Regulatory Impact Statement

6 NYCRR Part 490, Projected Sea Level Rise

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1. Statutory Authority

On September 22, 2014, the Community Risk and Resiliency Act, Chapter 355 of the Laws of 2014 (CRRA), was signed into law. CRRA, among other things, established Environmental Conservation Law (ECL) § 3-0319. ECL § 3-0319 requires the Department of Environmental Conservation (Department) to adopt regulations establishing science-based sea level rise projections for New York State and to update them no less than every five years. The Department established a new Part 490 of Title 6 of New York Codes, Rules, and Regulations (6 NYCRR), "Projected Sea-level Rise" (Part 490) in February 2017 and is updating the regulation through the current rulemaking. Part 490 adopts projections of sea level rise for three specified geographic regions over various time intervals but does not impose any requirements on any entity. Promulgation of Part 490 by the Department fulfilled the statutory requirement to adopt such regulations, and the current rulemaking will fulfill the statutory requirement to update them.

2. Legislative Objectives

CRRA was enacted with the purpose of ensuring that decisions regarding certain State permits, regulations, and expenditures include consideration of the future physical risks associated with climate change, including sea level rise and extreme weather events. Part 490 implements one component of this objective by providing a common source of sea level rise projections for consideration within the programs specified by CRRA. The adoption of Part 490 was the first step in the overall process to implement CRRA; the Department also prepared guidance, in consultation with the Department of State, regarding the implementation of CRRA.[1] This guidance addresses, among other things, incorporation of the Part 490 sea level rise projections into each of the programs enumerated in CRRA. The Climate Leadership and Community Protection Act, Chapter 106 of the Laws of 2019, added a new section17-b to CRRA to expand the scope of permits subject to the requirement for consideration of sea level rise and other climate hazards.

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[1] New York State Department of Environmental Conservation. 2020. New York State Flood Risk Management Guidance for Implementation of the Community Risk and Resiliency Act. Albany, NY. 100 pp. https://www.dec.ny.gov/docs/administration_pdf/crrafloodriskmgmtgdnc.pdf, accessed May 31, 2023.

3. Needs and Benefits

CRRA requires applicants to all permit programs regulated by the Uniform Procedures Act and several enumerated funding programs to demonstrate consideration of future climate risk, including sea level rise. CRRA also amends the State Smart Growth Public Infrastructure Policy Act, ECL Article 6, to add an additional smart growth criterion regarding mitigation of future climate physical risk due to sea level rise, storm surge or flooding. Adoption of the revisions to Part 490 will help to ensure that up-to-date science-based sea level rise projections are incorporated into decision-making processes in a consistent, transparent manner and will contribute to regulatory certainty.

The projections included in Part 490 are not intended to communicate flood risk by themselves, and the projections do not incorporate other factors that could contribute to coastal flooding, e.g., precipitation, coverage by impervious surfaces. The sea level rise projections may, however, be incorporated into maps and other products intended to project or communicate coastal flood risk.

In its 2017 Part 490, the Department adopted projections included in Horton et al. (2014), prepared for the New York State Energy Research and Development Authority (NYSERDA) "ClimAID" report. ClimAID provided model-based projections of sea level rise for three regions of the state, for three intervals of time (2020s, 2050s, 2080s) and for the year 2100. Each of the time intervals is centered on the given decade, e.g., 2020s refers to the years 2020 through 2029.[2]

ClimAID's sea level rise projections were based in part on the outputs of more than 20 global climate models from the Intergovernmental Panel on Climate Change's (IPCC) Coupled Model Intercomparison Project

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[2] Horton, R., D. Bader, C. Rosenzweig, A. DeGaetano, and W. Solecki. 2014. Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information. New York State Energy Research and Development Authority (NYSERDA), Albany, New York. https://www.nyserda.ny.gov/climaid.

Phase 5 (CMIP5),[3] downscaled to New York State. ClimAID's analysis used the IPCC's Representative Concentration Pathways (RCP) 4.5 and 8.5 as inputs. RCP 4.5 describes a scenario in which global greenhouse gas (GHG) emissions increase only slightly before declining around the year 2040, leading to a stabilization of atmospheric GHG concentrations shortly after the year 2100. RCP 8.5 assumes no significant global GHG emission-reduction policies are implemented and emissions increase, leading to higher atmospheric GHG concentrations.[4]

ClimAID's 2014 projections incorporated additional information, e.g., expert judgment, to account for anticipated changes in rates of melt of land-based ice that had not been more rigorously included in the IPCC's quantitative models. The methods used by Horton et al. (2014) to develop the 2014 ClimAID projections are identical to those used to generate sea level rise projections for the New York City Panel on Climate Change (NPCC) and are described in more detail in Horton et al. (2015[5]) and NPCC (2015[6]).

ClimAID reported its range of projection outputs in percentiles, e.g., 90th-percentile projection means that 90 percent of the outputs were equal to or less than that projection and 10 percent of the outputs were greater.[7] The Department based its low, low-medium, high-medium and high projections for the three regions of

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[3] Taylor, K.E., R.J. Stouffer, G.A. Meehl. 2012. An overview of CMIP5 and the experiment design, Bull. Amer. Meteor. Soc., 93, 485-498. DOI:10.1175/BAMS-D-11-00094.1.

[4] Ibid.

[5] Horton, R., C. Little, V. Gornitz, D. Bader and M. Oppenheimer. 2015. New York City Panel on Climate Change 2015 Report: Sea level rise and coastal storms. Ann. New York Acad. Sci. 1336:36-44. doi:10.1111/nyas.12593.

[6] NPCC. 2015. Appendix IIB. Sea level observations and projections: Methods and Analyses. Ann. N.Y. Acad. Sci. 1336(1):116-150. doi:10.1111/nyas.12593.

