Chapter 4

CLIMATE AND AIR QUALITY

The drainage, vegetation, and wildlife patterns of a region are largely determined by climate interacting with the geology and soils of the region. The most important climatic factors are wind velocity and direction, temperature variations, and precipitation.

Many environmental problems are associated with the atmosphere and climate. Extremes in weather can have disastrous effects — floods, storm damage to vegetation and man-made structures, wildlife destruction, and droughts. Air pollution can also have detrimental effects.

New Jersey is in the same north-south position as Northern California, Salt Lake City (Utah), Boulder (Colorado), Portugal, Southern Italy, Turkey, Mongolia's Gobi Desert, and North Korea. Clearly, climatic conditions in these places are quite different. Latitudinal position, then, is only one of a number of factors that determine the climate of a region. In addition to the angle of the sun's rays and the length of daylight (factors determined by the latitude), an area's altitude and nearness to oceans and mountain ranges have an influence on its climate. Also important are the source and direction of air masses that flow over a region.

New Jersey has a humid continental climate, similar to the midwestern states. A continental climate is characterized by significant variations between the temperatures of summer and winter, specifically, by a range in temperature of 40 degrees or more from the coldest month of the year to the warmest month. This climate also displays relatively large daily and day-to-day temperature fluctuations.

These cold winters and near-tropical summers result from the direction of the seasonal prevailing winds. Our latitudinal position places us within the global wind system known as the Prevailing Westerlies. Due to the influence of these winds, weather in the mid-latitudes generally moves from west to east.

Winter

In wintertime the prevailing winds are from the northwest, subjecting us to the regular invasion of cold air masses moving down from Canada. These outpourings of polar air are warmed slightly in their passage across the Midwest and eastern mountains, but not enough to protect us from bone-chilling temperatures. All weather monitoring stations in the northern part of the state have experienced -15°F (-26°C) or lower.

According to the Office of the New Jersey State Climatologist at Rutgers University for the month of January, which is the coldest month, temperatures at the National Weather Service station at Canoe Brook in Millburn Township range from a mean low of 18°F (-8°C) to a mean high of 40.4°F (5°C). The record low temperature for that station is -26°F (-32°C). The average annual degree days recorded at Newark Airport are 5,595, with 4,481 of them, or 80%, occurring between November 1 and March 31. Degree days are the measurements for space heating. They are computed by determining for each day the number of degrees that the median temperature falls below 65°F (18°C).

Summer

During the summer, warm tropical air masses move into New Jersey from the Southwest and South. Many of these moist, hot air masses originate over the Gulf of Mexico, flow inland, and then travel over very warm land before reaching New Jersey. At Canoe Brook, the average temperature for July, the warmest month, is 74°F (23°C). July temperatures average higher than 70°F (21°C) throughout the entire state, although shore and mountain areas are colder than inland and northeastern locales. Occasional heat waves elevate the mercury to the nineties and sometimes over 100°F (38°C), especially during July and August. The highest recorded temperature at Canoe Brook from January 1931 through August 2010 was 107°F (42 °C) on July 7, 2010.

Of special interest to gardeners is the average length of the frost-free season. The average date for the last killing Spring frost is May 4 and the the first frost in Fall is around October 7, giving, on the average, 155 days free of frost.

In general temperature has been rising throughout our state as illustrated in Figure 11A.

