

BOROUGH OF CALDWELL

ENVIRONMENTAL RESOURCE INVENTORY

January 2026

BOROUGH OF CALDWELL, ESSEX COUNTY

January 2026

ENVIRONMENTAL RESOURCE INVENTORY UPDATE

PREPARED BY

THE LAND CONSERVANCY OF NEW JERSEY

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The original document is appropriately signed and sealed in accordance with Chapter 41, Title 13 of the State Board of Professional Planners.

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Date: January 28, 2026

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When considering the use and/or development of a property, the information provided herein should be supplemented with onsite confirmation of the resources present at that particular property.

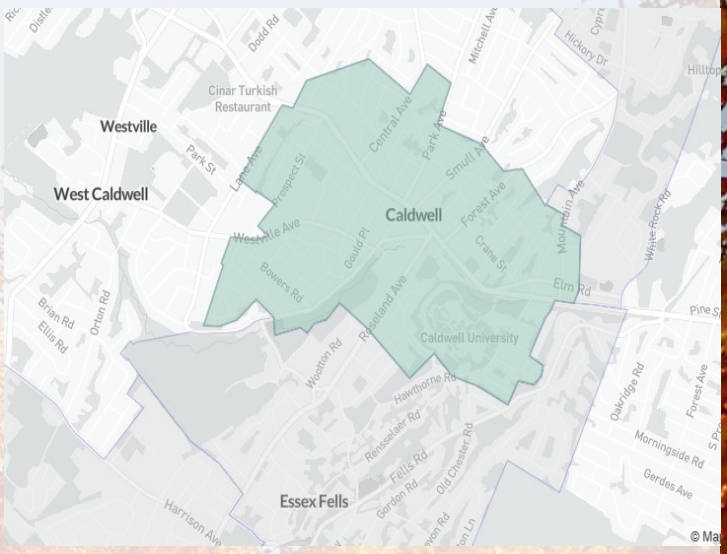
Photographs:

Cover:
Ruby-crowned Kinglet, a local, native bird that lives in Caldwell September to May.
Photographer: Janet Markman

Executive Summary:
Sugar Maple, Rutgers Landscape & Nursery
(https://www.rutgersln.com/blog/green-mountain-sugar-maple/)

Executive Summary

Much of the Borough of Caldwell's charm and character lies within its beautiful forested neighborhoods, busy downtown shops along Bloomfield Avenue, and its parks and historic sites, including the Grover Cleveland Birthplace National Historic Site and Caldwell University (**Map 1**).

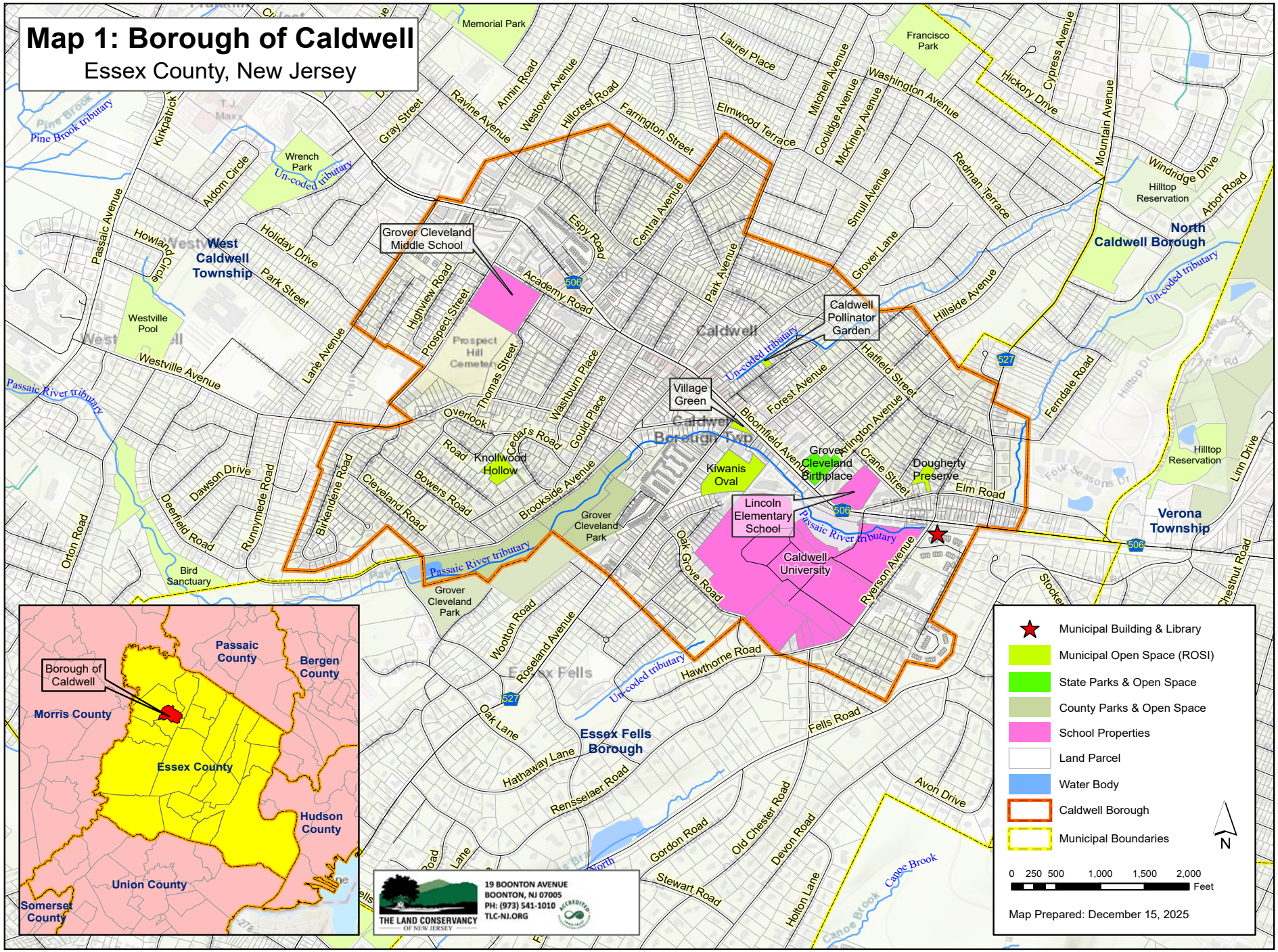


At 1.2 square miles, Caldwell is one of the smallest towns in Essex County. The conservation of its natural resources is a priority for the town. The Environmental Commission hands out annual sustainability awards recognizing local efforts to protect the environment. This photo from The Progress (newjerseyhills.com) highlights the award to the Willing Hearts consignment shop for their work in recycling and redistributing clothing and merchandise, creating strength and resilience in the community.



White-tailed deer, turkeys, rabbits, and squirrels frequent the Borough's parks and neighborhoods, and visitors to Grover Cleveland Park enjoy the sugar maple-mixed hardwood forest which predominate the landscape. As a walking community, residents appreciate what surrounds them and understand that it protects them from severe storms, offers shade from extreme heat, and respite from a busy day.

The Borough of Caldwell prepared its initial Environmental Resource Inventory (ERI) in 1996. Updated in 2014, the Borough is once again revisiting the data and conclusions in 2025. Based upon the best available data and local knowledge, the ERI offers a picture of what the Borough's natural features are, the soils and geology upon which it rests, and the changes it has experienced due to the cycles of climate change the region is experiencing. The information and maps contained within the ERI can be used by local officials when reviewing development applications, applying for grant funds, and assisting with local decision making regarding the future use and stewardship of its land. The Environmental Commission has built upon the base provided in the original 1996 ERI to construct rain gardens to hold stormwater, design and build a pollinator garden to help native plants, and provide educational materials to residents wanting to learn more about where they live and how they can help improve the environment which surrounds them.


Map 1: Borough of Caldwell
Essex County, New Jersey
Memorial Park
Francisco Park
Wrench Park
Un-coded tributary
Pine Brook tributary
Grover Cleveland Middle School
West Caldwell Township
Westville Pool
Prospect Hill Cemetery
Caldwell Pollinator Garden
Village Green
Caldwell Borough
Kiwanis Oval
Grover Cleveland Birthplace
Dougherty Preserve
Lincoln Elementary School
Caldwell University
Grover Cleveland Park
Bird Sanctuary
Passaic River tributary
Hilltop Reservation
North Caldwell Borough
Verona Township
Essex Fells Borough
Borough of Caldwell
Passaic County
Bergen County
Morris County
Essex County
Hudson County
Union County
Somerset County
Municipal Building & Library
Municipal Open Space (ROSI)
State Parks & Open Space
County Parks & Open Space
School Properties
Land Parcel
Water Body
Caldwell Borough
Municipal Boundaries
N
0 250 500 1,000 1,500 2,000
Feet
Map Prepared: December 15, 2025
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Environmental Resource Inventory

What is an Environmental Resource Inventory?

An Environmental Resource Inventory (ERI) provides the foundation for local decision-making. It details information that planners and local officials can use to craft public policy and make land use decisions that align with their community's priorities.[1]

The ERI describes the natural resources in a given locality. Natural resources include, for example, forests, surface and groundwater, and wildlife habitat.

For the Borough of Caldwell, the ERI has:

- **Maps** which show the location and extent of the existing resources.
- **Data** that provides additional detail about these features such as water quality or soils.
- **Report** that summarizes each of these resources in the town.

The ERI is a dynamic document which needs to be updated periodically to reflect current data, changing conditions and policies.

What is the importance of an ERI?

Incorporating the ERI into the Master Plan helps the members of the governing body, planning board, and environmental commission provide sound recommendations while reviewing proposed development applications. In this way, resources upon which the community depends are protected and integrated into the planning process.

What are the advantages of an ERI to the community?

According to the Association of New Jersey Environmental Commissions and Sustainable Jersey, an Environmental Resource Inventory:[2]

- Provides factual information for municipal land use planning.
- Assists in developing the land use element of the Master Plan.
- Serves as a guide during the site plan review process.
- Helps in the compilation of zoning regulations and municipal ordinances.
- Forms the basis for a land capability analysis and determining the intensity and location of development.
- Identifies sensitive areas and suitable locations for specific types of development.
- Enhances understanding of natural systems, their limitations, and opportunities for use.
- Acts as a long-term planning tool for identifying potential land use impacts and natural resource issues.
- Educates residents about their community and its environment.
- Aids in avoiding future problems and mitigating costs.

Who uses the ERI?

- Environmental Commissions
- Planning Boards
- Zoning Boards
- Planners
- Engineers
- Elected Officials
- Residents and Property Owners



Kiwanis Oval Entrance
Photo: The Land Conservancy

Chapter 1.

Geology & Topography

Why Geology & Topography?

Local geology is the basis upon which development and change can occur. In Caldwell, the geologic composition affects possible land use and character, as well as the quality and quantity of water. Topography, or the surface pattern of land features, affects the flow of water and the capacity of the land to support a variety of uses. Underlying bedrock layers determine the functionality of aquifers and quality of water they yield. Surface materials affect the land's vulnerability to erosion, types of vegetation it can support, and its suitability for development.

Overview

Borough of Caldwell is located within the Piedmont physiographic province of New Jersey. This province runs in a northeast to southwesterly direction from the northeastern corner of Bergen County to the Delaware River. It encompasses all of Essex County and includes a total of 1,600 square miles.[3] The geology of the region was developed from the ancient glacial flows in the Newark Basin, which formed the hard basalt bedrock.

Borough of Caldwell rests upon the western slope of the Second Watchung Mountain. The igneous basalt bedrock that comprises the Watchung Mountains is more resistant to weathering than the shales and sandstones that underlay their surrounding areas. The ridgelines

for the First and Second Watchungs cross Essex County in a northeast to southwest direction.

The Borough follows the slope of the Second Watchung Mountain from its high point at 560 feet above sea level in its northeastern corner near Arlington Road to its low point at 280 feet on its western boundary near Westville Avenue. Elevations continue to drop west of Borough of Caldwell.

Physiographic Provinces

New Jersey is divided into four physiographic provinces, each defined by unique geologic processes and landforms. New Jersey's physiographic provinces form diagonal bands across the state. From the northwest to southeast, these provinces are: the Valley and Ridge, Highlands, Piedmont, and Coastal Plain, sometimes further divided into the Inner and Outer Coastal Plain.[4] **(Figure 1)**

The Piedmont covers approximately 20% of the state (**Figure 2**). It is characterized by low rolling hills, winding river valleys with well-developed floodplains, and sudden steep, rocky ridges that trend northeast-southwest.[5] The overlap of the provinces forms a ridge marked by waterfalls and rapids, known along the East Coast as the Fall Line.[6]

To the northwest, the Highlands Province sits an average of 1,000 feet above sea level, making the Piedmont a relative lowland. The Piedmont slopes gently south-eastward, from an average of 400 feet elevation at its northern margin, to sea-level where it meets the Newark Bay. To the south where it meets the Delaware River, the Piedmont averages about 100 feet above sea level.[7]

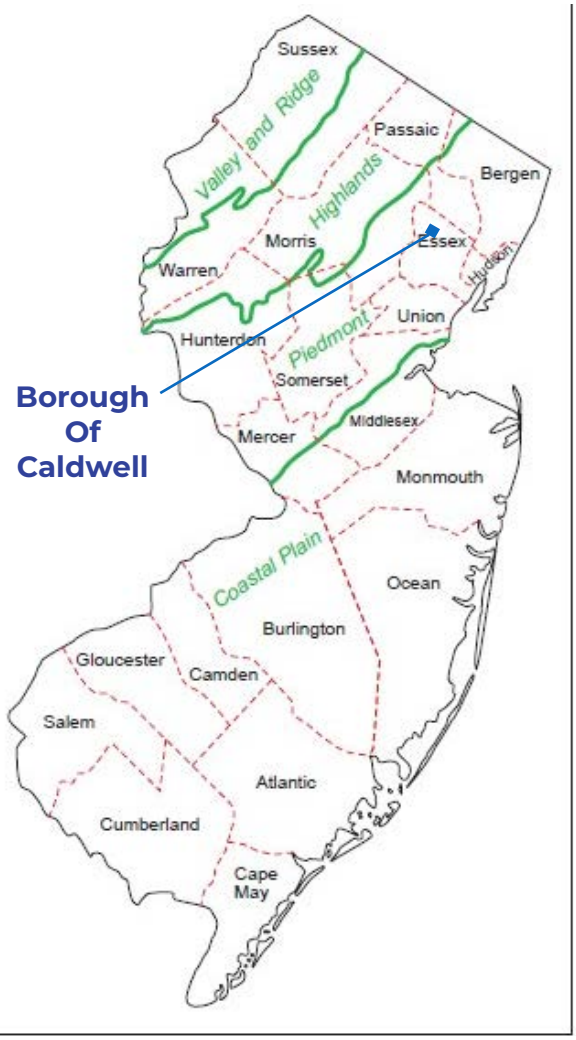


Figure 1. Physiographic Provinces and Counties of New Jersey

Source: New Jersey Geological Survey[18]

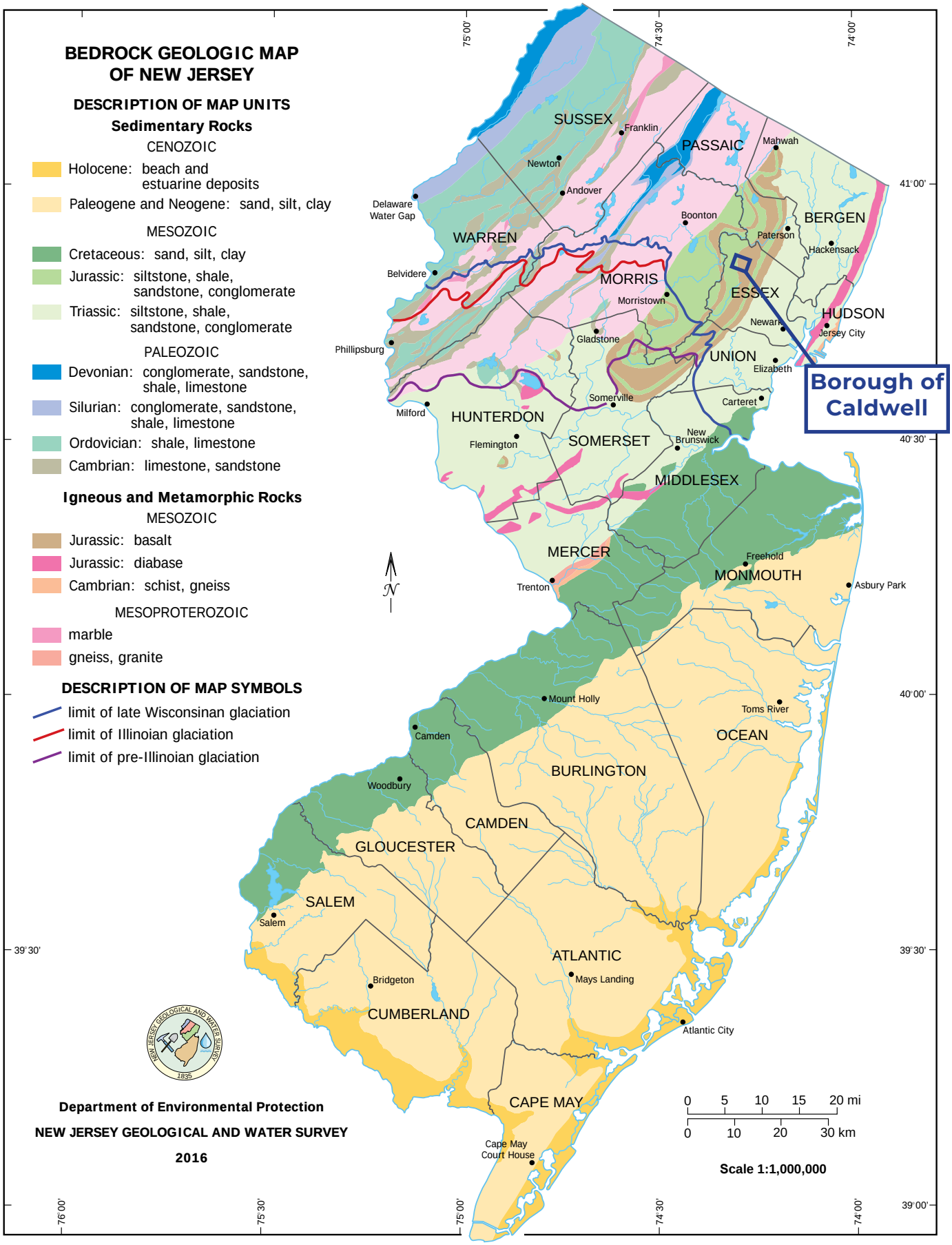
Bedrock Geology

Geologic composition is classified in two main layers:

- Bedrock geology: Consolidated, underlying rock that extends deep into the earth's crust; and
- Surficial geology: Unconsolidated sedimentary materials that overlie bedrock formations and serve as the parent material for soils.

Bedrock of the Piedmont was deposited during the late Triassic and early Jurassic

Figure 2. Bedrock Geology of New Jersey[19]



eras between 230 and 190 million years ago, with the formation of the Newark Basin.[8] The rock formations of the Newark Basin, which coincides with 95% of New Jersey's Piedmont Province, are comprised of shale, sandstone, and argillite formations that are typically brownish-red in color.[9] Though masked by a relatively thick surficial cover, the bedrock controls the direction of the northeasterly-trending topography.[10]

Several ridges run northeast-southwest through the Piedmont, including the three Watchung Mountains (at 850, 650, and 350 feet above sea-level), the Sourlands, and the Palisades. These ridges are made up of hard lava rock known as diabase and basalt. Between the ridges, formations of sandstone and shale are less hard and resistant to erosion, resulting in the gradual wearing of their elevations.[11]

Caldwell is underlain by the Second Watchung Mountain and Preakness Basalt bedrock (Jp) which is fine to coarse-grained (**Map 2**).

This bedrock layer follows the mountain's northeast-southwest form and is comprised of greenish-gray to black basalt.[12] To the northwest of Caldwell, Preakness turns to the Towaco formation of fine- to medium-grained micaceous sandstone, siltstone, and silty mudstone in layered sequences of 3 to 10 feet thick. To the southeast is the Feltville Formation, consisting of fine- to coarse-grained sandstone, siltstone, shaly siltstone, and silty mudstone, as well as calcareous siltstone, silty mudstone, and carbonaceous limestone. Where it meets the Preakness Basalt, up to two feet of Feltville has been thermally metamorphosed.[13] Specific properties of bedrock layers determine:

- The physical extent of aquifers and the chemical quality of water that they yield.
- Affect the movement of groundwater and contaminants through soils.
- Can indicate areas where natural hazards like sinkholes, radon, and seismic instability may occur.

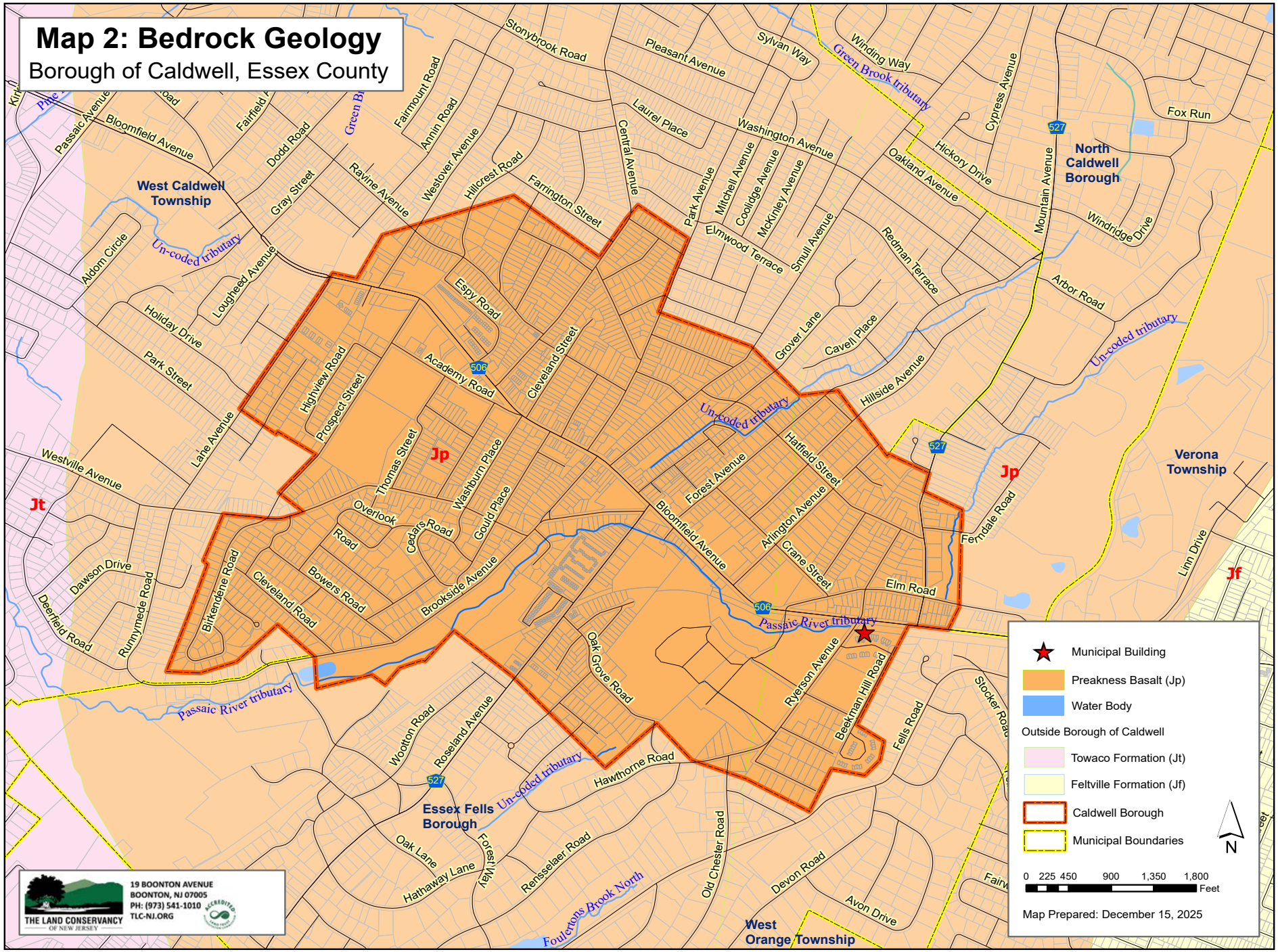
Such properties may suggest an area's suitability for septic systems, stormwater and surface runoff management systems, and degree of stability for building foundations, bridges, tunnels, and other structures.

The basalt of the Watchungs has been extensively quarried for crushed stone other minerals.[14] Within a few miles of Caldwell are the remnants of several copper mines dating to the late 18th century, including the Glen Ridge Mine (Montclair), Dod Mine (East Orange), and Wigwam Brook (Orange).[15]

Surficial Geology

Atop the bedrock, the surficial geology of the Piedmont Province is made up of stratified sand, gravel, silt, and clay that was deposited by glacial streams and ice, as well as swamp sediments of the postglacial age, estuarine, and alluvial fill. These surficial deposits formed during the Pleistocene era and through Wisconsinan glaciation. Surficial geologic layers of New Jersey are less than 30 feet thick over much of the state, though they can be as much as 400 feet thick in some areas.[16]

The Wisconsin Glacial Stage saw glacial lakes and streams lain over the volcanic formations of northern New Jersey. The pressure of thick ice formations affected these landforms, creating depressions


Map 2: Bedrock Geology
Borough of Caldwell, Essex County
West Caldwell Township
North Caldwell Borough
Verona Township
Essex Fells Borough
West Orange Township
Jp
Jt
Jf
Passaic River tributary
Un-coded tributary
Green Brook tributary
Foulertons Brook North
Stonybrook Road
Pleasant Avenue
Sylvan Way
Winding Way
Fox Run
Cypress Avenue
Hickory Drive
Mountain Avenue
Windridge Drive
Oakland Avenue
Washington Avenue
Laurel Place
Central Avenue
Park Avenue
Mitchell Avenue
Coolidge Avenue
McKinley Avenue
Elmwood Terrace
Smull Avenue
Redman Terrace
Arbor Road
Grover Lane
Cavell Place
Hillside Avenue
Fairmount Road
Annin Road
Westover Avenue
Hillcrest Road
Farrington Street
Ravine Avenue
Gray Street
Dodd Road
Bloomfield Avenue
Passaic Avenue
Aldom Circle
Lougheed Avenue
Holiday Drive
Park Street
Lane Avenue
Westville Avenue
Dawson Drive
Deerfield Road
Runnymede Road
Birkendene Road
Cleveland Road
Bowers Road
Overlook Road
Cedars Road
Thomas Street
Washburn Place
Gould Place
Brookside Avenue
Highview Road
Prospect Street
Espy Road
Academy Road
Cleveland Street
Forest Avenue
Hatfield Street
Arlington Avenue
Crane Street
Bloomfield Avenue
Ferndale Road
Elm Road
Linn Drive
Oak Grove Road
Ryerson Avenue
Beekman Hill Road
Fells Road
Stocker Road
Woolton Road
Roseland Avenue
Hawthorne Road
Oak Lane
Hathaway Lane
Forest Way
Rensselaer Road
Old Chester Road
Devon Road
Avon Drive
506
527
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Municipal Building
Preakness Basalt (Jp)
Water Body
Outside Borough of Caldwell
Towaco Formation (Jt)
Feltville Formation (Jf)
Caldwell Borough
Municipal Boundaries
N
0 225 450 900 1,350 1,800
Feet
Map Prepared: December 15, 2025

that later eased as the ice melted. Over the rise and fall of water levels, layers of sediment were left behind.[17]

The surficial coverage of Caldwell is primarily Late Wisconsinan glacial delta deposits (western half of the Borough) and Rahway till. To a more minor extent, there are Late Wisconsinan glacial lacustrine-fan deposits in a small corner of the municipality north of Ravine Avenue near Hillcrest Road.

The Wisconsinan deposits are made up of sand, pebble-to-cobble gravel, and minor silt, and they can be up to 200 feet thick. Rahway till is clayey silt to sandy silt with some pebbles, cobbles, and boulders, and it is generally less than 40 feet but can be as much as 100 feet thick (**Table 1** and **Map 3**).

What is Topography?

Topography refers to the slope and level of the land. Topographic maps are created by connecting contour lines that each represent a level of elevation on the surface of the land. Slope is the measure of the distance from one contour point to another, divided by the lateral distance between them.[22]

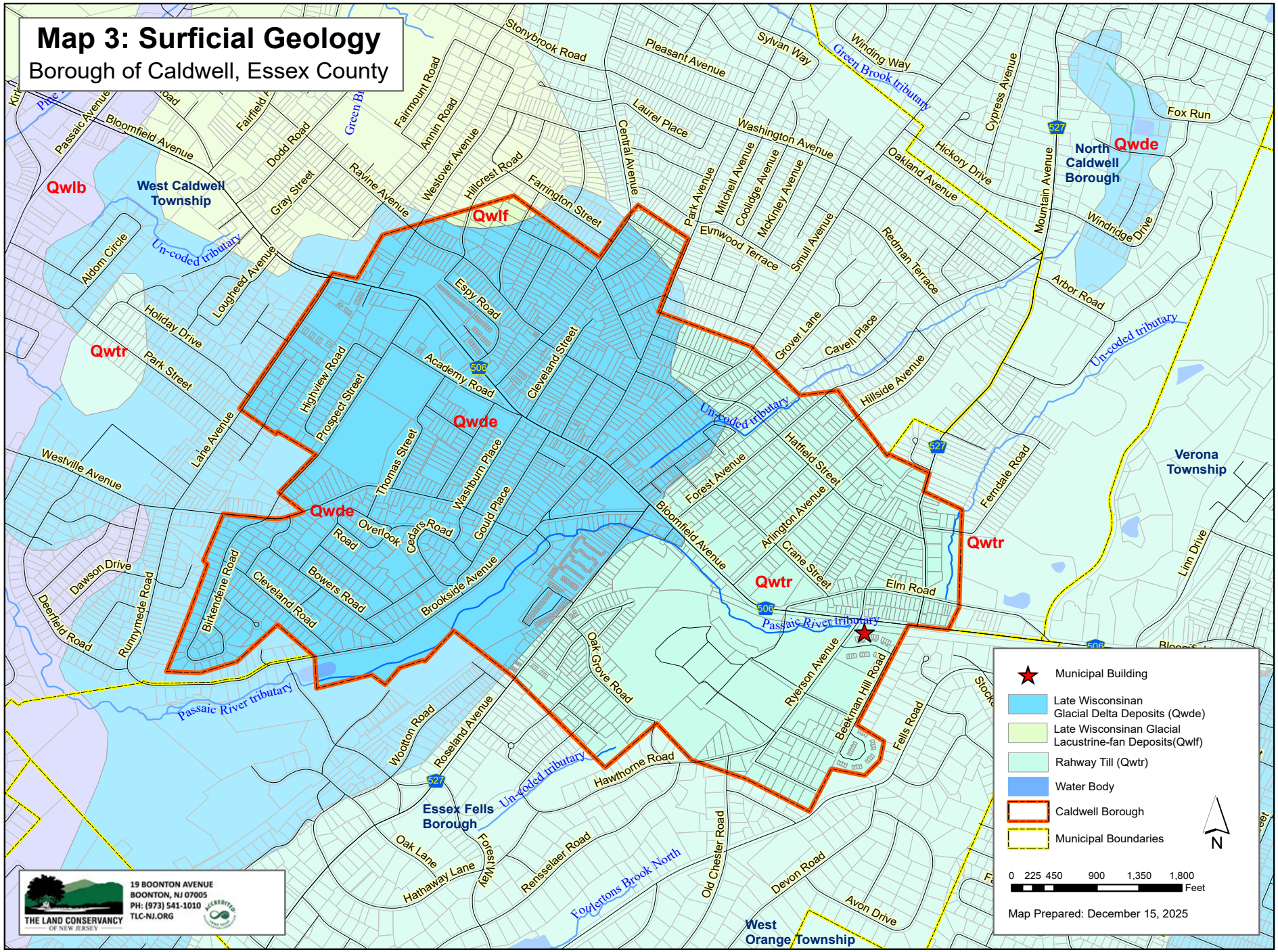
Topography

Caldwell sits on the inner slope of the Second Watchung Mountain, gaining its higher elevations on its southeastern side along Hawthorne Road. From southeast to northwest, the elevation descends from over 500 feet to about 300 feet. The Passaic River tributary and the

Table 1. Surficial Geology

Name	Description	Geologic Age	Acres	%
Late Wisconsinan Glacial Deposits (Qwde)	Sand, pebble-to-cobble gravel, minor silt; yellowish brown, reddish brown, light gray. As much as 150 feet thick.	late Pleistocene, late Wisconsinan	439.3	58.0%
Rahway Till (Qwtr)	Clayey silt to sandy silt with some to many pebbles and cobbles and few boulders; reddish brown, reddish yellow, yellowish brown, brown. As much as 100 feet thick, generally less than 40 feet thick.	late Pleistocene, late Wisconsinan	314.0	41.4%
Late Wisconsinan Glacial Lacustrine-fan Desposits	Sand, pebble-to-cobble gravel, minor silt; yellowish brown, reddish brown, light gray. As much as 200 feet thick.	late Pleistocene, late Wisconsinan	4.7	0.6%
		Total:	**7,700**	**100%**

Source: NJGS Surficial Geology


Map 3: Surficial Geology
Borough of Caldwell, Essex County
Qwlb
West Caldwell Township
Qwlf
Qwtr
Qwde
North Caldwell Borough
Verona Township
Essex Fells Borough
West Orange Township
Passaic River tributary
Un-coded tributary
Green Brook tributary
Foulertons Brook North
Municipal Building
Late Wisconsinan Glacial Delta Deposits (Qwde)
Late Wisconsinan Glacial Lacustrine-fan Deposits(Qwlf)
Rahway Till (Qwtr)
Water Body
Caldwell Borough
Municipal Boundaries
N
0 225 450 900 1,350 1,800
Feet
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unnamed tributary that run through the Borough outline the slopes of the Second Watchung. **Map 4** shows the contours and topography of Caldwell.

