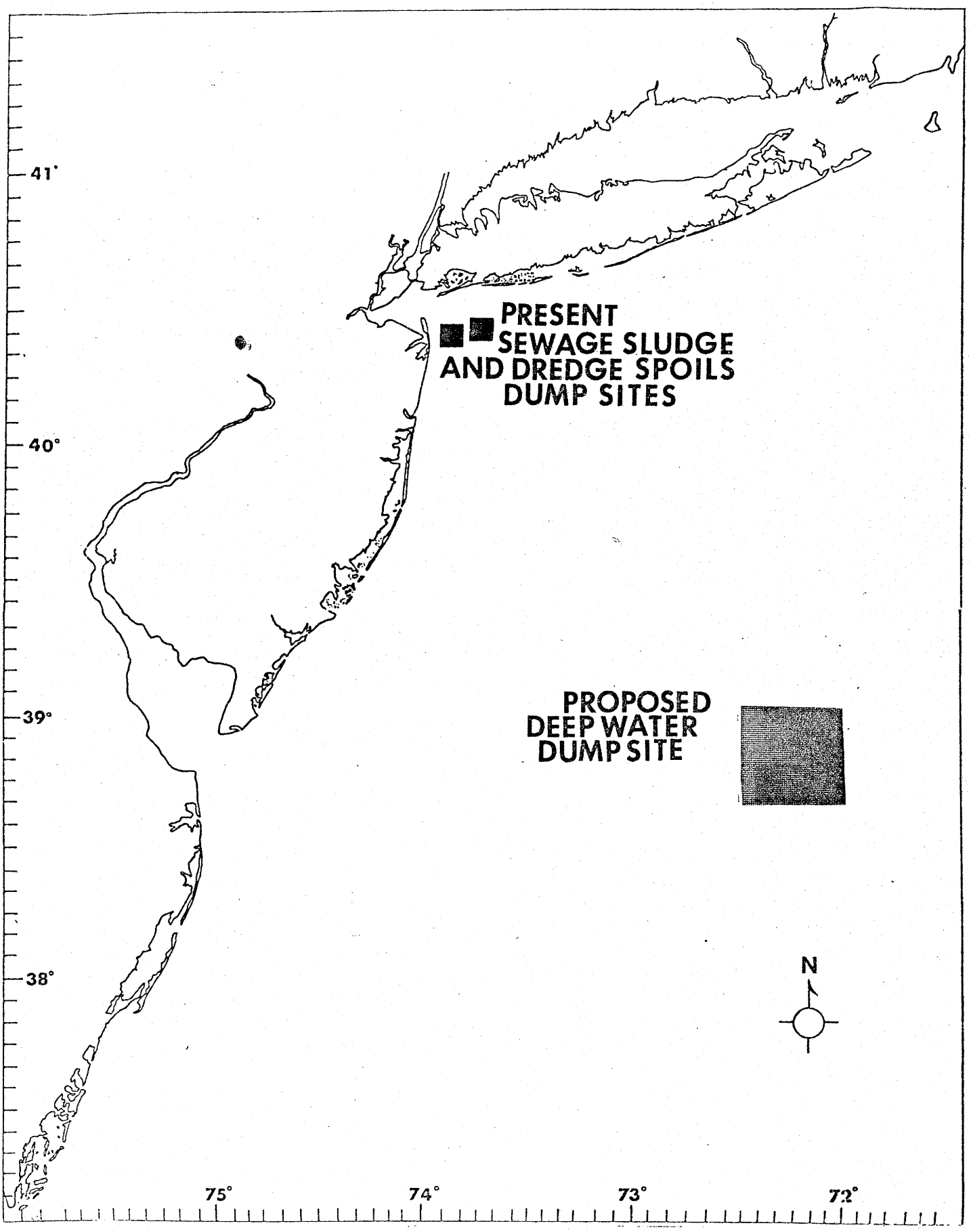

Figure 1. Present New York Metropolitan area ocean dumping sites and proposed deep water ocean dump site.

