lead to increased flooding events that will significantly impact land use practices, land resources, public safety, and infrastructure. The NJ Climate Science Report similarly describes cases of increased flooding due to extreme weather events. In the New England and Mid-Atlantic regions of the Northeastern United States, climate-induced increases in the magnitude and frequency of floods have been observed (NJDEP, 2020). In New Jersey, major flood events were observed in 2000, 2004, 2005, 2006, 2007, 2010, 2011, 2012, 2016, and 2021 (NJDEP, 2020).

The increased precipitation depth, intensity and duration of storms caused by climate change will additionally impact the runoff generated from development, the extent of floodplains, and the conveyance capacity of storm sewer systems (Berggren et al., 2012; Blair et al., 2014; Semadeni-Davies, 2008). As precipitation depth, intensity, and duration increase due to climate change, fluvial flood elevations will increase as well. Properties in known flood hazard areas will be subject to more frequent and severe flooding while properties currently located in proximity to mapped flood hazard areas will find themselves subject to flooding. In addition, stormwater best management practices (BMPs), such as basins, that were designed based on historical rainfall patterns, will become increasingly unable to manage the storm events they were initially designed to manage, thereby increasing the risk of flooding to the surrounding community.

Climate Change Projected Precipitation Totals for Design Storms

Design engineers currently obtain depths of the two-, 10-, and 100-year storms from NOAA Atlas 14. The data is published on a website hosted by NOAA's National Weather Service. It is based on a document titled, "NOAA Atlas 14 Precipitation-Frequency Atlas of the United States, Volume 2, Version 3, last revised in 2006" ("NOAA Atlas 14"). While 2006 is the most recent revision of NOAA Atlas 14, the daily and hourly rainfall records were last revised in December 2000.

The NJ Climate Science Report found that annual precipitation for the last 10 years increased 7.9 percent over the long-term average in part due to global warming and changing climate. As described above, increasing temperatures due to increasing concentrations of atmospheric carbon dioxide and other greenhouse gases will continue to contribute to an increase in precipitation and the intensity of extreme weather. This renders NOAA Atlas 14 outdated. Therefore, stormwater BMPs and flood hazard calculations based on this obsolete data will inadequately protect against the adverse impacts of flooding due to increasing precipitation resulting from climate change.

As noted above, Cornell University conducted a study of projected precipitation totals for New Jersey ("Cornell's Projection Study"). This report projects 24-hour rainfall depths of two-, 10-, and 100-year storms in New Jersey into the future for two time periods, 2020 to 2069 and 2050 to 2099. The projections were performed under a moderate greenhouse gas emissions scenario (RCP4.5) and a high greenhouse gas emissions scenario (RCP8.5). The moderate greenhouse gas emissions scenario assumes that there will be a gradual decrease in greenhouse gas emissions in the future, whereas the high greenhouse gas emissions scenario assumes continually increasing amounts of greenhouse gas emissions. Cornell's Projection Study utilizes historical rainfall data between 1950 and 2019 collected by 55 weather stations located within the area extending from latitude 41.7°N to 37.5°N and longitude 76.0°W to 72.5°W, which approximately includes the entirety of New Jersey and Delaware, a part of Maryland along Chesapeake Bay, a part of Pennsylvania adjacent to the western boundary of New Jersey, a portion of southern New

York, and the southwest portion of Connecticut. The results of this study have been assigned likelihood ranges for ease of understanding. The likely range, which represents a minimum 66 percent chance of occurrence (Mastrandrea, M.D., et al., 2010), can also be represented via the use of percentiles. A 66 percent chance of occurrence is equivalent to a range of values falling between the 17th and 83rd percentiles (Kopp, 2019). Statistically, this means that there is a 17 percent chance that a given value will be lower than the 17th percentile and a 17 percent chance that a given value is greater than the 83rd percentile.