Steep Slopes

Due to its geography, Caldwell is generally free of hazardous slopes. Limiting the disturbance of steep slopes is important in preventing soil loss, erosion, excessive stormwater runoff, and the degradation of surface water; as well as maintaining the natural topography and drainage patterns of the land.

Disturbing the natural vegetation, topography and drainage patterns of steep slopes. The combination of unstable slopes and greater runoff means that more water and sediment (silt) enter streams during precipitation events. Increases in water volume entering streams can lead to, or exacerbate, flooding downstream.

Steep slopes can be associated with geological hazards. Nearby West Orange has a history of landslides along the steep slopes of the First and Second Watchung Mountains, primarily in the vicinity of Route 280.

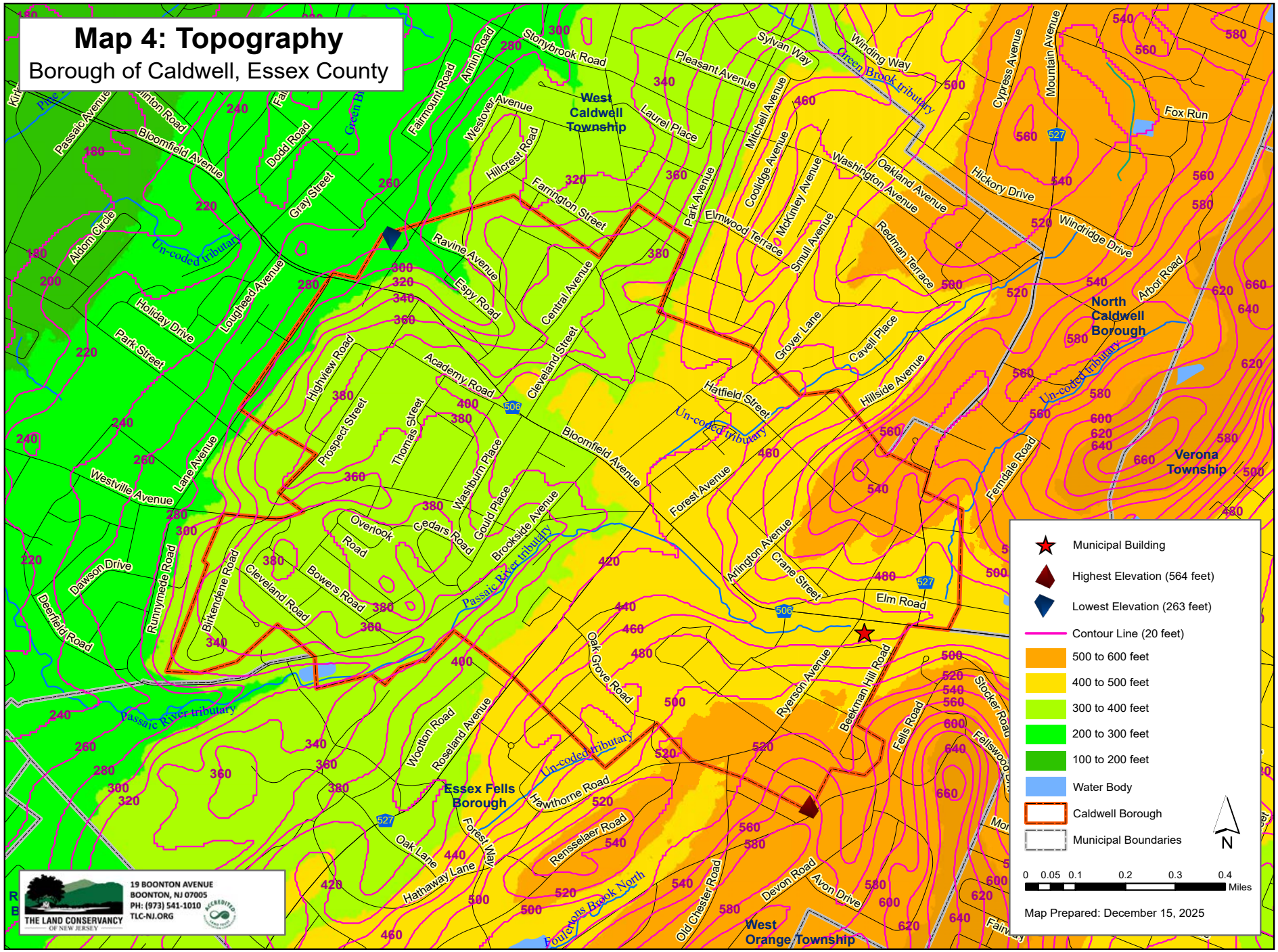
Caldwell is within the range of "moderate susceptibility" to landslides as identified in the 2019 New Jersey Hazard Mitigation Plan.[20] The term landslide captures a range of slope movements, including rock falls, slope failures, debris flow or mudslides. Contributing factors that may induce landslides include:

- Weather-induced erosion that steepens the slope.
- Saturation of slopes by heavy rains or snowmelt.
- Earthquakes.
- Stream erosion.
- Disturbance of the slope or its vegetation by human activities.

Changes in storm patterns due to climate change could pose increased risk of landslides in the future. The anticipated increase in intensity and frequency of tropical storms could bring heavy rains to fragile slopes, while growing risks of drought and wildfire may threaten the vegetation that plays a stabilizing role in sloped landscapes. For more information on landslides, see **Chapter 9: Climate**.

The Borough of Caldwell's zoning regulations require the following:

- In areas with slopes greater than 35%, no disturbance shall be permitted.
- In areas with slopes greater than 25% to 35%, no more than 30% of such area shall be disturbed.
- In areas with slopes greater than 15% to 25%, no more than 60% of such area shall be disturbed.
- In areas with slopes of 15% to 0%, unlimited disturbance shall be permitted, provided it is in compliance with other provisions of the ordinance.[21]


Map 4: Topography
Borough of Caldwell, Essex County
West Caldwell Township
North Caldwell Borough
Verona Township
Essex Fells Borough
West Orange Township
Municipal Building
Highest Elevation (564 feet)
Lowest Elevation (263 feet)
Contour Line (20 feet)
500 to 600 feet
400 to 500 feet
300 to 400 feet
200 to 300 feet
100 to 200 feet
Water Body
Caldwell Borough
Municipal Boundaries
N
0 0.05 0.1 0.2 0.3 0.4
Miles
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Pollinator Garden
Photographer: Warren Marchioni

Chapter 2.

Soil

What do soils tell us?

Along with climate conditions, soils determine the types of vegetation that are able to grow in the Borough. Soils influence the types of construction and development that can be supported in different areas.

Chapter 2 explores what soils are, how they are composed, where different soil types are located in the municipality, and what types of vegetation and land uses they typically support.

All information is provided by the NRCS Soil Survey, which identifies and maps over 20,000 different soil types in the United States.[199]

The Natural Resources Conservation Service (NRCS) of the US Department of Agriculture (USDA) defines soil as mineral or organic material that sustains plant and animal life, regulates water flow, filters and buffers pollutants, cycles nutrients, and provides physical stability.[23] Most soils are given names from the local area where they were mapped, forming a common soil series. Soils in a series are classified by their physical and chemical properties. Soil forming factors include:

- **Parent material**: Some soils weather directly from the underlying rocks. The residual soils have the same general chemistry as the original rocks.
- **Climate**: Temperature and moisture can cause different patterns of weathering and leaching. The intensity, timing, and amount of rain also influences soil formation.

• **Topography**: The slope and aspect (direction the physical slopes face) affect the temperature and moisture content of the soil.

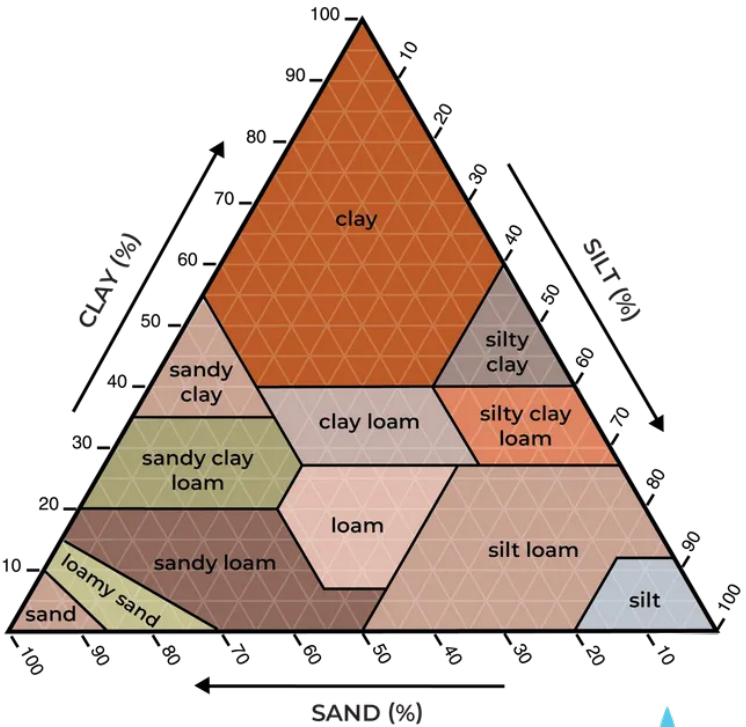
• **Biological factors**: Plants, animals, micro-organisms, and humans affect soil formation. Native vegetation depends on biology, topography, and climate factors, as well as soil factors (density, chemistry, depth, temperature, and moisture).

• **Time**: Soil formation is continuous, always altering according to climate, landscape position, and biological activity.

The following section contains technical information and context for the classification system used by the NRCS. This information is used to characterize the soil types in Caldwell, whose locations are shown in **Map 5 (**at the conclusion of this chapter). For further details of the soil content of a particular property, refer to the NRCS Web Soil Survey.

Figure 3. Soil Texture Triangle

Source: Nano-Yield



USDA soil textural triangle

Source: National Agronomy Manual, USDA

Soil Classifications

Soils are named and classified on the basis of physical and chemical properties in their layers (horizons).[24] Soil taxonomy uses color, texture, structure, and other properties to classify compositions. There are 12 major soil textures, defined by their component fractions of sand, silt, and clay (**Figure 3**). Classifications are typically named for the primary constituent particle size or the most abundant particle size. See **Figure 4** for illustrations of soil type, size, and texture.

The NRCS Soil Survey plots soils by map unit based on the dominant soil. The map unit further defines soils by their series classification(s). Each map unit has an associated abbreviation that offers a shorthand version of the naming/ classification system. These abbreviations identify soil types by steepness, stoniness, and frequency of flooding. This includes:

- The **first three letters** of the abbreviation name the soil or complex. For example, Bog refers to Boonton loam.

- **Capital letters** at the end of the abbreviation indicate the slope, with "A" being less steep and "E" being steeper. For example, Boonton loam with 0 to 8 percent slopes is BogB, while Boonton loam with 8 to 15 percent slopes is BogC.

- The **small "t"** at the end of an abbreviation indicates soils are frequently flooded. For example, the hydric soil known as Udifluvents is UcdAt.

The Soil Survey categorizes each map unit as one of four types: consociations, complexes, associations, and undifferentiated groups. Soils are categorized as consociations or complexes:

- **Consociations (Cn)** are named for the dominant soil. In a consociation, delineated areas use a single name from the dominant component in the map unit. Dissimilar components are minor in extent. An example is Boonton loam, which includes BogBc, BogCc, and BogDc.

- **Complexes (Cx)** consist of two or more dissimilar components that occur in a regular repeated pattern. The total amount of other dissimilar components is minor in extent. Complexes in Caldwell are mixed with urban soil components, such as the Knickerbocker – Urban land, Knickerbocker substratum complex (KnuB).

The lowest classification of map units is a soil series, where all soils have horizons similar in composition, thickness, and arrangement. Beyond the series and composition, soils are defined by steepness, stoniness, and frequency of flooding. The soils found in Caldwell are explored in the following section.

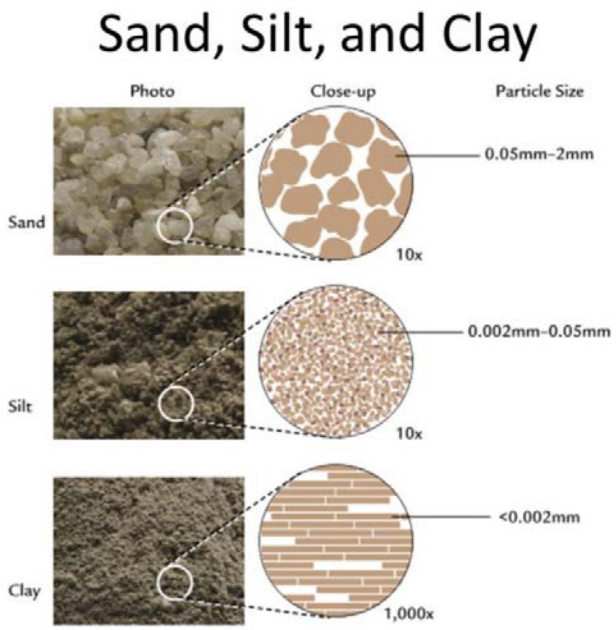
Soils of Caldwell

All soil types found in Caldwell are listed in **Table 2**. Excluded from this assessment are areas of rock outcrops and urban land, except for when they form complexes with other soils, in which case they are classified by their dominant soil components. Most of the soils in Caldwell have been modified by urban development, often forming urban complexes. The characteristics and functions of a soil type may be impacted by the presence of urban components.

Figure 4. Soil Types (top), Soil Size (middle), Soil Texture (bottom)

Source: Noble Research Institute





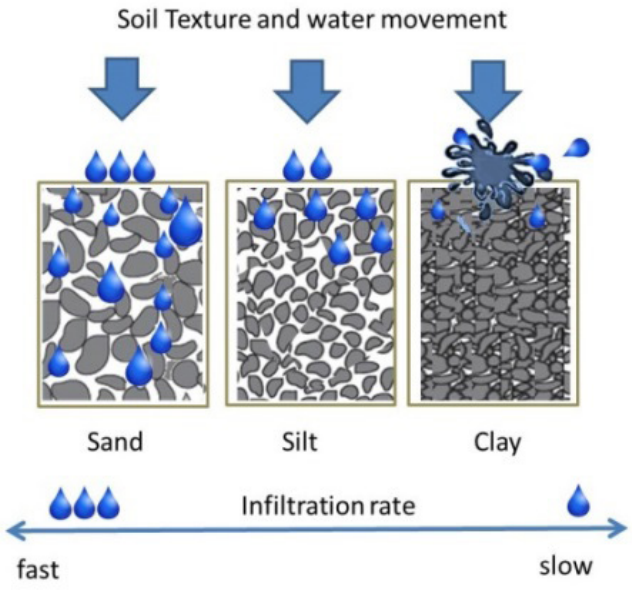


Table 2. Soil Units of Caldwell			
Abbrv.	**Map Unit Name**	**Total Acres**	**% of Total**
BogBc	Boonton loam, 0 to 8 percent slopes, extremely stony	1.0	0.1%
BogCc	Boonton loam, 8 to 15 percent slopes, extremely stony	8.6	1.1%
BosB	Boonton - Udorthents, Boonton substratum complex, 0 to 8 percent slopes	17.9	2.4%
BouB	Boonton - Urban land, Boonton substratum complex, 0 to 8 percent slopes	196.0	25.9%
BouC	Boonton - Urban land, Boonton substratum complex, 8 to 15 percent slopes	139.0	18.3%
BouD	Boonton - Urban land, Boonton substratum complex, 15 to 25 percent slopes	2.5	0.3%
HanBc	Haledon silt loam, 0 to 8 percent slopes, extremely stony	5.7	0.8%
HasB	Haledon - Urban land, Haledon substratum complex, 0 to 8 percent slopes	6.1	0.8%
HkrnB	Hinckley loamy sand, 3 to 8 percent slopes	7.3	1.0%
HokCh	Holyoke silt loam, 0 to 15 percent slopes, very rocky	2.2	0.3%
KneB	Knickerbocker fine sandy loam, 3 to 8 percent slopes	5.7	0.8%
KnuB	Knickerbocker - Urban land, Knickerbocker substratum complex, 0 to 8 percent slopes	188.7	24.9%
PohA	Pompton sandy loam, 0 to 3 percent slopes	19.7	2.6%
PokuB	Pompton - Urban land, Pompton substratum complex, 0 to 8 percent slopes	12.7	1.7%
RoeBc	Rockaway loam, 0 to 8 percent slopes, extremely stony	21.4	2.8%
RoeCc	Rockaway loam, 8 to 15 percent slopes, extremely stony	4.2	0.6%
RonB	Rockaway - Urban land, Rockaway substratum complex, 0 to 8 percent slopes	28.5	3.8%
RonC	Rockaway - Urban land, Rockaway substratum complex, 8 to 15 percent slopes	16.3	2.1%
UdbonB	Udorthents, Boonton substratum, 0 to 8 percent slopes	7.7	1.0%
UdhorB	Udorthents, Horseneck substratum, 0 to 8 percent slopes	3.6	0.5%
URKNKB	Urban land, Knickerbocker substratum, 0 to 8 percent slopes	62.8	8.3%
WATER	Water	0.5	0.1%
	Total acres:	**758**	**100%**
Source: NRCS Soil Survey			

- Over 70% of soils in Caldwell belong to the Boonton series (365 acres) or the Knickerbocker series (194 acres).
- The next common series are Rockaway (70 acres) and Pompton series (32 acres).

The characteristics of the four series are described below. Also present in minor amounts are the Haledon, Hinckley, Holyoke, and Udorthents series (less than 12 acres each).

Map 5 shows the location of different soil series in the municipality. Urban soils underlie the commercial corridor along Bloomfield Avenue and Roseland Avenue.

Boonton Series

The most common soil unit is the Boonton–Urban land, Boonton substratum complex:

- 0 to 8% slopes (BouB): 196 acres (26% of total soils).
- 8 to 16% slopes (BouC): 139 acres (18%).
- 15 to 25% slopes (BouD) is present to a minor extent.

Other Boonton series include;

- Boonton–Udorthents, Boonton substratum complex, 0 to 8% slopes: 18 acres.
- Boonton loams of 0 to 8% slopes (BogBc): 1 acre and 8 to 15% slopes (BogCc): 8.6 acres.

The Boonton series consists of deep or very deep moderately well and well drained soils formed in till on uplands. They are moderately deep to a fragipan or restrictive layer. The series is of moderate extent, making up 62,000 acres in northeastern New Jersey and southeastern New York. Slopes range from gentle to very steep, with gradients up to 50 percent. Boonton loams are extremely stony in composition.

- *Drainage and permeability*: Soils are moderately well and well drained, with slow to rapid runoff. Saturated hydraulic conductivity is moderately low to high in the mineral soil above the fragipan, low or very low in the fragipan, and low to high in the substratum. There is a perched water table at a depth of 46 to 91 centimeters (cm) in most years from November to May.
- *Use and vegetation*: Most soils are in highly urbanized areas, though some undeveloped sites are wooded or idle fields. Wooded areas consist of oaks, red maple, white ash, hickory, gray birch, and dogwood trees.

Knickerbocker Series

The second most abundant soil type in Caldwell is the:

- Knickerbocker–Urban land, Knickerbocker substratum complex, 0 to 8% slopes (KnuB) with 189 acres (25% of total soils).
- Similar but dominated by urban components is Urban land, Knickerbocker substratum, 0 to 8% slopes (URKNKB) which covers 63 acres (8%).
- To a minor extent, Knickerbocker fine sandy loam is also present, with 3 to 8% slopes (5.7 acres). In total – including the urban type – the Knickerbocker series comprises 257 acres, or 34% of soil coverage.

The Knickerbocker series consists of very deep, well and somewhat excessively drained soils formed in sandy glacio-fluvial deposits. Knickerbocker soils are

nearly level to steep soils on lake plains and terraces. Slopes can range from 0 to 35 percent. They are found at elevations of 100 to 800 feet above sea level in proximity to eastern New York State.

- *Drainage and permeability*: Soils are well or somewhat excessively drained, with potential for surface runoff ranging from low to high. Permeability is moderately rapid in the upper part of the solum and moderately to very rapid in the lower part and substratum.

- *Use and vegetation*: Most areas have been cleared; in non-urban areas they are used for crops or orchards. Wooded areas contain sugar maple, oak, and hickory.

Rockaway Series

The Rockaway series makes up about 70 acres or 9% of soil area in Caldwell. This includes

- Rockaway loams of 0 to 8% (RoeBc) and 8 to 15% (RoeCc).

- The urban complex Rockaway–Urban loam, Rockaway substratum is also present with 0 to 8% slopes (RonB) and 8 to 15 percent slops (RonC).

The Rockaway series consists of very deep well or moderately well-drained soils that are found in the glaciated uplands of northern New Jersey. Rockaway soils formed in coarse or moderately coarse textured till on complex hilly to mountainous glaciated topography, with slopes ranging from 3 to 60 percent. The till is composed primarily of granitic gneiss, but contains smaller amounts of quartzite, sandstone, shale, and sometimes limestone.

- *Drainage and permeability*: Soils are commonly moderately well-drained and sometimes well-drained. Permeability is moderately rapid or moderate above the fragipan, slow to very slow within the fragipan, and moderately rapid or rapid below the fragipan. Saturated hydraulic conductivity is moderately low to high above the fragipan, moderately to very low in the fragipan, and moderately high or high below the fragipan. Surface runoff is medium or high. A perched water table on the fragipan is common in late winter or early spring and following extended periods of rainfall.

- *Use and vegetation*: Non-urban uses are often wooded or in idle fields; others are used for residential or industrial development. Natural vegetation is largely woodland dominated by oak, ash, and hickory with some maple, birch, and hemlock.

Pompton Series

Pompton soils cover 32 acres or about 4% of Caldwell. Two types are found:

- Pompton sandy loam with 0 to 3% slopes (PohA).

- Pompton–Urban land, Pompton substratum, 0 to 8% slopes (PokuB).

The Pompton series consists of very deep, moderately well drained and somewhat poorly drained soils that formed in water-sorted sediments, mainly sandy and gravelly materials dominated by granitic gneiss. Pompton soils are found on broad outwash plains, beaches, deltaic deposits, and in drainageways that dissect outwash terraces. Slopes are often 0 to 5 percent but can be up to 15 percent. They are found in northern New Jersey, New York, Pennsylvania, and Massachusetts, with a total extent of about 20,000 acres.

- *Drainage and permeability*: Soils are moderately well drained and somewhat poorly drained. Saturated hydraulic

conductivity is high in the solum or very high in the substratum. Surface runoff is very low or low. The ground water table is located within 30 centimeters of the surface in late winter, early spring, and following periods of extended rainfall.

- *Use and vegetation*: Most areas are wooded or in idle fields and used for residential or industrial development sites. Native vegetation includes birch, oak, and ash with some hemlock.

Soil Characteristics

Erodibility

K-Factor. Soils are characterized by their susceptibility to erosion, or the natural processes by which wind, moving water, ice, and gravitational forces cause soil and particulate materials to be displaced. While erosion of exposed bedrock occurs over an extended time scale, soil erosion can occur acutely with more immediate consequences. The degree of soil erodibility is defined by the K factor, which accounts for soil texture, composition, and permeability.

K values range from 0.02 (least susceptible to erosion) to 0.69 (most susceptible).

- Clayey soils have the lowest K values (between 0.05 and 0.15 generally), as they are resistant to detachment and have low rates of runoff.

- Coarse textured soils, such as those with sandy compositions, also have low K values ranging from 0.05 to 0.2. With coarse soils, rates of runoff are low, but the materials are easily detachable.

- Medium textured soils such as silty loams have moderate K values ranging from 0.25 to 0.4. These soils are moderately susceptible to detachment and have moderate rates of runoff.

- Loose, silty soils have the highest K values between 0.4 and 0.69, as they are easily detached and have high rates of runoff.

K values for major soil units are included in **Table 3**. All soils in Caldwell range from low to moderate susceptibility to erosion, with K values from 0.20 to 0.32.

Table 3. Soil and Wind Erodibility Classifications of Largest Soil Units

Largest Map Units (By acreage)	Acres	K-Factor (0.02=least erodible, 0.69=most)	Wind Erodibility	
			Group (1=least erodible, 8=most)	Index (expected soil loss, tons/acre/year)
Boonton-Urban land, 0 to 8 percent (BouB)	196.0	0.32	5	56
Boonton-Urban land, 8 to 15 percent (BouC)	139.0	0.32	5	56
Knickerbocker-Urban, 0 to 8 percent (KnuB)	188.7	0.20	3	86
Urban land, Knickerbocker, 0 to 8 percent	62.8	n/a	n/a	n/a
Rockaway-Urban, 0 to 8 percent (RonB)	28.5	0.32	5	56
Rockaway loam, 0 to 8 percent (RoeBc)	21.4	0.32	5	56
Pompton sandy loam, 0 to 3 percent (PohA)	19.7	n/a	3	86
Source: NRCS Soil Survey				

Topographic Protection (Wind)

Some soils are more vulnerable to erosion by wind. Wind erosion most often affects soils on bare lands, where the force of winds detaches particles that protrude from the soil surface. Maintaining surface cover helps to minimize damage due to wind erosion. Wind erodibility is measured in two ways, using groupings and an index.

- Groups are assigned based on similar properties affecting susceptibility to wind erosion in cultivated areas. Soils assigned to group 1 are most susceptible to wind erosion, and those assigned to group 8 are least erodible. Soils in Caldwell range from group 3 to group 5.
- The index measures the tons of soil per acre per year that can be expected to be lost to wind erosion.

Expected soil loss in Caldwell ranges from 56 to 86 tons per acre per year (**Table 3**).

Hydric Soils

Hydric soils as soils are formed under conditions of saturation, flooding, or ponding for long enough during the growing season to develop anaerobic conditions in the upper part. These soils are regularly inundated and able to support hydrophytic vegetation.[25] Hydric soils provide natural support to wetland vegetation. Due to the ecological importance of wetlands, areas with hydric soils may be subject to federal and state regulations, including restrictions on land use and development.

The soils in Caldwell are not rated as hydric, although the Pompton sandy loam (PohA) has a rating of 10, which indicates some hydric characteristics.

Agricultural Soils

Agricultural soils are classified as either prime farmland, farmland of statewide importance, or farmland of unique importance.

- Prime farmland soils in Caldwell include Pompton sandy loam, zero to 3% slopes. This totals 20 acres (or 3%) of Borough of Caldwell.
- The Hinckley loamy sand (3 to 8% slopes) is classified as farmland soils of statewide importance in Caldwell. It totals 7.3 acres (or 0.96% of the Borough's land area).
- There are no farmland soils of unique (or local) importance in Borough of Caldwell.

Limitations for Use

There are measurable characteristics that determine the suitability of soils for certain types of development. These include:

- Risk of corrosion of construction materials (steel and concrete).
- Limits for septic systems.
- Depth to restrictive layers.
- Hydrological characteristics such as a shallow water table, tendency towards ponding or flooding, and potential for frost heaving.

Such limitation assessments account for factors such as soil composition, texture, water retention, and overall stability. For example, clayey or wet soils are poorly suited for septic tank absorption fields, and a water table can limit the suitability of underground construction, such as basements. Limitations for use include the following characteristics and are detailed in **Table 4**.

Depth to restrictive feature refers to the vertical distance between the soil surface and the upper boundary of a restrictive layer. The restrictive layer is a nearly continuous layer that impedes the movement of water and air through the soil or otherwise provides an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers. Depth to restrictive layer may vary throughout a unit, so a representative value is given, indicating the most common or most likely measurement for a chosen point.

In Caldwell, Boonton soils are about 76 cm deep to their restrictive layer. Knickerbocker soils and Pompton soils are more than 200 cm deep, while Rockaway soils are about 61 cm deep.

Drainage refers to the relative wetness of the soil under natural conditions of the water table. Drainage classes refer to the frequency and duration of wet periods under conditions similar to those under which the soil developed. Drainage classes range from excessively drained, where water is removed very rapidly from coarse or shallow soils, to very poorly drained, where water is removed very slowly so that free water is left at or near the surface during much of the growing season.

Common soil units of Caldwell are well drained, with the exception of Pompton

Table 4. Soil Limitations in Caldwell

	Major Soil Units						
	BouB	BouC	KnuB	URKNKB	RonB	RoeBc	PohA
Depth to Restrictive Feature (cm)	76	76	>200	>200	61	61	>200
Drainage	Well drained	Well drained	Well drained	n/a	Well drained	Well drained	Somewhat poorly drained
Depth to Water Table (cm)	>200	>200	107	107	>200	>200	38
Available Water Capacity (cm/cm)	0.12	0.12	0.10	0.09	0.06	0.06	0.13
Flooding	None	None	None	None	None	None	None
Frost Action Potential	Mod.	Mod.	Low	n/a	Mod.	Mod.	Mod.
Ponding	None	None	None	None	None	None	None
Risk of Corrosion - Steel	High	High	Mod.	n/a	Mod.	Mod.	High
Risk of Corrosion - Concrete	High	High	High	High	High	High	High
Septic Limitations	Very limited	Very limited	Very limited	Very limited	Not limited	Very limited	Very limited
Source: NRCS Soil Survey							

soils, which are somewhat poorly drained.

Depth to water table indicates the expected depth to a saturated zone in the soil known as the water table, which occurs for several months of the year. A saturated zone that lasts for less than a month is not considered a water table.

In Caldwell, Boonton soils have a depth to water table greater than 200 cm. Knickerbocker soils are 107 cm deep to the water table. Pompton soils are 38 cm to water table; Haledon and Udorthents soils are similarly shallow.

Available water capacity is the quantity of water that the soil is capable of storing for use by plants. This capacity is measured in centimeters of water per centimeter of soil. Available water capacity varies according to soil properties, including the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in selecting plants or crops, as well as in the design and management of irrigation systems.

Among the most common soil units of Caldwell, the available water capacity is between 0.06 and 0.13 cm per cm.

Flooding is the temporary inundation of an area caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding. The frequency of flooding is expressed as none, very rare, rare, occasional, frequent, and very frequent.