[7] op. cit. Horton et al., 2014.

the state on the 10th-, 25th-, 75th- and 90th-percentiles of ClimAID projection outputs, respectively. ClimAID assumed outputs were normally distributed, and the Department, in adopting the 2017 Part 490 medium projection as the 50th percentile of ClimAID's outputs, calculated the 50th percentile as the average of the 25th- and 75th-percentile outputs.

As adopted in 2017, Part 490 provided five sea level rise projections for each of three regions of the state: Long Island (Nassau and Suffolk counties), New York City and the Lower Hudson River upstream to Kingston, and the Mid-Hudson River from Kingston upstream to the federal dam at Troy. These three regions exhibit small differences in relative sea level rise due to local conditions. The five projections for these three regions were low, low-medium, medium, high-medium and high. Finally, each of these projections was presented for four different time periods: the 2020s, 2050s, and 2080s, and the year 2100. Table 1 provides the projections adopted as Part 490 in 2017.

Sea levels rose along the U.S. east coast at rates of 0.34 to 0.43 inches per decade prior to the Industrial Revolution (Gehrels, et al., 2005[8]; Donnelly et al., 2004[9]). This relative rise was due primarily to subsidence of the surface as the Earth's crust adjusted to glacial retreat. At the time of the Industrial Revolution, however, regional sea levels began to rise more rapidly than they had for the previous millennium as ocean waters began

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[8] Gehrels, R., J. Kirby, A. Prokoph, R. Newnham, E. Achertberg, H. Evans, S. Black, and D. Scott. 2005. Onset of recent rapid sea level rise in the western Atlantic Ocean. Quaternary Science Reviews 24:2083-2100.

[9] Donnelly, J., P. Cleary, P. Newby, and R. Ettinger. 2004. Coupling instrumental and geological records of sea-level change: Evidence from southern New England of an increase in the rate of sea level rise in the late 19th century. Geophysical Research Letters 31:L05203. doi:10.1029/2003GL018933.

to warm and expand (Holgate and Woodworth, 2004[10]). Further, as the atmosphere has warmed, the contribution to sea level rise by the melting of alpine glaciers and ice sheets, particularly on Greenland and Antarctica, has become the dominant component of global sea level rise.[11] As rates of both thermal expansion and melt of land-based ice increase, not only will sea levels continue to rise, but the rate of sea level rise can be expected to increase into the future.

Data collected at the National Oceanic and Atmospheric Administration's (NOAA) tide gauge at the Battery, New York City, demonstrate the long-term trend in relative sea level rise along New York State's tidal coast. The long-term trend in relative sea level, from 1856 through 2022, at the Battery, has been 2.9 millimeters (0.11 in.)/year, the equivalent of 0.95 feet per century (Figure 1). Other NOAA New York State tide gauges exhibit similar trends; however, all other New York State stations have much shorter records (Table 2).

Part 490 defines the 2020s as the years 2020 through 2029; thus, a 30-year interval separates the beginning of the baseline period on which the 2017 Part 490 projections were based, i.e., January 2000, from the end of the 2020s. The mean sea level trend at the Battery, from January 2000 through June 2023 was 0.22 in./year with a 95% confidence interval of ±0.06 in./yr, i.e., 0.16 – 0.28 in./yr.[12] Applying the observed mean annual sea level trend at the Battery over the entire 30-year interval indicates a rise of 6.6±1.8 in., consistent

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[10] Holgate, S. and P. Woodworth. 2004. Evidence for Enhanced Coastal Sea Level Rise During the 1990s. Geophysical Research Letters 31:L07305. doi:10.1029/2004GL019626.

[11] IPCC. 2019: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, 755 pp. https://doi.org/10.1017/9781009157964.

[12] http://sealevel.info/, accessed July 14, 2023.

with the 2017 Part 490 medium projection for the New York City/Lower Hudson Region for the 2020s, i.e., six in.

Table 1. ClimAID sea level rise projections (inches of rise relative to 2000-2004 baseline), adopted as 6 NYCRR Part 490, Projected Sea-level Rise, in 2017.

Mid-Hudson Region						
Percentile		**10th**	**25th**	**50th**	**75th**	**90th**
Projection		**Low**	**Low-**	**Medium**	**High-**	**High**
Time Interval	2020s	1	3	5	7	9
	2050s	5	9	14	19	27
	2080s	10	14	25	36	54
	2100	11	18	32	46	71
New York City/Lower Hudson Region						
Percentile		**10th**	**25th**	**50th**	**75th**	**90th**
Projection		**Low**	**Low-**	**Medium**	**High-**	**High**
Time Interval	2020s	2	4	6	8	10
	2050s	8	11	16	21	30
	2080s	13	18	29	39	58
	2100	15	22	36	50	75
Long Island Region						
Percentile		**10th**	**25th**	**50th**	**75th**	**90th**
Projection		**Low**	**Low-**	**Medium**	**High-**	**High**
Time Interval	2020s	2	4	6	8	10
	2050s	8	11	16	21	30
	2080s	13	18	29	39	58
	2100	15	21	34	47	72

