PHASE 2 REPORT - REVIEW COPY

FURTHER SITE CHARACTERIZATION AND ANALYSIS

VOLUME 2D - BASELINE MODELING REPORT

HUDSON RIVER PCBs REASSESSMENT RI/FS

MAY 1999

For

U.S. Environmental Protection Agency
Region 2
and
U.S. Army Corps of Engineers
Kansas City District

Volume 2D - Book 2 of 4
Fate and Transport Models

Limno-Tech, Inc.
Menzie-Cura & Associates, Inc.
Tetra Tech, Inc.

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Table 3-1
Comparison of Manning's 'n' from Previous Studies

Source	Main Channel 'n'	Floodplain 'n'
Zimmie, 1985	0.027	0.065
FEMA, 1982	0.028 - 0.035	0.075

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Table 3-2
Modeled Hudson River Flows at the Upstream Boundary of the TIP

Flow Description	River Discharge, (cfs)
Peak flow during spring and fall surveys, 1991	8,000
Peak flow for GE high flow survey, April 23-24, 1992	19,000
Peak flow for TAMS Phase 2 survey, April 12, 1993	20,300
Peak flow for spring 1994 (Bopp, 1994)	28,000
Peak flow in 1983	35,000
5-year high flow	30,126
25-year high flow	39,883
100-year high flow	47,330

Source: USGS Gaging Records, Butcher, 1993

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Table 3-3
Comparison of Model Results with Rating Curve Data

Flow (cfs)	Downstream Boundary Condition feet (NGVD)	Model Predicted Upstream Elevations feet (NGVD)	Rating Curve Gauge 119 (Upstream) Elevations feet (NGVD)
10,000	120.6	121.5	121.2
20,000	122.2	123.8	123.6
30,000	123.8	126.1	126.1

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Table 3-4
Effect of Manning's 'n' on Model Results for 100-Year Flow Event

	Main Channel Manning's 'n'	Floodplain Manning's 'n'	River Elevation at Roger's Island feet (NGVD)
Baseline	0.020	0.060	129.1
High 'n'	0.035	0.075	131.1
Low 'n' Main Channel	0.015	0.060	128.6
Low 'n' Floodplain	0.020	0.040	128.9
High 'n' Floodplain	0.020	0.080	129.3

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Table 3-5
Effect of Turbulent Exchange Coefficients on Model Results

	Turbulent Exchange Coefficients (lb-sec/ft^{2})	River Elevation Roger's Island feet (NGVD)
Baseline	100	129.1
Low Turbulent Exchange Coefficients	50	128.8
High Turbulent Exchange Coefficients	200	129.7

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Table 4-1
Summary of Inputs for Depth of Scour Model at Each High Resolution Core

Core Name	100 Year Flood Shear Stress (dynes/cm^2)	Surficial Dry Bulk Density (g/cm^2)
HR-19	12.7	0.369
HR-20	29.8	0.207
HR-23	19.1	0.619
HR-25	53.1	0.590
HR-26	31.7	0.276

Source: Hudson River Database Release 4.1
Thompson Island Pool Hydrodynamic Model results

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Table 4-2
Predicted Depth of Scour Range for 100 Year Flood at Each High Resolution Core Location

Core Name	Depth of Scour (cm)			
	Median	5th Percentile	95th Percentile	Depth of PCB Peak (cm)
HR-19	0.074	0.016	0.356	20-24
HR-20	1.820	0.311	7.695	24-28
HR-23	0.158	0.030	0.819	28-32
HR-25	3.714	0.500	21.789	2.5
HR-26	1.643	0.275	8.262	12-24

Source: Hudson River Database Release 4.1

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Table 4-3
TIP Cohesive Sediment Expected Values of Solids Erosion and Mean Depth of Scour for 100-Year Flood, from Monte Carlo Analysis

Erosion Type	Expected Value
Depth (cm)	0.317
Solids (kg)	1,740,000

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Table 5-1a
HUDTOX Water Column Segment Geometry in Thompson Island Pool (2-dimensional segmentation)

	HUDTOX Segment Number	Location Description	Downstream River Mile	Length (m)	Depth (m)	Surface Area (m^2)	Volume (m^3)	Cross-sectional Area (m^2)	Adjacent Segments		
									Below		Downstream
2-dimensional segmentation	1	West R. Island	194.11	721	1.66	111,167	184,239	256	48		3
	2	East R. Island	194.11	721	1.33	124,233	164,924	229	49		4
	3	West R. Island	193.59	845	1.66	179,319	301,100	357	50		5,6
	4	East R. Island	193.59	845	2.19	100,373	219,502	260	51		7
	5	west	193.00	942	1.55	93,705	145,320	154	53	52	8
	6	center	193.00	942	4.77	69,641	331,926	353	54	-	9
	7	east	193.00	942	1.60	51,501	82,167	87	55	-	10
	8	west	192.25	1,219	1.25	135,968	170,143	140	57	56	11
	9	center	192.25	1,219	3.68	118,933	437,877	359	58	-	12
	10	east	192.25	1,219	1.47	72,249	106,095	87	60	59	13
	11	west	191.69	896	1.63	116,614	190,137	212	62	61	14
	12	center	191.69	896	3.60	104,141	374,750	418	63	-	15
	13	east	191.69	896	0.72	88,892	65,047	73	65	64	16
	14	west	190.99	1,125	1.67	108,820	181,319	161	67	66	17
	15	center	190.99	1,125	4.82	98,464	481,381	428	69	68	18
	16	east	190.99	1,125	1.62	89,519	145,283	129	71	70	19
	17	west	190.33	1,054	1.71	77,285	132,461	126	73	72	20
	18	center	190.33	1,054	4.34	101,114	439,168	417	74	-	21
	19	east	190.33	1,054	2.00	66,975	133,699	127	76	75	22
	20	west	189.81	848	1.71	66,786	113,979	134	77	-	23
	21	center	189.81	848	4.29	78,114	335,126	395	79	78	24
	22	east	189.81	848	2.04	88,884	181,045	214	-	80	25
	23	west	189.22	941	2.07	76,079	157,460	167	82	81	26
	24	center	189.22	941	5.62	63,745	358,258	381	83	-	27
	25	east	189.22	941	2.01	60,339	121,202	129	85	84	28
	26	west TI Dam	188.50	1,160	1.92	106,532	200,215	173	86	-	29
	27	center TI Dam	188.50	1,160	3.58	146,361	517,870	446	87	-	29
	28	east TI Dam	188.50	1,160	1.48	157,473	232,375	200	89	88	29

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Table 5-1b
HUDTOX Water Column Segment Geometry Below Thompson Island Pool (1-dimensional segmentation)

	HUDTOX Segment Number	Location Description	Downstream River Mile	Length (m)	Depth (m)	Surface Area (m^2)	Volume (m^3)	Cross-sectional Area (m^2)	Adjacent Segments Below		Adjacent Segments Downstream
1-dimensional segmentation	29	Lock 6	186.20	3,757	1.95	837,947	1,634,430	435	91	90	30
	30		184.85	2,178	3.49	557,155	1,946,807	894	93	92	31
	31	Lock 5	183.41	2,317	3.86	474,625	1,832,981	791	95	94	32
	32		182.30	1,767	3.92	468,521	1,835,130	1,039	96		33
	33		181.40	1,446	3.12	229,378	715,684	495	97		34
	34		179.73	2,699	2.84	572,753	1,628,112	603	99	98	35
	35		178.08	2,647	3.76	501,225	1,882,175	711	101	100	36
	36		175.08	4,833	4.20	948,752	3,985,892	825	103	102	37
	37		170.98	6,597	4.24	1,377,869	5,844,528	886	105	104	38
	38		169.79	1,918	3.69	558,975	2,064,033	1,076	107	106	39
	39	Stillwater Dam	168.19	2,566	2.99	408,394	1,222,268	476	109	108	40
	40		166.67	2,454	1.93	952,848	1,835,070	748	111	110	41
	41	Lock 3 Dam	165.99	1,087	4.18	417,298	1,743,711	1,605	113	112	42
	42		164.31	2,715	3.18	623,849	1,982,413	730	115	114	43
	43	Lock 2 Dam	163.49	1,309	2.47	563,621	1,390,352	1,062	117	116	44
	44		160.87	4,214	2.89	1,090,832	3,148,431	747	119	118	45
	45	Lock 1 Dam	159.39	2,384	4.15	682,251	2,831,358	1,188	121	120	46
	46		156.41	4,795	4.56	1,280,753	5,841,577	1,218	122		47
	47	Federal Dam	153.89	4,056	5.77	1,282,972	7,405,588	1,826	123		0

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Table 5-2a
HUDTOX Sediment Segment Geometry in Thompson Island Pool for Surficial Sediment Segments (2-dimensional segmentation)

Layer thickness = 2 cm

	HUDTOX Segment Number	Sediment Type	Surface Area (m^2)	Volume (m^3)	HUDTOX Sediment Layer	Adjacent Segments	
						Above	Below
2-dimensional segmentation	48	N	86,468	1,729	1	1	124
	49	N	64,616	1,292	1	2	125
	50	N	104,029	2,081	1	3	126
	51	N	66,458	1,329	1	4	127
	52	C	9,251	185	1	5	128
	53	N	25,142	503	1	5	129
	54	N	69,532	1,391	1	6	130
	55	N	34,250	685	1	7	131
	56	C	67,706	1,354	1	8	132
	57	N	22,071	441	1	8	133
	58	N	102,034	2,041	1	9	134
	59	C	5,886	118	1	10	135
	60	N	32,421	648	1	10	136
	61	C	16,475	329	1	11	137
	62	N	33,064	661	1	11	138
	63	N	103,509	2,070	1	12	139
	64	C	28,928	579	1	13	140
	65	N	19,719	394	1	13	141
	66	C	34,407	688	1	14	142
	67	N	23,202	464	1	14	143
	68	C	17,791	356	1	15	144
	69	N	71,668	1,433	1	15	145
	70	C	36,064	721	1	16	146
	71	N	24,256	485	1	16	147
	72	C	22,973	459	1	17	148
	73	N	22,891	458	1	17	149
	74	N	84,520	1,690	1	18	150
	75	C	8,939	179	1	19	151
	76	N	13,685	274	1	19	152
	77	N	31,066	621	1	20	153
	78	C	12,148	243	1	21	154
	79	N	53,177	1,064	1	21	155
	80	C	58,927	1,179	1	22	156
	81	C	22,523	450	1	23	157
	82	N	23,873	477	1	23	158
	83	N	50,643	1,013	1	24	159
	84	C	19,342	387	1	25	160
	85	N	4,315	86	1	25	161
	86	N	64,343	1,287	1	26	162
	87	N	138,185	2,764	1	27	163
	88	C	63,742	1,275	1	28	164
	89	N	31,981	640	1	28	165

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Table 5-2b
HUDTOX Sediment Segment Geometry Downstream of Thompson Island Pool for Surficial Sediment Segments (1-dimensional segmentation)

Layer thickness = 2 cm

	HUDTOX Segment Number	Sediment Type	Surface Area (m^2)	Volume (m^3)	HUDTOX Sediment Layer	Adjacent Segments	
						Above	Below
1-dimensional segmentation	90	C	79,269	1,585	1	29	166
	91	N	449,376	8,988	1	29	167
	92	C	189,009	3,780	1	30	168
	93	N	160,637	3,213	1	30	169
	94	C	268,967	5,379	1	31	170
	95	N	145,117	2,902	1	31	171
	96	N	468,567	9,371	1	32	172
	97	N	229,401	4,588	1	33	173
	98	C	68,901	1,378	1	34	174
	99	N	503,907	10,078	1	34	175
	100	C	97,432	1,949	1	35	176
	101	N	403,842	8,077	1	35	177
	102	C	89,073	1,781	1	36	178
	103	N	859,771	17,195	1	36	179
	104	C	346,399	6,928	1	37	180
	105	N	1,031,605	20,632	1	37	181
	106	C	295,637	5,913	1	38	182
	107	N	263,392	5,268	1	38	183
	108	C	34,953	699	1	39	184
	109	N	373,481	7,470	1	39	185
	110	C	213,454	4,269	1	40	186
	111	N	739,487	14,790	1	40	187
	112	C	171,255	3,425	1	41	188
	113	N	246,085	4,922	1	41	189
	114	C	18,739	375	1	42	190
	115	N	605,171	12,103	1	42	191
	116	C	51,928	1,039	1	43	192
	117	N	511,748	10,235	1	43	193
	118	C	3,092	62	1	44	194
	119	N	1,087,846	21,757	1	44	195
	120	C	64,524	1,290	1	45	196
	121	N	617,793	12,356	1	45	197
	122	N	1,280,878	25,618	1	46	198
	123	N	1,283,097	25,662	1	47	199

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Table 6-1
Sediment Data Sets Used in Development and Application of the HUDTOX Model

Year	Agency	Program Description	Purpose of Study	Parameters*	Use in HUDTOX
1977	NYSDEC	Sediment core and grab sampling	Assess extent of PCB pollution in the UHR	Aroclor PCBs, visual texture	Specification of sediment Tri+ PCB initial conditions for the 1977-1997 calibration.
1984	NYSDEC	Sediment core and grab sampling	Confirm locations of PCB hotspots in TIP	Aroclor PCBs, visual texture, bulk density	Specification of sediment Tri+ PCB calibration targets.
1991	General Electric	Composite sediment sampling	Provide sufficient data to calculate mean PCB concentrations over 1 to 2 mile intervals of the UHR	PCB congeners, porewater PCB congeners, DOC, bulk density, texture, grain size	Specification of Total PCB, BZ#4, BZ#52, and Tri+ PCB initial conditions for the 1991-1997 calibration. Specification of sediment Tri+ PCB calibration targets. Specification of sediment DOC levels.
1994	USEPA	High resolution core sampling	Investigation of long-term trends in PCB transport, release and degradation via the sediment record	PCB congeners, porewater PCB congeners, DOC, bulk density, texture, grain size, radionuclides	Assesment of model-computed sediment burial rates in calibration.
1994	USEPA	Low resolution sediment core sampling	Investigation of PCB levels in selected hotspots of the UHR	PCB congeners, bulk density, texture, grain size, organic carbon	Specification of sediment Tri+ and Total PCB calibration parameters. Specification of sediment organic carbon levels.
1992	USEPA	Confirmatory sediment sampling	Calibration of the side scan sonar signal to sediment properties	Texture, grain size, bulk density, total carbon	Specification of mean cohesive and noncohesive bulk density values.
1992	USEPA	Sediment type mapping between Fort Edward and Northumberland Dam	Side scan sonar survey of bottom sediments	Areal distribution of fine and coarse sediment	Establishment of cohesive and noncohesive sediment segmentation
1997	General Electric	Sediment type mapping between Northumberland Dam and Federal Dam at 77 transects	Qualitative sediment type determinations based on visual inspection of grab samples or by probing	Qualitative sediment type determination at specific points	Establishment cohesive and noncohesive sediment segmentation.

*The list of parameters is not comprehensive and only presents those of interest to the development and calibration of HUDTOX.

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Table 6-2
Sediment Areas Used for Computing HUDTOX Sediment PCB Calibration Targets

Areal-Average Group No.	Upstream RM	Downstream RM	Total Cohesive Area	Total Non-cohesive Area	Reach	Area Description
1	194.5	192.5	82,841	607,025	Thompson Island Pool	Ft. Edward to bend above Snook Kill
2	192.5	191.5	133,664	275,421	Thompson Island Pool	Bend above Snook Kill to bend below Snook Kill
3	191.5	190.5	31,913	121,096	Thompson Island Pool	Bend below Snook Kill to Griffin Island
4	190.5	189.8	71,073	84,242	Thompson Island Pool	Griffin Island to below hotspot14
5	189.8	189.4	41,865	78,834	Thompson Island Pool	Hotspot14 to Moses Kill
6	189.4	188.5	63,740	234,511	Thompson Island Pool	Moses Kill to T.I. Dam
7	188.5	183.4	537,245	755,125		T.I. Dam to Northumberland Dam
8	183.4	168.2	932,393	4,133,925		Northumberland Dam to Stillwater Dam
9	168.2	159.4	458,471	3,872,660		Stillwater Dam to Lock 2
10	159.4	154.9	--	2,564,000		Lock 2 to Federal Dam

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Table 6-3

USGS Gauge Information for Gauges Used in Flow Estimation

USGS gaging station	USGS Station No.	Drainage Area (mi^2)	Period of Operation
Hudson River at Fort Edward, NY	01327750	2817	1/1/77 - 9/30/97
Hudson River at Stillwater, NY	01331095	3773	1/1/77 - 9/30/97[1]
Hudson River above Lock 1 near Waterford, NY	01335754	4611	3/1/77 - 9/30/97[1]
Glowegee Creek at West Milton, NY	01330000	26	10/1/90 - 9/30/97
Kayaderosseras Creek near West Milton, NY	01330500	90	1/1/77 - 9/30/96
Hoosic River near Eagle Bridge, NY	01334500	510	1/1/77 - 9/30/97
Mohawk River at Cohoes, NY	01357500	3450	1/1/77 - 9/30/97
Mohawk River Diversion at Crescent Dam, NY	01357499	N/A	1/1/77 - 9/30/97

Source: USGS

[1] Due to construction, many of the flows recorded after 6/30/92 were rated as "poor" by the USGS. "Poor" means that "about 95 percent of the daily discharges have less than "fair" accuracy. "Fair" means that about 95 percent of the daily discharges are within 15 percent.

Table 6-4
Drainage Areas and Reference Tributaries Used in the LTI Tributary Flow Estimation

Tributary	Reach into which Tributary Enters	Drainage Area (mi^2)	Gaged Reference Tributary
Snook Kill	Fort Edward-Stillwater	75	DAR to Kayaderosseras Creek for the period 1/1/77 – 9/30/96 and DAR to Glowegee Creek for the period 9/30/96 – 9/30/97. (Kayaderosseras Creek flow data are unavailable after 6/30/96 so Glowegee Creek was used.)
Moses Kill		55	
Thompson Island Pool direct runoff		31	
Batten Kill		431	
Fish Creek		245	
Flatey Brook		8	DAR to Hoosic River at Eagle Bridge, NY
Schuylerville-Stillwater direct runoff		80	
Hoosic River	Stillwater – Waterford	720	
Anthony Kill		63	
Deep Kill		16	
Stillwater-Waterford direct runoff		39	
Mohawk River		3,450	USGS gage at Cohoes + Diversion at Crescent Dam

Source: LTI GIS

[1]The Mohawk River stations are near the Mohawk-Hudson confluence so no drainage area adjustment was required.

Table 6-5

Mean Seasonal USGS Flows for Selected Flow Gauges in the Study Area for the Period 3/1/77 to 6/30/92

Season	Fort Edward	Stillwater	Waterford	Glowegee Creek	Kay. Creek @ West Milton	Hoosic River @ Eagle Bridge
Winter	5274.1	6582.5	8283.7	36.1	133.6	1042.9
Spring	7773.6	10052.9	12866.1	56.0	254.3	1770.4
Summer	3267.2	4000.1	4579.9	16.5	80.2	545.1
Fall	4489.8	5582.4	6579.0	31.5	106.1	743.5

Source: Hudson River Database Release 4.1

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Table 6-6

Seasonal Tributary Flow Adjustment Factors applied to Tributaries between Fort Edward and Stillwater, and between Stillwater and Waterford

	Fort Edward - Stillwater		Stillwater - Waterford	
Season	$\Delta\ \bar{Q}_{FE\text{-}Still}$ (cfs)	α_{FS}	$\Delta\ \bar{Q}_{Still\text{-}Watfd}$ (cfs)	α_{SW}
Winter	1175	0.88	658	0.98
Spring	2025	0.81	1043	0.92
Summer	653	0.83	35	0.10
Fall	986	0.94	253	0.53

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Table 6-7
Summary of Available Solids Data for Mainstem Stations; Number of Samples and Source of SS Sample Data by Station

Year	Ft. Edward			TID		Stillwater			Waterford		
	USGS	Phase 2	GE	Phase 2	GE	USGS	Phase 2	GE	USGS	Phase 2	GE
1977	1					33			47		
1978	30					30			31		
1979	52					34			32		
1980	55					27			37		
1981	55					29			24		
1982	49					43			32		
1983	40					126			134		
1984	34					209			247		
1985	17					82			129		
1986	27					306			295		
1987	15					49			85		
1988	38					68			101		
1989	23					157			334		
1990	3					275			242		
1991	19		65			373		60	251		120
1992	21		67			390		28	390		34
1993	27	58	56	78		387			410	288	1
1994	30	47	31	40		386			405	89	
1995	68		68			303			299		
1996	2719		71		4	30			66		
1997			155		19	19			25		

Source: Hudson River Database Release 4.1

Table 6-8
Summary of Available Solids Data for Tributaries; Number of Samples and Source of SS Sample Data by Station

Year	Batten Kill			Hoosic River			Mohawk River		Moses Kill		Snook Kill	
	USGS	Phase 2	GE	USGS	Phase 2	GE	USGS	Phase 2	Phase 2	GE	Phase 2	GE
1988	6			2								
1989				4			2					
1990				1			10					
1991			25	4		24	5					
1992			28			28	2					
1993		5	1	9	6	1	9	6				
1994		32		12	32		18	31	32		31	
1995				3			25					
1996							10					
1997										115		117

Source: Hudson River Database Release 4.1

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Table 6-9
Reference Tributaries for Unmonitored Tributaries

Reference Tributary	Unmonitored Tributaries
Moses Kill	TIP Direct Drainage Area, Flately Brook, TID-Schuylerville Direct Drainage Area, Schuylerville-Stillwater Direct Drainage Area
Batten Kill	Fish Creek
Hoosic River	Anthony Kill, Deep Kill, Stillwater- Waterford Direct Drainage Area

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Table 6-10
Cumulative Mainstem SS Loads and Yields

Station	Cumulative SS Load (MT) (1/1/77 - 9/30/97)	Cumulative SS Load (MT) (10/1/77 - 9/30/97)	Drainage Area (mi^2)	Yield (MT/mi^2*yr) (10/1/77 – 9/30/97)
Fort Edward	539,119	510,564	2,817	9.06
Stillwater	1,596,085	1,506,198	3,773	20.0
Waterford	3,519,798	3,159,690	4,611	34.3

Loads estimated from data in Hudson River Database Release 4.1

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Table 6-11
Cumulative SS Loads and Corresponding Yields by Reach (10/1/77 - 9/30/97)

Reach	Cumulative SS Load (MT)		Average Annual Yield by Reach (MT/mi^2*yr)	
	Load increment between mainstem stations	Sum of tributary SS loads	Yield increment between mainstem stations	Yield delivered by tributaries using rating curve
Fort Edward - Stillwater	995,634	601,061	52.1	31.4
Stillwater - Waterford	1,653,492	924,948	98.7	55.2

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Table 6-12
Tributary Drainage Areas Used in Tributary Load Adjustment

Tributary Drainage	Drainage Area (mi^2) used to estimate solids loads
Snook Kill	75
Moses Kill	55
TIP Direct Drainage Area[1]	8
Batten Kill	431
TID-Schuylerville Direct Drainage Area	31
Fish Creek[2]	90
Flately Brook	8
Schuylerville-Stillwater Direct Drainage Area	80
Hoosic River	720
Deep Kill	16
Anthony Kill	63
Stillwater - Waterford Direct Drainage Area	39
Mohawk River	3,450

Source: LTI GIS Analysis

[1] The TIP direct drainage area includes the Champlain Canal which is highly regulated. Tributaries draining into the Champlain Canal have a drainage area of 23 square miles. The TIP direct drainage area was therefore reduced by this amount (from 31 to 8 square miles), because the SS contribution from tributaries draining into the Champlain Canal is assumed to settle out before reaching the Hudson River.

[2]The Fish Creek drainage includes Saratoga Lake which has a surface area of 16.3 km^2, a mean depth of 7.7 meters, and a retention time of 0.4 years. As such, this large lake is expected to greatly reduce the solids load in Fish Creek. In the absence of monitoring data, it was assumed that 80% of the solids upstream of Saratoga Lake are trapped in the lake. All of the drainage downstream of the lake outlet was assumed to contribute solids to the Hudson River. In all, the drainage area used in the SS load estimation was reduced from 245 to 90 square miles.

Table 6-13
Inputs To SS Trapping Efficiency Calculations

	Cohesive	Non-cohesive
Assumed lower-bound, reach-wide, average burial velocity (m/yr)	0.003	0.000
Assumed upper-bound, reach-wide, average burial velocity (m/yr)	0.015	0.003
Assumed long-term average reach-wide burial velocity by sediment type (m/yr)	0.009	0.0015
Sediment solids specific weight (g/cc)	0.84	1.38
TIP bed area (m^2)	480,935	1,345,284
TID to Stillwater Dam bed area (m^2)	1,339,399	4,965,377
Stillwater Dam to Lock 1 Dam bed area (m^2)	522,991	6,032,086

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Table 6-14
SS Trapping Efficiency Estimates for Specific Reaches

Reach	Lower Bound Trapping Efficiency (%)	Upper Bound Trapping Efficiency (%)	Selected Trapping Efficiency Estimate (%)
TIP	9	28	15
TID-Stillwater	19	48	25
Stillwater-Federal Dam	8	15	10

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Table 6-15
Final Tributary SS Concentration Equations, Considering Deposition

Tributary Name	Low and High Flow Equations		Cutpoint flow (cfs)
Snook Kill	$= 6.9$ $= 0.007*Q^{1.56}$	when $Q \leq$ cutpoint when $Q >$ cutpoint	105
Moses Kill	$= 8.9$ $= 0.04*Q^{1.29}$	when $Q \leq$ cutpoint when $Q >$ cutpoint	77
TIP Direct Drainage	$= 8.9$ $= 0.04*Q^{1.29}$	when $Q \leq$ cutpoint when $Q >$ cutpoint	43
Batten Kill	$= 6.1$ $= 0.011*Q^{1.26}$	when $Q \leq$ cutpoint when $Q >$ cutpoint	602
TID to Schuylerville Direct Drainage	$= 8.9$ $= 0.04*Q^{1.64}$	when $Q \leq$ cutpoint when $Q >$ cutpoint	42
Fish Creek	$= 6.1$ $= 0.011*Q^{1.19}$	when $Q \leq$ cutpoint when $Q >$ cutpoint	357
Flately Brook	$= 8.9$ $= 0.04*Q^{1.9}$	when $Q \leq$ cutpoint when $Q >$ cutpoint	12
Schuylerville to Stillwater Direct Drainage Area	$= 8.9$ $= 0.04*Q^{1.26}$	when $Q \leq$ cutpoint when $Q >$ cutpoint	117
Hoosic River	$= 8.15$ $= 0.002*Q^{1.31}$	when $Q \leq$ cutpoint when $Q >$ cutpoint	1,328
Deep Kill	$= 8.15$ $= 0.002*Q^{2.26}$	when $Q \leq$ cutpoint when $Q >$ cutpoint	24
Anthony Kill	$= 8.15$ $= 0.002*Q^{1.81}$	when $Q \leq$ cutpoint when $Q >$ cutpoint	94
Stillwater to Waterford Direct Drainage	$= 8.15$ $= 0.002*Q^{1.95}$	when $Q \leq$ cutpoint when $Q >$ cutpoint	58
Mohawk River	$= 13.89$ $= 0.0002*Q^{1.28}$	when $Q \leq$ cutpoint when $Q >$ cutpoint	5,661

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Table 6-16
Estimated Average Annual Tributary SS Loads to HUDTOX (10/1/77 - 12/31/97)

Tributary	Average Annual SS Load (MT/yr)
Snook Kill	4,222
Moses Kill	2,619
TID Direct Drainage	198
Batten Kill	48,740
TID-Schuylerville Direct Drainage	3,506
Fish Creek	10,178
Flately Brook	905
Schuylerville-Stillwater Direct Drainage	9,047
Hoosic River	86,115
Deep Kill	1,914
Anthony Kill	7,535
Stillwater - Waterford Direct Drainage	4,665
Mohawk River	246,674

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Table 6-17
Seasonal Suspended Solids Load Difference by Reach Based on Preliminary Load Estimates for the period 10/1/77 to 12/31/96

	TID-Stillwater		Stillwater - Waterford	
Season	% of Load from Tributaries	% of Load Increment btwn. Mainstem Stations	% of Load from Tributaries.	% of Load Increment btwn. Mainstem Stations
Dec. - Feb.	23%	18%	23%	21%
Mar. - May	59%	63%	69%	70%
Jun. - Aug.	6%	6%	2%	4%
Sept. – Nov.	12%	13%	6%	5%

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Table 6-18

Number of Days on which PCB Data were Available for Batten Kill, Hoosic River, and Mohawk River

Year	Batten Kill				Hoosic River				Mohawk River			
	Tri+	Total	BZ#4	BZ#52	Tri+	Total	BZ#4	BZ#52	Tri+	Total	BZ#4	BZ#52
1991		25	8	8		24	10	10				
1992		28	6	6		28	14	14				
1993	5	7	1	1	6	6	5	5	6	6	5	5
Total	5	60	15	15	6	58	29	29	6	6	5	6

Source: Hudson River Database Release 4.1

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Table 6-19
Percent of PCB Transport Past Mainstem Upper Hudson River PCB Sampling Stations Under High and Low Flow (4/1/91 - 9/30/97)

Mainstem Station	Flow Range (cfs)	Tri+ PCB	Total PCB	BZ#4	BZ#52
Fort Edward	Q < 11,000	81%	86%	94%	88%
	Q ≥ 11,000	19%	14%	6%	12%
TID	Q < 11,000	78%	77%	90%	75%
	Q ≥ 11,000	22%	23%	10%	25%
Stillwater	Q < 13,000	64%			
	Q ≥ 13,000	36%			
Waterford	Q < 16,000	64%			
	Q ≥ 16,000	36%			

Source: Load estimates based on data in Hudson River Database Release 4.1

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Table 6-20
Percent of PCB Load at Fort Edward for Suspended Solids Concentration Above and Below 10 mg/L (4/1/91-9/30/97)

Fort Edward Water Column Solids Concentration (mg/l)	Tri+ PCB	Total PCB	BZ#4	BZ#52
SS < 10	83%	91%	94%	91%
SS ≥ 10	17%	9%	6%	9%

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Table 6-21
Comparison of Annual Tri+ PCB Loads estimates at Fort Edward, Schuylerville, Stillwater and Waterford presented in the DEIR (TAMS 1997) and this report

Year	Fort Edward		Schuylerville		Stillwater		Waterford	
	DEIR	LTI	DEIR	LTI	DEIR	LTI	DEIR	LTI
1977	1,414	858	2,519	2,496	2,926	3,076	2,439	2,581
1978	544	530	2,747	2,043	2,138	2,026	2,260	2,148
1979	1,272	1,290	4,635	4,047	3,008	4,030	2,963	3,524
1980	439	482	760	934	899	839	1,007	919
1981	354	324	962	1,383	922	1,114	1,299	1,140
1982	374	351	528	535	635	767	818	833
1983	657	530	997	1,138	1,612	1,677	1,191	1,307
1984	477	638	830	479	826	682	702	529
1985	294	209	324	194	299	202	432	187
1986	423	238	320	200	358	158	366	168
1987	197	270	213	226	235	207	300	295
1988	119	98	83	85	105	109	100	107
1989	445	179	195	199	200	198	151	168
1990	398	357		363	220	373	115	428
1991	185	349		457	208	281	212	274
1992	825	680		866	411	541	317	496
1993	310	223		322	420	559	229	334
1994	90	157		258		153		143
1995		138		188		121		131
1996		67		297		240		234
1997		32		179		98		171

Source: DEIR, Tams 1997, and load estimates based on Hudson River Database Release 4.1

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Table 7-1
HUDTOX Solids Model Calibration Parameter Values

Parameter	Definition	Units	Value	Comments
v_S	Gross solids settling velocity	D	flow-dependent	Constant at low and high flow, the settling rate is linearly interpolated in between these conditions. (see Figure 7-1 for rates in TI Pool)
v_{SL}	Gross solids settling velocity at low flow	m/day	1.0 (to RM 182.3); 0.8 (downstream)	Batten Kill enters the Upper Hudson at RM 182.3
q_{CTL}	Flow threshold for low-flow settling velocity	cms	148.0 - 423.3	The base Fort Edward flow threshold (148.0 cms) was adjusted according to cumulative drainage area in downstream reaches (see Table 7-2)
v_{SH}	Gross solids settling velocity at high flow	m/day	8.0 (to RM 182.3); 6.0 (downstream)	Model calibration
q_{CTH}	Flow threshold for high-flow settling velocity	cms	370.6 - 1,060	The base Fort Edward flow trigger (370.6 cms) was adjusted according to cumulative drainage area in downstream reaches (see Table 7-2).
v_{rL}	Background solids resuspension velocity	mm/year	0.2 (cohesive); 0.4 (non-cohesive)	Model calibration
v_{rH}	High flow solids resuspension velocity	m/day	flow and sediment type dependent	See Table 7-3 for coefficients used to control resuspension and sediment armoring during events in cohesive and non-cohesive sediments
ω_{ij}	Particle mixing rate between sediment layer i and j	m^2/day	1.0E-05 (layer1-2); 1.0E-06 (layer 2-3); 1.0E-07 (layer 3-4)	Same rate in both cohesive and non-cohesive sediments
D_L	Longitudinal dispersion	m^2/sec	18.8 - 37.2; 0.0 at dam interfaces	Estimates based on USGS dye survey results (USGS, 1969)
C_S	Sediment solids bulk density (dry)	g/cm^3	0.84 (cohesive) 1.38 (non-cohesive)	Estimated using Phase 2 and NYSDEC 1984 data
ρ	Solid density	g/cm^3	2.65	-

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Table 7-2
Transition Levels by Reach for Flow-dependent Settling in HUDTOX

Upper Hudson River Miles	Upper Hudson River Reach Description	HUDTOX Water Segment(s)	Low to High Flow Transition Levels for Settling						
			DA Increase [1]	Low Flow		High Flow		Low Flow	High Flow
				q_{CTL} (cms)	q_{CTL} (cfs)	q_{CTH} (cms)	q_{CTH} (cfs)	v_{SL} (m/d)	v_{SH} (m/d)
194.7 - 188.5	Fort Edward - TID	1 - 28	1	146.0	5,157	370.6	13,090	1.0	8.0
188.5 - 182.3	TID - Batten Kill	29 - 32	1.07	156.2	5,518	396.5	14,006	1.0	8.0
182.3	Batten Kill confluence	32	1.22	178.1	6,291	452.1	15,969	1.0	8.0
181.4 - 178.1	Fish Creek - Hoosic River	33 - 39	1.34	195.6	6,910	496.6	17,540	0.8	6.0
178.1 - 168.2	Hoosic River - Mohawk River	40 - 41	0.16	23.4	825	59.3	2,094	0.8	6.0
156.4 - 153.9	Mohawk River - Federal Dam	47	0.16	23.4	825	59.3	2,094	0.8	6.0

[1] UHR drainage area ratio at downstream of reach to UHR drainage area at Thompson Island Dam

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Table 7-3
HUDTOX Sediment Resuspension and Armoring Parameters

Segment	Cohesive Sediment[1]				Non-cohesive Sediment[2]					
	α_1	α_2	α_3	$\varepsilon = 0$ Flow (1,000 cfs)	β_1	β_2	β_3	β_4	β_5	β_6
Above Thompson Island Dam										
1	-17.88	0.03798047	2.946	8.08	1.15396	0.92966	0.004	1.0	6.0	0.03
2	-166.62	21.02054298	1.090	6.68	2.15954	0.71805	0.004	1.0	6.0	0.03
3	-2.08	0.17339826	2.024	3.41	1.32400	0.81022	0.004	1.0	6.0	0.03
4	-32.34	2.28040000	1.326	7.39	0.98969	0.76338	0.004	1.0	6.0	0.03
5	-5.33	0.00221500	3.294	10.63	0.46405	1.16126	0.004	1.0	6.0	0.03
6	-40.00	0.07454000	2.909	8.68	0.67817	1.08553	0.004	1.0	6.0	0.03
7	no cohesive sediment identified here				0.89857	1.02312	0.004	1.0	6.0	0.03
8	-1.30	0.00334178	2.716	8.99	0.58399	0.99892	0.004	1.0	6.0	0.03
9	-19.43	0.01881700	3.062	9.64	0.59242	1.07995	0.004	1.0	6.0	0.03
10	-32.03	0.03929738	2.950	9.70	0.64118	1.10696	0.004	1.0	6.0	0.03
11	-0.67	0.00323573	2.480	8.60	0.46651	0.98090	0.004	1.0	6.0	0.03
12	-16.16	0.07562286	2.419	9.18	0.53138	1.02711	0.004	1.0	6.0	0.03
13	-11.02	0.27144876	1.654	9.39	0.45752	1.03921	0.004	1.0	6.0	0.03
14	-2.18	0.00061881	3.440	10.74	0.24462	1.16511	0.004	1.0	6.0	0.03
15	-3.00	0.00471263	2.833	9.76	0.34730	1.13571	0.004	1.0	6.0	0.03
16	-7.05	0.02144044	2.501	10.14	0.25874	1.09311	0.004	1.0	6.0	0.03
17	-1.83	0.00663035	2.491	9.55	0.28690	1.09322	0.004	1.0	6.0	0.03
18	-10.29	0.03323969	2.451	10.38	0.44469	1.07877	0.004	1.0	6.0	0.03
19	-12.39	0.02901571	2.524	11.02	0.55993	1.02401	0.004	1.0	6.0	0.03
20	-1.95	0.01184945	2.267	9.50	0.18296	1.19690	0.004	1.0	6.0	0.03
21	-7.84	0.01900183	2.557	10.54	0.29332	1.15543	0.004	1.0	6.0	0.03
22	-15.71	1.40936058	1.160	7.99	0.43626	1.11088	0.004	1.0	6.0	0.03
23	-7.05	0.01277475	2.618	11.15	0.26723	1.16320	0.004	1.0	6.0	0.03
24	-13.89	0.09770687	2.175	9.77	0.43582	1.12535	0.004	1.0	6.0	0.03
25	-68.42	2.16242877	1.562	9.14	1.23705	0.79648	0.004	1.0	6.0	0.03
26	-0.55	0.00534900	2.352	7.19	0.65699	0.84558	0.004	1.0	6.0	0.03
27	-1.35	0.00025495	3.620	10.68	0.52736	1.01628	0.004	1.0	6.0	0.03
28	-3.14	0.00227800	3.001	11.12	0.95554	0.90227	0.004	1.0	6.0	0.03
Downstream of Thompson Island Pool										
29 - 47	-7.84	0.02144044	2.501	10.59	0.52937	1.05899	0.004	1.0	2.0	0.03

[1] Cohesive sediment:

$$\varepsilon = a + b * (Q / 1000)^c$$, units of mg/cm^2

[2] Non-cohesive sediment:

$$\tau_b = c * (Q / 1000)^d$$, units of dynes/cm^2

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Table 7-4
HUDTOX Fraction Organic Carbon and Dissolved Organic Carbon Parameterization by Reach

Upper Hudson River Miles	Upper Hudson River Reach Description	HUDTOX Water Segment(s)	f_{OC} [1]			DOC (mg/L) [2]		
			Water	Cohesive Sediment	Non-cohesive Sediment	Water	Cohesive Sediment	Non-cohesive Sediment
194.7 - 188.5	Fort Edward - TID	1 - 28	25%	2.2%	1.7%	4.86	50.0	38.6
188.5 - 182.3	TID - Batten Kill	29 - 32	18%	2.6%	2.4%	4.72	59.1	54.5
182.3 - 181.4	Batten Kill - Fish Creek	33	16%	1.8%	0.8%	4.72	40.9	18.2
181.4 - 178.1	Fish Creek - Flately Brook	34 - 35	16%	1.8%	0.8%	4.89	40.9	18.2
178.1 - 168.2	Flately Brook - Hoosic River	36 - 39	16%	1.8%	0.8%	4.89	40.9	18.2
168.2 - 166.0	Hoosic River - Anthony Kill	40 - 41	16%	2.8%	0.9%	4.30	63.6	20.5
166.0 - 163.5	Anthony Kill - Deep Kill	42 - 43	16%	2.8%	0.9%	4.30	63.6	20.5
163.5 - 156.4	Deep Kill - Waterford	44 - 46	16%	2.1%	1.0%	4.30	47.7	22.7
156.4 - 153.9	Waterford - Federal Dam	47	16%	2.1%	1.0%	4.05	47.7	22.7

[1] Fraction organic carbon on particulates were developed for:

a) Water, based on the Phase2 water column data (TAMS et al., 1997).

b) Sediment, using the Phase2 low-resolution core data and the 1991 GE composite sediment sampling data (O'Brien and Gere, 1993b).

[2] Dissolved organic carbon (DOC) concentrations were developed for:

a) Water, using data from Vaughn, 1996.

b) Sediment, based on the 1991 GE composite sediment sampling data (O'Brien and Gere, 1993b).

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Table 7-5
HUDTOX PCB Model Calibration Parameter Values

Parameter	Definition	Units	Calibration Value				Comments
			Total PCB	BZ#4	BZ#52	Tri+ PCB	
MW	Molecular Weight; chemical specific	g/mole	268.0[1]	223.1	292.0	279.0[1]	Estimated based on congener distribution
H_{25}	Henry's Law Constant; chemical specific, and temperature dependent	atm m^3/mole	2.26E-04[1]	0.00023 [2]	0.0002 [2]	2.26E-04[1]	Estimated based on congener distribution or literature values
log K_{poc}	Partition coefficient for sorbate on POC, based on three-phase equilibrium partitioning model; chemical specific	log (L/kg C)	5.6[1]	4.76	5.91	5.821[1]	Congener-specific Kpoc's are theoretical. DEIR
log K_{doc}	Partition coefficient for sorbate on DOC, based on three-phase equilibrium partitioning model; chemical specific	log (L/kg C)	4.6	3.76	4.91	4.216	Set at 10% of Kpoc
k_l	Air-water liquid film mass transfer rate	m/day	O'Connor - Dobbins formulation				(Chapra, 1997); (Thomann and Mueller, 1987)
k_g	Air-water gas exchange mass transfer rate	m/day	100.0				WASP5 User Guide (Ambrose et al, 1993)
υ	Surficial sediment-water mass transfer rate of particulate phase PCB	mm/yr	6.5 - 0.125 (See Figure 7-6b)				Model calibration
θ_l	Arrenhius temperature correction for air-water mass transfer rate	dimension-less	1.024				(Chapra, 1997); (Thomann and Mueller, 1987)
k_b	PCB dechlorination rate	day^{-1}	0	0	0	0	Dechlorination not simulated
tsf	Temperature slope factor constant affecting partitioning; chemical specific	°K	1195.7 (representative across all PCB forms)				DEIR (TAMS, 1997)
u_x	Particle concentration effect constant; chemical specific.	dimension-less	inactive (data analysis suggests minimal effect)				DEIR (TAMS, 1997)
V_{C01}	Cohesive sediment-water mass transfer coefficient for dissolved and DOC-bound PCB.	cm/day	1.5 - 6.5 (see Figure 7-6a for seasonal variation)				Model calibration
V_{C12}	Shallow (0-4 cm) cohesive sediment mass transfer for dissolved and DOC-bound PCB.	cm/day	0.15 - 0.65				Set to 1/10th of sediment-water mass transfer
V_{N01}	Non-cohesive sediment-water mass transfer coef. for dissolved and DOC-bound PCB	cm/day	0.5 - 2.167 (see Figure 7-6a for seasonal variation)				Set to 1/3rd of cohesive sediment mass transfer
V_{N12}	Shallow (0-4 cm) non-cohesive sediment mass transfer for dissolved and DOC-bound PCB	cm/day	0.05 - 0.2167				Set to 1/10th of sediment-water mass transfer
D_{deep}	Deep (>4 cm) sediment porewater diffusion coefficient for dissolved and DOC-bound PCB	m^2/sec	2.00E-10 (dissolved); 1.00E-10 (DOC-bound)				Set approximately to molecular diffusion rate
f_{oc}	Fraction organic carbon in particulate solids	dimension-less	0.25 - 0.16 in water 0.028 - 0.018 in cohesive sediment 0.024 - 0.008 in non-cohesive sediment (see Table 7-4 for spatial variation)				DEIR (TAMS, 1997); 1991 GE data (O'Brien and Gere, 1993b)

