June 3, 2008

INPUT DOCUMENTATION AND SUMMARY RESULTS FOR THE "PLANNED IMPROVEMENTS" AND "LIMIT OF TECHNOLOGY" REGIONAL SWEM SIMULATIONS

In advance of performing SWEM simulations supporting development of plans for attaining dissolved oxygen standards in various sub-regions of the Harbor, HydroQual was authorized to perform two regional SWEM simulations: "Planned Improvements" and "Limit of Technology". The purpose of the "Planned Improvements" and "Limit of Technology" SWEM simulations is to answer the questions: "Where will Harbor water quality be soon?" and "Where can the Harbor TMDLs go?". The two runs will put practical bounds on the minimum and maximum improvements in water quality that can be expected as a result of HEP nutrient TMDLs. Results of the two simulations will be used to inform planning for TMDLs in various sub-regions of the Harbor. Detailed results will be reported on in the context of developing and presenting specific sub-regional TMDL plans. Summary results are provided here in a tabular and color map format showing days of non-attainment of the enforceable State standards.

Summary Results

"Planned Improvements" SWEM Simulation Summary Results

The results of the "Planned Improvements" simulation were compared to current dissolved oxygen standards, including the established NY and NJ standards and the recently adopted revised standards for the SA, SB, and SC NY waters. For shared waters, the revised NY standards were applied. Table 1 presents the days of non-attainment of current standards as well as the incremental change in the days of non attainment for each successive loading reduction. The range of days of non-attainment of current standards and the range of change in days of non-attainment between runs are presented for each of six HEP regions for each run or successive pair of runs, respectively. The resulting numbers of days of non-attainment of current standards for the "Planned Improvements" run are presented in map format in Figures 1 and 2. Under the "Planned Improvements" loading conditions, there remains up to 211.4, 22.4, 50.5, 19.7, 70.0 and 18.2 days of non-attainment of current standards in the Hackensack River, Passaic River, Newark Bay, Arthur Kill and Kill Van Kull, Raritan River and Raritan Bay, and Hudson River below Piermont Marsh and Upper Bay regions, respectively.

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"LOT" SWEM Simulation Summary Results

The results of the "Limit of Technology" simulation were compared to current dissolved oxygen standards in both States. The days of non-attainment and incremental changes in days of non-attainment for the LOT run are presented in Table 1 and Figures 3 and 4. Under the "LOT" loading conditions, there remains up to 73.4, 11.2, 18.7, 6.2, 62.4, and 1.9 days of non-attainment of current standards in the Hackensack River, Passaic River, Newark Bay, Arthur Kill and Kill Van Kull, Raritan River and Raritan Bay, and Hudson River below Piermont Marsh and Upper Bay regions, respectively.

Input Documentation

"Planned Improvements" Run Loading Assumptions

The "Planned Improvements" run takes into account improvements in loading conditions already planned or implemented within the SWEM domain. The run is based on nitrogen and carbon loads at SWEM 94-95 measured concentrations as well as a number of planned or already implemented improvements including: loading reductions related to the implementation of the Clean Air Interstate Rule (CAIR), the Long Island Sound (LIS) Nitrogen TMDL (including associated carbon loading reductions), the Jamaica Bay Consent Order, the relocation of the North Bergen Central WWTP discharge, the Non-Tidal Passaic River Basin Phosphorus TMDL, and updated Owls Head WWTP loads.

Simulations of CAIR, LIS TMDL, and Jamaica Bay Consent order loading conditions were completed sequentially and accumulatively previously, with each set of loading reductions adding to those previously simulated. Taken together, CAIR, LIS TMDL, and Jamaica Bay Consent Order loadings represented a preliminary estimate of planned improvements. This preliminary estimate has been revised to consider additional loadings changes. The carbon and nitrogen loads for the CAIR plus the LIS TMDL plus the Jamaica Bay Consent Order simulation, along with the loadings for the baseline simulation, the HydroQual scenario, and the pastoral conditions simulation were tabulated on a regional basis. The tabulated loads were then reviewed by the States and the NWG to allow for any corrections or suggestions and to facilitate specification of loading modifications for the revised "Planned Improvements" run.

The revised "Planned Improvements" run includes the cumulative loading reductions associated with the first three sets of loading reductions considered as well as the final three: the relocation of the North Bergen Central WWTP discharge, the Non-Tidal Passaic River Basin Phosphorus TMDL, and updated Owls Head WWTP loads. In addition, a SWEM input error in the previous simulation of 1989 CSO carbon loading inputs for the LIS Nitrogen TMDL was corrected in the revised "Planned Improvements" run. The results of the revised "Planned Improvements" run can be used as a benchmark for comparison to future runs. The results of the run allows the HEP nutrient TMDL to account for future water quality benefits associated with already planned improvements, and identify improvements specifically associated with other potential future management actions.