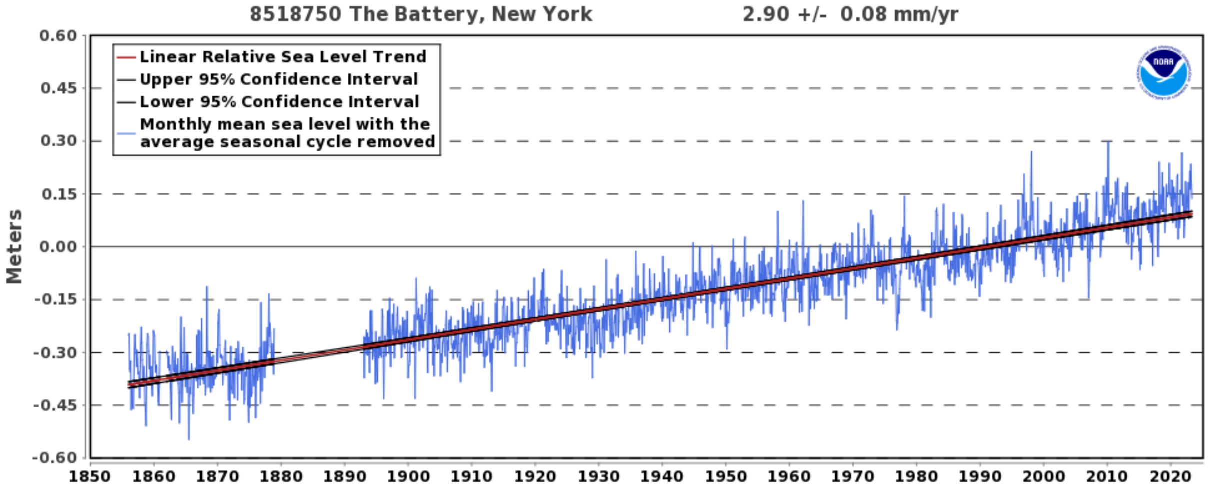

Fig. 1. Relative sea level trend, the Battery, New York City, 1856 to 2022. Plot shows monthly mean sea levels without the regular seasonal fluctuations from coastal ocean temperatures, salinity, wind, atmospheric pressure, and ocean currents. The relative sea level trend is also shown with its 95% confidence interval. Plotted values are relative to the most recent mean sea level datum established by the Center for Operational Oceanographic Products and Services. Plot taken from https://tidesandcurrents.noaa.gov/, accessed July 14, 2023.

Table 2. Relative sea level trends for four NOAA New York State tide gauging stations. Data taken from https://tidesandcurrents.noaa.gov/, accessed July 14, 2023.

Tide Station	**Record Interval**	**Relative Sea Level Trend (in./yr.)**	**Per Century Equivalent (ft.)**
Battery	1856-2022	0.11	0.95
Kings Point	1931-2022	0.10	0.85
Montauk	1947-2022	0.14	1.13

Bergen Point	1981-2022	0.17	1.43

In this Part 490 update, to ensure consistency in its regulatory and other programs, the Department intends to maintain the projection format used in the original Part 490 regulation. That is, the express terms will provide low, low-medium, medium, high-medium and high projections for three tidal regions of the State, as defined in the original regulation. However, the 2020s projections will be replaced by projections for the 2030s. Projections for the 2050s, 2080s and 2100 will be included, as in the original regulation, with updates as discussed further below. As discussed below, the Department proposes to include new projections for the year 2150 in the updated regulation and to include a new projection that reflects a potential low-confidence, high-consequence rapid ice melt (RIM) scenario.

The updated sea level rise projections are based on projections developed as part of the New York State Climate Impacts Assessment (CIA), funded by NYSERDA, which is the successive assessment to ClimAID.[13] All references to ClimAID in the original 2017 regulation have been updated to reflect the new assessment in the proposed regulation. Advances in the IPCC approach to projecting sea level rise allow NYSERDA and the Department to more fully ground the New York State projections on those provided by the IPCC in its 6th Assessment Report (AR6).[14] However, as AR6 provides projections based on several different RCP and GHG

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[13] New York State Climate Impacts Assessment. https://nysclimateimpacts.org/

[14] Fox-Kemper, B., H. T. Hewitt, C. Xiao, G. Aðalgeirsdóttir, S. S. Drijfhout, T. L. Edwards, N. R. Golledge, M. Hemer, R. E. Kopp, G. Krinner, A. Mix, D. Notz, S. Nowicki, I. S. Nurhati, L. Ruiz, J-B. Sallée, A. B. A. Slangen, and Y. Yu. 2021. Ocean, Cryosphere and Sea Level Change. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M.

emissions scenarios, the Department's New York State sea level rise projections depend on the scenarios chosen to be included in the analysis.

AR6 describes the climate response to five illustrative scenarios. Each illustrative scenario represents a combination of one of four shared socio-economic pathways (SSP) and one of six RCPs. For example, SSP1-1.9 describes a scenario in which the world follows the sustainable pathway described by SSP1 and adopts GHG-mitigation policies that result in 1.9 W/m^2 additional radiative forcing by 2100.[15] Projected changes in global surface temperature by 2081-2100 are provided in Table 3 for each of the five illustrative emissions scenarios.[16, 17]

AR6 intentionally assigns no probabilities to any of these scenarios and does not provide an opinion on whether any of the five illustrative emissions scenarios are more likely than others. Rather, the IPCC intends these scenarios to represent the full range of possible futures that planners should consider.

Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press.

[15] See Explainer: How "Shared Socioeconomic Pathways" explore future climate change, for a non-technical description of the use of shared socioeconomic and representative concentration pathways in understanding future climate change. https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change/, accessed December 20, 2022.

[16] op. cit. IPCC, 2021. Table SPM.1.

[17] Riahi, K., D.P. van Vuuren, E. Kriegler, J. Edmonds, B.C. O'Neill, S. Fujimori, N. Bauer, K. Calvin, R. Dellink, O. Fricko, W. Lutz, A. Popp, J. C. Cuaresma, S. KC, M. Leimbach, L. Jiang, T. Kram, S. Rao, J. Emmerling, K. Ebi, T. Hasegawa, P. Havlik, F. Humpenöder, L. A. Da Silva, S. Smith, E. Stehfest, V. Bosetti, J. Eom, D. Gernaat, T. Masui, J. Rogelj, J. Strefler, L. Drouet, V. Krey, G. Luderer, M. Harmsen, K. Takahashi, L. Baumstark, J.C. Doelman, M. Kainuma, Z. Klimont, G. Marangoni, H. Lotze-Campen, M. Obersteiner, A. Tabeau, M. Tavoni. 2016. The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview. Global Environmental Change. http://dx.doi.org/10.1016/j.gloenvcha.2016.05.009

Table 3. Projected changes in global surface temperature by 2081-2100, for five illustrative emissions scenarios, relative to 1850-1900 baseline.