[1]Estimated based on apparent PCB congener distribution.
[2]Brunner et al. 1990

FIGURE 1-1
LOCATION MAP FOR
HUDSON RIVER WATERSHED

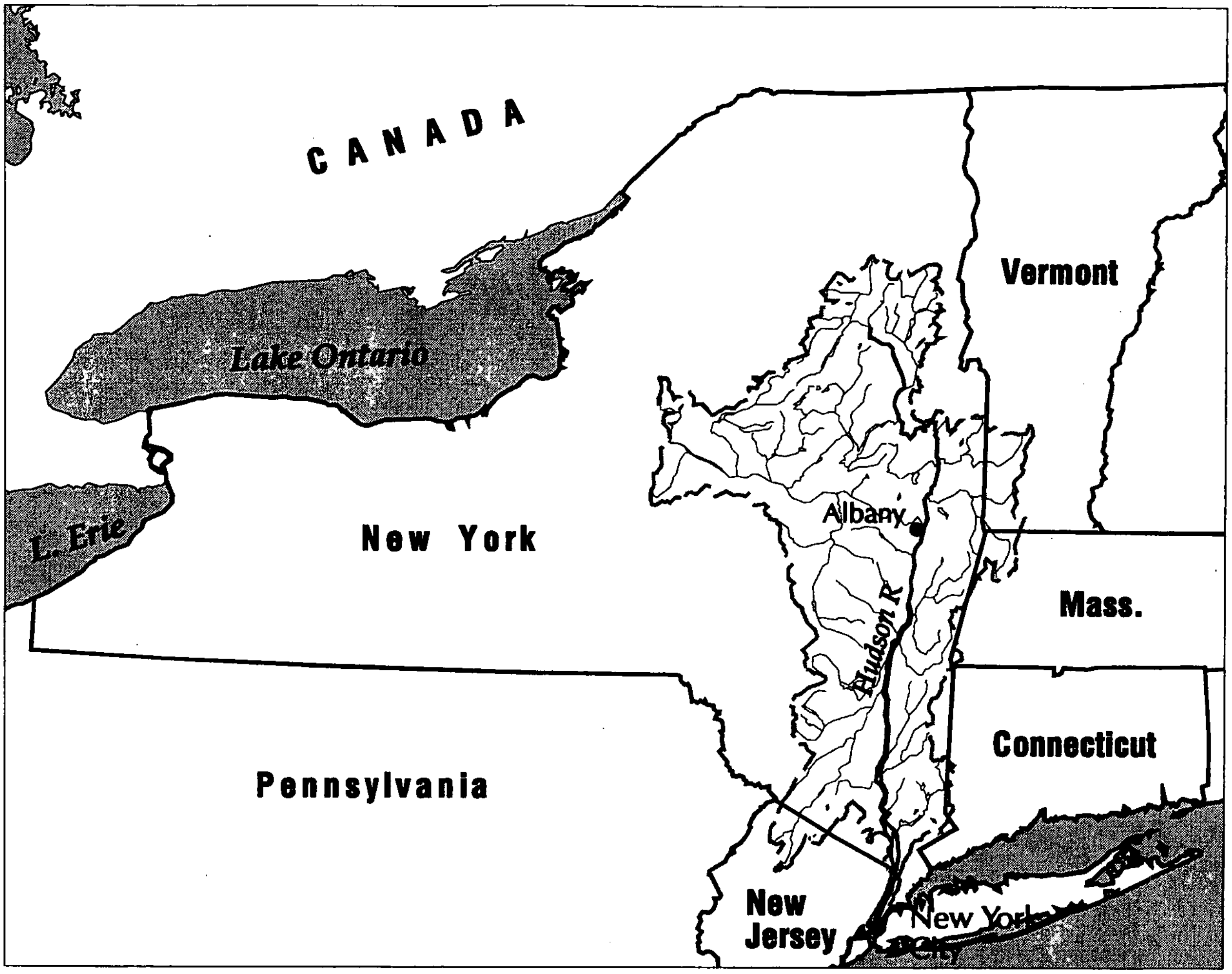


FIGURE 1-2
UPPER HUDSON
RIVER WATERSHED

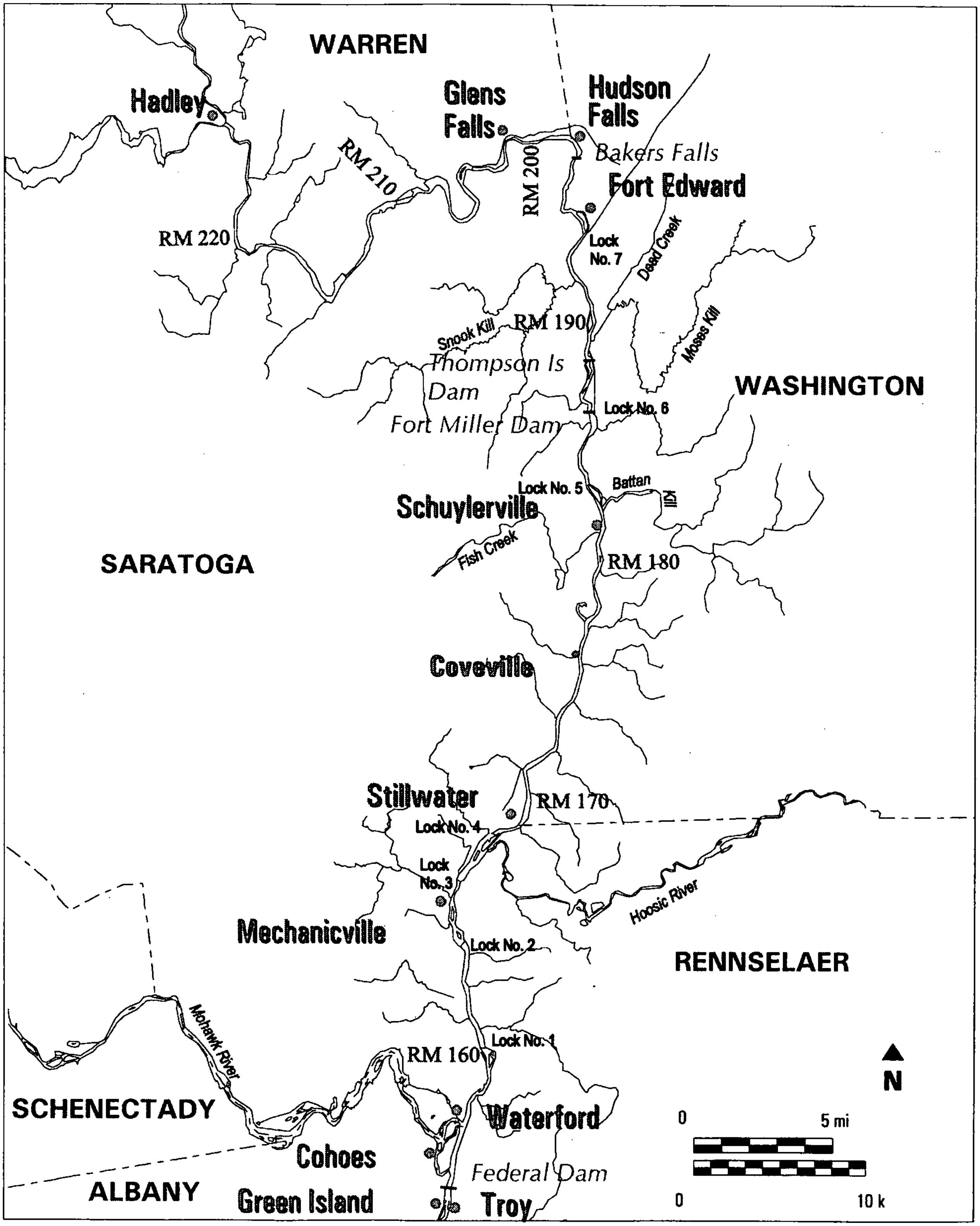


FIGURE 1-3
THOMPSON ISLAND POOL

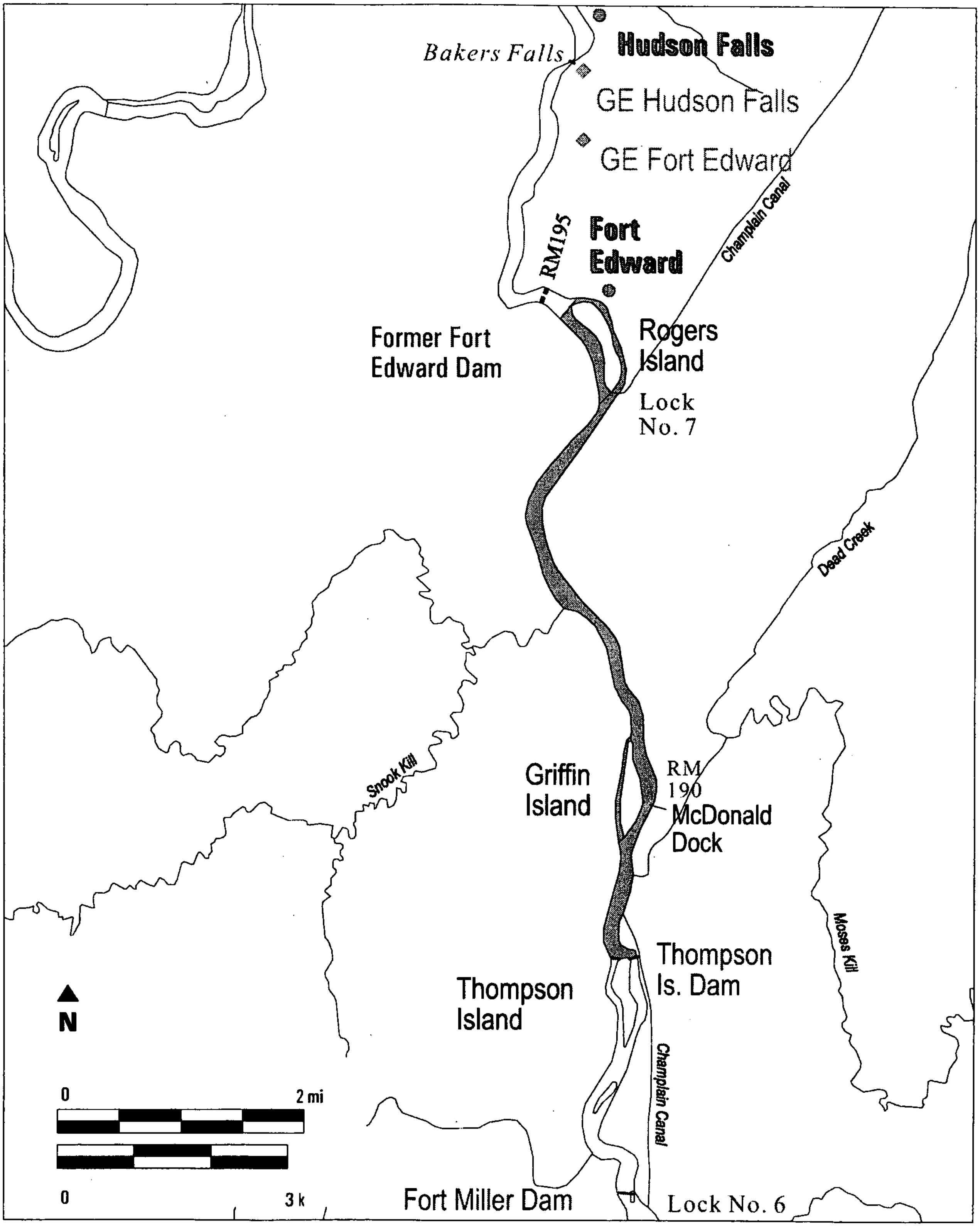
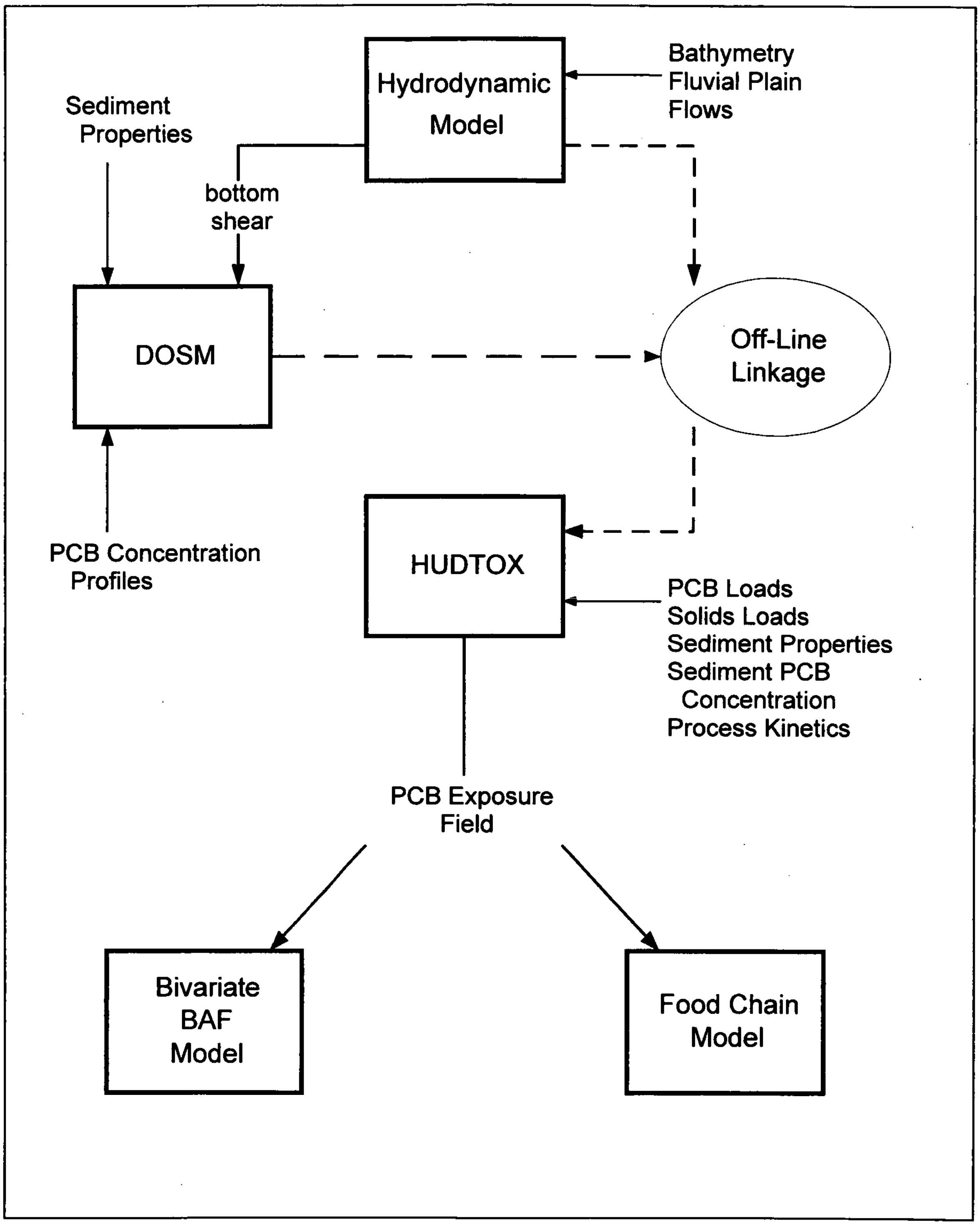


Figure 2-1
Upper Hudson River Reassessment Modeling Framework



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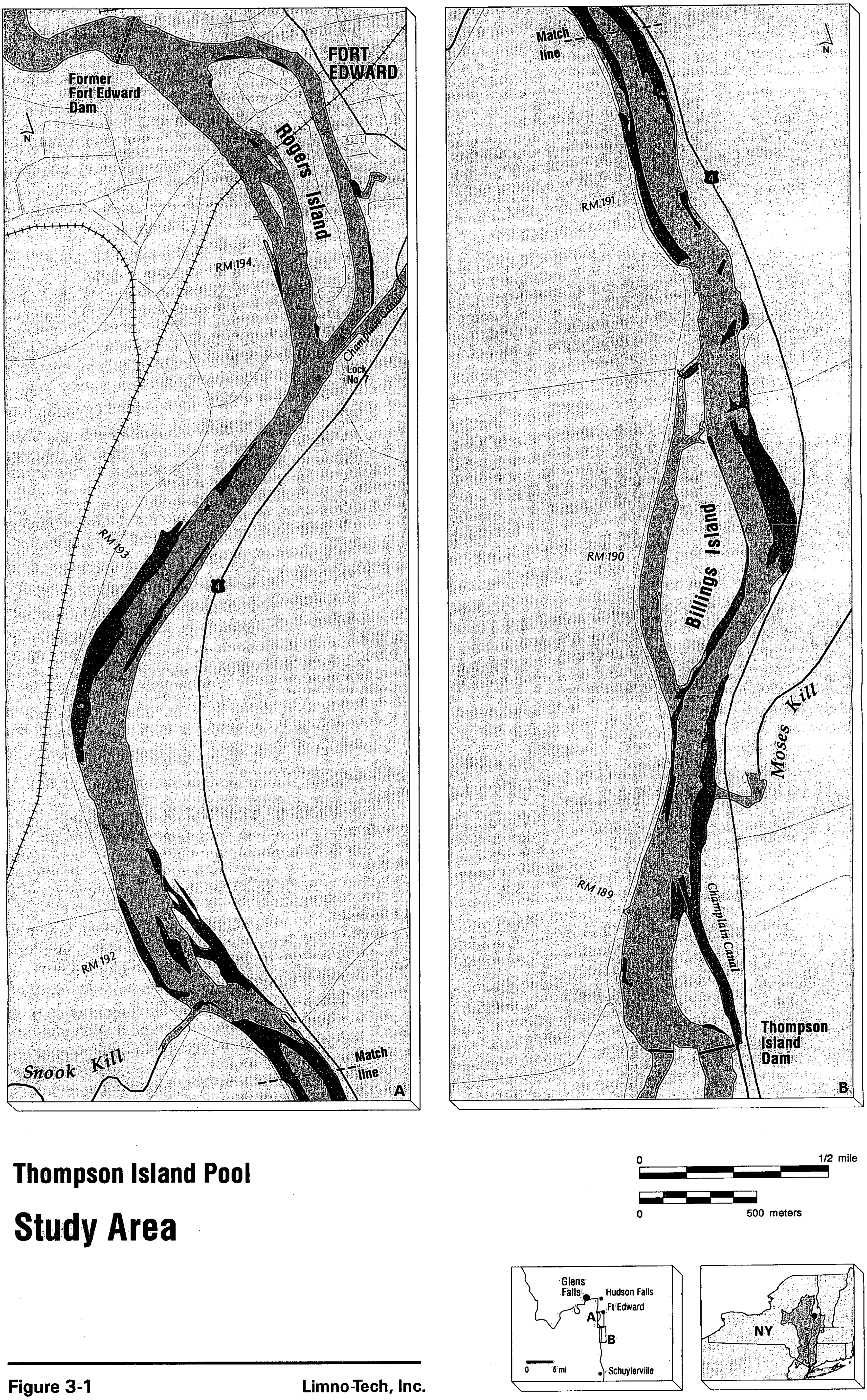
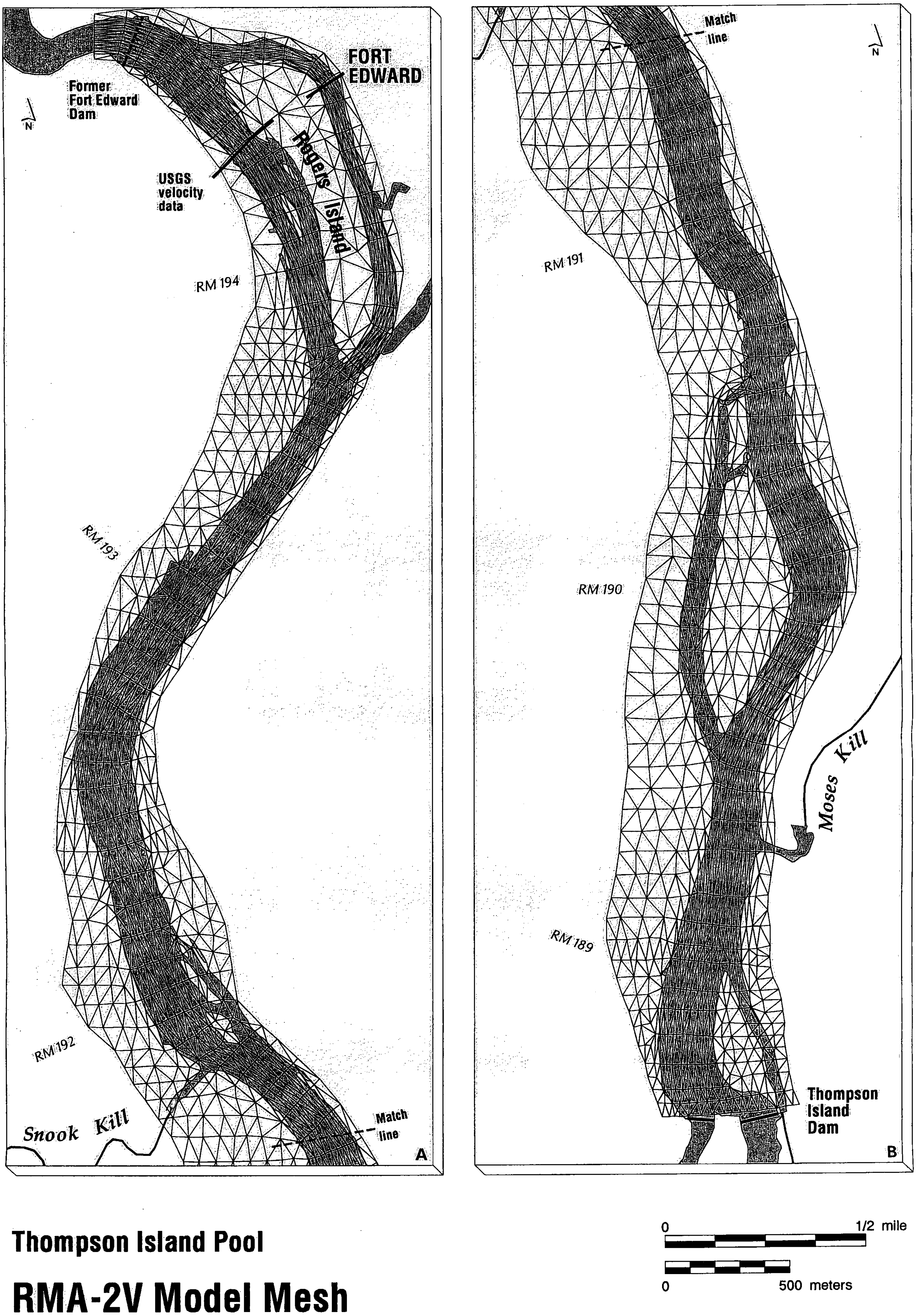


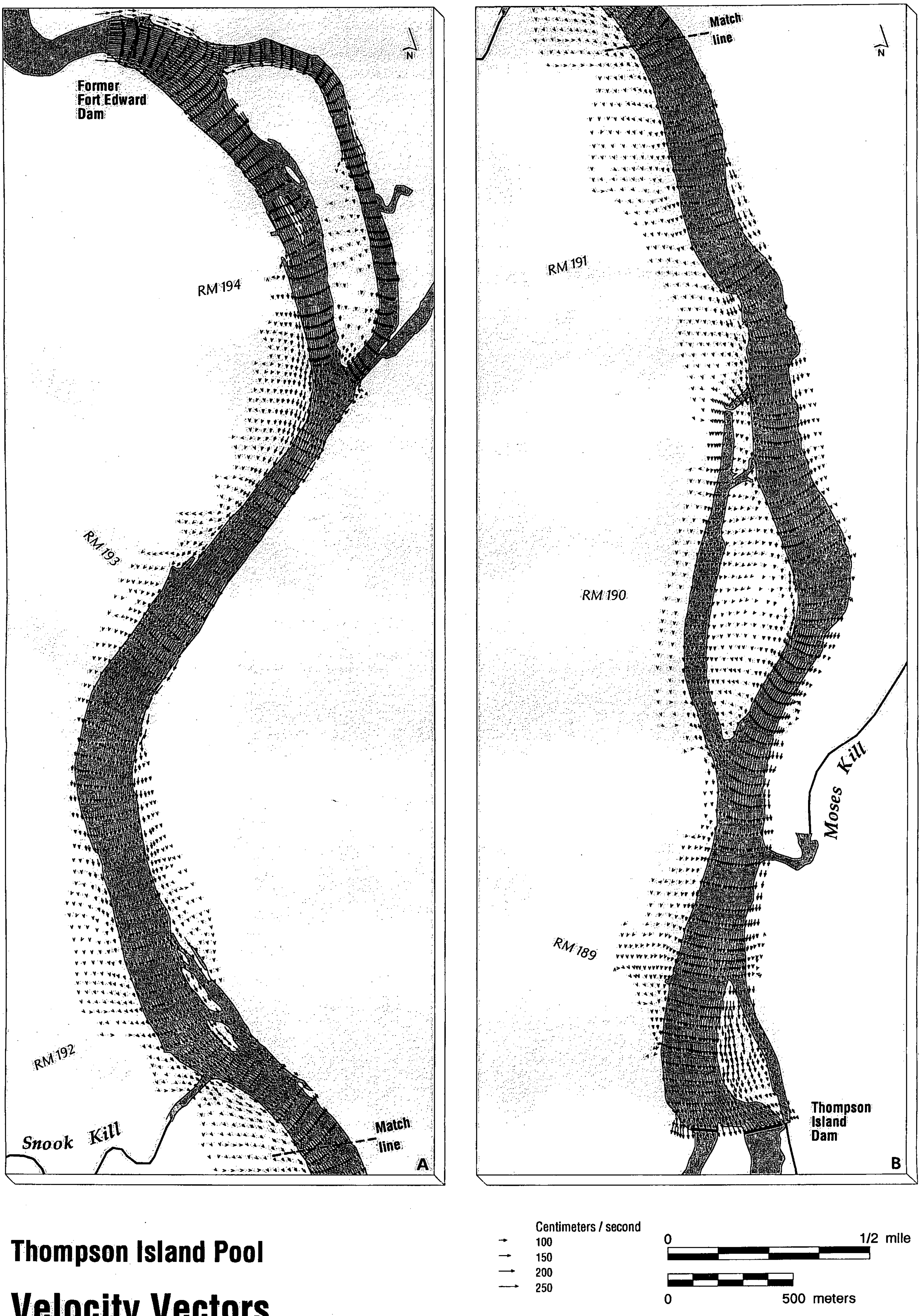
Thompson Island Pool

Study Area



Thompson Island Pool

RMA-2V Model Mesh



Thompson Island Pool

Velocity Vectors
100-year Flow Event

Figure 3-4
Shear Stress Computed from Vertically Averaged Velocity

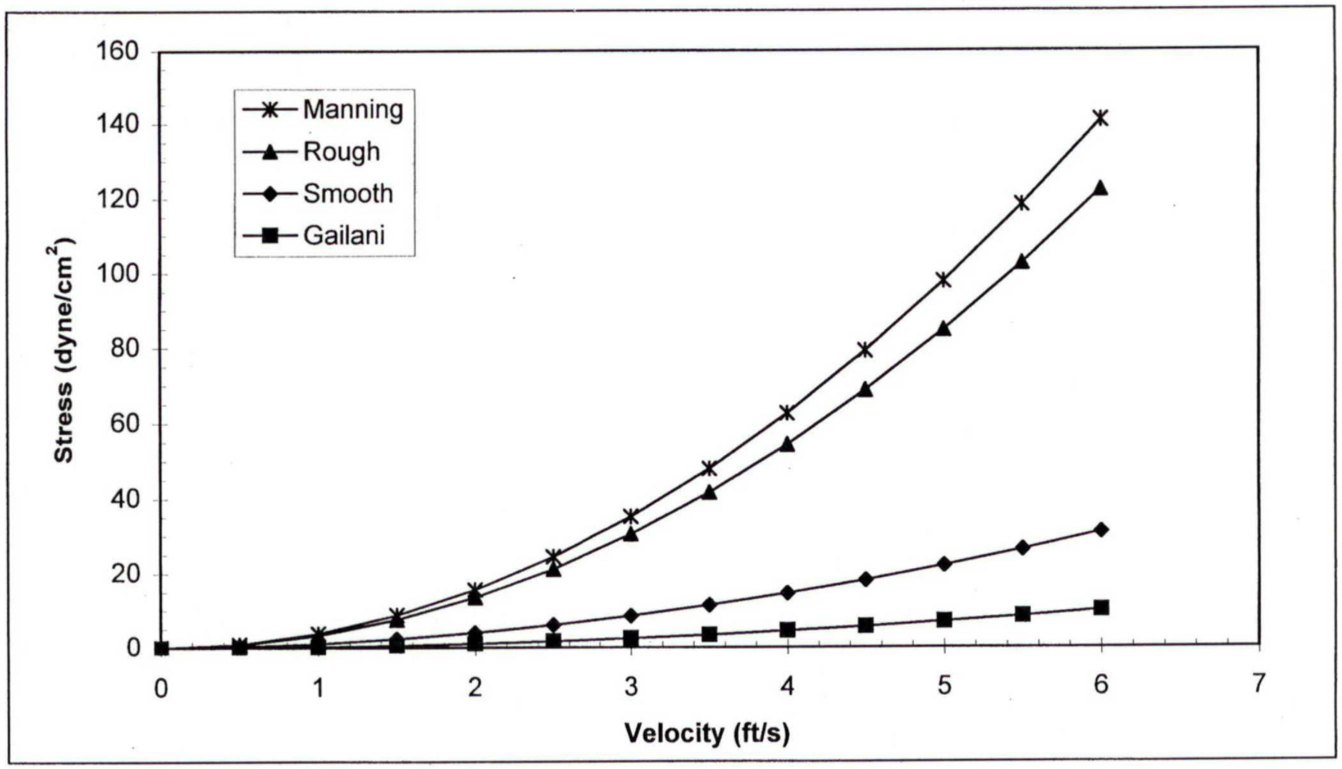


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Figure 4-1
Erosion versus Shear Stress

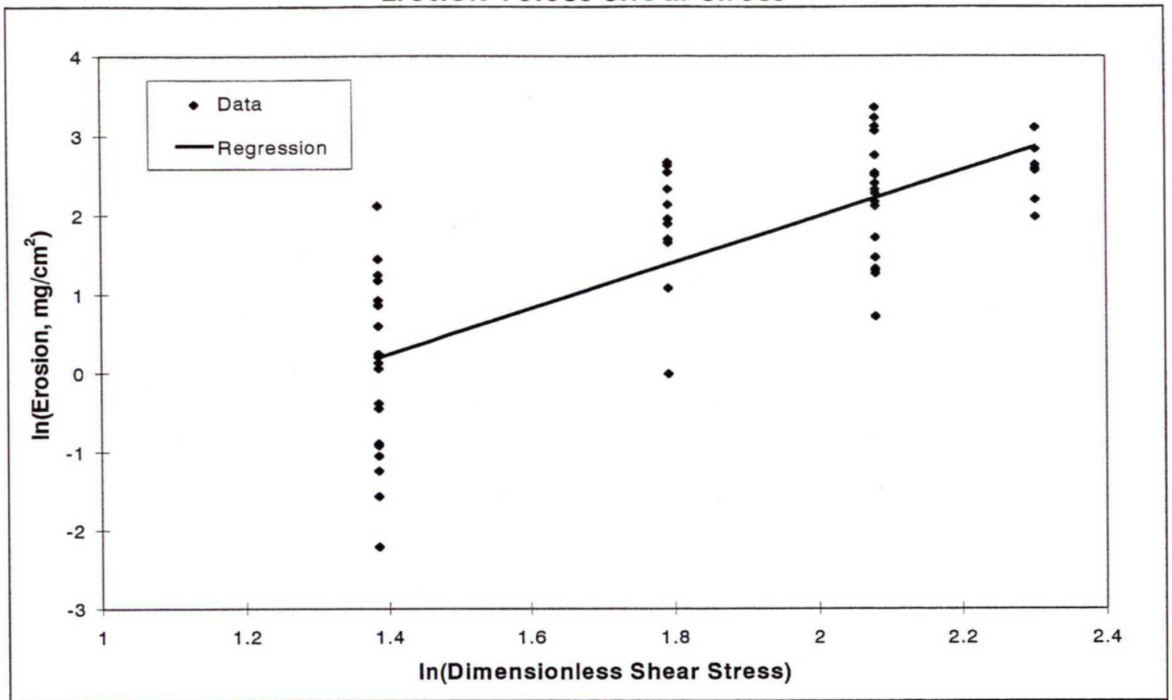

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Figure 4-2
Armoring Depth versus Shear Stress

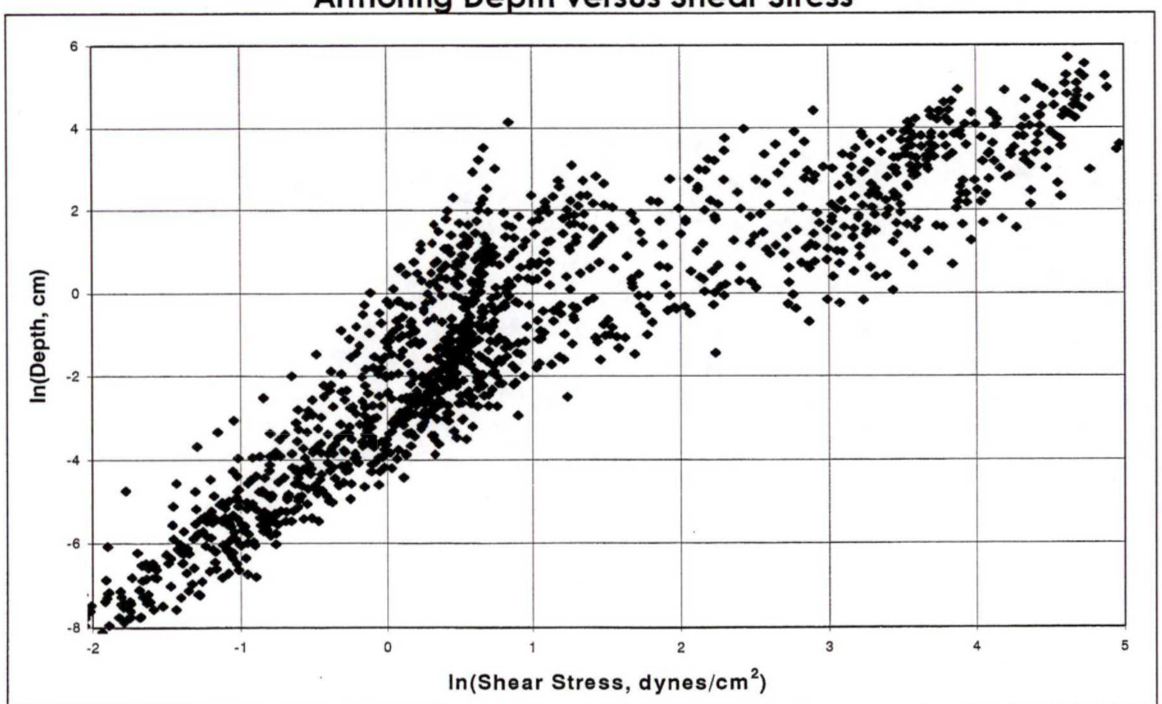

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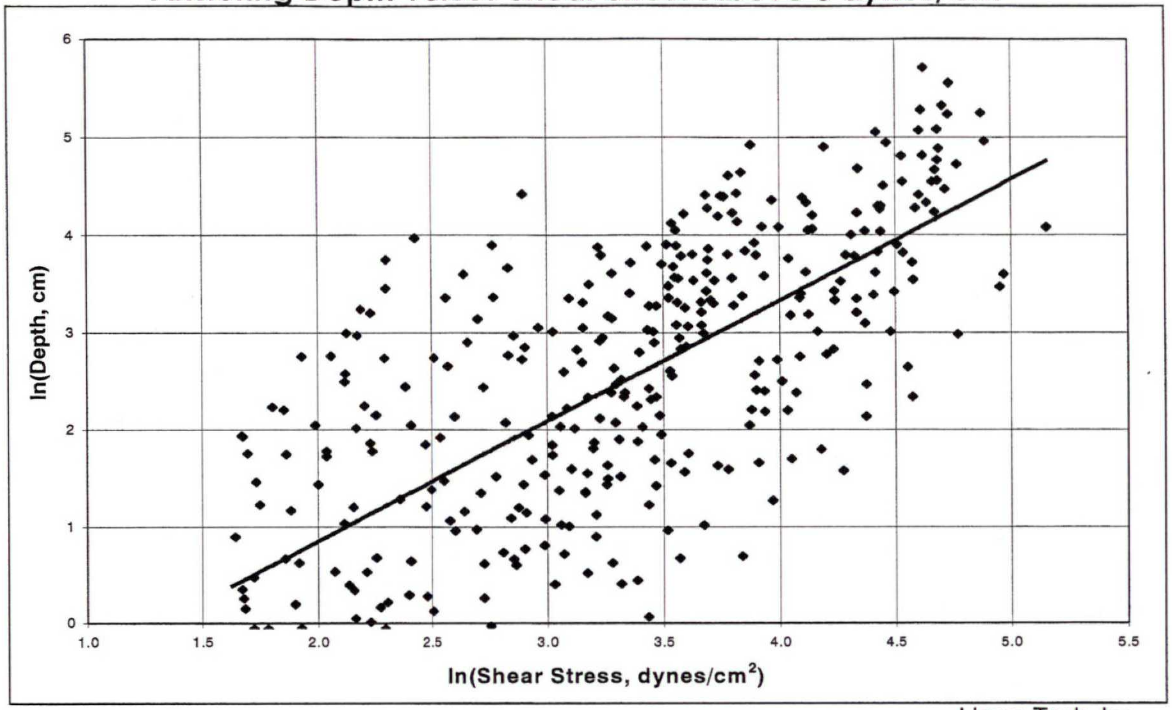
Figure 4-3
Armoring Depth versus Shear Stress Above 5 dynes/cm²



Limno-Tech, Inc.

Figure 4-4
Core HR-19: Likelihood of PCB Scour

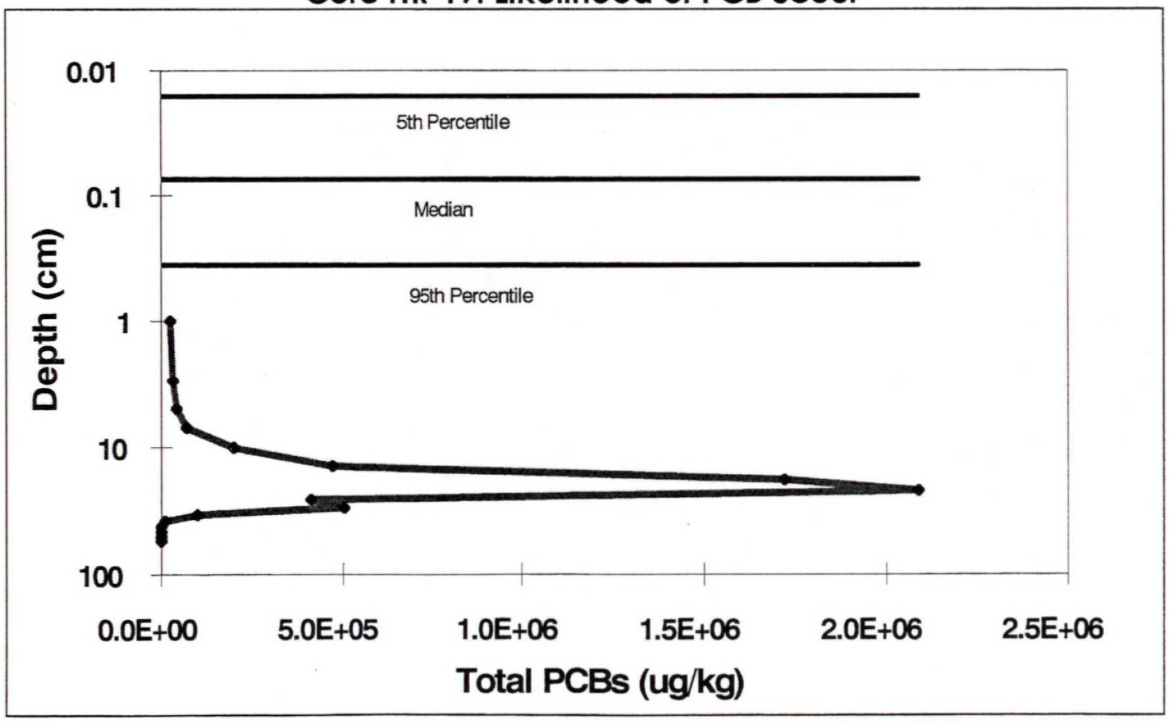


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Figure 4-5
Core HR-20: Likelihood of PCB Scour

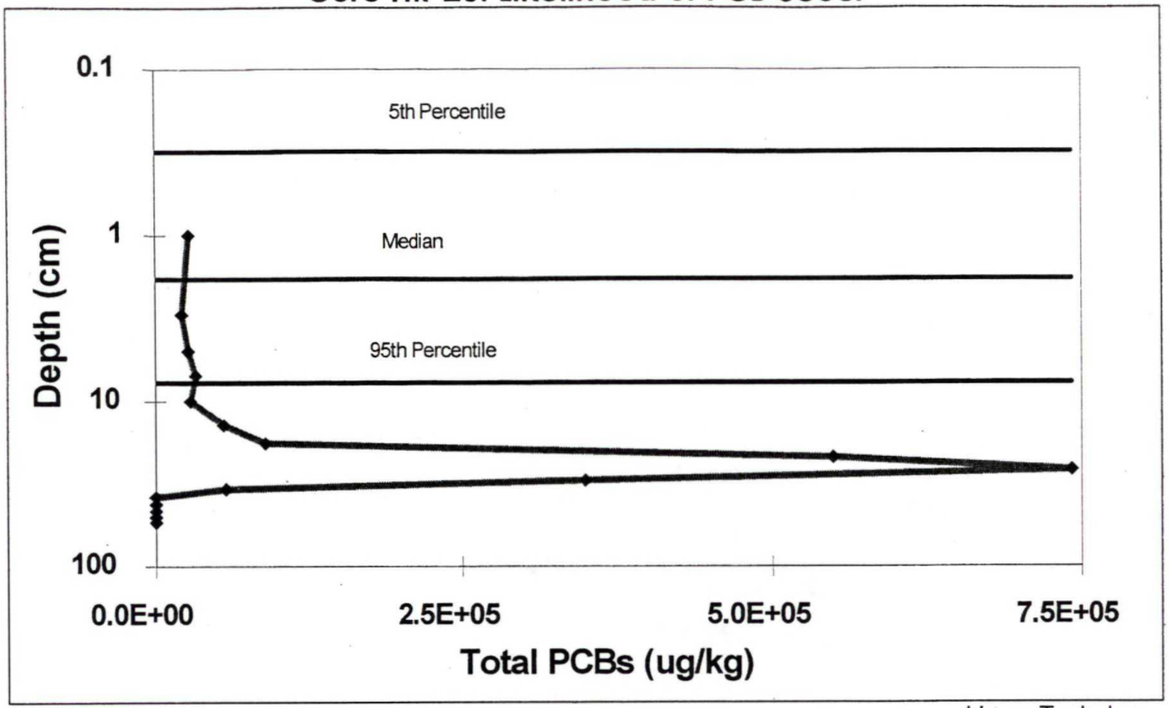

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Figure 4-6
Core HR-23: Likelihood of PCB Scour

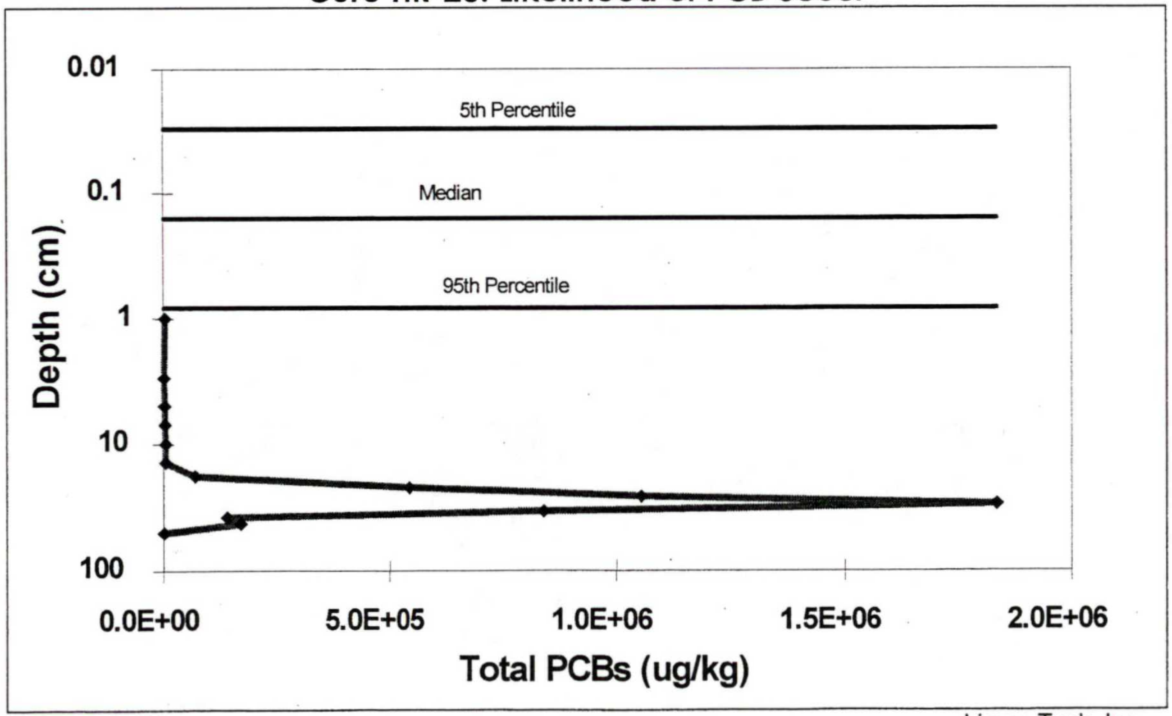

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Figure 4-7
Core HR-25: Likelihood of PCB Scour

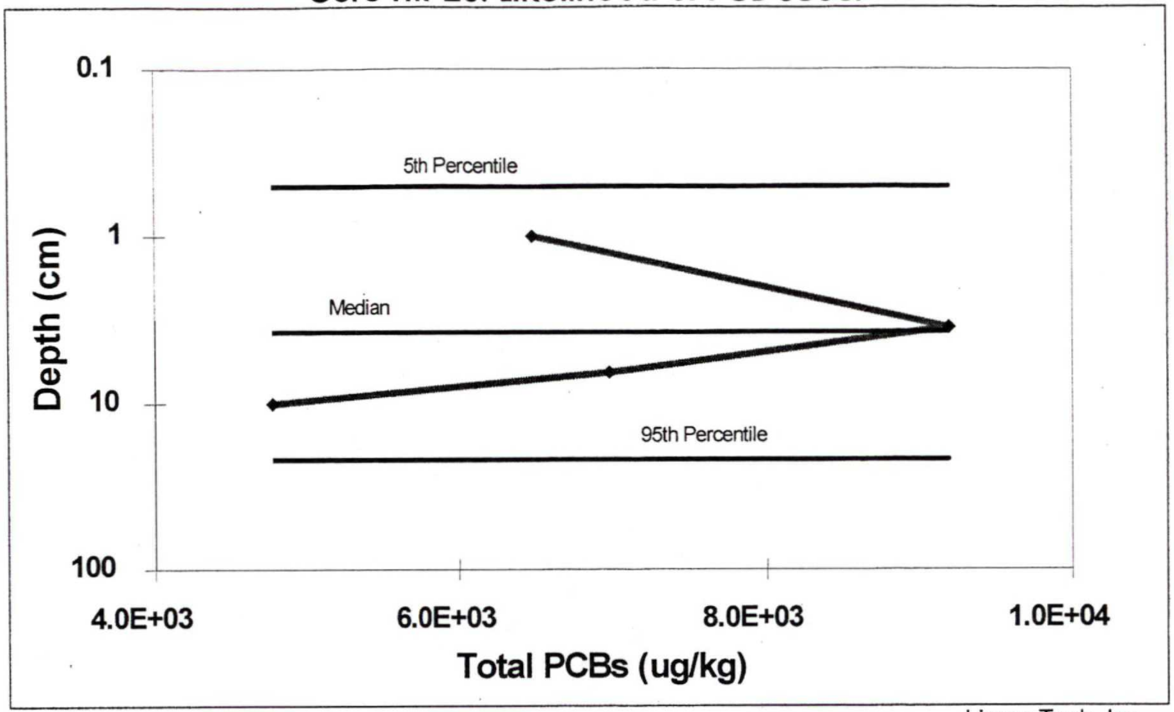

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Figure 4-8
Core HR-26: Likelihood of PCB Scour

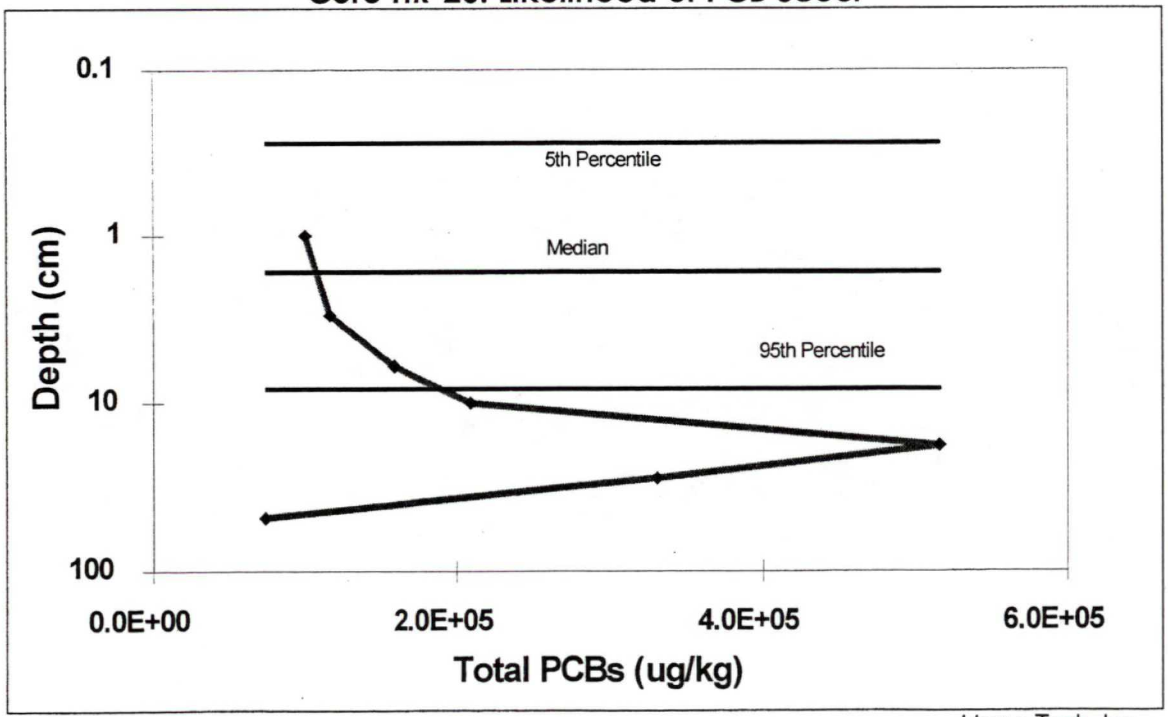

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Figure 4-9
Cumulative Percent versus Mean Depth of Scour

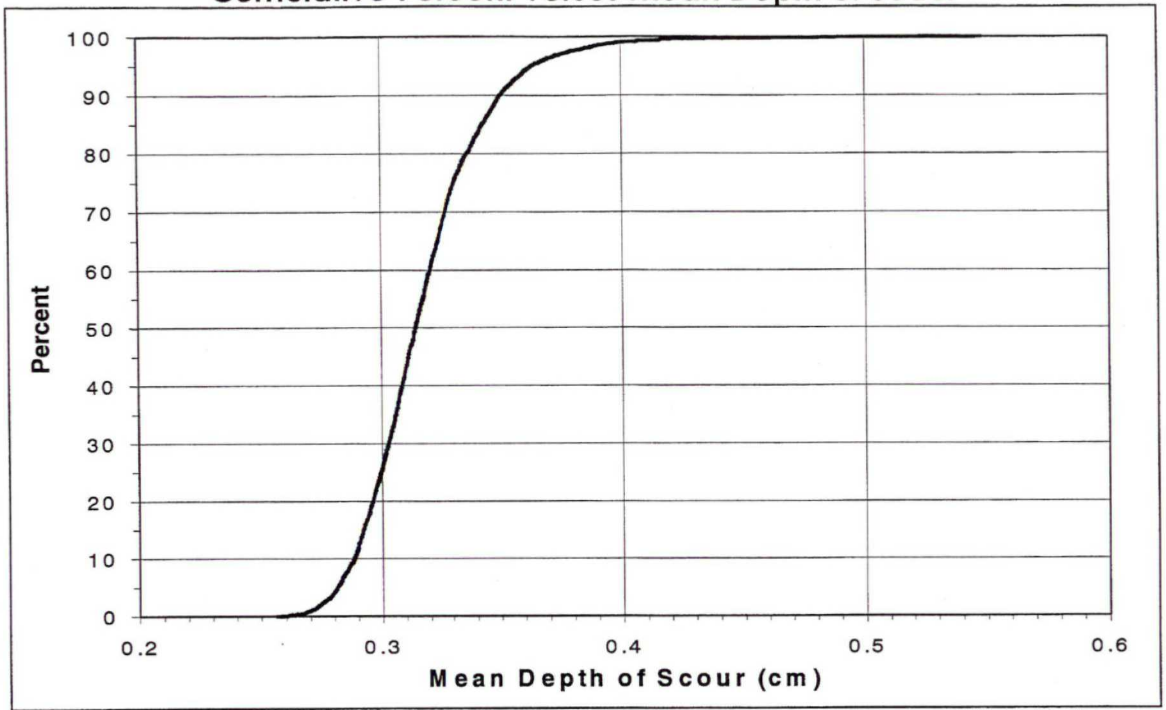

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Figure 4-10
Cumulative Percent versus Total Solids Scoured

