Surficial Sediment Plume Study - 1996

Red River, Manitoba

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LIMITED

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Executive Summary

Polycyclic aromatic hydrocarbon (PAH) contamination was discovered in sediments of the Red River in the vicinity of the Disraeli Bridge in March, 1994. The contamination was linked to PAH contamination in soils and groundwater on the adjacent site of a former manufactured gas plant which is now owned by Centra Gas Manitoba Inc. This report presents the results of a study conducted in October 1996 to determine if the areal extent of the contaminated sediments is changing over time. The base situation, against which the 1996 survey results are compared, is the extent of contamination documented in September-October 1995. The contamination assessment utilized the visual/olfactory NC/TC/VC protocol used in the preceding studies.

The 1996 survey results indicate the area of PAH contaminated surficial sediments has decreased by about 35% since 1995, primarily due to a reduction in the downstream extent of the plume. The decrease in area has several possible causes, including year to year variations in PAH loading to the sediments, rates of river bed scour, and rates of clean sediment deposition. Given that the area of contamination does not appear to be increasing, it is recommended that monitoring work should remain limited to the plume surveys which are scheduled for the 1997 and 1998 open water seasons.

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Acknowledgments

Thanks to Gwenn Kruszynski for her able assistance in the field, often during difficult autumn weather conditions.

1.0 Introduction

Polycyclic aromatic hydrocarbon (PAH) contamination was discovered in sediments of the Red River in the vicinity of the Disraeli Bridge in March, 1994 (CH2M Hill 1995). The contamination was linked to PAH contamination in soils and groundwater on the adjacent site of a former manufactured gas plant which is now owned by Centra Gas Manitoba Inc. Subsequent studies were undertaken in 1994 and 1995 to examine the extent of the plume in the river and to determine the effects of the contamination on aquatic biota. The plume of visible contamination in surficial river sediments was found to begin approximately 22 m upstream of the bridge, extending approximately 135 m downstream, and from 30 to 50 into the river channel from the winter waterline on the south side of the river (Figure 1). The contamination has had a measurable, but minor impact on zoobenthos abundance and does not appear to have adversely affected fish or fish habitat (Agassiz North 1996).

The only major uncertainty related to the contaminated sediments is the stability of the zone of contamination, although studies to date suggest the plume is not rapidly expanding in size, if it is changing in size at all (Agassiz North 1996). This report presents the results of a study conducted in October 1996 to determine if the areal extent of the contaminated sediments is changing over time. The base situation, against which the 1996 survey results are compared, is the extent of contamination documented in September-October 1995 (Agassiz North 1996).

2.0 Methods

The sediment contamination survey involved the collection of sediment samples along a series of transects located within and adjacent to the known area of contamination. The shoreline was staked at 25 m intervals, beginning at the 150 m marker used in the 1995 survey and continuing 200 m downstream to the 350 m marker. Sediment samples were taken at about 10 m intervals along each transect, and at closer intervals in some cases, beginning about 10 m offshore. The nearshore sample (i.e., within 10 m of shore) could not be taken in all cases due to access difficulties related to debris (e.g., concrete slabs), or mudflats. Transect locations and sampling points are shown on Figure 2. Samples were not taken at the 46 m location on the 150 m transect nor at any location beyond 9 m along the 175 m transect in order to avoid interference with the submarine gas pipeline. The 275, 300, and 325 m transects were sampled on 16 October 1996, and the 150, 175, 230, 250, and 350 m transects were sampled on 19 October 1996.

A stainless steel Burton-Ekman dredge (0.023 m^2 sampling area) was used to collect sediment samples along the 275, 300, and 325 m transects. Samples along the 150, 175, 230, 250, and 350 m transects were taken with a stainless steel Wildco Ekman dredge (0.023 m^2 sampling area). Water depth was measured at each sample location using an Eagle Model 7200 depth sounder. Distance off shore was determined using a Ranging model TLR75 coincidence range-finder.