For this rulemaking, the Department proposes utilizing the projected precipitation totals at the 83rd percentile under the "moderate" RCP 4.5 scenario for the two-, 10-, and 100-year storms using the timeframe of 2050-2099 from Cornell's Projection Study. Roads, bridges and buildings built today will be used and occupied for decades to come and must therefore be designed and constructed to anticipate future conditions. For example, according to the Federal Highway Administration, the "designer should consider the performance of the project over its design life given the design criteria. The design life is a reference period over which a project feature is expected to meet a particular service objective (75 years for bridges according to the AASHTO LRFD Bridge Design Specifications)." (US DOT, Hydraulic Engineering Circular 17, 2016). Further, considering the age of New Jersey's current infrastructure, the service life of such structures can be much longer than the design life. Similarly, it is not uncommon for homes and other buildings to be occupied for over 75 years. Because roads, bridges, and buildings are generally built with an expected useful life of 75 years or more, use of this timeframe is necessary to ensure that roads, bridges, buildings, and other structures designed and constructed today will be sufficiently resilient to withstand the exacerbated flooding that increasing precipitation will bring about over the lifetime of that structure. Similarly, usage of the 83rd percentile ensures that runoff calculations encompass the full breadth of the likely range. Consistent with Cornell's Projection Study, the changes in future precipitation amounts are best communicated using "change factors," which are the projections of rainfall depths from 2050 to 2099 divided by the historical rainfall data from 1950 to 1999. The change factors for the two-, 10-, and 100-year storms computed by Cornell are presented for each county in New Jersey in the table below.

Future Precipitation Change Factors			
County	**2-year Design Storm**	**10-year Design Storm**	**100-year Design Storm**
Atlantic	1.22	1.24	1.39
Bergen	1.20	1.23	1.37
Burlington	1.17	1.18	1.32
Camden	1.18	1.22	1.39
Cape May	1.21	1.24	1.32
Cumberland	1.20	1.21	1.39
Essex	1.19	1.22	1.33
Gloucester	1.19	1.23	1.41
Hudson	1.19	1.19	1.23
Hunterdon	1.19	1.23	1.42
Mercer	1.16	1.17	1.36

Middlesex	1.19	1.21	1.33
Monmouth	1.19	1.19	1.26
Morris	1.23	1.28	1.46
Ocean	1.18	1.19	1.24
Passaic	1.21	1.27	1.50
Salem	1.20	1.23	1.32
Somerset	1.19	1.24	1.48
Sussex	1.24	1.29	1.50
Union	1.20	1.23	1.35
Warren	1.20	1.25	1.37

The projected precipitation depths at a given site are equivalent to the precipitation depths of the two, 10, and 100-year storms from NOAA Atlas 14, as measured for the county in which the development is located (or for the specific site location), multiplied by the future precipitation change factor for the county wherein the site is located. For example, Mercer County has a 100-year, 24-hour rainfall of 8.33 inches per NOAA Atlas 14. The change factor for Mercer County in the above table is 1.36. Therefore, the projected 100-year, 24-hour precipitation amount is 8.33 inches multiplied by 1.36. This yields a value of 11.33 inches. Alternatively, instead of using countywide data to obtain the published precipitation value, site specific data can be used. In the previous example, if the project is located in Trenton, NJ, then NOAA Atlas 14 informs that the 100-year, 24-hour rainfall is 8.16 inches, via https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=nj. Therefore, using the change factor for Mercer County in the above table, the projected 100-year, 24-hour precipitation amount is 8.16 inches multiplied by 1.36. This yields a value of 11.10 inches. For the site in this example, either calculated projected precipitation value is acceptable for regulatory usage.

Use of these change factors will result in the calculation of higher peak flow rates than would have been calculated under the methodologies authorized under either the FHACA Rules or SWM rules prior to these proposed amendments. As a result, calculated flood hazard areas in fluvial areas will be more expansive and deeper, placing more land area in the State under the protection of the FHACA Rules. The expanded regulatory area serves to ensure that proposed development accounts for climate change, which results in increased flood resiliency. Similarly, stormwater BMPs required under the SWM rules will need to account for greater volumes of runoff.