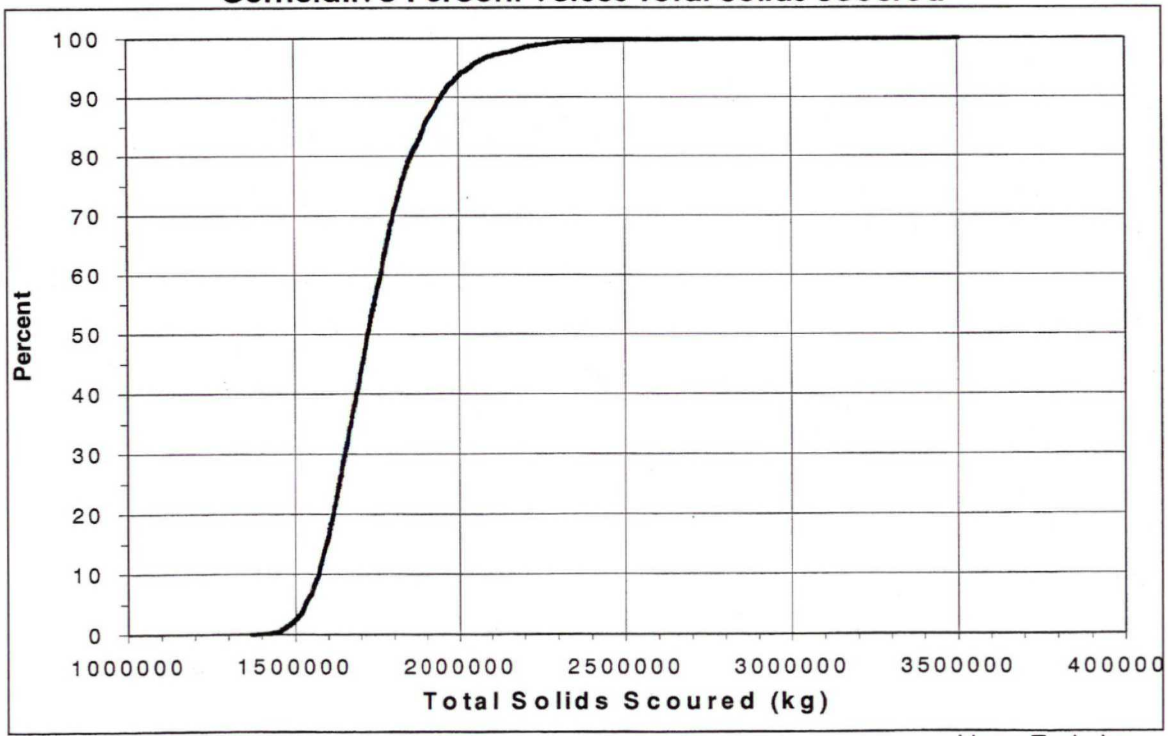

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Figure 5-1

Conceptual Framework for the HUDTOX PCB Model

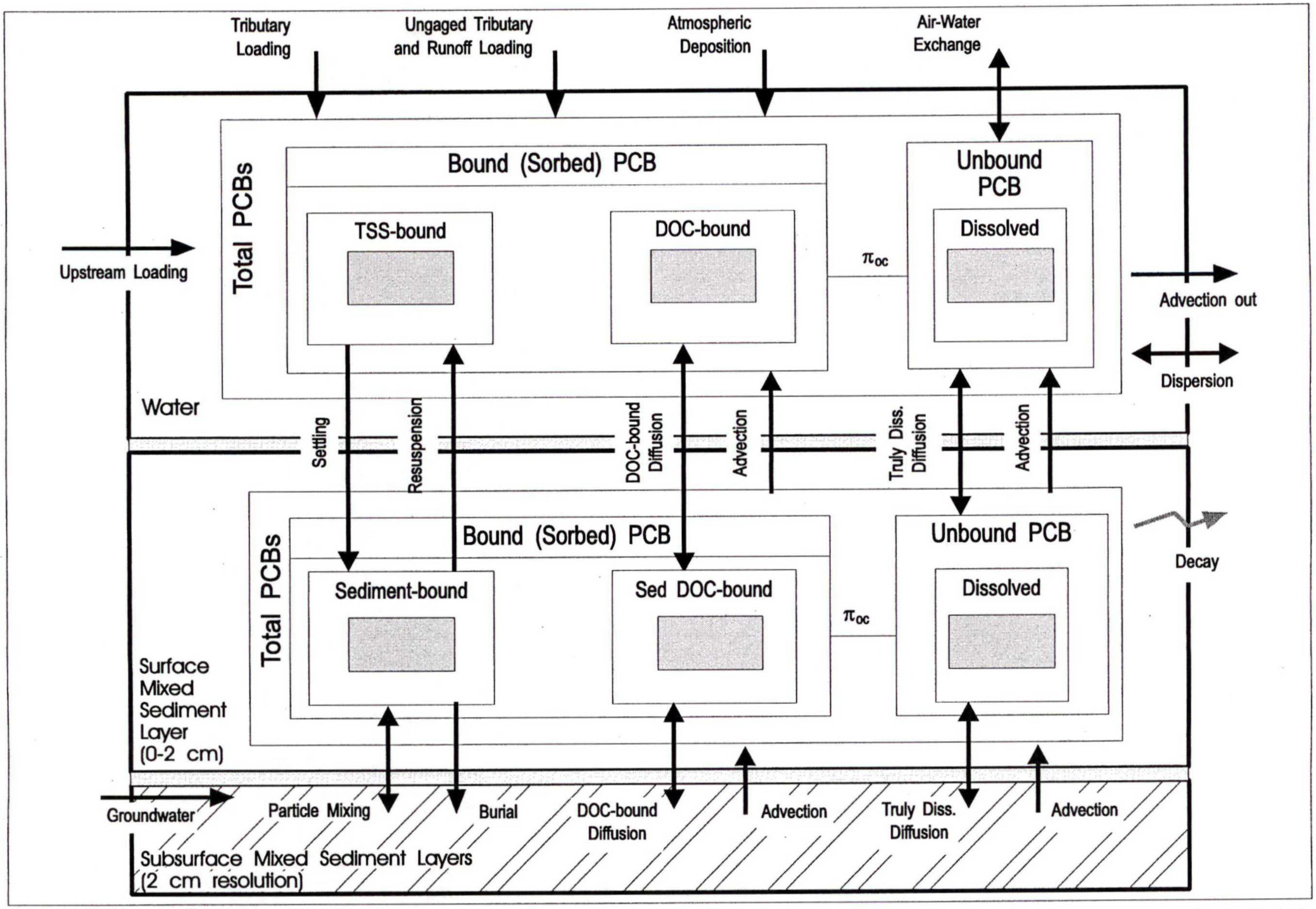

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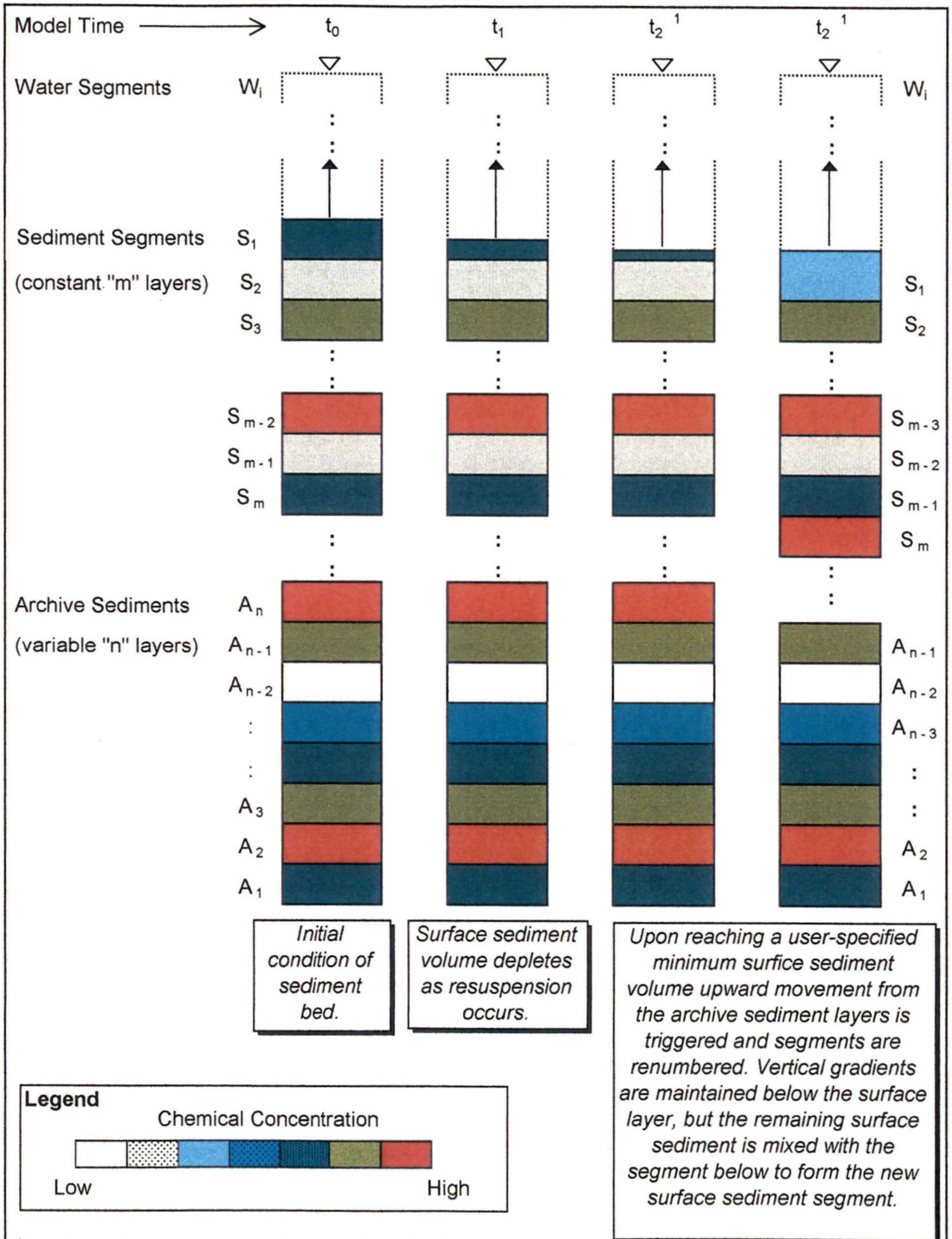
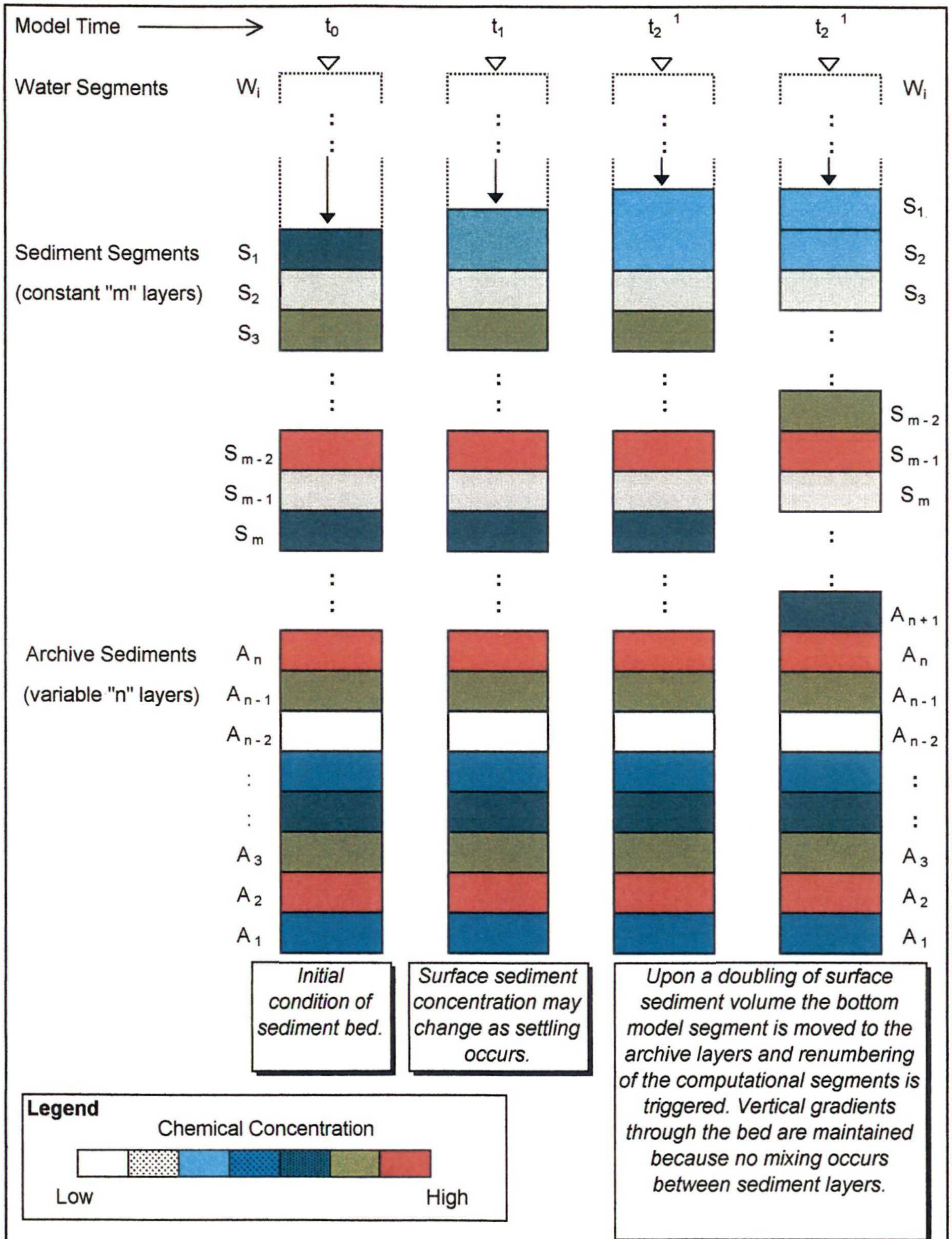
Figure 5-2
Illustration of Sediment Scour in the HUDTOX Model



[1] t_2 = time when minimum surface sediment volume is reached.

Figure 5-3
Illustration of Sediment Burial in the HUDTOX Model



[1] t_2 = time when a doubling of the surface sediment volume is reached.

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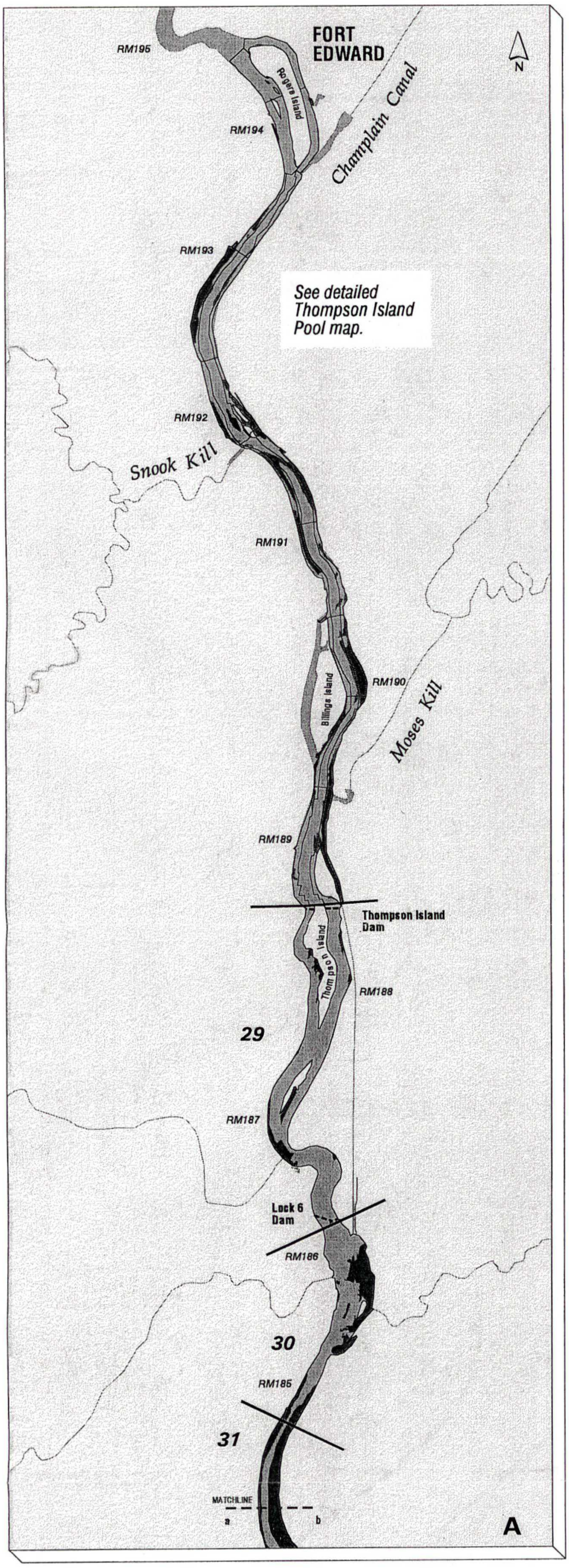
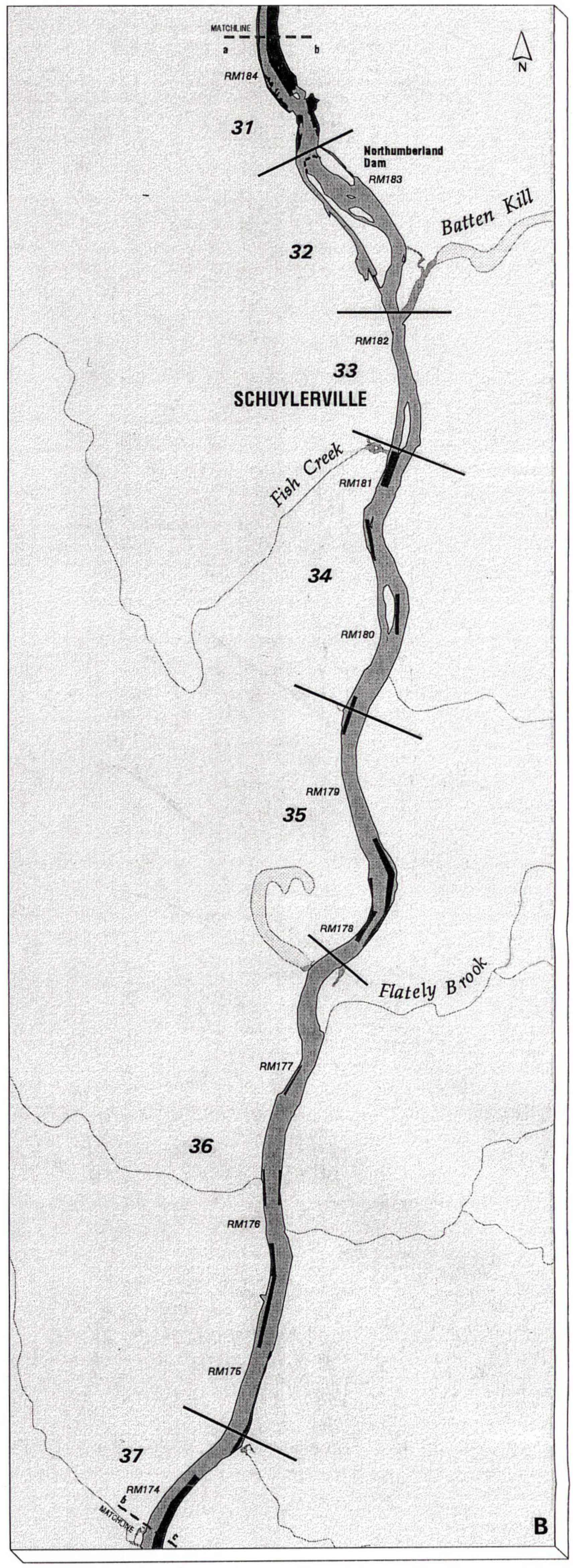




HUDTOX Model Water Column Segmentation Grid for Upper Hudson River

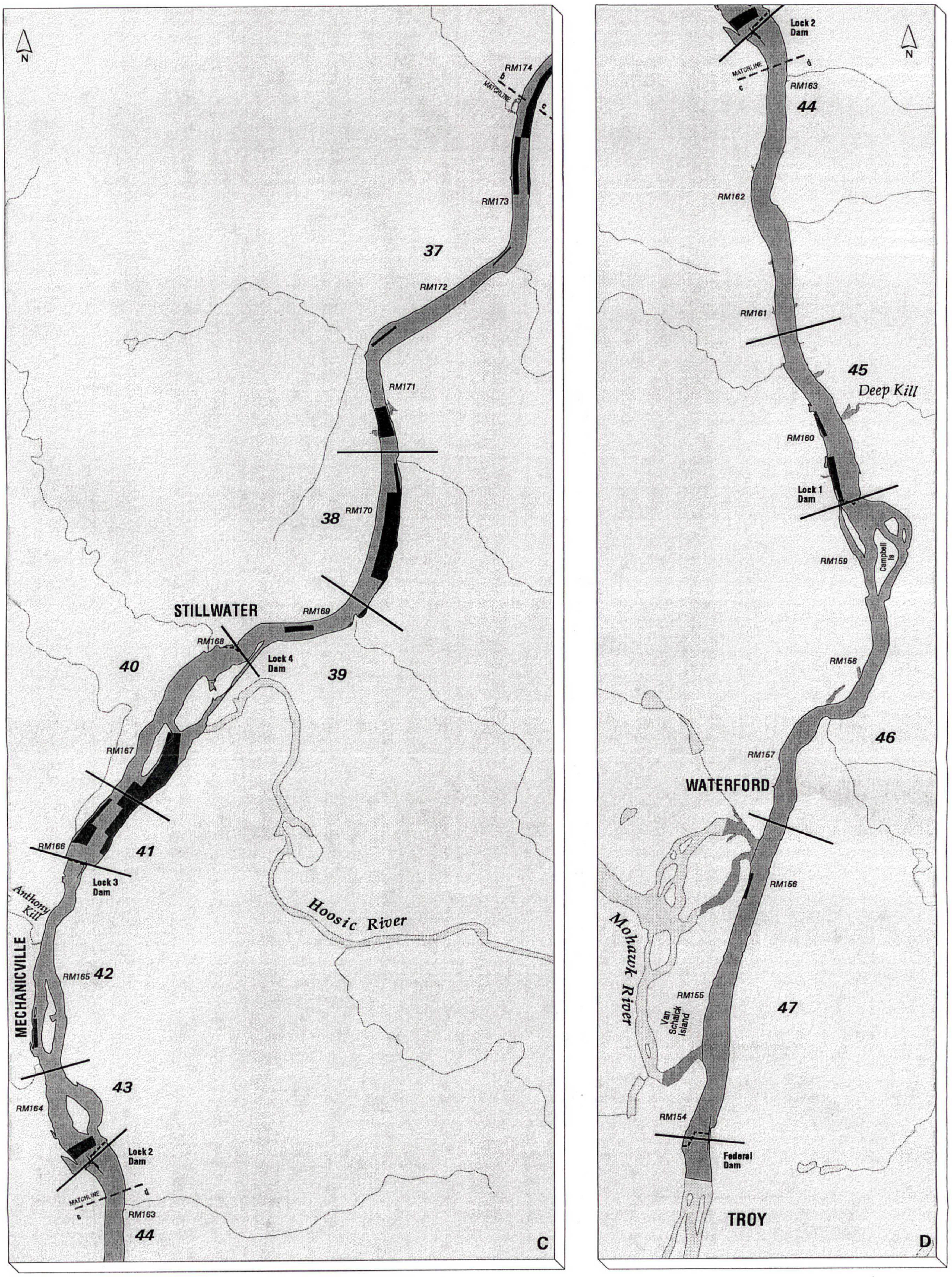
Parts A and B

■	Cohesive sediments	——	Segment boundary below Thompson Is. Dam
■	Noncohesive sediments	——	Segment boundary above Thompson Is. Dam
		-------	Dam
29	HUDTOX segment number	*RM188*	River mile

0 — 1 mile

0 — 1 km

Figure 5-4 A, B — Limno-Tech, Inc.

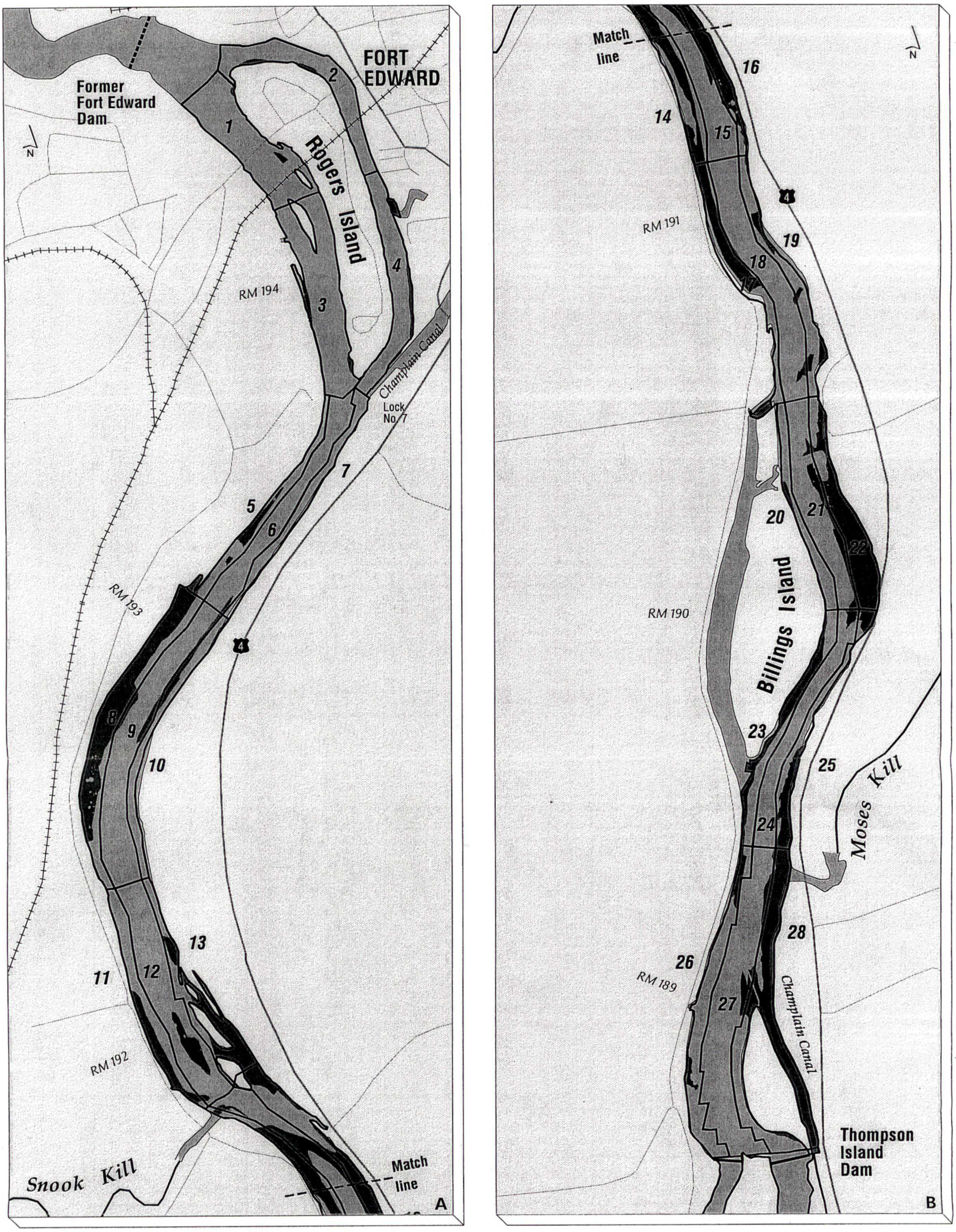


HUDTOX Model
Water Column Segmentation Grid for Upper Hudson River
Parts C and D

Cohesive sediments	Segment boundary below Thompson Is. Dam
Noncohesive sediments	Segment boundary above Thompson Is. Dam
	Dam
29 HUDTOX segment number	RM188 River mile

0 — 1 mile
0 — 1 km

Figure 5-4 C, D   Limno-Tech, Inc.



Thompson Island Pool

Study Area

(black)	Cohesive sediments	(line)	Roads
(grey)	Noncohesive sediments	(line with ticks)	Railroad
12	HUDTOX segment number	*RM194*	River mile

0 — 1/2 mile

0 — 500 meters

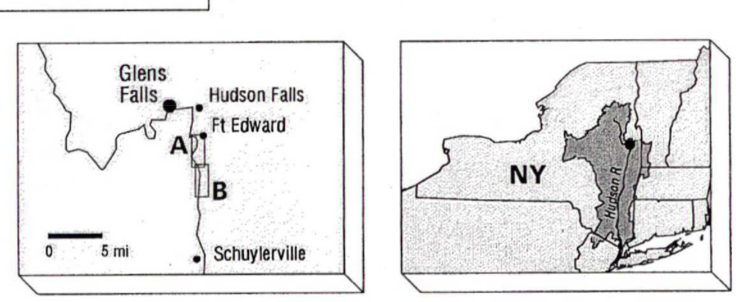


Figure 5-6
Schematic of the HUDTOX Water Column Segmentation Grid

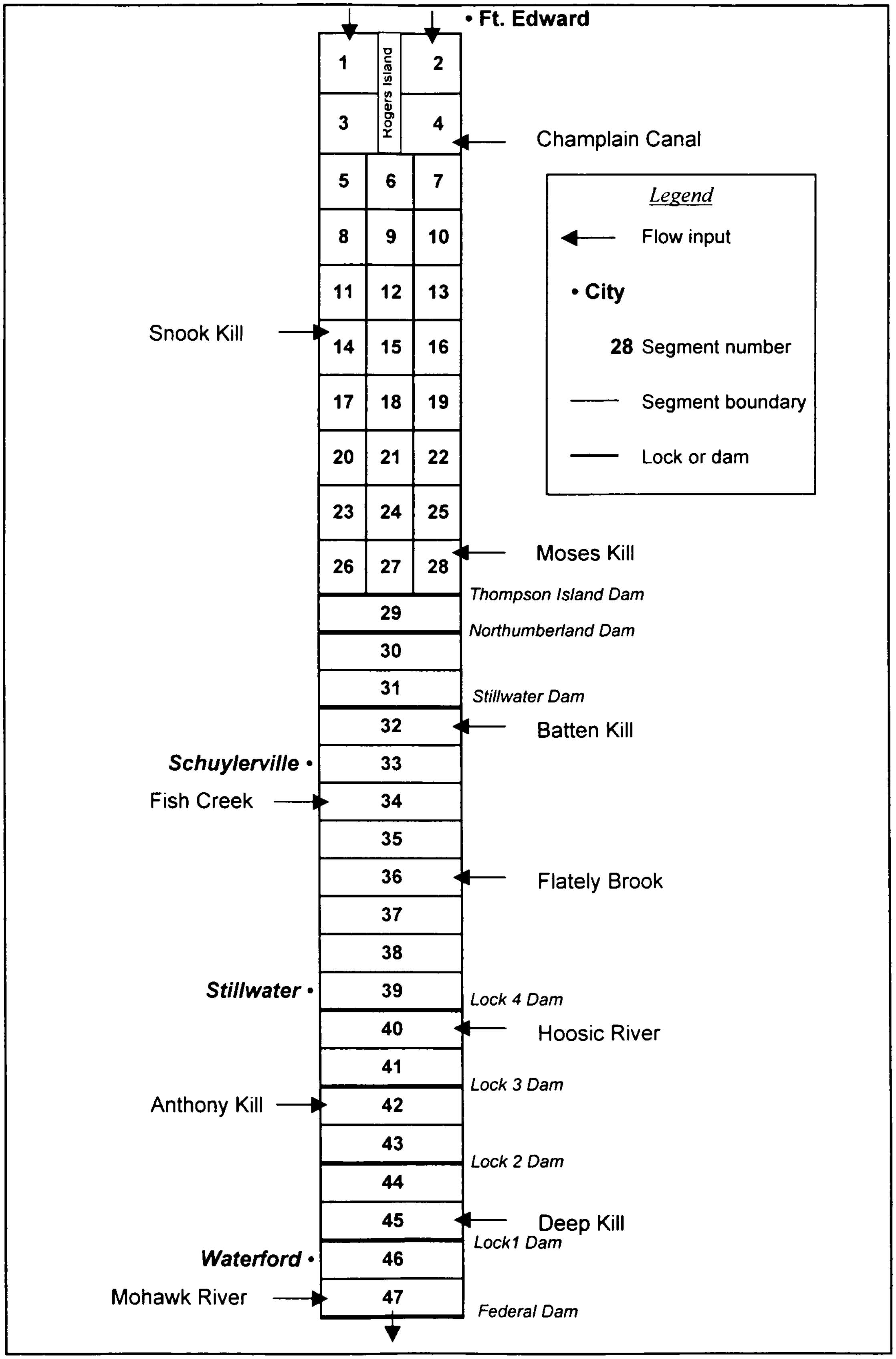


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Figure 5-7
HUDTOX Water Column Segment Depths by River Mile

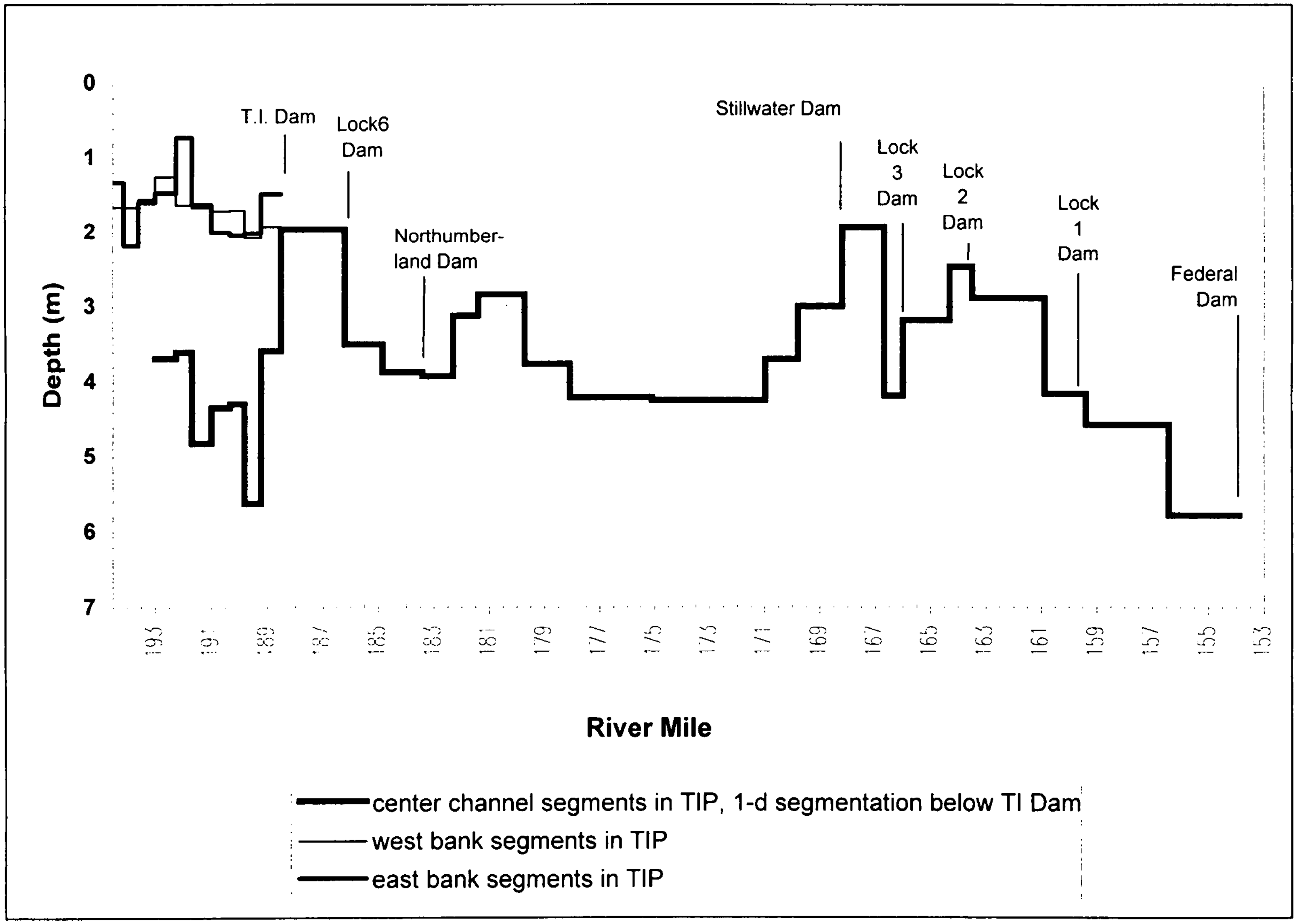

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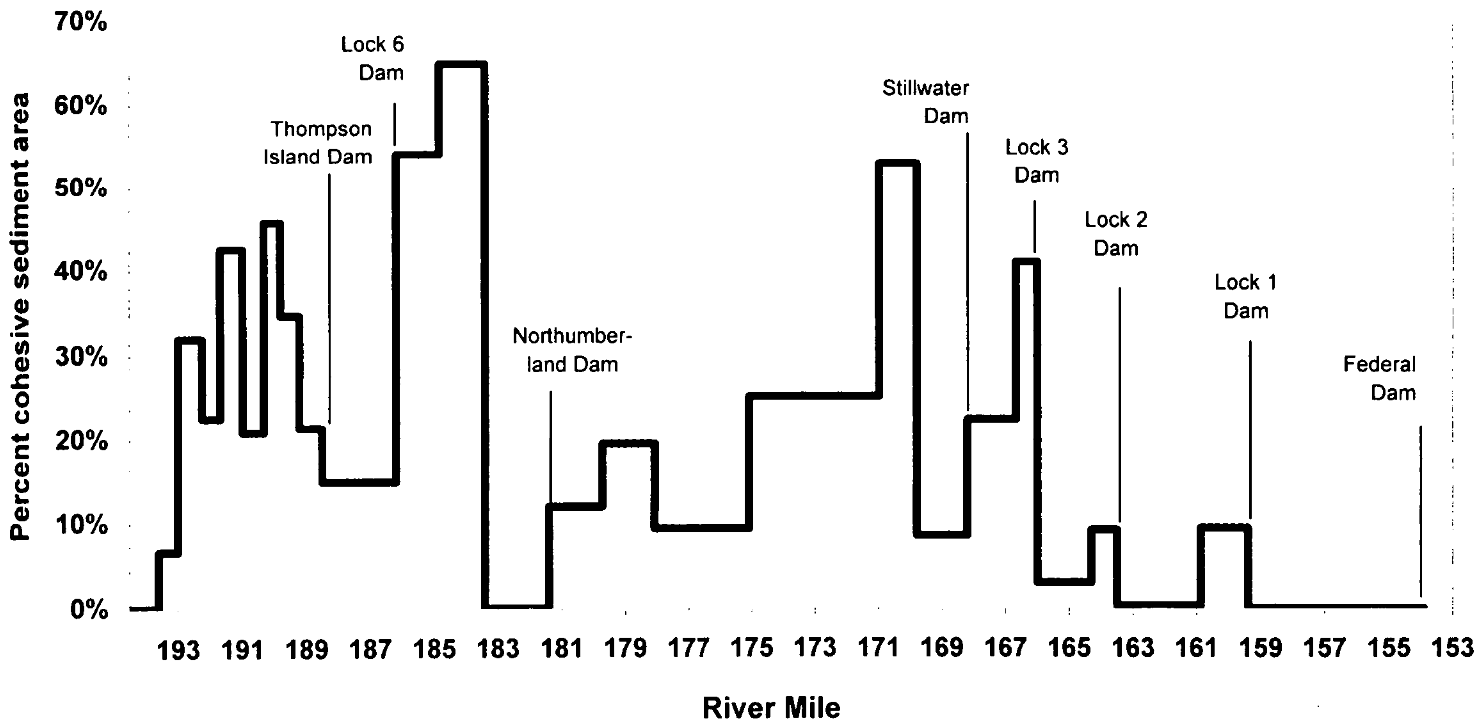
Figure 5-8
Percent Cohesive Sediment Area Represented in HUDTOX by River Mile



Note:

1. Percent cohesive area = (cohesive sediment area) / (cohesive sediment area + noncohesive sediment area)
2. Fort Edward to Northumberland Dam cohesive and noncohesive sediment areas were determined from USEPA Phase 2 side scan sonar study (DEIR, TAMS, 1997)
3. Northumberland Dam to Federal Dam at Troy cohesive and noncohesive sediment areas were determined from the Sediment Bed Mapping Study of the Upper Hudson River from Northumberland Dam to Troy Dam (QEA, 1998).

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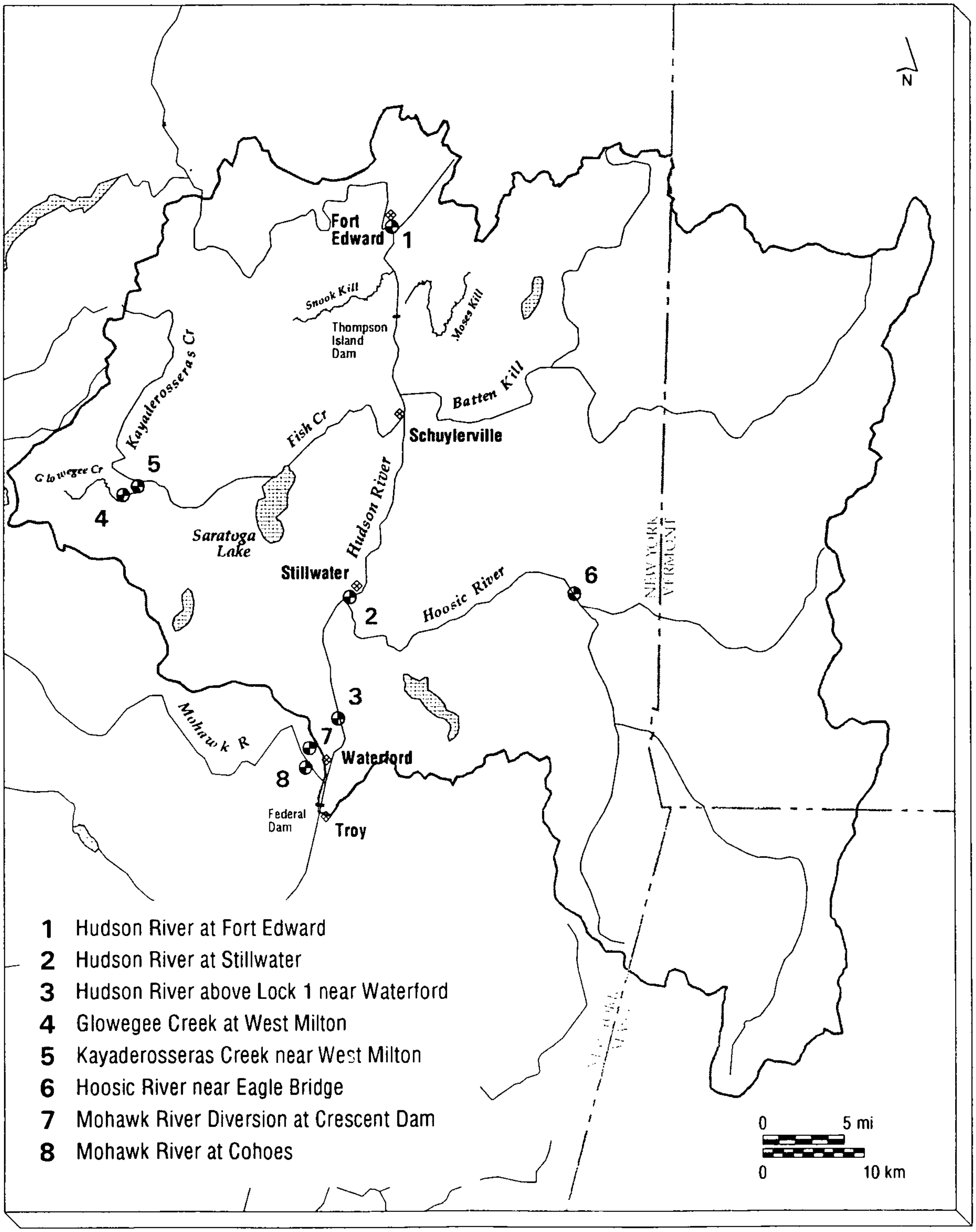
Figure 6-1
Upper Hudson River Basin USGS Flow Gage Stations
Used in HUDTOX Modeling



1 Hudson River at Fort Edward
2 Hudson River at Stillwater
3 Hudson River above Lock 1 near Waterford
4 Glowegee Creek at West Milton
5 Kayaderosseras Creek near West Milton
6 Hoosic River near Eagle Bridge
7 Mohawk River Diversion at Crescent Dam
8 Mohawk River at Cohoes

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Figure 6-2
Comparison of Sources of Flow as a Percentage of the Flow at the Federal Dam

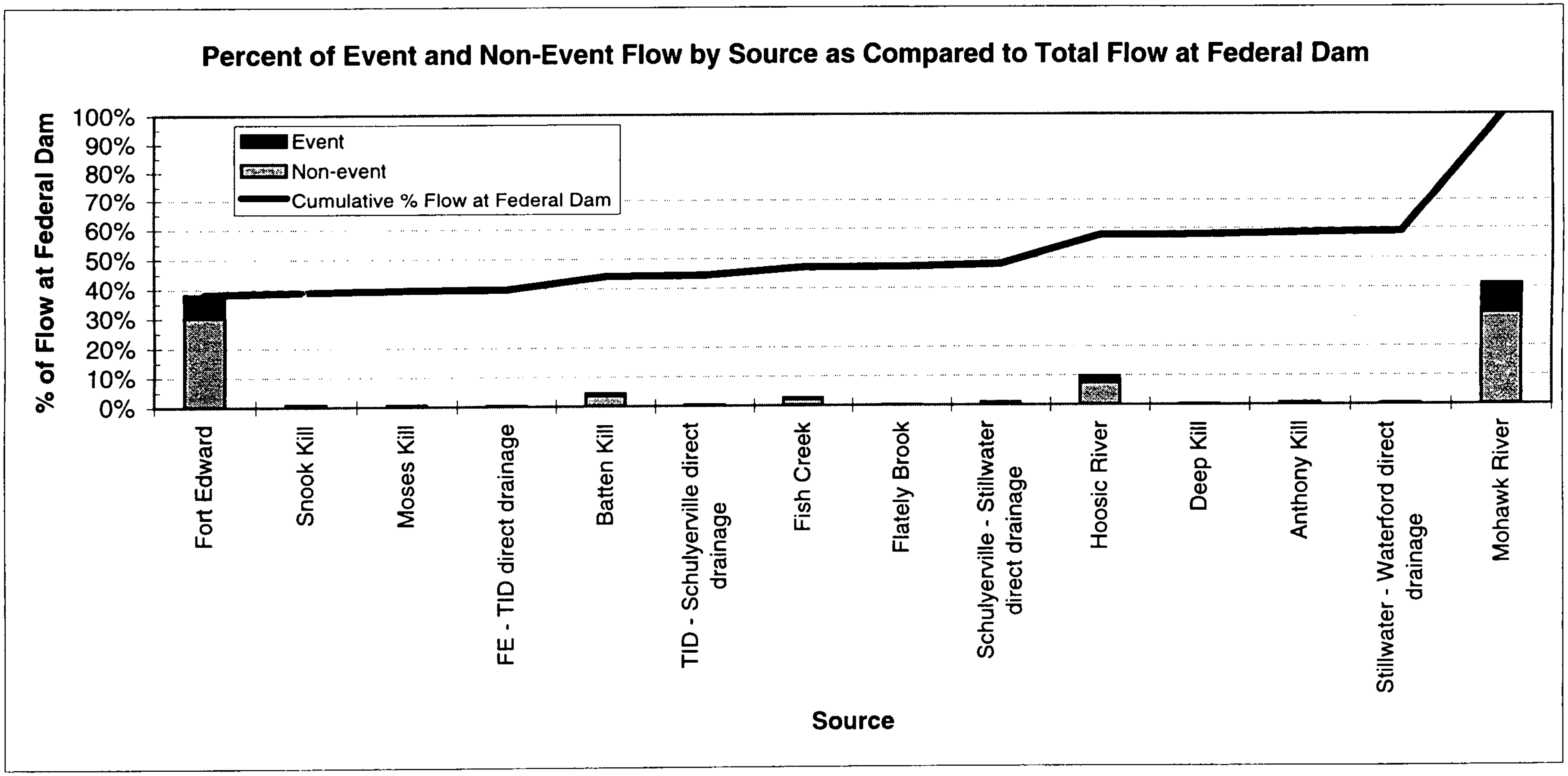

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Figure 6-3
Estimated Daily Average Mainstem and Tributary Flows for the Upper Hudson River between Fort Edward and Federal Dam
(1/1/77 - 9/30/97)

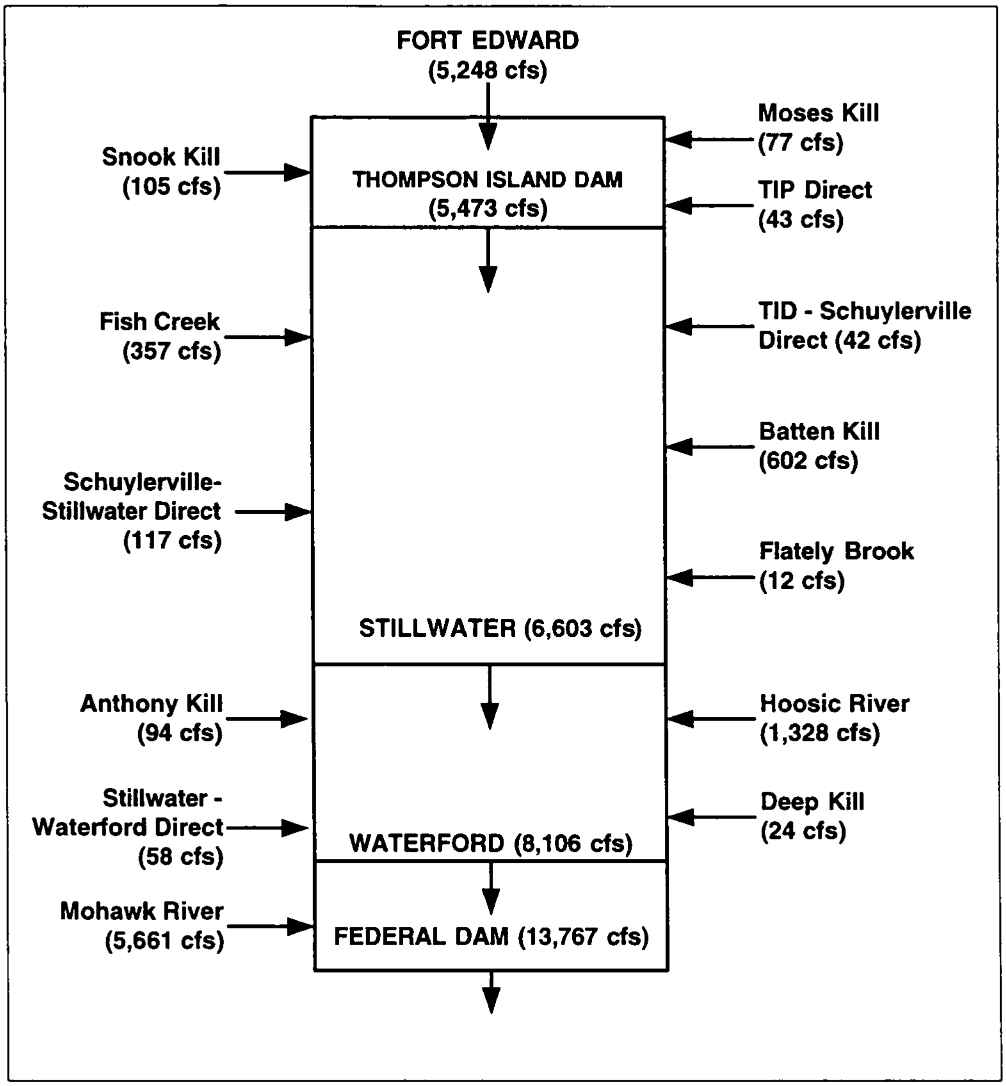

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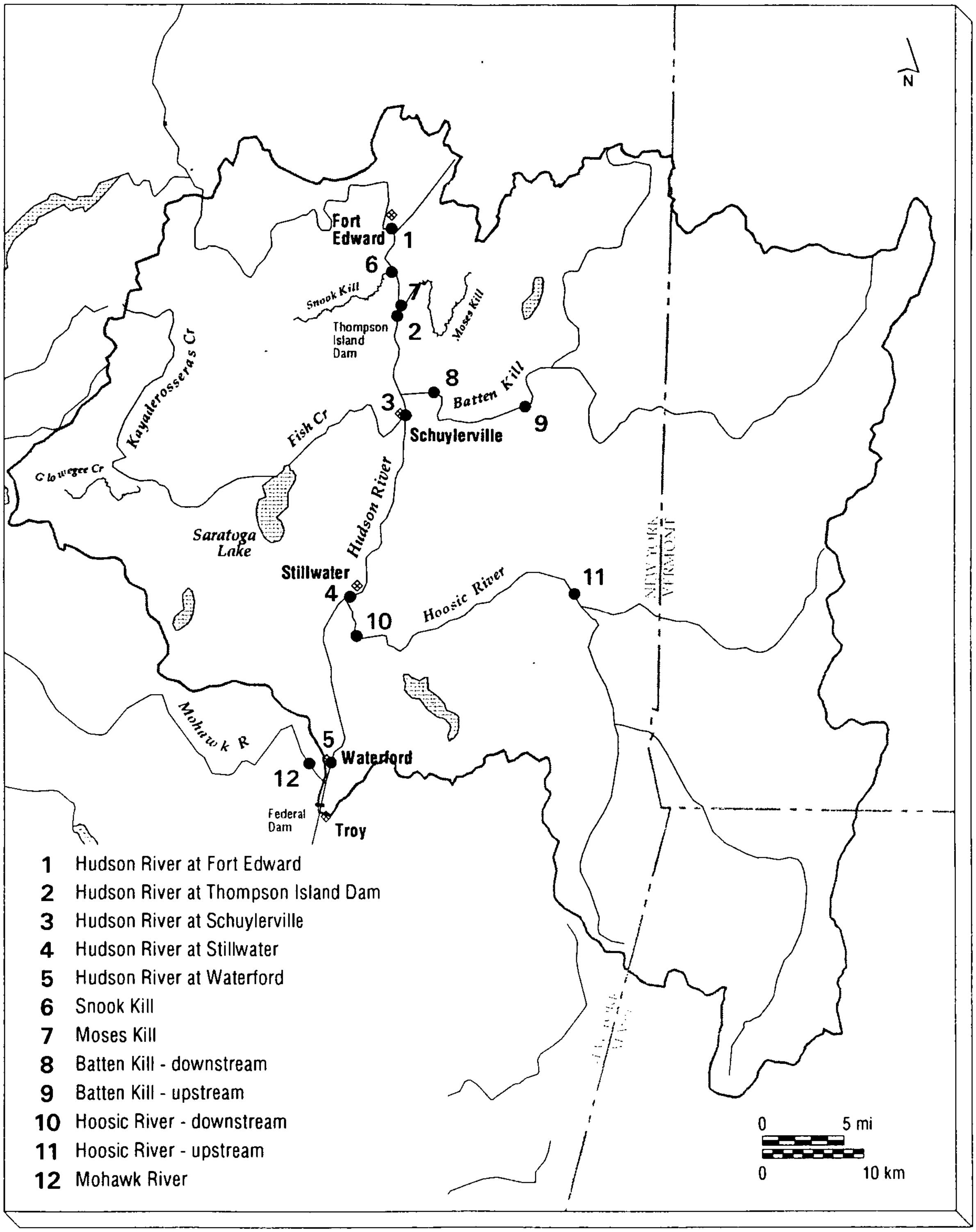
Figure 6-4
Upper Hudson River Basin Primary Long-Term Sampling Locations for Solids Used in HUDTOX Modeling