- None: Flooding is not probable. The chance of flooding is nearly zero in any year. Flooding occurs less than once in 500 years.
- Very rare: Flooding is very unlikely but possible under extremely unusual weather conditions. The chance of flooding is less than 1% in any year.
- Rare: Flooding is unlikely but possible under unusual weather conditions. The chance of flooding is one to five percent in any year.
- Occasional: Flooding occurs infrequently under normal weather conditions. The chance of flooding is five to 50% in any year.
- Frequent: Flooding is likely to occur often under normal weather conditions. The chance of flooding is more than 50% in any year but is less than 50% in all months in any year.
- Very frequent: Flooding is likely to occur often under normal weather conditions. The chance of flooding is more than 50% in all months of any year.

All soils in Caldwell have a flowing frequency of “none.”

Potential for frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave), leading to the subsequent collapse of the soil and loss of strength upon thawing. Frost action occurs when moisture moves into the freezing zone of the soil. During thawing periods, this movement results in damage to pavement and other rigid structures.

Evaluating the potential for frost action requires consideration of temperature, texture, density, saturated hydraulic conductivity (Ksat), content of organic matter, and depth to the water table. This assessment assumes that the soil is not insulated by vegetation or snow and is not artificially drained. Most susceptible

to frost action are silty, highly-structured, clayey soils that have a high water table in winter. Conversely, well drained, very gravelly or sandy soils are the least susceptible.

All common soils in Caldwell have moderate frost action potential except for Knickerbocker soils, which have low potential. Udorthents and Hinckley soils also have low frost action potential.

Ponding refers to standing water in a closed depression. Unless a drainage system is installed, the water is removed only by percolation, transpiration, or evaporation. Frequency of ponding is expressed as none, rare, occasional, or frequent.

- None: Ponding is not probable.
- Rare: It is unlikely but possible under unusual weather conditions (the chance of ponding is nearly 0 to 5% in any year).
- Occasional: It occurs, on the average, once or less in two years (the chance of ponding is 5-50% in any year).
- Frequent: It occurs, on the average, more than once in two years (the chance of ponding is more than 50% in any year).

All soils in Caldwell have a ponding frequency of "none."

Risk of corrosion is the potential for soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. Generally, steel or concrete installations that intersect soil layer boundaries are more susceptible to corrosion than ones that are entirely within one kind or layer of soil.

All soils in Caldwell are regarded as highly corrosive to concrete. Boonton and Pompton soils are highly corrosive to steel as well, while Knickerbocker and Rockaway soils are moderately corrosive.

Septic limitations cover the suitability of a soil type to effectively manage septic tank absorption. Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tile or perforated pipe. Only the part of the soil between depths of 24 and 60 inches is evaluated. Septic suitability ratings are based on the soil properties that affect absorption of the effluent, construction and maintenance of the system, and broader factors of public health.

The most important soil properties that determine septic limitations are saturated hydraulic conductivity (Ksat), depth to water table, depth to restrictive layers, frequency of ponding, and frequency of flooding. Restrictive layers such as stones and boulders, ice, bedrock or cemented pan interfere with system installation. Subsidence interferes with installation and maintenance. Excessive slope may cause lateral seepage and surfacing of the effluent in downslope areas.

Most soils in Caldwell are rated as "very limited" for septic systems. Some soils in the Rockaway series are not limited or somewhat limited.

Soil Limitations for Building Site Development

Soils are rated for their ability to support dwellings (single-family homes of three stories or fewer) based on properties that affect the capacity of a soil to support a load without movement, and properties that affect excavation and construction costs. Ratings are separately considered for dwellings with and without basements, as well as small commercial buildings of three stories or fewer. These ratings differ for several reasons:

- For dwelling without basements and small commercial buildings, the foundation is assumed to consist of spread footing of reinforced concrete, built on undisturbed soil at a depth of two feet or at a depth of maximum frost penetration, whichever is deeper.
- For dwellings with basements, the foundation is assumed to consist of spread footings of reinforced concrete built in undisturbed soil at a depth of about seven feet.

The properties that affect the load-supporting capacity of soils include depth to a water table, ponding and flooding, subsidence, linear extensibility (shrink-swell potential), and compressibility. Properties that affect excavation and construction costs are depth to a water table, ponding and flooding, slope, depth to bedrock or cemented pan, hardness of bedrock or cemented pan, and the amount and size of rock fragments. An area's soils may be rated:

- Not Limited: indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected.
- Somewhat Limited: the soil has features that are moderately favorable for specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected.
- Very Limited: the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Soil limitations for dwellings with basements in Caldwell:

- Boonton and Rockaway soils with zero to 8% slopes are not limited for dwellings with basements.
- Boonton and Rockaway soils with 8 to 15% slopes are somewhat limited.
- Knickerbocker soils are somewhat limited.
- Pompton soils are very limited.
- For Caldwell, 56% of the land area is somewhat limited, 37% is not limited, and 7% is very limited for construction of dwellings with basements.

For dwellings without basements:

- 54% of the land area is rated very limited, 36% is not limited, and 10% is somewhat limited.
- Boonton and Pompton soils are very limited.
- Knickerbocker soils are not limited.
- Rockaway soils are somewhat limited.

Ratings are similar for small commercial buildings, with 57% being very limited, 34% being somewhat limited, and 9% being not limited.

Limitations - Recreational Use

Different types of recreational amenities can require different supportive functions of soils. Recreational development is thus similarly ranked and advised according to soil properties. Picnic areas are used for preparing food and eating outdoors. They require soils that can remain firm under heavy foot traffic, absorb rainfall readily, and not be dusty when dry. Soil slope and stoniness are the main concerns affecting the development of picnic areas.

Playgrounds are used for games and similar recreational activities. They require soils that are nearly level, free of stones, and can withstand heavy foot traffic. Playground surfaces should absorb rainfall, remain firm under heavy foot traffic, and not be dusty when dry. Very limited areas are due to the presence of slopes, the factor of being too dusty or sandy, slow water movement, and the depth to cemented pan.

Camp areas are used as sites for tents, trailers, campers, and activities of outdoor living. They require leveling and stabilization, as well as the installation of utility lines and sanitary facilities. important soil properties in these areas are slope, stoniness, and depth to restrictive layer. The surface of a camp area should absorb rainfall readily, remain firm under heavy foot traffic, and not be dusty when dry

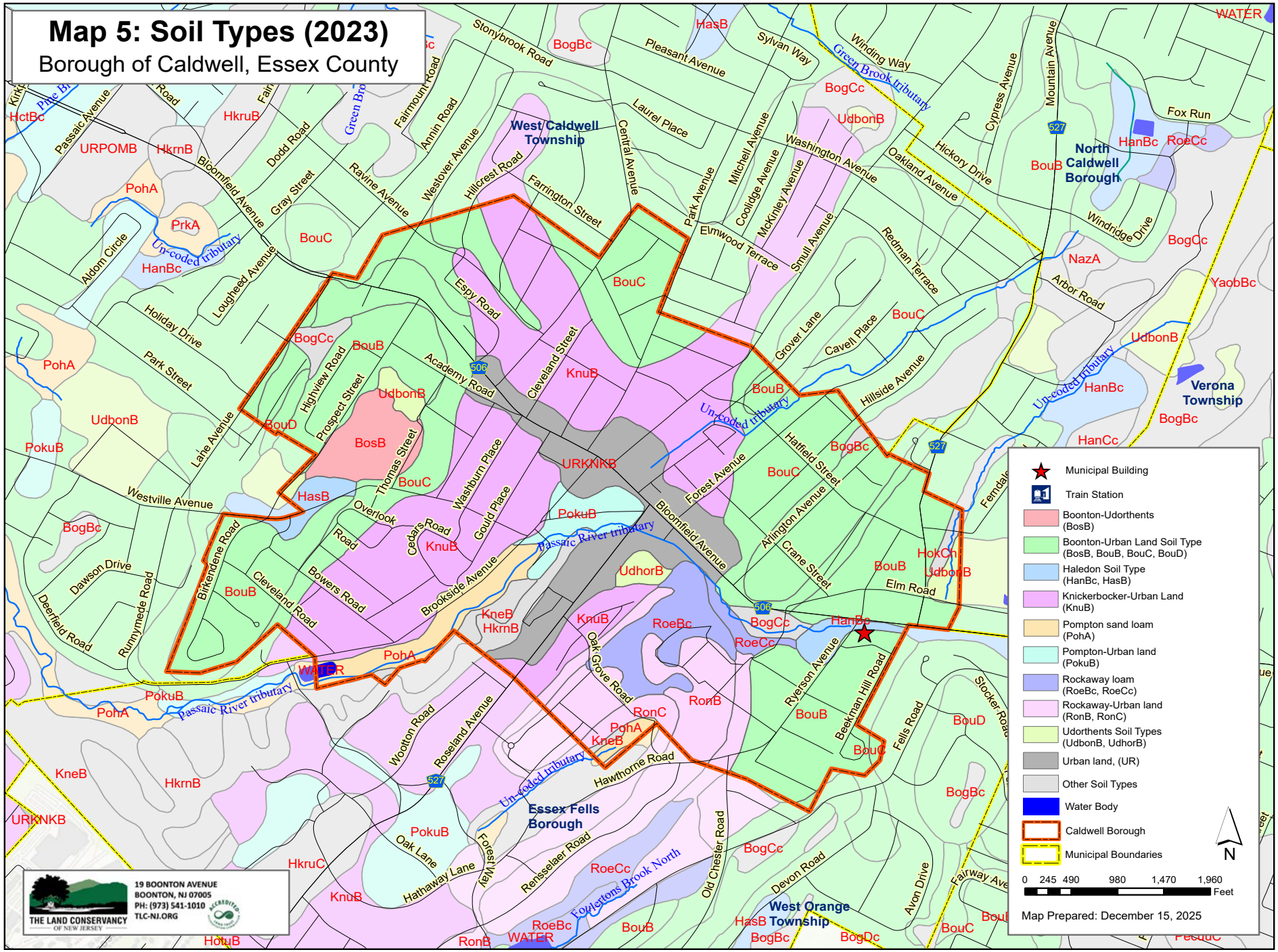
Table 5 summarizes the limits for recreational land uses in Caldwell according to the NRCS. In summary:

- 7% of soil area is very limited for picnic areas, while 85% is somewhat limited.
- 85% of soil area is very limited for playgrounds, while 6% is somewhat limited.
- 11% of soil area is very limited for camp areas, while 81% is somewhat limited.

Table 5. Soil Limitations for Recreational Use

Soil Units of Caldwell	Camp Area	Picnic Area	Playground
Boonton-Urban land, 0 to 8 percent (BouB)	Somewhat limited	Somewhat limited	Very limited
Boonton-Urban land, 8 to 15 percent (BouC)	Somewhat limited	Somewhat limited	Very limited
Knickerbocker-Urban, 0 to 8 percent (KnuB)	Somewhat limited	Somewhat limited	Very limited
Urban land, Knickerbocker, 0 to 8 percent	Not rated	Not rated	Not rated
Rockaway-Urban, 0 to 8 percent (RonB)	Somewhat limited	Somewhat limited	Somewhat limited
Rockaway loam, 0 to 8 percent (RoeBc)	Somewhat limited	Very limited	Very limited
Pompton sandy loam, 0 to 3 percent (PohA)	Very limited	Somewhat limited	Very limited

Source: NRCS Soil Survey


Map 5: Soil Types (2023)
Borough of Caldwell, Essex County
West Caldwell Township
North Caldwell Borough
Verona Township
Essex Fells Borough
West Orange Township
Municipal Building
Train Station
Boonton-Udorthents (BosB)
Boonton-Urban Land Soil Type (BosB, BouB, BouC, BouD)
Haledon Soil Type (HanBc, HasB)
Knickerbocker-Urban Land (KnuB)
Pompton sand loam (PohA)
Pompton-Urban land (PokuB)
Rockaway loam (RoeBc, RoeCc)
Rockaway-Urban land (RonB, RonC)
Udorthents Soil Types (UdbonB, UdhorB)
Urban land, (UR)
Other Soil Types
Water Body
Caldwell Borough
Municipal Boundaries
0 245 490 980 1,470 1,960
Feet
N
Map Prepared: December 15, 2025
THE LAND CONSERVANCY OF NEW JERSEY
19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973) 541-1010
TLC-NJ.ORG



The Borough of Caldwell Entry Sign
Photographer: Warren Marchioni

Chapter 3.

Land Use/Land Cover

A Revolutionary Town

Established in 1798 and named after a hero of the American Revolutionary War, Caldwell gradually developed around the "Big Road", or Bloomfield Avenue, as a regional commercial center and tourist destination.[200]

The Borough serves as a regional center of economic activity, with residential, commercial, and civic uses comprising the built environment of Caldwell. The resilience of this landscape is dependent upon the natural resources which support it. Together, these environmental qualities form the heart of the pleasant, small town setting that Caldwell is known for.

Land uses are mapped, delineated, and classified by the NJDEP using digital orthophotography and color infrared images. The Land Use/Land Cover (LU/LC) data describes the composition of land use types that are present in a given area. Six primary types of land cover are mapped: urban or built-up land, forest, agriculture, barren land, water, and wetlands. Full descriptions of the NJDEP major land use categories can be found in the box on **page 32**.

LU/LC data reflects the composition of both natural and human-built land features in a municipality. This data illustrates what types of environments are present and how the composition has changed over time. Assessment of LU/LC has implications for development, environmental protection, and future planning.

The distribution of land use categories in the Borough of Caldwell is shown in **Figure 5** and mapped in **Map 6**. Present categories include:

- **Urban or built-up land**: 92% of land in Caldwell is classified as urban or built-up land (700 acres). Urban land is characterized by intensive use where the landscape has been altered or developed by human activities. In Caldwell this is predominantly residential (74%), with subcategories of single-unit medium density (60%), high density or multiple dwelling (10%), and single-unit low density (3%). Another 16% of urban land is commercial/ services (see **Figure 6** and **Table 6**).

- **Forest**: 7% of the land is classified as forest (54 acres). Forest cover in Caldwell is largely found in the riparian areas and along the edges of residential neighborhoods, particularly in the southern portions of the Borough. All forest land is classified as deciduous forest, with 44 acres having greater than 50% crown closure and 10 acres having 10-50% crown closure. For more information on forest types, see **Chapter 4, Vegetation**.

- **Wetlands**: 0.4% of land in the Borough is classified as wetlands (three acres). These mapped areas are found in riparian areas around streams and other low-lying areas. Two acres are "managed wetlands in built-up maintained recreation areas," referring to the portion of Grover Cleveland Park that surrounds the tributary to the Passaic River. One acre is deciduous wooded wetlands, surrounding an un-coded river tributary in the Borough's southern corner bordering Essex Fells.

- **Water**: less than one acre of Caldwell is open water. This is the artificial pond located in Grover Cleveland Park.

- **Barren Land**: less than one acre of Caldwell is classified as barren land. This is an erroneous identification of the PSE&G substation on Roseland Avenue.

- **Agriculture**: There is no agricultural land use in Caldwell.

Figure 5. Land Use Types, Borough of Caldwell
Source: USGS LULC Data

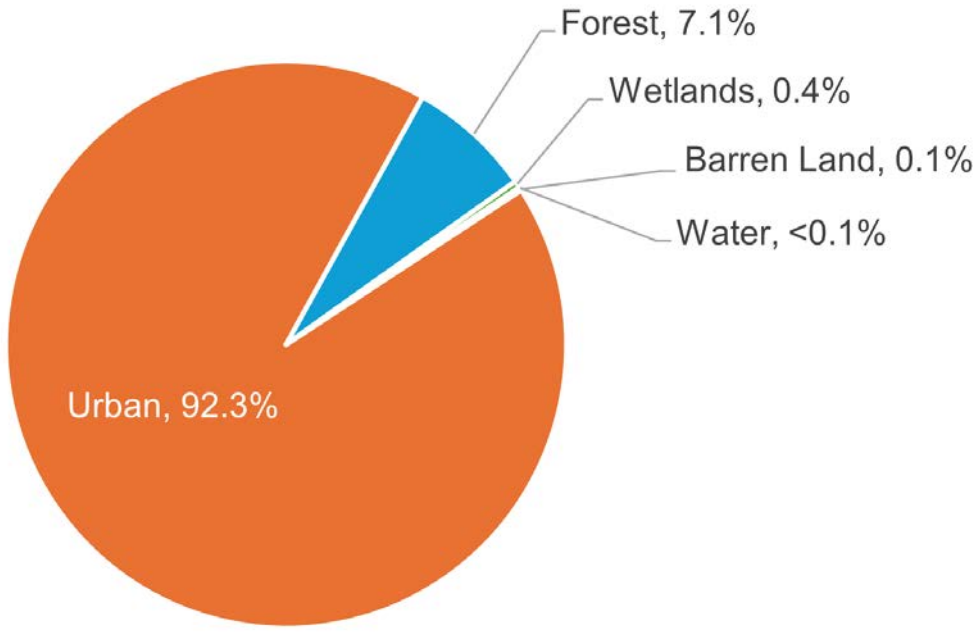


Figure 6. Urban Land Use Types, Borough of Caldwell

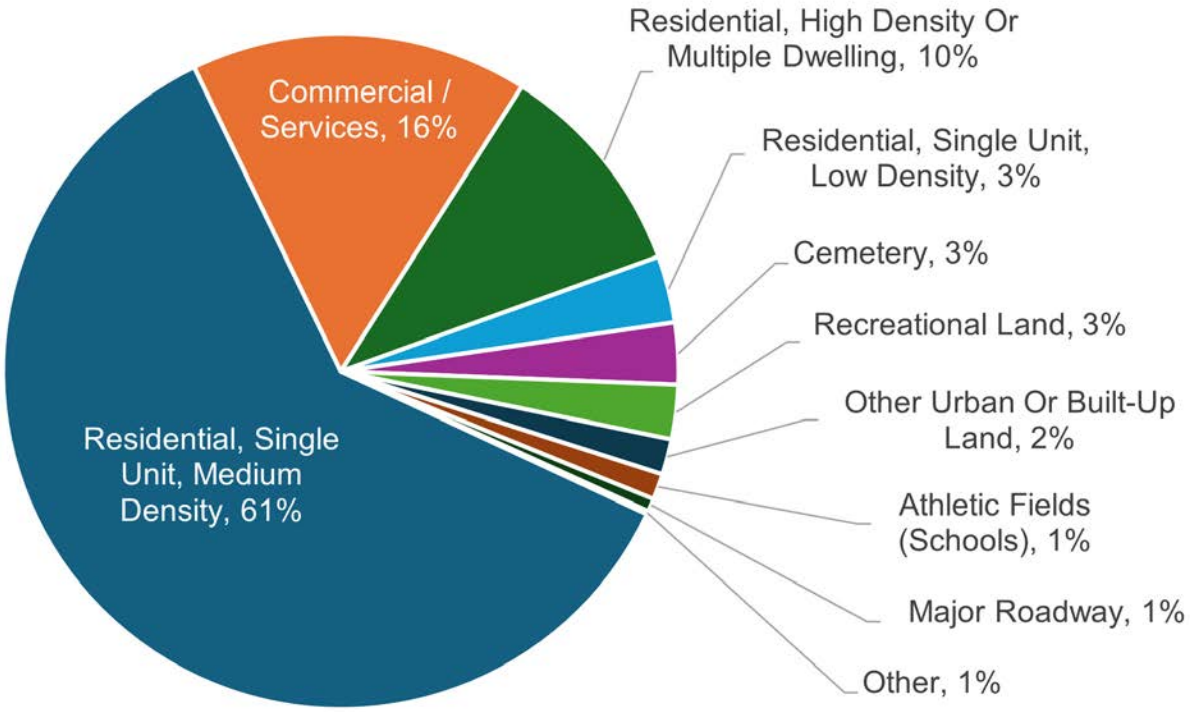


Table 6. Urban Land Use Sub-categories, Borough of Caldwell		
Residential, Single Unit, Medium Density	424.3	60.7%
Commercial / Services	112.6	16.1%
Residential, High Density Or Multiple Dwelling	72.9	10.4%
Residential, Single Unit, Low Density	22.3	3.2%
Cemetery	20.6	2.9%
Recreational Land	18.1	2.6%
Other Urban Or Built-Up Land	11.9	1.7%
Athletic Fields (Schools)	8.6	1.2%
Major Roadway	4.3	0.6%
Mixed Urban Or Built-Up Land	2.8	0.4%
Transportation/Communication/Utilities	0.8	0.1%
Stormwater Basin	0.2	<0.1%
Residential, Rural, Single Unit	<0.1	<0.1%
Source: NJDEP LULC Data 2020		

Land Use/Land Cover Change

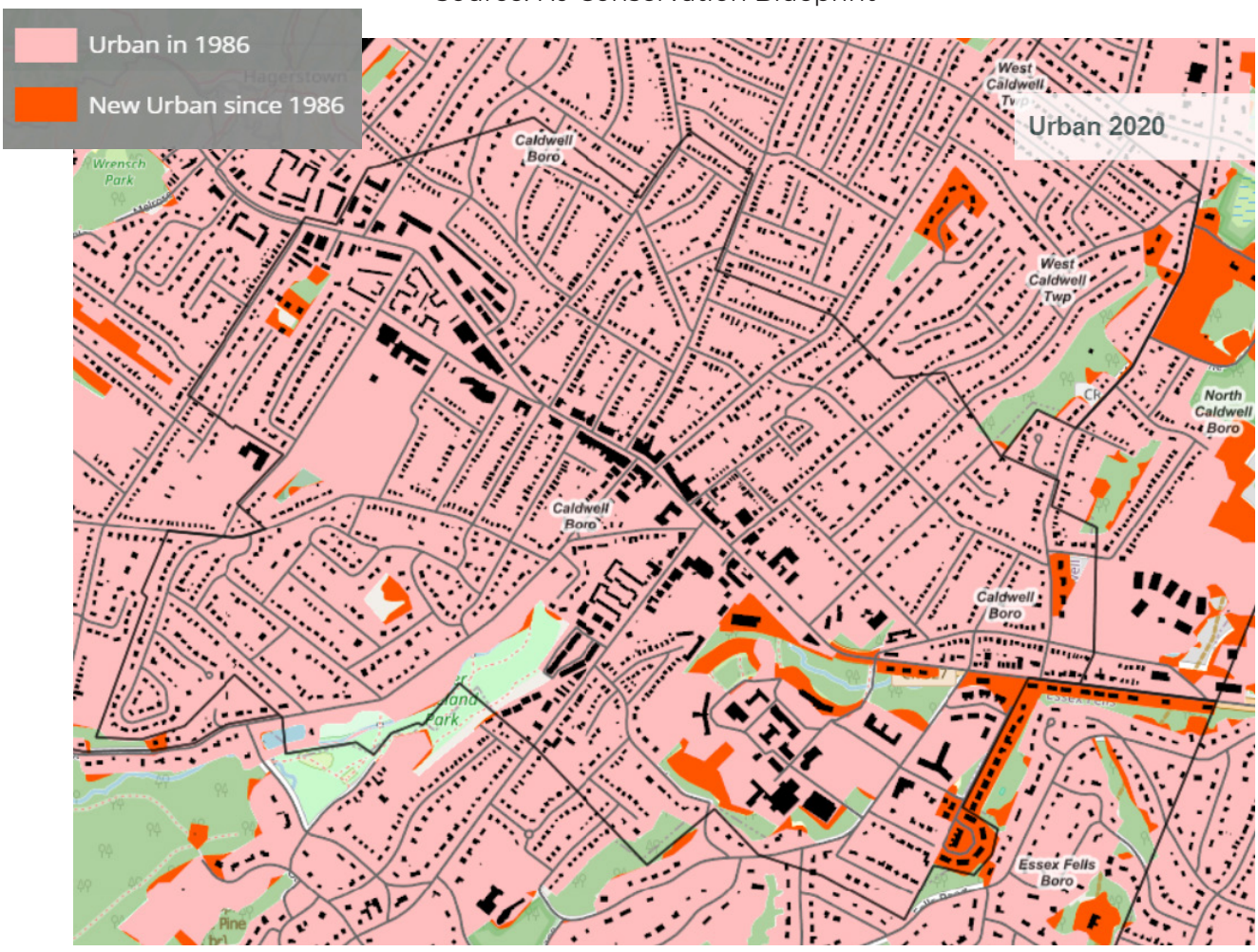
Land use/land cover data can be used to illustrate changes and trends in land use over time, quantifying development and other environmental changes. **Table 7** shows LU/LC data for the six primary land use categories in 1986 and 2020. Over the 34-year period, Caldwell's land use has remained relatively stable. There has been a slight drop in forest cover (6 acres) and a corresponding increase in urban land cover. **Figure 7** illustrates the growth in urban land use for this time period.

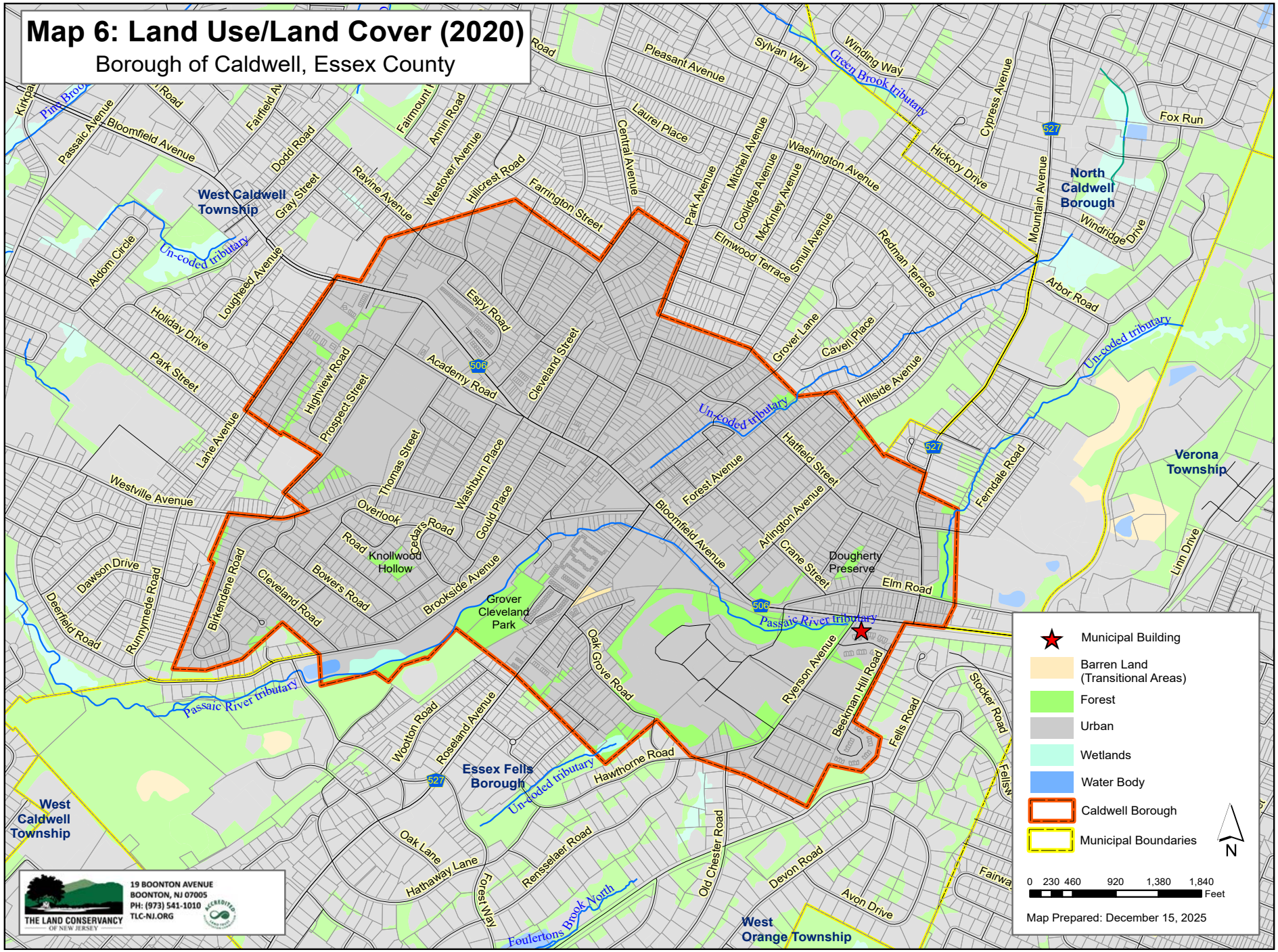
Table 7. Land Use Change Over Time, Caldwell, 1986 to 2020

	1986		2020	
LU/LC Category	**Acres**	**%**	**Acres**	**%**
Agriculture	0	0	0	0
Barren Land	0	0	0.82	0.11%
Forest	61.4	8.1%	54.07	7.1%
Urban	693.2	91.4%	699.4	92.3%
Water	0.55	0.07%	0.67	0.09%
Wetlands	2.85	0.37%	3.03	0.4%
		Total	**758**	**100%**
Source: USGS Land Use/Land Cover Data				

Figure 7. Urban Land Growth in Borough of Caldwell, 1986-2020

Source: NJ Conservation Blueprint[26]




Map 6: Land Use/Land Cover (2020)
Borough of Caldwell, Essex County
West Caldwell Township
North Caldwell Borough
Verona Township
Essex Fells Borough
West Caldwell Township
West Orange Township
Un-coded tributary
Passaic River tributary
Green Brook tributary
Foulertons Brook North
Municipal Building
Barren Land (Transitional Areas)
Forest
Urban
Wetlands
Water Body
Caldwell Borough
Municipal Boundaries
N
0 230 460 920 1,380 1,840
Feet
Map Prepared: December 15, 2025
THE LAND CONSERVANCY OF NEW JERSEY
19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973) 541-1010
TLC-NJ.ORG

NJDEP Modified Anderson System of Land Use Classification (2015)[27]

Urban or Built-up Land - The Level I Urban or Built-up Land category is characterized by intensive land use where the landscape has been altered by human activities. Although structures are usually present, this category is not restricted to traditional urban areas. Urban or Built-up Land Level II categories include Residential; Commercial and Service; Industrial; Transportation, Communication and Utilities; Industrial and Commercial Complexes; Mixed Urban or Built-up; Other Urban or Build-up and Recreational. Included with each of the above land uses are associated lands, buildings, parking lots, access roads, and other appurtenances, unless these are specifically excluded.Urban or Built-up Land takes precedence over other categories when the criteria for more than one category are met. For example, recreational areas that have enough tree cover to meet Forest category criteria are placed in the Recreational category.

Forestland - The Level I Forestland category contains any lands covered by woody vegetation other than wetlands. These areas are capable of producing timber and other wood products, and of supporting many kinds of outdoor recreation. Forestland is an important category environmentally, because it affects air quality, water quality, wildlife habitat, climate, and many other aspects of the ecology of an area. The Level II categories under Forestland are Deciduous; Coniferous; Mixed Deciduous-Coniferous; and Brushland.

Agricultural Land - The Level I Agricultural Land category includes all lands used primarily for the production of food and fiber and some of the structures associated with this production. These areas are easily distinguished from the other categories and represent a significant land use in New Jersey. The Level II categories of Agricultural Land are: Cropland and Pastureland; Orchards; Vineyards; Nurseries and Horticultural Areas; Confined Feeding Operations; and Other environmental concern because of the non-point source pollution associated with confined feeding operations.

Barren Land - Barren lands are characterized by thin soil, sand or rocks and a lack of vegetative cover in a non-urban setting. Vegetation, if present, is widely spaced. Barren land such as beaches and rock faces are found in nature but also result as a product of man's activities. Extraction mining operations, landfills and other disposal sites compose the majority of man-altered barren lands.

Water - All areas within the landmass of New Jersey periodically water covered are included in this category. All water bodies should be delineated as they exist at the time of data acquisition, except areas in an obvious state of flood. Level I includes four (4) Level II categories; Streams and Canals; Natural Lakes; Artificial Lakes; and Bays and Estuaries and Other Tidal Waters. Not included in this category are water treatment and sewage treatment facilities.

Wetlands - The wetlands are those areas that are inundated or saturated by surface or ground waters at a frequency and duration sufficient to support vegetation adapted for life in saturated soil conditions. Included in this category are naturally vegetated swamps, marshes, bogs and savannas which are normally associated with topographically low elevations but may be located at any elevation where water perches over an aquiclude. Wetlands that have been modified for recreation, agriculture, or industry will not be included here but described under the specific use category.