Scenario	Description	Best estimate (°C)	Very likely range of warming (°C)
SSP1-1.9	Sustainability: The world shifts to a more sustainable economy with consumption oriented toward lower resource and energy intensity.	1.4	1.0-1.8
SSP1-2.6	Inequality: GHG emissions are reduced, but not as quickly as in SSP1-1.9.	1.8	1.3-2.4
SSP2-4.5	Middle of the road: Some improvements, and resource and energy use are reduced, but environmental systems are degraded.	2.7	2.1-3.5
SSP3-7.0	Regional rivalry: Low international priority to address environmental problems results in environmental degradation in some regions.	3.6	2.8-4.6
SSP5-8.5	Fossil fueled development: Emphasis on development is coupled with use of abundant fossil fuels and adaptation of resource and energy intensive lifestyles.	4.4	3.3-5.7

AR6 provides updated projections of global mean and regional sea level rise up to the year 2150. These projections were developed by assessing the individual contributions of the drivers of projected sea level change (the same drivers assessed by Horton et al.[18, 19]) and combining them to project total change. (See box.) An energy budget emulator, i.e., a simplified model of the earth system's response to changes in atmospheric GHG levels, was used to develop projections of global surface air temperatures (GSAT) and of temperature-dependent factors contributing to sea level change: thermal expansion, and ice sheet and glacier mass balance. (See Forster et al., 2021[20]).[21]

Drivers of sea level change assessed in AR6

- Thermal expansion
- Greenland ice sheet mass balance
- Antarctic ice sheet mass balance
- Glacier mass balance

AR6 projections of land-water storage were based on water impoundments, and relationships between population, and groundwater depletion. The Coupled Model Intercomparison Project Phase 6 (CMIP6) model ensemble[22] was used to derive a correlation between global sea level change and ocean dynamic sea levels

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[18] op. cit., Horton et al., 2014.

[19] op. cit., Horton et al., 2015.

[20] Forster, P., T. Storelvmo, K. Armour, W. Collins, J.L. Dufresne, D. Frame, D.J. Lunt, T. Mauritsen, M.D. Palmer, M. Watanabe, M. Wild, and H. Zhang. 2021: The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 923–1054, doi:10.1017/9781009157896.009.

[21] op. cit. Fox-Kemper et al. 2021.

[22] Eyring, V., Bony, S., Meehl, G. A., Senior, C. A., Stevens, B., Stouffer, R. J., and Taylor, K. E.: Overview of the Coupled Model Intercomparison Project Phase 6 (CMIP6) experimental design and organization, Geosci. Model Dev., 9, 1937-1958, doi:10.5194/gmd-9-1937-2016, 2016.

(regional variations in sea level driven by wind, heating, evaporation, precipitation), and changes in the earth's gravity field resulting from loss of ice mass. This correlation was then used with projections of global sea level change to project changes in ocean dynamic sea levels. Estimates of gravitational, rotational and deformational effects were driven by projected ice-sheet, glacier and land-water storage changes. Projections of vertical land motion were based on a statistical model of tide-gauge data. See Fox-Kemper et al. (2021) for a full discussion of the methods used to generate the sea level rise projections provided by AR6.[23]

AR6 provides projections of global sea level rise for the five SSP scenarios listed in Table 3. Projections for these five scenarios include only processes for which there is medium confidence, including projections from ice-sheet models. AR6 also provides low-confidence projections for SSP1-2.6 and SSP5-8.5. These low-confidence projections integrate potential, but uncertain, ice sheet processes and marine ice cliff instability, about which a low level of agreement exists. The low-confidence projections have not been assessed as likely but are included in AR6 due to their potential high consequence. (See Bamber et al., 2019[24], DeConto et al., 2021[25].) In addition to the provided projections of global sea level rise, AR6 provides regional projections on a regular global grid and for individual tide gauge stations. AR6 projections are based on a 1995 to 2014 baseline. These projections are described as medium confidence, and the 17th- to 83rd- percentile range is described as likely.[26]

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[23] op. cit. Fox-Kemper et al. 2021.

[24] Bamber, J.L., M. Oppenheimer, R.E. Kopp, and R.M. Cooke. 2019. Ice sheet contributions to future sea-level rise from structured expert judgment. Proc. Natl., Acad. Sci. U.S.A. 116 (23) 11195-11200. https://doi.org/10.1073/pnas.1817205116.

[25] DeConto, R.M., D. Pollard, R.B. Alley, I. Velicogna, E. Gasson, N. Gomez, S. Sadai, A. Condron, D. M. Gilford, E. L. Ashe, R. E. Kopp, D. Li, and A. Dutton. 2021. The Paris Climate Agreement and future sea-level rise from Antarctica. *Nature* 593, 83–89 2021.

[26] op. cit. Fox-Kemper et al. 2021.

The National Aeronautics and Space Administration (NASA) has made the AR6 projections available for visualization and download through its Sea Level Projection Tool. The NASA tool provides the 5th-, 17th-, 50th-, 83rd- and 95th-quantile projections, in decadal increments, from 2020 through 2150, for each of the seven sea level rise scenarios described above:

- SSP1-1.9
- SSP1-2.6
- SSP2-4.5
- SSP3-7.0
- SSP5-8.5
- SSP1-2.6 low-confidence
- SSP5-8.5 low-confidence[27]

The NASA tool provides median gridded regional projections and projections at locations of individual tide gauges for the seven sea level rise scenarios, including for a region that includes eastern Long Island (latitude 41°, longitude -73°) and for the tide gauge at the Battery, New York City.