Planned Improvements Run - Previously Evaluated Loading Changes

The "Planned Improvements" run builds upon four runs that were completed previously. The loads for these four previous runs are described in further detail below. Also, the baseline and cumulative CAIR plus the LIS TMDL plus the Jamaica Bay Consent Order loads were tabulated in the loading tables distributed to the NWG and the states.

Baseline Loading Assumptions

The baseline loads come from the SWEM 1994-1995 model calibration. The baseline loads are based mainly on the SWEM 1994-1995 sampling program along with some DMR data and are discussed in detail in the original SWEM loading report. For the HEP TMDL baseline condition, all treatment plant loads and atmospheric loads were kept at 1994-1995 levels while heads of tide, CSOs, and SWOs were based on 1988-1989 flows and 1994-1995 concentrations. These loadings have been tabulated and distributed to the NWG.

CAIR Loading Assumptions

The Clean Air Interstate Rule (CAIR) resulted in reductions to nitrogen loads directly from the atmosphere as well as indirectly from storm water and heads of tide throughout the SWEM domain. The implementation of CAIR in the SWEM model framework resulted in a 25.3% reduction in the atmospheric nitrogen load and a 6.64% reduction in storm water nitrogen loads. CAIR results were combined with SPARROW results (i.e., percentage of a tributary loading influenced by the atmosphere) to determine tributary specific reductions in nitrogen loads which ranged from 0.9 to 11.9 %. The average reduction in tributary nitrogen loadings, 6.64%, was assigned for storm water reductions. The nitrogen load reductions associated with the CAIR are discussed in further detail in the July, 2006 HydroQual memo "*Use of SWEM to Address HEP TMDL Oversight Group Nutrient Management Questions".*

Long Island Sound Nitrogen TMDL plus Carbon Removal Loading Assumptions

The Long Island Sound TMDL was implemented in SWEM based on the 2000 LISS TMDL and adding onto the loading reductions associated with the CAIR. Nitrogen loadings in the Long Island Sound TMDL plus carbon removal scenario were the phase III and IV WLA/LA annual loadings of total nitrogen specified in *"A Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound (2000)".* The Carbon loads were specified as described in the August, 2006 HydroQual memo "*C Loadings for TMDL Scenario"*, and included reductions to WWTP, CSO, SW, and head of tide carbon loads associated with the implementation of nitrogen reduction technologies required to meet the TMDL requirements. The Long Island Sound TMDL plus carbon removal scenario adds to the nitrogen reductions associated with the implementation of the CAIR.

Jamaica Bay Consent Order Loading Assumptions

The Jamaica Bay Consent Order run included reductions in loads associated with both CAIR and the LIS TMDL plus carbon scenario as well as planned load reductions for the four NYC WWTPs in Jamaica Bay (Coney Island, 26th Ward, Rockaway, and Jamaica)

under the Jamaica Bay Consent Order. Treatment plant loads for the Jamaica Bay Consent Order run were taken directly form Table 3-1 of the NYCDEP Jamaica Bay Plan document. The 26th Ward ammonia and nitrate plus nitrite loads reflect seasonal splits between the two dissolved inorganic nitrogen fractions based on the tabulated concentrations and annual loads.

Planned Improvements Run – Additional Load Reduction Assumptions

The "Planned Improvements" run includes the three previously considered updates to the baseline loads as well as three additional changes to the loads based on projects that are currently planned or underway. The three additional changes included in this run are the relocation of the North Bergen Central WWTP discharge, the non-tidal Passaic River phosphorus TMDL, and updates to the Owls Head WWTP loads.

Relocation of the North Bergen Central WWTP Discharge Loading Assumptions

Work is currently underway on the relocation of the North Bergen Central WWTP discharge to the Passaic Valley Sewerage Commissioners (PVSC) discharge. For model simulation purposes, the North Bergen Central WWTP load was added to the PVSC load. At the original North Bergen Central WWTP discharge site, the discharged load (i.e., nutrients, dissolved oxygen deficit) was set equal to zero. Because the hydrodynamics were not re-run for this particular scenario, the small volume of water associated with the North Bergen Central discharge (approximately 10 MGD) still enters the Hackensack River in the model, but carries zero load of dissolved oxygen deficit. In order to avoid introducing an unrealistic dissolved oxygen deficit by adding zero dissolved oxygen along with the discharge volume in the model, the dissolved oxygen load was set equal to the flow times dissolved oxygen saturation. Saturation was calculated based on the discharge segment temperature and salinity. Saturation represents no incoming load of dissolved oxygen deficit. In the real world, there would be no volume of saturated water discharging from the former North Bergen Central WWTP outfall to the Hackensack River.