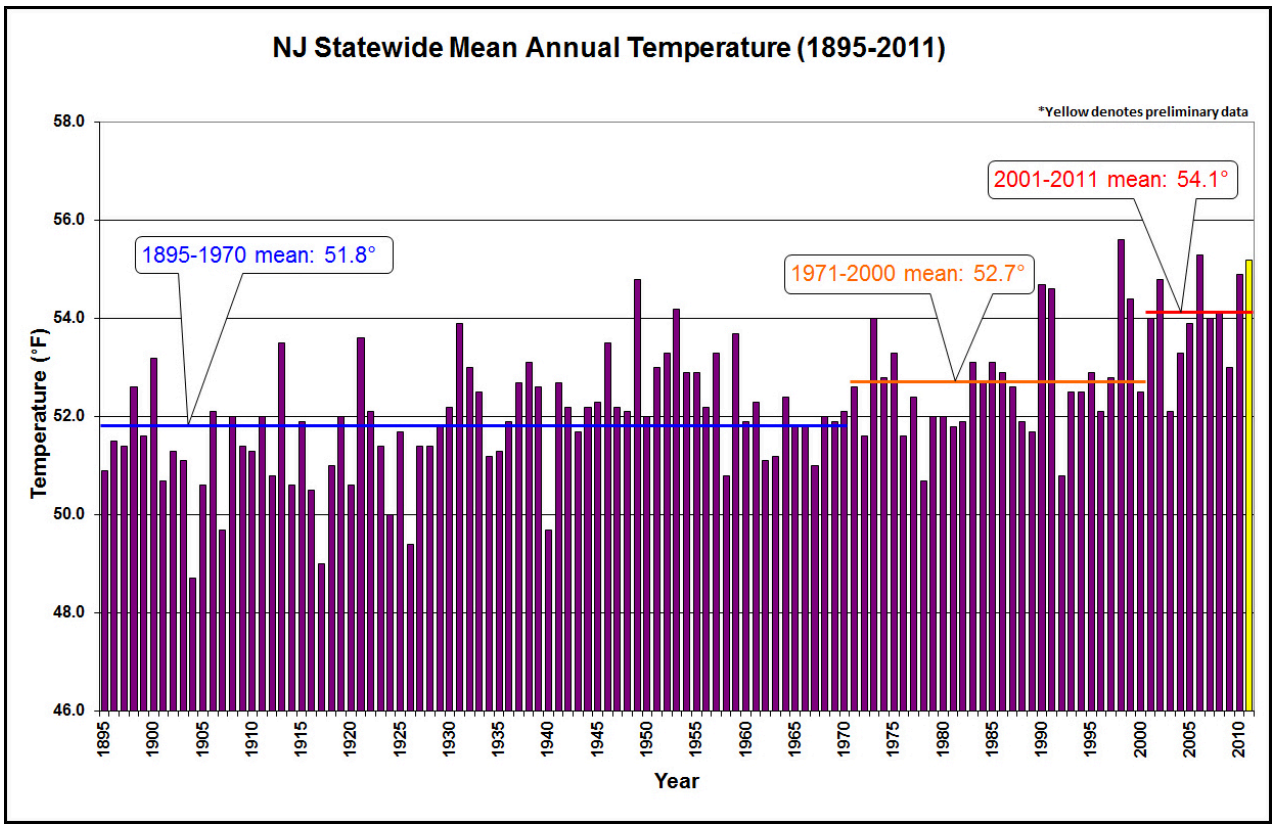

Figure 11A Source: http://climate.rutgers.edu/stateclim_v1/images/nj_temp.jpg

Precipitation

New Jersey's precipitation is well above the national average of 20 inches per year. The southeast coast of New Jersey receives about 40 inches, and the north central part of the state receives up to 51 inches. Chatham's average annual precipitation is 49.56 inches.

The number of days a month with measurable precipitation averages 8 for each of the months of September, October, and November and 9 to 12 for the other months of the year. In total, almost 120 days a year have measurable precipitation. Rainfall is well distributed throughout the year, but is heavier during the summer. Average monthly precipitation varies from a low of 2.8 inches in February to a high of 4.89 inches in September.

The mean snowfall at Canoe Brook recording station is 29 inches a year. New Jersey occasionally experiences snowfalls of 10 or more inches in a single storm. Snow seldom occurs in Northern New Jersey before mid-October or after April 20.

Figure 11B indicates that statewide precipitation has also been gradually increasing.

