Memorandum

Gradient

To: Cynthia Taub
Steptoe & Johnson

Date: June 14, 2010

From: Manu Sharma and Andy Bittner

Subject: **Review of Newark Bay Study Area Screening Level Ecological Risk Assessment (SLERA)**

This report presents Gradient's review of the Screening Level Ecological Risk Assessment (SLERA) for Newark Bay, prepared by Malcolm Pirnie and Battelle, on behalf of the United States Environmental Protection Agency (US EPA) (Malcolm Pirnie, 2008). The SLERA divides Newark Bay into three sections ("Reaches"): Northern, Middle, and Southern. The report concludes that:

- There are distinct sources of metals (mercury, cadmium, arsenic, and chromium) contributing to the Middle and Southern Reaches of the Bay;
- The Lower Passaic River is the only source of 2,3,7,8-TCDD in Newark Bay; and
- There are sources of PCBs to the Bay in the Middle Reach.

We have identified several key deficiencies and issues in the SLERA, summarized in this document, that raise serious doubts about the SLERA's conclusions. We believe that the SLERA needs to be revised prior to proceeding to the Baseline Ecological Risk Assessment (BERA). In addition, we also present here a critique of a mercury mass balance model for Newark Bay (Malcolm Pirnie, 2006).

1 An inappropriate coordinate system was used to analyze contaminant distribution and sources.

The SLERA uses an inappropriate coordinate system, which has led to assignment of sampling locations to incorrect "Reaches" within Newark Bay and generation of inaccurate concentration-distance plots. The coordinate system used in the SLERA measures distance along an arbitrary north-south axis rather than along the axis of flow within the Bay (Figure 1). This seemingly small difference in axis orientation has a significant effect on data interpretation (Figure 1). For example, as illustrated in Figure 1, samples collected from Port Newark Channel and portions of the Northern Reach appear at the same location in the concentration-distance plots presented in the SLERA (Figures 8-15 of the SLERA). Consequently, concentrations measured in samples collected in the Northern Reach are being interpreted

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as having been collected in the Middle Reach and/or Port Newark Channel. This problem with the coordinate system appears to have led to assigning sampling location NB901 (discussed below) to the Middle Reach in the SLERA. We recommend that the coordinate system misalignment be rectified and the assignment of samples to Newark Bay Reaches be reviewed by US EPA, prior to commencement of the BERA.

2 A key Northern Reach data point (NB901) was incorrectly included in the Middle Reach.

Due to the misaligned coordinate system, a key sediment sample in Newark Bay (NB901), located in the Northern Reach, was incorrectly used to assess ecological risks for the Middle Reach (Figure 2). Sample location NB901 is important because it contained high sediment concentrations of several compounds, including the highest surficial mercury concentration recorded in the Northern Reach (10,700 µg/kg). This sample also contained high concentrations of arsenic (26,100 µg/kg), copper (234,000 µg/kg), total DDx (730 µg/kg), and 2,3,7,8-TCDD (0.26 µg/kg). Since NB901 is located within the depositional area of the Passaic River, this sample is a good representation of sediments contributed to Newark Bay from the Passaic River.

3 There are several other deficiencies in the SLERA.

The SLERA calculates Hazard Quotients (HQs) for each chemical by taking the maximum sediment concentration detected in the top 6 inches and dividing by a sediment screening benchmark protective of direct toxicity to benthic invertebrates and wildlife (protective of exposures to higher trophic levels, referred to as protective concentration level, or PCL in the SLERA). A summary of the SLERA deficiencies is provided below.

- A key data point (NB901) was assigned to the Middle Reach, but it belongs in the Northern Reach. This incorrect assignment of NB901 to the Middle Reach significantly affects sediment concentrations and values for both the Middle and Northern Reaches. For example, the corrected maximum mercury concentration in Northern Reach increases from 5,600 to 10,700 µg/kg, the maximum arsenic concentration increases from 17,600 to 26,100 µg/kg, and the maximum copper concentration increases from 190,000 to 234,000 µg/kg; whereas, the corrected maximum mercury concentration detected in the Middle Reach declines from 10,700 to 5,500 µg/kg .
- The maximum 2,3,7,8-TCDD concentration in the Southern Reach was detected at sample location NB01SED019. However, the 2,3,7,8-TCDD concentration measured at this location does not appear to have been used in the HQ calculations, although

concentrations for many other analytes measured at this location were used in the analysis.