Pollinator Garden
Photographer: Warren Marchioni

Chapter 4.

Vegetation

Local Forests, Local Priorities

54 acres of deciduous forest cover 7% of the town's 1.2 square miles. Small sections of forest are found in Grover Cleveland Park, Knollwood Hollow, and Caldwell University. Among the remaining urban land are ample street trees and gardens, which mitigate surface temperatures and provide habitat for pollinators and other wildlife. The Borough has taken initiatives to protect its trees and to enhance the quality and quantity of vegetation in the urban landscape for its many benefits. These include the Caldwell Pollinator Pathways network, its Community Forestry Management Plan, and the Tree Protection Ordinance.

NJDEP Forest Classifications

Forests classified by the state using the NJDEP Modified Anderson System. The 54 acres of forest in Caldwell are classified as deciduous, composed of trees that lose their leaves at the end of the growing season and sprout new leaves in the spring. Deciduous forest mapping must have a stand of trees which average at least 20 feet in height and consist of at least 75% deciduous species (less than 25% coniferous) (**Table 8**).

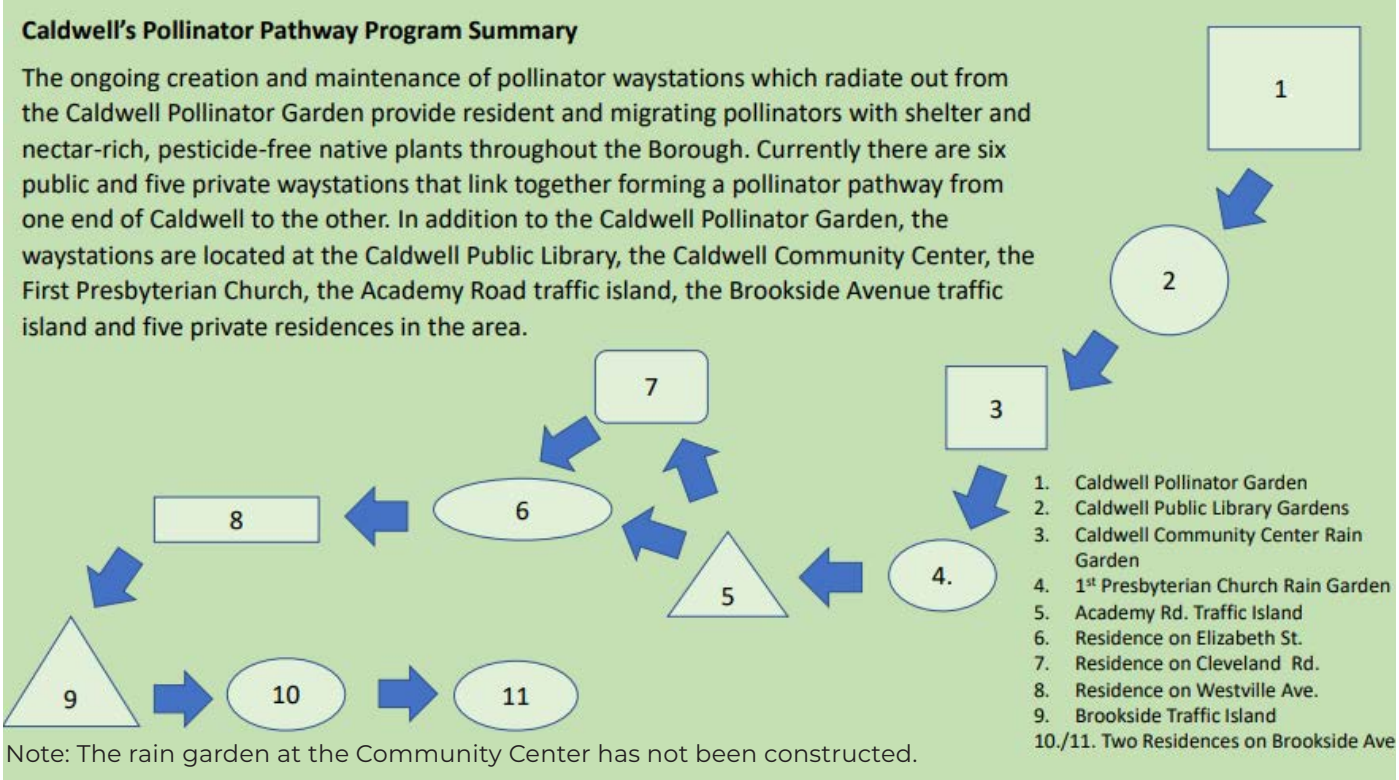
Crown closure refers to the percentage of forest area occupied by the vertical projections of tree crowns. Crown closure provides a reasonable estimate of stand density. 81% of the forest in Caldwell has greater than 50% crown closure, indicating that most forest is highly dense. The other 19% of deciduous forest has crown closure of 10-50%.

Pollinator Garden

The Caldwell Pollinator Garden was initially planned in 2015 when the Borough purchased property on Personette Street with the help of NJDEP Green Acres and the municipal Open Space Trust Fund. With the support of volunteers, grants, and private donations, the garden was designed and planted. Support came from surrounding businesses, the Passaic/Essex/Union Soil Conservation Service, schools, churches, and local community/civic organizations.

In the first year, the meadow was established using a seed mixture of native plants. The perimeter of the property was planted with native trees, including serviceberries, redbuds, a dogwood, and a paw paw tree. The middle of the property was planted with native meadow species. The outer gardens are planted with perennials best suited to the site conditions, chosen to bloom at different times of year to provide consistent food sources for pollinators.[28] The meadow requires very little maintenance; it is cut once per year in late fall.

The pollinator garden was carefully designed to withstand the challenges of the site: there is a black walnut tree,



Caldwell Pollinator Pathways Program

The Pollinator Pathway is a corridor of pesticide-free native plant gardens that provide nutrition and habitat for important pollinator species. The Caldwell Pollinator Garden is the central installation from which several "waystations" radiate, guiding pollinators from one end of the Borough to the other. The network is comprised of public and private gardens that vary in size and species variation. For information on the network and planting pollinator-friendly gardens, see the Borough website.





Informational sign and the walkway surrounding the pollinator garden.
Photos: Borough of Caldwell, Environmental Commission website

which requires plants that can tolerate juglone – a toxic biochemical that can harm susceptible plants up to 80 feet from the trunk; the soils are clayey and difficult to penetrate; there is nearly day-long sun exposure on much of the site; and deer are abundant in the area. Well-designed and maintained, the garden has been a great success in attracting pollinators and educating the public on the importance of planting with native species. The Caldwell Pollinator Garden is featured in the Native Plant Society's Garden Tour on YouTube. At the conclusion of this **Chapter** are two fact sheets on native and non-native species endemic to this region.

Community Forestry

The Borough's Community Forestry Management Plan (2018-2022) provided recommendations for improving the sustainability, safety, and quality of the local forest canopy, including both street trees and parkland. Supplementing this, in March 2020, Caldwell completed an inventory of its street trees. It found a total of 2,529 street trees of over 20 species, the most common being maples (40%), oaks (11%), cherry, plum and crabapple (10%).

The Community Forestry Plan highlighted several tree-related issues that required continued maintenance. These included a declining inventory of street trees and resulting loss in canopy coverage. This was caused by natural mortality and removals, aging oaks that demanded frequent pruning and monitoring, and the anticipated loss of ash trees due to the Emerald Ash Borer. It also noted conflicts from road reconstruction projects and issues with line clearance pruning that compromised tree health.

The plan proposed strategies such as increasing funding for tree planting and pruning, maintaining a no-net-loss policy, and applying for grants to support inventory updates and maintenance programs. It emphasized proactive management through annual hazard tree inspections, a 7–10 year pruning cycle, and replacement of removed trees. Additionally, it encouraged community engagement through Arbor Day programs, public education, and outreach via the Borough's website. The Environmental Commission implemented several of these recommendations through its tree planting and native tree programs.

The Borough's Tree Removal and Protection Ordinance states:

"...the preservation, maintenance, protection and planting of trees aids in the stabilization of soil by the prevention of erosion and sedimentation; reduces stormwater runoff and the potential damage it may create; aids in the removal of pollutants from the air and assists in the generation of oxygen; provides a buffer and screen against noise and pollution; provides protection against severe weather; aids in the control of drainage and restoration of denuded soil subsequent to construction or grading; provides a haven for birds and other wildlife and otherwise enhances the environment; protects and increases property values; preserves and enhances the Borough's physical and aesthetic appearance; and generally protects the public health and safety as well as the general welfare."

Tree Removal & Protection Ordinance

The Borough's tree ordinance calls for annual hazard tree inspections during the summer to identify dead, diseased, or structurally compromised trees. In addition, it requires a permit for removing any tree over six inches in diameter (or ornamental trees over three inches). Removal is permitted without mitigation for trees that are dead, diseased, hazardous, or located within approved construction footprints; all other cases require a mitigation plan to replace removed trees. The ordinance also mandates protective barriers for trees not being removed during construction and imposes fines up to $2,000 per tree for violations. For the full ordinance, see: § 227 Tree Removal and Protection

Forests as Carbon Storage

In addition to providing wildlife habitat, clean air, and shade, forests perform the service of removing carbon from the atmosphere. Carbon, released in molecules such as carbon dioxide (CO_2), is absorbed by trees and stored for long periods in its biomass (including live material such as leaves, bark, stems, branches, and roots; but also woody debris and other materials) and in soil.[29] This process is referred to as carbon sequestration. Even without intentional carbon-focused management, forests in the United States are estimated to offset about 10-15% of annual U.S. CO_2 emissions.[30]

The Nature Conservancy (TNC) provides estimates of current (2020) and future (2070) rates of carbon sequestration. The ability of forests to perform sequestration in the future will depend on management and land use change. Actual carbon sequestered may be higher or lower depending on management practices or the success of forest preservation efforts.[31]

Caldwell's forests, isolated within a highly developed region, exhibit relatively low ecological resilience, diversity, and connectivity. Collectively, Caldwell's forests store an estimated 4,860 metric tons (mt) of carbon, averaging about 90 mt per forested acre (**Figure 8**). The largest contiguous forested area is Grover Cleveland Park, which stores roughly 1,695 mt of carbon with 754 mt of this on the Caldwell side. Over the next 50 years (2020–2070), the forest is projected to sequester approximately 34 mt of carbon annually, totaling about 1,696 mt.

The Nature Conservancy emphasizes the importance of restoring and preserving forest, native trees and vegetation cover. In highly developed areas, carbon sequestration potential can be gained by increasing urban tree canopy cover and converting urban land into green space. These actions have other beneficial effects on nature and society, such as improving air quality and reducing the impact of severe heat, leading to improved physical and mental health.

Figure 8. Forest Carbon Stocks, Forests of Caldwell, 2020

Source: The Nature Conservancy Resilient Land Mapping Tool[32]

Highlighted area: Grover Cleveland Park



Native Vegetation



Leaves of a red oak tree
Photo: Andreas Rockstein/Flickr

Native plants species are those which have evolved over hundreds or thousands of years to be adapted to a particular region.[33] Over time, they have established complex relationships with other native species, including plants, insects, wildlife, fungi, and other organisms. Native plants play a key role in resilient, biodiverse ecosystems, serving as preferred food sources for native pollinator species like butterflies, birds, and insects.[34]

The predominant type of native forest in northern New Jersey is a mixed oak forest. These include red oak (*Quercus rubra*), chestnut oak (*Quercus montana*), and black oak (*Quercus velutina*), along with several species of beech, ask, hickory, and maple. Mature mixed oak trees form a canopy of 60 to 100 feet, supporting an understory of smaller trees up to 30 to 40 feet. Common understory species in the mixed oak forest include shrubs such as maple-leaved vibernum (*Vibernum acerifolium*), arrowwood (*Vibernum dentatum*), spicebush (*Lindera benzoin*), and pinxter flower (*Rhododendrum periclymenoides*). Common herbaceous species include wild sarsaparilla (*Aralia nudicaulis*), false Soloman's seal (*Maianthemum racemosum*), and Jack-in-the-Pulpit (*Arisaema triphyllum*).

Compared to most common horticultural plants, native species can thrive in their natural ecosystems once established, relying less on human inputs such as fertilizers.[35] As ecosystems—including flora, fauna, other living organisms—co-evolve, native plants provide appropriate food, shelter, and nesting sites for local wildlife. In areas that have been highly developed, native plants are a key tool for restoring environmental health. Aside from supporting local wildlife, native plants perform soil stabilization, rainwater infiltration and pollutant removal, thereby helping to reduce erosion and maintain clean water.



Leaves of a chestnut oak tree
Photo: Katja Schultz/Flickr

The Caldwell Environmental Commission promotes the use of native species in tree planting and replacement. The municipal website includes resources for choosing native plants and supporting healthy ecosystems.[36] The Commission has hosted native tree workshops and giveaways, offering native saplings to residents provided by the Great Swamp Watershed Association.[37]

Rutgers University offers guidance for incorporating native plants in residential landscapes, including planting lists.[38] The Native Plant Society of NJ also publishes lists of trees, shrubs, and vascular plants that are native to Essex County. For consideration in future planting projects, see the list online.

Invasive, Non-Native Plants

Invasive plant species are not native to a particular ecosystem and can exhibit aggressive growth patterns, causing harm to the environment and native populations.[39] They are introduced through intentional or accidental transport, and dispersed via human activity, wildlife, or other natural processes.[40] Once introduced, invasive species may establish and spread quickly in an ecosystem, lacking natural predators. By out-completing local species, invasives can dramatically reduce biodiversity and the integrity of ecosystems, impeding their natural functions.[41]

Initiatives to target invasive species in Essex County Parks have been underway for several years. The New Jersey Invasive Strike Team has been working with Essex County Parks to protect urban forests since 2017. Efforts have been made at the Hilltop Reservation in nearby Verona Township to remove invasive plant species. Targeted species include Oriental Photinia, Japanese Aralia, Siebold's Viburnum, and Lunden Viburnum, which threaten the health of forests due to their height (up to 20 feet) and ability to grow in shaded habitat.

Emerald Ash Borer (EAB) is an invasive wood-boring insect that has killed millions of ash trees in North America since its discovery in Michigan in 2002. The species was first detected in Essex County in 2016.[42] EAB affects all true ash species (*Fraxinus sp.*) as well as the white fringe tree (*Chionanthus virginicus*). The EAB lays its eggs among the bark, and juvenile larvae cause damage by feeding on the tree, interfering with its ability to circulate nutrients and water. EAB ultimately causes girdling to the trunk and branches, canopy loss, and dieback. Infested trees can die within 2-4 years if untreated. A guide to treatment options for the EAB is available from the NJDEP.[43]

Beech Leaf Disease (BLD) impacts trees in the beech genus, including the American beech (*Fagus grandiflora*) and ornamental beech varieties. The disease has spread through the Northeast over the last decade. BLD was first observed in Essex County in 2020.[44] The disease has come to be associated with a newly recognized subspecies of the nematode *Litylenchus crenatae mccanii*.[45] Symptoms include dark banding of leaves, visible throughout the lower canopy, and later leaves may become shrunken, crinkled, and thickened with a leathery texture. The effects of BLD can kill beech saplings in as little as 2-5 years and large trees within 6 years.

Spotted Lanternfly (SLF), *Lycorma delicatula*, was first discovered in the United States in Pennsylvania in 2014.[46] Since its arrival from Asia, it has spread throughout the mid-Atlantic states and beyond. While they are primarily attracted to the invasive tree-of-heaven (*Ailanthus altissima*), they feed on over 70 different host species.[47] They excrete large quantities of honeydew, a sugary substance that facilitates mold growth. Insect secretions and consumption of vegetation can cause severe damage to trees and plants where the insects gather.[48] SLF nymphs and adults are susceptible to insecticides, including less-toxic oils and soaps.[49] For dealing with smaller populations removing favored hosts like the tree-of-heaven (cultural control), removing and smashing eggs, and stomping nymphs and adults (mechanical control) are effective. For more severe cases, less-toxic insecticides like soaps and neem oils can be effective. The NJ Department of Agriculture has grant funds available to counties and municipalities to battle the SLF.[50]



Large Milkweed Bug (Oncopeltus fasciatus)
Photographer: Warren Marchioni

Chapter 5.

Wildlife

Backyard Wildlife

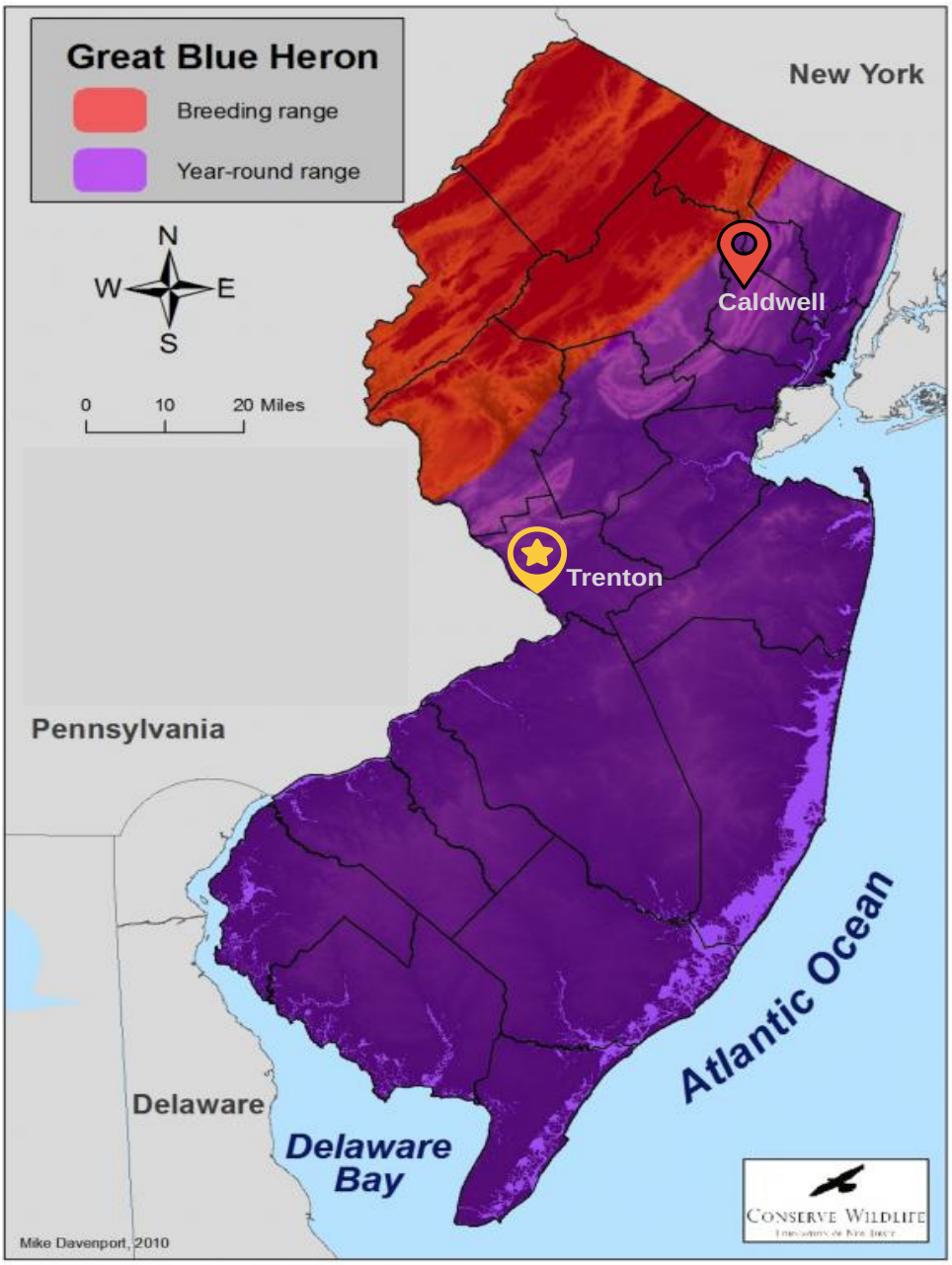
Caldwell supports a wide variety of backyard wildlife, much of which coexists comfortably with the town's neighborhoods. These animals often live in yards and public parks, especially those adjacent to Grover Cleveland Park and the Glen in Caldwell and neighboring Essex Fells. In fact, the majestic great blue heron, a species of special concern, has been spotted at the pond in Grover Cleveland Park.

It is not unusual for people to spot fox or deer wandering through the town and due to conflicts with people and property, these species are considered pests by many residents.

Threatened & Endangered Species

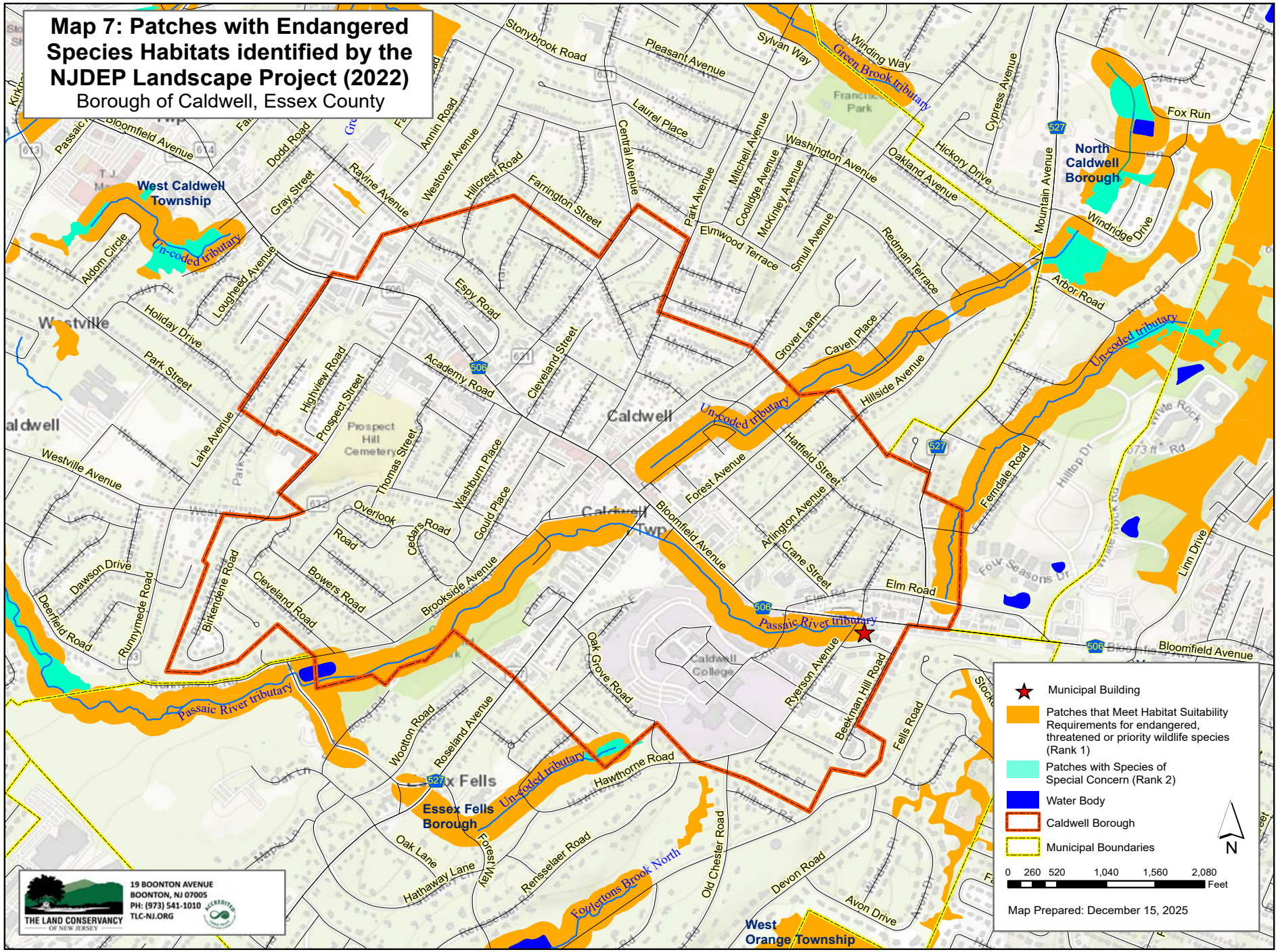
The NJDEP Natural Heritage Program tracks the location and status of rare, threatened, and endangered species. A search of the database for Caldwell finds the presence of the great blue heron (*Ardea herodias*), a species of special concern, within the municipality (**Map 7**). It is a Rank 2 species, threatened in the state due to their restricted range, limited populations, or vulnerability to endangerment. The great blue heron nests in upland and wetland habitats, but remains close to bodies of water. It commonly feeds in lakes, ponds, rivers, and marshes.[51] The heron maintains year-round nesting in Caldwell (**Figure 9**). In the photo on the following page**,** a great blue heron stands on the banks of pond at Grover Cleveland Park. With the pond and surrounding wetlands, the park provides an ideal habitat for the herons.

Figure 9. Great Blue Heron Range in New Jersey
Source: Conserve Wildlife Foundation of New Jersey





Great Blue Heron (*Ardea herodias*)
Photo: Warren Marchioni


Map 7: Patches with Endangered Species Habitats identified by the NJDEP Landscape Project (2022)
Borough of Caldwell, Essex County
West Caldwell Township
North Caldwell Borough
Caldwell
Caldwell Twp
Essex Fells
Essex Fells Borough
West Orange Township
Westville
Prospect Hill Cemetery
Caldwell College
Francis A. Byrne Park
Green Brook tributary
Passaic River tributary
Un-coded tributary
Foulgertons Brook North
Stonybrook Road
Pleasant Avenue
Sylvan Way
Winding Way
Laurel Place
Central Avenue
Mitchell Avenue
Coolidge Avenue
McKinley Avenue
Park Avenue
Washington Avenue
Oakland Avenue
Hickory Drive
Cypress Avenue
Mountain Avenue
Fox Run
Windridge Drive
Arbor Road
Elmwood Terrace
Smull Avenue
Redman Terrace
Grover Lane
Cavell Place
Hillside Avenue
Ferndale Road
Linn Drive
Bloomfield Avenue
Passaic Avenue
Dodd Road
Annin Road
Westover Avenue
Hillcrest Road
Farrington Street
Ravine Avenue
Gray Street
Aldom Circle
Lougheed Avenue
Holiday Drive
Park Street
Lane Avenue
Westville Avenue
Highview Road
Prospect Street
Thomas Street
Academy Road
Espy Road
Cleveland Street
Washburn Place
Gould Place
Overlook Road
Cedars Road
Bowers Road
Cleveland Road
Birkendene Road
Dawson Drive
Deerfield Road
Runnymede Road
Brookside Avenue
Forest Avenue
Hatfield Street
Arlington Avenue
Crane Street
Elm Road
Oak Grove Road
Ryerson Avenue
Beekman Hill Road
Fells Road
Woolton Road
Roseland Avenue
Hawthorne Road
Oak Lane
Hathaway Lane
Forestview
Rensselaer Road
Old Chester Road
Devon Road
Avon Drive
Municipal Building
Patches that Meet Habitat Suitability Requirements for endangered, threatened or priority wildlife species (Rank 1)
Patches with Species of Special Concern (Rank 2)
Water Body
Caldwell Borough
Municipal Boundaries
N
0 260 520 1,040 1,560 2,080
Feet
Map Prepared: December 15, 2025
THE LAND CONSERVANCY OF NEW JERSEY
19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973) 541-1010
TLC-NJ.ORG

Critical Habitat for Threatened & Endangered Species

New Jersey's list of endangered, threatened, and special concern wildlife species is maintained by NJDEP Fish & Wildlife's Endangered and Nongame Species Program. The program defines them as follows:

- **Endangered species** are those "whose prospects for survival in are in immediate danger because of a loss or change in habitat, over-exploitation, predation, competition, disease, disturbance of contamination."[68]
- **Threatened species** are those at risk of reaching endangered status if habitat conditions begin or continue to deteriorate.
- **Species of special concern** warrant attention due to evidence of decline or vulnerability, possibly due to habitat modification, or due to unknown population status in the state.

The NJDEP Landscape Project (V3.3) ranks patches of land using a numeric system to identify habitat that is suitable for threatened and endangered species.[69] These are given a ranking from zero to five based on the occurrence of specific wildlife species and the presence of suitable habitat for their populations, where five is the most environmentally sensitive:

- **Rank 5:** Species-specific patches containing one or more occurrences of wildlife listed as endangered and threatened in Federal Endangered Species Act of 1973.
- **Rank 4:** Species-specific patches with one or more occurrences of state endangered species.
- **Rank 3:** Species-specific patches containing one or more occurrences of state threatened species.
- **Rank 2:** Species-specific patches containing one or more occurrences of species of special concern.
- **Rank 1:** Species-specific patches that meet habitat-specific suitability requirements such as minimum size criteria for endangered, threatened, or priority wildlife species, but do not intersect with confirmed occurrences of such species.
- **Rank 0:** Species-specific patches that do not contain any species occurrences and do not meet any habitat-specific suitability requirements.

Common Wildlife

The Borough of Caldwell is home to a variety of common wildlife species that thrive in diverse habitats within the developed landscape. Red foxes live in close proximity to homes and parks, especially adjacent to Grover Cleveland Park and the deciduous forest that becomes the Glen at the border with Essex Fells. While foxes may become accustomed to human activity, they are rarely aggressive and pose little to no threat to people.[52]

The ruby-crowned kinglet exhibits distinct seasonal habitat preferences. During the summer, it primarily inhabits coniferous forests where it breeds. In winter, it shifts to a broader range of environments, favoring open deciduous woodlands but also coniferous and mixed forests and streamside thickets. Caldwell falls within the ruby-crowned kinglet's typical winter range. This migratory bird finds ideal habitat in the deciduous wetlands and forest found south of Caldwell University, which extend into the Glen.[53]

Wild turkeys are highly adaptable birds that thrive in a variety of habitats, including open fields, woodlands, and even residential neighborhoods. Although they are capable of flight, they typically move about by walking or running. At night, they roost in trees or, occasionally, on buildings.[54] In Caldwell, wild turkeys are seen in open areas such as the meadows of Grover Cleveland Park, or, as shown in the photo of the Wild turkey (*Meleagris gallopavo*), wandering through residential yards. Like other commonly seen species, the wild turkey also inhabits deciduous forests, making the wooded area south of Caldwell University, near Park Lane, a potential habitat.

Some typical wildlife sightings in Caldwell...



Red Fox (*Vulpes vulpes*)



Ruby-crowned kinglet (*Regulus calendula)*



Wild Turkey (*Meleagris gallopavo*)
Wildlife photos: Warren Marchioni

White-Tailed Deer

The white-tailed deer is a common species in Caldwell and the rest of New Jersey whose overabundant population has negative impacts on forests, wildlife, and human communities. The Essex County Parks System, in line with its mission of responsible land stewardship and resource protection, maintains a deer management program to reduce negative impacts of overabundant deer populations in the County.[55] Studies have shown that a healthy deer population is approximately 10-20 animals per square mile.[56] This is the level that allows for the forest understory to recover from deer browsing and regenerating, while continuing to support other wildlife. In areas supporting high deer population density, the forest ecosystem can be highly degraded. Effects of overbrowing include the local disappearance of native species, minimal tree regeneration, and loss of forest structure through browsing of shrubs.[57]

These impacts threaten birds and other wildlife that rely on the understory for foraging and nesting. By consuming vegetation in large amounts, deer create a physical disturbance in the ecosystem that facilitates the entry and establishment of invasive plant species. These plants are typically unfavorable to the diet of deer, allowing them to thrive.[58]

Deer overpopulation also poses problems for human communities. As forest habitat decreases, deer encroach further into developed areas in search of alternative food sources, which may come from residential landscapes. The increased presence of deer in urban and suburban areas can pose a public safety hazard, with higher risk of deer-vehicle collision.[59]

Essex County Parks supports actions to control the population of white-tailed deer and to support the growth of healthy native forests.

Several strategies to control deer populations and restore healthy forests have been implemented in the last decade. At least 47 deer fencing exclosures have been installed between Eagle Rock and South Mountain Reservations to facilitate forest restoration.[60] Deer fencing is designed to keep out deer and large mammals, while allowing smaller wildlife to travel freely. Within the exclosures, replanting programs have been underway to reestablish native plant communities, using grants from Green Acres and the Essex County Recreation and Open Space Trust Fund. The South Mountain Conservancy has created several successful regeneration sites through the use of deer exclosure fencing.