1 Hudson River at Fort Edward
2 Hudson River at Thompson Island Dam
3 Hudson River at Schuylerville
4 Hudson River at Stillwater
5 Hudson River at Waterford
6 Snook Kill
7 Moses Kill
8 Batten Kill - downstream
9 Batten Kill - upstream
10 Hoosic River - downstream
11 Hoosic River - upstream
12 Mohawk River

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Figure 6-5

Subwatersheds Monitored for Solids between Fort Edward and Waterford

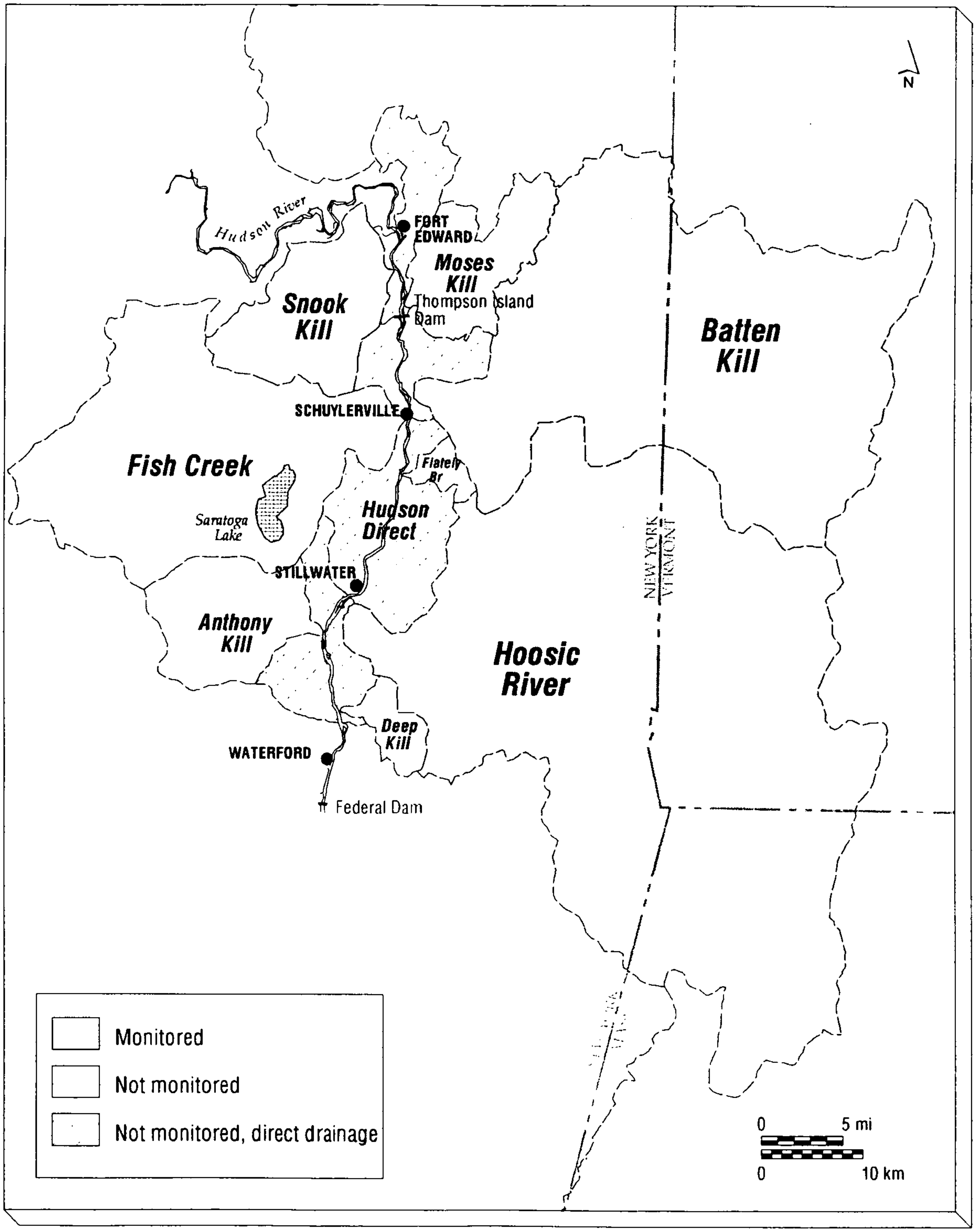

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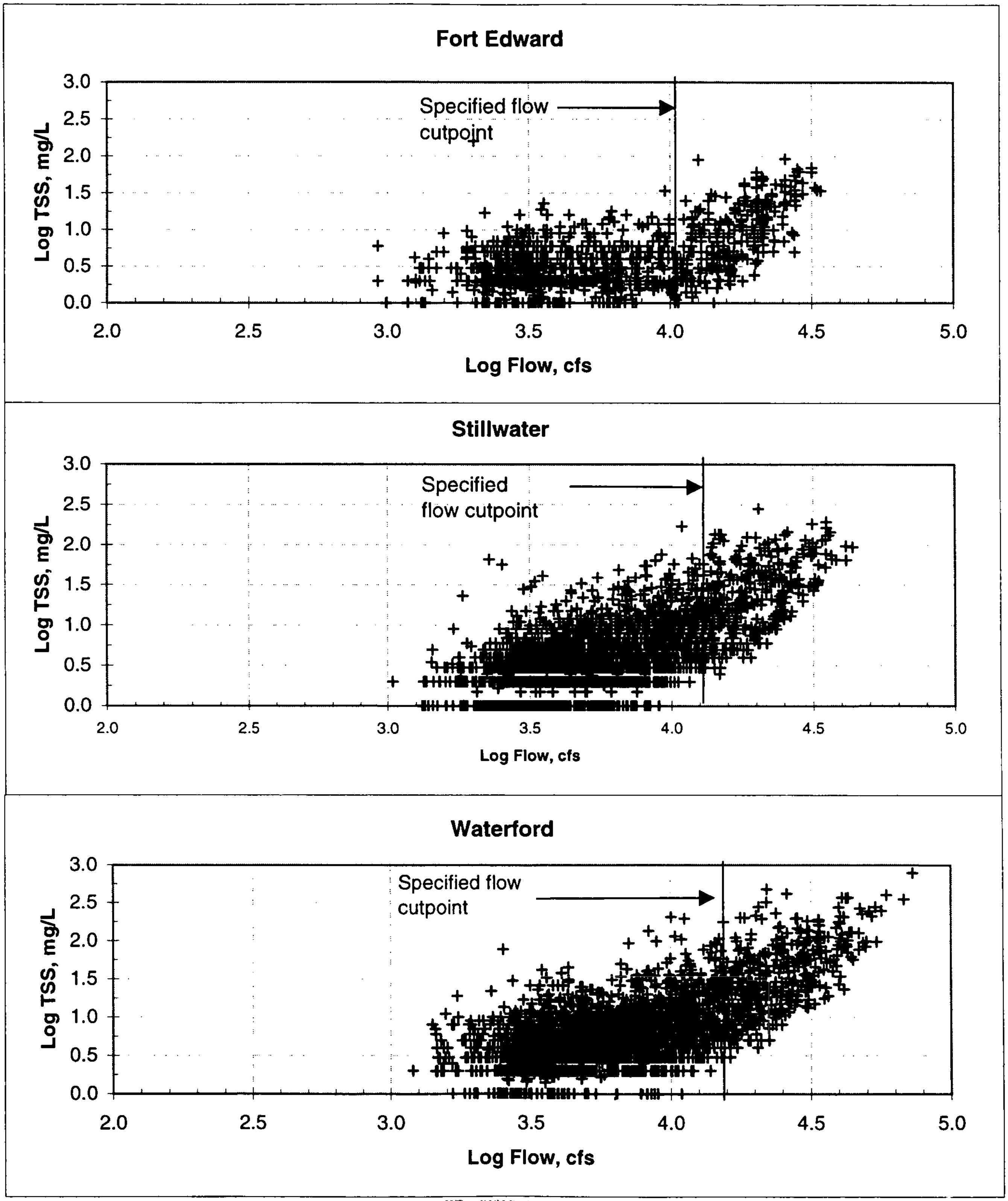
Figure 6-6
Log Flow vs. Log TSS Concentration at Fort Edward, Stillwater, and Waterford



Source: Hudson River Database Release 4.1

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Figure 6-7
Mainstem and Tributary Suspended Solids Watershed Yield based on HUDTOX Suspended Solids Loading Estimates (10/1/77 - 9/30/97)

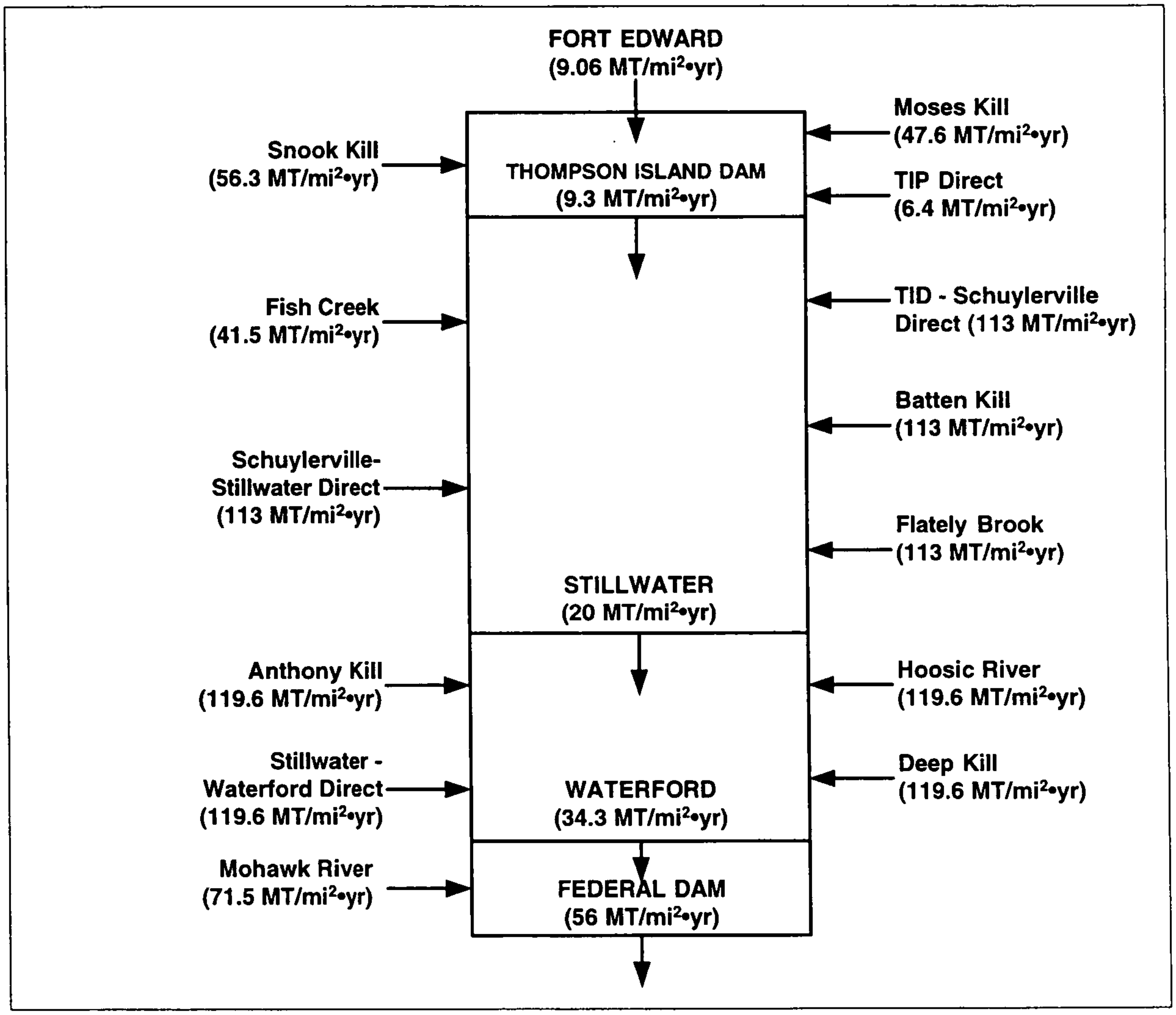

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Figure 6-8
Relative Contribution of Estimated External Suspended Solids Loads to the Upper Hudson River
1/1/77 to 9/30/97

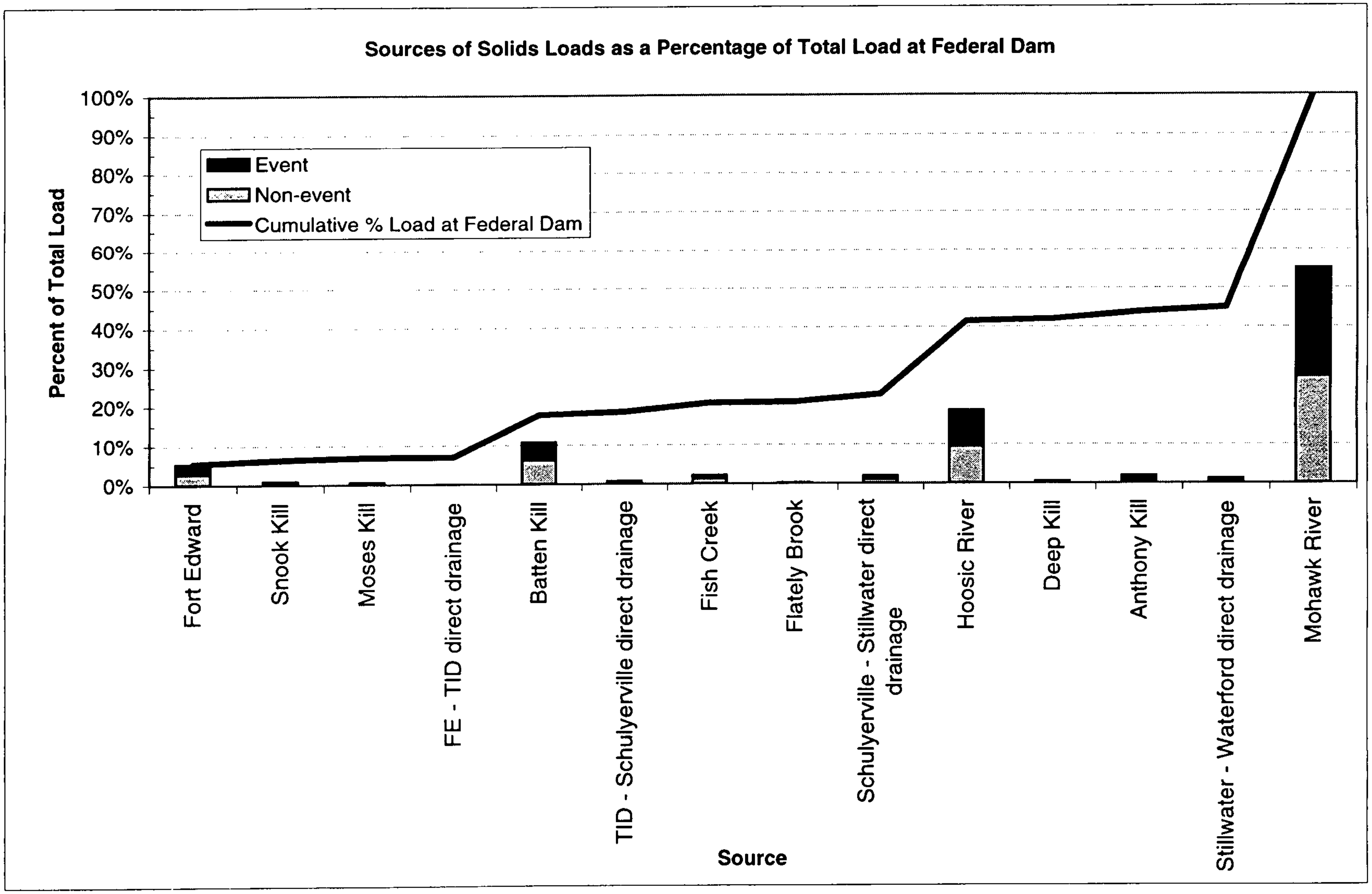

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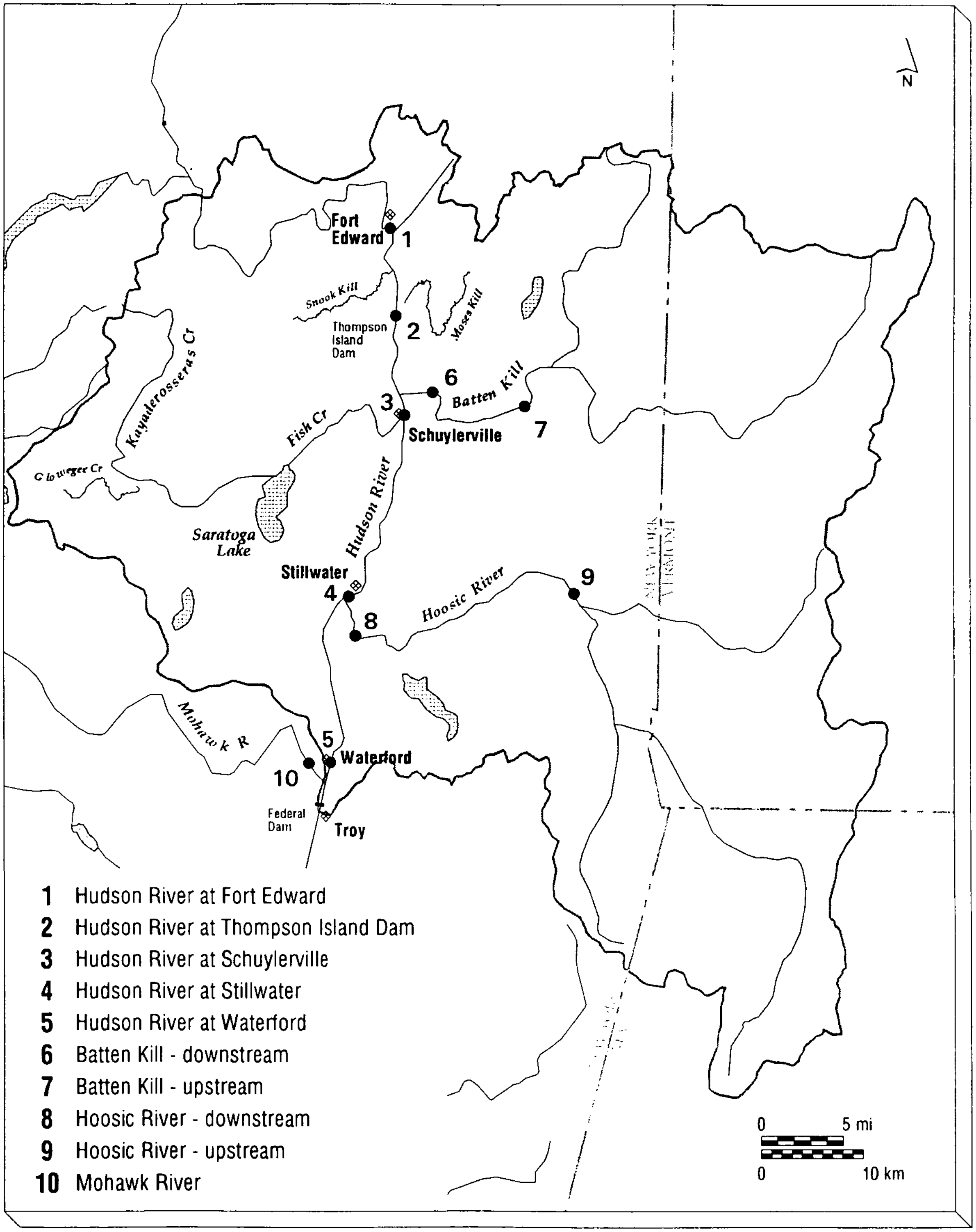
Figure 6-9
Upper Hudson River Basin Primary Long-Term Sampling Locations for PCB Data Used in HUDTOX Modeling



1 Hudson River at Fort Edward
2 Hudson River at Thompson Island Dam
3 Hudson River at Schuylerville
4 Hudson River at Stillwater
5 Hudson River at Waterford
6 Batten Kill - downstream
7 Batten Kill - upstream
8 Hoosic River - downstream
9 Hoosic River - upstream
10 Mohawk River

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Figure 6-10

Available Mainstem Upper Hudson River PCB Data from Hudson River Database Release 4.1

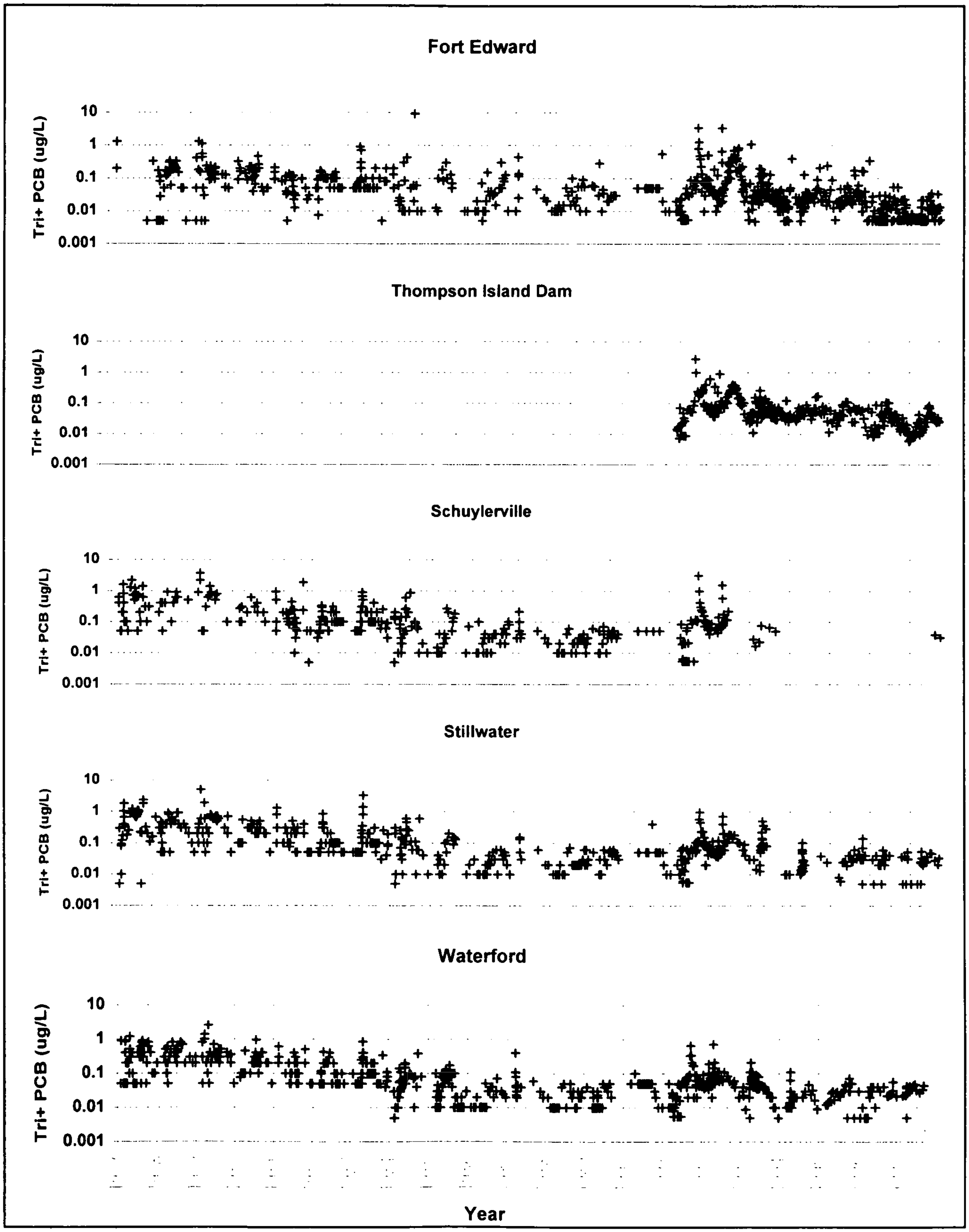

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Figure 6-11
Estimated Annual Tri+ PCB Load at Historical PCB Sampling Stations on the Upper Hudson River

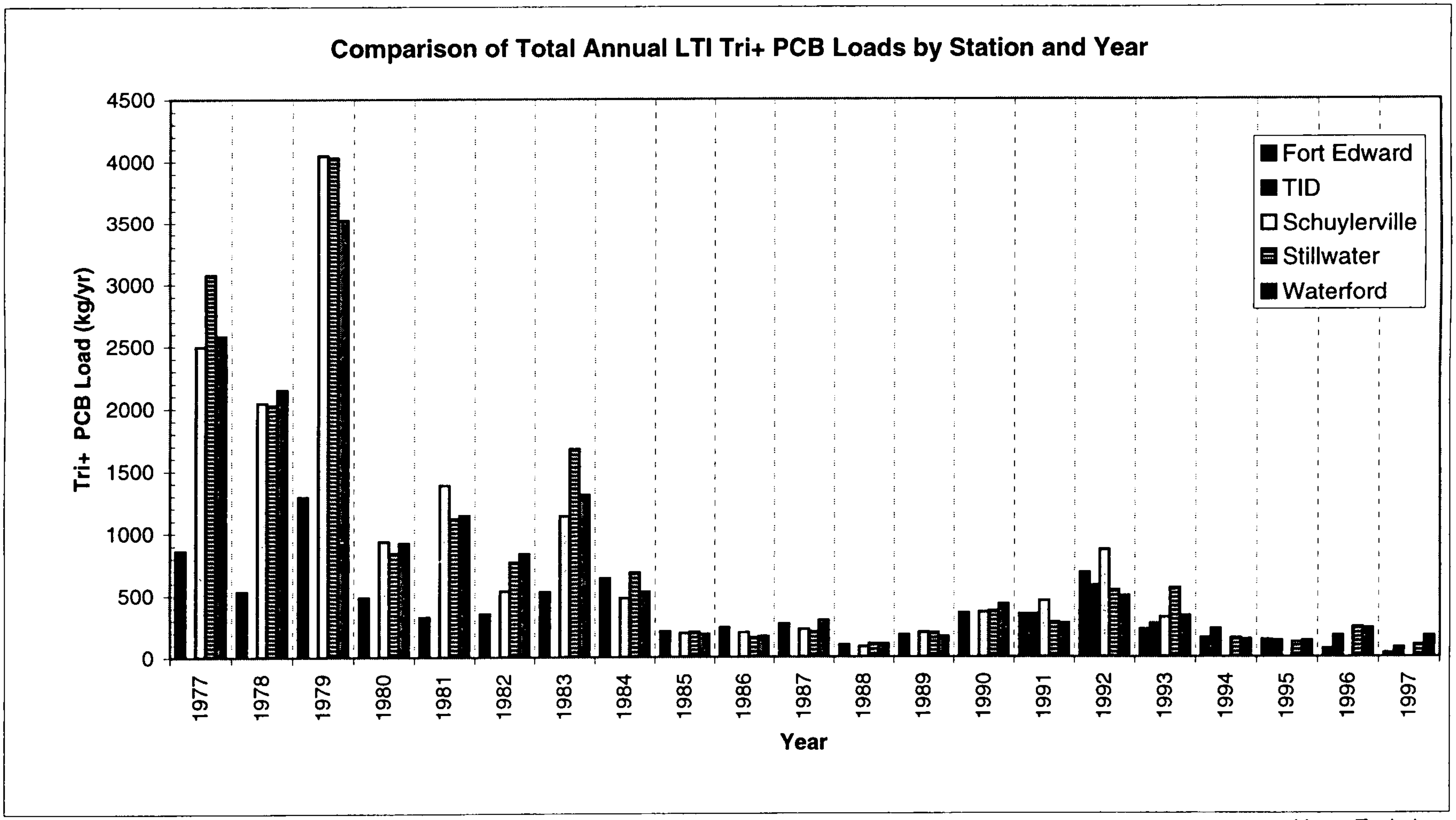

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Figure 6-12
Estimated Annual Load of Total PCB, BZ#4, and BZ#52 past Fort Edward 4/1/91 to 9/30/97

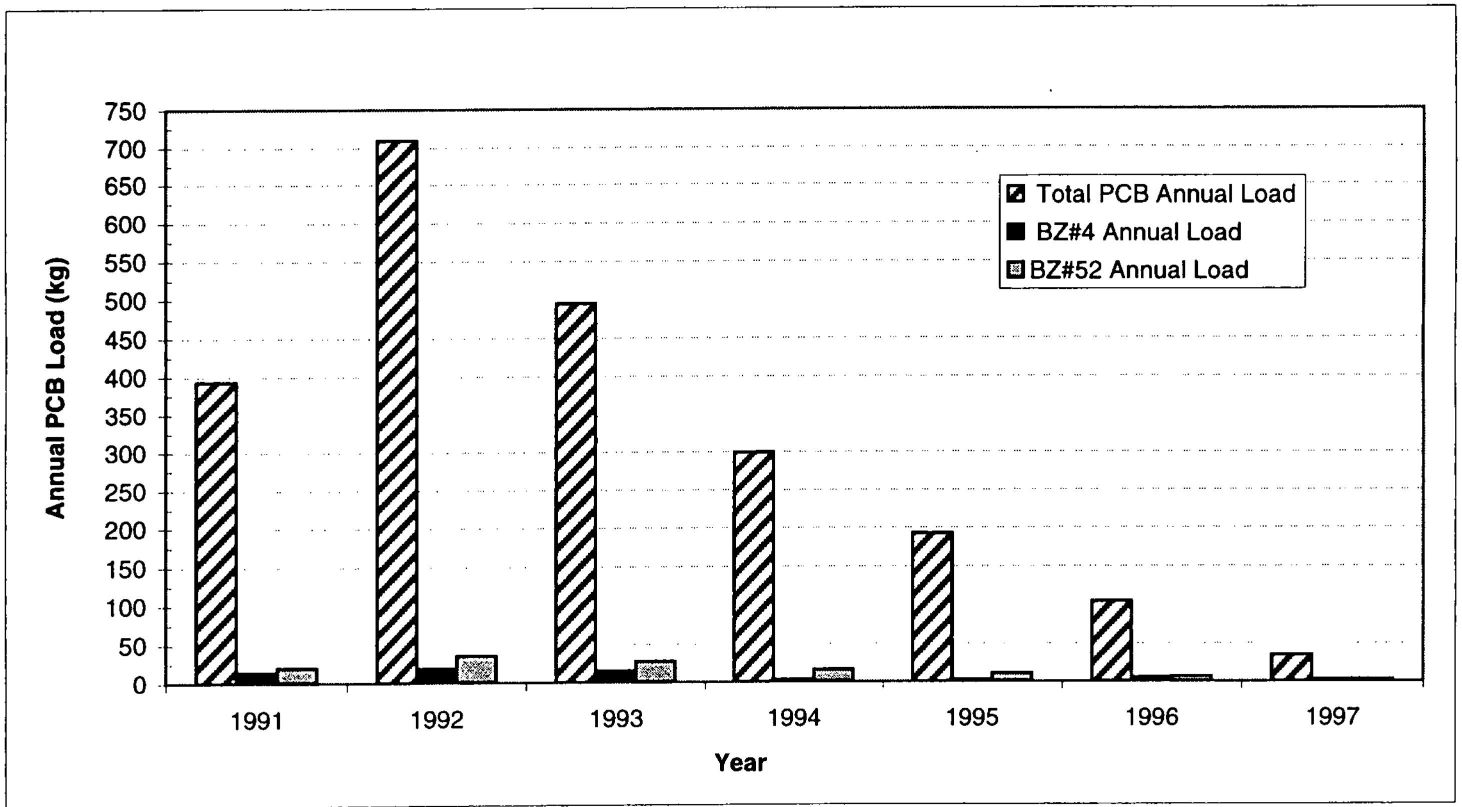

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Figure 6-13
Relative Contribution of Estimated External PCB Loads to the Upper Hudson River
1/1/77 to 9/30/97

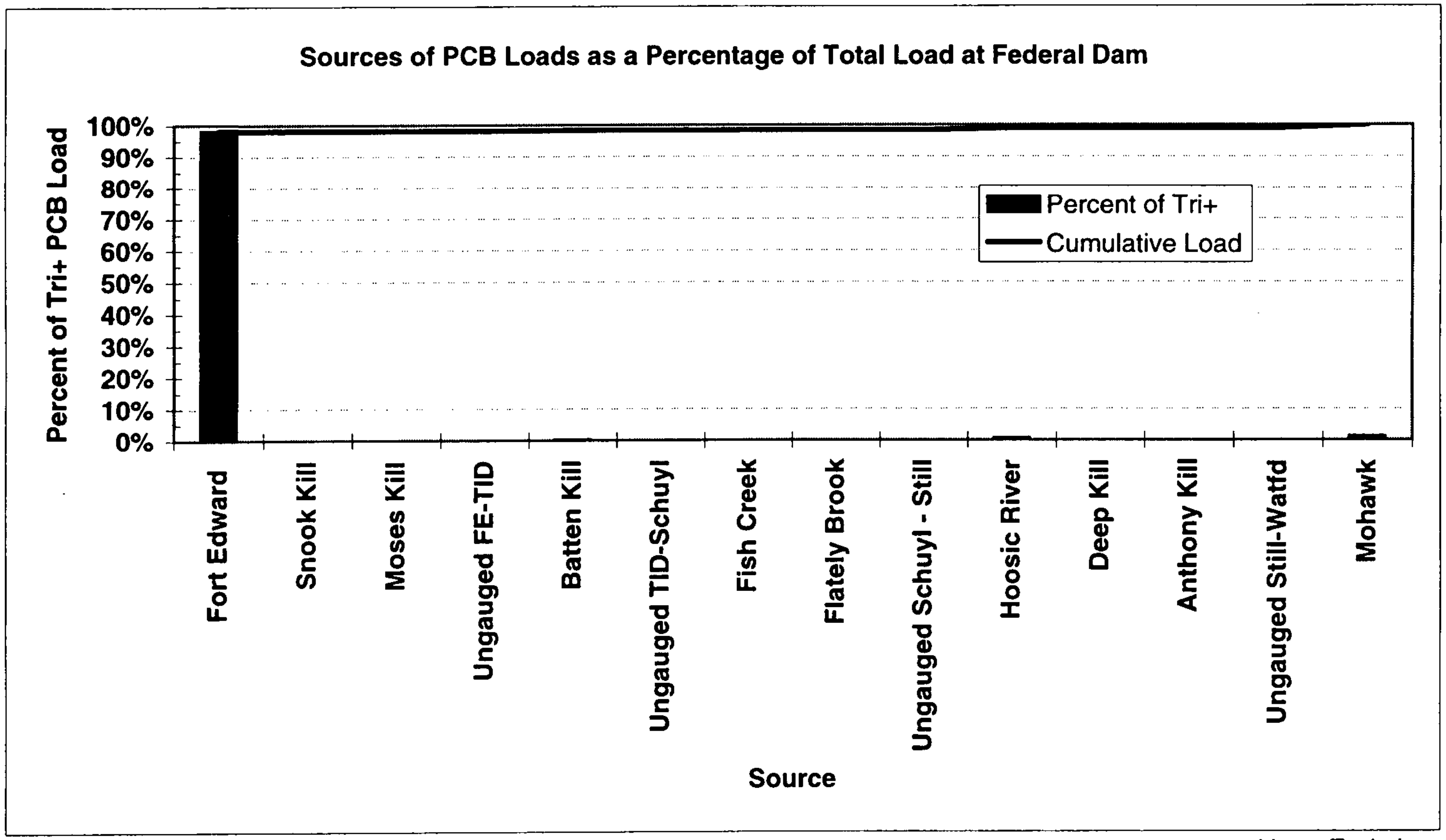

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Figure 6-14
Estimated Cumulative Tri+ PCB Load passing Fort Edward, Schuylerville, Stillwater, and Waterford compared to DEIR Estimates

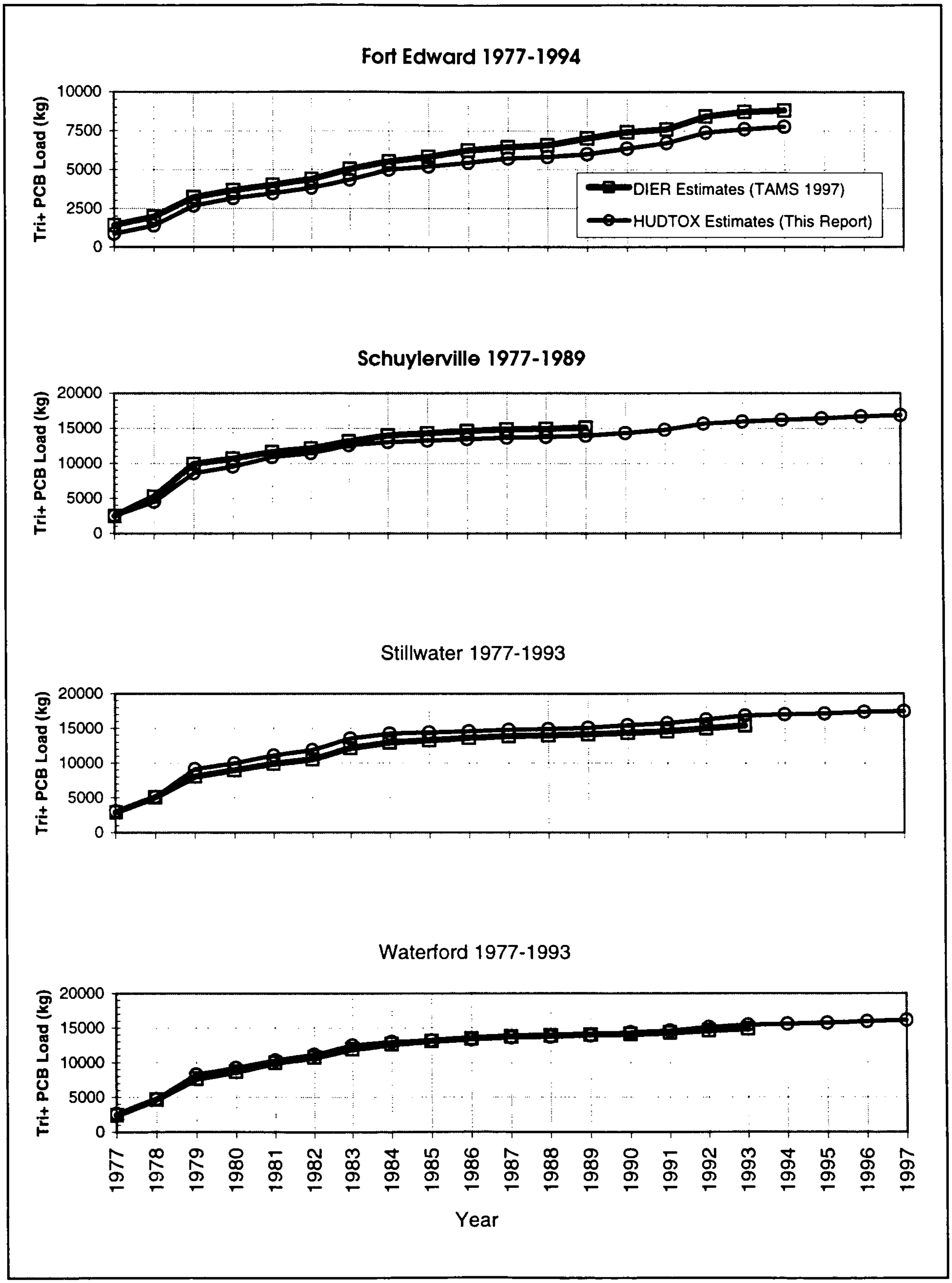

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Figure 6-15
Estimated Annual Tri+ PCB Load at Fort Edward, Stillwater, and Waterford compared to DEIR Estimates

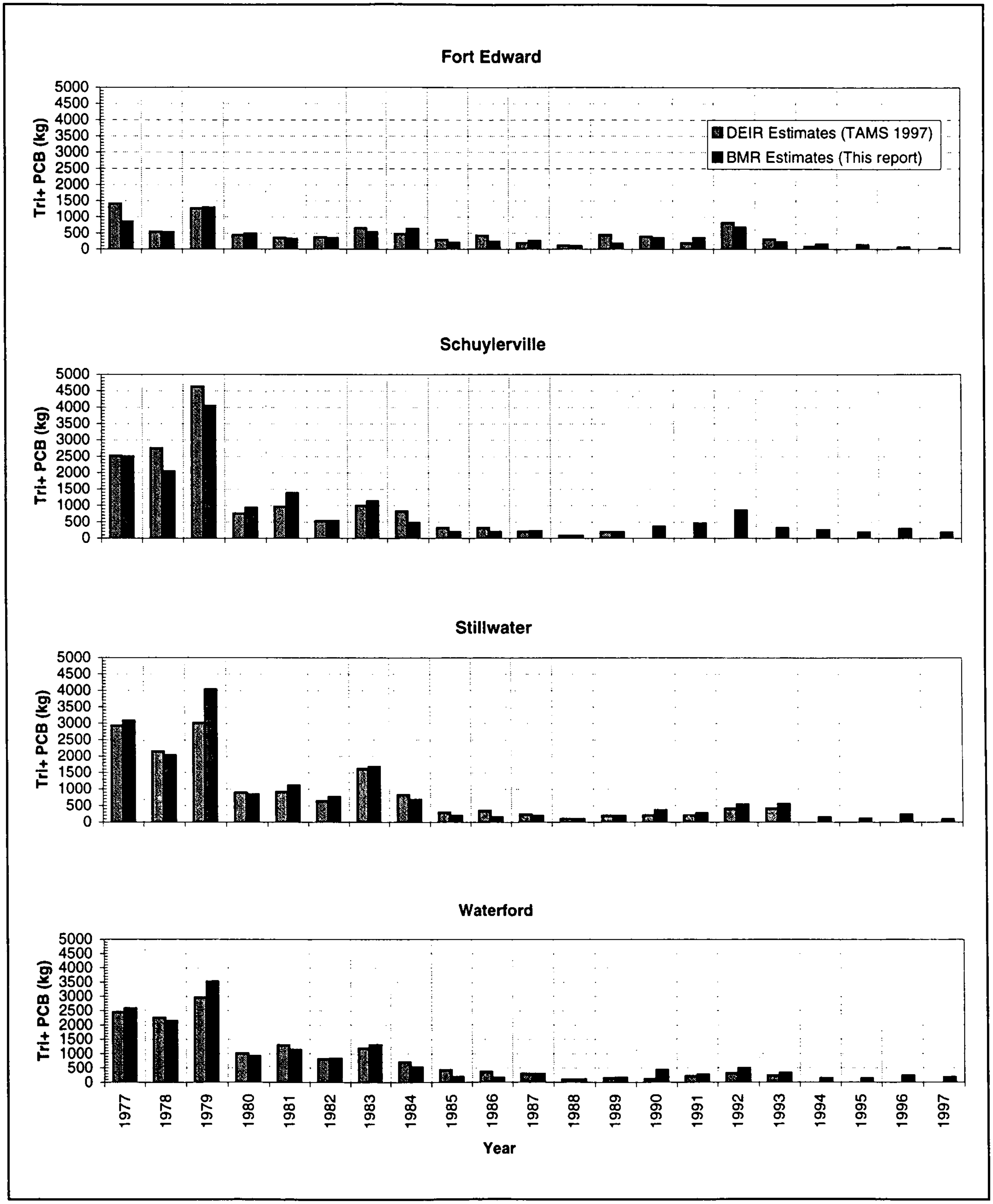

Figure 7-1
Flow Transition Levels for Gross Settling in the Thompson Island Pool
Specified for HUDTOX Calibration

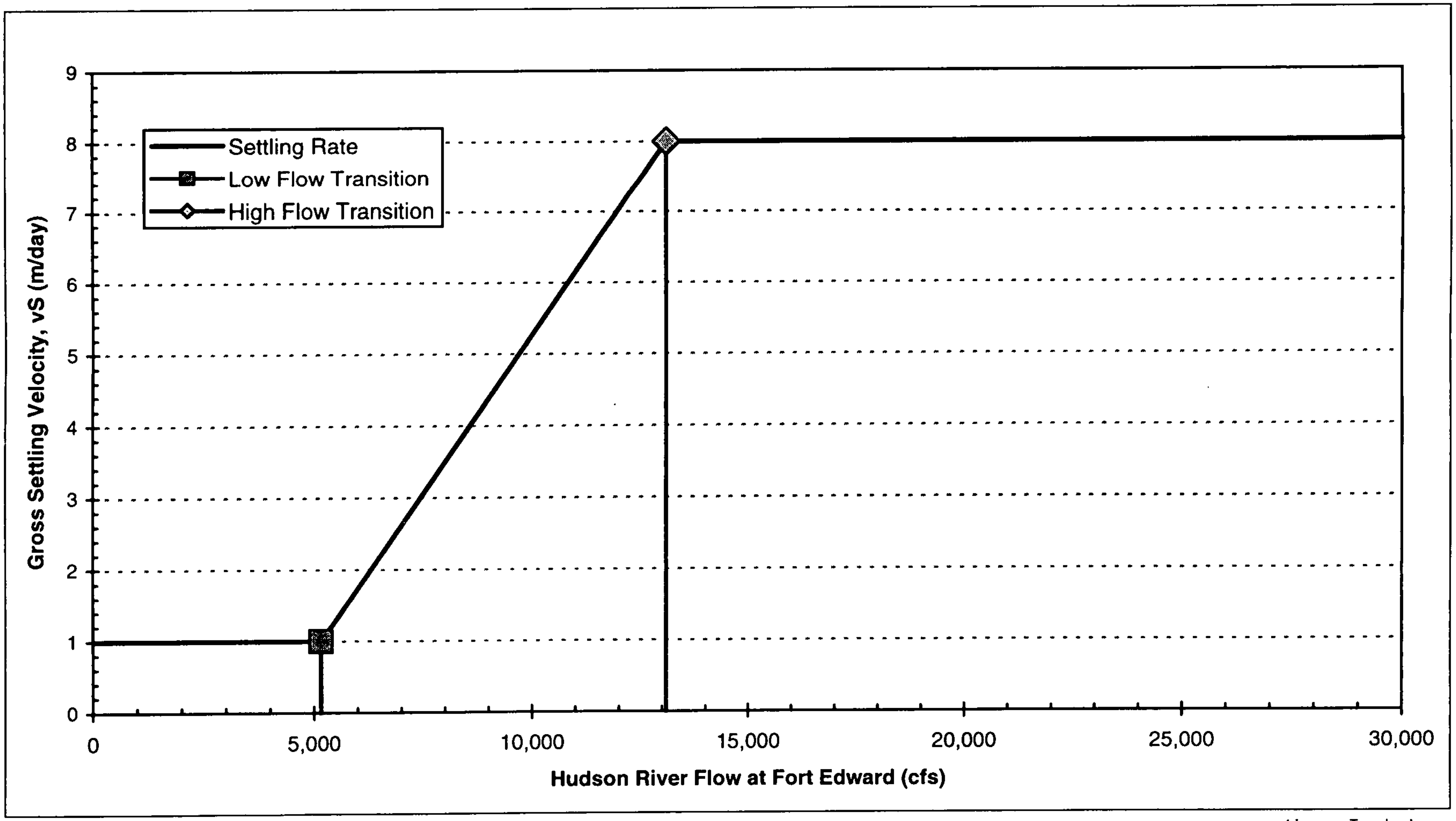

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Figure 7-2
Spring 1994 High Flow Event Settling and Resuspension Rates in HUDTOX