- A key data point (85A, referred to in the SLERA as sample '105') used in the calculations is located within the transitional slope region of Port Newark Channel. Since it was collected in 1993 in an area that may have since been dredged (Tierra, 2004), it is not representative of current conditions and should not have been used in the ecological screening calculations. Eliminating this sample results in significant reductions in the maximum concentration of metals, PCBs and dieldrin within the Middle Reach (see Table 1).

Table 1 presents revised ecological screening calculations for selected compounds addressing the above listed issues and a comparison of the Malcolm Pirnie and Gradient-revised HQ results. Overall, addressing the above listed issues results in higher HQs in the Northern Reach for 4 of 12 analytes, lower HQs in the Middle Reach for 10 of 12 analytes, and higher HQs in the Southern Reach for 8 of 12 analytes.

4 The wildlife PCLs used in the Newark Bay SLERA are very different from the Passaic River SLERA.

The sediment bioaccumulation PCL values used in the Newark Bay SLERA differ considerably from those used in the Passaic River SLERA (Malcolm Pirnie, 2007), although the receptors and overall approach used for PCL calculations are identical. The two documents appear to use different bioaccumulation sediment accumulation factors (BSAFs), although the reasons for these changes are not clear. Nonetheless, the resulting PCL values in the two reports are very different and have a significant impact on the calculated HQ values and the identified compounds of potential environmental concern (COPECs).

For example,

- The sediment wildlife PCL for 2,3,7,8-TCDD in the Passaic River SLERA is 0.0025 µg/kg, whereas the corresponding PCL value for Newark Bay is 2.3 µg/kg, approximately 3 orders of magnitude higher than the Passaic River value. Thus, an equivalent concentration of dioxins will result in a much lower HQ in Newark Bay than in the Passaic River.
- The copper wildlife PCL used in the Passaic River SLERA is 13,000 µg/kg, whereas the PCL used for Newark Bay is 297 µg/kg, 44 times lower than the Passaic River value.
- The chromium wildlife PCL used in the Passaic River SLERA is 41,000 µg/kg, whereas the PCL used for Newark Bay is 368 µg/kg, 110 times lower than the Passaic River value.

- The high molecular weight polycyclic aromatic hydrocarbon (HPAH) wildlife PCL used in the Passaic River SLERA is 552 µg/kg, whereas the PCL used for Newark Bay is 6.1 µg/kg, 90 times lower than the Passaic River value.

Overall, these differences in wildlife PCLs have the effect of overestimating the ecological risk of metals and PAHs and underestimating the ecological risk of dioxins in the Bay compared to the recently-completed SLERA for the Passaic River. Table 2 presents a comparison of the sediment PCL values used in the Newark Bay and the Passaic River SLERAs and the impact of these differences on the calculated HQs.

5 Consideration of the Phase II sediment data indicates that the conclusions reached by the prior Newark Bay Mercury Mass Balance model are not valid.

Mass balance modeling, performed by Malcolm Pirnie (2006), and alluded to in the SLERA, did not appropriately characterize mercury loadings from sources, such as Arthur Kill and Kill van Kull, the largest sources of sediment loading to the Bay. Malcolm Pirnie (2006) developed a mass balance for mercury, 2,3,7,8-TCDD, and total TCDD. For this analysis, they modeled Newark Bay as a well-mixed basin with an annual sediment deposition equal to the sum of the sediment loads from the inflowing rivers, CSOs/WWTPs, and atmospheric deposition. The sediment loading from each source was calculated using historical studies of sediment transport rates, comparing differences in upstream sediment erosion, downstream deposition and dredged sediment volumes, and by calibrating the loading rates such that the 2,3,7,8-TCDD and total TCDD chemical mass balances were closed. The calculated sediment loads and average mercury concentrations of each river were then used to estimate the total mercury input to Newark Bay. By comparing the mercury loading rates, the analysis concluded that 158 kg/year of mercury could not be accounted for and must originate from another source.