Beyond the enclosures, Essex County has supported an annual cull in its reservations to keep the deer population at a sustainable level.[61] This year marks the 16th time Essex County has held the deer hunt. Since 2008, over 3,000 have been removed.[62]

The Essex County Environmental Center, operated by the County Parks Department, maintains a Native Plant Forest Garden in West Essex Park. to demonstrate the biodiversity of a native forest understory without the impacts of heavy deer browsing.[63]

Vernal Habitat

Vernal pools are confined wetland depressions that fill with water for at least two consecutive months, usually in the fall rainy season, and later become completely dry, making them unable to sustain fish species.[64] Without predatory fish that would eat larvae, vernal habitat is crucial for some amphibian species to reproduce and thrive. They are also inhabited by reptiles, insects, wetland plants, and other wildlife.

There are over twenty species of amphibians in New Jersey that use vernal pools for breeding, including seven "obligate vernal poor breeders" whose survival is dependent upon them.[65]

Vernal habitat can take different forms, for example: isolated depressions in upland forests, seasonally flooded meadows, floodplain swamps, or abandoned gravel pits.[66] Vernal pools in New Jersey tend to be found in rural areas of the Skylands, Piedmont, and Coastal Plain regions.

The NJDEP initiated the Vernal Pool Survey Project in 2000 to identify, monitor, and protect vernal habitat in the state. New Jersey's Freshwater Wetlands Protection Act Rules (N.J.A.C. 7:7A-1.4)[67] defines vernal habitat as a wetland that meets all of the following criteria:

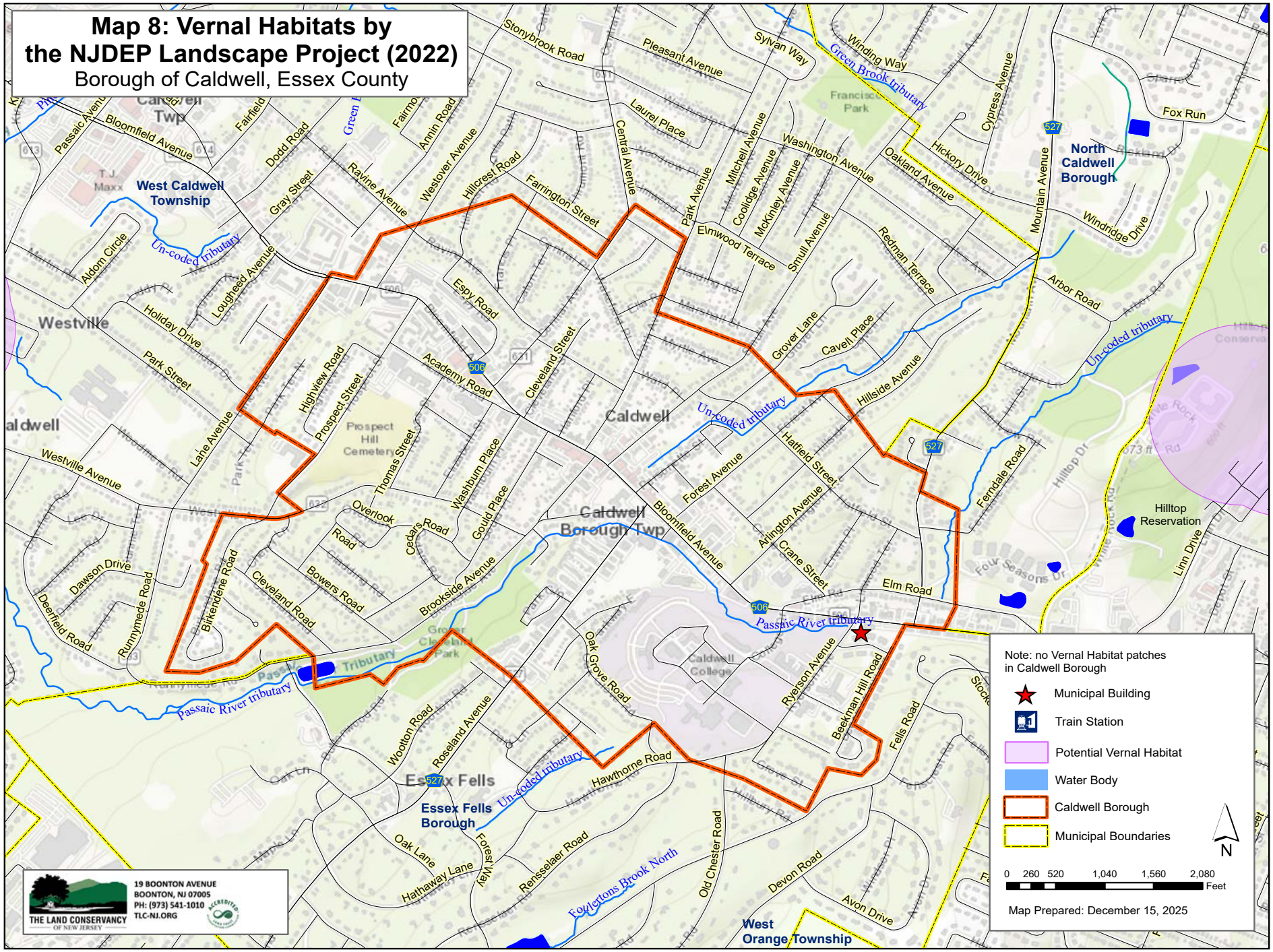
- Must consist of or contain a confined basin or depression without a permanently flowing outlet.
- Must feature evidence of breeding by at least one facultative vernal habitat species (identified in N.J.A.C. 7:7A.)
- Must contain ponded water for at least two continuous months between March and September of a normal rainfall year.
- Must remain free of fish populations throughout the year, or dry up for some time in a normal rainfall year.

The NJDEP's Landscape Project maps vernal habitats as either potential or certified:

- Potential vernal habitats meet physical criteria but lack confirmed biological data or have not yet been field-verified.
- Certified vernal habitats meet both physical and biological criteria and have been verified by NJDEP staff.

These habitats are protected as wetlands, requiring a 50-foot buffer zone—or a 150-foot buffer if they support a state-listed threatened or endangered species.

Map 8 shows the locations of potential vernal habitat within Caldwell using circles of a 300 meter (m) radius. Potential habitat is found in neighboring Hilltop Reservation in Verona Township.


Map 8: Vernal Habitats by the NJDEP Landscape Project (2022)
Borough of Caldwell, Essex County
Note: no Vernal Habitat patches in Caldwell Borough
Municipal Building
Train Station
Potential Vernal Habitat
Water Body
Caldwell Borough
Municipal Boundaries
N
0 260 520 1,040 1,560 2,080
Feet
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West Caldwell Township
North Caldwell Borough
Caldwell
Caldwell Borough Twp
Westville
Essex Fells
Essex Fells Borough
West Orange Township
Passaic River tributary
Un-coded tributary
Green Brook tributary
Foulgertons Brook North
Hilltop Reservation
Caldwell College
Prospect Hill Cemetery
Grover Cleveland Park
Stonybrook Road
Pleasant Avenue
Sylvan Way
Winding Way
Fox Run
Cypress Avenue
Hickory Drive
Mountain Avenue
Windridge Drive
Arbor Road
Laurel Place
Central Avenue
Park Avenue
Mitchell Avenue
Coolidge Avenue
McKinley Avenue
Washington Avenue
Oakland Avenue
Elmwood Terrace
Smull Avenue
Redman Terrace
Grover Lane
Cavell Place
Hillside Avenue
Ferndale Road
Linn Drive
Hilltop Dr
Four Seasons Dr
Fairfield
Dodd Road
Gray Street
Ravine Avenue
Westover Avenue
Annin Road
Hillcrest Road
Farrington Street
Espy Road
Academy Road
Cleveland Street
Aldom Circle
Loughreed Avenue
Holiday Drive
Park Street
Lane Avenue
Highview Road
Prospect Street
Thomas Street
Washburn Place
Gould Place
Overlook Road
Cedars Road
Brookside Avenue
Bowers Road
Cleveland Road
Birkendene Road
Dawson Drive
Deerfield Road
Runnymede Road
Westville Avenue
Hatfield Street
Forest Avenue
Arlington Avenue
Crane Street
Bloomfield Avenue
Elm Road
Ryerson Avenue
Beekman Hill Road
Fells Road
Oak Grove Road
Hawthorne Road
Roseland Avenue
Wootton Road
Oak Lane
Hathaway Lane
Forest Way
Rensselaer Road
Old Chester Road
Devon Road
Avon Drive
Passaic Avenue
Bloomfield Avenue
T.J. Maxx



Pollinator Garden
Photo: The Land Conservancy

Chapter 6.

Hydrology

From the Upper to the Lower Passaic River

Caldwell is uniquely situated within two watersheds: the Upper Passaic River, which drains 83% of the Borough, and the Lower Passaic River, which captures runoff from the northwest corner. Three tributaries of the Passaic River flow through Caldwell. Pine Brook has two branches: the Essex Fells Branch and the Caldwell Branch. A third tributary originates in North Caldwell, crosses into the Borough west of Forest Avenue.

These waterways support important wetland and riparian habitats within the municipality.

Watersheds

Caldwell is split into two Watershed Management Areas each containing two sub-watersheds (**Table 8**).[70] A watershed is a topographic area within which surface water runoff drains into a specific point on a stream or another body of water.[71] The NJDEP delineates New Jersey into Watershed Management Areas (WMAs), each encompassing a particular group of major rivers. Watersheds are mapped and identified by the US Geological Survey (USGS) using a hierarchical numbering system, assigning a hydrological unit code (HUC) to each watershed and sub-watershed in the county.

As a geographic unit, watersheds define areas based on hydrological characteristics. They are useful for understanding the quantity and quality of water in an area, creating aggregate

data measured from points along a stream. The watershed framework has been adapted as an approach for management of water resources in New Jersey and beyond.[72]

The methods of this approach are three-fold: defining geographic boundaries of watersheds, basing water policy on scientific principles, and developing public partnerships to involve people in the management of their watersheds. Further advancing this approach, the NJDEP created the Watershed and Land Management Program in 2020 to integrate elements of the Land Use Management and Water Resource Management programs.[73]

The Borough's HUC sub-watershed divisions are shown in **Map 9**. The two WMAs are:

- Lower Passaic and Saddle Watershed Management Area (WMA 4). This includes the Lower Passaic River (from the Pompton River confluence downstream to the Newark Bay) and its tributaries, including the Saddle River. It covers 129 square miles of urban/suburban land across Passaic, Essex, Hudson, Morris, and Bergen Counties.
- Upper Passaic, Whippany, and Rockaway Watershed Management Area (WMA 6) represents the area drained by waters from the upper reaches of the Passaic River Basin, including the Passaic River from its headwaters in Morris County, to the confluence of the Pompton River. The Upper Passaic River is a significant source of drinking water for much of northeastern New Jersey.

Surface Water

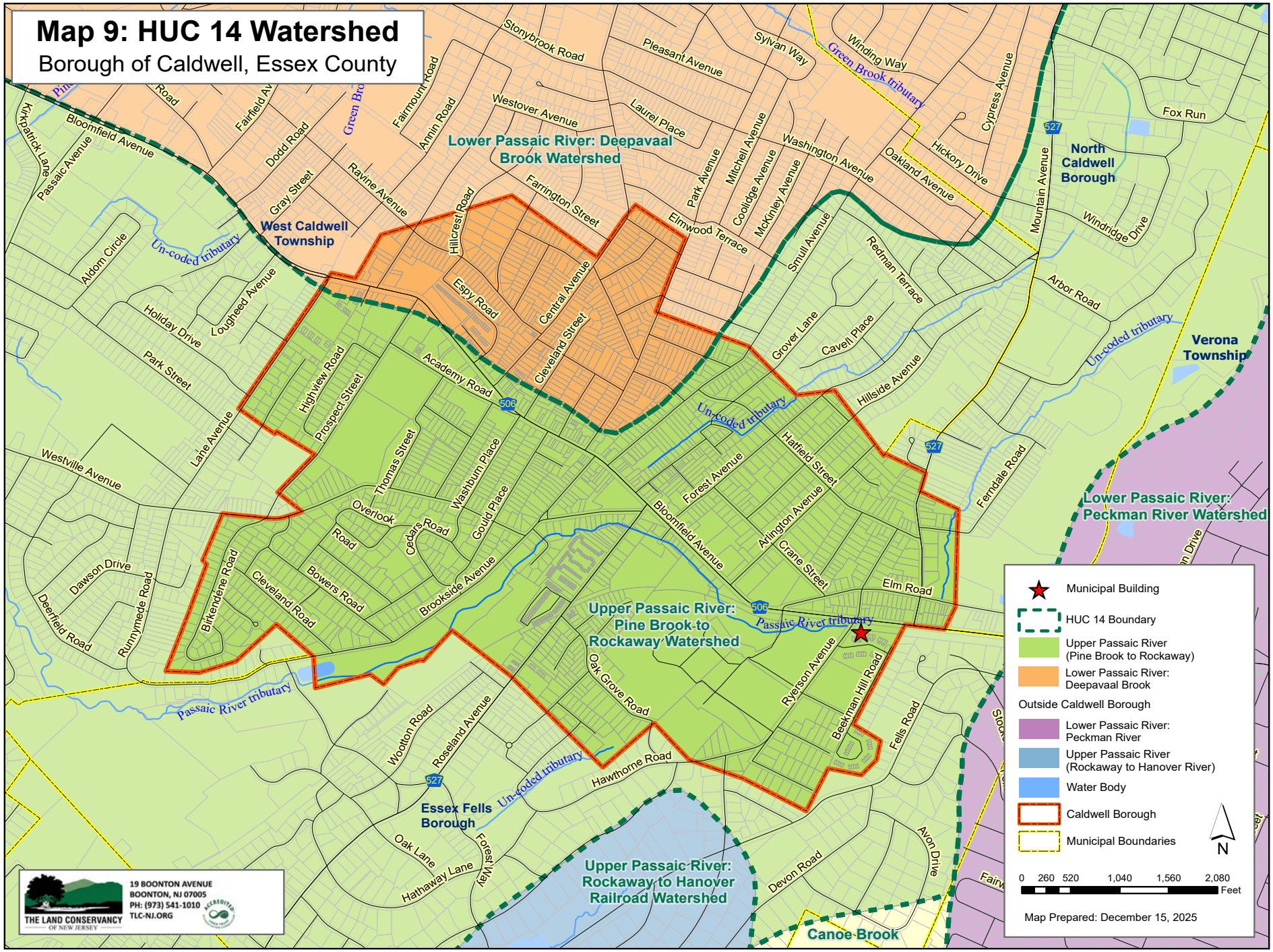
Surface water found in lakes, ponds, rivers, and streams performs essential services for aquatic ecosystems as well as humans. It serves as habitat for diverse plant and animal life and regulates water quality, used for drinking water, irrigation, wastewater treatment, industrial and recreational uses.[74] In Caldwell, there are three water bodies (**Map 10**):

- Grover Cleveland Pond, which straddles Caldwell and Essex Fells and drains into the Essex Fells branch of the Pine Brook.
- Pine Brook, which is a tributary of the Passaic River. The Caldwell branch of the Pine Brook initially enters the Borough in Grover Cleveland Park and continues to run parallel to Bloomfield

Table 8. HUC14 Watersheds in Caldwell

WMA	Watershed Name	Sub-Watershed Name	Acres	% Total
04 - Lower Passaic and Saddle	Passaic River Lower (Saddle to Pompton)	Deepavaal Brook	130	17%
06 - Upper Passaic, Whippany, and Rockaway	Passaic River Upper (above Pine Brook bridge)	Passaic River Upper (Pine Brook Bridge to Rockaway)	628	83%
		Total	**758.0**	**100%**

Source: NJDEP HUC14 Watershed Tabular Data


Map 9: HUC 14 Watershed
Borough of Caldwell, Essex County
Lower Passaic River: Deepavaal Brook Watershed
Upper Passaic River: Pine Brook to Rockaway Watershed
Upper Passaic River: Rockaway to Hanover Railroad Watershed
Lower Passaic River: Peckman River Watershed
West Caldwell Township
North Caldwell Borough
Verona Township
Essex Fells Borough
Canoe Brook
Un-coded tributary
Passaic River tributary
Green Brook tributary
Municipal Building
HUC 14 Boundary
Upper Passaic River (Pine Brook to Rockaway)
Lower Passaic River: Deepavaal Brook
Outside Caldwell Borough
Lower Passaic River: Peckman River
Upper Passaic River (Rockaway to Hanover River)
Water Body
Caldwell Borough
Municipal Boundaries
N
0 260 520 1,040 1,560 2,080
Feet
Map Prepared: December 15, 2025
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Avenue and the old Morristown & Erie Railroad bed, eventually ending at a dam east of Runnymede Road.

• Unnamed tributary of the Passaic River also referred to as the "northeast tributary". The northeast tributary begins in North Caldwell and crosses into the Borough west of Forest Avenue. It parallels Forest Avenue, flows under Hatfield Street and Grover Lane, and eventually runs parallel to the western side of Personette Street. After Personette Street it enters a culvert that directs the stream under Bloomfield Avenue and to the West Avenue/Brookside Avenue intersection (this is not pictured on the map because it does not appear as surface water).

The New Jersey Surface Water Quality Standards (SWQS), N.J.A.C. 7:9, classify streams based on their functions and establish quality criteria for monitoring surface waters. SWQS are the basis for legislation to protect water quality in the state, including general, technical, anti-degradation, nutrient, and mixing zone policies. Surface waters are categorized according to the type and quality of water body and its designated use.

Fresh Water 1 (FW1) is the highest classification, reserved for surface waters distinguished by unique ecological significance, recreational value, or aesthetic quality. They are not subject to any man-made wastewater discharges.[75]

Fresh Water 2 (FW2) waters are all other freshwaters types except for Pinelands waters. FW2 are further classified based on their ability to support trout production (FW2-TP) and maintenance (FW2-TM), or as non-trout waters (FW2-NT).[76] All of the surface waters in Caldwell are FW2-NT (**Table 9**).

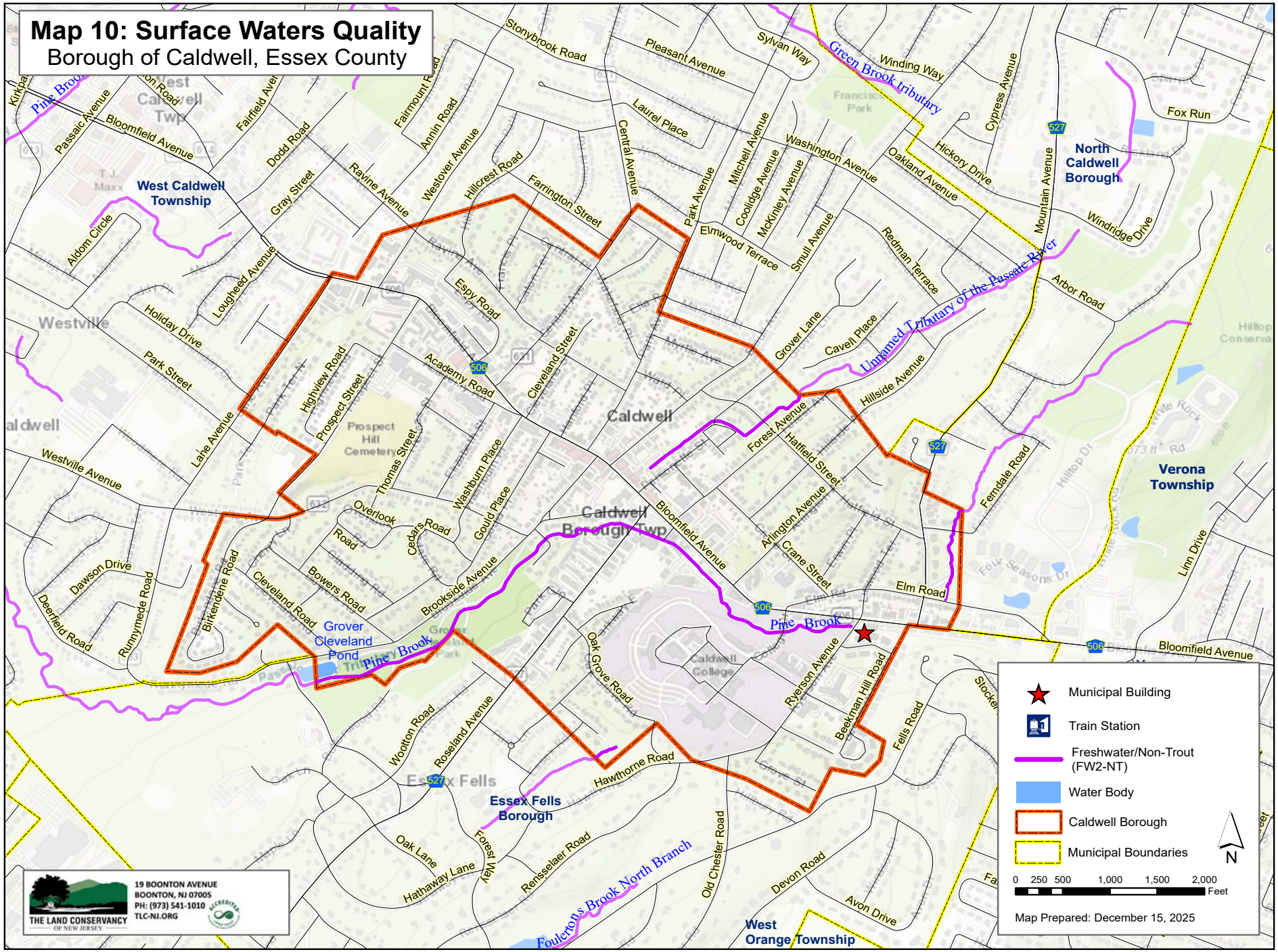
Category 1 Waters (C1) are further protected for exceptional ecological significance. Anti-degradation policies are set forth in N.J.A.C. 7:9B-1.5(d) to protect surface waters from measurable changes in quality characteristics related to clarity, color, scenic setting, other characteristics of aesthetic, ecological, or recreational value, exceptional water supply or fisheries resources. There are no C1 waters in Caldwell.

In 2020, the NJDEP Division of Water Monitoring amended the SWQS (N.J.A.C. 7:9B) to designate an additional 600 miles of rivers and streams as C1 waterways. This rule widened the riparian zone around newly listed C1 waters.

Table 9. Surface Water Streams in Caldwell

Class.	Stream	Miles	% Total
FW2-NT	Pine Brook (6,966 feet)	1.3	67.9%
	Northeast Tributary (3,299 feet)	0.6	32.1%
	Surface Water Total:	**1.9**	**100%**

UNT = Unnamed tributary
Source: NJDEP Surface Water Data


Map 10: Surface Waters Quality
Borough of Caldwell, Essex County
West Caldwell Township
North Caldwell Borough
Verona Township
Caldwell
Caldwell Boroughn Twp
Essex Fells Borough
West Orange Township
Westville
Prospect Hill Cemetery
Caldwell College
Grover Cleveland Pond
Pine Brook
Green Brook tributary
Unnamed Tributary of the Passaic River
Foulertons Brook North Branch
Municipal Building
Train Station
Freshwater/Non-Trout (FW2-NT)
Water Body
Caldwell Borough
Municipal Boundaries
N
0 250 500 1,000 1,500 2,000 Feet
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Surface Water Quality Factors

Pollution

Surface water quality can be affected by pollution - including point sources and non-point sources - air deposition, erosion and sedimentation, and the presence of invasive species. Point sources of pollution are any discernible, confined, and discrete point from which pollutants may be discharged.[77] This includes discharges from sewage treatment plants and factories, stormwater runoff, illegal dumping, malfunctioning underground storage tanks and septic tanks. Non-point source pollution can come from many different sources. As rainfall or snow melt moves over and through the ground, it carries natural and human-made pollutants (such as fertilizers, herbicides, and motor oil) and deposits them into surface and groundwater. The effects of pollutants on specific waterways can vary, but pollution creates overall negative outcomes for drinking water supplies, recreation, fisheries, and wildlife.

Eutrophication

One effect of runoff is known as eutrophication, which refers to the addition of substances, either human-made or natural, to a freshwater body that affect its primary productivity. The introduction of excess nutrients, such as nitrates and phosphates found in fertilizers, promote large-scale growth of cyanobacteria. Though sometimes called “algal blooms,” this phenomenon does not involve true algae, but harmful bacteria that resemble it.

Harmful algal blooms (HAB) cause surface water to become cloudy and discolored, which prevents light penetration and inhibits the growth of aquatic plants.[78]When cyanobacteria die, excess nutrient availability from decomposition can cause depleted levels of dissolved oxygen (hypoxia or anoxia), threatening life in the water.[79] Human exposure to cyanobacteria cells can cause a range of health effects, including allergy-like reactions, respiratory and gastrointestinal irritation. Ingestion can cause more serious health effects, especially in children and pets. Recreational lakes and other water bodies are monitored for algal blooms and restricted accordingly.

NJDEP maintains a dashboard to monitor algal blooms across the state. See the HAB Alert Dashboard for more information.

Sedimentation

Water quality can also be impacted by sedimentation, or the transportation and deposition of eroded materials.[80] A primary cause of sedimentation is land development near streams and on steep slopes that reduce vegetative cover and results in exposed soil. The vegetative cover can typically absorb the impact of raindrops, but when it is removed the exposed soil can easily be eroded. Eroded soil can then be transported to surface waters, where it contaminates and increases the turbidity of the water, blocking sunlight to plant species and damaging the health of the aquatic ecosystem.

Local Surface Water Quality

As a densely populated and developed state, New Jersey has long faced issues with water quality. Areas of the state with unimpaired waters tend to be those that are less inhabited and undeveloped, where riparian zones and stream buffers fully intact. Much of Essex County is highly urbanized, containing historic industrial

centers such as Newark, Paterson, Clifton, and East Orange. Past and present contamination problems, regular sources of point and non-point pollution, and hazardous waste sites affect the health of these watersheds.[81]

The NJ Integrated Water Quality Assessment Report for 2022 focuses on the Northeast Water Region, which includes the watersheds of Caldwell. The water quality trend analysis in the report indicates that overall water quality has improved since the 1970s, particularly in regard to total nitrogen and phosphorus content. However, there has been an upward trend in the level of nitrates in the Passaic and Saddle Rivers. These watersheds are expected to have higher nitrate levels due to significant NJPDES discharges to surface waters from major wastewater treatment plants. As treatment plants implement measures to reduce ammonia through oxidization, they inadvertently raise nitrate concentrations. Ammonia is considered to be much more detrimental for its toxicity to aquatic life. See the following section for more information on NJPDES discharges.

In the last decades, the Northeast Water Region has seen the most significant improvements in the levels of ammonia and metals in surface water. In 1998, there were 208 metals and toxics at levels of impairment; in 2022, only 75 remain. This change is the result of implementing discharge limits for point source pollution (water and air), remediation of contaminated sites, and the closing of industrial manufacturing sites.

Surface Water Discharge

The NJDEP Division of Water Quality regulates wastewater discharges through the NJ Discharge Elimination System (NJPDES) permitting program. This ensures the proper treatment and discharge of wastewater (and its residuals) and stormwater from various types of facilities and activities.[82] Surface water discharge locations are classed as major or minor, where major sources see flows of 50 million gallons per day (mgd). There is one surface water discharge point within the Borough of Caldwell (highlighted in **Figure 10**), which conducts "minor" flows of less than 50 mgd. This discharge point is located near Ron's Auto Shop Service along Bloomfield Avenue, close to the border with West Caldwell. The receiving water for this discharge is Pine Brook via the storm sewer. Additional discharge points are located in nearby municipalities, including major outfalls in both West Caldwell and Verona.

Outfalls

Outfalls are structures that transfer water during storm events into a subsurface drainage system and/or stormwater basin.[83] The proper construction of outfalls ensures stability of drainage systems and minimizes erosion at the point of discharge. According to NJDEP data, there are two outfalls within the limits of Caldwell (**Figure 11**). They are adjacent to each other and owned by the Borough of North Caldwell.