The Non-Tidal Passaic River Basin Phosphorus TMDL Loading Assumptions

The Non-Tidal Passaic River Basin Phosphorus TMDL was implemented in the SWEM model by taking the median values for phosphorus, carbon, and dissolved oxygen concentration from the farthest down stream segment of the Non-Tidal Passaic River Model (i.e., immediately above Dundee Dam) on a monthly basis and applying that value as the head of tide concentration in SWEM The Non-Tidal Passaic River Basin Phosphorus TMDL model included concentrations calculated using the Non-Tidal Passaic River WASP7 Model under TMDL conditions for the time period from October 1999 through November 2003.

Since the SWEM boundary conditions are specified on a monthly basis, the downstream median value for each month from the four to five years simulated by the Non-Tidal Passaic River Model were applied to the Passaic River head of tide in SWEM. Dissolved inorganic phosphorus concentrations were used directly from the Non-Tidal Passaic River Model output. The calculated organic phosphorus concentration just above Dundee Dam from the Passaic River Model was split into the four SWEM systems

(refractory and labile POP and DOP) based on the split of existing loadings in SWEM. The $CBOD_5$ concentration was converted to the five SWEM organic carbon systems (refractory and labile POC and refractory, labile, and reactive DOC) based on SWEM BOD decay coefficients and the existing split of SWEM loadings. The strategy was to match the oxygen demand implied by the CBOD5 concentrations from the Non-Tidal Passaic River model with the oxygen demand implied by the newly assigned organic carbon concentrations in SWEM. The algal carbon from the Non-Tidal Passaic River Model was used directly as the SWEM head of tide concentration and split between the summer and winter assemblage based on the existing ratio in SWEM of the two functional groups. The monthly median dissolved oxygen concentration calculated by the Non-Tidal Passaic River model was used directly without any modification as the SWEM head of tide value.

The nitrogen concentrations calculated under the Non-Tidal Passaic River Basin Phosphorus TMDL presented some difficulty. Nitrogen loadings specified in the Non-Tidal Passaic River model were based on no removal of nitrogen with all treatment plant flows and concentrations set at permit levels. The resulting total nitrogen concentrations at the downstream boundary of the Non-Tidal Passaic River Basin Phosphorus TMDL model were elevated to as much as three times the existing values in SWEM, based on loads that are potentially far greater than existing loads. Due to the elevated nitrogen concentrations calculated under the Non-Tidal Passaic River Basin Phosphorus TMDL, nitrogen boundary conditions for the Passaic River were kept at the SWEM concentrations for the "Planned Improvements" run.

Updated Owls Head WWTP Loading Assumptions

As a result of the review of the tabulated loads for the previously completed runs, NYSDEC and the NWG determined that it was appropriate to update the Owls Head WWTP loads. The Owls Head WWTP in SWEM was previously represented by fiscal year 1996 performance in recognition of a major plant upgrade taking place in 1994-95. Although fiscal year 1996 performance was a closer representation of current performance than 1994-95 concentrations, the plant was still undergoing adjustments to the treatment process in fiscal year 1996. Per the request of NYSDEC, calendar year 2007 DMR data were used to update loads for Owls Head to better reflect current operations at the plant.

Limit of Technology Run Loading Assumptions

The "Limit of Technology" (LOT) run puts a practical upper bound on what water quality improvements can potentially be achieved by the TMDL. The LOT run includes all of the loading reductions included in the "Planned Improvements" run as well as maximum achievable loading reductions applied at all WWTPs located within the HEP core area to be addressed by TMDLs (i.e., the HEP core area less Jamaica Bay and the East and Harlem Rivers). The LOT simulation also includes loading reductions related to MS4 requirements for SW loads within the SWEM domain.

LOT Treatment Plant Loads

As part of the TMDL analysis, the dischargers developed a cost analysis for a number of levels of nitrogen and carbon reductions for each plant discharging to the HEP

core area. Included in the cost analyses were LOT nitrogen and carbon reductions. LOT conditions were applied to all plants within the HEP core area with the exception of plants already included in the LIS TMDL and Jamaica Bay Consent Order. For each plant the level of treatment that resulted in the lowest overall nitrogen and carbon load was chosen.

In the case of NYC, the Membrane Bioreactor (MBR) level of treatment was chosen for North River, Oakwood Beach, Owls Head, and Port Richmond from Table EX-1 of "*Conceptual Design at North River, Owls Head, Port Richmond, and Red Hook*" (NYCDEP, 2007). LOT values for the New Jersey Harbor Dischargers Group (NJHDG) plants were taken from "*Nutrients Reduction Cost Estimation Study: Preliminary Plant-Specific Cost Estimates*" (Metcalf & Eddy, 2007). For the NJHDG, plant specific paired nitrogen and carbon removals were not provided. In this case the highest levels of plant specific nitrogen targeting removals were paired with the generic plant carbon removals associated with those nitrogen removals. The LOT technology chosen was fully nitrifying biological aerated filter (BAF) and deep bed denitrifying filter for the trickling filter and activated sludge plants (North Bergen Woodcliff, Hoboken, West New York, Secaucus, Passaic Valley, Edgewater, and Middlesex County). The conventional activated sludge plants (Linden Roselle, Joint Meeting Essex Union, Rahway, and Bergen County) would use full step biological nutrient removal (BNR) with denitrifying filters under LOT conditions.