Gradient reviewed the mass balance and updated the analysis incorporating the Phase II sediment quality data for Newark Bay (Tables 3 and 4). The conclusion from the prior mass balance that 158 kg/year could not be accounted for using the modeled sources is not valid. Using average surficial sediment mercury concentrations for each water body (Table 3), our analysis indicates that:

- The input of mercury to the Bay from the four inputs (Passaic, Hackensack, Kill an Kull, and Arthur Kill) accounts for all mercury deposition in Newark Bay, *i.e.* there is no indication of other sources contributing significant quantities of mercury to the Bay (Table 4).

- Kill van Kull is a significant source of mercury, accounting for two-thirds of the total mercury mass loading to the Bay.

Overall, the updated mercury mass balance model indicates that the four inputs considered in the analysis fully accounts for mercury deposited in Newark Bay, *i.e.* there is no other significant mercury source to the Bay.

References

Malcolm Pirnie, Inc. (Malcolm Pirnie). 2006. "Lower Passaic River Restoration Project: Draft Geochemical Evaluation (Step 2)". Prepared for US EPA, Region II and US Army Corps of Engineers. February.

Malcolm Pirnie, Inc. (Malcolm Pirnie). 2007. "Source Control Early Action Focused Feasibility Study, Lower Passaic River Restoration Project." June.

Malcolm Pirnie, Inc.; Battelle. 2008. "Screening-Level Ecological Risk Assessment Report for Newark Bay Study Area." December 15.

Tierra Solutions, Inc. (Tierra). 2004. "Newark Bay Study Area, Remedial Investigation Work Plan – Sediment Sampling and Source Identification Program (Phase I), Newark Bay, New Jersey." June.

US EPA. 1997. "The Incidence and Severity of Sediment Contamination in Surface Waters of the United States, Volume 1: National Sediment Quality Survey." EPA 823-R-97-006, September.

Table 1
Comparison of Newark Bay Ecological Screening Hazard Quotients
Newark Bay Study Area, Newark, NJ

Reach	Chemical	Maximum Concentration Detected (ug/kg)		Hazard Quotient (HQ)		HQ Basis
		Malcolm Pirnie (SLERA)	Gradient Corrected	Malcolm Pirnie (SLERA)	Gradient Corrected	
Northern	Mercury	5,600	10,700	133	255	(a)
	Arsenic	17,600	26,100	2.1	3.2	(b)
	Cadmium	9,100	9,100	7.6	7.6	(b)
	Chromium	277,000	277,000	753	753	(a)
	Lead	243,000	243,000	23	23	(a)
	Copper	190,000	234,000	640	788	(a)
	HPAH	67,800	67,800	11,115	11,115	(a)
	LPAH	9,260	9,260	17	17	(b)
	Total DDx	156	299	99	189	(b)
	Total Aroclor PCBs	3,478	1,340	153	59	(b)
	Dieldrin	43	43	2,165	2,165	(b)
	2,3,7,8-TCDD	0.47	0.47	235	235	(b)
Middle	Mercury	10,700	5,500	255	131	(a)
	Arsenic	35,700	20,700	4.4	2.5	(b)
	Cadmium	18,500	12,900	15	11	(b)
	Chromium	397,000	305,000	1,079	829	(a)
	Lead	777,000	882,000	73	83	(a)
	Copper	1,330,000	436,000	4,478	1,468	(a)
	HPAH	124,300	124,000	20,377	20,328	(a)
	LPAH	38,800	13,300	70	24	(b)
	Total DDx	730	379	462	240	(b)
	Total Aroclor PCBs	12,250	4,280	540	189	(b)
	Dieldrin	131	60	6,550	3,000	(b)
	2,3,7,8-TCDD	0.26	0.16	132	82	(b)
Southern	Mercury	3,900	20,600	93	490	(a)
	Arsenic	24,000	54,100	2.9	6.6	(b)
	Cadmium	4,800	21,500	4.0	18	(b)
	Chromium	206,000	649,000	560	1,764	(a)
	Lead	240,000	863,000	23	81	(a)
	Copper	271,000	598,000	912	2,013	(a)
	HPAH	471,640	472,000	77,318	77,377	(a)
	LPAH	49,300	44,100	89	80	(b)
	Total DDx	2,496	2,491	1,580	1,576	(b)
	Total Aroclor PCBs	23,040	14,000	1,015	617	(b)
	Dieldrin	460	460	23,000	23,000	(b)
	2,3,7,8-TCDD	0.09	0.59	46	296	(b)