Aquifer Recharge

An aquifer is an underground formation of permeable rock or unconsolidated materials that can yield significant quantities of water to wells or springs. Aquifer recharge refers to natural or human-controlled process by which water is conveyed underground, replenishing the groundwater stored in aquifers.[84] The rate of recharge is not the same for all aquifers, and that must be considered when pumping well water. Pumping too much water too quickly draws down

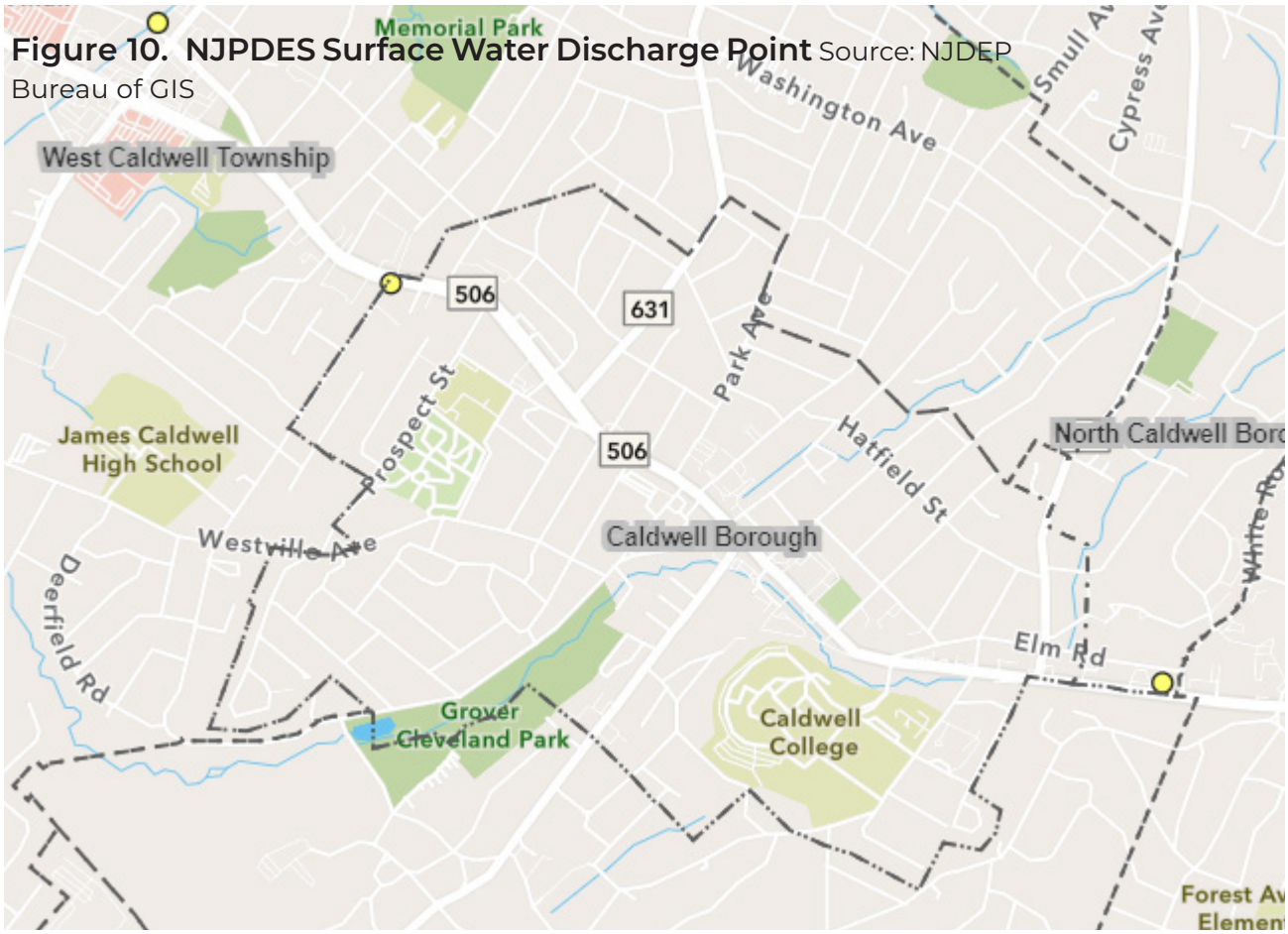


Figure 10. NJPDES Surface Water Discharge Point Source: NJDEP Bureau of GIS

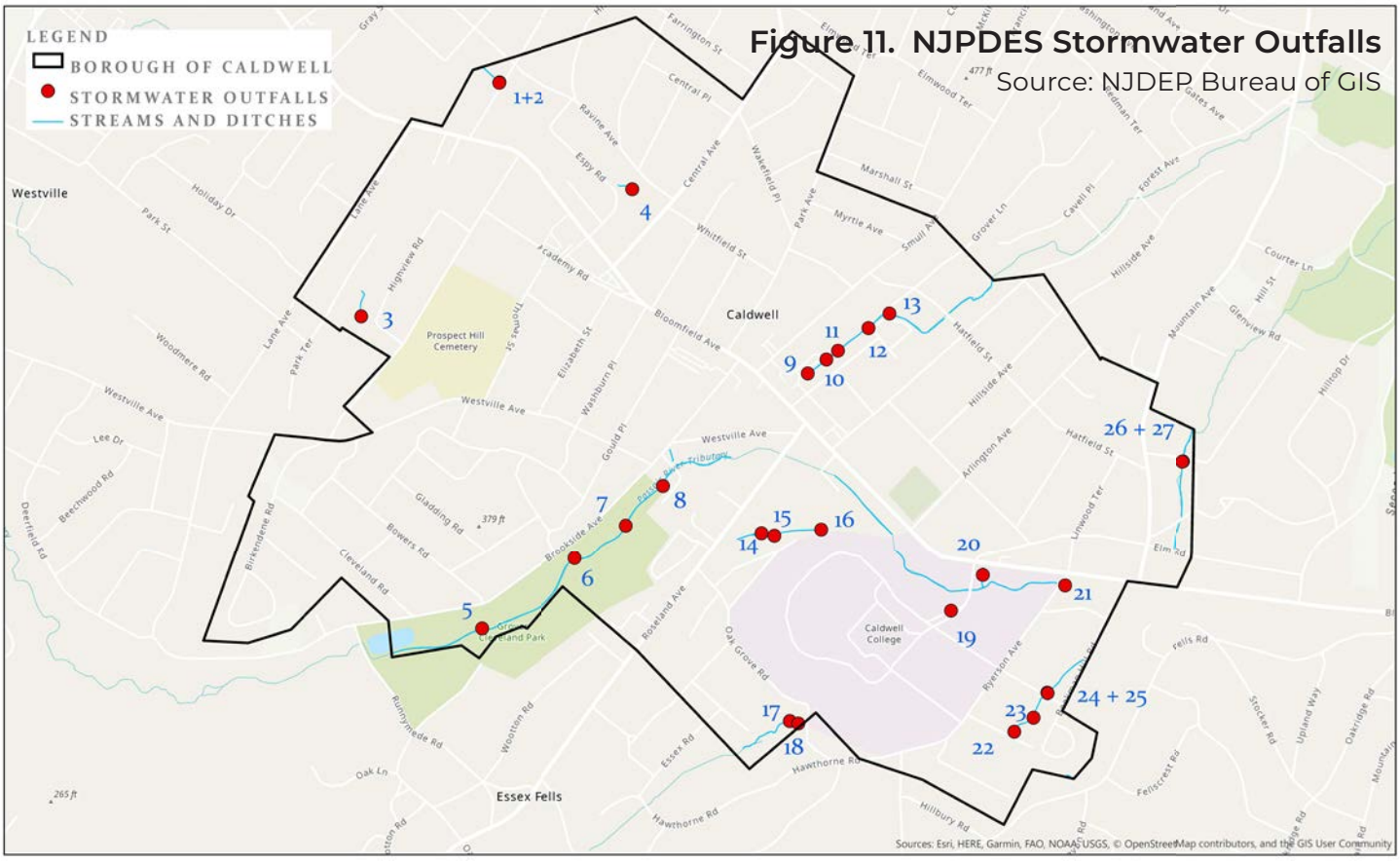


Figure 11. NJPDES Stormwater Outfalls Source: NJDEP Bureau of GIS

the water in the aquifer and eventually causes a well to yield less water or run dry.

Aquifers are ranked based on their ability to yield groundwater to high-capacity wells for water supply, irrigation, and industrial supply wells that are sited and tested for maximum yield. The five aquifer rank values (A, B, C, D, E) are based on the median yields for over 8,000 high-capacity wells (**Table 10)**. Each aquifer or confining unit is assigned a rank based on its median yield or, where data is lacking, professional judgment. Aquifers of rank A have the highest median yield of over 500 gallons per minute (gpm), while the rank E yield is less than 25 gpm. Data with more than one ranking value (e.g., B/C) variations in well-yield throughout the area based on lithologic and structural conditions.

Aquifers are characterized by the type of geologic formation that underlies an area. Bedrock aquifers consist of rock formations while surficial aquifers are formed from unconsolidated materials, such as sand, gravel, or glacial sediment. Bedrock aquifers are categorized by geologic composition and ranked based on capacity to yield groundwater to high-capacity wells for water supply, irrigation, and industrial-supply wells. Bedrock aquifers in the Piedmont contain water in fractures within the rock while surficial aquifers contain water primarily in the spaces between sand and gravel particles. Caldwell lies in the Newark Basin part of the Piedmont region, consisting of aquifers made of shale and sandstone.[85]

Borough of Caldwell, due to its location on the western slopes of the Second Watchung Ridge, is underlain by the Jurassic-Triassic basalt bedrock aquifer and the western third is also covered by a part of the sand and gravel glacial (surficial) aquifer. Caldwell is serviced by the bedrock basalt aquifer through igneous and metamorphic rock and a portion (37%) is serviced by a sand and gravel surficial aquifer (**Map 11** and **Map 12**).

Table 10. Statewide Aquifer Well Yield Rankings

Statewide Well Yield Rankings	
Aquifer Rank	**Median Well Yield (Gallons/Minute)**
A	>500
B	250-500
C	100-250
D	25-100
E	<25

Source: NJGS
No recharge is calculated for hydric soils (L/L), wetlands and open water (W/W).

The ridges contain basalt aquifers, comprised of hard, dense, and highly-fractured igneous rocks. Groundwater is stored and transmitted through the system of fractures in the rock. Water in this aquifer tends to be fresh, slightly to highly alkaline, moderately hard, and of the calcium-bicarbonate type. The basalt aquifer has a ranking of D, indicating a well yield of 25 to 100 gpm. The western portion of the Borough is a Rank B surficial aquifer composed of sand and gravel overlays the basalt bedrock aquifer. This surficial aquifer is classified as Rank B due to its moderate permeability and potential to transmit groundwater.

Wellhead Protection

The 1986 Federal Safe Drinking Water Act Amendments (Section 1428, P/L. 93-523, 42 USC 300 et. seq) direct all states to develop a Well Head Protection

Program Plan for both public community and public non-community water-supply wells.[86] Groundwater resources provide drinking water to over 40% of the population in New Jersey. By defining Well Head Protection Areas (WHPAs), steps can be taken to prevent contamination of groundwater resources, controlling pollutants that are most likely to contaminate drinking water. WHPAs are delineated in tiers that reflect the average time of travel to the well so that the closest pollution sources and remedies can be prioritized. Tier 1 areas have a time of travel of two years; Tier 2 is five years, and Tier 3 is twelve years.

Caldwell does not contain any public water supply wells within its borders. Areas of the Borough lie in the WHPAs associated with wells in surrounding towns (**Map 13**). Portions of the Borough of Caldwell fall within Tier 1, Tier 2, and Tier 3 wellhead protection areas, based on the proximity to nearby public community water supply wells.

Drinking Water Quality

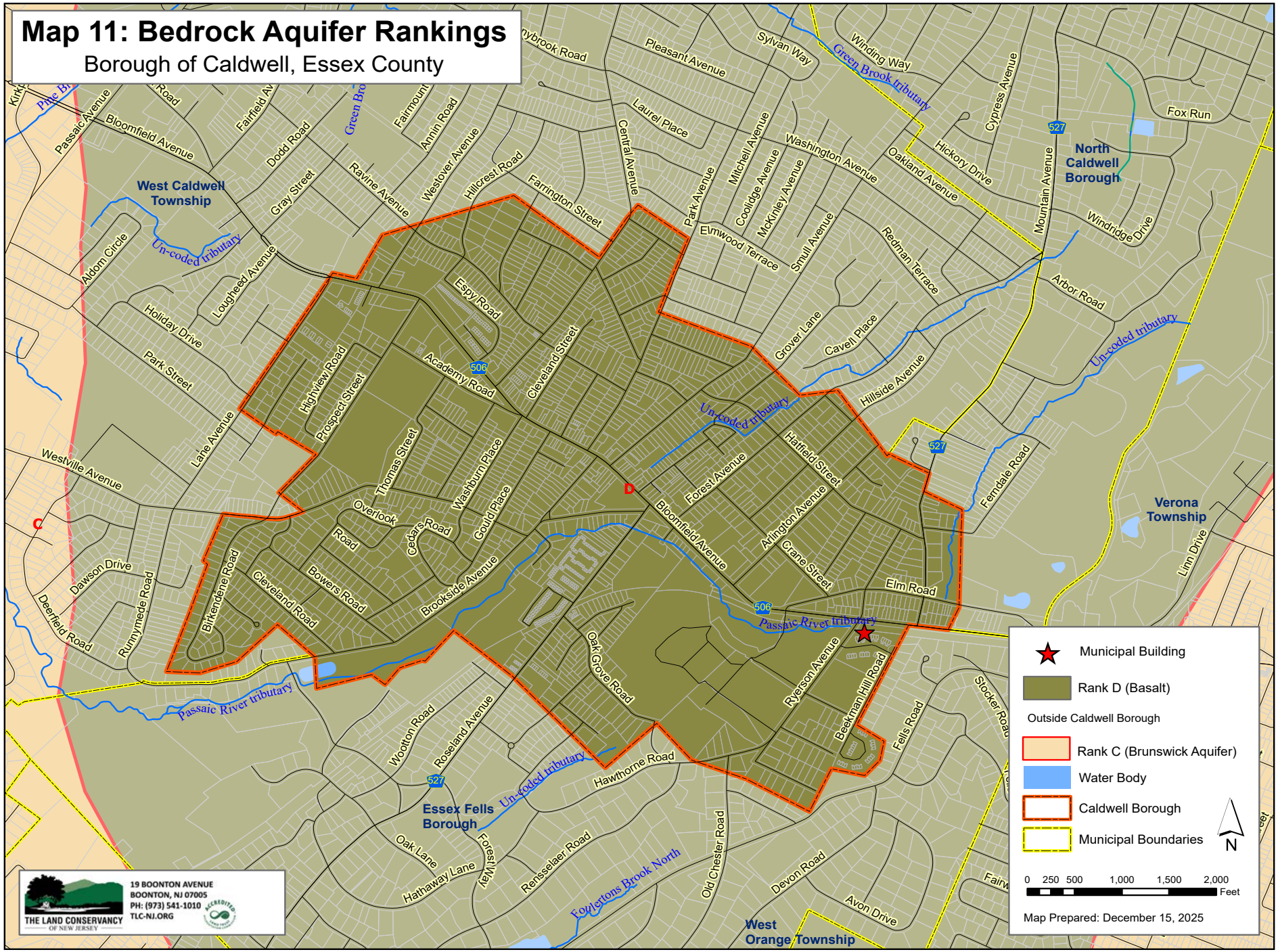
Essex Fells Water Department

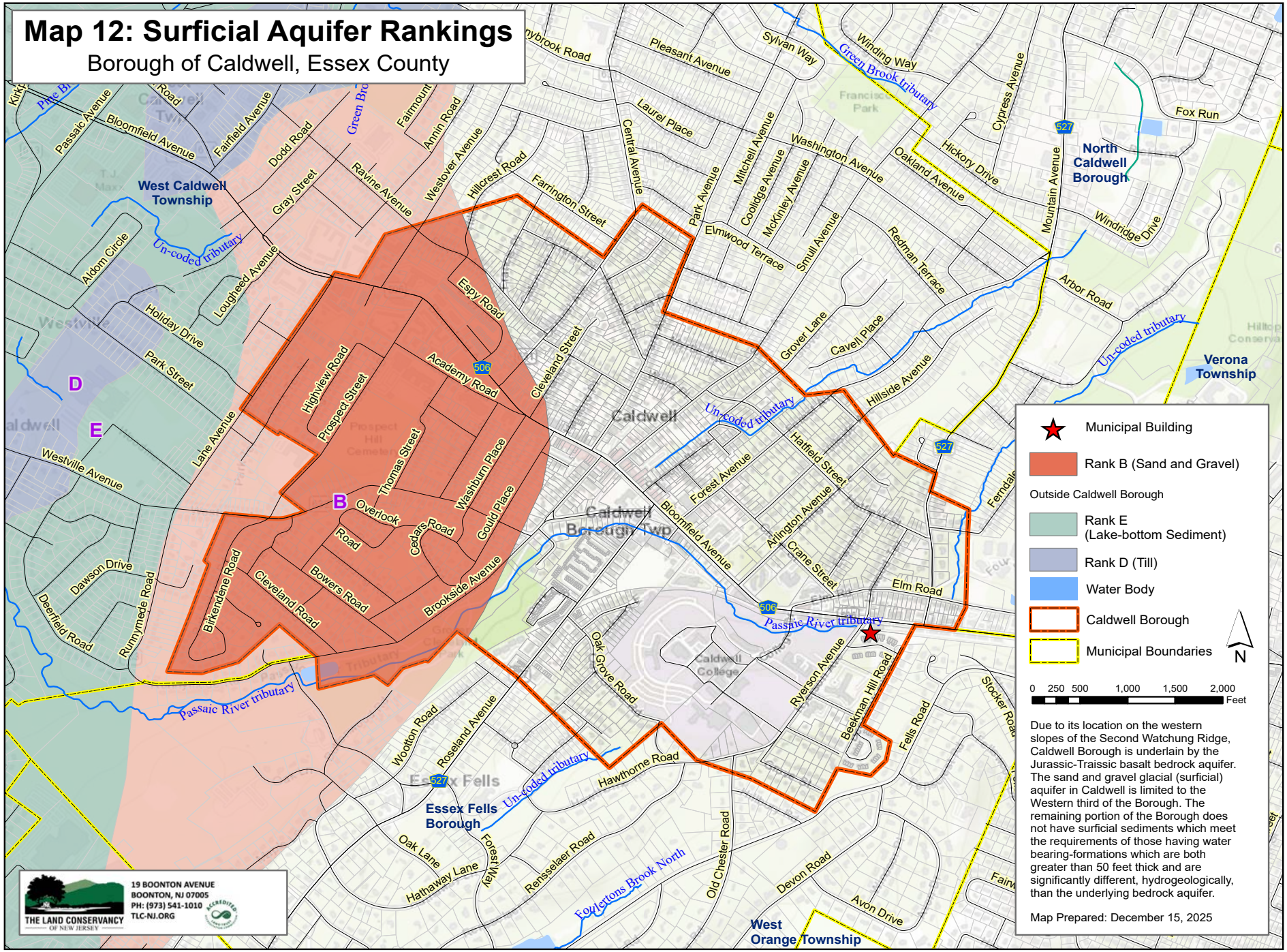
Caldwell receives its drinking water from the Essex Fells Water Department, which also supplies the neighboring communities of Roseland, North Caldwell, and the Hilltop area of Verona. The department operates 16 wells and maintains three water storage tanks with a combined capacity of approximately 2.8 million gallons. In accordance with NJDEP standards, the department oversees the maintenance of well pumps, storage facilities, water mains, fire hydrants, water meters, and conducts regular water sampling.. Water hardness in the system ranges from 80 to 180 parts per million (ppm), and the pH levels are maintained between 6.5 and 7.8.[87]

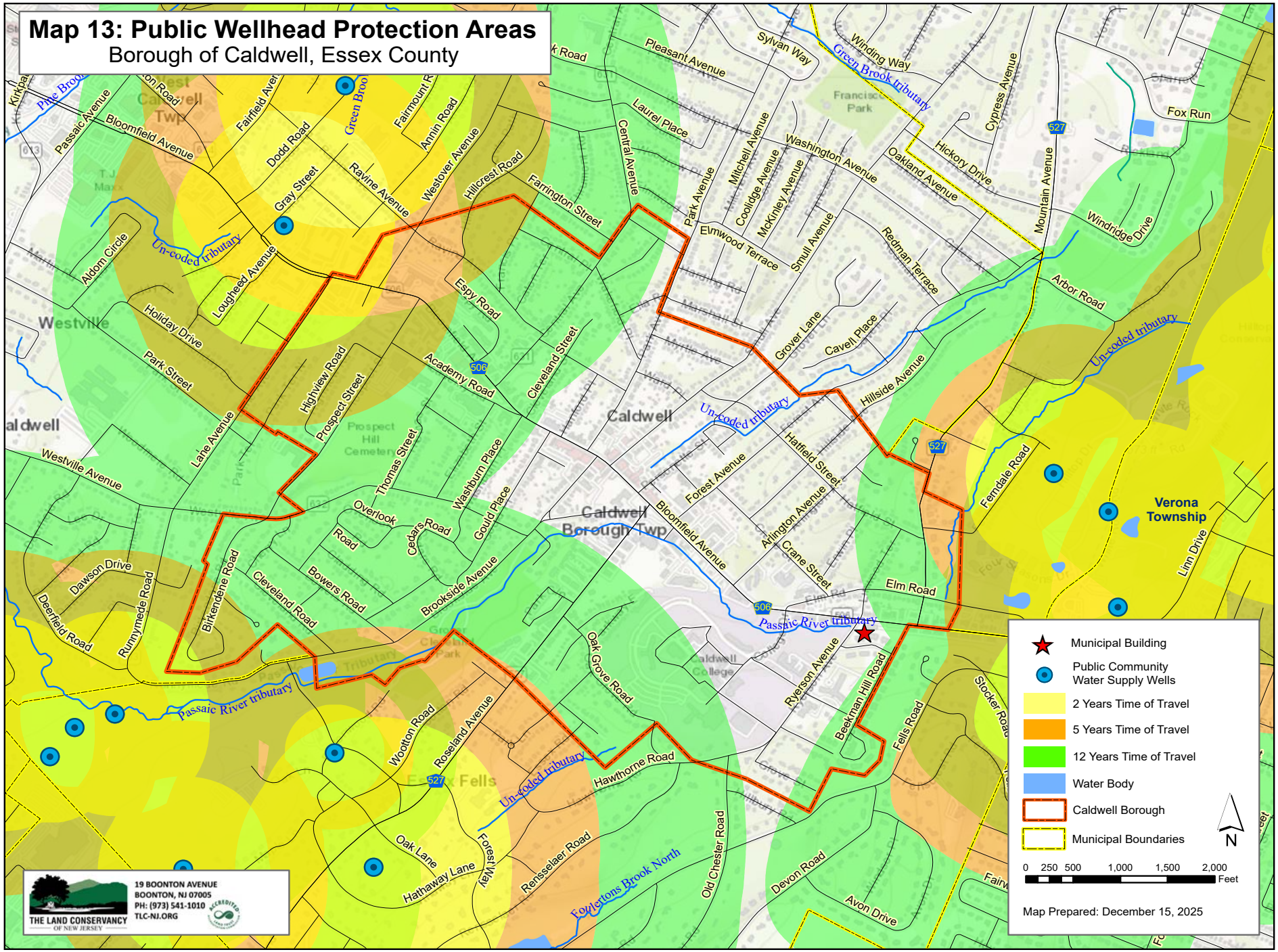
EPA: How's My Waterway?

The EPA's community waterway program monitors the quality of surface water for physical, chemical, and biological factors, weighing them against EPA-approved standards or thresholds.[88] While treated drinking water is assessed separately, the waterway quality has implications for not only drinking water, but aquatic habitat and wildlife, fish and shellfish consumption, and swimming and boating activities.

In water quality reports since 2020, the major water bodies of Caldwell have been flagged as "impaired" for several reasons. Identified issues affecting the Passaic River include bacteria, degraded aquatic life, metals, nitrogen and phosphorus, and salts. For more information on the condition of local waterways and suitability for different activities, visit mywaterway.epa.gov.


Map 11: Bedrock Aquifer Rankings
Borough of Caldwell, Essex County
West Caldwell Township
North Caldwell Borough
Verona Township
Essex Fells Borough
West Orange Township
Passaic Avenue
Bloomfield Avenue
Dodd Road
Gray Street
Ravine Avenue
Fairfield Avenue
Fairmount Avenue
Annin Road
Westover Avenue
Hillcrest Road
Farrington Street
Central Avenue
Laurel Place
Pleasant Avenue
Sylvan Way
Winding Way
Green Brook tributary
Cypress Avenue
Fox Run
Hickory Drive
Mountain Avenue
Windridge Drive
Washington Avenue
Oakland Avenue
Park Avenue
Mitchell Avenue
Coolidge Avenue
McKinley Avenue
Elmwood Terrace
Smull Avenue
Redman Terrace
Arbor Road
Un-coded tributary
Aldom Circle
Lougheed Avenue
Holiday Drive
Park Street
Lane Avenue
Westville Avenue
Espy Road
Academy Road
506
Cleveland Street
Highview Road
Prospect Street
Thomas Street
Washburn Place
Gould Place
Overlook Road
Cedars Road
Bowers Road
Cleveland Road
Brookside Avenue
Birkendene Road
Dawson Drive
Runnymede Road
Deerfield Road
Grover Lane
Cavell Place
Hillside Avenue
Forest Avenue
Hatfield Street
Arlington Avenue
Crane Street
Ferndale Road
Linn Drive
Elm Road
Bloomfield Avenue
527
D
C
Passaic River tributary
Oak Grove Road
Ryerson Avenue
Beekman Hill Road
Fells Road
Stocker Road
Woolton Road
Roseland Avenue
Hawthorne Road
Oak Lane
Hathaway Lane
Forestway
Rensselaer Road
Foxlertons Brook North
Old Chester Road
Devon Road
Avon Drive
Municipal Building
Rank D (Basalt)
Outside Caldwell Borough
Rank C (Brunswick Aquifer)
Water Body
Caldwell Borough
Municipal Boundaries
N
0 250 500 1,000 1,500 2,000
Feet
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Map 12: Surficial Aquifer Rankings
Borough of Caldwell, Essex County
West Caldwell Township
North Caldwell Borough
Verona Township
Caldwell
Caldwell Borough Twp
Essex Fells
Essex Fells Borough
West Orange Township
D
E
B
Municipal Building
Rank B (Sand and Gravel)
Outside Caldwell Borough
Rank E (Lake-bottom Sediment)
Rank D (Till)
Water Body
Caldwell Borough
Municipal Boundaries
N
0 250 500 1,000 1,500 2,000 Feet
Due to its location on the western slopes of the Second Watchung Ridge, Caldwell Borough is underlain by the Jurassic-Traissic basalt bedrock aquifer. The sand and gravel glacial (surficial) aquifer in Caldwell is limited to the Western third of the Borough. The remaining portion of the Borough does not have surficial sediments which meet the requirements of those having water bearing-formations which are both greater than 50 feet thick and are significantly different, hydrogeologically, than the underlying bedrock aquifer.
Map Prepared: December 15, 2025
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BOONTON, NJ 07005
PH: (973) 541-1010
TLC-NJ.ORG
Passaic River tributary
Un-coded tributary
Green Brook tributary
Foxrun
Pleasant Avenue
Sylvan Way
Winding Way
Laurel Place
Central Avenue
Park Avenue
Mitchell Avenue
Coolidge Avenue
McKinley Avenue
Washington Avenue
Oakland Avenue
Hickory Drive
Cypress Avenue
Mountain Avenue
Windridge Drive
Fox Run
Arbor Road
Elmwood Terrace
Smull Avenue
Redman Terrace
Grover Lane
Cavell Place
Hillside Avenue
Cleveland Street
Academy Road
Espy Road
Highview Road
Prospect Street
Thomas Street
Washburn Place
Gould Place
Overlook Road
Cedars Road
Bowers Road
Cleveland Road
Birkendene Road
Brookside Avenue
Lane Avenue
Westville Avenue
Park Street
Holiday Drive
Lougheed Avenue
Aldom Circle
Dawson Drive
Deerfield Road
Runnymede Road
Passaic Avenue
Bloomfield Avenue
Fairfield Avenue
Dodd Road
Gray Street
Ravine Avenue
Westover Avenue
Hillcrest Road
Farrington Street
Fairmount
Annin Road
Forest Avenue
Hatfield Street
Arlington Avenue
Crane Street
Elm Road
Bloomfield Avenue
Ferndale
Oak Grove Road
Ryerson Avenue
Beekman Hill Road
Fells Road
Stocker Road
Hawthorne Road
Roseland Avenue
Woolton Road
Oak Lane
Hathaway Lane
Forestway
Rensselaer Road
Old Chester Road
Devon Road
Avon Drive
Foxlettons Brook North
Caldwell College
506
527


Map 13: Public Wellhead Protection Areas
Borough of Caldwell, Essex County
Municipal Building
Public Community Water Supply Wells
2 Years Time of Travel
5 Years Time of Travel
12 Years Time of Travel
Water Body
Caldwell Borough
Municipal Boundaries
N
0 250 500 1,000 1,500 2,000 Feet
Map Prepared: December 15, 2025
THE LAND CONSERVANCY OF NEW JERSEY
19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973) 541-1010
TLC-NJ.ORG
Caldwell
Caldwell Borough Twp
Verona Township
Westville
Essex Fells
Passaic River tributary
Un-coded tributary
Green Brook tributary
Foxertons Brook North
Pleasant Avenue
Sylvan Way
Winding Way
Laurel Place
Central Avenue
Park Avenue
Mitchell Avenue
Coolidge Avenue
McKinley Avenue
Washington Avenue
Oakland Avenue
Cypress Avenue
Hickory Drive
Fox Run
Mountain Avenue
Windridge Drive
Arbor Road
Elmwood Terrace
Smull Avenue
Redman Terrace
Grover Lane
Cavell Place
Hillside Avenue
Ferndale Road
Linn Drive
Elm Road
Crane Street
Arlington Avenue
Hatfield Street
Forest Avenue
Bloomfield Avenue
Ryerson Avenue
Beekman Hill Road
Fells Road
Stocker Road
Hawthorne Road
Oak Grove Road
Old Chester Road
Devon Road
Avon Drive
Rensselaer Road
Forestway
Oak Lane
Hathaway Lane
Roseland Avenue
Woolton Road
Brookside Avenue
Gould Place
Washburn Place
Cedars Road
Overlook Road
Thomas Street
Cleveland Street
Academy Road
Espy Road
Farrington Street
Hillcrest Road
Westover Avenue
Ravine Avenue
Gray Street
Dodd Road
Annin Road
Fairmount Road
Fairfield Avenue
Bloomfield Avenue
Passaic Avenue
Aldom Circle
Lougheed Avenue
Holiday Drive
Park Street
Lane Avenue
Highview Road
Prospect Street
Westville Avenue
Dawson Drive
Deerfield Road
Runnymede Road
Birkendene Road
Cleveland Road
Bowers Road
Prospect Hill Cemetery
Caldwell College
Francisco Park
T.J. Maxx
506
527
613



Grover Cleveland Pond
Photo: The Land Conservancy

Chapter 7.

Wetlands

What is a wetland?

The NJDEP defines a freshwater wetland as an area that is inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support vegetation adapted for life in saturated soil conditions. Wetlands are among the most productive ecosystems in the world, an immense variety of species can be part of a wetland. The USEPA describes wetlands as "biological supermarkets" due to the volume of food they provide for the many animal species that use wetlands for part or all of their lifecycle!

Wetlands of Caldwell

According to the NJDEP 2020 Land Use/ Land Cover data, there are three acres of wetlands in Caldwell. Their locations are shown in **Map 14** and detailed in **Table 13**. The larger of these two mapped wetland areas is located within Grover Cleveland Park. It is classified as a managed wetland in a maintained recreation area. According to the NJDEP, this type of wetland lacks traditional vegetation and instead is dominated by grasses and other plants, which tend to be more landscaped or manicured and often require routine mowing. In Grover Cleveland Park, the wetland area is located within the Great Meadow, a broad, grassy area designed for picnicking, outdoor concerts, and community events. The wetlands run adjacent to Pine Brook. **Figure 12** shows the managed wetland area (shown in light blue) within the park.

Table 17: Wetland Types in Borough of Caldwell			
Wetland Classification Category	**Acres**	**% of Wetland Category**	**% of Caldwell Land Cover**
Managed Wetlands in Built-Up Maintained Recreation Area	2.04	67%	0.27%
Deciduous Wooded Wetlands	0.99	33%	0.13%
Total Wetlands	**3.03**	**100%**	**0.4%**
Source: NJGS Wetland Types			



Figure 12. Wetlands in Grover Cleveland Park
Source: NJDEP GeoWeb

The remaining mapped wetlands are located within The Glen, off of Park Lane, which is a local bird sanctuary (see **Figure 13**). These are classified as deciduous wooded wetlands. These closed-canopy wetlands are dominated by broad-leafed, deciduous trees. They are typically found in low-lying areas with poor drainage, where water tends to accumulate and saturate the soil for extended periods. Common tree species of these types of wetlands include red maple (*Acer rubrum*), black gum (*Nyssa sylvatica*), green ash (*Fraxinus pennsylvanica*), and swamp white oak (*Quercus bicolor*).