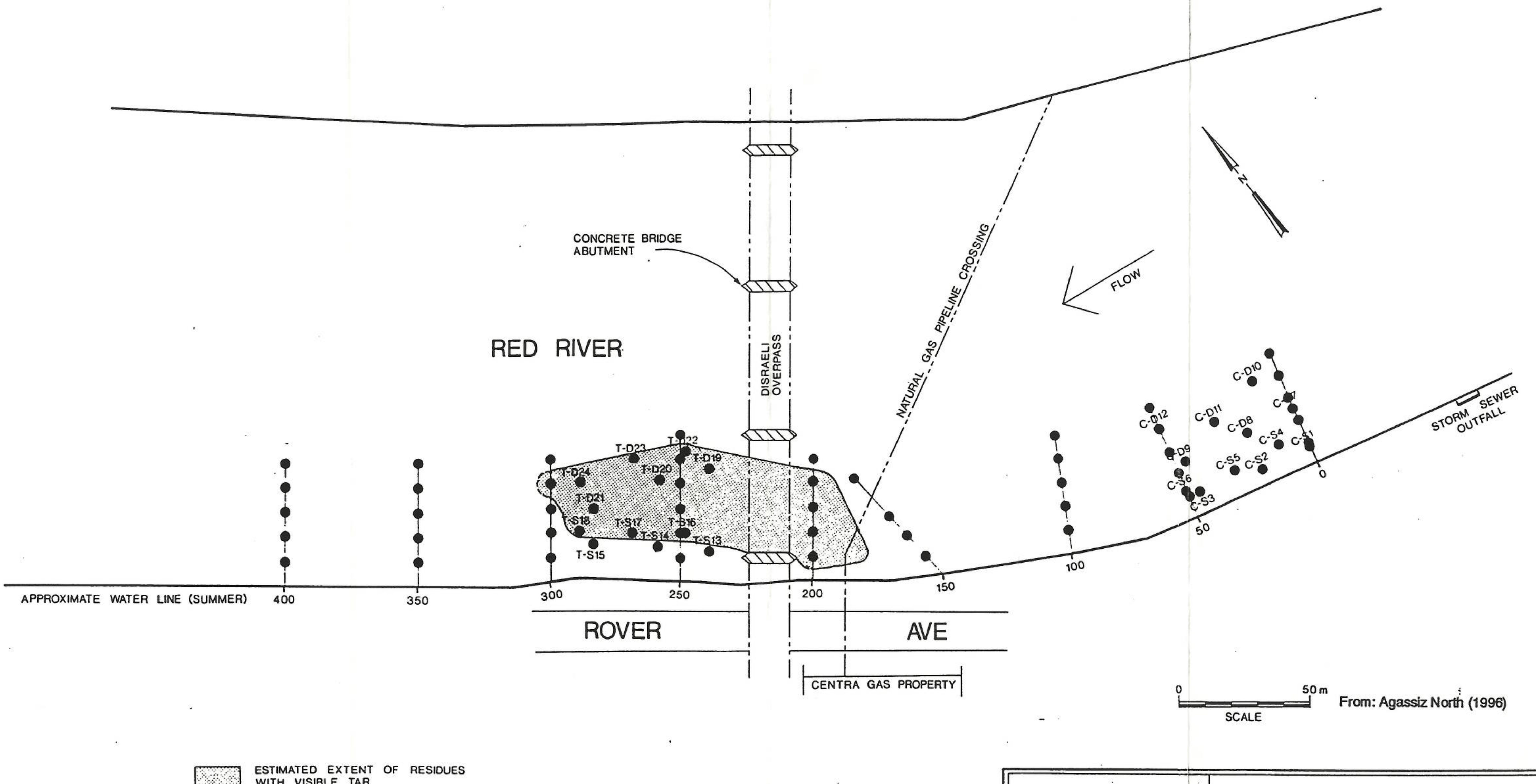

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Figure 1
Estimated Extent of Sediments with Visible PAH Tar Residues
September - October 1995