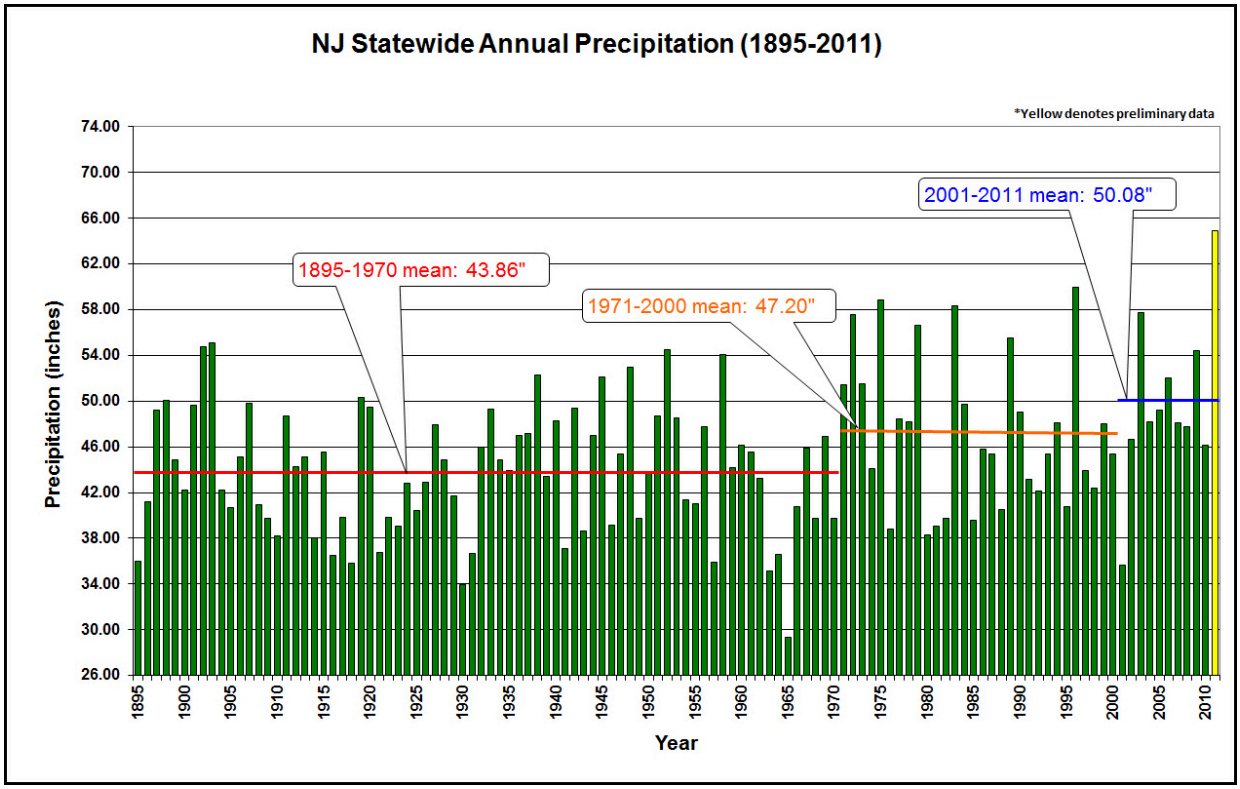

Figure 11B Source: http://climate.rutgers.edu/stateclim_v1/images/nj_pcp.jpg

Drought

Not all years are equally wet, however. Yearly rainfall may be 15 inches less than average - 30 inches less than in a wet year. Brief periods of drought during the growing season are not uncommon, but prolonged droughts are relatively rare, occurring, on the average, once in 15 years. The drought of early to mid-1960's was very severe. While Chatham Township residents have had to put up with water use restrictions in such times, they have not suffered as much as towns in the state with a less adequate water supply.

During the 1960's, many towns allowed development to take place on soil that appeared dry and stable only to find, in later years when rainfall returned to normal, that those subdivisions had serious problems with drainage and water-related building characteristics. Such mistakes can be avoided by making use of the Soils Maps prepared by the Soil Conservation Service.