Current Precipitation Data Update

In addition to the projection study mentioned above, Cornell University performed another study to update NOAA Atlas 14. This study is described in a report entitled “Changes in Hourly and Daily Extreme Rainfall Amounts in NJ since the Publication of NOAA Atlas 14 Volume” (“Cornell’s Present Update Study”). As with the Cornell’s Projection Study, this study utilizes historical rainfall data between 1950 and 2019 collected by 55 weather stations located within the area extending from latitude 41.7 degrees north to 37.5 degrees north and longitude 76.0 degrees west to 72.5 degrees west. Cornell updated the precipitation data to present day using the same methods undertaken to derive the precipitation depths currently provided by NOAA’s Atlas 14 and included rainfall records from 1999 through 2019, which represents the most recent available data. The study shows that, over the approximately 20-year period ending in 2019, increases in extreme precipitation were seen at over 75 percent of the weather stations in New Jersey.

Similar to the projection data discussed in the preceding section of this summary, Cornell developed “adjustment factors” meant to be applied to the published NOAA Atlas 14 data. These results are presented as “current precipitation adjustment factors” in the table below. However, unlike Cornell’s Projection Study, the adjustment factors were presented in this study only for each weather station analyzed as opposed to creating countywide averages. To make the data more user-friendly, the Department developed countywide averages for the adjustment factors using Thiessen polygons. Thiessen polygon methodology is a commonly used hydrological methodology that determines the extent of an area surrounding a given weather station that shares the same rainfall depth as measured at that rainfall station. (American Meteorological Society, 2012). For the purpose of this rule proposal, the Thiessen polygon methodology was used to find the extent of an area surrounding a weather station that shares the same adjustment factor. The Thiessen polygons and the associated adjustment factors obtained from the above step are imposed within county boundaries. Each county has one or more Thiessen polygons, which are wholly contained within the boundaries of each county. The resulting adjustment factors are shown in the table below:

Current Precipitation Adjustment Factors			
County	**2-year**	**10-year**	**100-year**
Atlantic	1.01	1.02	1.03
Bergen	1.01	1.03	1.06

Burlington	0.99	1.01	1.04
Camden	1.03	1.04	1.05
Cape May	1.03	1.03	1.04
Cumberland	1.03	1.03	1.01
Essex	1.01	1.03	1.06
Gloucester	1.05	1.06	1.06
Hudson	1.03	1.05	1.09
Hunterdon	1.02	1.05	1.13
Mercer	1.01	1.02	1.04
Middlesex	1.00	1.01	1.03
Monmouth	1.00	1.01	1.02
Morris	1.01	1.03	1.06
Ocean	1.00	1.01	1.03
Passaic	1.00	1.02	1.05
Salem	1.02	1.03	1.03
Somerset	1.00	1.03	1.09
Sussex	1.03	1.04	1.07
Union	1.01	1.03	1.06
Warren	1.02	1.07	1.15

The table shows that within the last 20 years, precipitation depth has either remained roughly the same for the two-year storm or has increased slightly. The precipitation depths for the 10 and 100-year storms have largely either increased slightly or by as much as 15 percent. Data in this table is meant to be used similar to the way the change data is used in the table accompanying Cornell's Projection Study.

Stormwater Management

Subchapter 1. General Provisions

N.J.A.C. 7:8-1.2 Definitions

The Department proposes a new defined term for "public transportation agency" at N.J.A.C. 7:8-1.2 and N.J.A.C. 7:13-1.2. This defined term would distinguish public transportation entities from other public entities that are not municipalities, counties, or other highway agencies. As noted in the summaries of proposed N.J.A.C. 7:8-5.2 and N.J.A.C. 7:13-12.6 below, the Department recognizes the unique challenges associated with new, expanded, reconstructed and improved public transportation infrastructure, which can lead to impracticability of strict compliance with the proposed new standards in this rulemaking. The new defined term identifies the agencies that would be able to rely on the proposed new flexibility for public transportation infrastructure described below.

In addition, the Department proposes the addition of a definition of the term "public roadway or railroad." The proposed definition ensures that the increased flexibility proposed is limited to specific types of projects. Public roadways and railroads are those used by motor vehicles or trains which are intended for public use and developed on behalf of the above