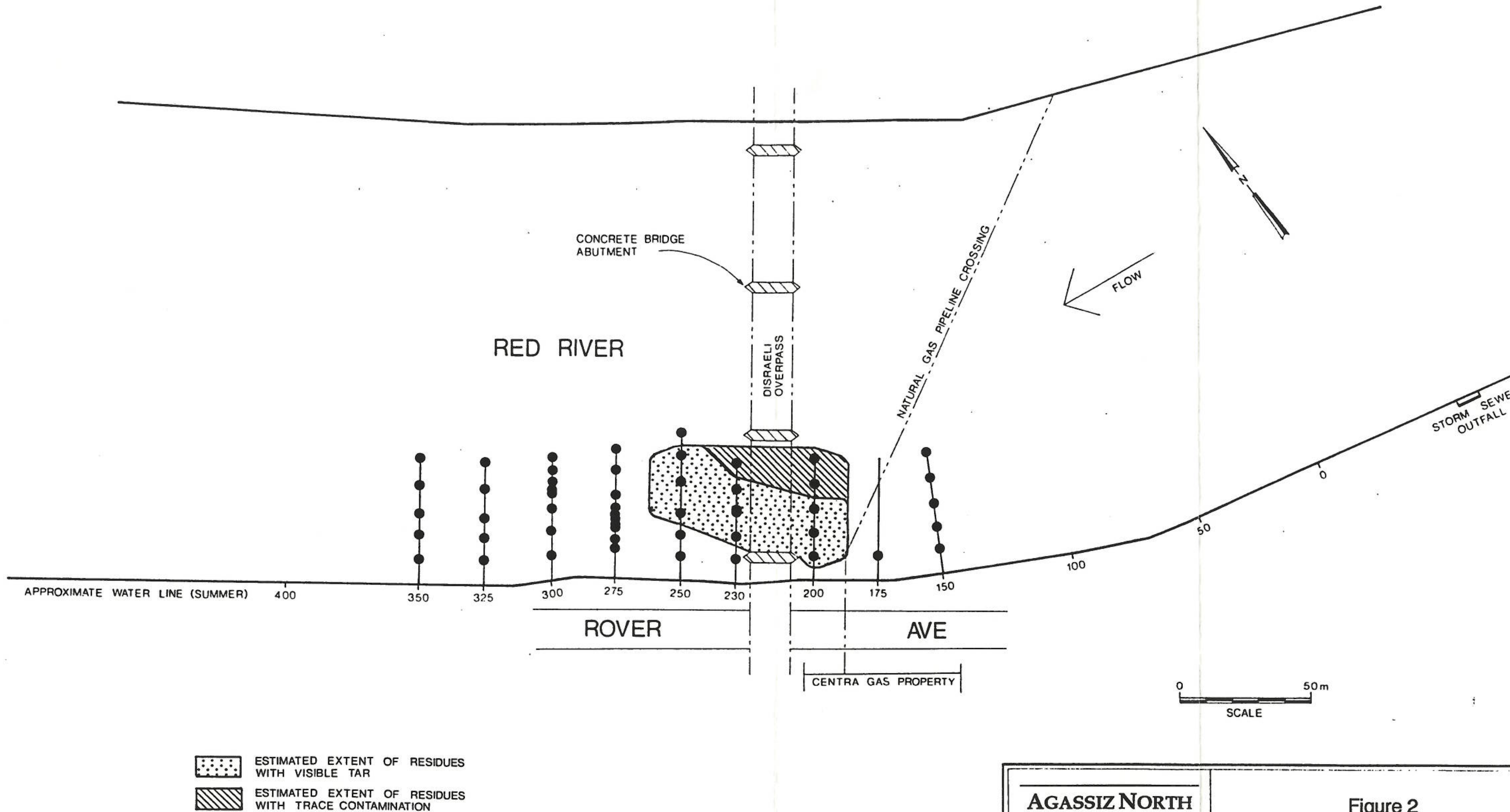

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Figure 2
Estimated Extent of Sediments with Visible PAH Tar Residues
October 1996

The contents of each dredge sample were transferred to a plastic pan for a visual/tactile assessment of substrate and a visual/olfactory evaluation of contamination. The substrate assessment involved classification of the surface and sub-surface sediment as clay, silt, sand, or gravel, along with notation of sediment colour. The contamination assessment followed the NC/TC/VC protocol used in the previous Phase II (CH2M Hill 1995) and Phase IIB (Agassiz North 1996) studies.

3.0 Results

The near-surface river sediments consisted primarily (i.e., at 37 of the 46 stations at which sampling was attempted) of brown silty-clay which occurred in a layer ranging from 1 cm to more than 18 cm thick (Table 1). Hard bottom materials (either granular or hardpan) occurred 20 to 30 m offshore along the 275 m transect, 34 m offshore on the 300 m transect, and 25 m offshore on the 325 m transect. Granular materials and construction debris occurred up to 28 m offshore on the 230 m transect, and up to 27 m offshore on the 200 m transect.