Floods

At the other extreme is the flooding which results from the severe storms which converge on New Jersey from three directions. Polar storms originate in Canada, cross the Great Lakes region, and then move down the St. Lawrence Valley, the southern fringes of these storms have an important influence on the weather of the northern part of the state. Continental disturbances begin over western U.S. and areas and move eastward. Our heaviest rains, however, come from storms of tropical origin.

Storm systems may be born in the Gulf of Mexico, the Caribbean, or off the Carolinas, and travel northerly across ocean or land. Some of these storms may be of sufficient strength to be classified as hurricanes, but storm systems of less intensity may still dump considerable rain on our state.

The centers of these tropical disturbances often pass some distance off the coast of New Jersey. Occasionally, though, tropical storms move inland on the southern Atlantic coast and move northward either through or to the west of New Jersey. Finally, a tropical disturbance may decay south of the state, before its center can reach us. Any of these situations may produce very heavy rainfall over all or part of New Jersey.

While most occurrences of very heavy rainfall are associated with tropical disturbances, it is important to realize that cloudburst-type rainfall in a limited area can produce very heavy rainfall also.

From the standpoint of flooding, we have been very fortunate during the last six decades; actual flooding has been far below potential. At any time, we in New Jersey could experience floods of great magnitude. The following table indicates the degree of severity of storms which have hit New Jersey in the past 130 years.

Some Past Heavy Rainfalls in New Jersey

Date		*Location Cited*	*Rainfall*	*Remarks*
Aug. 5,	1843	Newark	15"	
Sept. 21-23,	1882	Paterson and South Orange	11"- 17.9"	Hurricane just touching the southern New Jersey coast
Sept (month)	1882	Paterson	25.98"	Total monthly rain fall
July 30-31,	1889	South Orange	8.40"	Heavy flood damage
Oct 8-9,	1903	Newark, Paterson & Perth Amboy	10+"	Decaying tropical storm off coast
Sept 17-21,	1938	New Jersey	6-11"	Passage of hurricane off New Jersey coast
Aug. 19-20,	1939	Tuckerton 1	4.81"	Decaying tropical storm
Sept 1,	1940	Clayton	10.52"	Heavy thunderstorm actively along with a tropical storm centered 150 miles east of the New Jersey coast
Aug. 11-16,	1955	Sussex County	8.10"	Hurricane Diane traversed Central New Jersey in a northeasterly direction
Aug. 26-28,	1971	New Jersey Chatham	3.05-11.43" 9.33"	Hurricane Doria
Sept 11-14,	1971	Northeastern New Jersey	4.54"-7.50"	Tropical storm Heidi moving north northeastward, passing well off the New Jersey Coast
Aug. 3-7,	1978	Morristown	8.1"	Four day continuous rainfall
July 26,	1981	Madison	4.0"	
October	1993	Madison	8.0"	High intensity storm
September	1999	Madison	+10.0"	Hurricane Floyd
September	2004	Maplewood	5.5”	Hurricane Ivan
April	2007	North/Central NJ	6-8”	Severe rain storm
March	2010	Long Hill Township	7.5”	Four day rainfall
March	2011	Morris, Essex, Passaic	4.0+”	Fifth worst innundation of Passaic basin
August	2011	Morris & all New Jersey	10.0+”	Tropical Storm Irene,(3rd wettest rainstorm, worst flooding)

Source: Floods of August and September, 1971, in New Jersey, New Jersey Department of Environmental Protection with USGS and NJDEP NJGS Daily Precipitation Charts, 1982, Office of the NJ State Climatologist at Rutgers University (http://climate.rutgers.edu/stateclim/?section=menu&%20target=climate_summaries).