As described above, the IPCC has not indicated the relative probabilities that any of the illustrative scenarios included in AR6 will occur. However, the IPCC Working Group III contribution to AR6 assessed trends in international ambition to reduce GHG emissions and projected emissions associated with policies implemented before 2021 and nationally determined contributions (NDCs) announced prior to the 2021 COP26. Working Group III concluded, with medium confidence, that GHG emissions will rise to a median global warming level of 3.2°C unless policies implemented before 2021 are strengthened. This level of warming is

[27] https://sealevel.nasa.gov/data_tools/17, accessed March 12, 2023.

consistent with the upper range of warming associated with SSP2-4.5, for which the IPCC projects a very likely range of warming of 2.1-3.5°C, and near the lower range associated with SSP5-8.5 (3.3-5.7°C).[28]

The Department considered basing its projections on SSP2-4.5, on the assumption that sea level rise projections associated with in-place GHG-reduction policies could be considered the most likely. However, growing confidence that a certain GHG concentration level, or even an amount of global warming, may not be reached is very different from confidence that a certain sea level height will not be reached, given all the uncertainties in the causal chain from GHG concentration and global warming to sea level height. Moreover, the IPCC first global stocktake describes a significant gap between the Paris NDCs and actual GHG emission reductions to date.[29] Thus, emissions and associated warming have the potential to be substantially greater than those projected by models based on SSP2-4.5. The Department also notes reports of increasing ice loss from Antarctic and Greenland ice sheets and increasing uncertainty among experts regarding the ice sheet contribution to sea level rise, as described by Bamber et al., who also note that consideration of the upper tail of sea level projections is critical to robust decision making in managing risk.[30]

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[28]IPCC. 2022. Summary for Policymakers. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.001. https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_SPM.pdf.

[29] IPCC. 2023. First Global Stocktake: High-Level Event on Mitigation. https://unfccc.int/topics/global-stocktake. Accessed July 18, 2024.

[30] op. cit. Bamber et. al. 2019.

To provide for consideration of a range of possible futures, including potential for low-confidence, high-consequence sea level rise scenarios associated with rapid melt of land-based ice, the Department proposes adoption of projections based on a blending of projections associated with three illustrative scenarios:

- SSP2-4.5 – medium-confidence – consistent with Paris Agreement Nationally Determined Contributions
- SSP5-8.5 – medium-confidence – additional amplifying feedback mechanisms
- SSP5-8.5 – low-confidence – includes some RIM

To generate New York State projections, researchers with the CIA obtained the full distribution of IPCC projections, i.e., the 1^{st}- to 99^{th}-percentile projection, for three selected sea level rise scenarios for 2030, 2050, 2080, 2100, and 2150, for the Battery and the region that includes eastern Long Island. Researchers combined the 1^{st}- to 99^{th}-percentile model outputs, for the three scenarios, generating 297 values for each of the specified years, for New York City and eastern Long Island. They then used the resultant distributions to determine the 10^{th}-, 25^{th}-, 50^{th}-, 75^{th}- and 90^{th}-percentile projections and adjusted them to solve for the decadal "middle" years, e.g., 2035, for consistency with the ten-year averaging used in the Part 490 projections. The methods used to generate the CIA projections, including the blending of model outputs used in the assessment, are described in the CIA methodology report.[31] The methods used were peer-reviewed by the Climate Impacts Assessment Physical Climate Modeling Project Advisory Committee and by independent peer reviewers.

The CIA Methodology Report (p. 21) provides additional rationale for including projections based on SSP5-8.5:

[31] Bader, D., R. Horton. 2023. New York State Climate Change Projections Methodology Report. Prepared for the New York State Climate Impacts Assessment

- Continuity with previous New York State projections, which were based on representative concentration pathways with the same end-of-century radiative forcing.
- Stakeholder interest in these projections, based on the CIA Needs Assessment (NYSERDA, 2020).[32]
- Value of identifying a broad range of plausible outcomes.
- Current climate impact models' underestimation of plausible outcomes when driven by only moderate GHG forcing.[33]

As the IPCC did not develop projections for the Mid-Hudson region, from Troy to Kingston, the Mid-Hudson projections are based on the New York City projections, with an adjustment to account for glacial isostatic rebound north from Kingston.

Confidence is low that ice-sheet processes will influence global mean sea level rise through 2100 under low-emission scenarios. However, ice-sheet processes in which confidence is low could lead to total global mean sea level rise substantially greater than considered likely by AR6.[34] Gornitz et al. (2020) argue that acceleration of ice mass losses and potential ice sheet instability may result in sea levels by the latter part of the

[32] New York State Energy Research and Development Authority (NYSERDA). 2020. "Climate Needs Assessment for New York State," NYSERDA Report Number 20-31. Prepared by A. LoPresti, R. Horton, and D. Bader, Columbia University, New York, NY. nyserda.ny.gov/publications

[33] op. cit. Bader and Horton 2023.

[34] op. cit. Fox-Kemper et al. 2021.

21st century that are higher than previously anticipated.[35] These authors provide an Antarctic RIM scenario for New York City for the 2080s and the year 2100. No projections reflecting a RIM scenario are available for the Long Island or Mid-Hudson regions or for beyond 2100. Due to the high degree of uncertainty of any RIM projection relative to the small differences among the three tidal regions described in Part 490, the Department proposes to apply the New York City RIM projection of Gornitz et al. (2019) to the Long Island and Mid-Hudson regions. [36]

The Department does not propose to include projections beyond 2150 in this update due to the deep uncertainty regarding multi-century ice-sheet response in high emissions scenarios. AR6 concludes that under SSP1-2.6, a relatively low emissions scenario with a very likely range of warming of 1.3 to 2.4°C by 2100, global mean sea level will rise between 12 and 122 inches. Adding to this large uncertainty regarding long-term committed sea level rise, global mean sea level is projected to rise by 67 to 268 inches by 2300, even if marine ice cliffs remain stable. Marine ice cliff instability could result in up to 52 feet of additional sea level rise by 2300.[37]

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35 Gornitz, V., Oppenheimer, M., Kopp, R., Horton, R., Orton, P., Rosenzweig, C., Solecki, W., Patrick, L., 2020. Enhancing New York City's resilience to sea level rise and coastal flooding. Urban Climate. 33: https://doi.org/10.1016/j.uclim.2020.100654.