For Westchester County, only the Yonkers WWTP discharges to waters targeted for TMDLs. A cost analysis had not been performed for Yonkers. Accordingly, Yonkers was assigned the maximum of the LOT effluent nitrogen and carbon concentrations determined for the plants included in the costing analysis.

The effluent concentrations and loads for $CBOD_5$ and total nitrogen under the HEP LOT conditions are given in Table 2.

LOT SWO Loads

Under LOT conditions, per MS4 program requirements, BMPs would be implemented for storm water overflows. Based on the performance review of technologies conducted by HydroQual and input from the NWG, 30% removal for carbon and 40% removal for nitrogen were chosen to represent the reductions attainable under a concerted effort to implement BMPs. The level of BMP implementation will be limited by capture, technology, and space restraints. Based on input from the NWG these reductions will be applied to 50% of the storm water discharged to the HEP core area, excluding the areas already included in other programs (the Harlem River, East River, and Jamaica Bay)

Table 1. Current Standards Compliance

Year	Run	Days of Non-Attainment of Current Standards						Decrease in Days of Non-Attainment of Current Standards					
		Hackensack River	Passaic River	Newark Bay	Arthur Kill and Kill Van Kull	Raritan River and Raritan Bay	Hudson River Below Tappan Zee and Upper Bay	Hackensack River	Passaic River	Newark Bay	Arthur Kill and Kill Van Kull	Raritan River and Raritan Bay	Hudson River Below Tappan Zee and Upper Bay
1988	HEP Baseline	22.8 - 218.8	0.0 - 27.2	0.2 - 43.1	0.0 - 20.6	0.0 - 68.0	0.0 - 46.9						
	CAIR + LIS TMDL + Jamaica Bay CO	20.8 - 218.1	0.0 - 25.6	0.1 - 35.7	0.0 - 17.0	0.0 - 67.0	0.0 - 9.5	0.0 - 12.6	-0.1 - 1.6	0.1 - 7.4	0.0 - 5.3	-1.0 - 9.0	0.0 - 46.9
	Planned Improvements	18.4 - 211.4	0.0 - 22.4	0.1 - 32.3	0.0 - 16.1	0.0 - 66.0	0.0 - 9.2	0.2 - 23.9	0.0 - 3.5	0.0 - 3.8	0.0 - 1.3	0.0 - 2.0	0.0 - 0.3
	LOT	0.2 - 73.4	0.0 - 11.2	0.0 - 18.7	0.0 - 6.2	0.0 - 62.4	0.0 - 0.0	7.4 - 153.7	0.0 - 11.2	0.1 - 15.3	0.0 - 10.0	-1.0 - 64.0	0.0 - 9.2
	Pastoral	0.0 - 0.3	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 62.0	0.0 - 0.0	0.2 - 73.4	0.0 - 11.2	0.0 - 18.7	0.0 - 6.2	-41.0 - 12.5	0.0 - 0.0
1989	HEP Baseline	0.1 - 200.3	0.0 - 22.8	0.0 - 76.6	0.0 - 28.5	0.0 - 82.2	0.0 - 43.0						
	CAIR + LIS TMDL + Jamaica Bay CO	0.1 - 199.9	0.0 - 18.2	0.0 - 64.1	0.0 - 22.5	0.0 - 75.1	0.0 - 20.3	0.0 - 12.5	0.0 - 6.3	0.0 - 12.7	0.0 - 6.0	-1.0 - 10.0	0.0 - 43.0
	Planned Improvements	0.0 - 191.8	0.0 - 10.6	0.0 - 50.5	0.0 - 19.7	0.0 - 70.0	0.0 - 18.2	0.0 - 25.6	0.0 - 8.9	0.0 - 14.8	0.0 - 2.8	0.0 - 5.0	0.0 - 2.1
	LOT	0.0 - 25.6	0.0 - 0.6	0.0 - 0.6	0.0 - 3.7	0.0 - 62.0	0.0 - 1.9	0.0 - 171.1	0.0 - 9.9	0.0 - 49.9	0.0 - 17.4	-0.9 - 66.0	0.0 - 16.4
	Pastoral	0.0 - 13.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 63.0	0.0 - 0.0	-1.5 - 25.6	0.0 - 0.6	0.0 - 0.6	0.0 - 3.7	-21.0 - 35.1	0.0 - 1.9
1988 & 1989	HEP Baseline	0.1 - 218.8	0.0 - 27.2	0.0 - 76.6	0.0 - 28.5	0.0 - 82.2	0.0 - 46.9						
	CAIR + LIS TMDL + Jamaica Bay CO	0.1 - 218.1	0.0 - 25.6	0.0 - 64.1	0.0 - 22.5	0.0 - 75.1	0.0 - 20.3	0.0 - 12.6	-0.1 - 6.3	0.0 - 12.7	0.0 - 6.0	-1.0 - 10.0	0.0 - 46.9
	Planned Improvements	0.0 - 211.4	0.0 - 22.4	0.0 - 50.5	0.0 - 19.7	0.0 - 70.0	0.0 - 18.2	0.0 - 25.6	0.0 - 8.9	0.0 - 14.8	0.0 - 2.8	0.0 - 5.0	0.0 - 2.1
	LOT	0.0 - 73.4	0.0 - 11.2	0.0 - 18.7	0.0 - 6.2	0.0 - 62.4	0.0 - 1.9	0.0 - 171.1	0.0 - 11.2	0.0 - 49.9	0.0 - 17.4	-1.0 - 66.0	0.0 - 16.4
	Pastoral	0.0 - 13.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 63.0	0.0 - 0.0	-1.5 - 73.4	0.0 - 11.2	0.0 - 18.7	0.0 - 6.2	-41.0 - 35.1	0.0 - 1.9