Air Quality

Air pollution exposure occurs throughout New Jersey. Airborne pollutants are created by industry, utilities, manufacturing and commercial facilities, vehicles and residential activities (such as home heating, cooking and electrical appliances) and many other sources. Most of the air pollution in Chatham Township comes to us from external sources. Prevailing winds in New Jersey are from the southwest in summer (when pollution levels are higher) and from the northwest in winter. Thus much of our air pollution blows from the Washington, Baltimore and Philadelphia metropolitan areas to New Jersey.

Chatham Township benefits from the relatively high percentage of tree cover in and around town which helps to cleanse the air of pollution. Multiplying this benefit are the "islands of green" that are found in surrounding areas: the Great Swamp, Jockey Hollow National Park and the Morris County Park System.

After the passage of the Clean Air Act in 1970, the USEPA set National Ambient Air Quality Standards (NAAQS) for five pollutants, ozone, sulfur dioxide, carbon monoxide, nitrogen dioxide and particulate matter. These pollutants are addressed throughout the country through a planning process and the concentrations of these pollutants in air have been monitored for compliance with the air quality standards. Since 1970, concentrations of these six pollutants have been significantly reduced in New Jersey. The state is now in compliance with all NAAQS, except for ozone. and particulate matter and Chatham Township is in a region that has been in compliance with (i.e. below) the particulate matter standard for several years.

The EPA and New Jersey Department of Environmental Protection (NJDEP) developed the Air Quality Index (AQI) shown in Figure 11C below. It is based on the five NAAQS. Generally the index value of100 is equal to the primary, or health based, NAAQS for each pollutant. The AQI rating for any reporting source is equal to the highest (i.e. worst) rating recorded for any pollutant within that area. The AQI is available in real-time on the internet for many monitoring sites.

Air Quality Index

Numerical AQI Rating*	Descriptive Rating	AQI Color Code
0 – 50	Good	Green
51 – 100	Moderate	Yellow
101 – 150	Unhealthy for Sensitive Groups	Orange
151 – 200	Unhealthy	Red
201 -300	Very Unhealthy	Purple

* 100 is set equal to the relevant Ambient Air Quality Standard

Figure 11C Source: NJDEP Air Quality Report 2010

Chatham Township is located in the Suburban Air Quality Index Region, which includes Middlesex, Morris and Somerset Counties. For 2010 the Suburban Region reported 286 green days, 63 yellow days and only16 orange days. There were no Unhealthy or Very Unhealthy days. The Suburban Region ranked fifth out of the 9 State regions.

The monitoring sites closest to Chatham Township are located in Chester (Morris County) and Morristown. The Chester site monitors for nitrogen dioxide (NO2), ozone (O3), sulfur dioxide (SO2) and meteorological conditions. It should be noted that actual pollutant measurements for Chatham Township would be somewhat worse than the Chester readings since the latter does not include the I-287 corridor and more congested intervening areas.

The following summaries for ground-level ozone and particulates are summarized from the 2010 Air Quality Report published by the NJDEP Division of Air Quality (NJDEP Division of Air Quality web site).

Ground-level Ozone

Ground-level ozone causes serious adverse health and environmental effects. It forms in

the air from volatile organic compounds (VOCs) and nitrogen oxides (NOx) under conditions of high temperature and bright sunlight. Sources include vehicles, power plants and factories. The hottest days of summer can yield unhealthy levels of ozone. Ozone is monitored at both the Chester and Flemington air quality stations.

Figure 11D shows the number of days the ozone standards were exceeded per year at the Chester monitoring station. The 1-hour ozone standard is an average of 0.12 parts per million (ppm), and the 8- hour ozone standard (that became effective in 2008) is an average of 0.075ppm. The 8-hour ecceedence days for 2000 through 2007 are significantly understated since they are based in the previous standard of .080ppm.