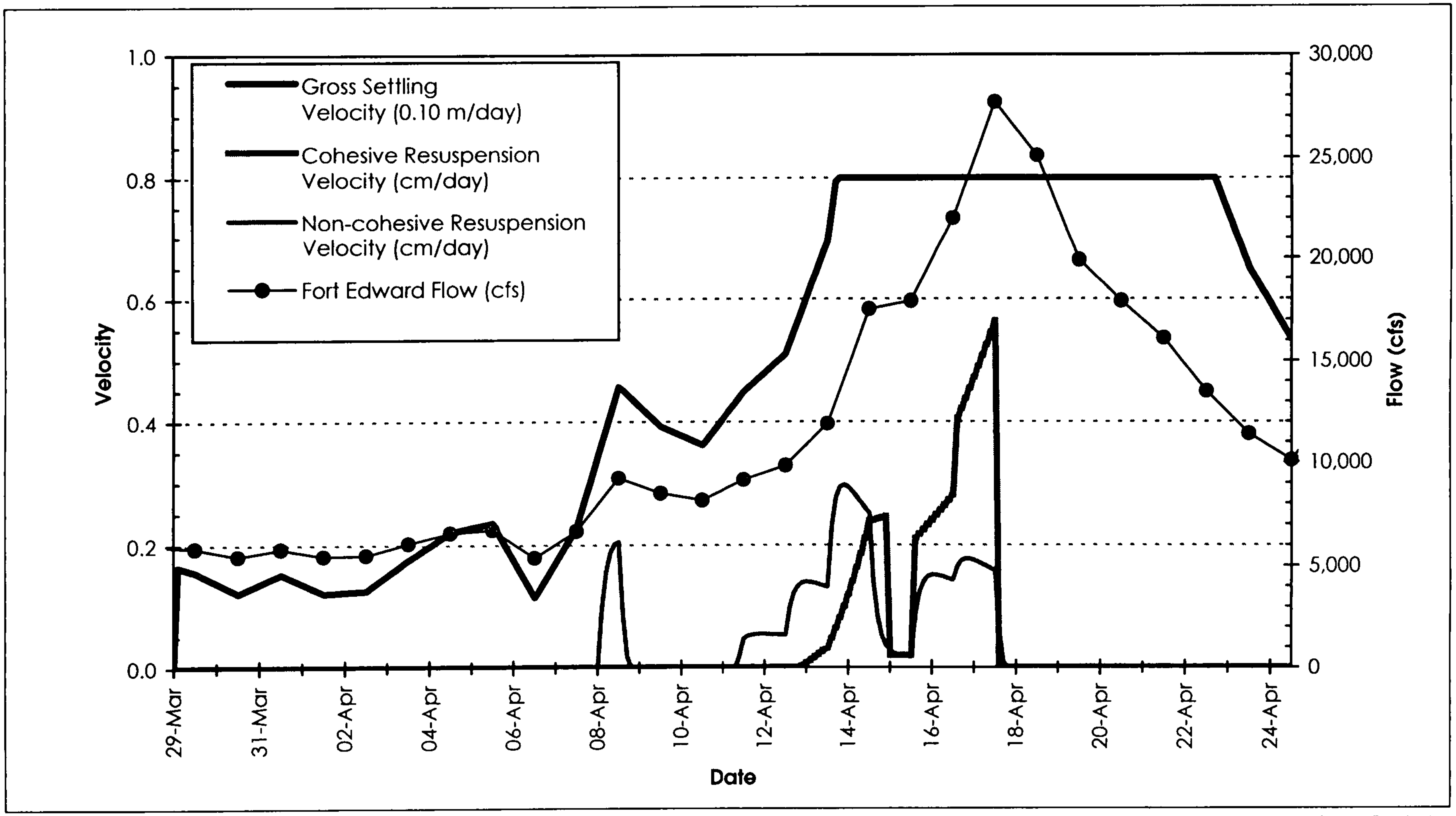

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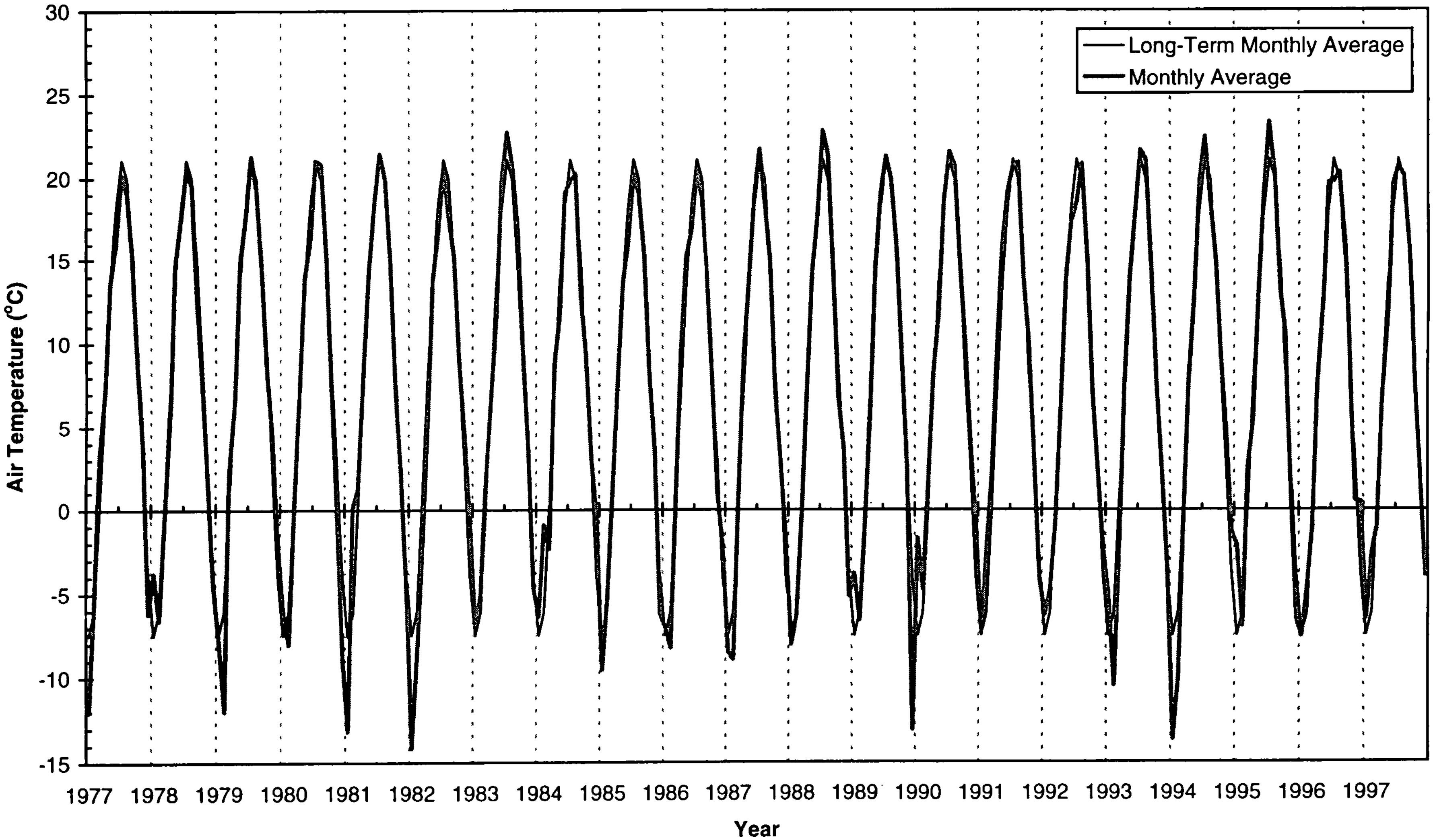
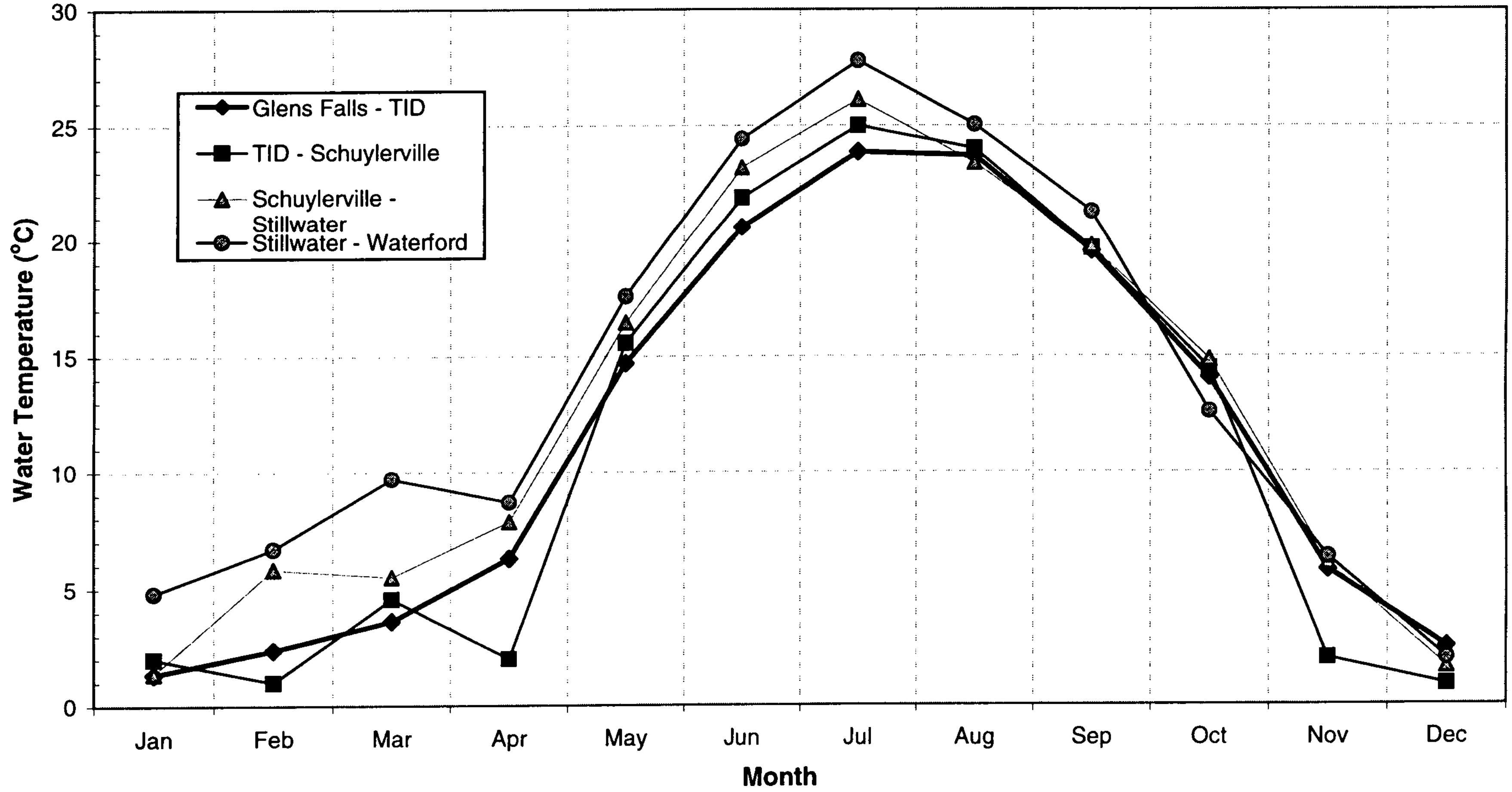
Figure 7-3

Monthly Air Temperature at Glens Falls, NewYork for 1977-1997



Source: NOAA-NCDC Summary of the Day for Glens Falls / Warren County

Figure 7-4
Monthly Average Water Temperature by Reach in the Upper Hudson River



Source: Hudson River Database Release 4.1

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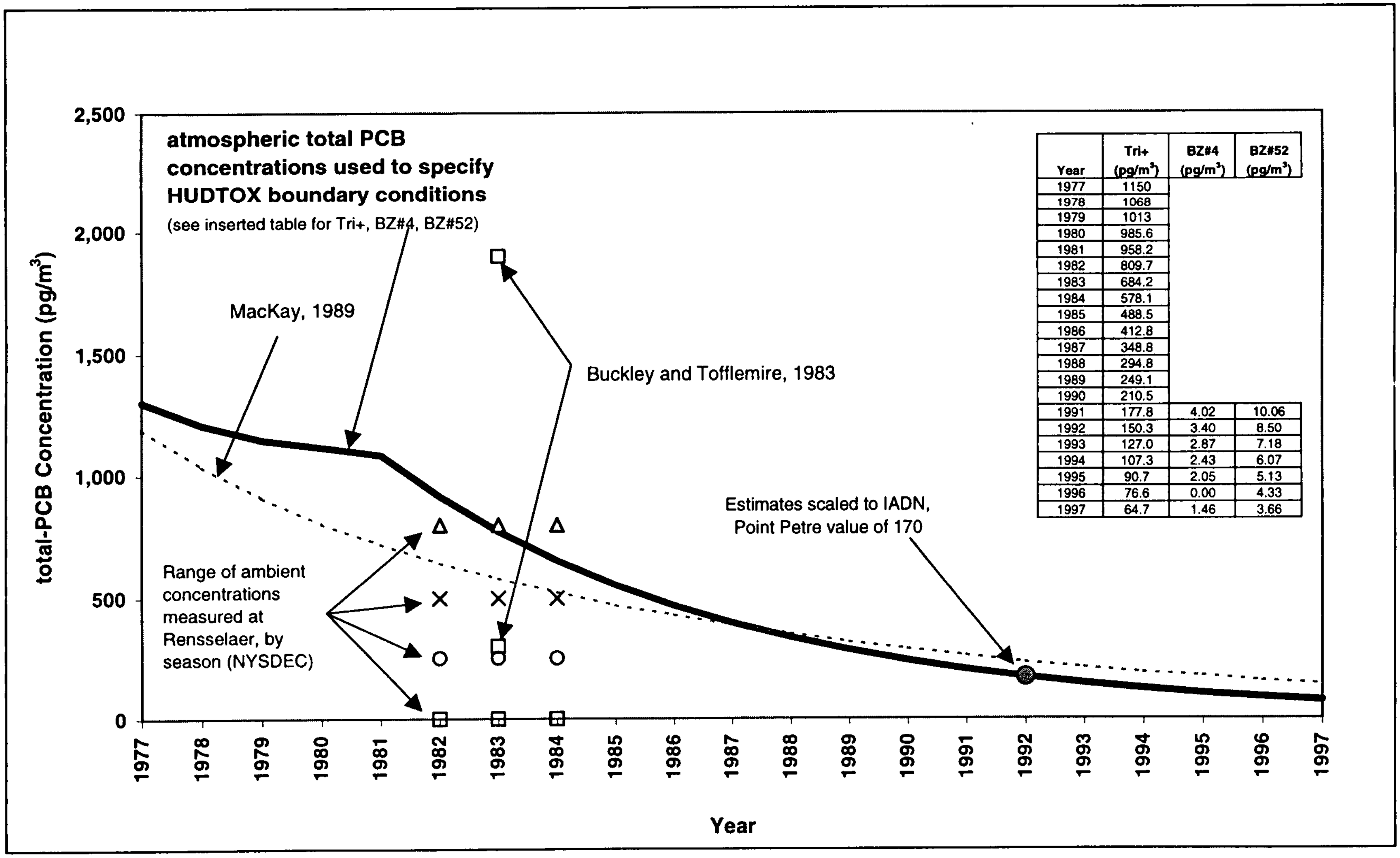
Figure 7-5
Specification of Historical Atmospheric Gas-Phase PCB Boundary Concentrations for the 1977 - 1997 HUDTOX Calibration Period



Year	Tri+ (pg/m^3)	BZ#4 (pg/m^3)	BZ#52 (pg/m^3)
1977	1150		
1978	1068		
1979	1013		
1980	985.6		
1981	958.2		
1982	809.7		
1983	684.2		
1984	578.1		
1985	488.5		
1986	412.8		
1987	348.8		
1988	294.8		
1989	249.1		
1990	210.5		
1991	177.8	4.02	10.06
1992	150.3	3.40	8.50
1993	127.0	2.87	7.18
1994	107.3	2.43	6.07
1995	90.7	2.05	5.13
1996	76.6	0.00	4.33
1997	64.7	1.46	3.66

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Figure 7-6a
HUDTOX Annual Surficial Sediment Porewater Diffusive Mass Transfer Rates for Cohesive and Non-cohesive Sediment

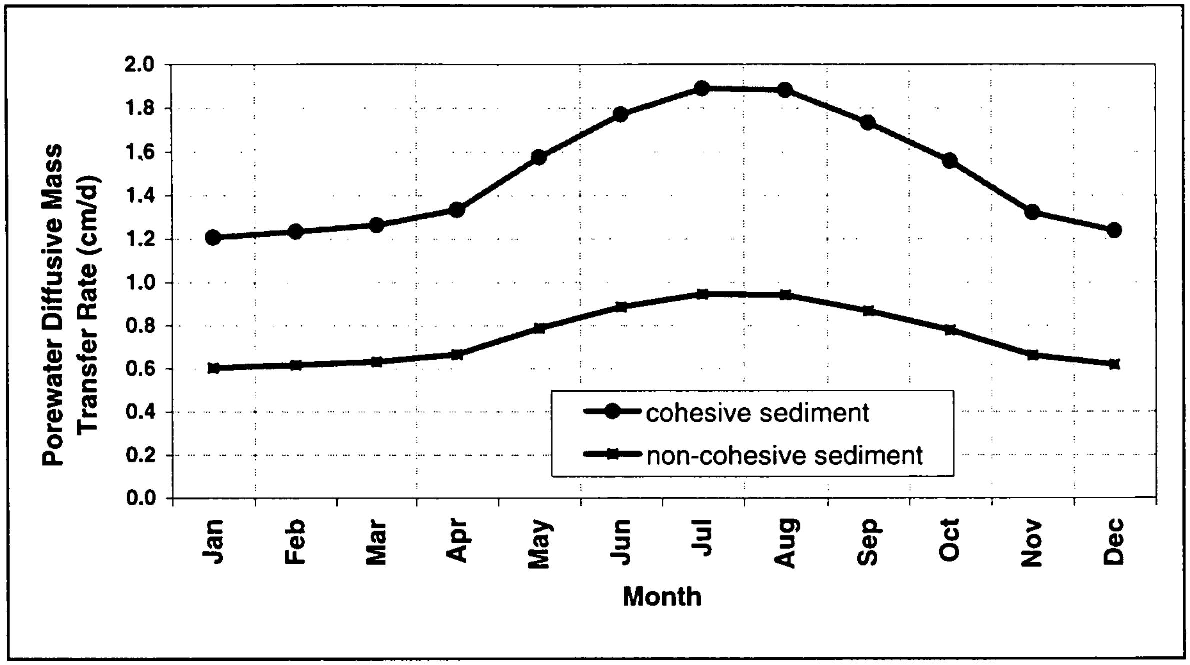


Figure 7-6b
HUDTOX Reach-Specific Annual Particulate Chemical Mass Transfer Rates

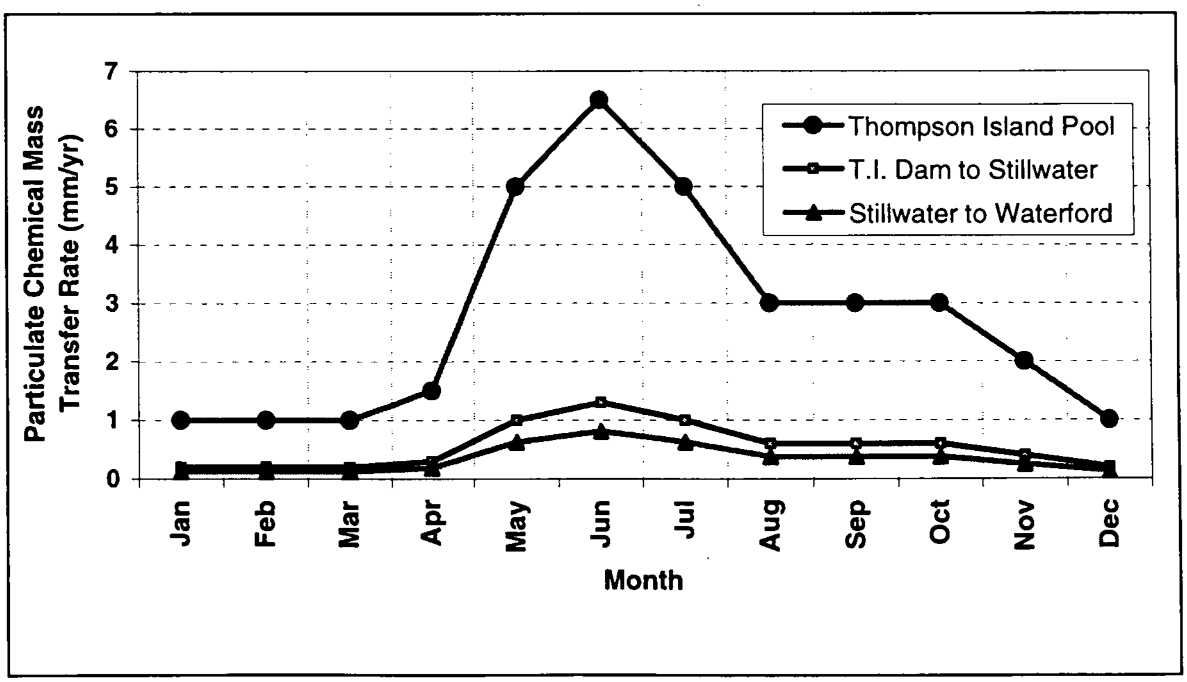
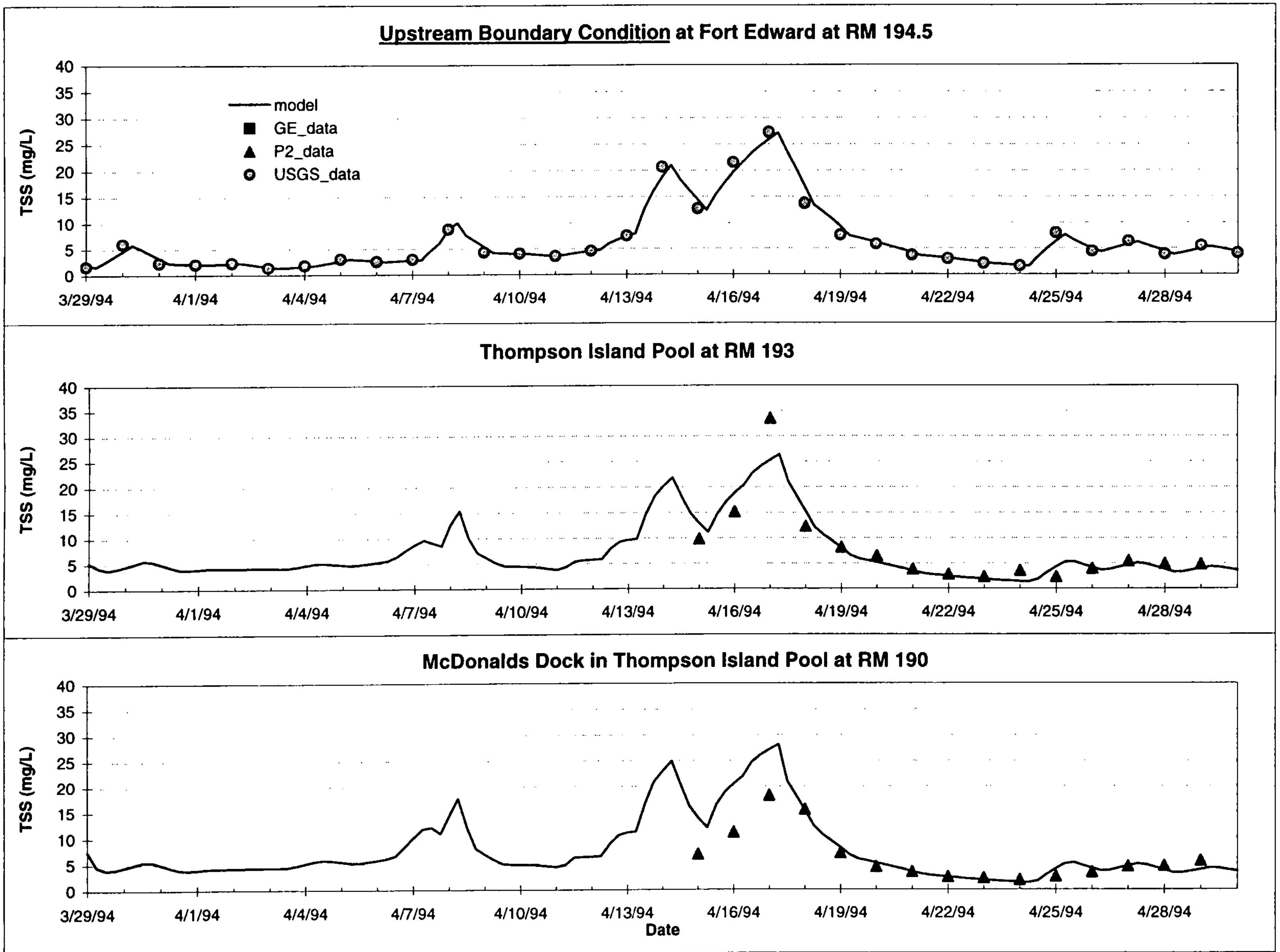


Figure 7-7a
Spring 1994 Total Suspended Solids HUDTOX Calibration Results



Data Source: Hudson River Database Release 4.1

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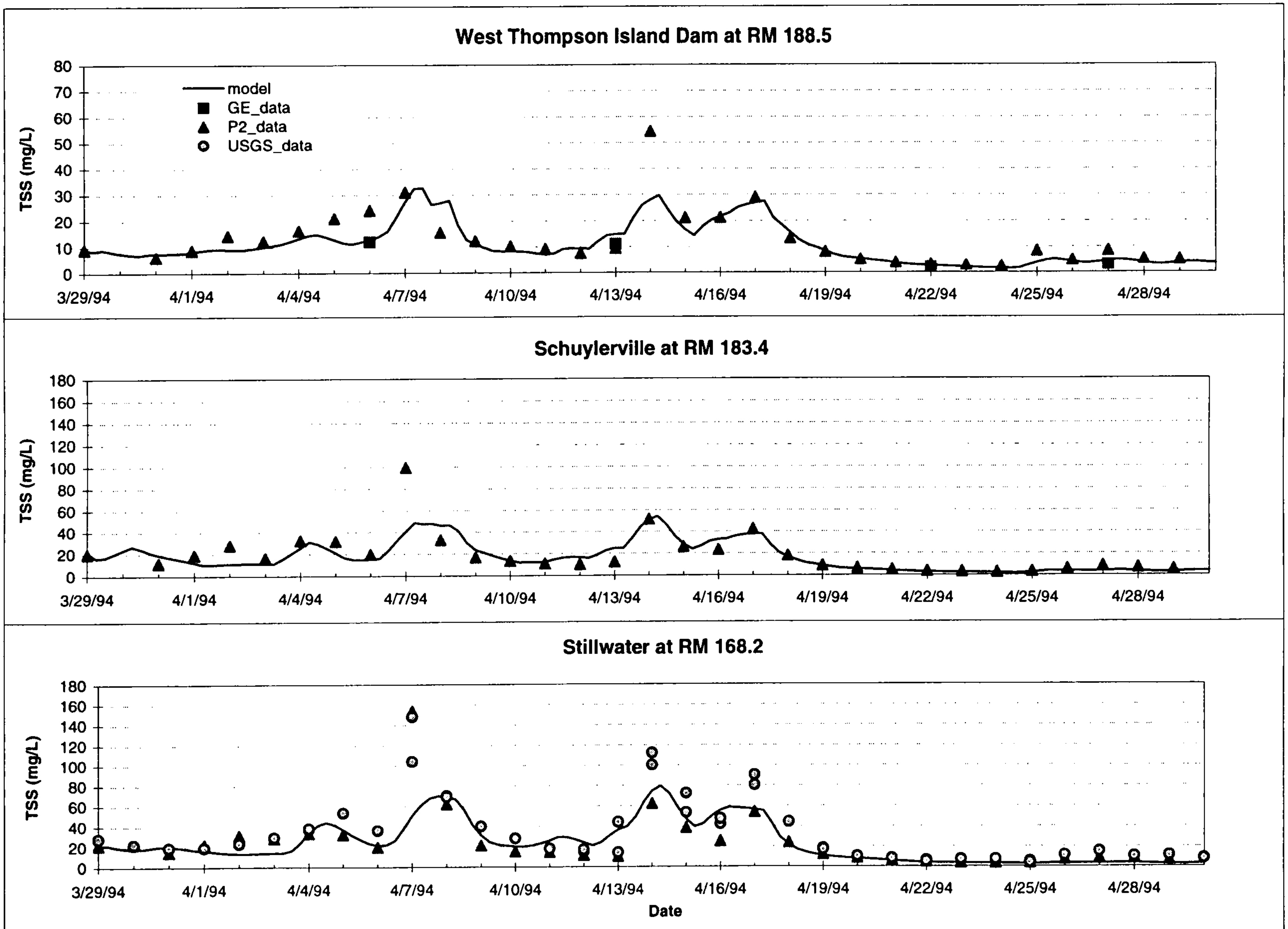
Figure 7-7b
Spring 1994 Total Suspended Solids HUDTOX Calibration Results



Data Source: Hudson River Database Release 4.1

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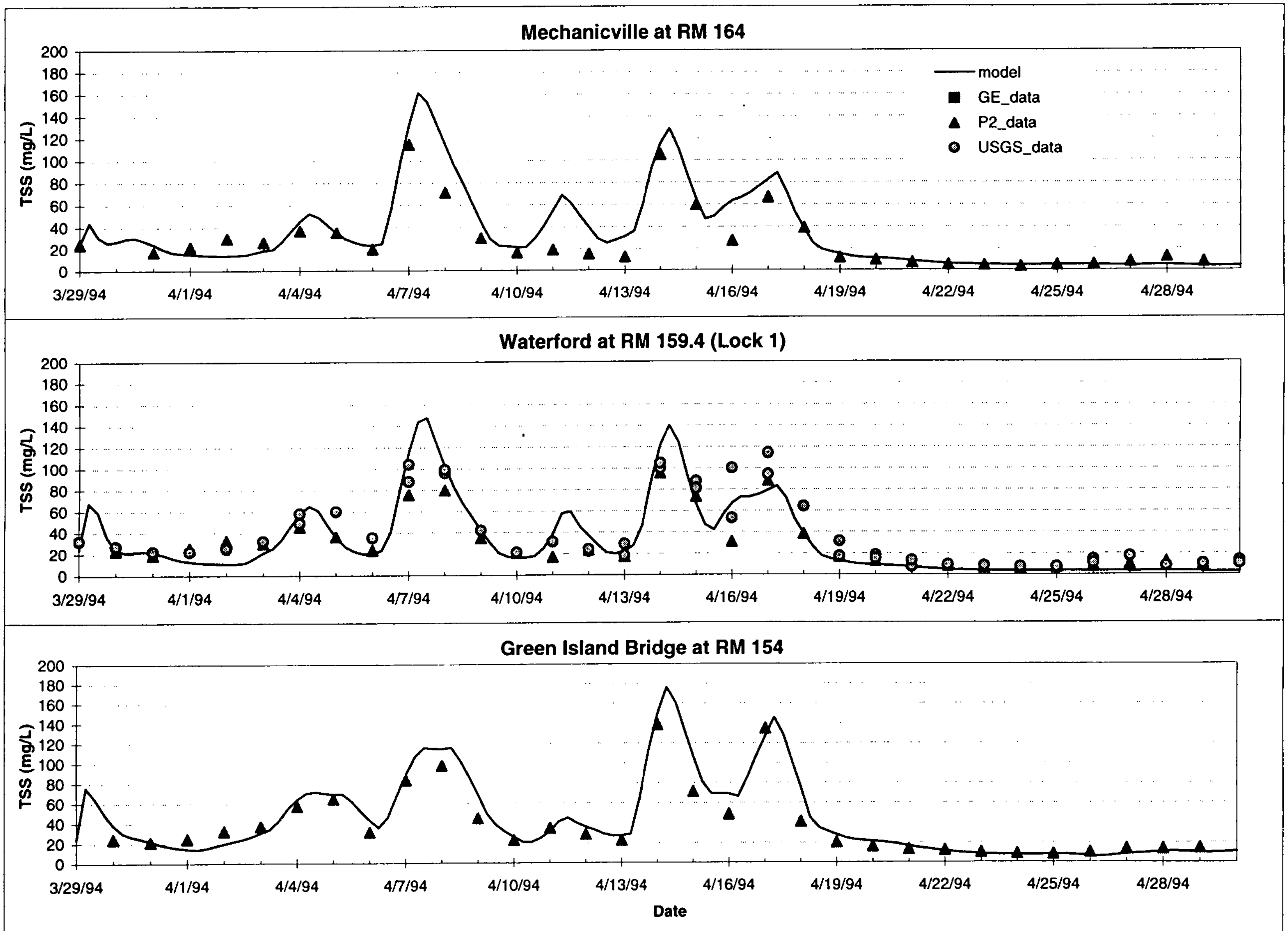
Figure 7-7c
Spring 1994 Total Suspended Solids HUDTOX Calibration Results



Data Source: Hudson River Database Release 4.1

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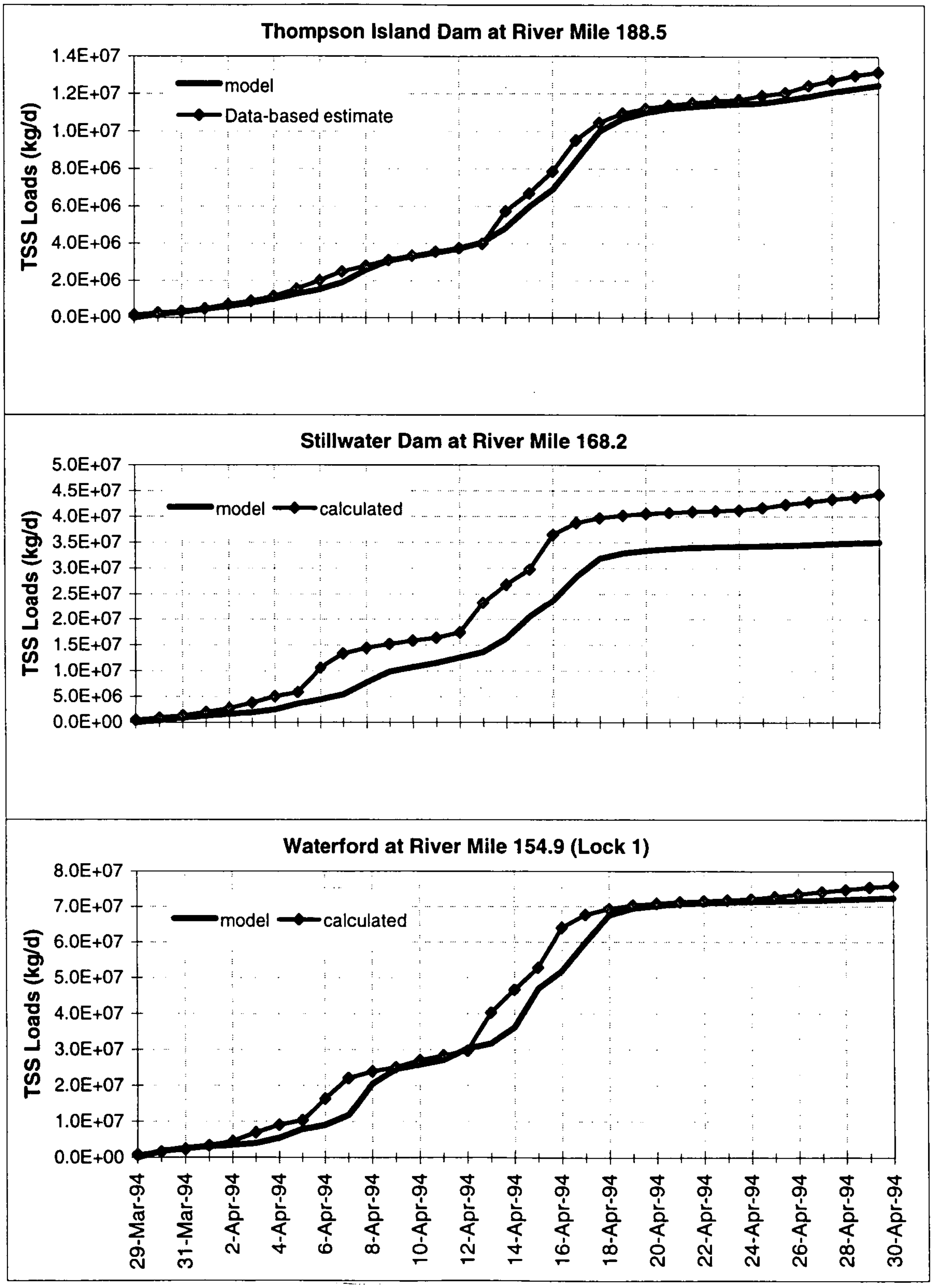
Figure 7-8
Spring 1994 HUDTOX-Computed versus Estimated Cumulative TSS Flux



Data Source: Hudson River Database Release 4.1

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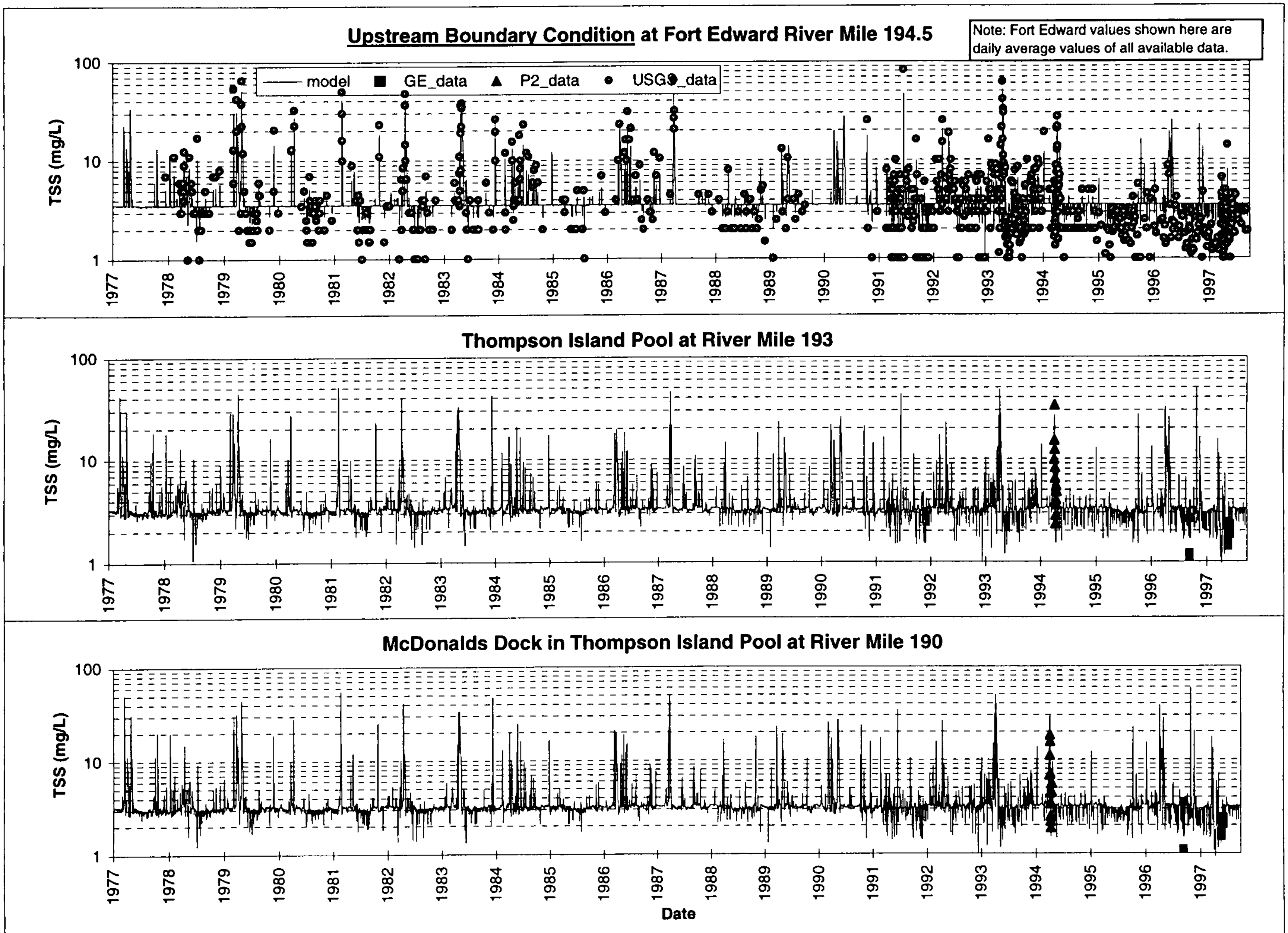
Figure 7-9a
1977-1997 Total Suspended Solids HUDTOX Calibration Results



Data Source: Hudson River Database Release 4.1

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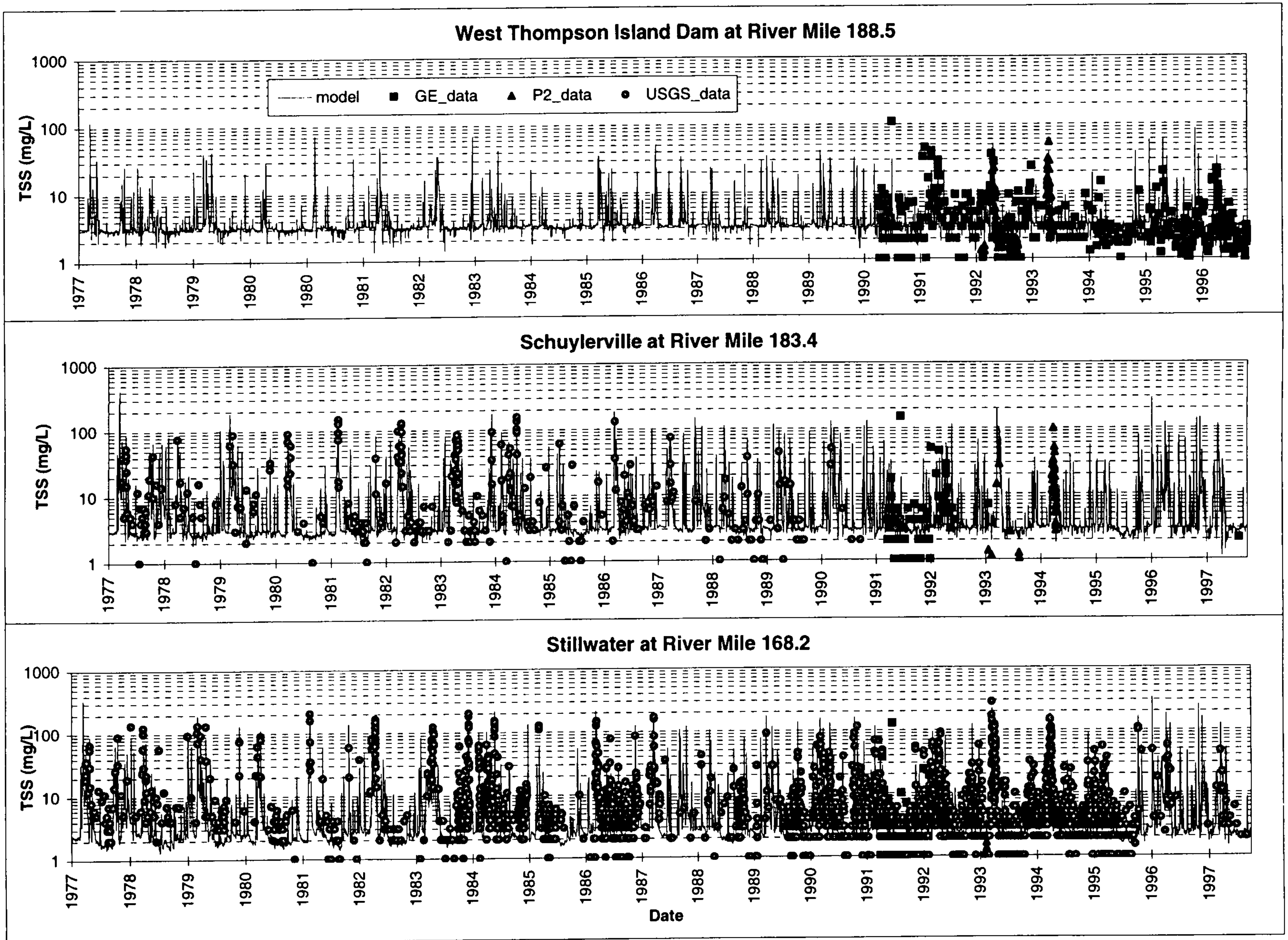
Figure 7-9b
1977-1997 Total Suspended Solids HUDTOX Calibration Results



Data Source:Hudson River Database Release 4.1

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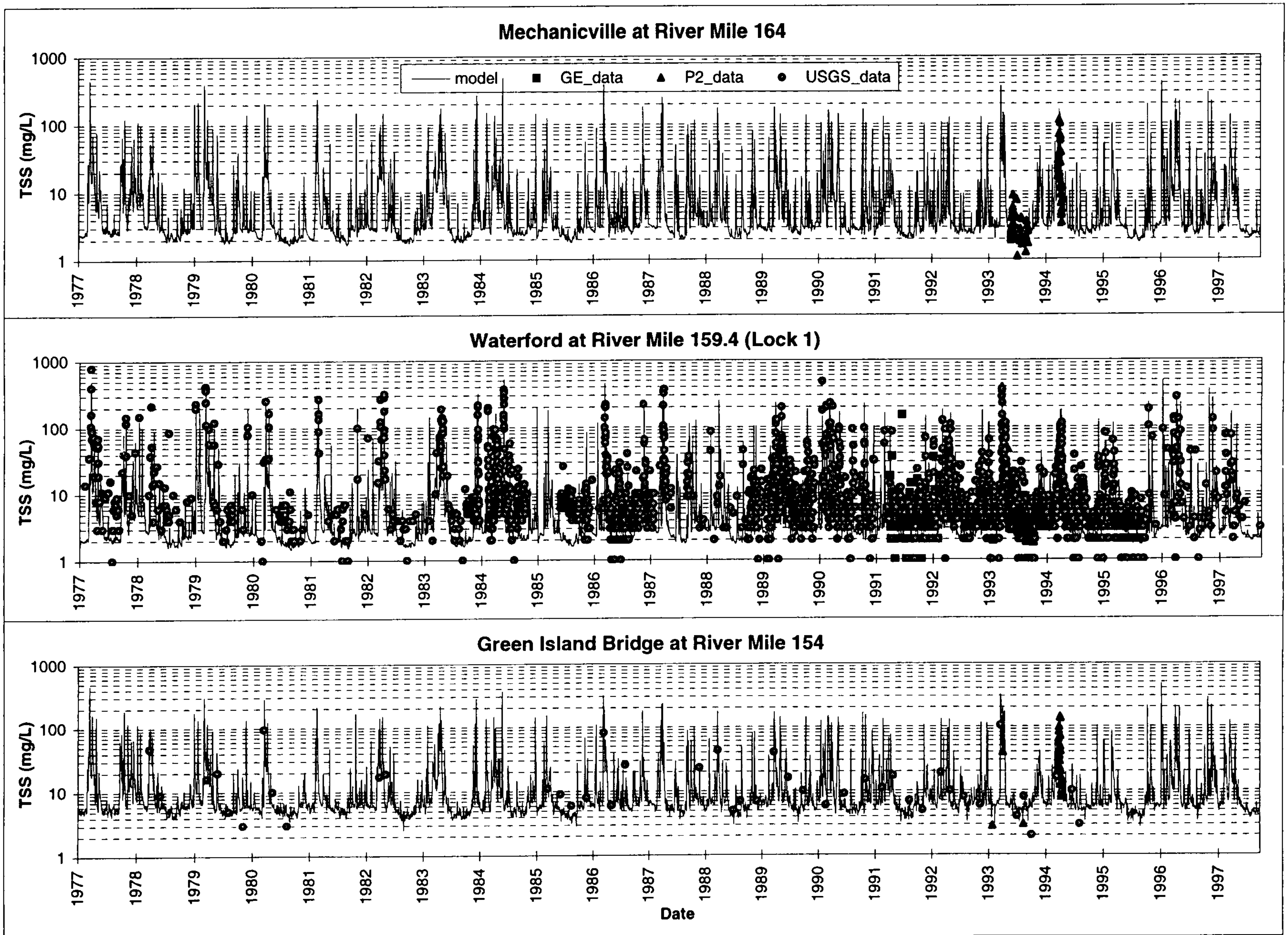
Figure 7-9c
1977-1997 Total Suspended Solids HUDTOX Calibration Results