Table 2. LOT Nitrogen and Carbon Concentrations and Loads for WWTPs in HEP TMDL Regions

Plant	CBOD5 (mg/L)	Range	TN (mg/L)	Range	CBOD5 (kg/d)	TN (kg/d)
North River	2.0	1.0 - 2.0	4.0	3.0 - 4.0	1196	2361
Oakwood Beach	2.0	1.0 - 2.0	4.0	3.0 - 4.0	199	398
Owls Head	2.0	1.0 - 2.0	4.0	3.0 - 4.0	931	1879
Port Richmond	4.0	4.0	2.3	2.3	566	324
North Bergen Central					0	0
North Bergen Woodcliff	4.0	3.0 - 5.0	4.0	4.0	35	38
North Hudson Sewerage Authority – Adams Street Plant (Hoboken, in SWEM)	4.0	3.0 - 5.0	4.0	4.0	165	164
North Hudson Sewerage Authority – River Road Plant (West New York, in SWEM)	4.0	3.0 - 5.0	4.0	4.0	141	136
Secaucus	4.0	3.0 - 5.0	4.0	4.0	44	47
Linden Roselle	4.0	3.0 - 5.0	4.5	4.5	161	208
Joint Meeting Essex Union	4.0	3.0 - 5.0	4.5	4.5	869	981
Rahway	4.0	3.0 - 5.0	4.5	4.5	345	428
Passaic Valley	4.0	3.0 - 5.0	4.0	4.0	3876	4046
Edgewater	4.0	3.0 - 5.0	4.0	4.0	44	45
Middlesex County	4.0	3.0 - 5.0	4.0	4.0	1508	1628
Bergen County	4.0	3.0 - 5.0	4.5	4.5	940	1129
Yonkers	4.0	3.0 - 5.0	4.5	4.5	1090	1226