Notes:
a) HQ driven by wildlife PCL for Newark Bay.
b) HQ driven by sediment effects criteria.

Table 2
Comparison of Wildlife Protect Concentration Levels (PCLs)
Newark Bay SLERA and Lower Passaic River SLERAs
Newark Bay Study Area, Newark, NJ

Chemical	Maximum Detected Sediment Concentration - Northern Reach, Newark Bay [1] (ug/kg)	Wildlife PCL (ug/kg)		Hazard Quotient for Northern Reach of Newark Bay based on Wildlife PCL for:	
		Newark Bay	Lower Passaic River[2]	Newark Bay	Lower Passaic River
Mercury	10,700	42	37	255	289
Arsenic[3]	26,100	173,228	170,000	0.15	0.15
Cadmium[3]	9,100	3,974	3,000	2.3	3.0
Chromium[3]	277,000	368	41,000	753	6.8
Lead	243,000	10,606	11,000	23	22
Copper	234,000	297	13,000	788	18
HPAH	67,800	6.1	552	11,115	123
LPAH	9,260	418,164	1,700	0.02	5.4
Total DDx	299	19	19	16	16
Total Aroclor PCBs	1,340	365	370	3.7	3.6
Dieldrin	43	271	270	0.16	0.16
2,3,7,8-TCDD	0.47	2.3	0.0025	0.20	188

Notes:
1) Calculations performed only for Northern Reach of Newark Bay; similar effects on HQs are expected for the Middle and Southern Reaches.
2) Wildlife PCLs From Malcolm Pirnie Lower Passaic River Restoration Project Feasibility Study (2007).
3) Compounds were not listed as Chemicals of Potential Ecological Concern (COPECs) in the Lower Passaic.

Table 3
Surface Sediment Mercury Concentrations
Newark Bay Study Area, Newark, NJ

Source	Number of Samples Collected	Number of detects	Maximum concentration (mg/kg)	Minimum concentration (mg/kg)	Average concentration (mg/kg)
Passaic River	259	259	12.4	0.56	3.1
Hackensack River	8	7	5.2	ND	2.1
Kill Van Kull	14	13	7.7	ND	2.6
Arthur Kill	17	16	5.4	ND	3.3
Newark Bay	284	253	20.6	ND	2.2

Notes:
a) ND = Not detected
b) Data from databases available from www.ournewarkbay.org.
c) Only samples detected in the top 6 inches of sediment were used.

Table 4
Updated Mercury Mass Balances for Newark Bay
Newark Bay Study Area, Newark, NJ

Mercury Inputs to Newark Bay

Passaic River	21,200	3.1	66
Hackensack River	3,870	2.1	8
Kill van Kull	116,000	2.6	298
Arthur Kill	23,700	3.3	77
Total			**449**

Mercury Deposition in Newark Bay

Sediment Deposition (metric tons/year)	Average Mercury Concentration (mg/kg)	Mercury Loading Rate to Newark Bay (kg/year)
171,240	2.2	**373**