Data Source: Hudson River Database Release 4.1

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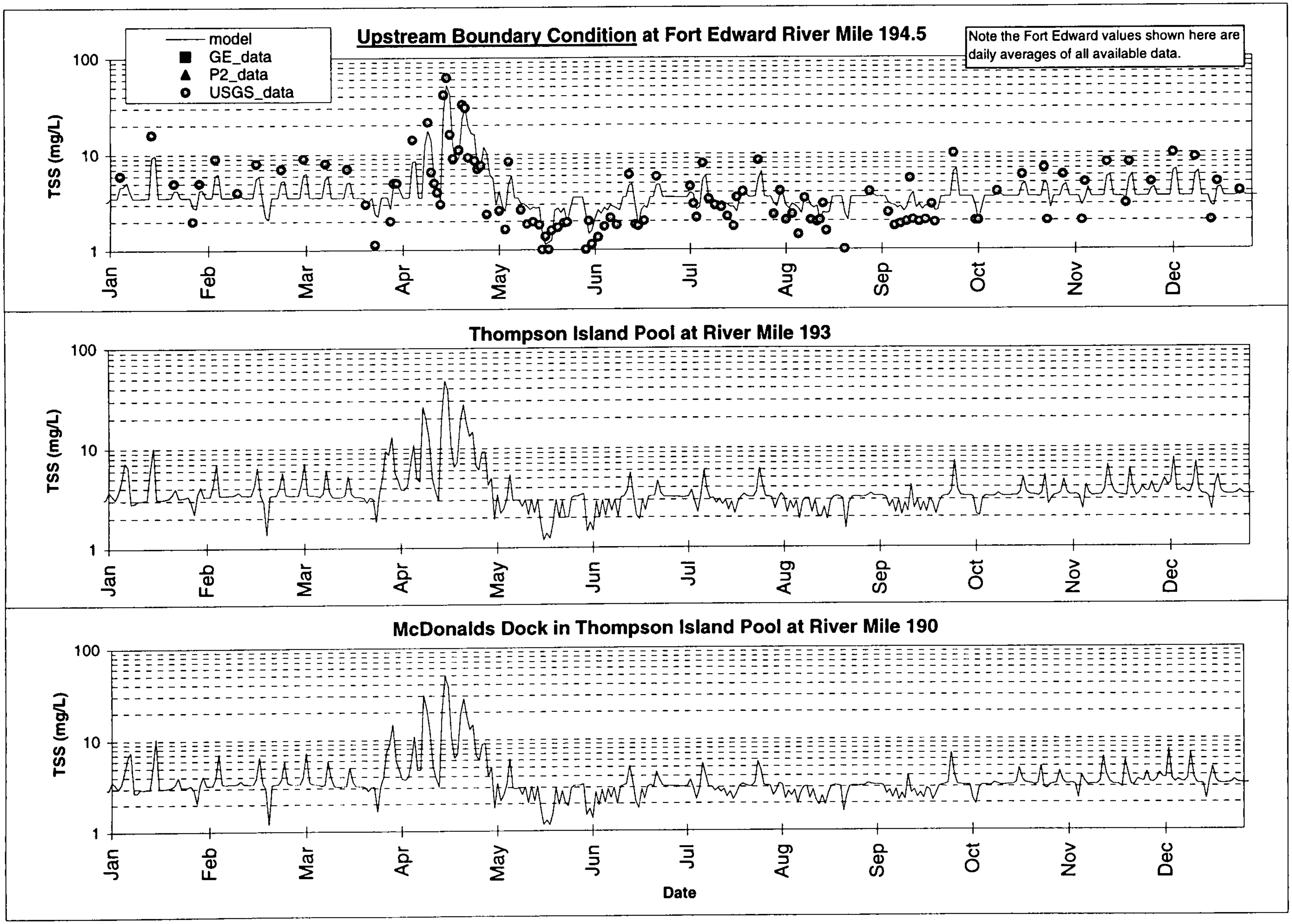
Figure 7-10a
1993 Total Suspended Solids HUDTOX Calibration Results



Data Source: Hudson River Database Release 4.1

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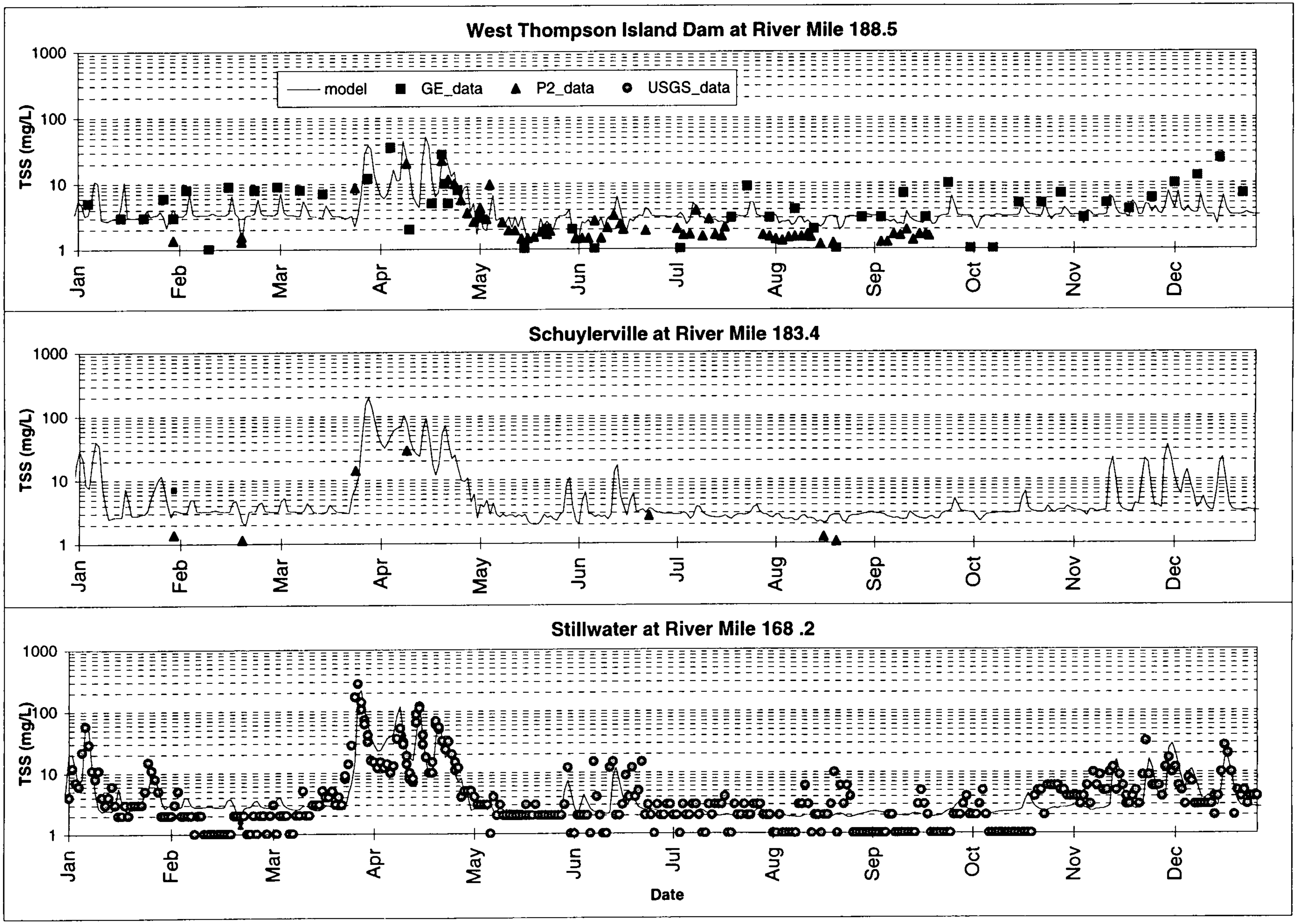
Figure 7-10b
1993 Total Suspended Solids HUDTOX Calibration Results



Data Source: Hudson River Database Release 4.1

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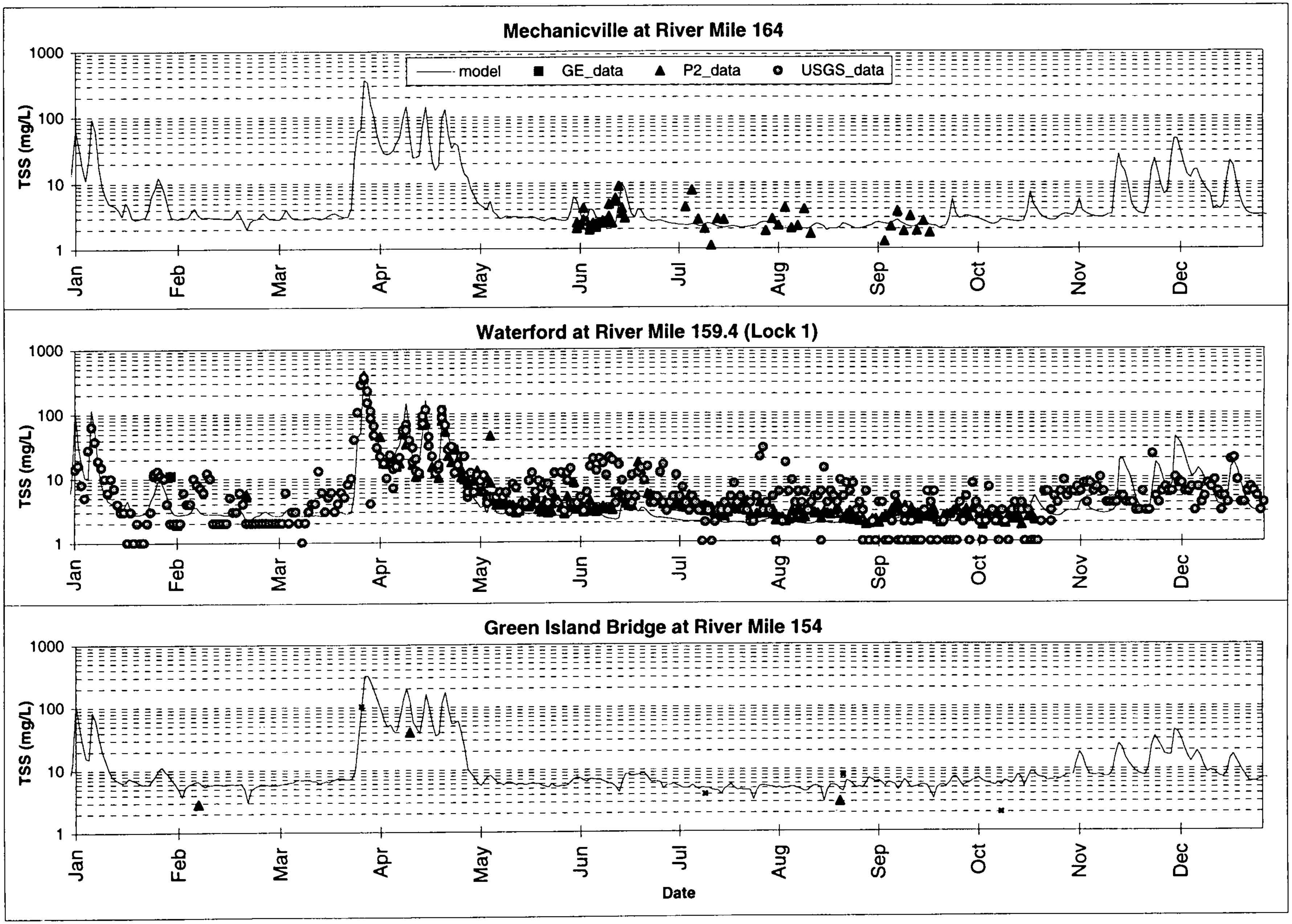
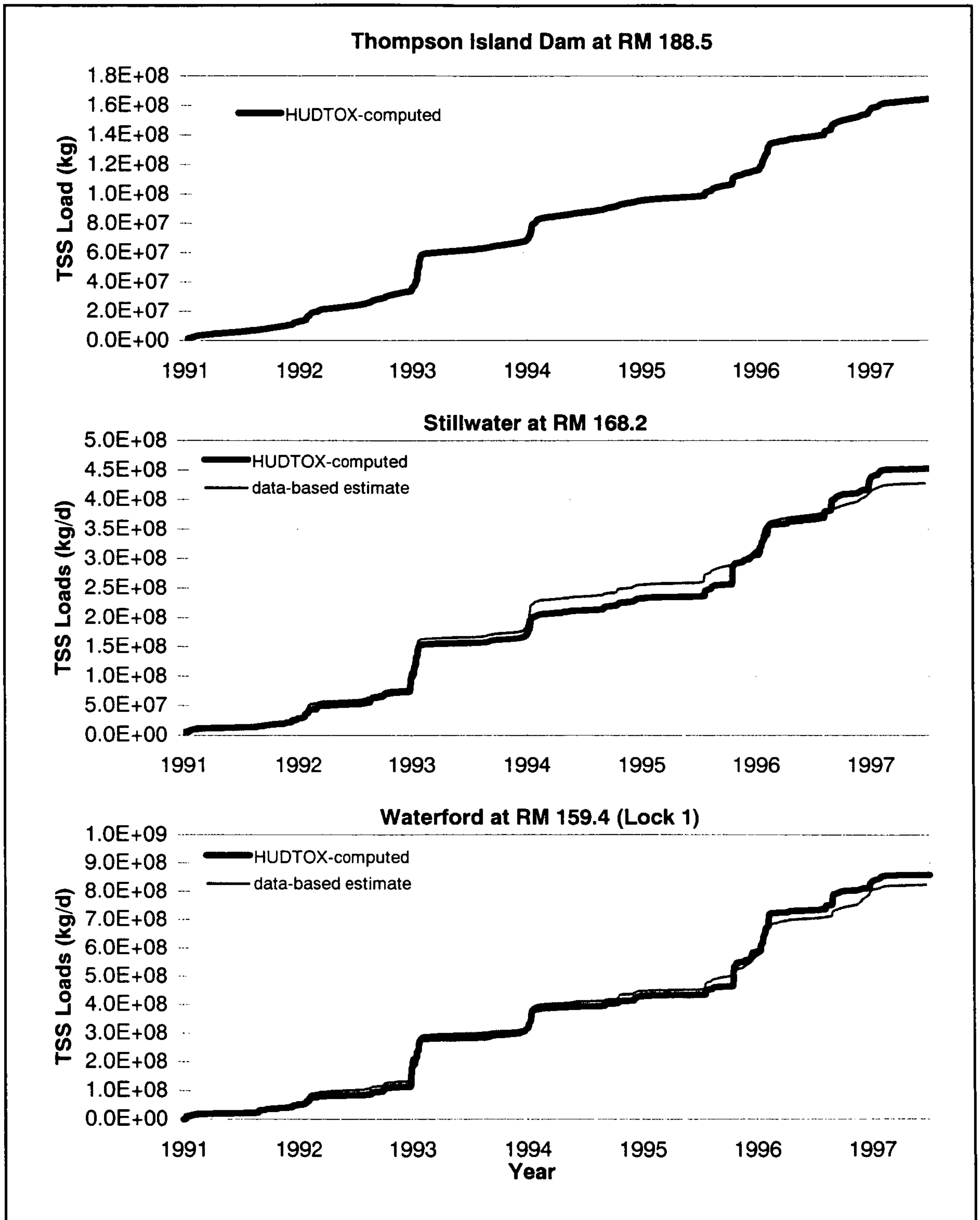
Figure 7-10c
1993 Total Suspended Solids HUDTOX Calibration Results



Data Source: Hudson River Database Release 4.1

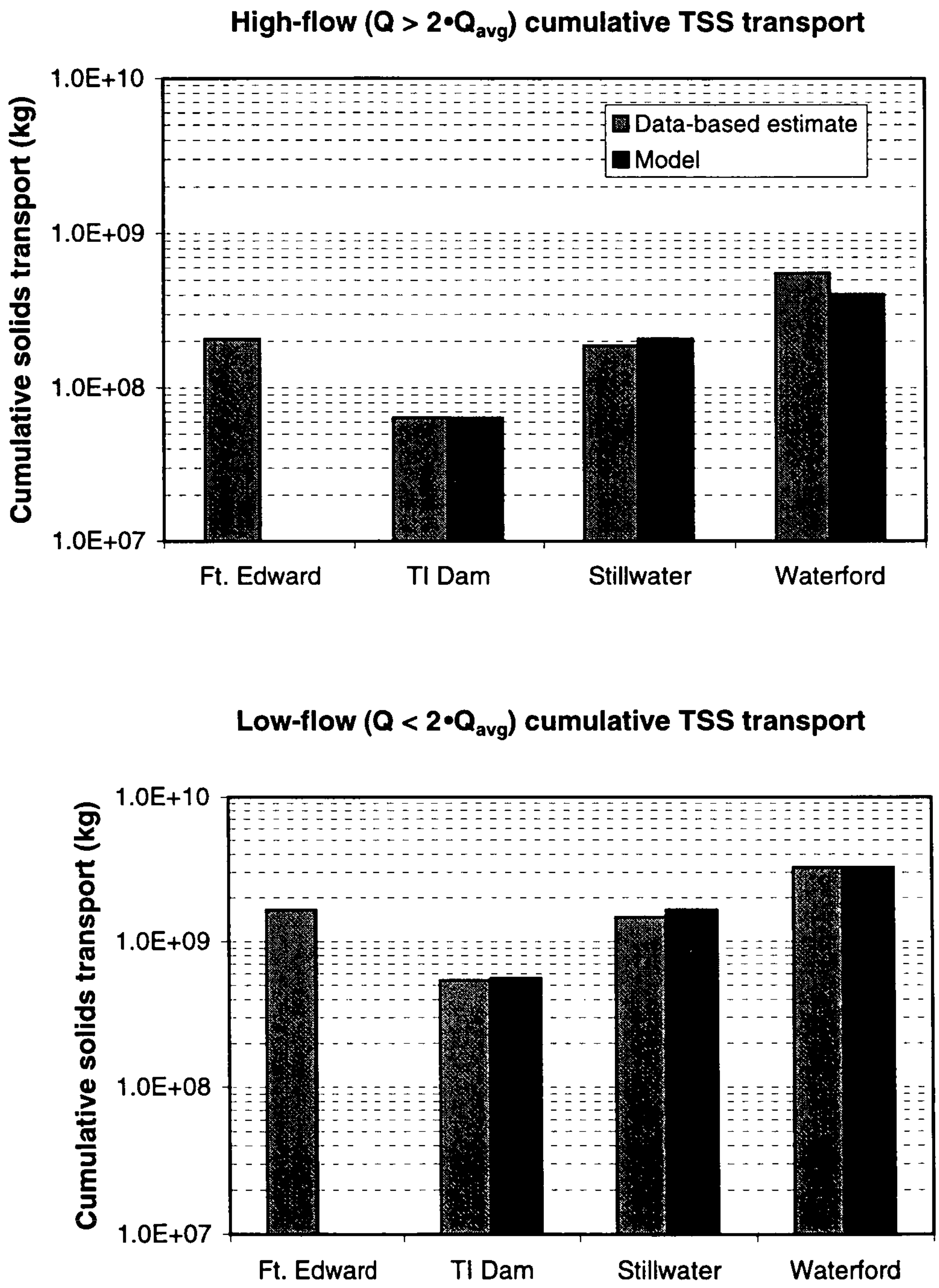
Limno-Tech, Inc.

Figure 7-11
1991-1997 HUDTOX-Computed versus Estimated Cumulative TSS Flux



Data Source: Hudson River Database Release 4.1 Limno-Tech, Inc.

Figure 7-12
1977-1997 Cumulative HUDTOX-computed Versus Estimated Solids Transport at High and Low Flows* Past Mainstem Hudson River Sampling Stations



*High flow is defined as flow greater than 2 times the average flow at each station.
Data Source: Hudson River Database Release 4.1

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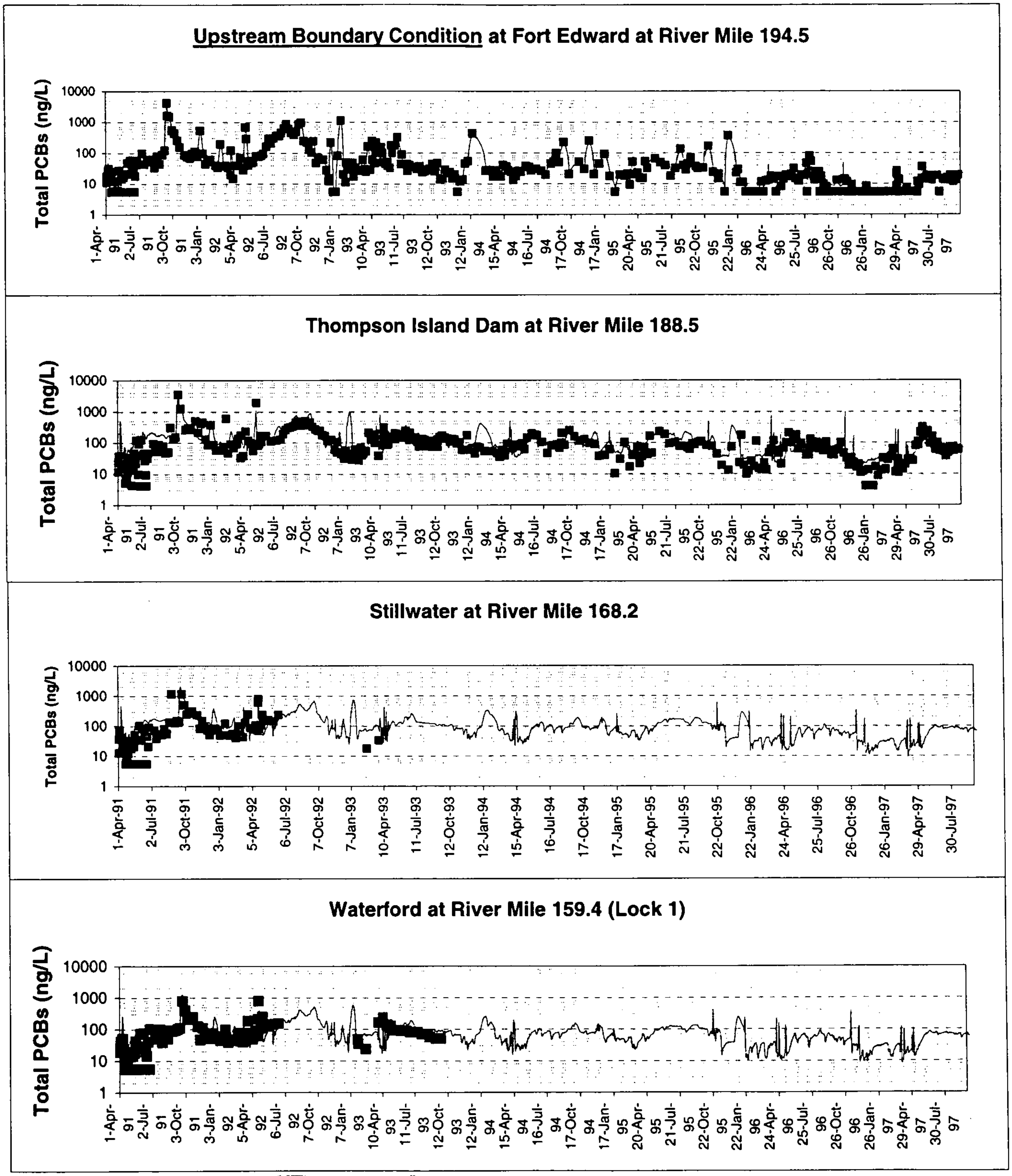
Figure 7-13
1991-1997 HUDTOX-Computed versus Observed Total PCB Concentrations



Data Source: Hudson River Database Release 4.1

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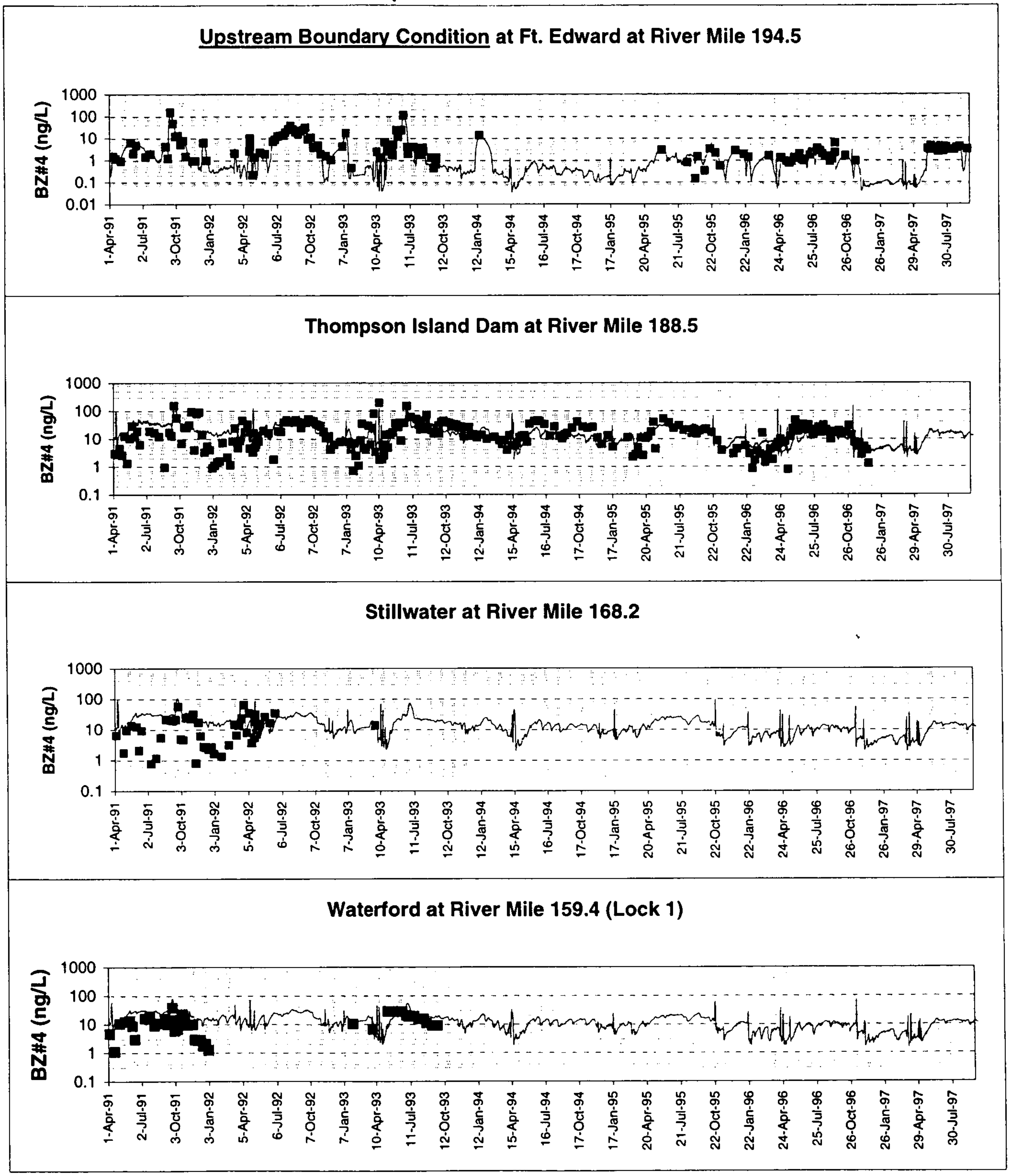
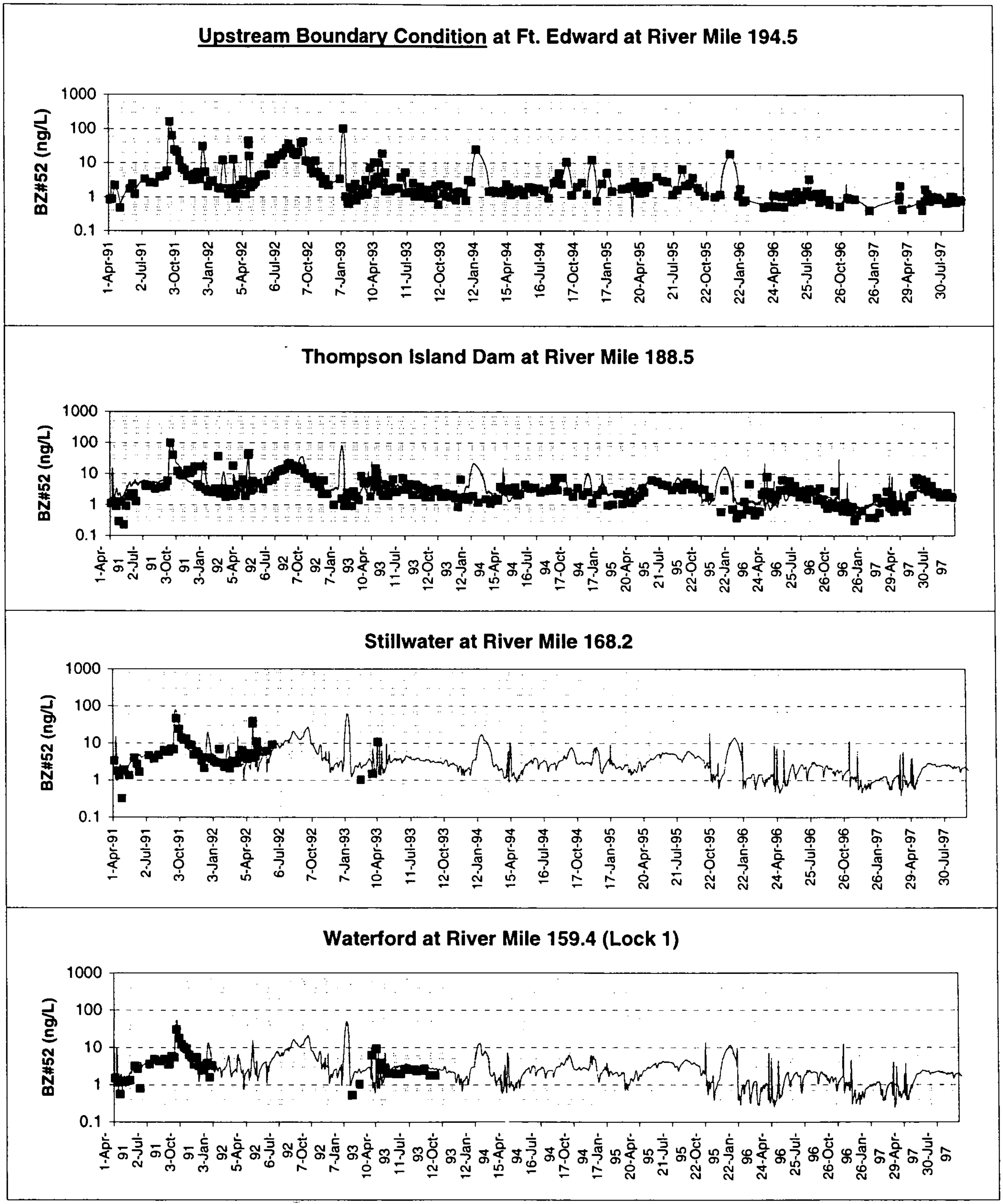
Figure 7-14
1991-1997 HUDTOX-Computed versus Observed BZ#4 Concentrations



Data Source: Hudson River Database Release 4.1 Limno Tech, Inc.

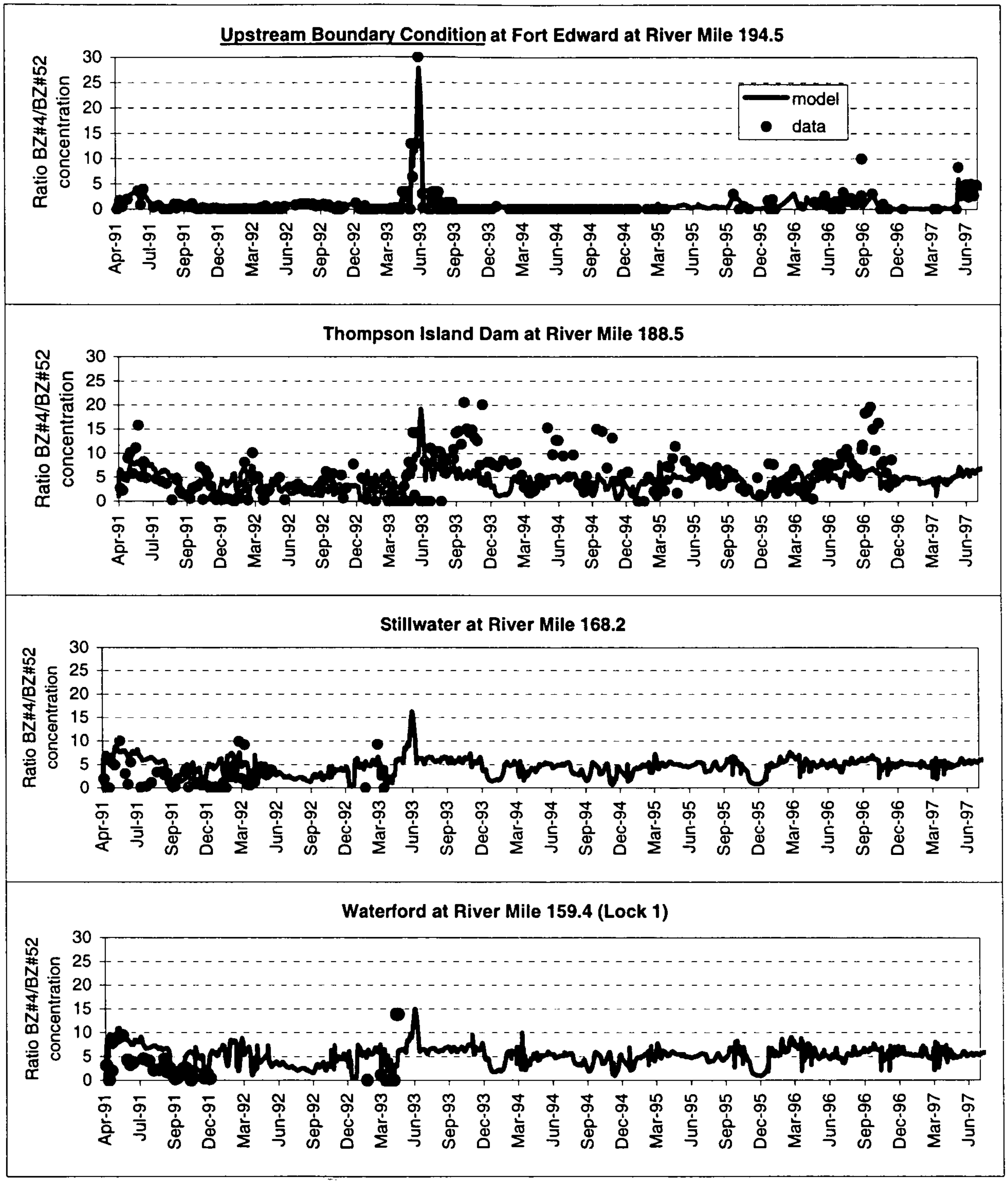
Figure 7-15
1991-1997 HUDTOX-computed versus observed BZ#52 concentrations



Data Source: Hudson River Database Release 4.1

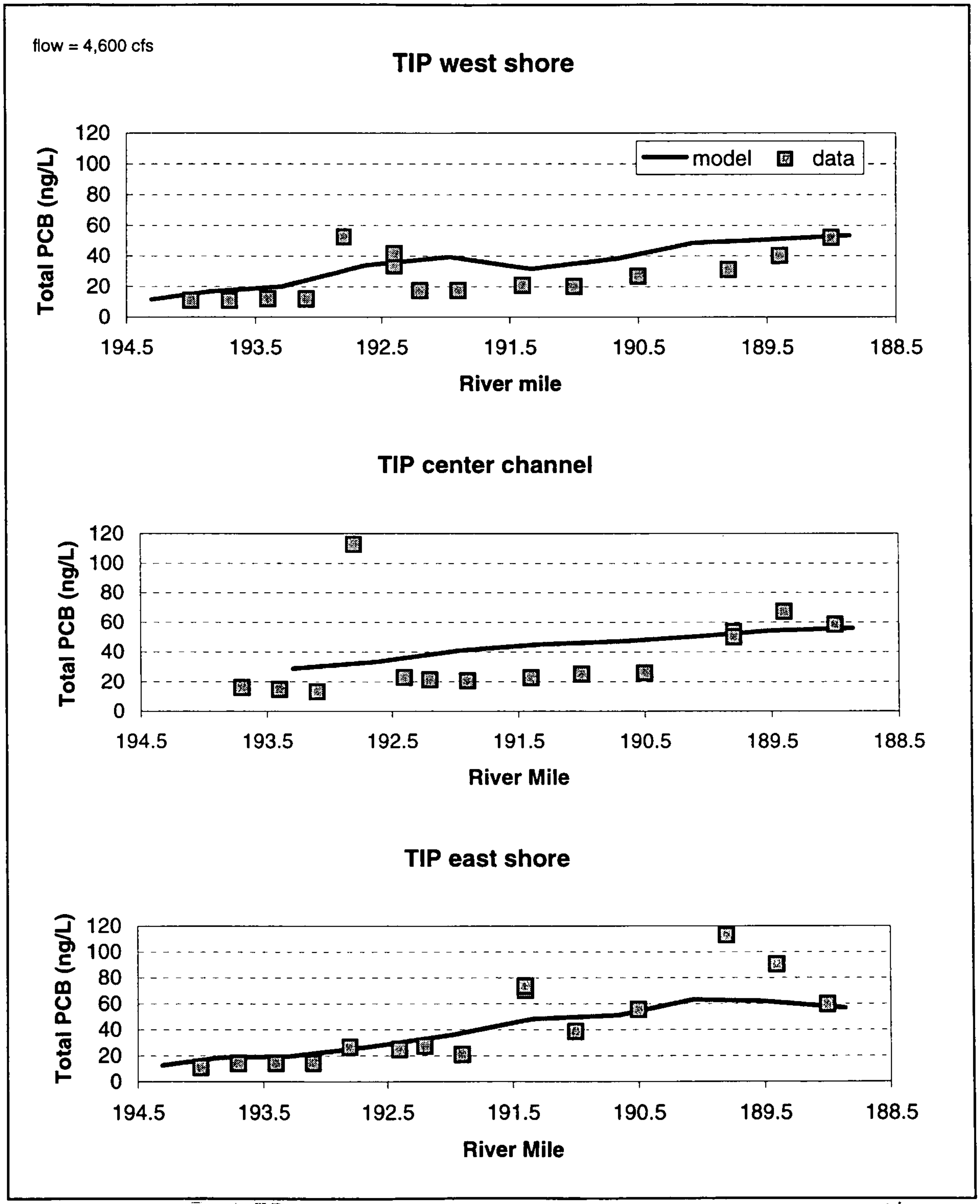
Limno Tech, Inc.

Figure 7-16
Observed versus Computed Water Column BZ#4 to BZ#52 Concentration Ratios



Data Source: Hudson River Database Release 4.1 Limno Tech, Inc.

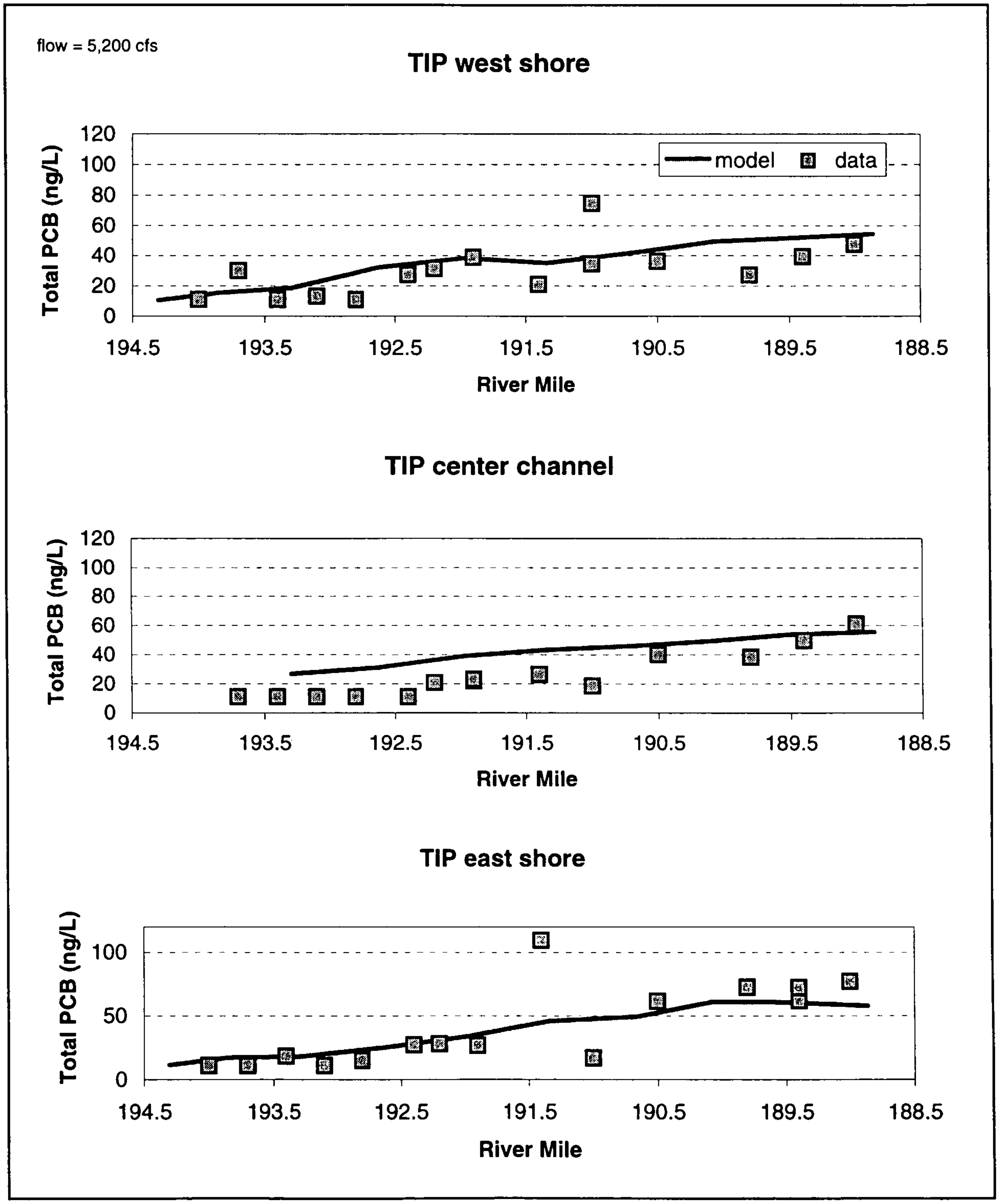
Figure 7-17a
Computed versus Observed Total PCB Concentrations through TIP during the GE September 24, 1996 Time of Travel Survey



Data Source: Hudson River Database Release 4.1

Limno Tech, Inc.

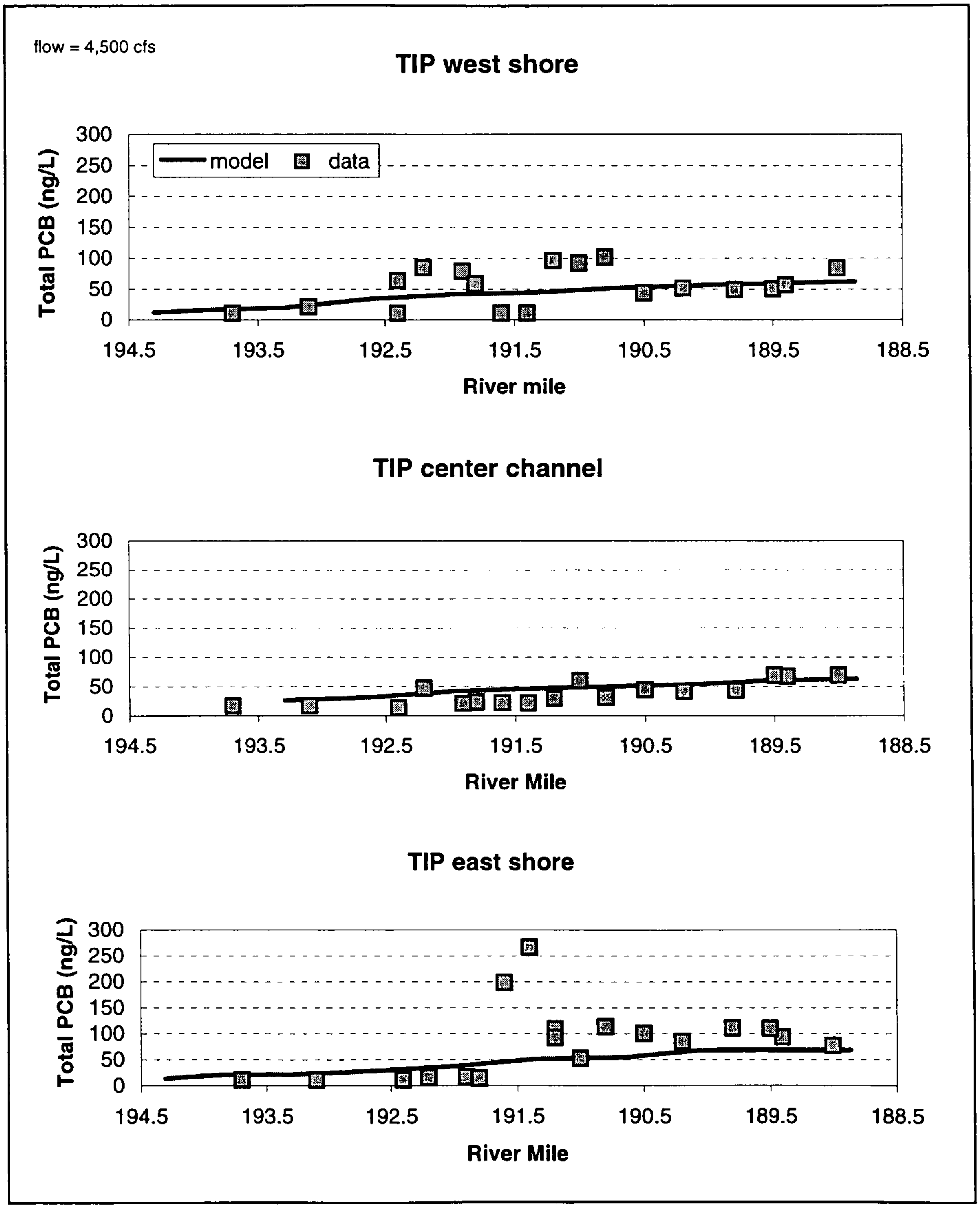
Figure 7-17b
Computed versus Observed Total PCB Concentrations through TIP during the GE September 25, 1996 Time of Travel Survey



Data Source: Hudson River Database Release 4.1

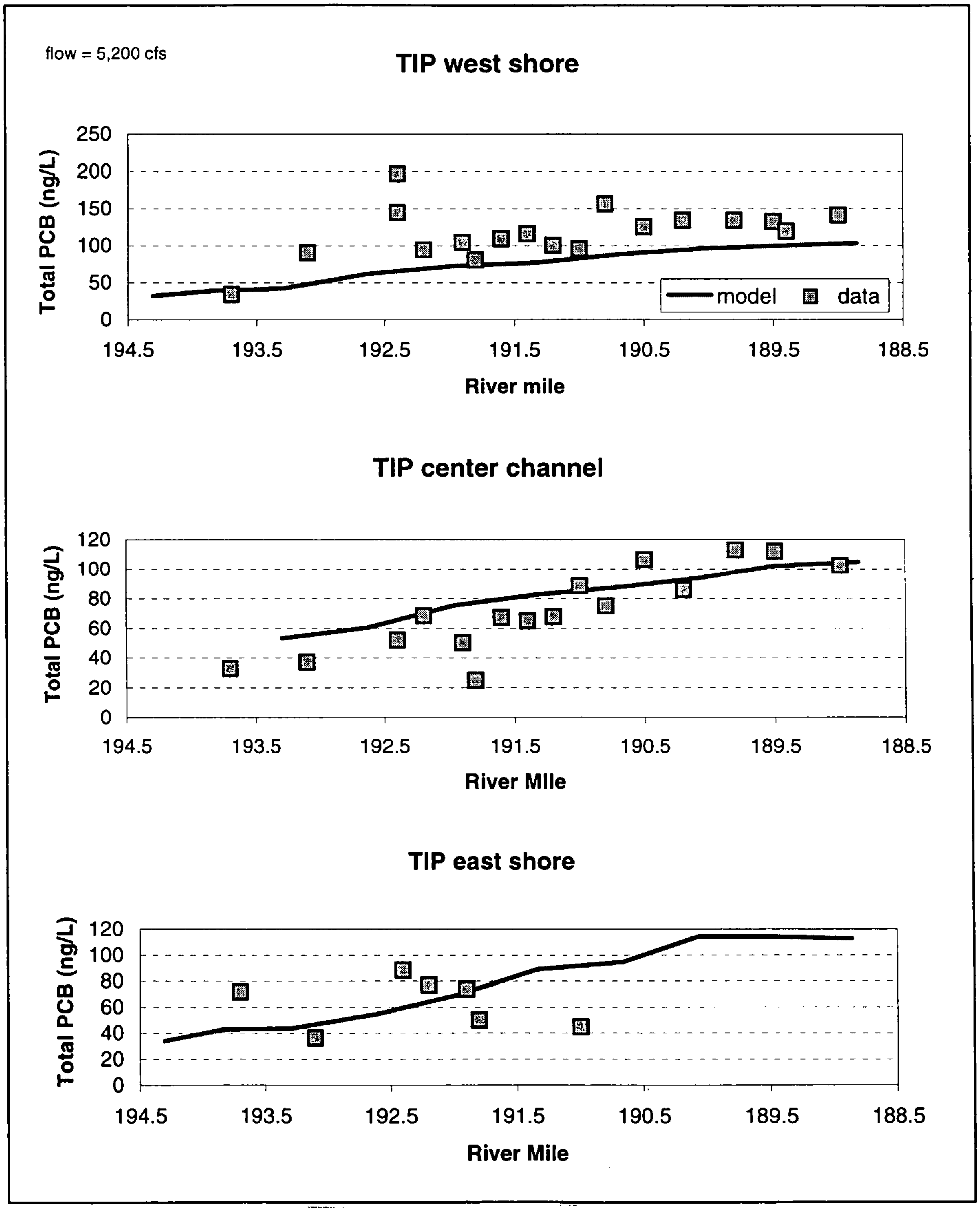
Limno Tech, Inc.