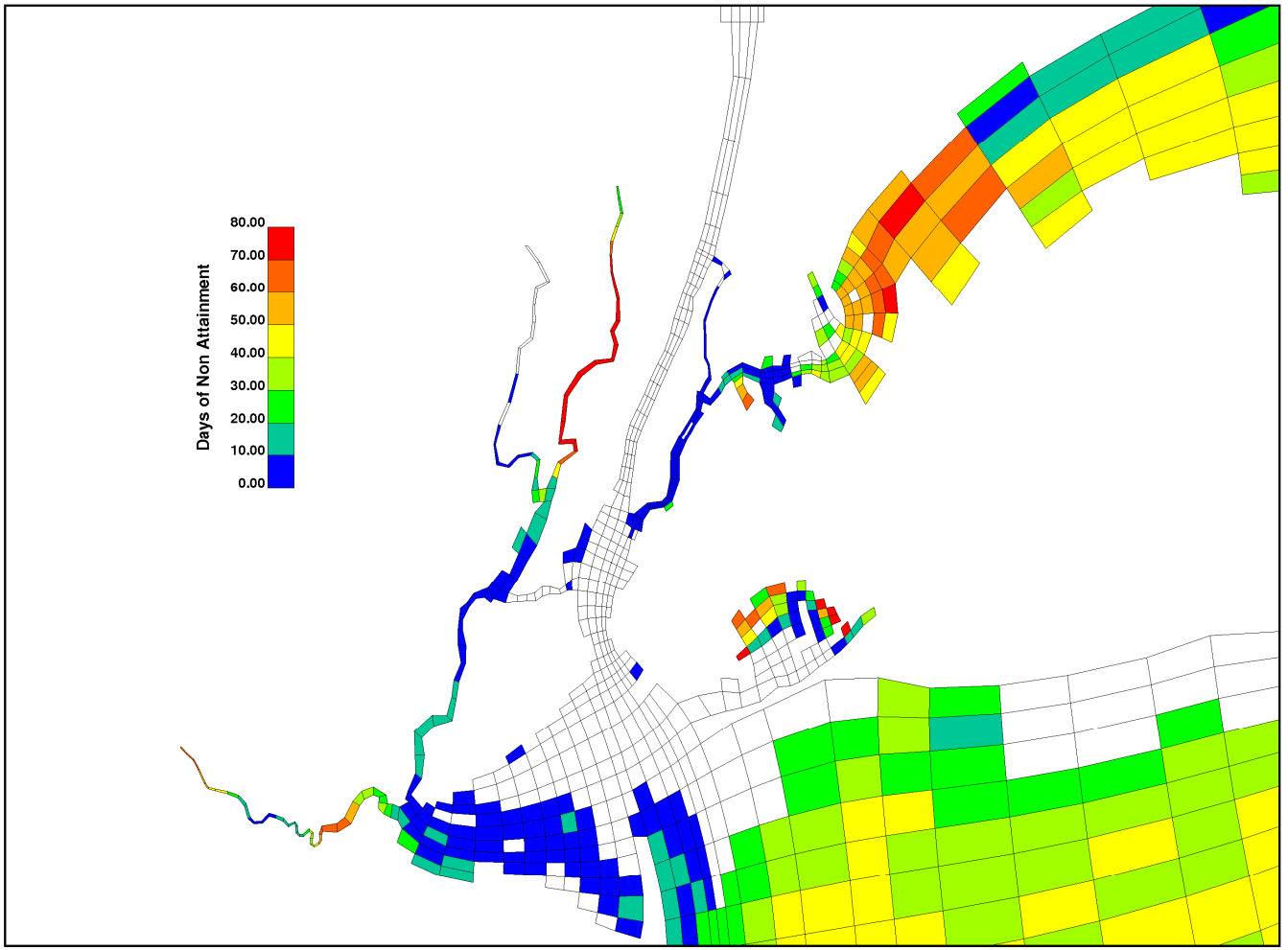

Figure 1. Planned Improvements Simulation, Current Dissolved Oxygen Standards Attainment, 1988 Hydrodynamic Conditions