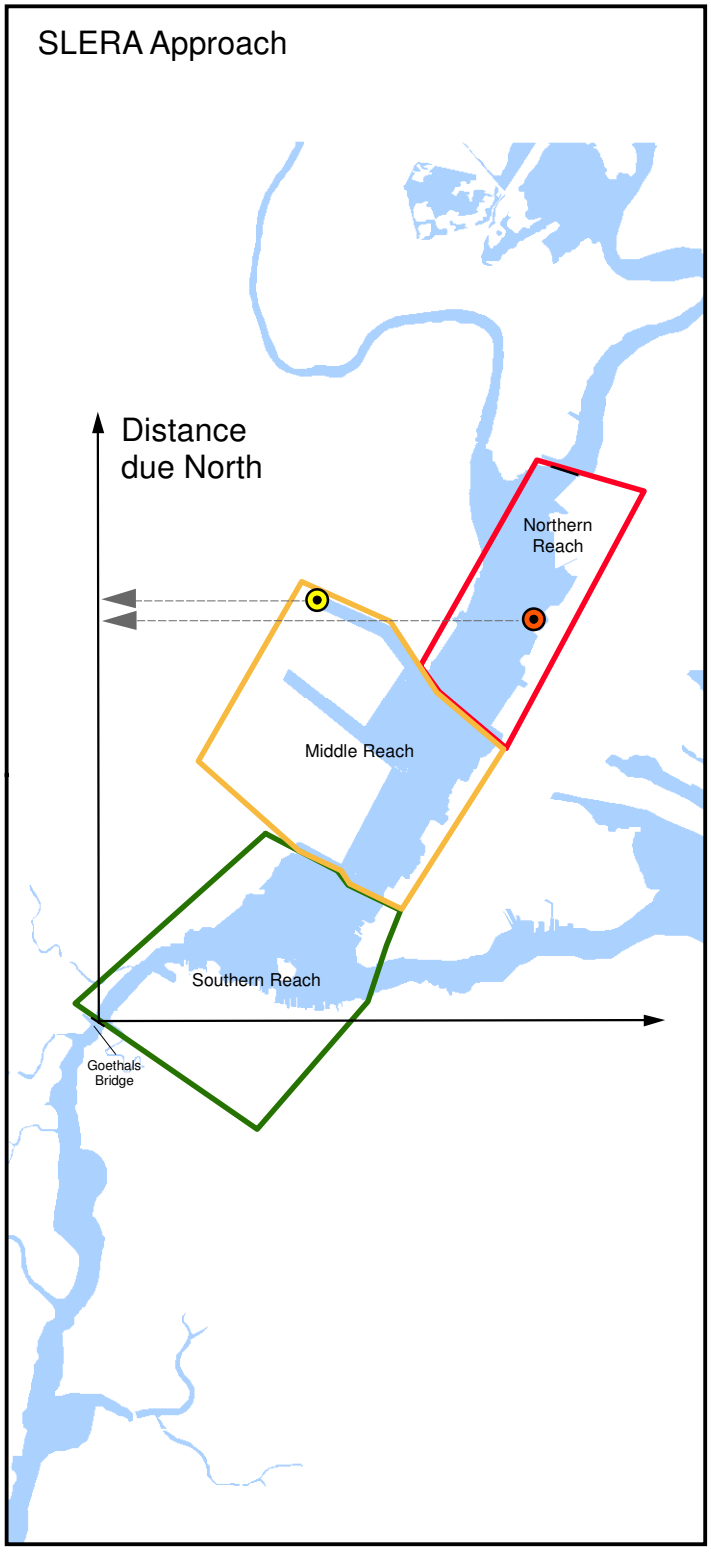
Conclusion: Mercury influx from 4 sources fully accounts for all mercury deposition in Newark Bay.