[36] Gornitz, V., Oppenheimer, M., Kopp, R., Orton, P., Buchanan, M., Lin, N., Horton, R., and Bader, D., 2019. New York City Panel on Climate Change 2019 Report. Chapter 3. Sea level rise, in: Advancing Tools and Methods for Flexible Adaptation Pathways and Science Policy Integration. Rosenzweig C, Solecki W (eds). Ann. New York Acad. Sci. 1439, 71-94.

[37] op. cit. Fox-Kemper et al. 2021.

The Department's current Flood Risk Management Guidance relies primarily on the medium and high projections of sea level rise.[38] However, the proposed RIM projection may serve as a proxy for a longer-term projection for siting and design of projects or land uses for which the risk of flooding would be unacceptable.

The Department's proposed updated sea level rise projections, based on the described methodology, are presented in Table 4. Table 5 provides a comparison of the proposed updated projections with those included in Part 490 (2017) for the 2050s and 2080s time slices and the year 2100, with differences presented in inches. Table 6 provides the same comparison, with differences shown as a percentage of the Part 490 (2017) projection.

As Table 6 highlights, the proposed updated low (10th-percentile) and low-medium (25th-percentile) projections are considerably higher than the corresponding 2017 projections. Further, the range of projections from low to high is considerably smaller in the updated projections through the 2050s, i.e., a 22-inch low to high range in the 2017 projections vs. a 10- to 12-inch range in the updated projections. This narrowing of the range of mid-century projections is consistent with the AR6 finding that, up to 2050, projections exhibit little dependence on emission scenarios, with scenarios diverging after 2050.[39]

Furthermore, Hinkel et al. (2015[40]) warn that sea level rise projections based on process-based models, such as those used by IPCC, are primarily intended for the purpose of understanding earth system physics and are not appropriate for risk-based decision making as they do not fully incorporate the effects of accelerated ice

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[38] New York State Department of Environmental Conservation. 2020. Flood Risk Management Guidance for Implementation of the Community Risk and Resiliency Act. 100 pp. Albany, NY. https://www.dec.ny.gov/docs/administration_pdf/crrafloodriskmgmtgdnc.pdf.

[39] op. cit. Fox-Kemper et al. 2021.

[40] Hinkel, J., C. Jaeger, R. Nicholls, J. Lowe, O. Renn, and P. Shi. 2015. Sea-level rise scenarios and coastal risk management. Nature Clim. Change. doi: 10.1038/nclimate2505.

melt. They warn that projections based on the IPCC AR5 projections of mean global sea level rise of 11 to 39 inches by 2100 may not be adequate for risk management due to the intolerably high residual risk associated with RIM. Parris et al. (2012[41]) also cautioned that focusing only on the most probable outcome could lead to vulnerability or maladaptation. Decision makers, including residents and local leaders, should understand the full range of potential risk. Communities and stakeholders in New York State that have been presented with the ClimAID projections have tended to adopt and plan for high levels of sea level rise rather than more moderate levels. These stakeholders have placed a high degree of importance on ensuring the viability of proposed infrastructure investments and the social and economic fabric of their communities from even unlikely eventualities.

Table 4. Updated projections of sea level rise for three tidal regions of New York State, based on the Department's proposed methodology. Projections are in inches, relative to a 1995-2014 baseline, and are based on a combination of the SSP2-4.5, SSP5-8.5-medium-confidence and SSP5-8.5-low-confidence projections, with the addition of a RIM scenario.

Projection	**Low**	**Low-Medium**	**Medium**	**High-Medium**	**High**	**RIM**
Percentile	**10th**	**25th**	**50th**	**75th**	**90th**	**RIM Scenario**
Mid-Hudson (Albany)						

[41] op. cit. Parris et al. 2012.

2030s	5	7	8	10	12	NA
2050s	11	12	14	17	21	NA
2080s	18	21	26	35	41	83
2100	21	25	32	46	60	114
2150	32	41	52	82	171	NA
New York City/Lower Hudson Region (New York City)						
2030s	6	7	9	11	13	NA
2050s	12	14	16	19	23	NA
2080s	21	25	30	39	45	83
2100	25	30	36	50	65	114
2150	38	47	59	89	177	NA
Long Island Region (Montauk Point)						
2030s	7	8	10	12	14	NA
2050s	13	15	18	21	25	NA
2080s	23	26	32	41	48	83

2100	27	32	39	54	69	114
2150	42	50	63	94	185	NA

Table 5. Differences between updated projections of sea level rise based on the Department's proposed methodology and projections included in 6 NYCRR Part 490, Projected Sea-level Rise (2017), for three tidal regions of New York State. Differences are in inches. Positive values indicate updated projection greater than 2017 projection.

Projection	Low	Low-Medium	Medium	High-Medium	High
Percentile	**10th**	**25th**	**50th**	**75th**	**90th**
Mid-Hudson (Albany)					
2030s	NA	NA	NA	NA	NA
2050s	6	3	0	-2	-6
2080s	8	7	1	-1	-13
2100	10	7	0	0	-11
2150	NA	NA	NA	NA	NA
New York City/Lower Hudson Region (New York City)					
2030s	NA	NA	NA	NA	NA
2050s	4	3	0	-2	-7

2080s	8	7	1	0	-13
2100	10	8	0	0	-10
2150	NA	NA	NA	NA	NA
Long Island Region (Montauk Point)					
2030s	NA	NA	NA	NA	NA
2050s	5	4	2	0	-5
2080s	10	8	3	2	-10
2100	12	11	5	7	-3
2150	NA	NA	NA	NA	NA

Table 6. Percentage differences between updated projections of sea level rise based on the Department's proposed methodology and projections included in 6 NYCRR Part 490, Projected Sea-level Rise (2017), for three tidal regions of New York State. Differences are shown as percentage of 2017 projections. Positive values indicate updated projection greater than 2017 projection. Green shading indicates an updated projection

substantially lower than the corresponding 2017 projection, red shading, an updated projection substantially greater than the corresponding 2017 projection.