Visual evidence of PAH contamination (i.e., tarry material) was found along the 200, 230, and 250 m transects (Table 1). The tars were evident from 9 to 27 m offshore along the 200 m transect and from 25 to 47 m offshore along the 250 m transect. Granular bottom materials prevented the collection of useful samples at 18, 27, and 28 m along the 230 m transect. Trace evidence of PAH contamination (i.e., an odour of "mothballs" but no visual evidence of tars) was found at the 37 and 46 m stations on the 200 m transect and at the 46 m station on the 230 m transect. Debris on the river bottom immediately downstream of the nearby bridge abutment prevented sampling on the 230 m transect in the zone from 50 to 70 m offshore.

No evidence of contamination was found on the 275, 300, 325, or 350 m transects. Although hard bottom conditions precluded sampling at all of the stations on these transects, it is unlikely that any isolated pockets of contamination occurred in these unsampled areas based on our experience in 1995.

Table 1. Description of sediments and evidence of PAH contamination in the Red River near the Disraeli Bridge. Transects at 275 m, 300 m, and 325 m were sampled 16 October 1996. Transects at 150 m, 175 m, 200 m, 230 m, 250 m, and 350 m were sampled 19 October 1996. Evidence of contamination codes are defined as: NC (no contamination); VC (visual contamination, indicated by the presence of tar and of PAH odour); and, TC (trace contamination, indicated by detection of PAH odour but no visual evidence of tar).

Transect	Distance from Shore (m)	Water Depth (m)	Sediment Description	Evidence of Contamination
150 m	9	0.9	Brown silty clay (about 5 cm deep) over clay mixed with gravel	NC
	18	2.4	Brown silty clay (about 5 cm deep) over sand and gravel; fresh smell	NC
	27	4.3	Brown silty clay (about 8 cm deep) over sand and gravel; fresh smell	NC
	37	4.9	Brown silty clay (about 18 cm deep) over gravel	NC
	46		Crosses gas line; no sample	
175 m	9	0.6	Brown silty clay (about 1 cm deep) over clay/gravel	NC
	18		Crosses gas line; no sample	
	27		Crosses gas line; no sample	
	37		Crosses gas line; no sample	
	46		Crosses gas line; no sample	
200 m	9	0.9	Black staining on gravel; PAH odour; fresh tar on bottom of dredge	VC
	18	1.5	Rocky bottom; no sample	
	27	4.0	Brown silty clay (about 6 cm deep); PAH stained concrete fragment; tarry residue below brown silty clay layer	VC
	37	4.0	Brown silty clay (about 5 cm deep) over gravel; very faint PAH odour	TC
	46	4.3	Brown silty clay (about 10 cm deep); trace PAH odour	TC
230 m	9		At waters edge; inaccessible; no sample	
	18		Rocky bottom; no sample	
	27	3.1	Brown silty clay over gravel; insufficient sample for conclusive assessment	
	28	3.4	Thin layer of brown silty clay (about 1 cm deep) over hard gravelly bottom; insufficient sample for conclusive assessment	
	36	4.3	Brown silty clay (about 10 cm deep) grading to dark grey silty clay; distinct PAH odour; tars evident in bottom of dredge	VC
	46	5.2	Brown silty clay (about 8 cm deep) over fine sand and gravel; slight PAH odour; no tar	TC

Table 1. Continued.