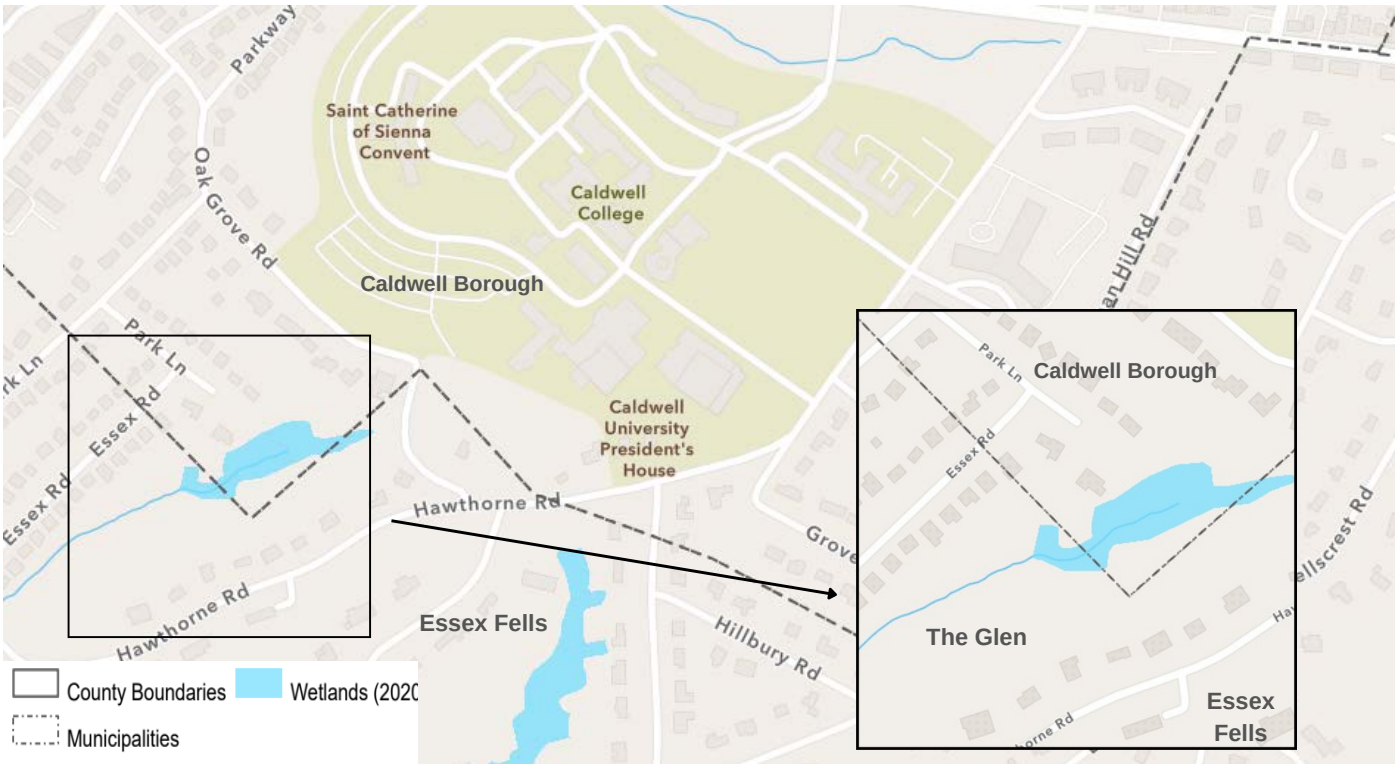
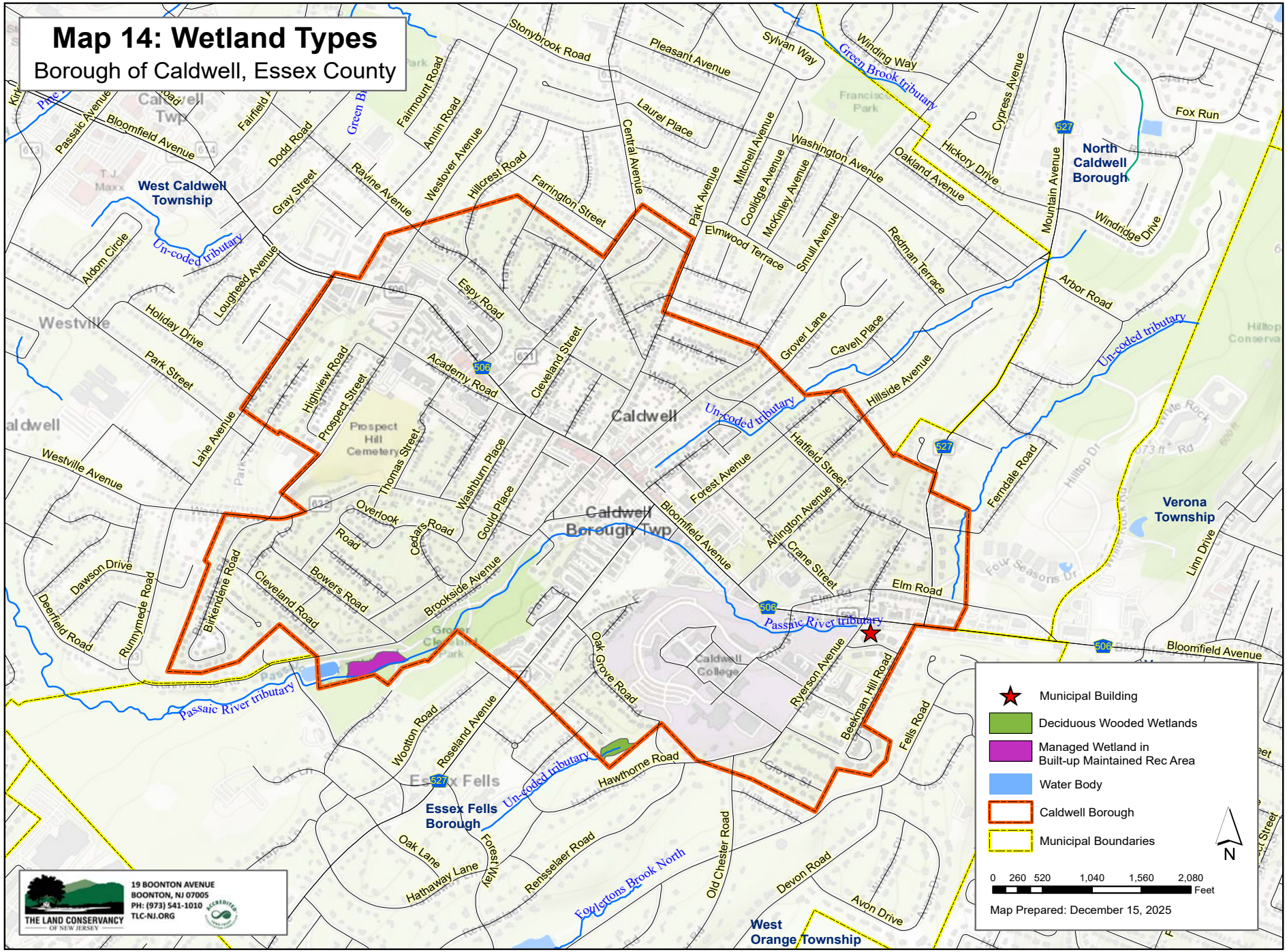


Figure 13. Deciduous Wetlands in Caldwell
Source: NJDEP GeoWeb

Wetland Maps and the ERI

Wetland mapping from the NJDEP is approximate and to be used for preliminary planning purposes. Unmapped wetlands may exist in Caldwell and are still subject to NJDEP regulation. The assessment of wetlands and their boundaries requires a professional delineation through the Presence/ Absence or Line Verification Letter of Interpretation (LOI) Application with the NJDEP Division of Land Use Regulation before a regulated activity can occur in or around the area.


Map 14: Wetland Types
Borough of Caldwell, Essex County
West Caldwell Township
North Caldwell Borough
Verona Township
Essex Fells Borough
West Orange Township
Caldwell
Caldwell Borough Twp
Westville
Prospect Hill Cemetery
Caldwell College
Un-coded tributary
Passaic River tributary
Green Brook tributary
Foxrun
Stonybrook Road
Pleasant Avenue
Sylvan Way
Winding Way
Laurel Place
Central Avenue
Park Avenue
Mitchell Avenue
Coolidge Avenue
McKinley Avenue
Washington Avenue
Oakland Avenue
Hickory Drive
Cypress Avenue
Mountain Avenue
Windridge Drive
Fox Run
Elmwood Terrace
Smull Avenue
Redman Terrace
Arbor Road
Grover Lane
Cavell Place
Hillside Avenue
Ferndale Road
Linn Drive
Hilltop Drive
Farrington Street
Hillcrest Road
Westover Avenue
Annin Road
Fairmount Road
Fairfield Road
Dodd Road
Ravine Avenue
Gray Street
Bloomfield Avenue
Passaic Avenue
Aldom Circle
Lougheed Avenue
Holiday Drive
Park Street
Lane Avenue
Westville Avenue
Espy Road
Academy Road
Cleveland Street
Highview Road
Prospect Street
Thomas Street
Washburn Place
Gould Place
Overlook Road
Cedars Road
Forest Avenue
Hatfield Street
Arlington Avenue
Crane Street
Elm Road
Bloomfield Avenue
Brookside Avenue
Bowers Road
Cleveland Road
Birkendene Road
Runnymede Road
Deerfield Road
Dawson Drive
Oak Grove Road
Ryerson Avenue
Beekman Hill Road
Fells Road
Roseland Avenue
Woolton Road
Hawthorne Road
Oak Lane
Hathaway Lane
Forestway
Rensselaer Road
Old Chester Road
Devon Road
Avon Drive
Eggertons Brook North
Municipal Building
Deciduous Wooded Wetlands
Managed Wetland in Built-up Maintained Rec Area
Water Body
Caldwell Borough
Municipal Boundaries
N
0 260 520 1,040 1,560 2,080
Feet
Map Prepared: December 15, 2025
THE LAND CONSERVANCY OF NEW JERSEY
19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973) 541-1010
TLC-NJ.ORG

Wetland Buffers & Regulations

The NJDEP regulates virtually all activities in a wetland, including removing vegetation, filling, and placing obstructions. Depending on the environmental value of a wetland, there may also be a transition area, or buffer, around the wetland that requires a waiver issued by the NJDEP for any activity within that zone. For example, a wetland containing endangered species habitat would require a 150-foot transition area, whereas a small wetland in a ditch may not require any transition area. Most freshwater wetlands will require a 50-foot transition area. The NJDEP has adopted the **1989 Federal Manual (N.J.A.C. 7:7A)** as the technical basis for identifying and delineating wetlands.[89]

The criteria for wetland classifications in New Jersey are used to determine the appropriate regulatory conditions. The three classifications are:

1. Exceptional Resource Value Wetland

- Discharges into FW-1 water and FW-2 trout producing waters and their tributaries;
- Is a present habitat for threatened or endangered species; or
- Is a documented habitat for threatened or endangered species, and remains suitable for breeding, resting, or feeding by the species during the normal period these species would use the habitat.

2. Ordinary Resource Value Wetland

- A freshwater wetland which does not exhibit any of the characteristics of an exceptional resource value wetland, and is one of the following:
- An isolated wetland (N.J.A.C. 7:7A-1.4) smaller than 5,000 square feet, with the uses covering more than 50% of the area within 50 feet of the wetland boundary: lawns, maintained landscaping, impervious surfaces, active railroad right-of-way, and graveled or stoned parking/storage area and roads. NJDEP will consider a use that was legally existing in that location prior to July 1, 1988, or was permitted since that date.
- A drainage ditch.
- A swale.
- A detention facility that was uplands at the time it was created regardless of the wetland resource classification of the wetlands under these rules, or classification of the body of water, as FW-1 or FW-2 trout production, to which it discharges.

3. Intermediate Resource Value Wetland

- A freshwater wetland of intermediate resource value is any wetland not defined as exceptional or ordinary.



Storm surge, Grover Cleveland Park
Photographer: Warren Marchioni

Chapter 8.

Riparian & Flood Zones

High Intensity = High Risk

The land surrounding waterways plays a critical role in mitigating downstream flooding and maintaining a healthy stream ecology. Development within riparian areas can cause significant damage to the ecosystem and the benefits that it provides for controlling stormwater. The Borough has experienced high intensity, short duration rainfall events which have caused significant flooding and stormwater runoff. Recognizing the risk, the Environmental Commission received a $20,000 grant from Sustainable Jersey in 2019 to work with Rutgers to determine ways to reduce stormwater runoff.

Riparian Zones

A riparian zone refers to the land and vegetation within and adjacent to all surface water bodies including lakes, ponds and streams. . Effects of disrupting riparian ecosystems include:

- Intensified stormwater flow
- Destabilized streambanks
- Increased levels of sedimentation and other nonpoint pollutants
- Rise in water temperatures
- Damaged stream habitat
- Reduced infiltration into soils
- Increased frequency and intensity of flooding and low stream flows

Riparian zones, which typically overlap with flood zones, are subject

to regulation from different State and Federal authorities. NJDEP regulation is performed by establishing buffer zones along surface water bodies.

As a baseline, all surface waters require the maintenance of a riparian zone of at least 50 feet along both sides of the waterway. Larger riparian zones are regulated under various environmental conditions. Riparian zones shall measure:[90]

- 300 feet along Category One (C1) waters and all upstream waters/ tributaries situated in the same HUC14 watershed;
- 150 feet along non-C1 waters that are trout-producing or maintaining, including all upstream waters/ tributaries within one linear mile as measured along the length of the water body;
- 150 feet along any segment of water flowing through an area with documented protected species habitat, including all upstream waters/ tributaries within one linear mile measured along the length of the surface water body;
- 150 feet along any segment of a water body flowing through an area with acid-producing soils.

Riparian areas beyond the surface water body are measured landward from the top of the bank, or in the case that there is no discernible bank, from the centerline of the stream or swale. In the case of a lake or pond, it is measured landward of the normal surface water limit. There are no C1 waters in Borough of Caldwell.

Municipal Stormwater Control

In March 2021, the Borough of Caldwell revised its Stormwater Control Ordinance to align with the NJ Stormwater Management Practices Manual. The measures of §206-3 through 206-14 are designed to provide erosion control, groundwater recharge, stormwater runoff control,[91] and stormwater runoff quality treatment in new major developments:

"Flood control, groundwater recharge, and pollutant reduction shall be achieved through the use of stormwater management measures, including Green Infrastructure Best Management Practices (GI BMPs) and nonstructural stormwater management strategies. GI BMPs and low-impact development (LID) should be utilized to meet the goal of maintaining natural hydrology to reduce stormwater runoff volume, reduce erosion, encourage infiltration and groundwater recharge, and reduce pollution. GI BMPs and LID should be developed based upon physical site conditions and the origin, nature and the anticipated quantity, or amount, of potential pollutants."[92]

The ordinance can be found at: Borough of Caldwell, NJ Stormwater Control.

Green Infrastructure Strategic Plan

In 2020, an analysis of impervious surface cover in Caldwell was completed by the Rutgers Cooperative Extension (RCE) Water Resources Program. Its purpose was to provide the municipality with a blueprint for implementing green infrastructure practices to reduce the impact of stormwater runoff from impervious surfaces.[93]

Using 2015 LU/LC data, RCE analyzed the proportion of impervious surface coverage on a subwatershed basis. Caldwell is divided between two subwatersheds, Deepavaal Brook and Upper Passaic River, each having 38% impervious coverage. Due to the level of impervious cover, it is likely that the streams no longer support

diverse ecosystems, but are primarily conduits for stormwater flow.

With the slow loss of its forest cover, Caldwell's rainfall is not absorbed by the soil (through natural infiltration) but instead runs off paved surface areas at a higher velocity, creating a sheet flow of water. This runoff is associated with the movement of pollutants, sediment, and small objects across the landscape.[94]

Impervious surfaces include the roads, paved parking lots, sidewalks, and buildings, areas where stormwater cannot be absorbed by the ground. The result is a higher volume of runoff that requires management by human-built drainage systems. Storm sewers and ditches carry water to streams much more quickly than it would arrive through infiltration, causing higher frequency and severity of flooding.

Based on this, the report recommended the Borough manage stormwater runoff through alternative means. The plan outlines 19 green infrastructure projects for the Borough. The suggested project sites were located along Bloomfield Avenue, where the road and commercial development have a high concentration of impervious coverage. Recommendations include disconnected downspouts to redirect rainwater to pervious areas, bioretention systems, downspout planter boxes, rainwater harvesting systems, bioswales, stormwater planters, and tree filter boxes.

The Caldwell Environmental Commission secured a $20,000 Grant from Sustainable Jersey to design and install a rain garden at the rear of the Caldwell Community Center near Kiwanis Oval. Constructed with support from the Caldwell Department of Public Works, the rain garden is a shallow, landscaped basin that captures and filters stormwater runoff, allowing it to infiltrate the ground within 24–48 hours.

Additional projects included in the RCE study and supported by the Environmental Commission include:

- Green infrastructure at the Grover Cleveland Center for Senior Citizens and the United States Postal Service. These sites will feature bioretention systems (rain gardens) and pervious pavement to capture and treat runoff. The rain garden at the senior center will redirect rooftop runoff, while the postal service site will convert parking spaces to porous pavement to address pooling issues.

- In the Upper Passaic River subwatershed, a wide range of sites are targeted, including the Caldwell Municipal Complex, Caldwell University, and several churches and schools. These locations will host bioretention systems, pervious pavement, stormwater planters, tree filter boxes, and rainwater harvesting systems.

- The plan also includes installations in public spaces such as Grover Cleveland Park, municipal parking lots, and right-of-way areas like Gould Place and Bloomfield Avenue. These projects aim to intercept stormwater before it enters the sewer system, using features like tree filter boxes and sidewalk-integrated planters.

- The short-term goal is to manage runoff from 5% of Caldwell's impervious surfaces within five years, with long-term plans to expand community engagement and incentivize private property owners to adopt green infrastructure.

See the full Green Infrastructure Strategic Plan prepared for the Borough of Caldwell at: http://water.rutgers.edu/Projects/Caldwell/Caldwell_SJ_GI_StrategicPlan1.pdf

NJDEP Green Infrastructure Grant

In 2023, Caldwell was awarded a $91,110 grant from the New Jersey Department of Environmental Protection (NJDEP) to support green infrastructure projects. With this funding, Caldwell will design and install three rain gardens to capture roof runoff.[95]

Flood Zones

Areas prone to flooding are overseen by municipal, state, and federal agencies in order to minimize negative ecological effects to the area and to mitigate property damage from floods.

At the federal level, the USGS conducts mapping of flood-prone areas. The Federal Emergency Management Agency (FEMA) also evaluates and maps Special Flood Hazard Areas (SFHAs), which can be used in participating communities to determine flood insurance rates. At the state level, the NJDEP delineates Flood Hazard Areas along streams and regulates activities within these areas. In recent years, FEMA and the DEP have coordinated to integrate NJDEP flood hazard area parameters into FEMA updates. Municipal codes may set standards that are stricter than either the state or FEMA.

FEMA, SFHA and NJDEP Flood Hazard Areas are delineated by different methods, but the intended areas are overlapping. These areas include all lands which would be inundated in the case of a 100-year flood, or a flood which is expected to occur every 100 years. Each year, these areas have a 1% chance of becoming flooded. Estimates for 100-year floods do include a small margin of safety to factor in potential increased flow due to upstream development.[96]

NJDEP Regulations

NJDEP regulates flood prone areas through the New Jersey Flood Hazard Area Control Act, N.J.A.C. 7:13, last amended July 17, 2023.[97] The act outlines the risks posed by flood hazards and the need to govern human activity that affects land and vegetation in critical riparian areas. Development and disturbance can negatively impact the integrity of ecosystems and their natural capacity to absorb flood waters. For example, vegetation adjacent to surface waters is essential for maintaining bank stability and water quality. The destabilization of banks leads to erosion and sedimentation which can exacerbate flooding. For these reasons, the NJDEP enforces rules for development in riparian and flood hazard areas. Per N.J.A.C. 7:13-2.4, regulated activities in these areas include:

- The alteration of topography through excavation, grading, and/or placement of fill;
- The clearing, cutting, and/or removal of vegetation in a riparian zone;
- The creation of impervious surface;
- The storage of unsecured material;
- The construction, reconstruction and/or enlargement of a structure;
- The conversion of a building into a private residence, multi-residence building, or critical building.

Permits must be obtained in order to

engage in activities in a regulated area. There are several different categories: permits by rule, general permits and individual permits. Area-specific standards affect the necessary measures, depending on the presence of a channel, floodway, flood fringe, fishery resource, threatened and endangered species, or acid producing soils.

> The full rules governing delineation and regulation of flood hazard areas are included in Title 7, Chapter 13 of the New Jersey Administrative Code, available on NJDEP's website.

Inland Flood Protection Rule

The NJDEP adopted the Inland Flood Protection Rule in July 2023, updating the methods used to delineate Flood Hazard Areas to account for stormwater flow risks due to climate change and upstream development.[98] This change expands the scope of areas subject to regulation by the NJDEP. The Inland Flood Protection Rule specifically expands Flood Hazard Areas to include all lands up to two feet higher than current 100-year flood areas in NJDEP maps and three feet higher than current 100-year flood areas in FEMA maps. New rules also require that all new major developments address stormwater runoff using an updated NJDEP data set for peak flow rates of streams and rivers, to account for changes in regional precipitation patterns since the previous 1999 data.[99]

In connection with this rule, the NJDEP has created an online Flood Indicator Tool to provide information about potential flood risks on or near a property of interest. The tool is intended for use only as a reference, and does not show precise NJDEP standards, calculate actual risk, or demarcate a zone where NJDEP regulations apply.

2021 Hurricane Ida Flooding

Photos, Warren Marchioni



Flooding outside of Caldwell Library



Roseland Avenue Flooding

FEMA Flood Mapping

SFHAs as delineated by FEMA are used along with other flood zone designations to create official Flood Insurance Rate Mapping (FIRM). Communities can choose to participate in the National Flood Insurance Program (NFIP), which requires mandatory flood insurance in SFHA. NFIP mapping also delineates 100- and 500-year flood zones.[100] SFHAs

in Caldwell are illustrated in **Map 15**.

- 6.35 acres of land fall within the 100-year flood zone (Zones A and AE), which have a 1% chance of flooding in any given year. This is within Grover Cleveland Park adjacent to the Pine Brook and Grover Cleveland Pond.
- 0.22 acres, part of the Foulertons Brook North flood zone in Essex Fells Borough, falls within Caldwell. This is mapped as within the 500 year flood limits (0.2% chance of flooding).

Essex County Hazard Mitigation Plan
Flood problems and risks in Caldwell are outlined in the 2020-2025 Essex County Hazard Mitigation Plan (HMP). Based on FEMA Flood Insurance Studies from 2007 and 2017, the HMP provides descriptive reports of flood hazard areas based on historic events, elaborating the information in the SFHA map. The main flood problem area outlined in the HMP are:[101]

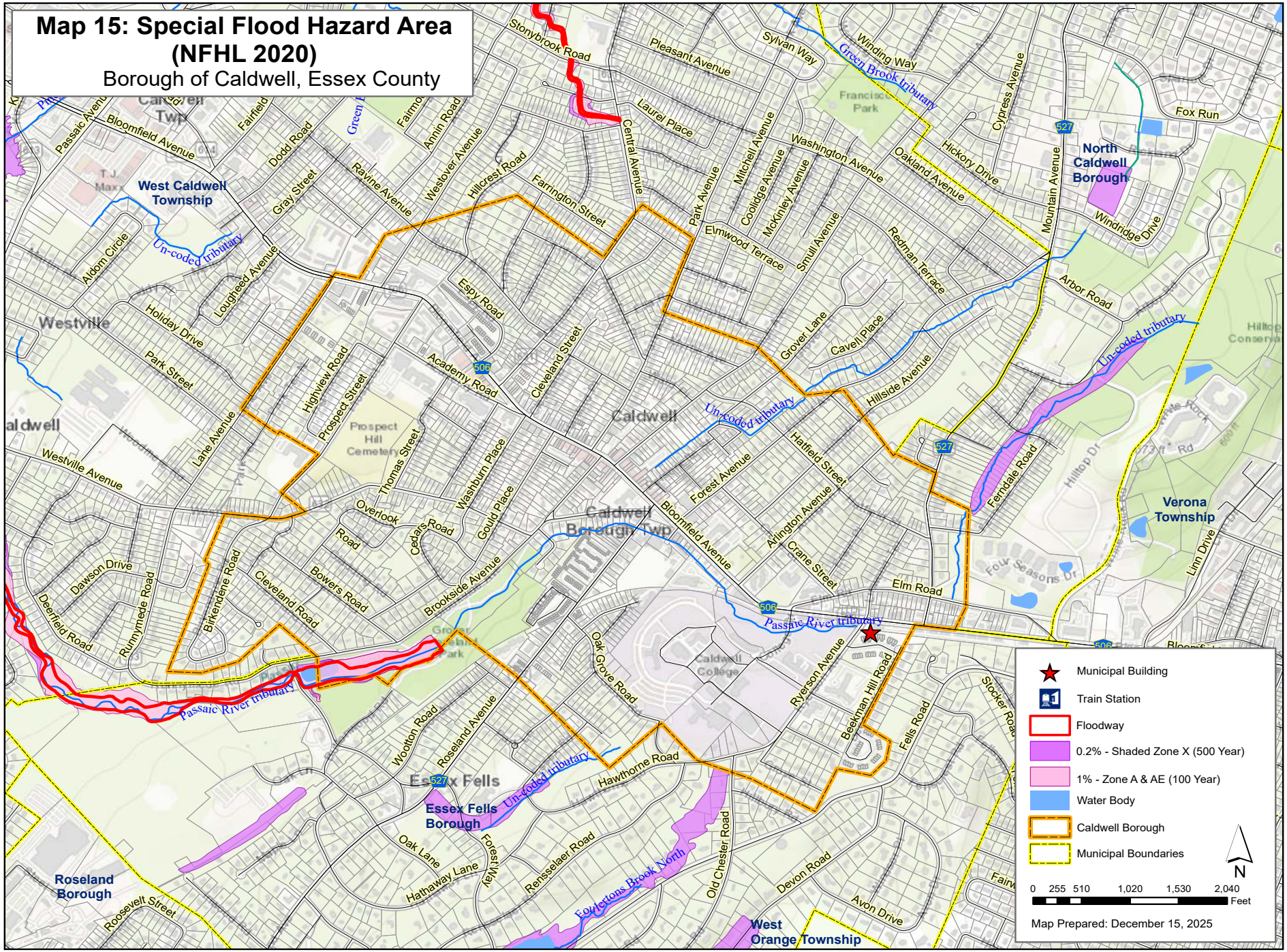
- Pine Brook is obstructed by vegetation and debris, causing flooding along Bloomfield Avenue.
- Bloomfield Avenue Corridor experiences stormwater flooding due to inadequate drainage and intense, short-duration rainfall.
- Urban flooding occurs in the Downtown/Municipal Complex, including Personette Street, Hatfield, Brookside, and Westville.
- Much of Caldwell lies outside FEMA-designated flood zones but still suffers significant flooding due to stormwater runoff and dense development.
- August 2018 flooding caused by intense rainfall led to approximately $700,000 in damage to the Caldwell Municipal Library.
- The same 2018 event caused widespread damage to residential, commercial, and municipal buildings along Bloomfield Avenue.

A significant portion of the Borough does not fall within the SFHA, but high intensity, short duration rainfall events can cause significant flooding and stormwater runoff due to the Borough's suburban development and limited natural drainage.

Caldwell Stormwater Planning Study
After experiencing several repeat flooding events, including the devastating impact of Hurricane Ida in September 2021, where both the public library and Borough Hall were damaged, Caldwell commissioned a comprehensive stormwater planning study. Prepared by Mott MacDonald, the study identified multiple areas in the Borough that are prone to flooding during heavy rain events. These locations were recommended for regular inspection and monitoring to mitigate future flood risks. These included:

- Orchard Square Culverts.
- Culvert inlet on Pine Brook East Branch at Magnuson Field.
- Bloomfield Avenue Sewer at intersection with Mountain Avenue.
- Prospect Place.
- Westbrook Road.

The report recommended that the Borough take steps to locate and document all existing stormwater facilities in Caldwell, including those on both public and private property. This effort supports compliance with the Borough's MS4 permit and ensures that stormwater systems are properly


Map 15: Special Flood Hazard Area (NFHL 2020)
Borough of Caldwell, Essex County
West Caldwell Township
Caldwell
Caldwell Borough Twp
Westville
Essex Fells
Essex Fells Borough
North Caldwell Borough
Verona Township
Roseland Borough
West Orange Township
Un-coded tributary
Passaic River tributary
Green Brook tributary
Eqwilgtons Brook North
Municipal Building
Train Station
Floodway
0.2% - Shaded Zone X (500 Year)
1% - Zone A & AE (100 Year)
Water Body
Caldwell Borough
Municipal Boundaries
N
0 255 510 1,020 1,530 2,040
Feet
Map Prepared: December 15, 2025



Caldwell Green
Photographer: Warren Marchioni

Chapter 9.

Climate

Where do we get climate data?

The Office of the New Jersey State Climatologist (ONJSC) publishes state climate data through Rutgers University using data from the National Centers for Environmental Information (NCEI). The ONJSC gathers and reports climate data using a cooperative network of monitoring stations located throughout the state, supported by the National Weather Service (NWS).[201] These sites report local data and compile data averages locally and statewide. The nearest weather station to Caldwell is the Essex County Airport in Fairfield.

Climate Zones

Atmospheric circulation is dominated by prevailing westerly winds which move air from west to east in a broad, undulating flow. New Jersey's weather is influenced by the north-south movement of these westerly currents and the variation in their strength throughout the year. The result is a highly variable climate throughout the state, with influences from wet, dry, hot, and cold airstreams that change from day to day. For the analysis of climate data, NCEI and the National Oceanic and Atmospheric Administration (NOAA) divide New Jersey into three climatic zones based on similar geographic and environmental characteristics: Northern (Division 1), Southern (Division 2), and Coastal (Division 3). Caldwell and all of Essex County lie in Division 1 (**Figure 14**).[102]

Climate Data Reporting

The nearest weather station to Caldwell is the Essex County Airport, located in Fairfield. This station was established in 1999.[103] The Little Falls station at Montclair University has kept records since 1914.[104] The nearest station that monitors snowfall is located at Canoe Brook in Millburn Township, towards the southern border of Essex County.

Temperature

Monthly temperature data has been recorded in Essex County since 1895, taking aggregate data from several stations in the regions over time. **Table 11** displays the average temperature for each month for Division 1, Essex County, and Caldwell Essex County Airport Station. The POR Mean ("Period of Record") represents the total mean value across 129 years for Division 1 and Essex County. Below, the "30-year Normal" represents the average value over 30 recent years, taken from 1991-2020. The disparity between the POR and 30-year normal indicates **a gradual rise in year-round temperatures**.

Figure 14. NOAA Climate Divisions of New Jersey

Source: NOAA Climate Prediction Center

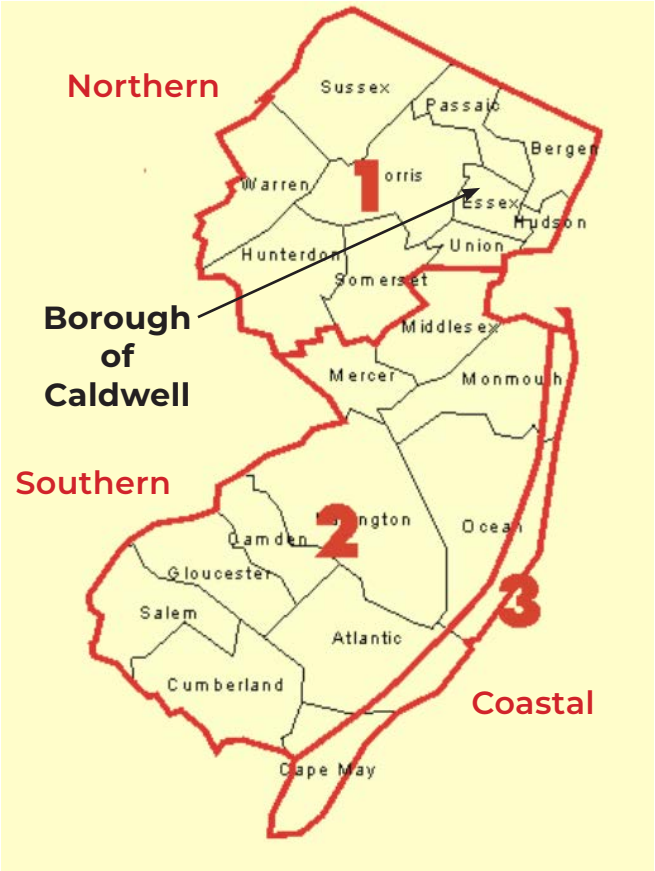


Table 11. Monthly Average Temperature, NJ Division 1 (North), 1895-2024													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
POR Mean	27.1	28.4	37.3	48.3	58.8	67.4	72.3	70.3	63.5	52.4	41.4	31.1	49.9
30yr Normal	28.9	31.3	38.8	49.9	59.9	68.6	73.7	71.9	64.9	53.3	43.1	34.1	51.5
Monthly Average Temperature, Essex County, 1895-2024													
POR Mean	29.4	30.6	39.1	49.9	60.3	69.2	74.3	72.3	65.4	54.2	43.5	33.4	51.8
30yr Normal	31.1	33.3	40.6	51.5	61.5	70.6	75.9	74.0	66.9	55.2	45.0	36.2	53.5
Monthly Average Temperature, Caldwell Essex County Airport, 1999-2024													
Mean	30.9	33.2	41.4	52.1	62.1	70.9	76.4	74.5	67.2	55.7	45.1	36.0	53.9
Source: Office of the New Jersey State Climatologist[105]													

Figure 15 shows the history of average year-round temperature for Essex County. In 2024, the average annual temperature in Essex County was 56.4, making it the **warmest year in state recordkeeping**.

Temperature patterns are also captured by the number of heating and cooling degree days recorded in a given year, (**Figure 16** and **Figure 17**). Heating and cooling degrees refer to the number of degrees required to reach comfortable indoor temperatures of 65°F during the winter or summer months. Heating/cooling days are reflected in the use of household heating/cooling systems. There has been a decline in the amount of annual heating degree days over the last 20 years, meaning fewer days have required the use of indoor heating systems. Conversely, the amount of annual cooling degree days has risen, indicating **an increase in the number of hot days**.

Precipitation

Table 12 displays the average temperature for each month in the history of record keeping for Division 1, Essex County, and Caldwell Essex County Airport Station.