Projection	Low	Low-Medium	Medium	High-Medium	High
Percentile	10^{th}	25^{th}	50^{th}	75^{th}	90^{th}
Mid-Hudson (Albany)					
2030s	NA	NA	NA	NA	NA
2050s	120%	33%	0%	-11%	-22%
2080s	80%	50%	4%	-3%	-24%
2100	91%	39%	0%	0%	-15%
2150	NA	NA	NA	NA	NA
New York City/Lower Hudson Region (New York City)					
2030s	NA	NA	NA	NA	NA
2050s	50%	27%	0%	-10%	-23%
2080s	62%	39%	3%	0%	-22%

2100	67%	36%	0%	0%	-13%
2150	NA	NA	NA	NA	NA
Long Island Region (Montauk Point)					
2030s	NA	NA	NA	NA	NA
2050s	63%	36%	13%	0%	-17%
2080s	77%	44%	10%	5%	-17%
2100	80%	52%	15%	15%	-4%
2150	NA	NA	NA	NA	NA

Finally, as explained above, sea level rise will continue for many centuries as the earth system comes into equilibrium over many centuries or even millennia. Thus, the question for decision makers is not if a critical sea level will be reached, but when. Strauss (2013[42]) calculated that historic emissions have already committed the globe to a mean sea level rise of 6.2 feet. Levermann et al. (2013[43]) estimated that the current international target of 2°C warming will result in an eventual mean global sea level rise of more than 15 feet after 2000 years. Thus, a full range of projections in Part 490 that includes higher values is appropriate to allow

[42] op. cit. Strauss. 2013.

[43] Levermann, A., P. Clark, B. Barzeion, G. Milne, D. Pollard, V. Radic, and A. Robinson. 2013. The multimillennial sea-level commitment of global warming. Proc. Natl. Acad. Sci. USA. 10.1073/pnas1219414110.

for consideration of a level of sea level rise that will likely occur at some point, even if the timing of such occurrence is uncertain.

The Department acknowledges that current GHG emissions policies would result in actual emissions lower than projected by SSP5-8.5. Thus, the inclusion of higher projections of sea level rise, especially those based on SSP5-8.5, could lead to consideration of conditions that are unlikely to occur, at least in the more immediate future. Unfortunately, current literature does not provide a basis for assessment of the emissions levels at which ice shelf and marine ice cliff instability, important factors in sea level rise in high emissions scenarios, such as SSP5-8.5, become significant.[44]

This gap in the literature, however, does not relieve decision makers from the responsibility to at least consider the potential consequences of future events about which scientific uncertainty remains. Adoption of several levels of projections allows for consideration of risk tolerance in decision making. The high or even the RIM projections might be used for long-term projects for which there is low risk tolerance, for example, while lower projections may be appropriate for consideration in situations in which risk tolerance is high. Inclusion of low-confidence, but plausible, projections provides benchmarks against which long-term decisions, e.g., those regarding critical infrastructure and land-use change, can be evaluated for high-consequence events. If Part 490 did not include higher projections of sea level rise, decision makers would not be able to even consider the possibility of such levels occurring. The Department proposes, therefore, to adhere to the recommendation of Stammer et al. (2019) to include "high-end storylines," that reflect physical processes about which high uncertainty exists, i.e., the RIM scenario, with probabilistic projections.[45]

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[44] Kopp, R.E., Oppenheimer, M., O'Reilly, J.L. et al. 2023. Communicating future sea-level rise uncertainty and ambiguity to assessment users. *Nat. Clim. Chang.* **13**, 648–660. https://doi.org/10.1038/s41558-023-01691-8.

[45] Stammer, D. et al. 2019 Framework for high-end estimates of sea level rise for stakeholder applications. Earths Future 7, 923–938.

The Climate Impact Assessment, from which the proposed updated projections are drawn, presents projections based on each of the three SSPs on which the blended projections are based. Those projections are presented in Table 7 for New York City and allow comparison between the projections based solely on SSP2-4.5 and those based on the three blended scenarios and proposed for adoption in the updated Part 490. The differences between the end-of-century medium and high projections, which are most relevant in current regulatory contexts, are nine inches, i.e., 59 vs. 50 inches, and 19 inches, i.e., 65 vs. 46 inches, respectively. DEC concludes that these differences represent a reasonable additional element of safety to account for uncertainty and the gap between GHG emission reduction commitments and implementation for the projections that are most likely to be used in regulatory contexts.

Table 7. Projected sea level rise at the Battery (New York City) under three shared socioeconomic pathways and the same pathways blended.