Transect	Distance from Shore (m)	Water Depth (m)	Sediment Description	Evidence of Contamination
250 m	9		At waters edge; inaccessible; no sample	
	17	1.5	Brown silty clay (about 18 cm deep) grading to dark grey silty clay; broken beer bottle in silty clay	NC
	25	3.1	Brown silty clay (about 3 cm deep) over gravel; broken glass; tar in gravel	VC
	37	4.0	Brown silty clay (about 15 cm deep) grading to dark grey silty clay; tar in silty clay	VC
	47	4.3	Brown silty clay (about 15 cm deep) grading to sandy clay; tar in sandy clay; about 5 cm visually contaminated clay under apparently clean brown silty clay	VC
	56	5.5	Brown silty clay (about 15 cm deep) over sand	NC
275 m	11	0.9	Brown silty clay (about 15 cm deep) grading to dark grey silty clay	NC
	14	0.9	Brown silty clay (about 23 cm deep) grading to dark grey silty clay	NC
	19	2.4	Hard bottom; no sample	
	20	2.7	Brown silty clay (about 3 cm deep) over gravel and rocks; concrete	NC
	21	2.7	Brown silty clay (about 5 cm deep) over gravel; coal evident	NC
	24	2.7	Hard bottom; no sample	
	27	3.1	Hard bottom; no sample	
	31	3.7	Hard bottom; no sample	
	41	6.1	Brown silty clay (about 13 cm deep) over sand (about 3 cm deep)	NC
	49	6.4	Brown silty clay (about 18 cm deep) over dark grey sand; fingernail clam	NC
300 m	9	0.4	Brown silty clay (about 25 cm deep) grading to dark grey silty clay; twigs, grass on surface	NC
	18	2.4	Brown silty clay (about 10 cm deep) over grey silty clay	NC
	27	3.4	Brown silty clay (about 5 cm deep) over hard bottom	NC
	32	3.7	Brown silty clay (about 13 cm deep) over 5 cm black silty sand and gravel	NC
	34	4.0	No sample	
	37	4.6	Brown silty clay (about 13 cm deep) over dark grey silty clay with some gravel	NC
	41	5.8	Brown silty clay (about 2 cm deep) over hard bottom; very little sample; fresh smell	NC
	46	6.1	Brown silty clay (about 13 cm deep) over sandy silt (about 5 cm deep); fresh smell	NC

Table 1. Continued.

Transect	Distance from Shore (m)	Water Depth (m)	Sediment Description	Evidence of Contamination
325 m	9	0.3	Brown silty sand (about 13 cm deep) over grey silty sand; some black reduced organic matter; fresh smell	NC
	18	2.7	Brown silty clay (about 1 cm deep) over grey silty clay (about 10 cm deep); fresh smell	NC
	25	3.1	Hard bottom; no sample	
	36	5.2	Brown silty clay (about 15 cm deep) over 8 cm grey silty clay; fresh smell	NC
	46	5.5	Brown silty clay (about 15 cm deep) over grey silty sand; some black reduced organic matter subsurface; fresh smell	NC
350 m	9		At waters edge; inaccessible; no sample	
	18	0.9	Brown silty clay (about 10 cm deep) grading to dark grey silty clay; 1 Tricops; fresh smell	NC
	27	3.7	Brown silty clay (about 8 cm deep); clam; fresh smell	NC
	37	4.6	Brown silty clay (about 5 cm deep); fresh smell	NC
	47	5.8	Rope broke; dredge lost; no sample	

4.0 Discussion

The 1996 contamination survey results indicate the zone of near-surface sediments with visible tars is about 35% smaller in area than found in 1995 (Figures 1 and 2). The visually detectable contamination begins at about the same location as in 1995, and the offshore extent is similar, but the downstream extent of the plume is approximately 40 m shorter than seen in 1995.

The decrease in area of contamination cannot be attributed to variation in survey methods or time of sampling. The same methods were employed in sample collection and contamination assessment, the same personnel conducted the assessments, and the surveys were conducted at about the same time of year; October 16-18 in 1996 and September 11 to October 10 in 1995). It must, therefore, be concluded that a reduction in the areal extent of contamination in the surficial sediments has occurred.

The change in size of the surficial sediment PAH contamination plume has several possible causes, including; reduced PAH loading to the river via groundwater seepage, due to lower PAH concentrations in the groundwater, decreased groundwater seepage rates, or a combination of these factors; increased river bed scour, resulting in increased suspension and downstream transport of contaminated sediments; or increased sedimentation, which may have covered the contaminated sediments with cleaner sediment transported from upstream sites. These factors may be operating individually or in some combination.

Although the area of surficial sediment contamination decreased between 1995 and 1996, the area remains somewhat larger than estimated in March 1994, extending 15 m farther downstream and up to 20 m farther offshore (Figure 2 and 3). While this difference in area may in part be due to differences in sampling methods, as discussed in the 1995 survey report (Agassiz North 1996), it is now apparent there is substantial year to year variation in the area of contamination which is not attributable to methodological differences. Given this additional information, it becomes possible that the apparent increase in the area of contamination between March 1994 and September-October 1995 may, in some part, represent a real change.