Table 1. Trace metal concentrations in marine biota collected offshore in the New York Bight.

Common Name	Scientific Name	N	Tissue	Latitude	Longitude	Metal Concentrations (ppm, wet wt.) Ag	Cd	Cr	Cu	Pb	Zn
Butterfish	Prepilus triacantnus	5	Whole	39°30'N	72°34'W	0.14	0.23	0.54	4.6	1.1	28.8
Deep Sea Slickhead	Alepacephalus agassizi	3	Muscle	38°50'N	72°34.5'W	<0.09	0.09	<0.3	0.2	<0.3	11.6
Deep Sea Slickhead	"	11	Liver	38°50'N	72°34.5'W	1.16	13.9	0.6	28.6	0.5	271.
Deep Sea Slickhead	"	11	Gills	38°50'N	72°34.5'W	0.12	0.27	0.5	1.1	1.3	69.0
Deep Sea grenadier	Nematonurus armatus	3	Muscle	30°09'N	72°19.5'W	<0.08	<0.07	0.4	0.4	<0.4	3.7
Deep Sea grenadier	"	9	Liver	39°09'N	72°19.5'W	<0.1	<0.1	1.1	2.4	<0.6	18.5
Deep Sea grenadier	"	9	Gills	39°09'N	72°19.5'W	0.15	0.08	0.8	1.2	2.0	18.0
	Dicrolene intronigra	11	Whole	39°02'N	72°25'W	0.20	0.17	0.94	2.2	2.1	12.3
Eel	Synaphobranchus kaupi	11	Whole	39°02'N	72°25'W	0.11	0.51	0.58	4.2	1.7	14.7
	Halosaupsis macrochin	4	Muscle	38°38'N	72°06'W	<0.09	<0.07	<0.45	2.7	<0.4	4.3
	Halosaupsis macrochin	3	Liver	38°38'N	72°06'W	0.33	0.30	<0.67	2.0	<0.6	4.9
	Halosaupsis machrochin	3	Gills	38°38'N	72°06'W	0.16	0.13	0.75	1.4	2.3	15.5
	Halosaupsis macrochin	2	Gonad	38°38'N	72°06'W	<0.29	<0.23	1.4	3.6	<1.2	55.5
	Nematonurus armatus	3	Muscle	39°30'N	72°34'W	0.09	<0.07	<0.40	1.2	0.8	9.7
	Nematonurus armatus	3	Gills	39°30'N	72°34'W	<0.10	0.08	0.58	1.4	1.3	27.0
	Pontaster hebitus	18	Whole	38°38'N	72°06'W	0.54	0.83	1.00	4.0	8.0	59.4

Table 1. Trace metal concentrations in marine biota collected offshore in the New York Bight.

Common Name	Scientific Name	N	Tissue	Latitude	Longitude	Metal Concentrations (ppm, wet wt.) Ag	Cd	Cr	Cu	Pb	Zn
Rattail	*Nezumia bairdi*	60	Whole	39°09'N	72°19.5'W	0.17	0.26	0.95	3.0	2.7	32.9
Rattail	"	4	Muscle	39°02'N	72°25'W	<0.08	<0.07	0.45	0.6	0.6	5.8
Rattail	"	4	Liver	39°02'N	72°25'W	0.12	0.79	<0.5	10.9	0.8	59.9
Rattail	"	7	Gills	39°02'N	72°25'W	0.21	0.15	<0.7	2.2	4.2	32.0
Rattail	"	11	Gonad	39°02'N	72°25'W	<0.08	0.15	<0.4	6.5	1.1	56.0
Redcrab		1	Muscle	39°09'N	72°19.5'W	0.16	0.11	0.48	25.2	0.6	51.0
Redcrab		1	Digestive gland	39°09'N	72°19.5'W	0.62	1.14	<0.42	107.	1.2	19.6
Sea Cucumber	*Benthedites giganteus*	1	Whole	38°50'N	72°34.5'W	0.48	0.03	0.23	0.2	0.3	1.3
Whiting	*Merloccius bilinearus*	4	Muscle	39°30'N	72°34'W	<0.09	<0.08	0.49	1.0	<0.3	4.2
Whiting	"	4	Gills	39°30'N	72°34'W	<0.09	0.15	0.54	1.8	2.4	26.8
Whiting	"	4	Liver	39°30'N	72°34'W	0.08	0.29	0.52	14.7	<0.4	12.2
Whiting	"	4	Gonad	39°30'N	72°34'W	<0.09	0.07	0.45	1.2	<0.4	12.7
Witch Flounder	*Glyptocephalus cynoglassus*	58	Whole	39°09'N	72°19.5'W	0.13	0.20	0.73	1.8	3.3	14.7