SSP245	**Decade \ Percentile**	**10th**	**25th**	**50th**	**75th**	**90th**	
	2030s	6	7	9	11	13	
	2050s	11	13	16	19	22	
	2080s	18	22	26	32	37	
	2100	22	26	32	40	46	
	2150	32	38	50	65	77	
SSP585-med		**10th**	**25th**	**50th**	**75th**	**90th**	
	2030s	6	8	9	11	13	
	2050s	13	15	18	21	24	
	2080s	23	27	32	39	45	
	2100	28	32	40	49	57	
	2150	45	52	67	87	102	
SSP585-low		**10th**	**25th**	**50th**	**75th**	**90th**	
	2030s	6	8	9	11	13	
	2050s	13	15	17	16	21	
	2080s	23	27	34	43	55	
	2100	28	32	45	66	82	
	2150	45	52	93	186	219	
Across Scenarios		**10th**	**25th**	**50th**	**75th**	**90th**	**ARIM**
	2030s	6	7	9	11	13	

	2050s	12	14	16	19	23	
	2080s	21	25	30	39	45	81
	2100	25	30	36	50	65	114
	2150	38	47	59	89	177	

Table reproduced from Bader and Horton (2023).[46]

Abstracts

Following are abstracts of reports used as the sources of projections of sea level rise for this rulemaking:

Gornitz, V., Oppenheimer, M., Kopp, R., Orton, P., Buchanan, M., Lin, N., Horton, R., and Bader, D., 2019. New York City Panel on Climate Change 2019 Report. Chapter 3. Sea level rise, in: Advancing Tools and Methods for Flexible Adaptation Pathways and Science Policy Integration. Rosenzweig C, Solecki W (eds). Ann. New York Acad. Sci. 1439, 71-94.

> Observations and modeling of global mean sea level rise suggest the possibility that the rise in the latter part of the 21st century may be greater than previously anticipated. This potential high rate of rise could result in the event of ice sheet destabilization and rapid ice melt in the Antarctic under high GHG emissions scenarios but is implausible under the lowest emission scenarios. This low-probability, upper-end scenario is highly uncertain due to incomplete knowledge about processes related to ice loss, including the speed with which these processes may proceed. Based on modeling of ice sheet-ocean behavior, this paper includes sea level rise projections for an Antarctic Rapid Ice Melt scenario of 6.75 ft. in the 2080s and 9.5 ft. for the Battery, New York City. The authors note that these projections provide insight into the magnitude of sea level rise that could occur after 2100.

New York State Climate Impacts Assessment.

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[46] op. cit. Bader and Horton 2023.

With the exception of the RIM scenario projections, the sea level rise projections used in the Part 490 update are taken from projections developed for the New York State Climate Impacts Assessment. The projections are included in the report,[47] while the models, scenarios and calculation approaches are reported in Bader and Horton (2023).[48] The investigators based their updated projections on those developed for the IPCC 6th Assessment Report, which were based on CMIP6 models. Researchers selected three scenarios used by the IPCC: SSP2-4.5-medium-confidence, SSP5-8.5-medium-confidence, and SSP5-8.5-low-confidence, which include a wide range of outcomes. IPCC projections were adjusted to match the format used in previous reports, including, 6 NYCRR Part 490. Distributions of one-percentile projections from each of the three scenarios were combined to yield 297 values for each location. The updated sea level rise projections were derived from this distribution, for each of the three locations.

4. Costs

Part 490 will not impose any costs on any entity because the regulation consists only of sea level rise projections and does not in and of itself impose any standards or compliance obligations. In other words, while Part 490 will provide a common source of sea level rise projections for consideration within programs specified by CRRA, as well as for consideration by planners and decisionmakers in other contexts, it will not impose any requirements on any entity. Therefore, no costs are associated with Part 490. Likewise, the regulation will also not impose any additional costs on the Department or local government entities.

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[47] https://nysclimateimpacts.org/results/

[48] op. cit. Bader, D., and Horton, R., 2023.

5. Local Government Mandates

Part 490 will not create any mandates for local governments, including any additional recordkeeping, reporting, or other requirements.

6. Paperwork

No additional record keeping, reporting, or other requirements will be imposed under this rulemaking.

7. Duplication

This proposal does not duplicate, overlap, or conflict with any other existing federal or State regulations or statutes.

8. Alternatives

Alternatives to this proposal include (1) No action, or not updating Part 490, (2) basing the projections in Part 490 on alternative analyses and scientific reports, (3) using an alternative projection format, and (4) including different scenarios in the analysis.

1) No Action – Not updating Part 490 is not an available alternative because ECL § 3-0319 requires the Department to adopt and update a regulation establishing science-based State sea level rise projections.
2) Other Reports – No other available reports include projections specific to New York State.
3) Other Formats –To maintain regulatory consistency, the Department proposes to substantially maintain the format currently used in Part 490.
4) The Department's proposed projections are based on a combination of a scenario based on committed GHG emission reductions and scenarios based on continued heavy use of fossil fuels. Alternatives include reliance on scenarios in which emission reductions are significantly greater than current commitments,

scenarios in which emission reductions are significantly less than current commitments, or simple extrapolation of historical sea level rise. Assuming emissions will be significantly greater than current commitments could potentially lead to over-investment in coastal protective strategies. Assuming emissions will be significantly lower than current commitments would fail to recognize that most nations are not complying with current commitments and, as discussed, would ignore indications of previously unanticipated sensitivity of land-based ice and ice cliffs to higher sea temperatures. Simple linear extrapolation of the long-term historical trend would mask the effects of increasing global temperatures and resultant higher rates of rise over the past several decades.

The Department considered adoption of projections based on a scenario of committed GHG emission reductions (i.e., SSP2-4.5) rather than projections based on a blending of this scenario with others entailing higher emissions (i.e., SSP5-8.5-medium confidence and SSP5-8.5-low confidence). As described above, the Department concludes that the difference in sea level height between the SSP2-4.5 and blended projections represents a reasonable additional element of safety to account for uncertainty and the gap between GHG emission reduction commitments and implementation, particularly for the end-of-century medium and high projections that are most likely to be used in regulatory contexts.

9. Federal Standards

No federal rules or other legal requirements are relevant to Part 490. Therefore, this proposal does not result in the imposition of requirements that exceed any minimum standards of the federal government for the same or similar subject areas.

10. Compliance Schedule

There is no compliance schedule required by the establishment of Part 490 because the rule does not impose any compliance obligations on any entity.