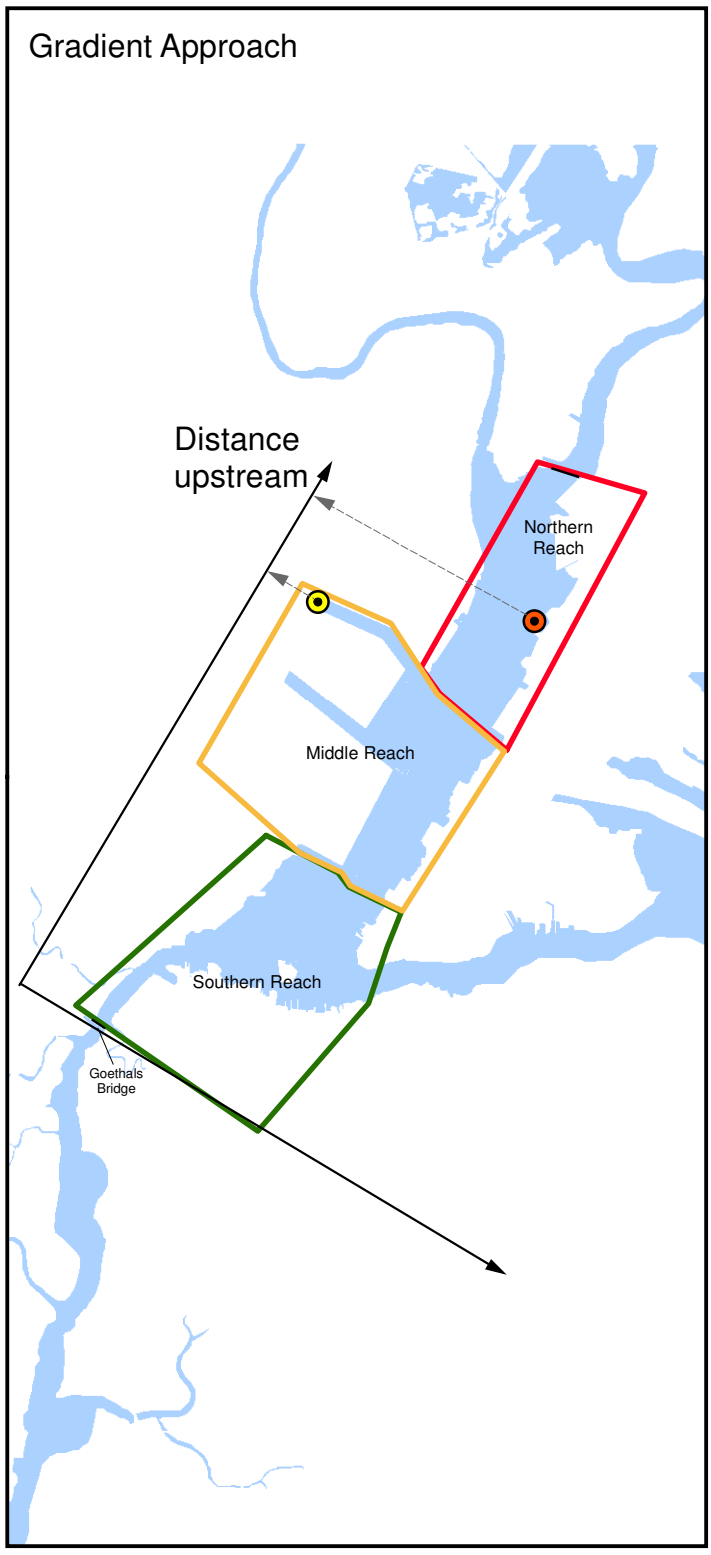
Notes:

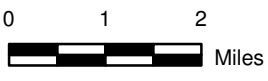
a) Sediment loading and deposition rates are from Malcolm Pirnie (2006).

b) An additional 6,470 metric tons/year were included in the sediment deposition into Newark Bay from Combined Sewer Overflows(CSOs), Publicly Owned Treatment Works (POTWs) and atmospheric deposition. The mercury loadings due to these sources are set to zero for the analysis (Malcolm Pirnie, 2006).

c) Calculated surficial sediment mercury concentrations from databases available from www.ournewarkbay.org (See Table 3).