Table 2. Trace metal concentrations in the top 1 1/2 inches of sediments collected from deep water stations of the New York Bight.

Field Code	Latitude	Longitude	Concentrations (ppm, dry weight)				
			Cr	Cu	Ni	Pb	Zn
D-74-2-1G1	39°32'N	72°32'W	6.8	3.0	3.2	6.	14.8
D-74-2-1G2	39°32'N	72°32'W	6.6	3.0	4.2	8.	13.2
D-74-2-2G1	39°11'N	72°15'W	26.2	28.2	24.4	26.	60.
D-74-2-2G2	39°11'N	72°15'W	23.2	24.0	19.0	28.	53.
D-74-2-St2G1	39°10'N	71°50'W	27.0	22.8	22.2	20.	64.
D-74-2-St2G2	39°10'N	71°50'W	26.0	21.0	22.4	22.	63.
D-74-2-3G3	38°57'N	72°29'W	34.2	23.2	25.4	28.	64.
D-74-2-3G1	38°57'N	72°29'W	25.6	28.0	22.8	26.	59.
D-74-2-3G2	38°57'N	72°29'W	23.4	19.6	17.8	24.0	58.
D-74-2-4G1	38°51'N	72°16'W	27.4	29.6	28.4	32.	63.
D-74-2-4G2	38°51'N	72°16'W	24.2	26.6	24.4	32.	56.
D-74-2-5G1	38°42'N	72°22'W	26.8	31.2	29.6	32.	61.
D-74-2-5G2	38°42'N	72°22'W	28.0	30.6	28.4	26.	64.
D-74-2-St6G1	38°30'N	72°06'W	28.6	37.2	32.4	26.	65.
D-74-2-6G1	38°30'N	72°06'W	27.8	34.8	31.8	30.	53.
D-74-2-St6G2	39°30'N	72°06'W	24.6	33.6	30.6	30.	58.
D-74-2-St6NG1	38°34'N	72°06'W	26.8	32.0	28.6	26.	56.
D-74-2-6NW	38°33'N	72°10'W	26.6	34.6	33.6	28.	58.
D-74-2-W of 6G1	38°30'N	72°11.5'W	27.4	34.0	27.8	30.	57.
D-74-2-SW6G1	38°26.5'N	72°11'W	26.4	32.6	26.4	28.	54.
D-74-2-6S	38°26.5'N	72°07'W	23.4	29.0	29.8	24.	52.
D-74-2-E of St6G1	38°29'N	72°00'W	24.6	36.0	28.2	26.	56.
D-74-2-7G1	39°05'N	71°40'W	25.4	26.2	23.0	26.	56.
D-74-2-7G2	39°05'N	71°40'W	22.6	23.6	22.4	20.	53.
D-74-2-WH-1G1	39°46'N	70°40'W	16.8	13.4	12.6	16.	33.2
D-74-2-WH-1G2	39°46'N	70°40'W	21.8	21.6	20.6	24.	45.