Figure 7-17c
Computed versus Observed Total PCB Concentrations through TIP during the GE June 4, 1997 Time of Travel Survey



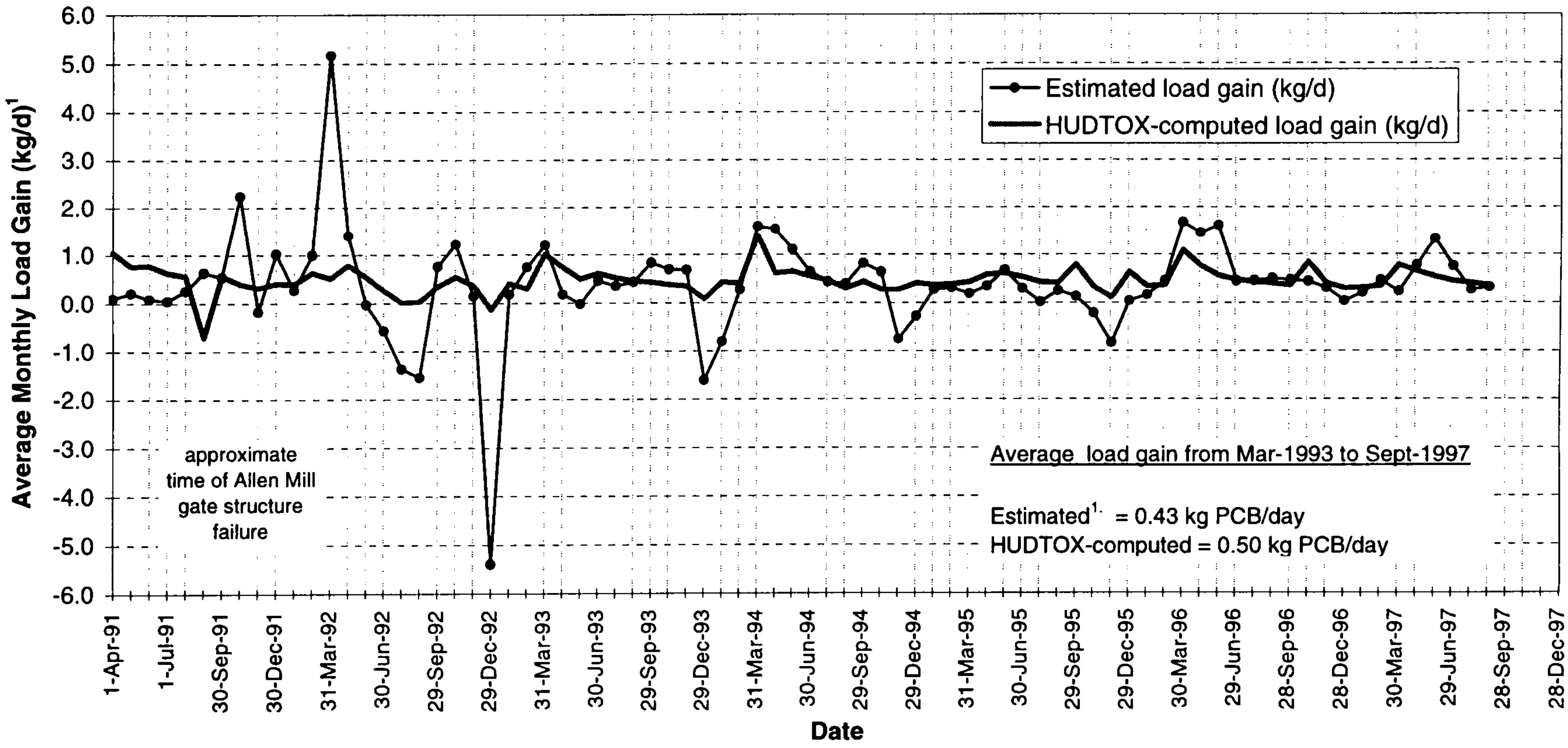
Data Source: Hudson River Database Release 4.1 Limno Tech, Inc.

Figure 7-17d
Computed versus Observed Total PCB Concentrations through TIP during the GE June 17, 1997 Time of Travel Survey



Data Source: Hudson River Database Release 4.1 Limno·Tech, Inc.

Figure 7-18
HUDTOX-Computed versus Data-Estimated Total PCB Load Gain across Thompson Island Pool 1/1/91 to 9/30/97

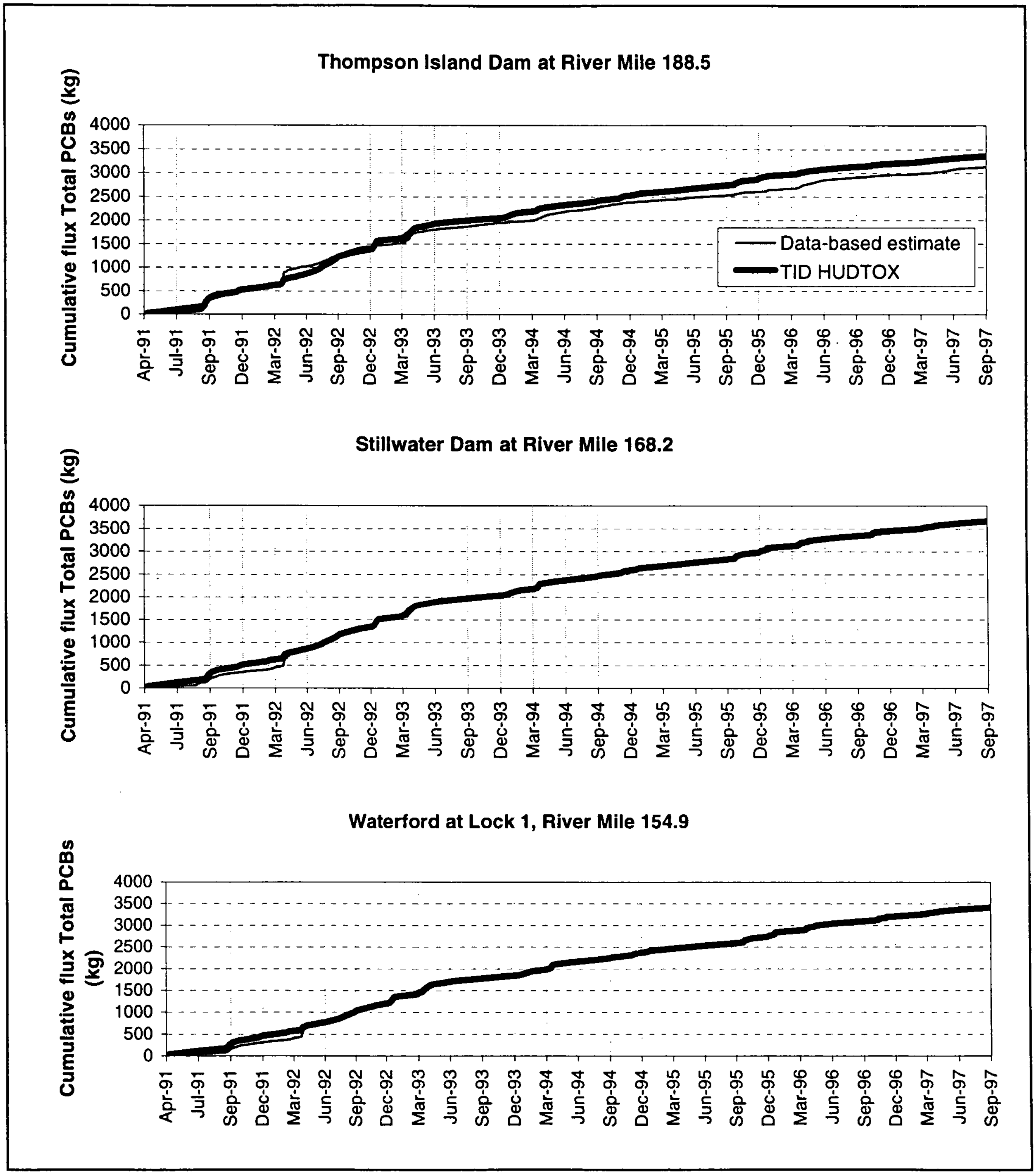


[1.] HUDTOX Delta load = Flux across Thompson Island Dam + Volatilization Loss - Load at Fort Edward
Data-based delta load = Flux over Thompson Island Dam - Load at Fort Edward. Note that the TI Dam load gain represented here is based on a bias correction for west shore samples that is being revised in ongoing work (See Chapter 6). The data-based estimate here under-estimates actual load gain from the pool.

Source: Hudson River Database Release 4.1

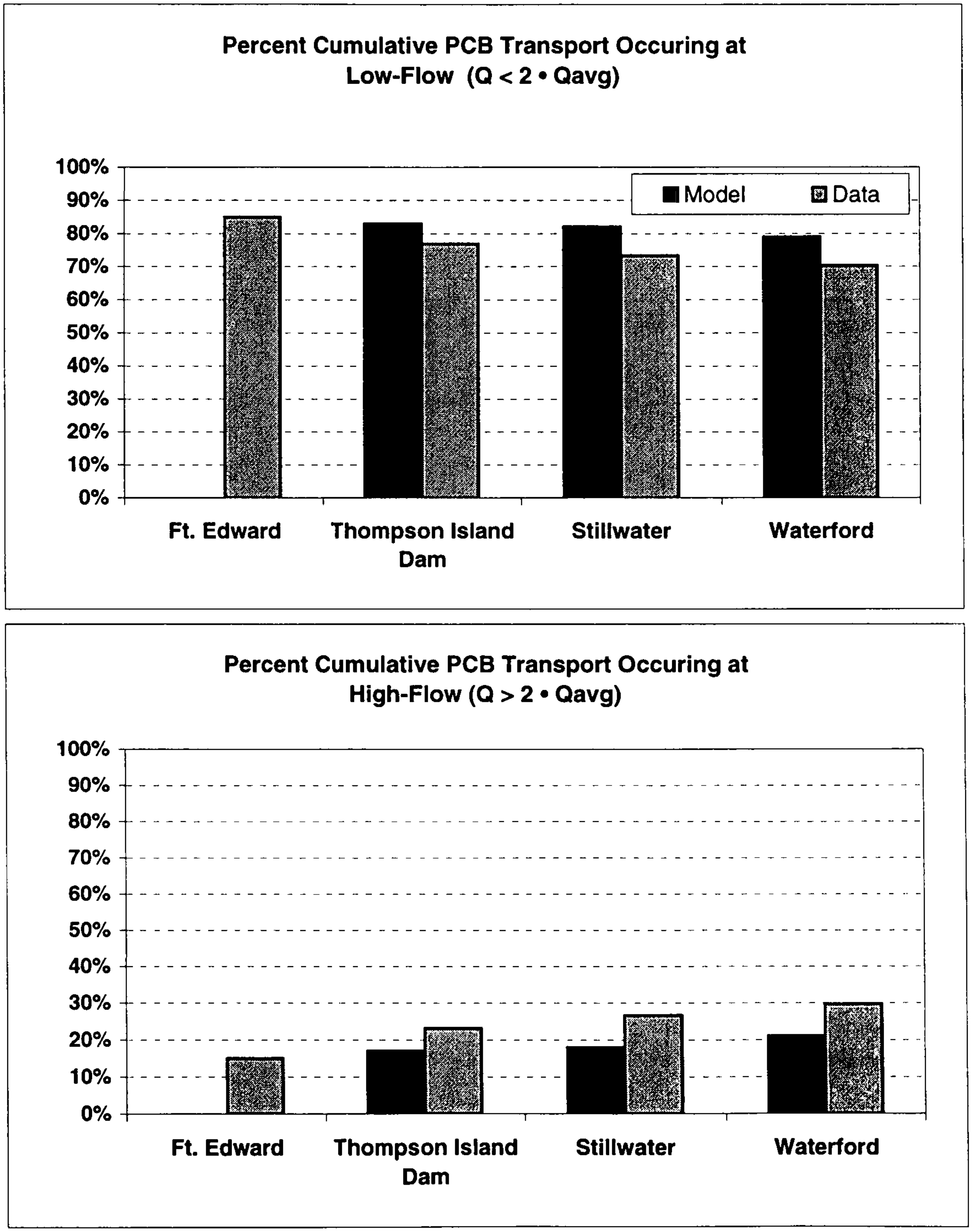
Limno-Tech, Inc.

Figure 7-19
Cumulative Total PCB In-River Fluxes Past Mainstem Hudson River Sampling Stations from 4/1/91 to 9/30/97



Limno-Tech, Inc.

Figure 7-20
Percent of Total PCB Transport Occuring at High* and Low Flow at Mainstem Hudson River Sampling Stations



* High flow is defined as flow greater than 2 times the average flow at each station.
Data Source: Hudson River Database Release 4.1

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Figure 7-21
Cumulative Tri+ PCB Flux at Schuylerville 1977 - 1984 with and without Additional External PCB Load Specified at Fort Edward

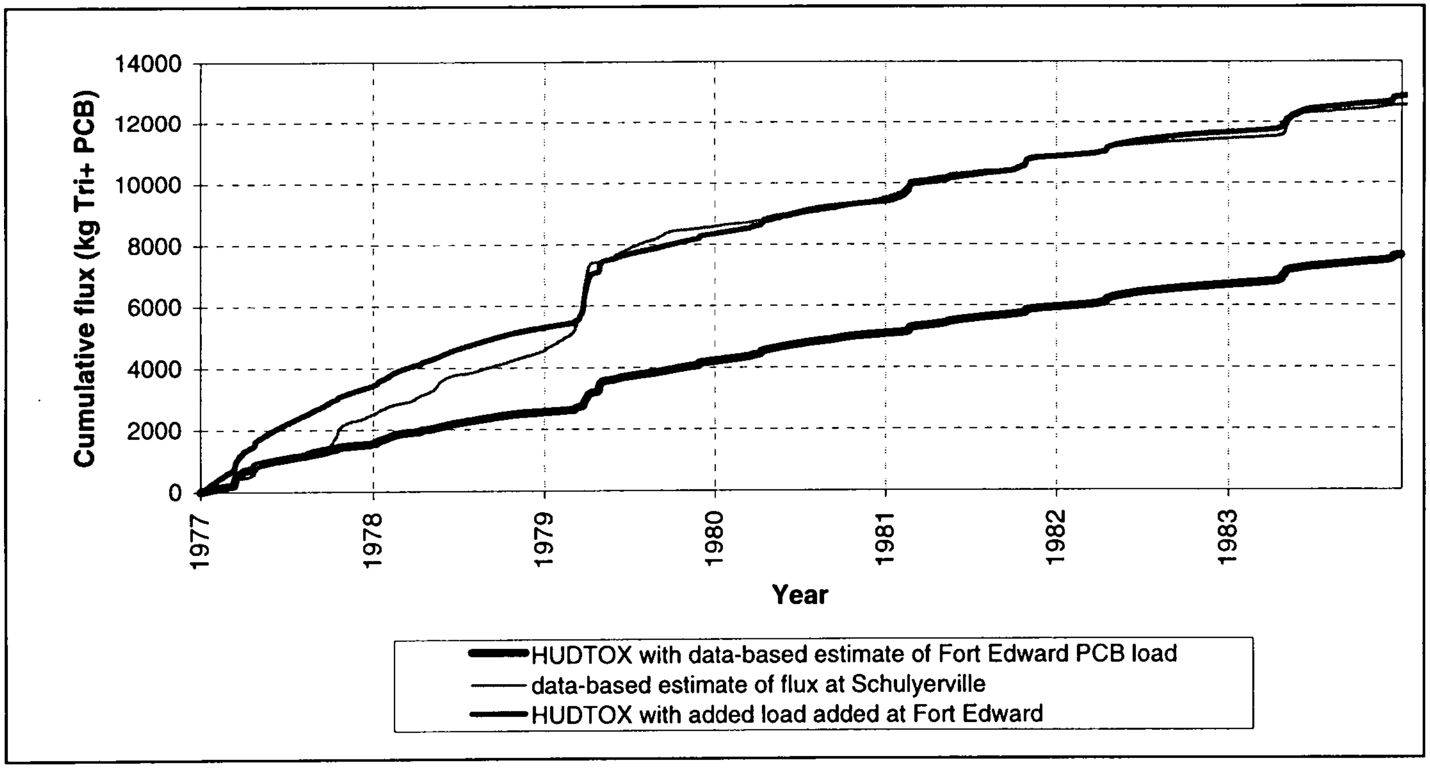

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Figure 7-22
Calibration Results of Total Suspended Solids 21-Year Cumulative Mass Flux in the Hudson River

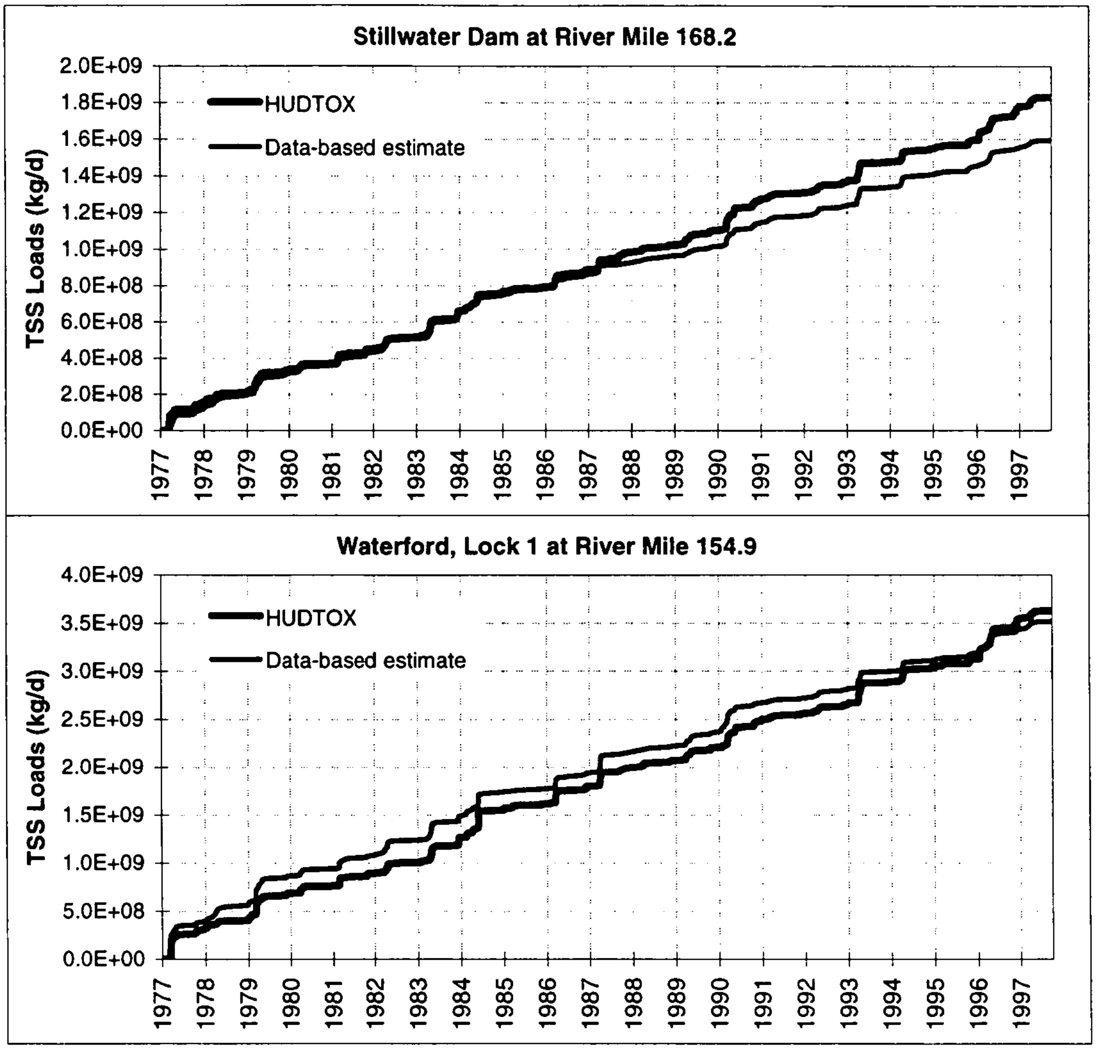

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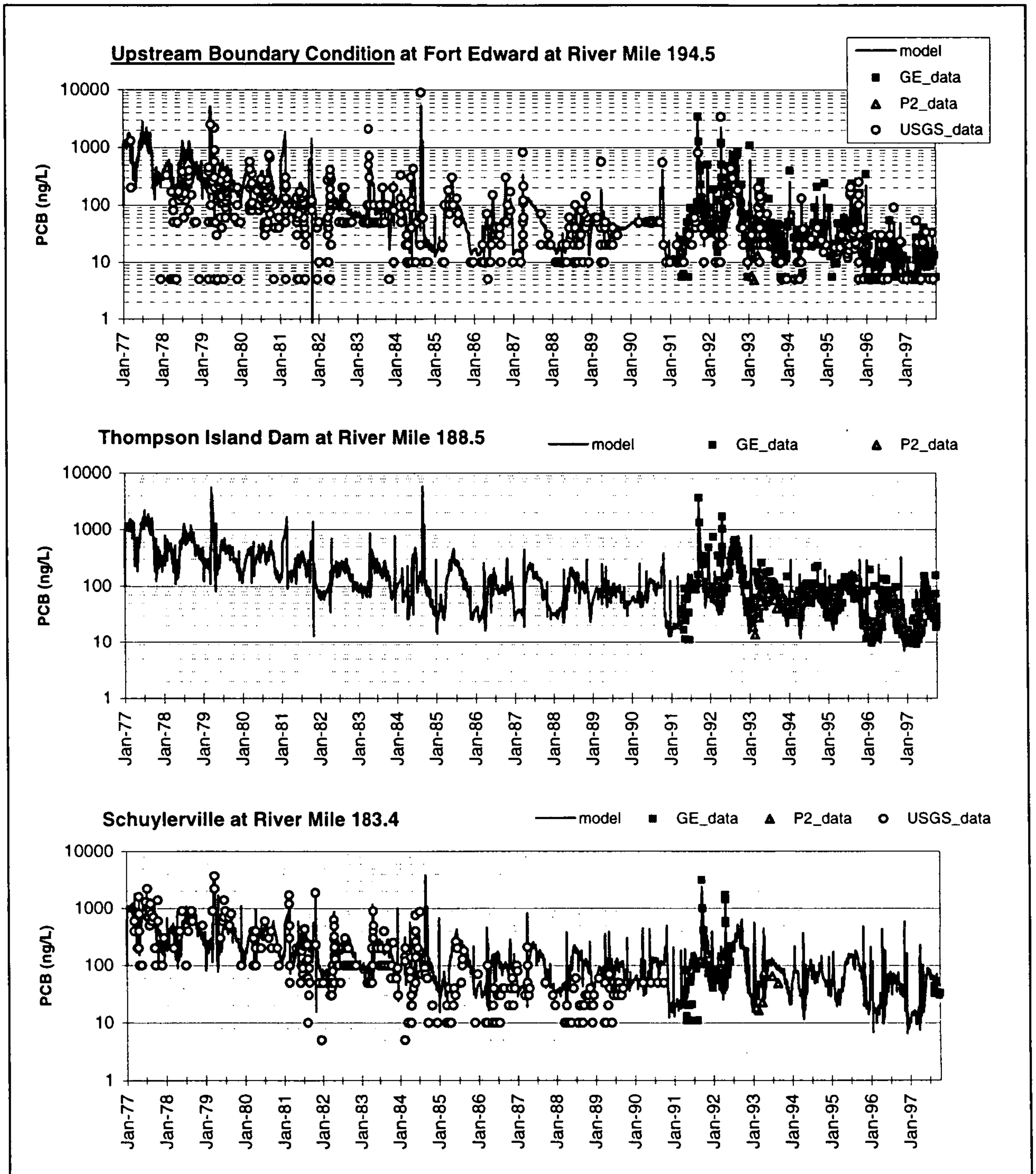
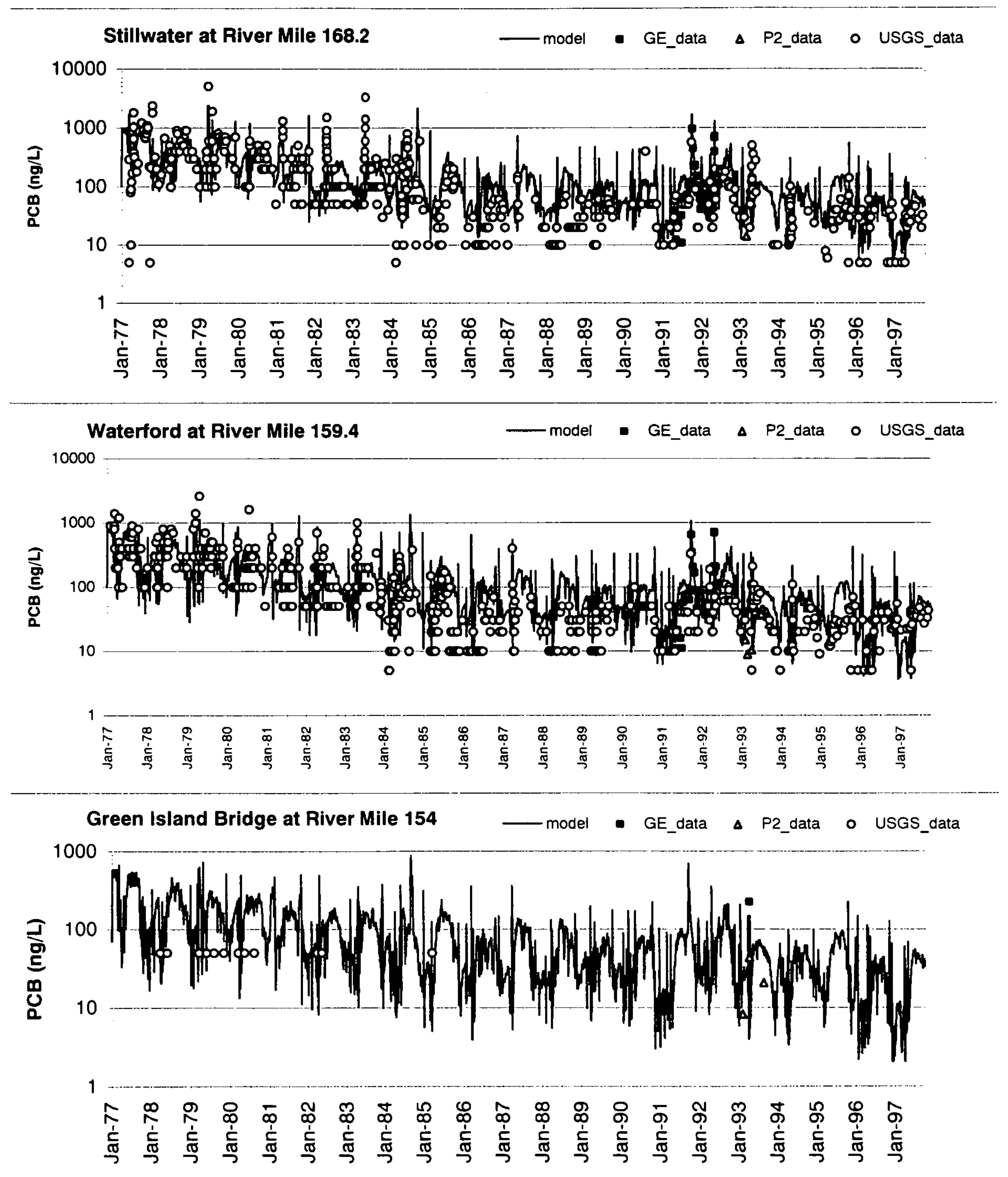
Figure 7-23a
1977 - 1997 Computed versus Observed Water Column Tri+ Concentrations



Data Source: TAMS/Gradient Database/Release 4.1b

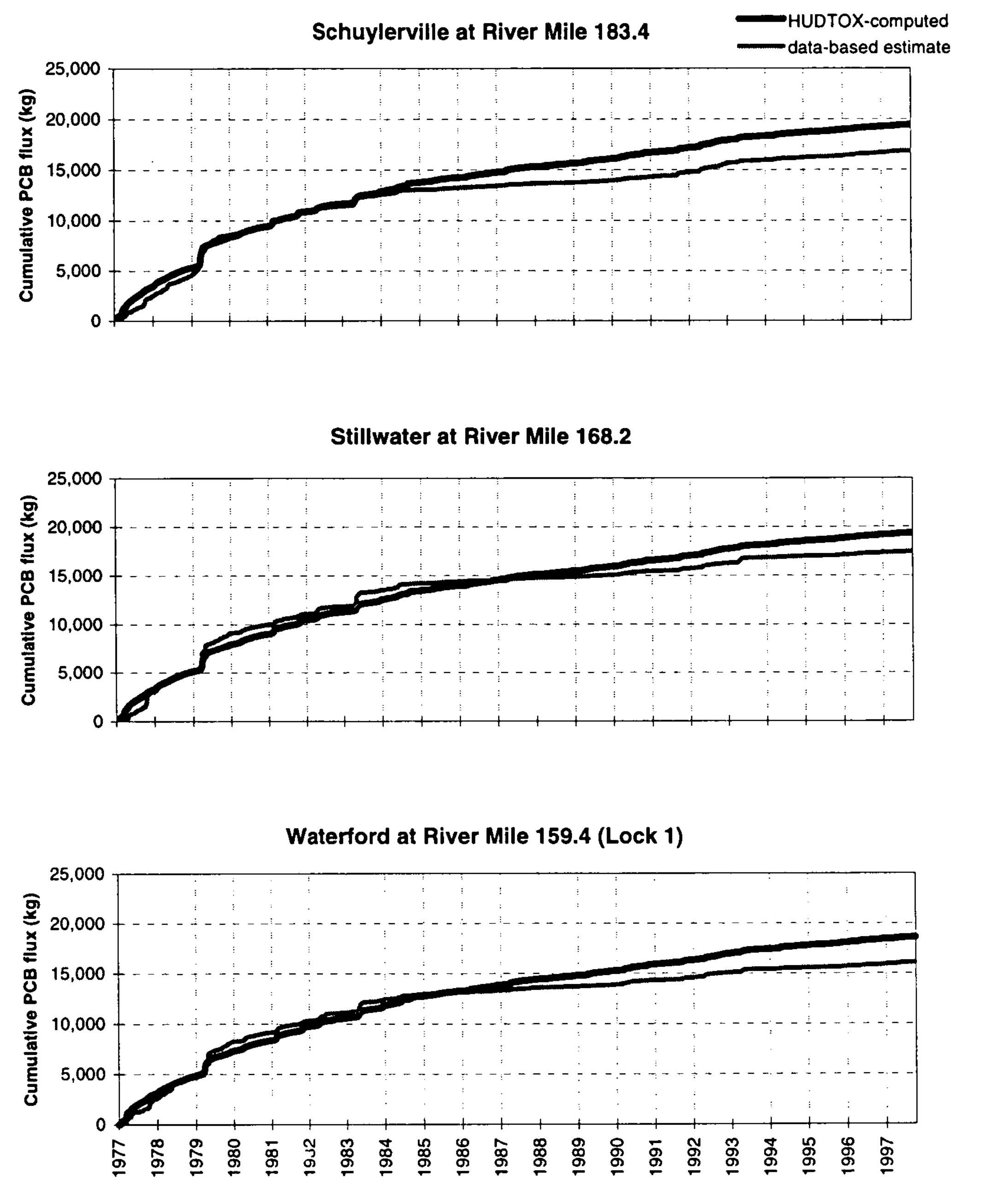
Limno Tech, Inc.

Figure 7-23b
1977 - 1997 Computed versus Observed Water Column Tri+ Concentrations



Data Source: TAMS/Gradient Database/Release 4.1b

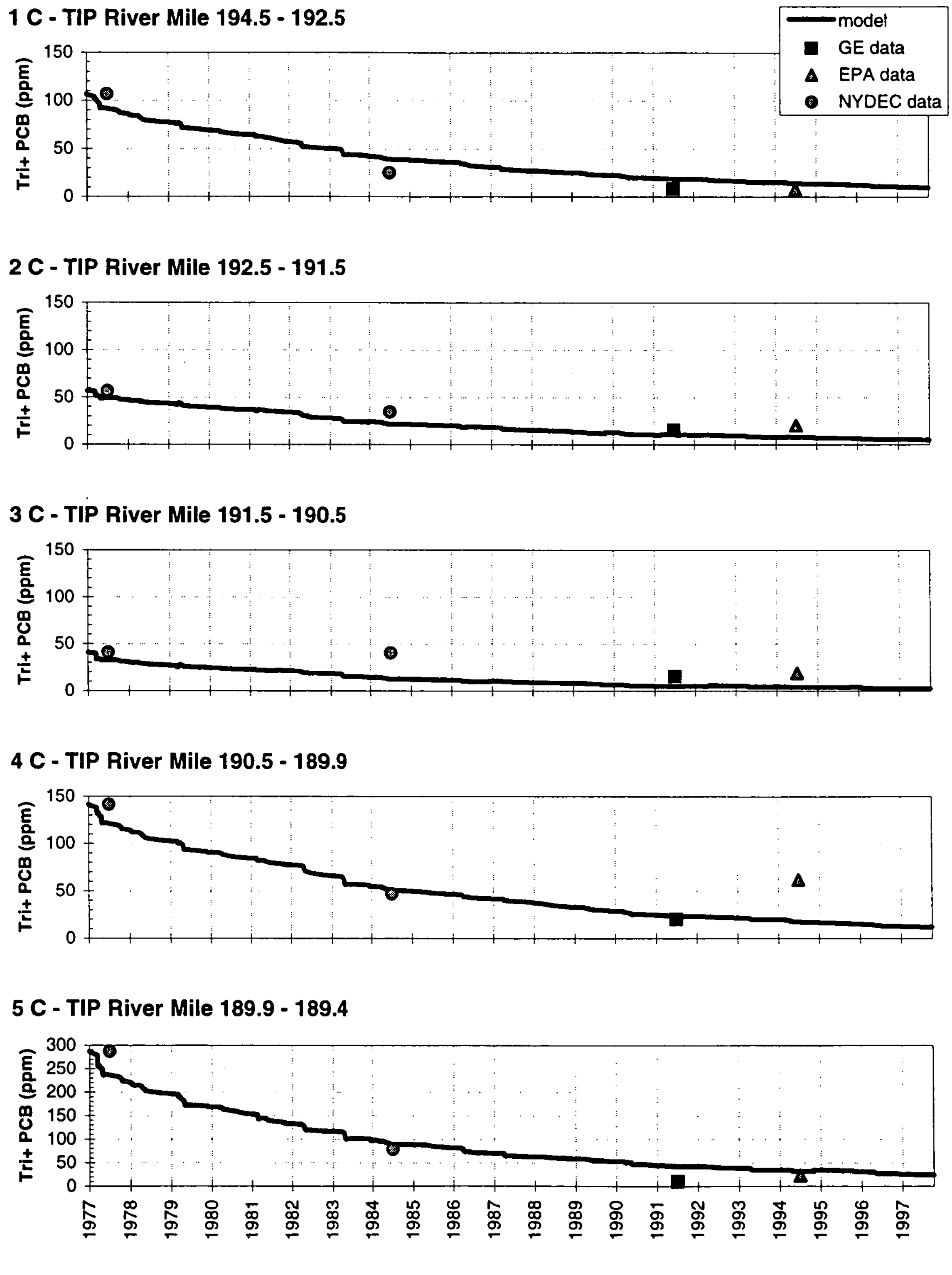
Figure 7-24
1977-1997 HUDTOX-Computed versus Estimated
Cumulative Tri+ Flux past Schuylerville, Stillwater, and Waterford



Data Source: TAMS/Gradient Database/Release 4.1b

Limno Tech, Inc.

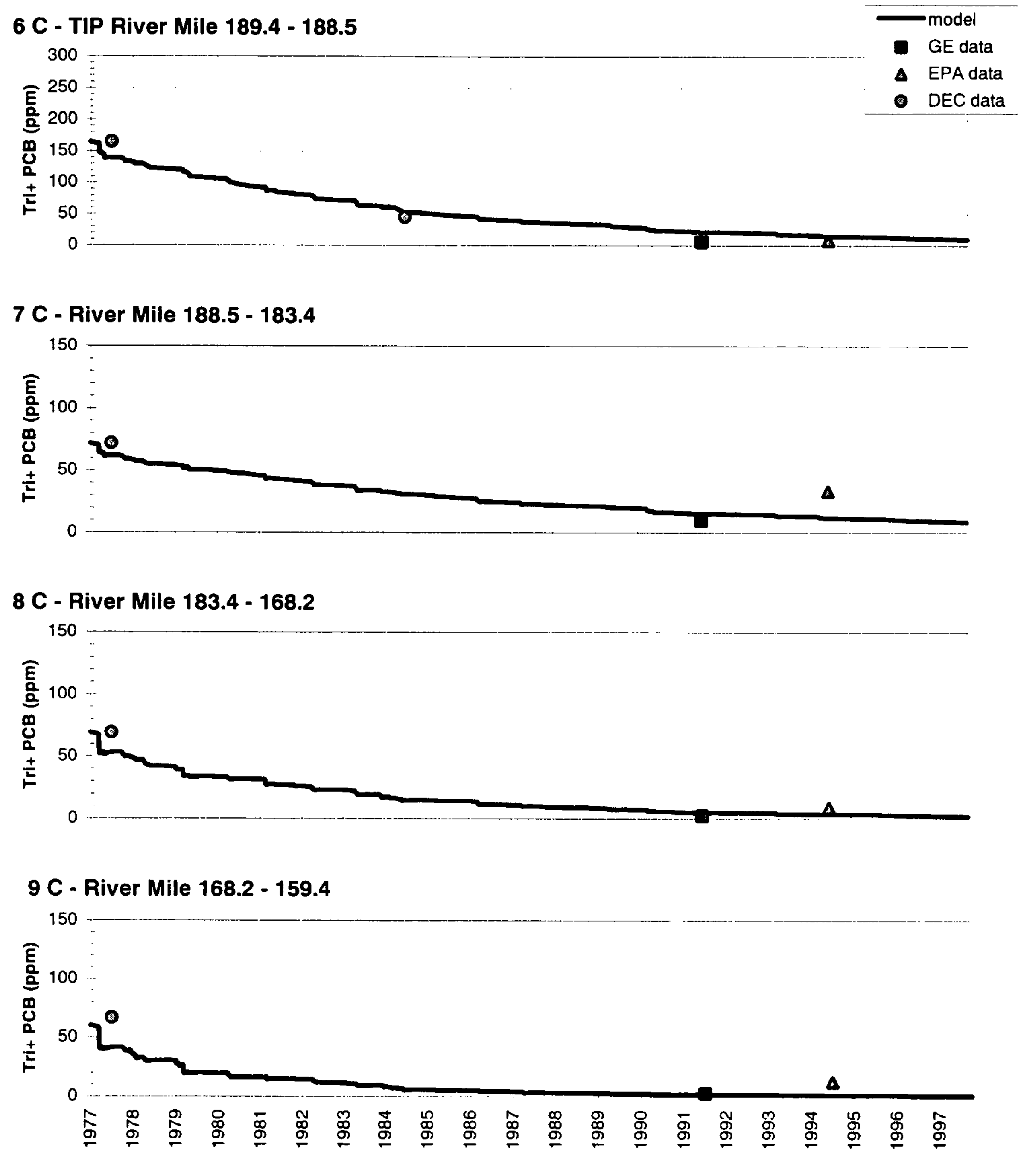
Figure 7-25a
1977-1997 HUDTOX-Computed versus Observed Surficial (0-4 cm) Bulk Tri+ Concentrations in Cohesive Sediments



Data Source: TAMS/Gradient Database/Release 4.1b

Limno Tech, Inc.

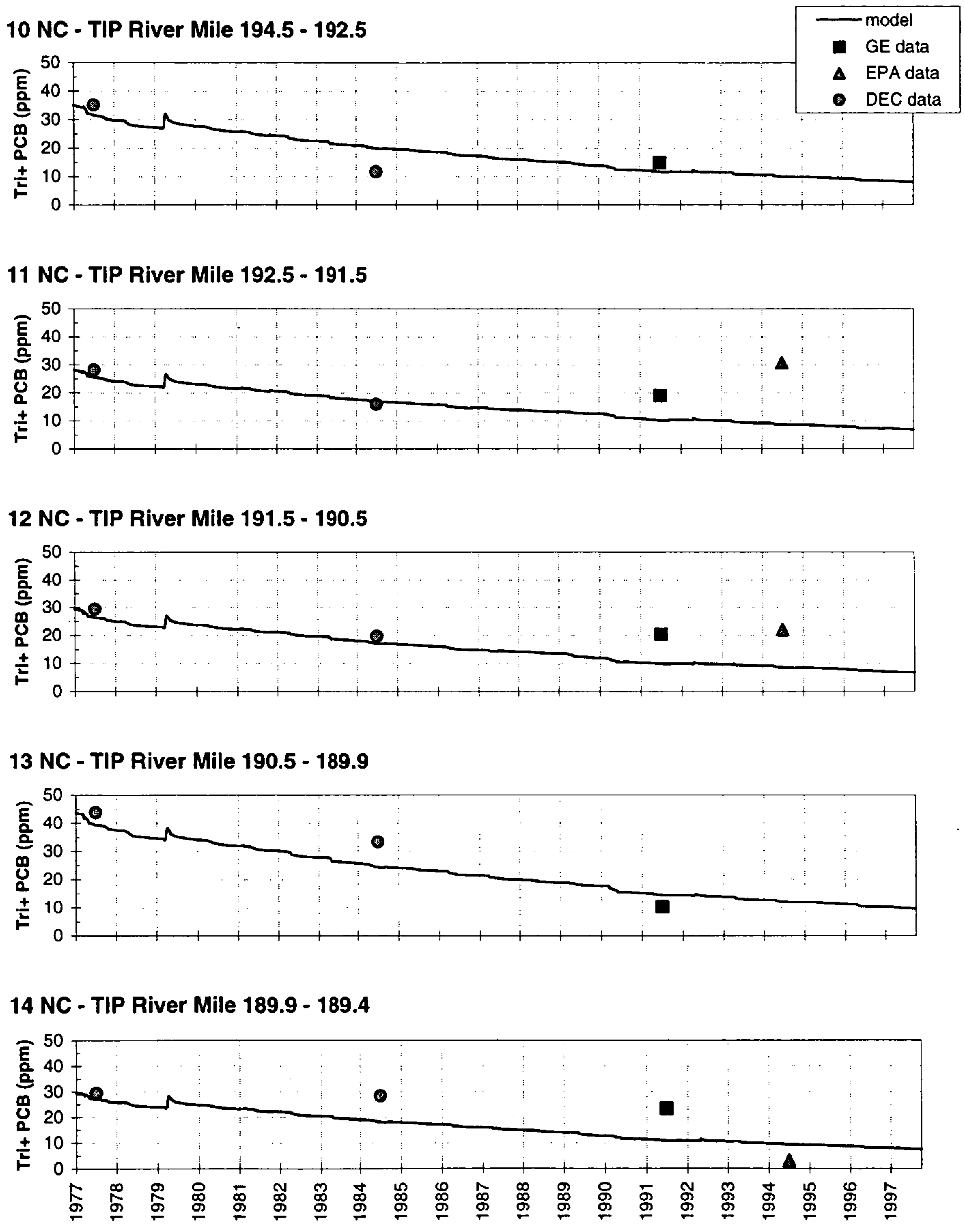
Figure 7-25b
1977-1997 HUDTOX-Computed versus Observed Surficial (0-4 cm Bulk Tri+ Concentrations in Cohesive Sediment



Data Source: TAMS/Gradient Database/Release 4.1b

Limno Tech, Inc.

Figure 7-25c
1977-1997 HUDTOX-Computed versus Observed Surficial (0-4 cm) Bulk Tri+ Concentrations in Non-Cohesive Sediments



Data Source: TAMS/Gradient Database/Release 4.1b

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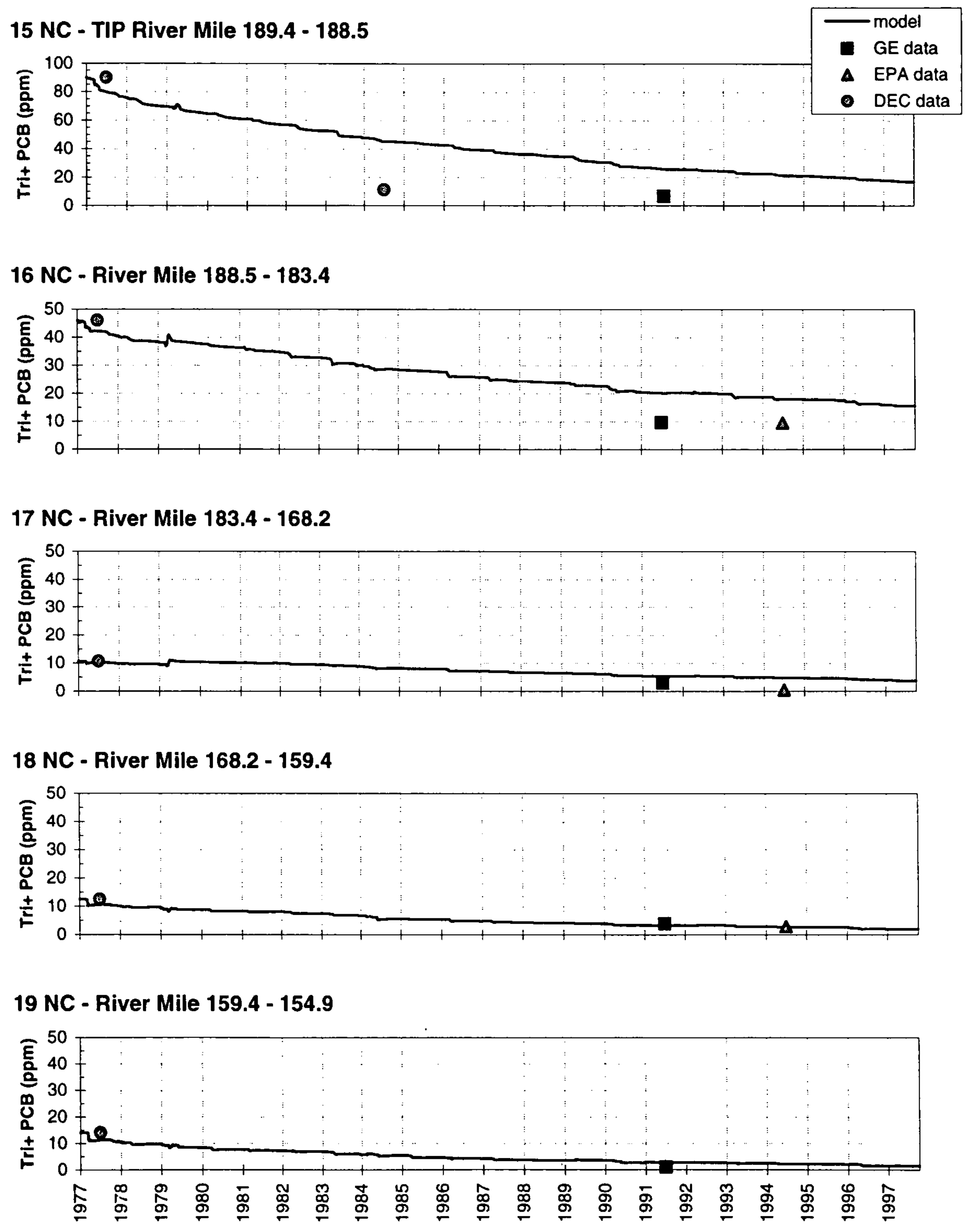
Figure 7-25d
1977-1997 HUDTOX-Computed versus Observed Surficial (0-4 cm) Bulk Tri+ Concentrations in Non-Cohesive Sediments



Data Source: TAMS/Gradient Database/Release 4.1b

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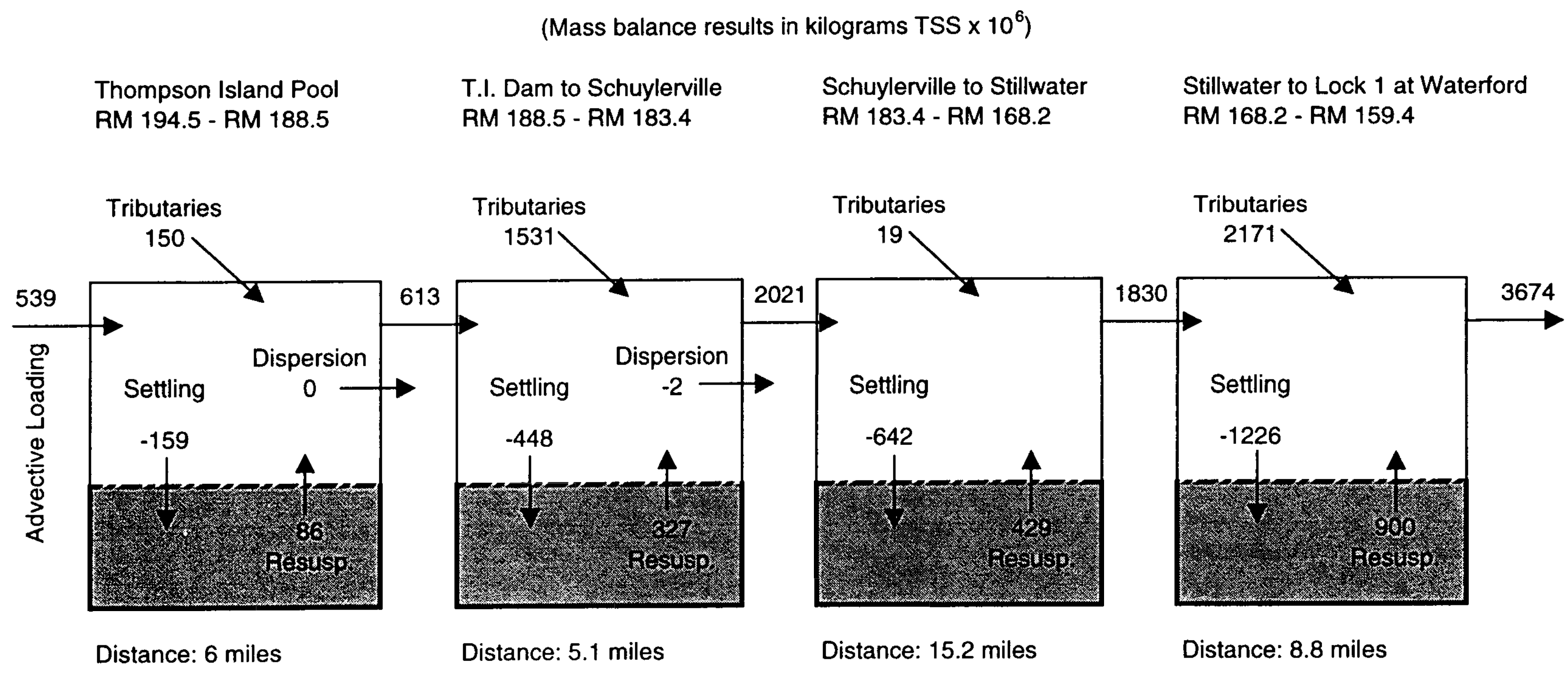
Figure 7-26
Computed (HUDTOX) TSS Mass Balance by Reach for 1977-1997



Note that the mass balance output does not include deep burial because the entire sediment bed is simulated and represented by the sediment compartment in this diagram.