Days Ozone Levels Exceeded Standard

Year	# of days with 1-hour averages above 0.12ppm	# of days with 8-hour above 0.075ppm
2000	0	6
2001	0	15
2002	2	27
2003	0	5
2004	0	0
2005	0	3
2006	0	8
2007	0	8
2008	0	9
2009	0	1
2010	0	5

Figure 11D Source: NJDEP Air Quality Reports (2000 - 2010)

There were no exceedances of the 1-hour standard in 2010. However, the 8-hour ozone standard was exceeded 5 times in Chester . The Clean Air Act requires that all areas of the country be evaluated and then classified as attainment or nonattainment areas for each of the National Ambient Air Quality Standards (NAAQS). Based on the 3-year period from January 2008 through December 2010, the USEPA has designated all of New Jersey as non-attainment with respect to the 8-hour ozone standard (NJDEP Division of Air Quality 2010).

Particulates

Particulate air pollution consists of both solid particles and liquid droplets suspended in the atmosphere, usually less than 70 microns in diameter. In addition to human health and environmental effects, particulate matter is a major cause of reduced visibility. Particles larger than 10 microns are usually trapped by the human respiratory system before they reach the lungs, whereas coarse particles smaller than 10 microns (PM10) are considered harmful, while fine particles less than 2.5 microns (PM2.5) are even more detrimental to human health. Coarse particle sources include windblown dust and industrial sources, while fine particles come from combustion sources or are formed in the atmosphere from gasses.

The nearest monitoring sites for particulates are in Chester and Morristown (for PM2.5) and in Trenton (for PM10). In 2010, the results at the Trenton site did not exceed the PM10 24- hour maximum standard of 50µg/M3 * or the annual average standard of 50µg/M3; values were 66µg/M3 and 2µg/M3 respectively. The annual PM2.5 average at Chester was 7.5µg/M3, and at Morristown it was 8.7µg/M3; both below the standard of 15µg/M3 annual average. The PM2.5 24- hour maximum value of 26.9µg/M3 in Chester was within the new 24-hour maximum standard of 35µg/M3 but Morristown exceeded that standard for just one day with its highest concentration of 41.0µg/M3.

* μg/M3 = micrograms per cubic meter of air (a microgram is one millionth (10-6) of a gram).

Radon

Radon is a radioactive gas, which occurs as a natural decay product of uranium and can be found in all soils. Indoors it can become concentrated and long exposure has been linked to lung cancer. Radon is measured in picoCuries per liter (pCi/L) of air. The average U.S. indoor level is 1.3 pCi/L. The U.S. Environmental Protection Agency and NJDEP recommend that action be taken to reduce radon levels if the level in the home is greater than or equal to 4 pCi/L. Chatham Township is rated Tier 2, Moderate Radon Potential (NJDEP Radon Program). However municipalities on Chatham Township's western border are rated Tier 1, High Radon Potential.

BIBLIOGRAPHY

Basis and Background for Proposed Land Use Regulations in Flood Hazard Areas, New Jersey DEP, 1974.

The Climate of New Jersey, March 1967, Dunlap, Donald V., U.S. Department of Commerce, 1974.
Floods of August and September, 1971, in New Jersey, U.S. Geological Survey, 1972.
Land and Its Use: Part I - Physical Characteristics, Morris County Planning Board, 1966.

Natural Resources Inventory, Millburn Township Environmental Commission, 1974.

Travelling Weatherwise in the U.S.A., Powers, Edward and James Witt, 1972.

Vegetation of New Jersey: A Study of Landscape Diversity, Robichaud, Beryl and Murray F. Buell, 1973.

The Weather Almanac, Ruffner, James and Frank E. Bair, 1974.

Weather. A Guide to Phenomena and Forecasts, Lehr, Paid I-L, R- Will Burnett and Herbert S. Zim, 1957.

The New Jersey Almanac, 1964-1965, 1965.

"Water: The Next Crisis?", Walcott, John., Communication Magazine (v.2, no.2).

The NJ State Office of Climatology at Rutgers University,
http://climate.rutgers.edu/stateclim_v1/njclimoverview.html

NJDEP Air Quality Reports (2000 – 2010)
http://climate.rutgers.edu/stateclim_v1/monthlydata/index.html

Natural Resource Inventory for Bedminster, Somerset County, February, 2010