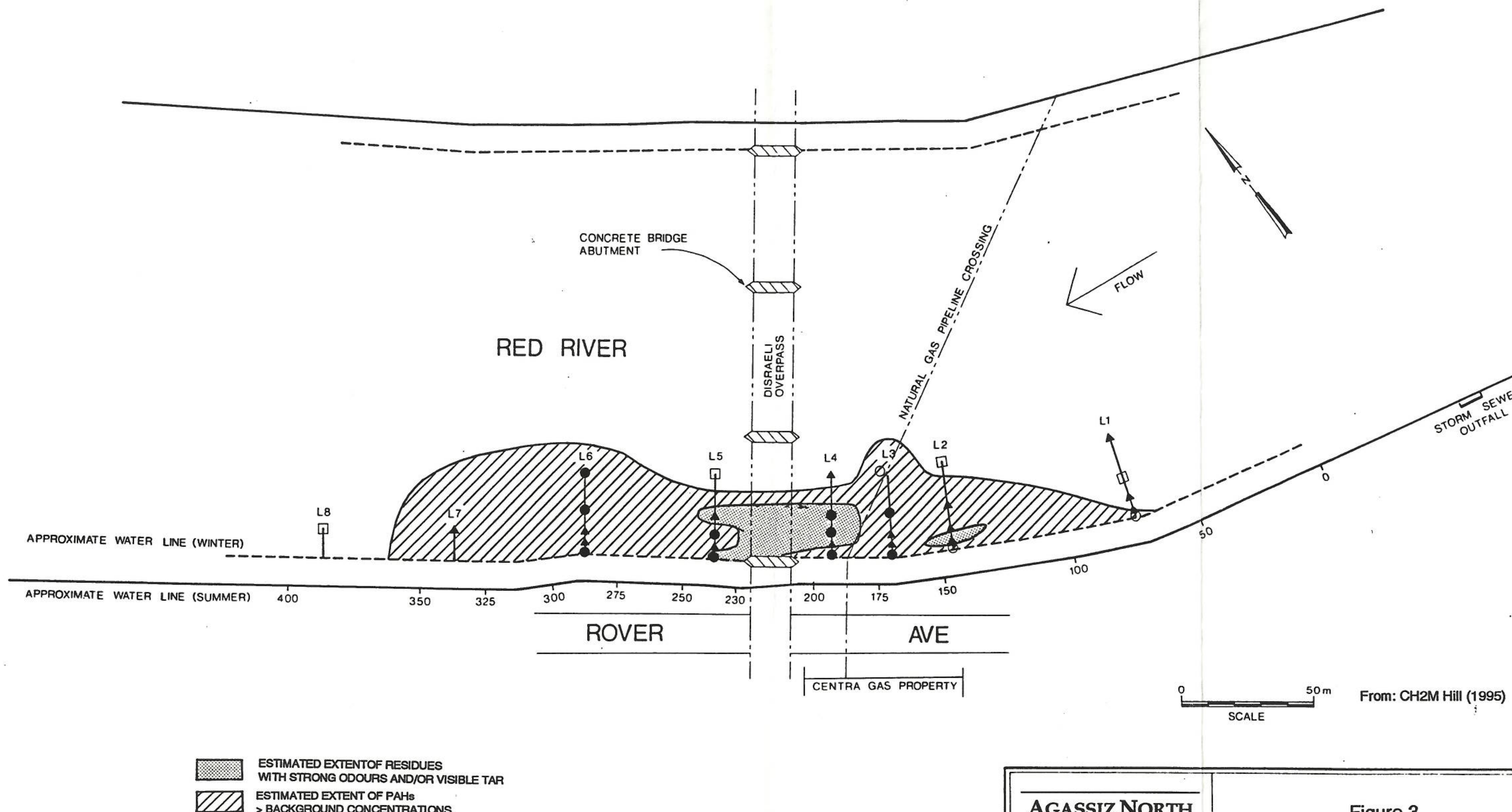

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Figure 3
Estimated Extent of Sediments Containing PAH Tar Residues
March 1994

5.0 Conclusions and Recommendations

The 1996 survey results indicate the area of PAH contaminated surficial sediments has decreased by about 35% since 1995, primarily due to a reduction in the downstream extent of the plume. The decrease in area has several possible causes, including year to year variations in PAH loading to the sediments, rates of river bed scour, and rates of clean sediment deposition. Given that the area of contamination does not appear to be increasing, it is recommended that monitoring work should remain limited to the plume surveys which are scheduled for the 1997 and 1998 open water seasons.

6.0 References

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