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Figure 7 - 27
HUDTOX-Computed Long-term Average Burial Velocity for Cohesive and Noncohesive Sediment in Thompson Island Pool for 1977-1997

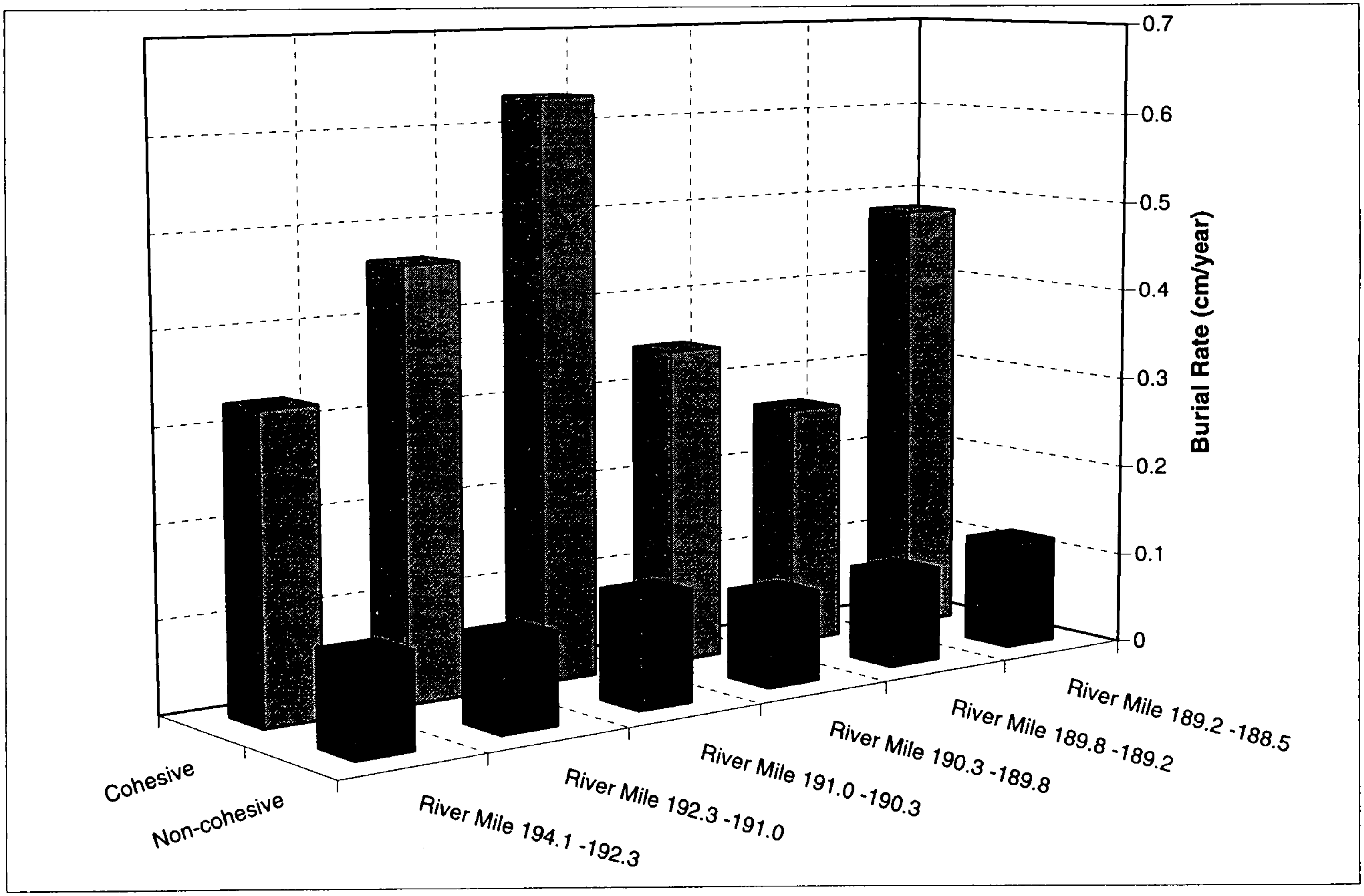

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Figure 7-28
HUDTOX-Computed Cumulative Bed Elevation Change in Thompson Island Pool during 1977-1997

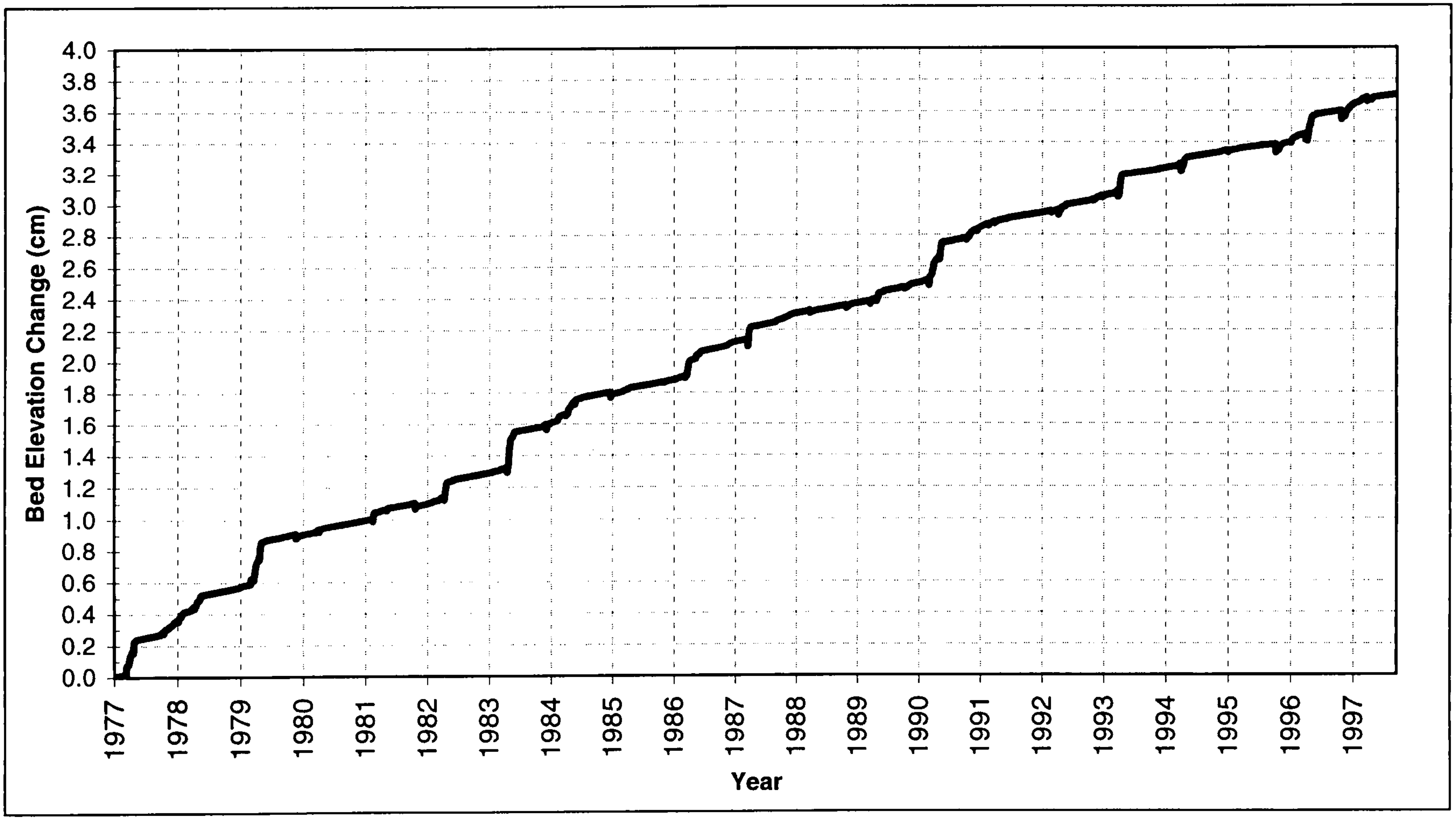

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Figure 7-29
Computed (HUDTOX) Total PCB Mass Balance by Reach for Period from 4/1/91 to 9/30/97

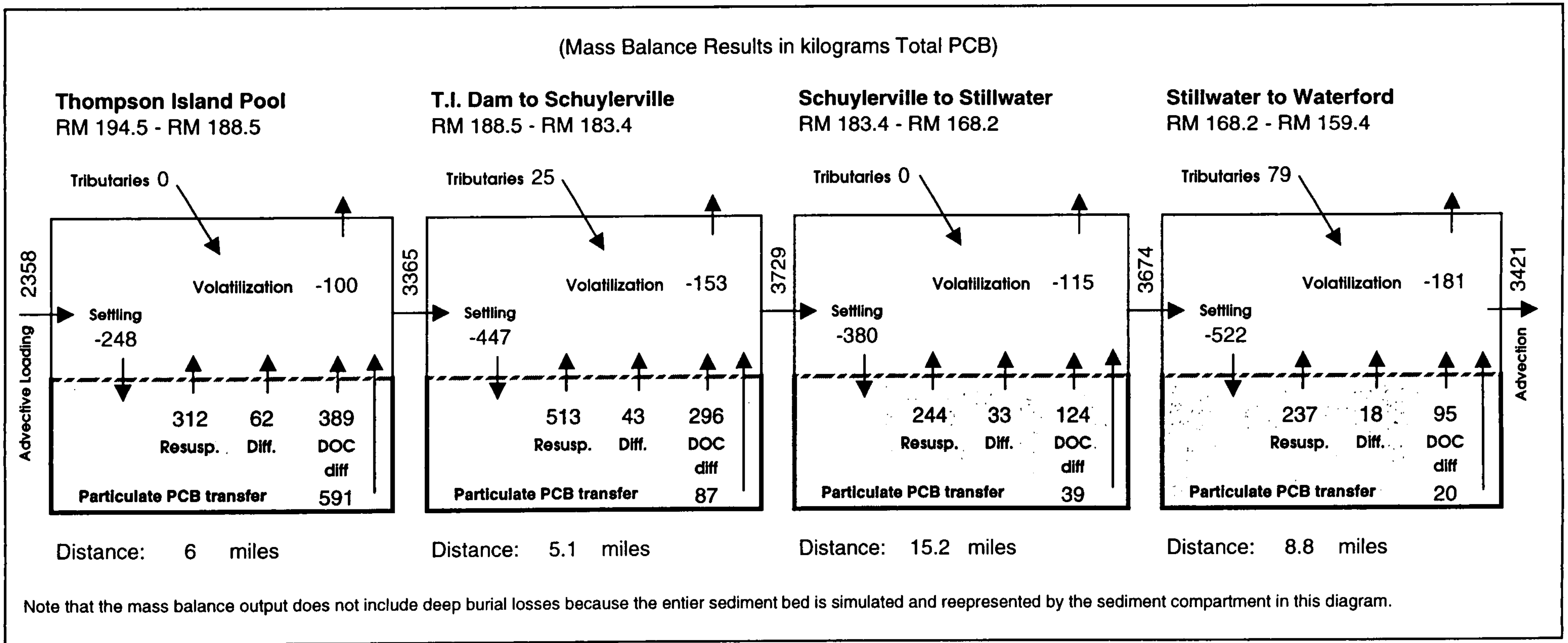

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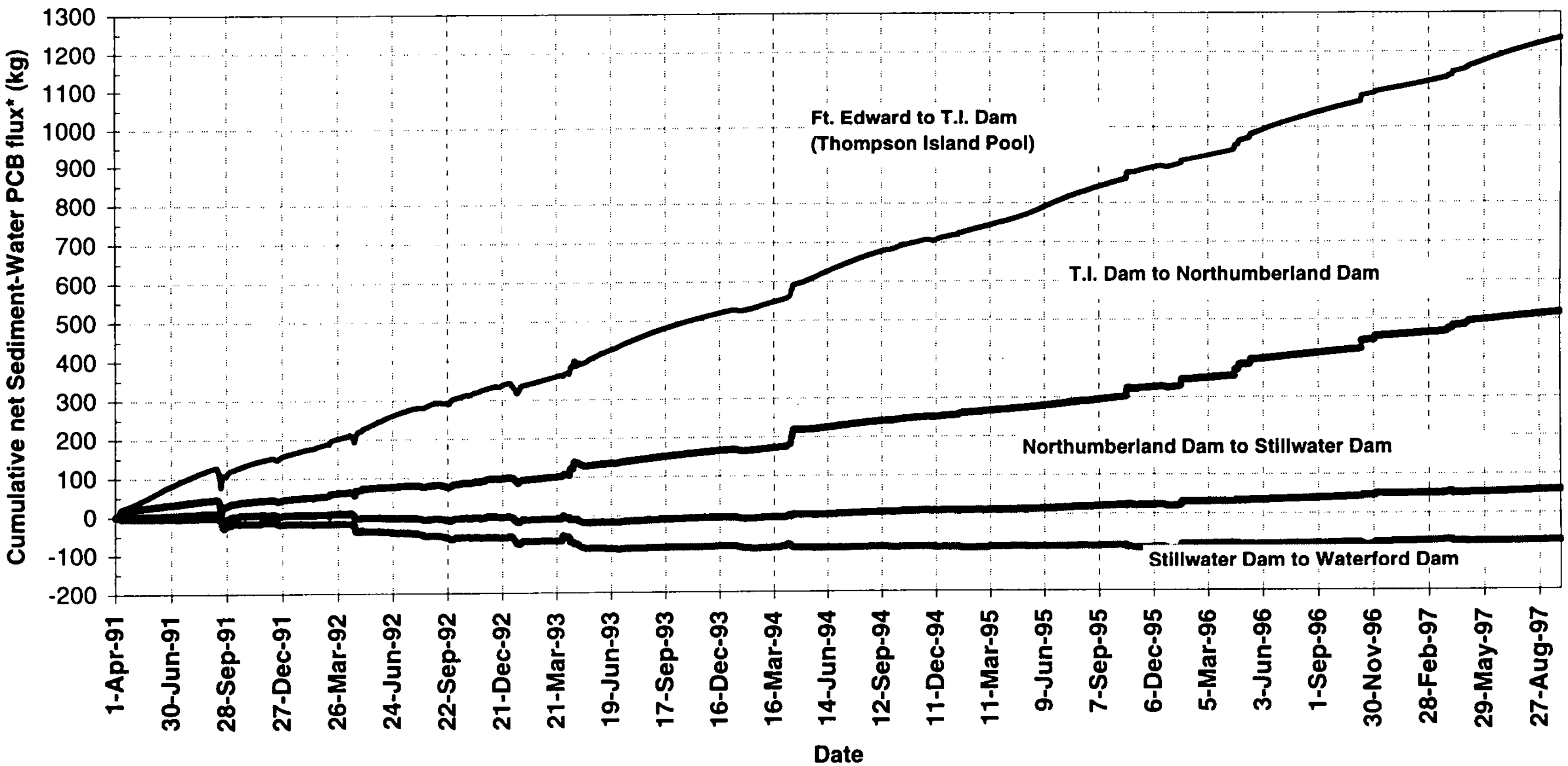
Figure 7-30
Cumulative HUDTOX-Computed Contribution of Sediment-Water Total PCB Flux to Cumulative PCB Load Gain between Mainstem Hudson River Sampling Stations from 4/1/91 to 9/30/97



*Sediment-water PCB flux by reach computed as: (downstream load + volatilization loss) - (upstream load + tributary load)

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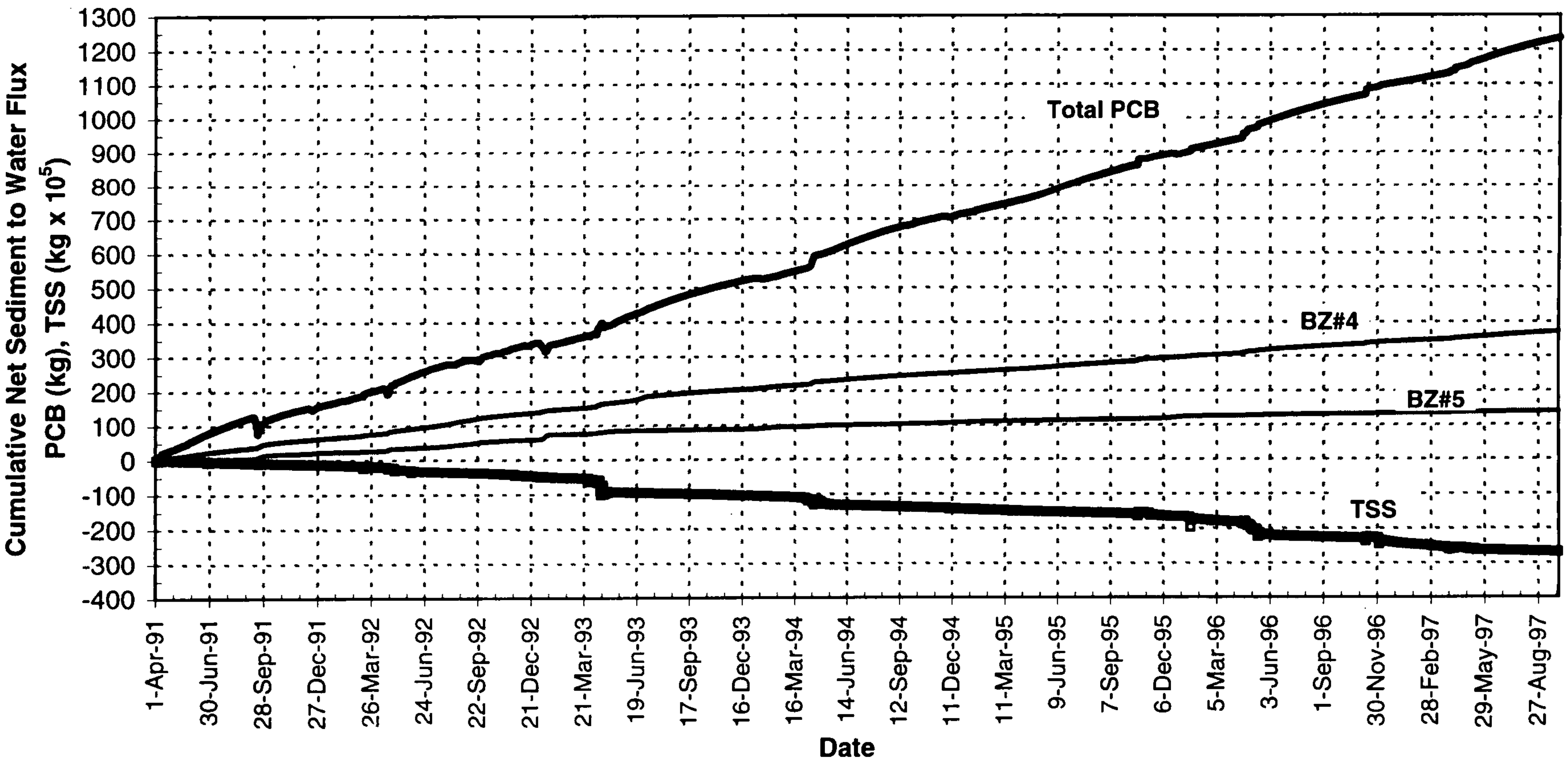
Figure 7-31
Cumulative HUDTOX-Computed Sediment Contribution to Load Gain across Thompson Island Pool from 1991-1997 for TSS, Tot-PCB, BZ#4 and BZ#52



* Net sediment to water flux computed as: (downstream load + volatilization loss) - (upstream load + tributary load)

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Figure 8-1
Water Column PCB Concentrations at Thompson Island Dam and Waterford (Lock 1) for the No Action Forecast Simulations (1998 - 2018)

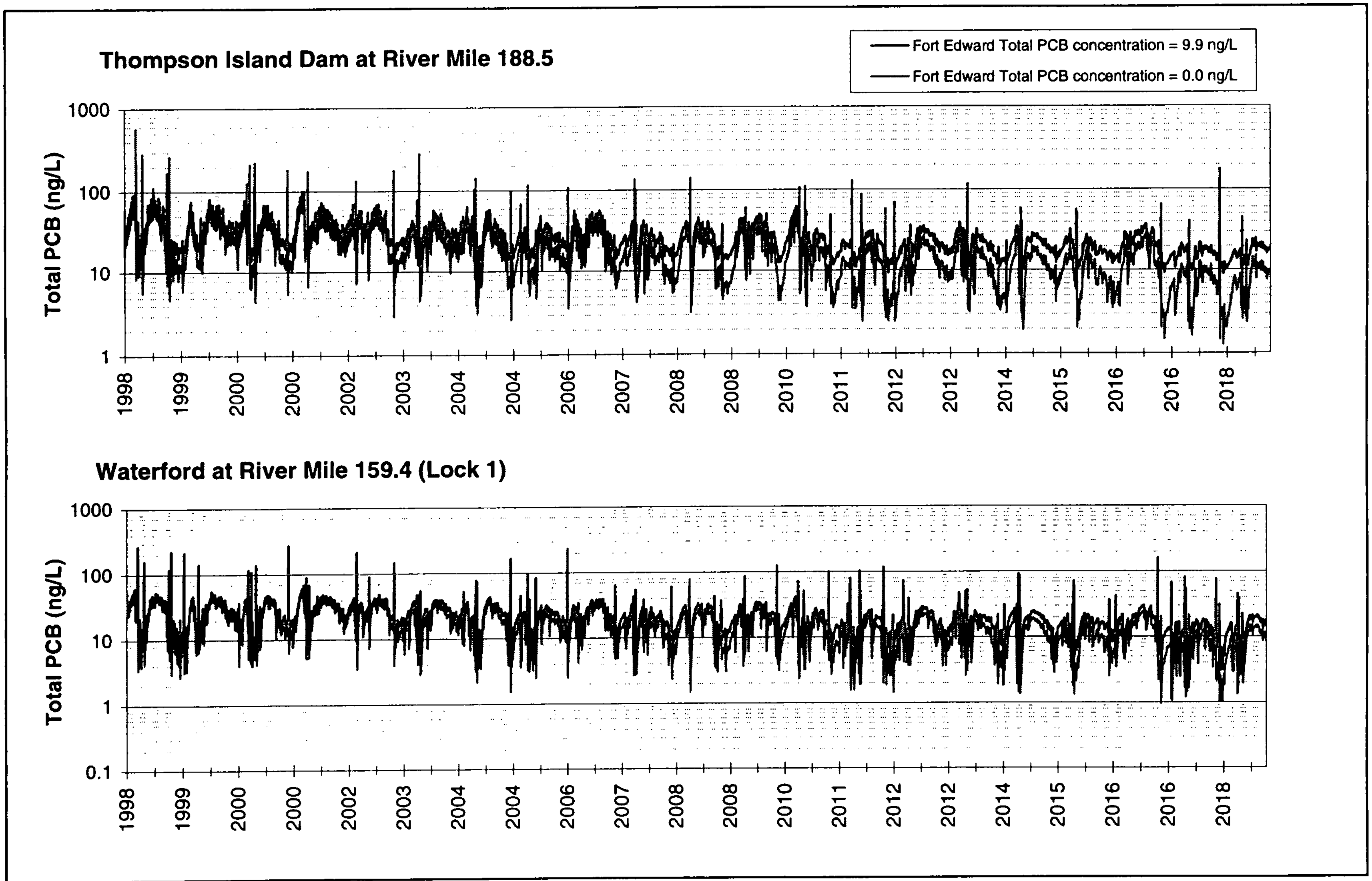

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Figure 8-2
1998 - 2018 Summer Average (June through September) Total PCB Concentrations at Thompson Island Dam and Waterford for the No Action Forecast Simulations

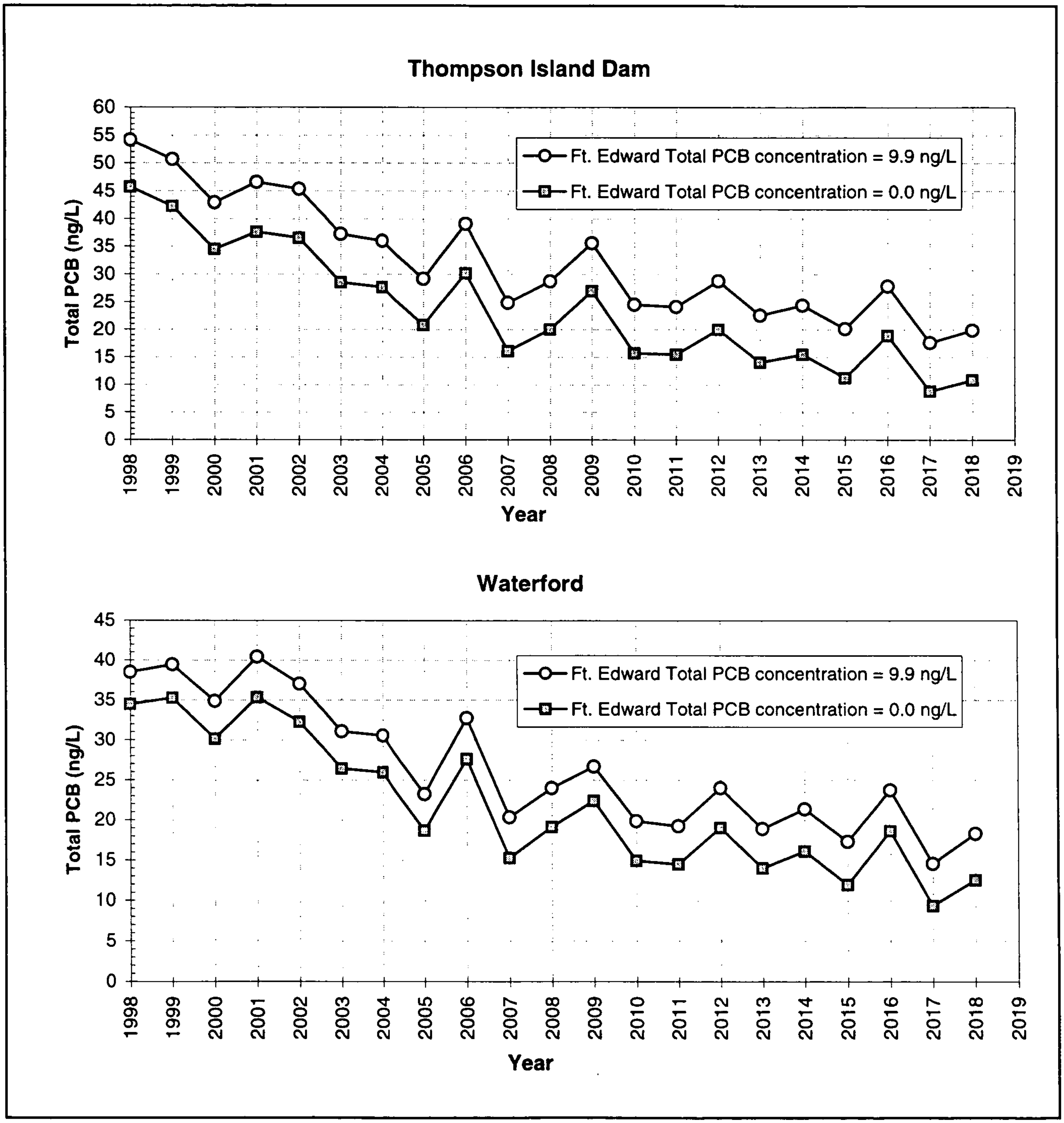

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Figure 8-3
Annual Total PCB Flux at Thompson Island Dam and Waterford for the 1998 - 2018 No Action Forecast Simulations

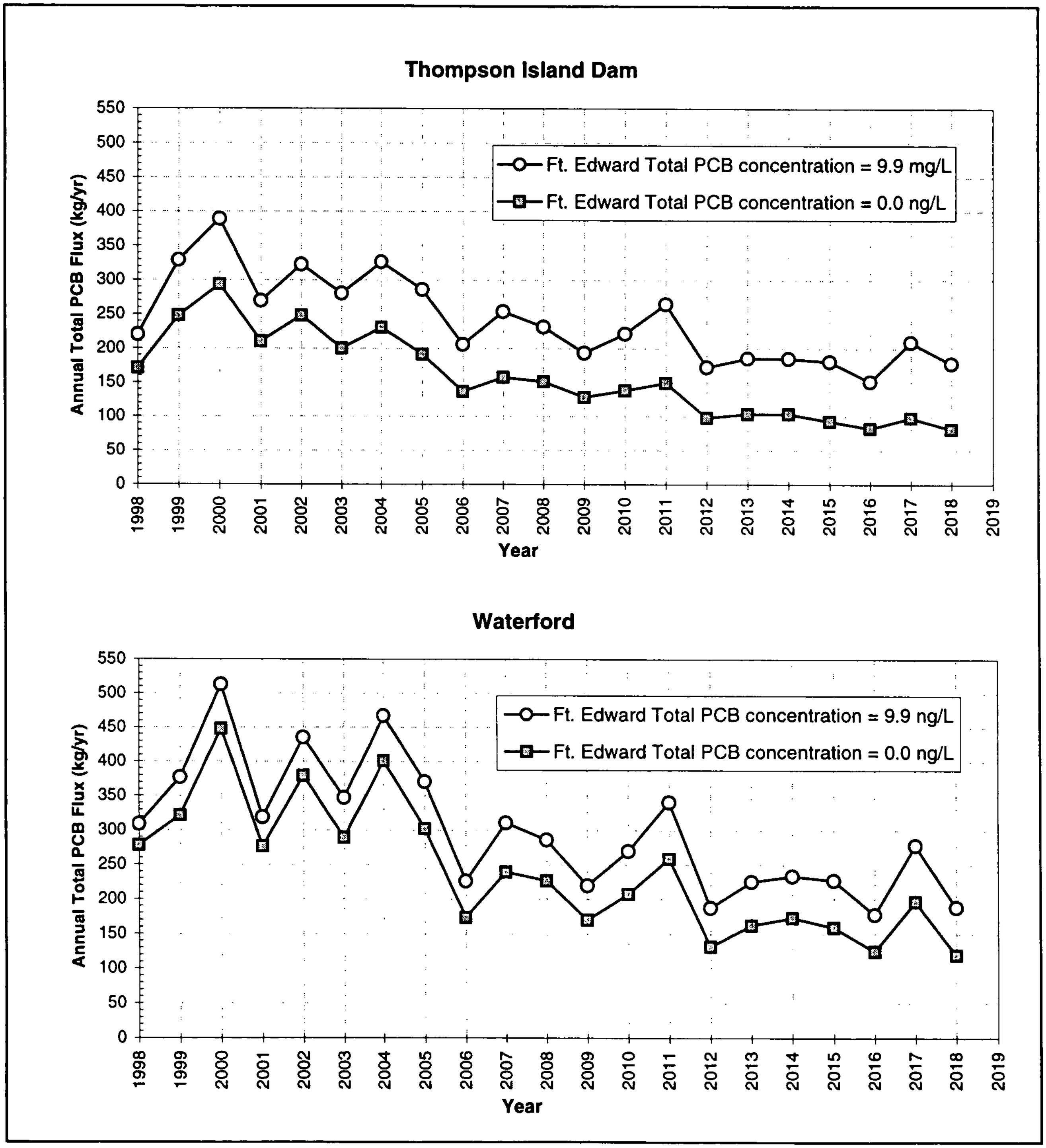

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Figure 8-4
Predicted Reach Average Suficial Sediment Tot PCB Concentrations for the No Action Forecast Simulations (1998-2018)

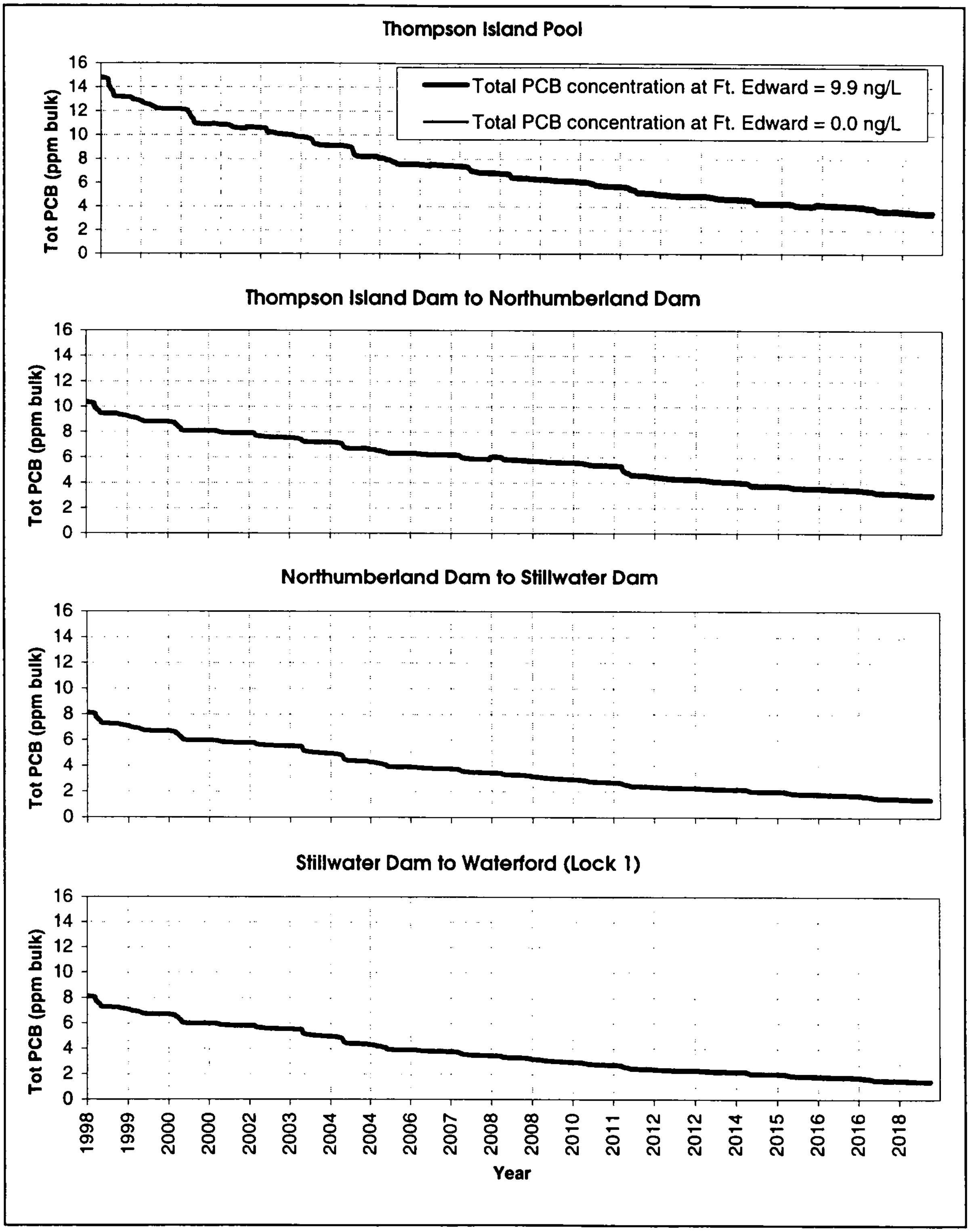

Figure 8-5
Adjustment of 1977 Fort Edward Hydrograph to Include the 100 Year Flow (47,330 cfs)

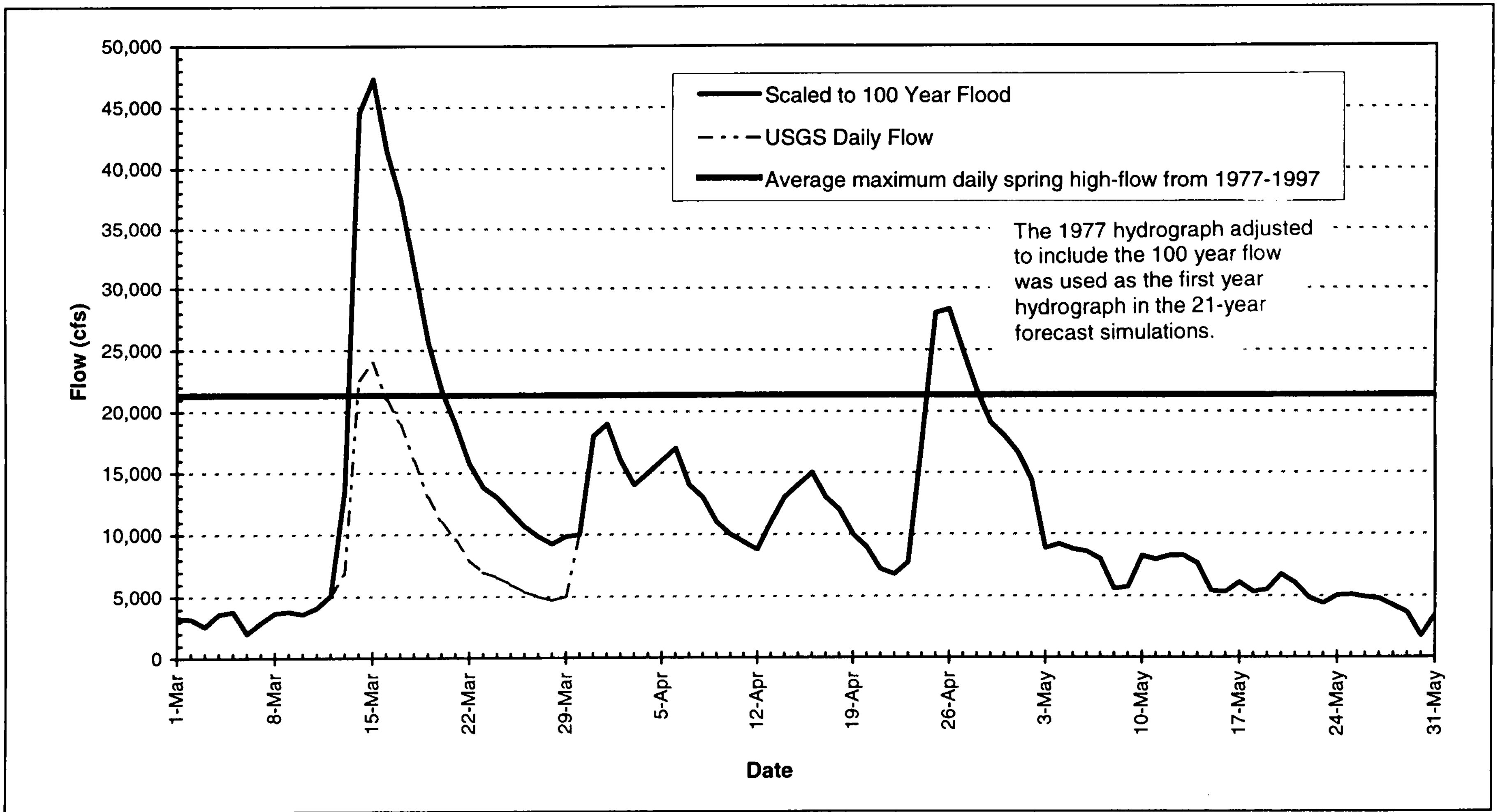

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Figure 8-6
HUDTOX-Computed PCB Concentrations at Thompson Island Dam for the 100 Year Flow and 1977 Flow Forecast Simulations

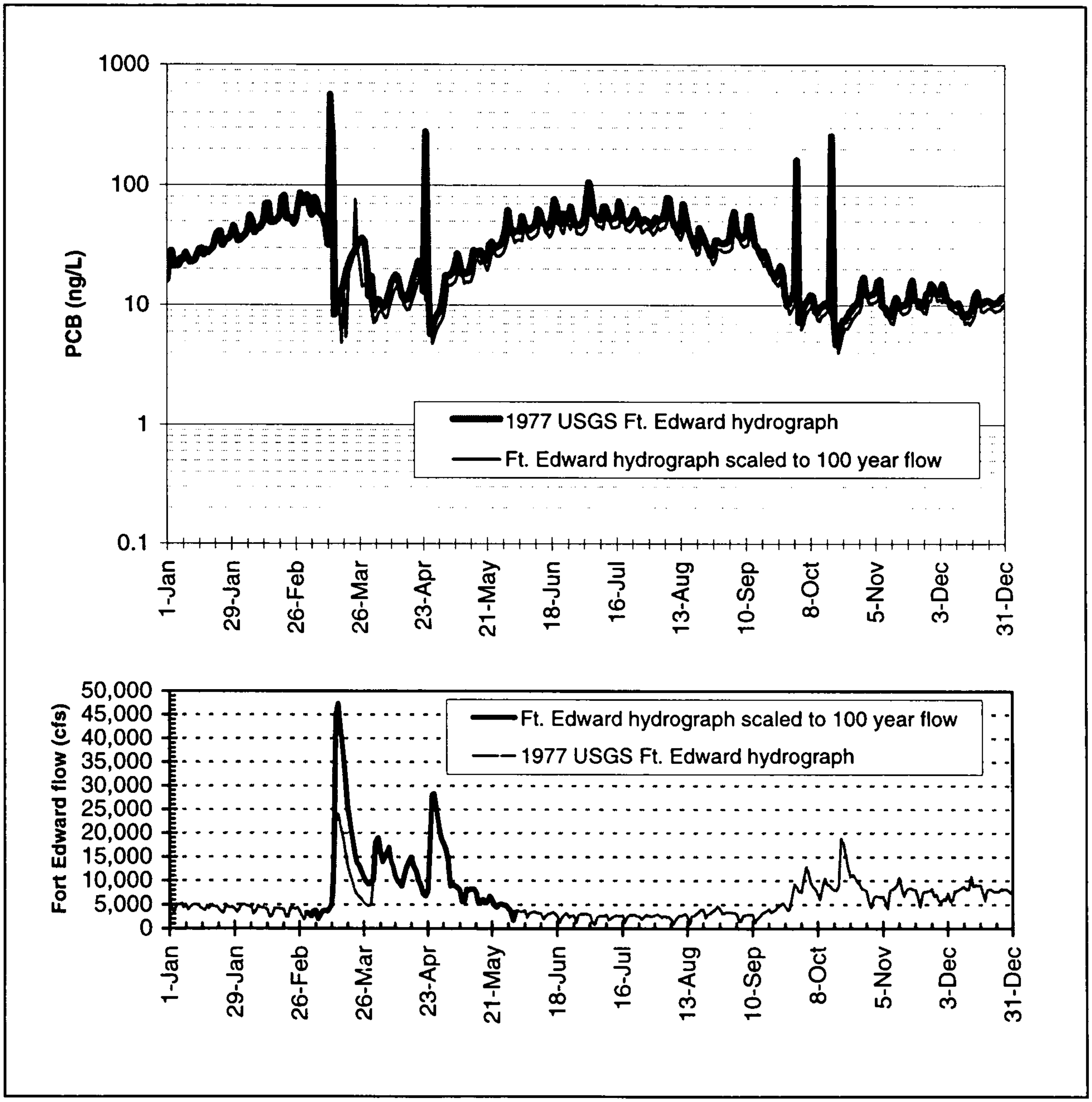

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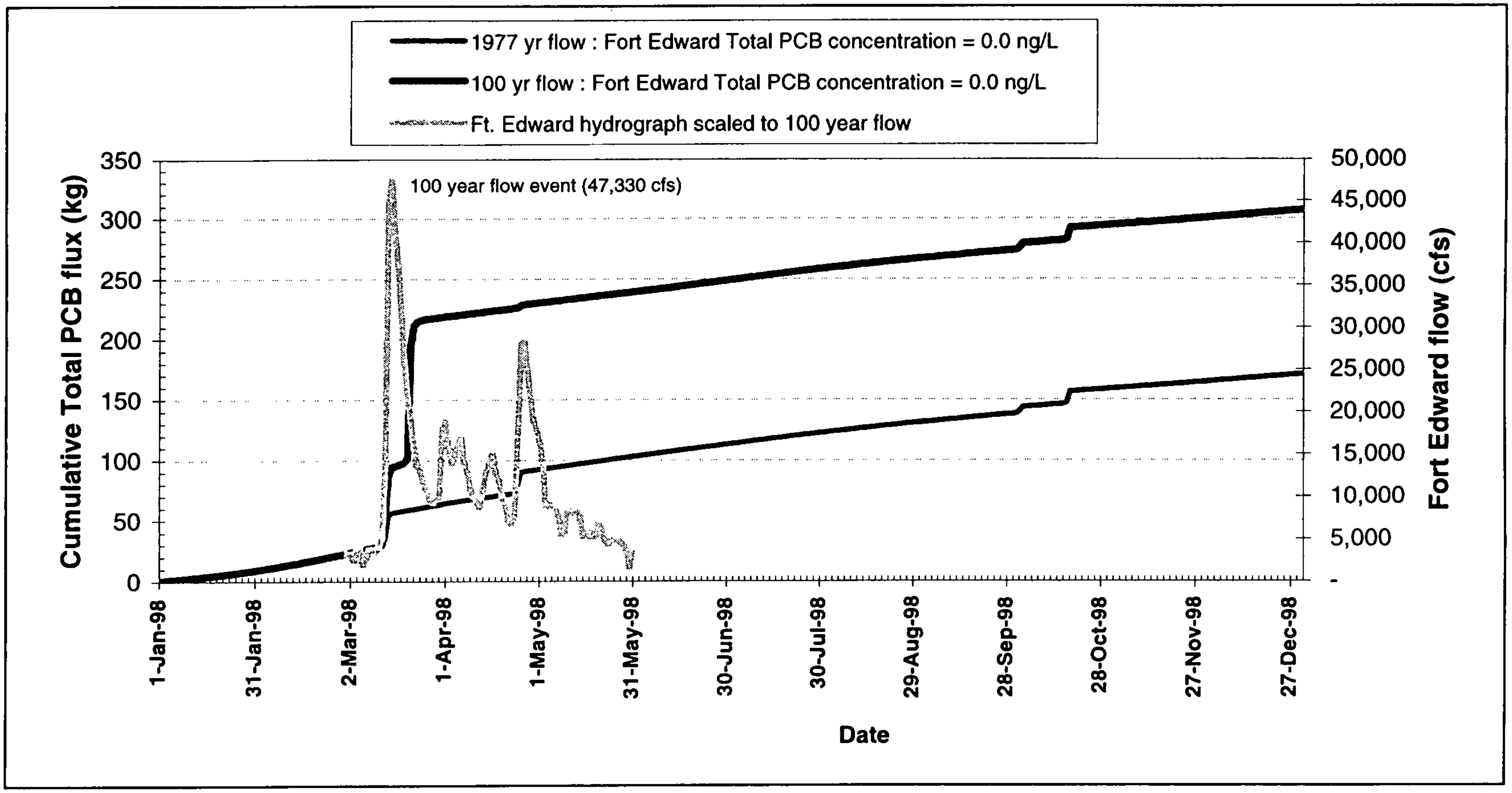
Figure 8-7

Cumulative Total PCB Flux Over Thompson Island Dam for the 1st Year of the 1998-2018 Forecast Simulations with the 100 Year Flow and 1977 Flow



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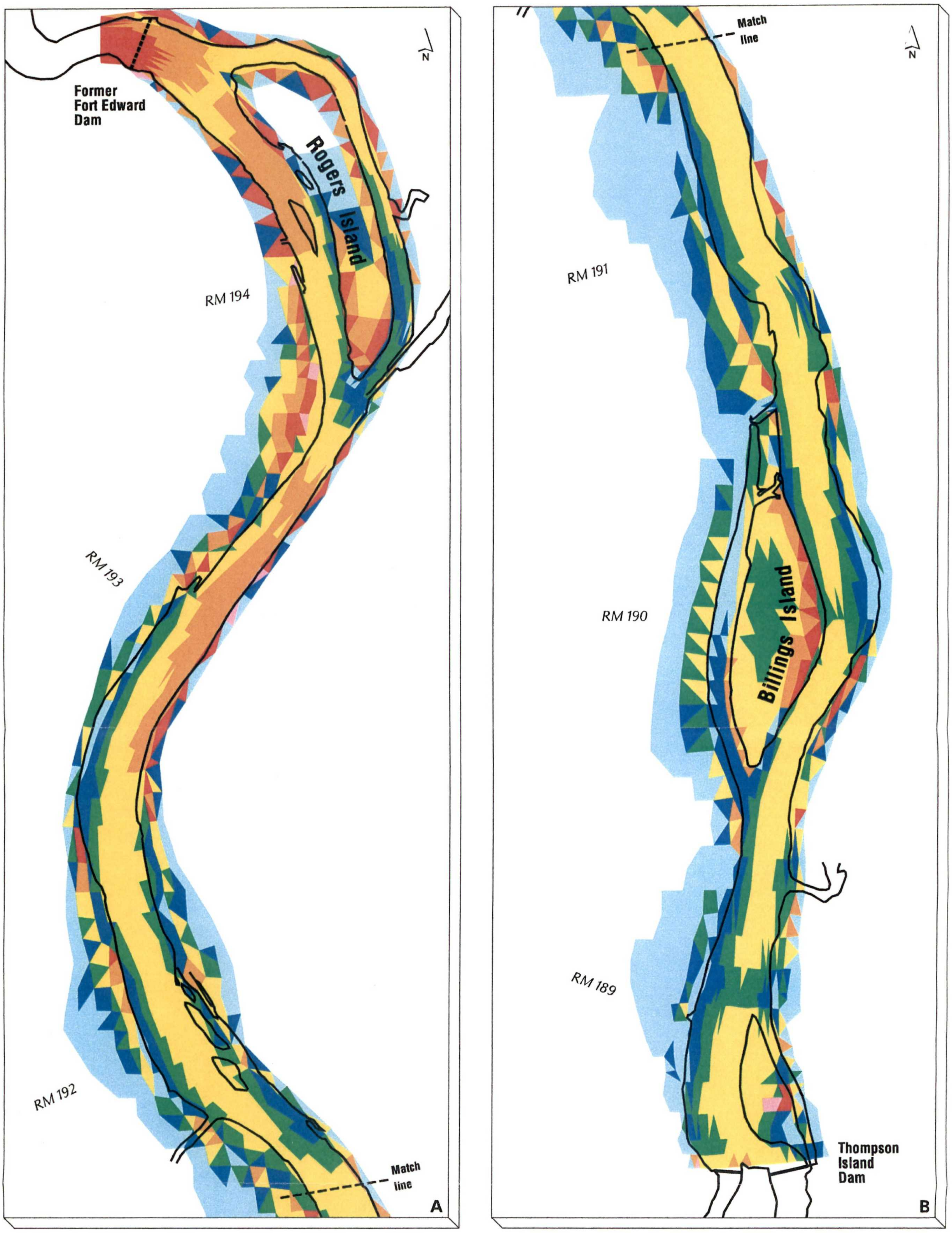

Thompson Island Pool

Bottom Shear Stress 100-year Flow Event