Note:

1) All Site Features and locations are approximate

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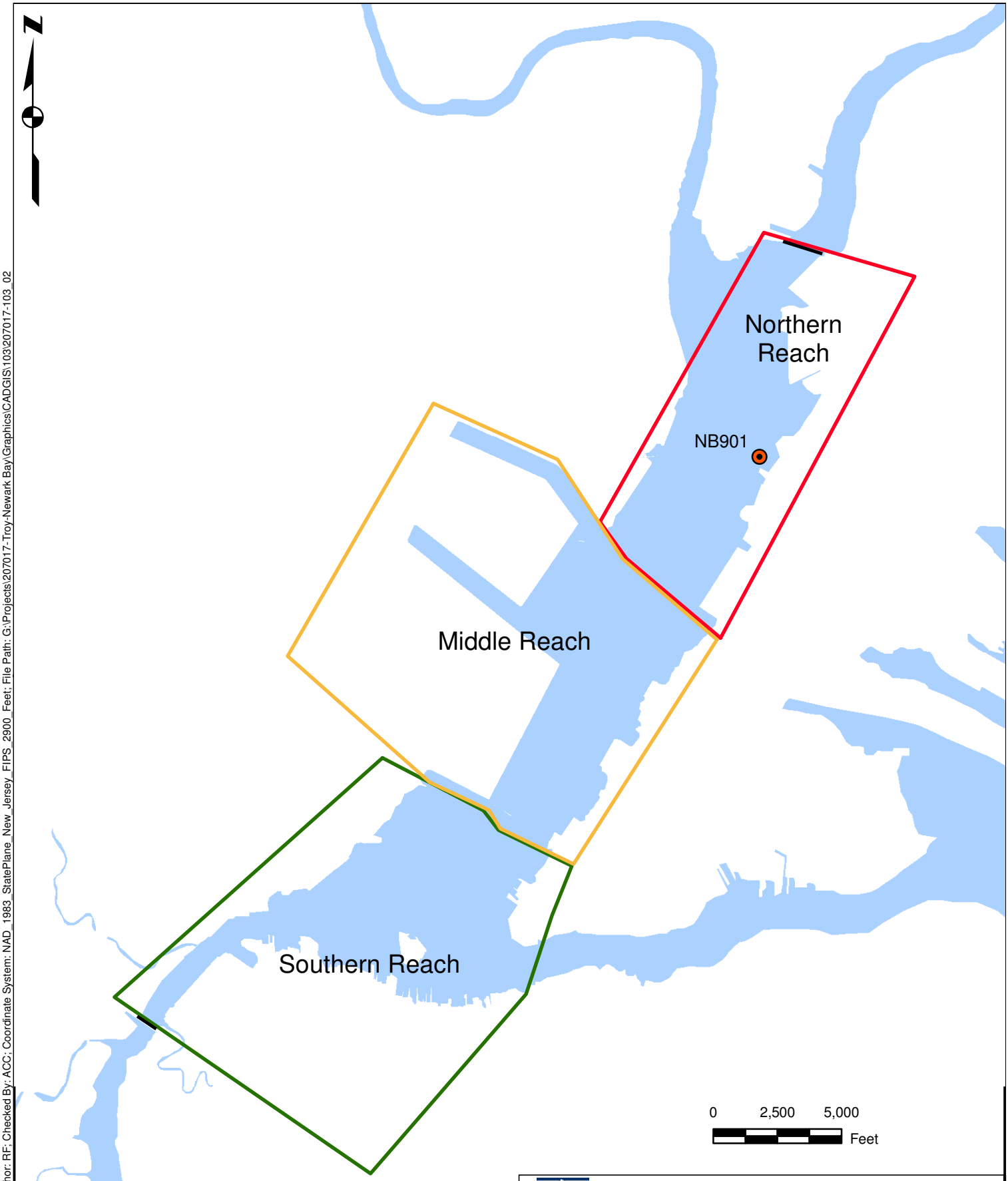
Misleading Coordinate Orientation Used by SLERA

Newark Bay Study Area

FIGURE 1

Date: 05/24/2010

Project No.: 207017; PM: ACC; Author: RF; Checked By: ACC; Coordinate System: NAD_1983_StatePlane_New_Jersey_FIPS_2900_Feet; File Path: G:\Projects\207017-Troy-Newark Bay\Graphics\CADGIS\103\207017-103_05



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Note:

1) All Site Features and locations are approximate

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Location of Sediment Sample NB901

Newark Bay Study Area

FIGURE 2

Date: 05/24/2010