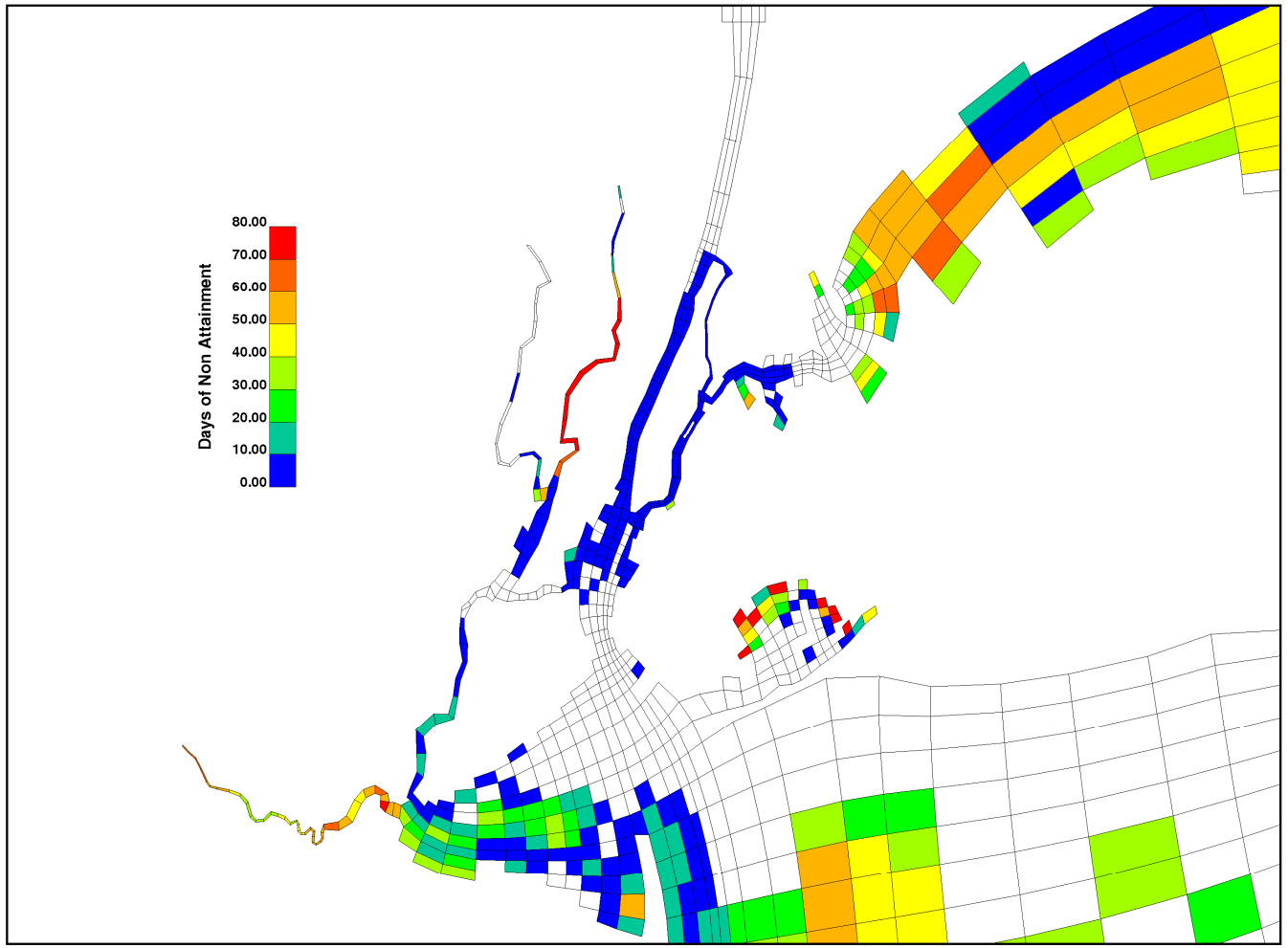

Figure 2. Planned Improvements Simulation, Current Dissolved Oxygen Standards Attainment, 1989 Hydrodynamic Conditions

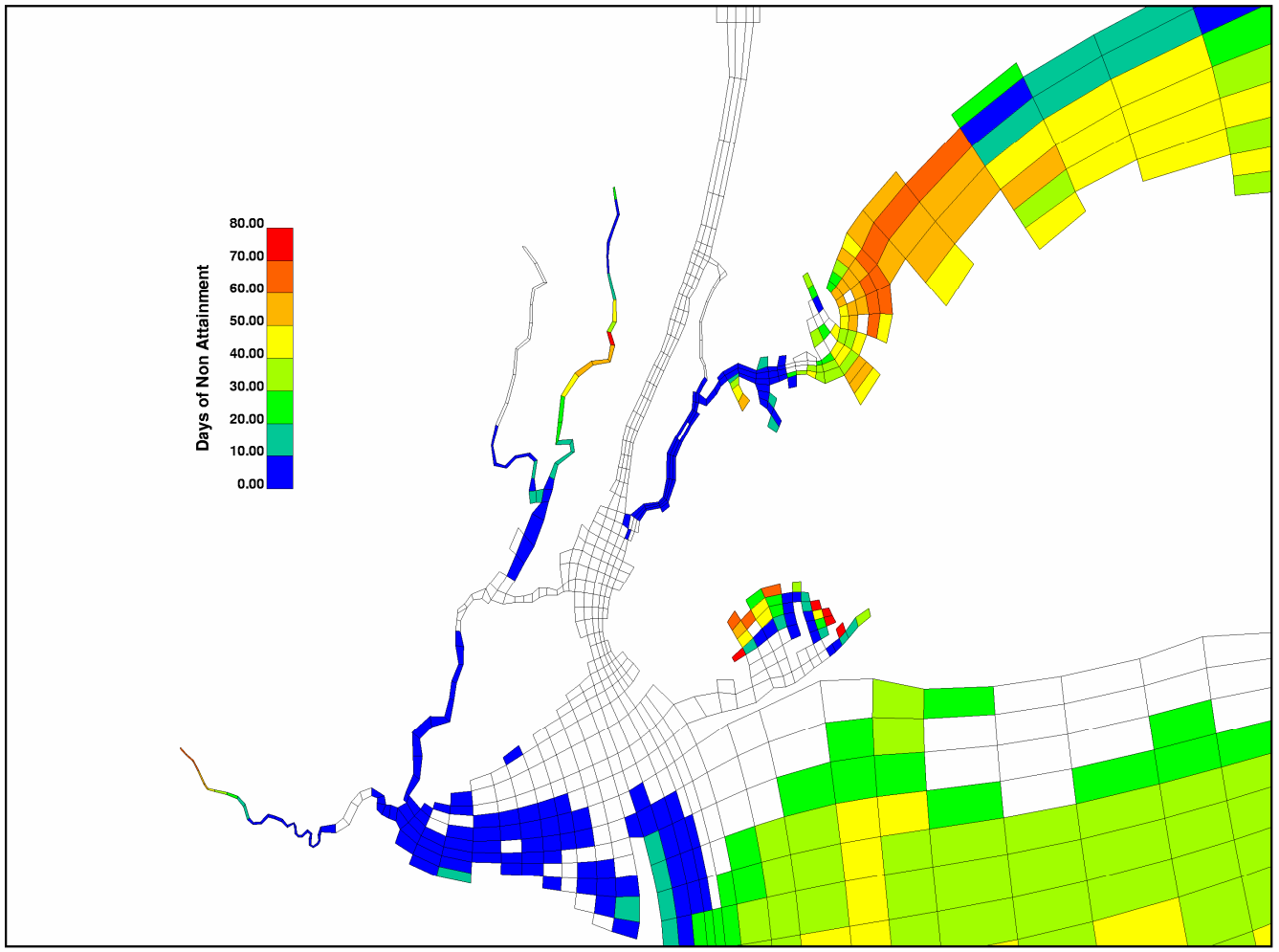

Figure 3. LOT Simulation, Current Dissolved Oxygen Standards Attainment, 1988 Hydrodynamic Conditions

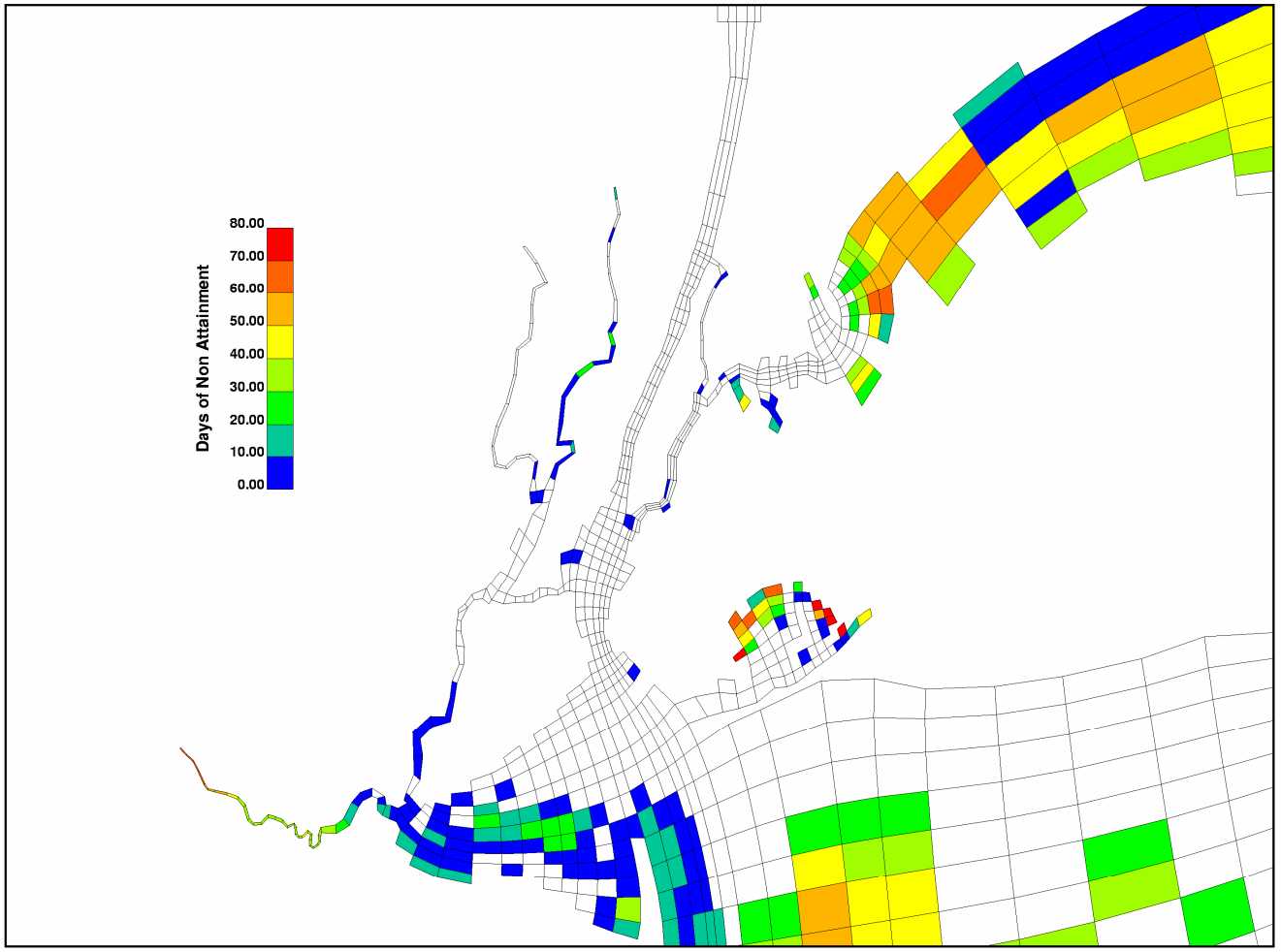

Figure 4. LOT Simulation, Current Dissolved Oxygen Standards Attainment, 1989 Hydrodynamic Conditions