- The yearly average precipitation in Division 1 is 47.2 inches, with a 30-year normal of 48.72 inches.
- In Essex County, the yearly average precipitation fall is 47.95 inches, with a 30-year normal of 48.58 inches.
- The average annual total precipitation captured at Caldwell Essex County Airport since 1991 is 45.6 inches.

Climate data reported in this chapter was retrieved from the Office of the New Jersey State Climatologist at Rutgers University.

Figure 15. Average Annual Temperature, Essex County, 1895-2024

Source: ONJSC Climate Tables

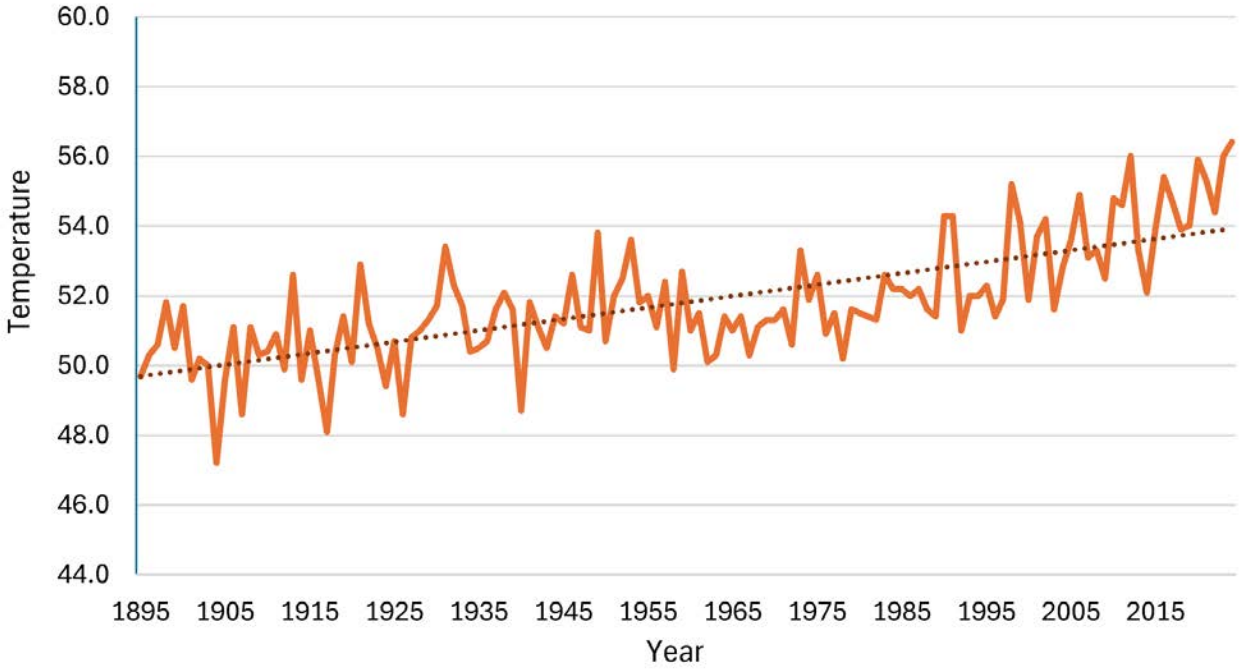


Figure 16. Annual Heating Degree Days, Essex County, 1895/1896 - 2023/2024

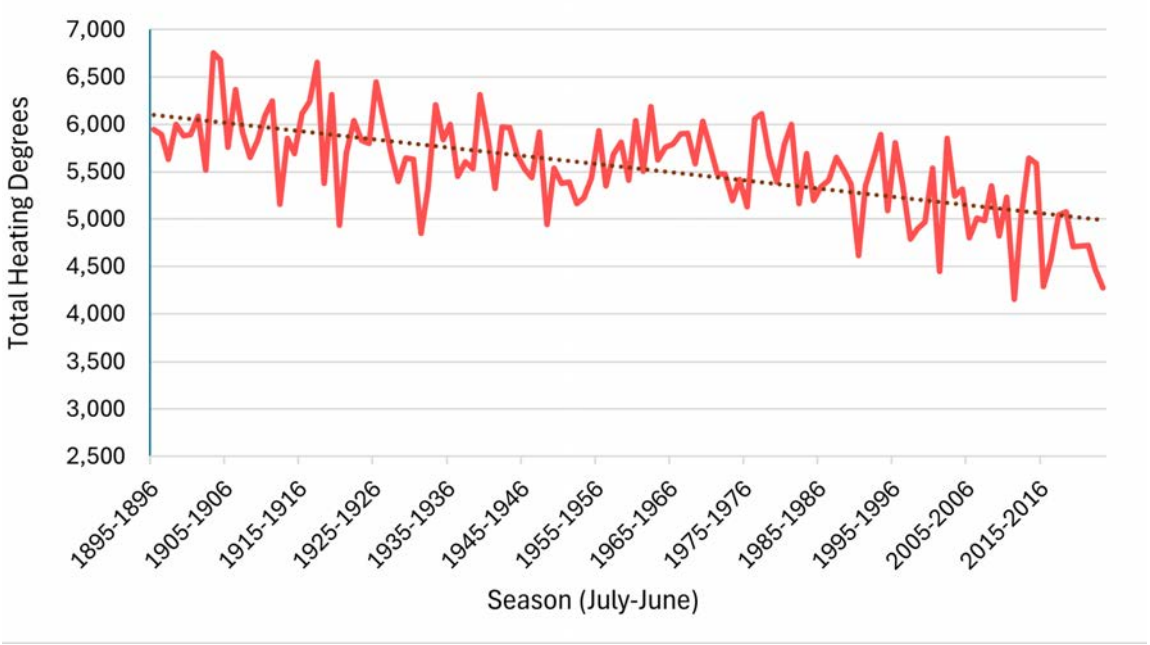
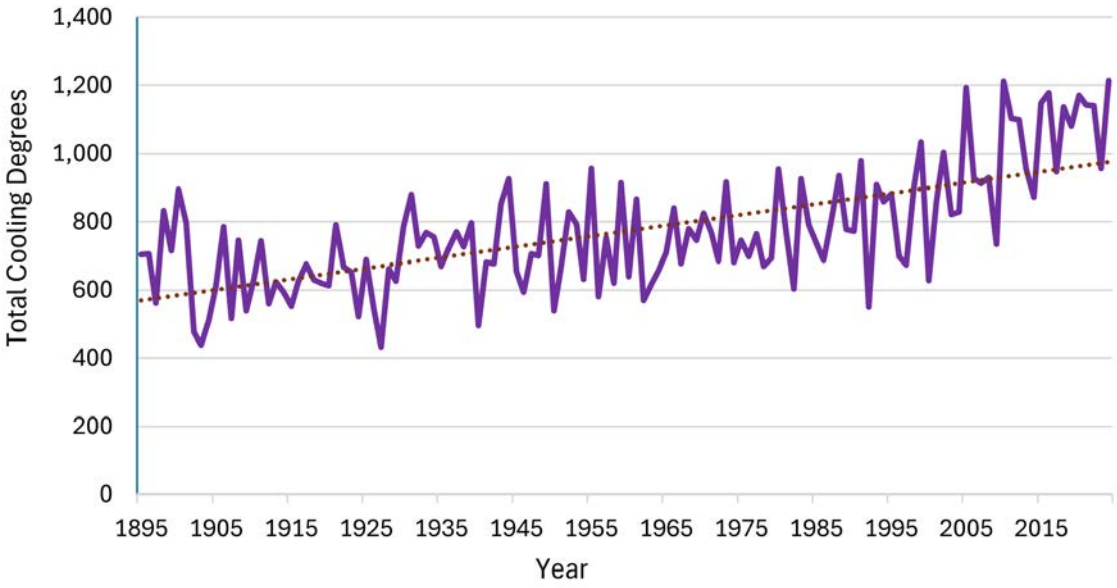


Figure 17. Annual Cooling Degree Days, Essex County, 1895-2024



Heating or cooling degree days are measured by adding or subtracting the number of degrees needed to reach 65°F on a given day. The yearly total is the sum of all degrees.

- On average, the months of July and August see the most rainfall – over 4.5 inches.

While precipitation is highly variable by nature, data from the last century shows that interannual **rainfall is becoming even more variable, with some years being drier and others being very wet. Figure 18** shows the total annual precipitation in Essex County, 1895-2024.

Snowfall

In records from the 1949/1950 season to present, the average annual snowfall measured at Canoe Brook is 28.3 inches. However, Canoe Brook records are missing data from several months and years. The station at Newark Liberty International Airport has kept more consistent records over the years since 1931/1932, though it is farther from Caldwell and nearer to the coast. The historic mean snowfall at Newark Airport is 27.8 inches **(Figure 19)**. A total of 12.2 inches of snow was measured in 2023-2024.

Climate Extremes

Rising Temperatures

Temperature data has been recorded and aggregated for Essex County since 1895. **Table 13** displays the record monthly average temperatures and the year in which they were recorded. Record-breaking temperatures that have occurred since 2010 are highlighted in light red, and those since 2020 are darker red. The first column shows the highest average temperature for each month and the year in which it occurred; for example, January 2023 had a higher monthly average temperature (taken as the mean of daily average temperatures) than any previous January on record. Average temperatures account for the full 24-hour day, including nights.

All twelve months have seen their highest average temperature in years since 2007. January, June, July, and August had record high averages within the last five years. June of 2024 was the hottest June

Table 12. Monthly Average Precipitation, NJ Division 1 (North), 1895-2024

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
POR Mean	3.41	3.05	3.84	3.94	4.09	4.09	4.79	4.64	4.11	3.77	3.61	3.85	47.20
30yr Normal	3.50	2.79	4.01	3.90	4.02	4.61	4.72	4.56	4.46	4.45	3.47	4.25	48.72
Monthly Average Precipitation, Essex County, 1895-2024													
POR Mean	3.51	3.22	4.03	4.01	4.12	4.01	4.72	4.65	4.12	3.82	3.74	3.97	47.95
30yr Normal	3.46	2.86	4.11	3.94	4.00	4.57	4.60	4.46	4.32	4.34	3.58	4.33	48.58
Monthly Average Precipitation, Caldwell Essex County Airport, 1999-2024													
Mean	2.85	2.43	3.66	3.95	3.70	4.16	4.32	5.03	4.01	4.05	3.20	4.21	45.60

Source: Office of the New Jersey State Climatologist[106]

Figure 18. Annual Precipitation, NJ Division 1, 1895-2024

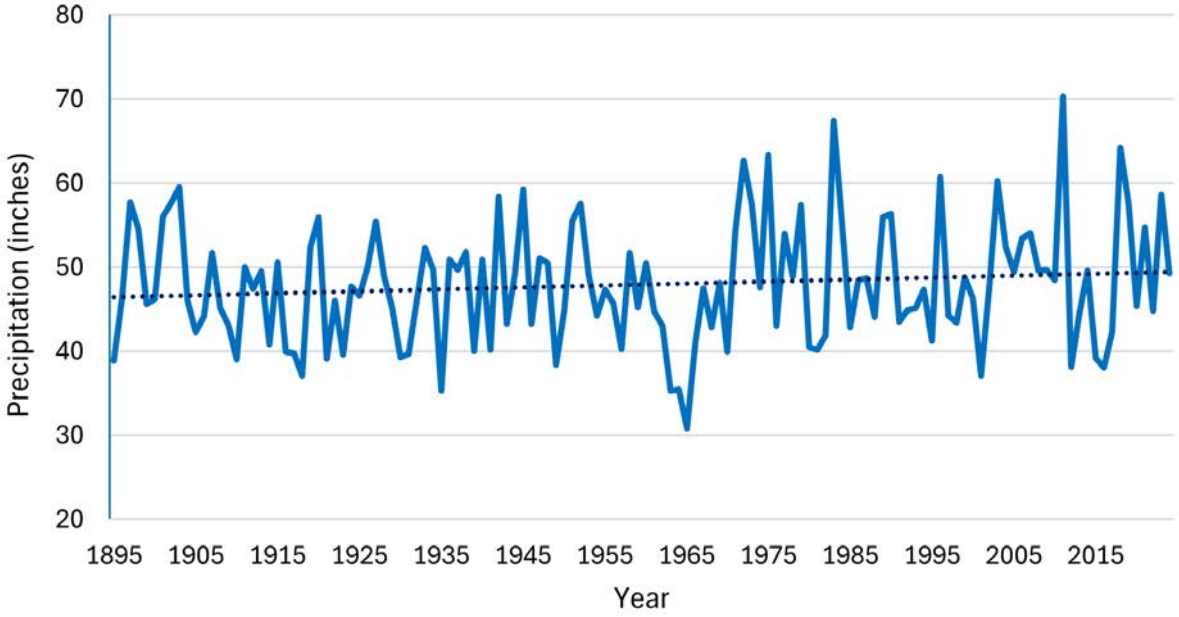
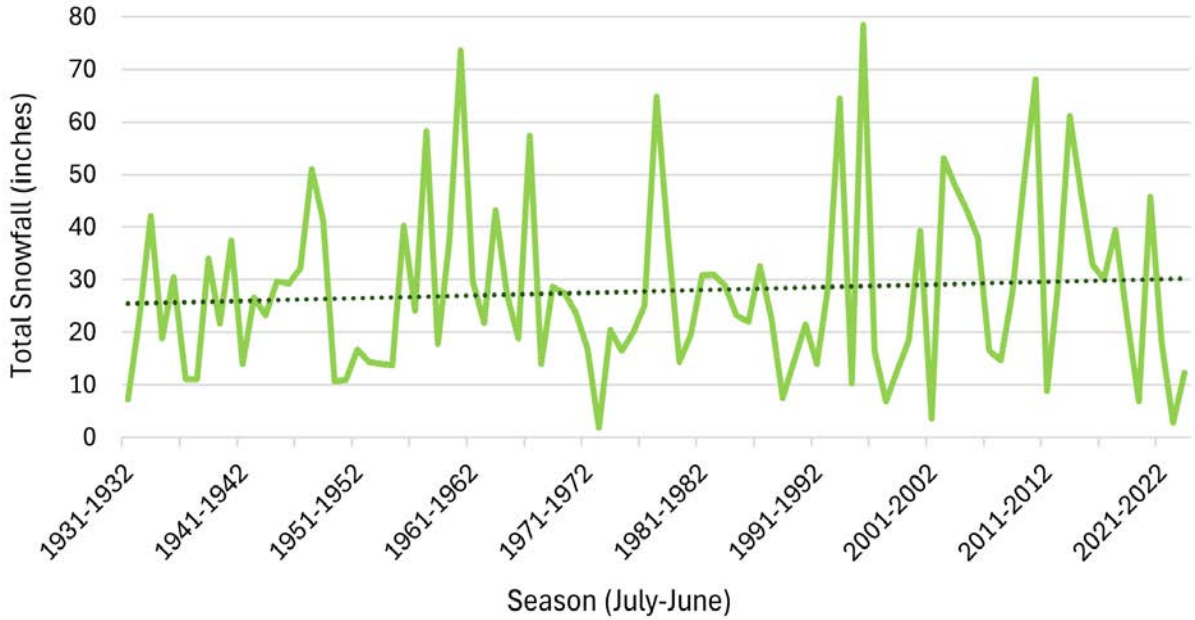


Figure 19. Annual Snowfall, Newark Liberty International Airport, 1931/1932-2023/2024



on record, with an average temperature of 74.5°F. No new record average lows have been recorded since 1989. This data indicates a steady increase in average year-round temperatures, with new highs being reached in both the summer and winter.

Aside from the steady rise in average temperatures, data shows that very hot days are getting hotter and more frequent. Highest monthly average maximum temperatures are shown to the right in the table below. The highest maximum temperatures of all days in June 2024 average to 85.6°F, beating all previous Junes on record. The same record was broken in 2022 for the month of August, which had an average maximum temperature of 88.2°F.

Drought

A drought is a period characterized by long durations of below-normal precipitation that can affect agriculture, water supply, aquatic ecology, wildlife, and plant life. Drought can affect virtually all climate zones. Like much of New Jersey, Caldwell is a typically water-rich environment with frequent and substantial precipitation. While annual precipitation totals are on a rising trend overall, there have also been changes in the intensity and variability of precipitation events throughout the year. While large storms are occurring more frequently and with greater intensity, this is coupled with very dry periods and drought during other times of the year.[107]

Drought conditions in the U.S. are assessed by the U.S. Drought Monitor, which assigns ranked categories of drought, ranging from Abnormally Dry

Table 13. All-time Record Monthly Average Temperatures and Temperature Maximums, Essex County, 1895-2024

Month	Highest Monthly Avg. (°F)	Year of Record High	Lowest Monthly Avg. (°F)	Year of Record Low	Highest Monthly Avg. Max (°F)	Year of Record High
January	41.5	2023	18.3	1918	48.4	1932/2023
February	39.6	2017	16.9	1934	49.0	2002
March	50.0	2012	29.9	1916	60.4	1945
April	56.1	2017	44.2	1907/1943	68.4	2010
May	66.5	2015	52.7	1917	78.8	2015
June	74.5	2024	62.7	1903	85.6	2024
July	79.8	2020	69.6	1895	90.9	1999
August	77.8	2022	66.2	1927	88.2	2022
September	71.3	2015	60.5	1917	83.1	2005
October	61.8	2007	47.1	1925	73.0	1947
November	49.8	2015	36.2	1901	60.1	2001
December	47.5	2015	22.1	1989	55.4	2015
Source: Office of the New Jersey State Climatologist						

(D0) to Exceptional Drought (D4).[108] This assessment clarifies conditional risks for environmental, social, and economic factors:

- In Moderate Drought (D1) conditions, irrigation use increases, and trees, vegetation, and fish become stressed. Reservoir and lake levels are below normal capacity and water conservation is requested. There is greater risk for wildfire and ground fires.

- Severe Drought (D2) conditions have negative effects on water quality and groundwater availability, crop yields, wildlife survival, and forest health. There is a higher risk for fires and poor air quality.

- Extreme Drought (D3) conditions bring widespread loss of crops, dry wells and extremely reduced flows of surface water, high river temperatures, and wildlife disease. Efforts to conserve water are recommended, warnings are issued, and outdoor activities such as hunting and water recreation may be limited.

The Essex County Hazard Mitigation Plan (HMP) was updated in 2020 to outline vulnerability and mitigation strategies for environmental risks including drought. The County is described as vulnerable to drought due to its dense population and reliance on above-ground reservoirs for water supplies. The risk assessment cites several drought events that occurred in Essex County between 2014 and 2019 **(Table 14)**.[109]

In the fall of 2024, New Jersey entered historic drought conditions. There was less rainfall in October than in any previous year on record—measuring a statewide total of 0.02 inches. September was the third driest on record, bringing total precipitation for September and October 2024 to 0.8 inches. This is 0.55 inches lower than the previous month-pair record of December 1980/January 1981.[110]

Since October 2024, conditions across the state have ranged from moderate to extreme drought. As of January 2025, the U.S. Drought Monitor indicates Essex County is in a period of Moderate Drought (D1), while much of South Jersey remains in Severe (D2) and Extreme (D3) conditions.[111]

Tropical Storms

Tropical storms, nor'easters, hurricanes, seasonal thunderstorms, and flooding rains are the typical extreme weather events in New Jersey. These are low-pressure weather systems that bring heavy rain, high speed winds, and potentially other hazardous phenomena like lightning strikes and tornadoes. The state experiences at least one coastal

Table 14. U.S. Drought Monitor Events for Essex County, 2014-2019

Date of Event	Conditions
Sept. 9 - Dec. 1, 2014	D0
May 5 - June 23, 2015	D0, D1
Aug. 11 - Jan. 25, 2016	D0, D1
Apr. 19, 2016 - Apr. 10, 2017	D0, D1, D2 - forest fire and drought watch
Oct. 3 - 30, 2017	D0 - fall leaves dropping prematurely
Dec. 5, 2017 - Feb. 12, 2018	D0 - drinking water in reservoirs low

Source: Essex County HMP

storm event per year, but some years see as many as 5 to 10 storms.[112]

NOAA defines tropical cyclones, including tropical storms and hurricanes, as rotating, organized systems of clouds and thunderstorms that originate over tropical or subtropical waters.[113] Hurricanes are distinguished by maximum sustained winds of over 74 mph. They typically occur between summer and late fall. On the other hand, nor'easters are fueled by the interaction of colder air with warmer coastal air above the Atlantic Ocean. They travel northeastward along the East Coast, typically between the months of October and April.

Severe storms have had impacts in Caldwell in recent years, bringing strong winds, flooding, and damage to property in the Borough. During a strong thunderstorm in August 2018, Caldwell received nearly five inches of rain.[114] Streams overflowed their banks, causing severe damage to the municipal building, public library, and municipal parking deck.

In September of 2021, Hurricane Ida brought torrential rains and flash floods across New Jersey, causing at least 25 fatalities. Essex County received over eight inches of rain during the storm. The Borough's public library sustained extensive damage, leading to the building's permanent closure.[115]

For more information on flood risks in Caldwell, see **Chapter 8: Riparian & Flood Zones**.

Landslides

The NJDEP defines landslides as geologic hazards that occur in areas with steep to moderate slopes, or under geologic units that are prone to failure.[116] Landslides can be triggered by destabilization of the slope, which may be due to construction and development, deforestation, heavy rains, or a combination of impacts. While no landslides are recorded in NJDEP records, Caldwell lies in the zone of "moderate susceptibility."[117]

Earthquakes

While infrequent and typically minor, earthquakes have been recorded for over two centuries in New Jersey. Earthquakes tend to occur more frequently along the fault lines in North-Central New Jersey, such as the Ramapo Fault.[118] Several small earthquakes (magnitude of 2 or lower) have been recorded with epicenters near Caldwell in recent years, in towns such as Orange and Clifton City.[119]

The largest earthquake on record in New Jersey struck in April 2024 and had several aftershocks. The magnitude 4.8 earthquake saw its epicenter in Tewksbury Township, approximately 30 miles west of Caldwell.[120] It caused damage to buildings and infrastructure in northern New Jersey and New York City. Effects could be felt in Caldwell, but no damage or injuries were reported.[121]



Rain Garden at First Presbyterian Church
Photographer: Warren Marchioni

Chapter 10.

Climate Change

Climate Change: NJ Impacts

Due to its geography, high population density, development patterns, and abundance of coastline, New Jersey sees local impacts from climate change more strongly and quickly than other places.[195]

The most direct impacts of climate change include increases in:

- Temperature;
- Variability of precipitation;
- Frequency/intensity of storms;
- Sea-level rise; and
- Ocean acidity.

The release of carbon dioxide and other greenhouse gases (GHGs) into the atmosphere has come to impact climate conditions across the planet, having complex effects on ecosystems, natural resources, the health of communities, and the economy. GHGs affect the rate at which heat from the Earth radiates back into space. Most GHGs are naturally occurring, playing a regulatory function in atmospheric temperature. However, human and industrial activities release excess GHGs and other climate pollutants, creating an increased concentration in the atmosphere. As a result, more heat is retained in the atmosphere for longer periods. This phenomenon impacts planetary temperatures and weather patterns, causing many spillover effects.

The NJDEP has a multi-level strategy to monitor and manage the impacts

of climate change, to support climate adaptation efforts throughout the state, and curb emissions statewide. Several reports have been published to help state and local decision-makers respond to climate change, including the 2020 New Jersey Scientific Report on Climate Change.[122] Informing these efforts, the New Jersey Climate Change Resource Center at Rutgers University releases an annual State of the Climate Report which provides up-to-date information on climate trends and projections.[123]

Warming Temperatures

Global temperatures have increased by roughly 2°F since the late nineteenth century and have been rising more rapidly since the 1970s. New Jersey's temperatures have risen by approximately 4°F, roughly 1.4 times the global average over land.[124] The World Meteorological Organization projects that 2024 has been the warmest year on record, topping the previous record of 2023.[125] Climate data from the ONJSC indicates that New Jersey is warming faster than the rest of the northeastern U.S. and the world. New Jersey is projected to warm by 4.1 to 5.7°F by 2050.[126]

Figure 20 from the NOAA state Climate Summary shows the gradual historic rise in near-surface air temperatures in New Jersey and projects two future scenarios: one where GHG emissions continue to increase (higher emissions), and one where GHG emission increase at a slower rate (lower emissions).[127]

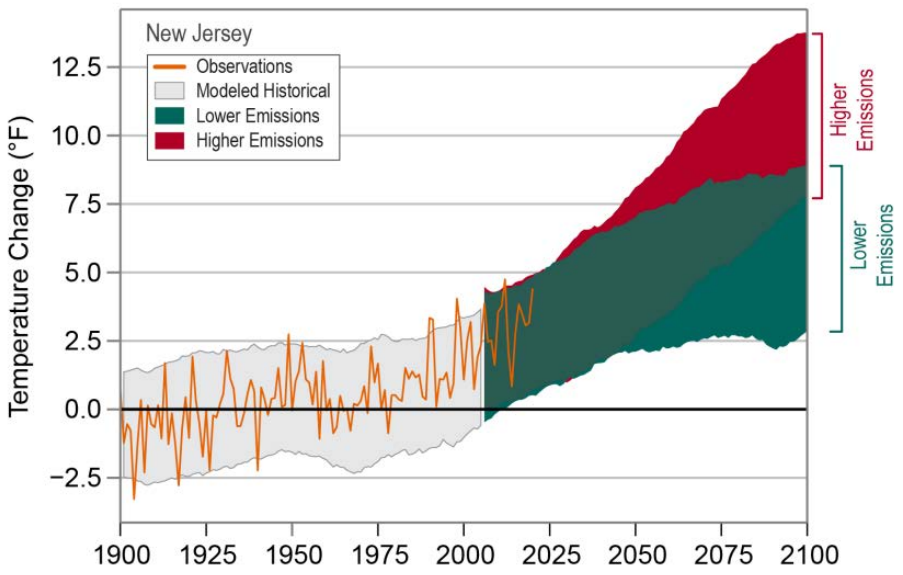
In future decades, warming is expected to occur at unprecedented rates. If we are able to curb emissions, we could expect a slower rate of warming, as shown in the lower emissions scenario.[128] The effects of rising temperatures will lead to more intense heatwaves, causing increased water and energy demand, air pollution, stress on agriculture and crop yields, and human health effects associated with heat-related illness, declining urban air quality, and ozone exposure.

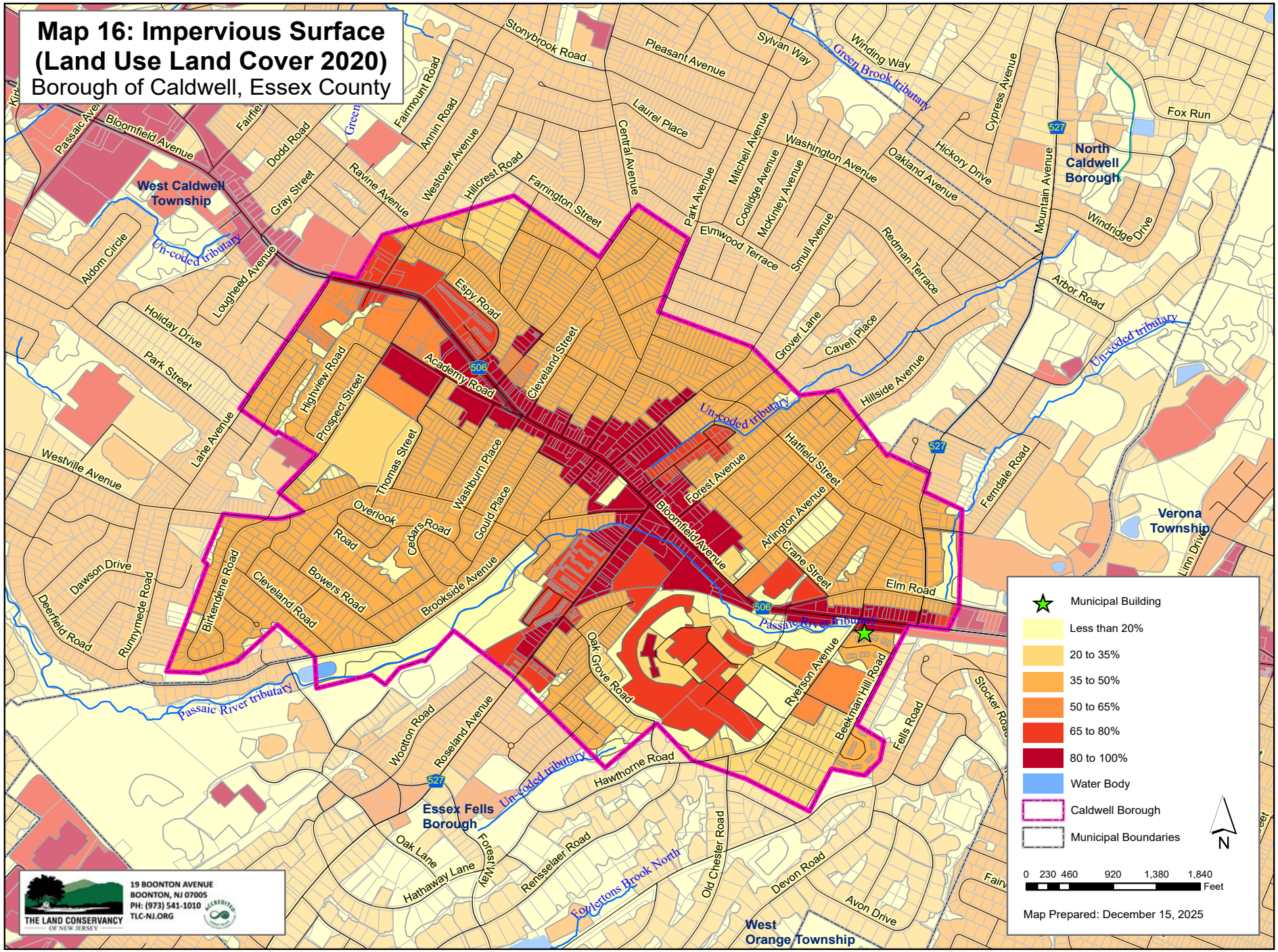
Impervious Surface

With a rapidly urbanized world, adapting urban and suburban areas to climate change is one of the challenges local government leaders face. **Map 16** shows the concentration of impervious surface coverage in Caldwell. The darker areas indicate higher levels of impervious surface. 55% of Caldwell has 35-50% impervious cover, with the Bloomfield Avenue commercial corridor between 80-100% impervious (12% of the Borough).

Figure 20. Observed and Projected Temperature Change in New Jersey, 1900-2100

Source: NOAA, Climate Summary for NJ




Map 16: Impervious Surface (Land Use Land Cover 2020)
Borough of Caldwell, Essex County
West Caldwell Township
North Caldwell Borough
Verona Township
Essex Fells Borough
West Orange Township
Municipal Building
Less than 20%
20 to 35%
35 to 50%
50 to 65%
65 to 80%
80 to 100%
Water Body
Caldwell Borough
Municipal Boundaries
N
0 230 460 920 1,380 1,840
Feet
Map Prepared: December 15, 2025
THE LAND CONSERVANCY OF NEW JERSEY
19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973) 541-1010
TLC-NJ.ORG

Urban Heat Island Effect

Higher impervious surface cover has been connected with elevated urban temperatures impacting the health and well-being of local residents and increasing the consumption of energy and emissions of greenhouse gases.[129] Known as the heat island effect, areas of dense urban development experience higher temperatures than surrounding areas, especially during the hot summer months. Concrete and other impervious materials tend to absorb more heat from the sun and retain it for longer, causing hotter days as well as nights. **Figure 21** shows typical land surface temperatures on hot days in Caldwell using records from summer of 2022.[130]

On a hot summer day, exposed urban surfaces like roofs and pavement can be 50 to 90°F warmer than the air, while shaded or moist surfaces remain close to air temperatures.[131] As a result, heat-related risks to human health can be much higher among people who live and work in urban areas. These risks are exacerbated by the increase in air pollutants that is observed during hot conditions, due to high energy usage and increased evaporation of particulate matter components.

Extreme surface temperatures (113 to 162°F) occur in the downtown core along Bloomfield Avenue. Here, there is a stretch of land with high concentrations of pavement, buildings with large footprints, and little tree canopy. In this area, the effects of urban heating are more likely to pose risks to health. In residential neighborhoods beyond

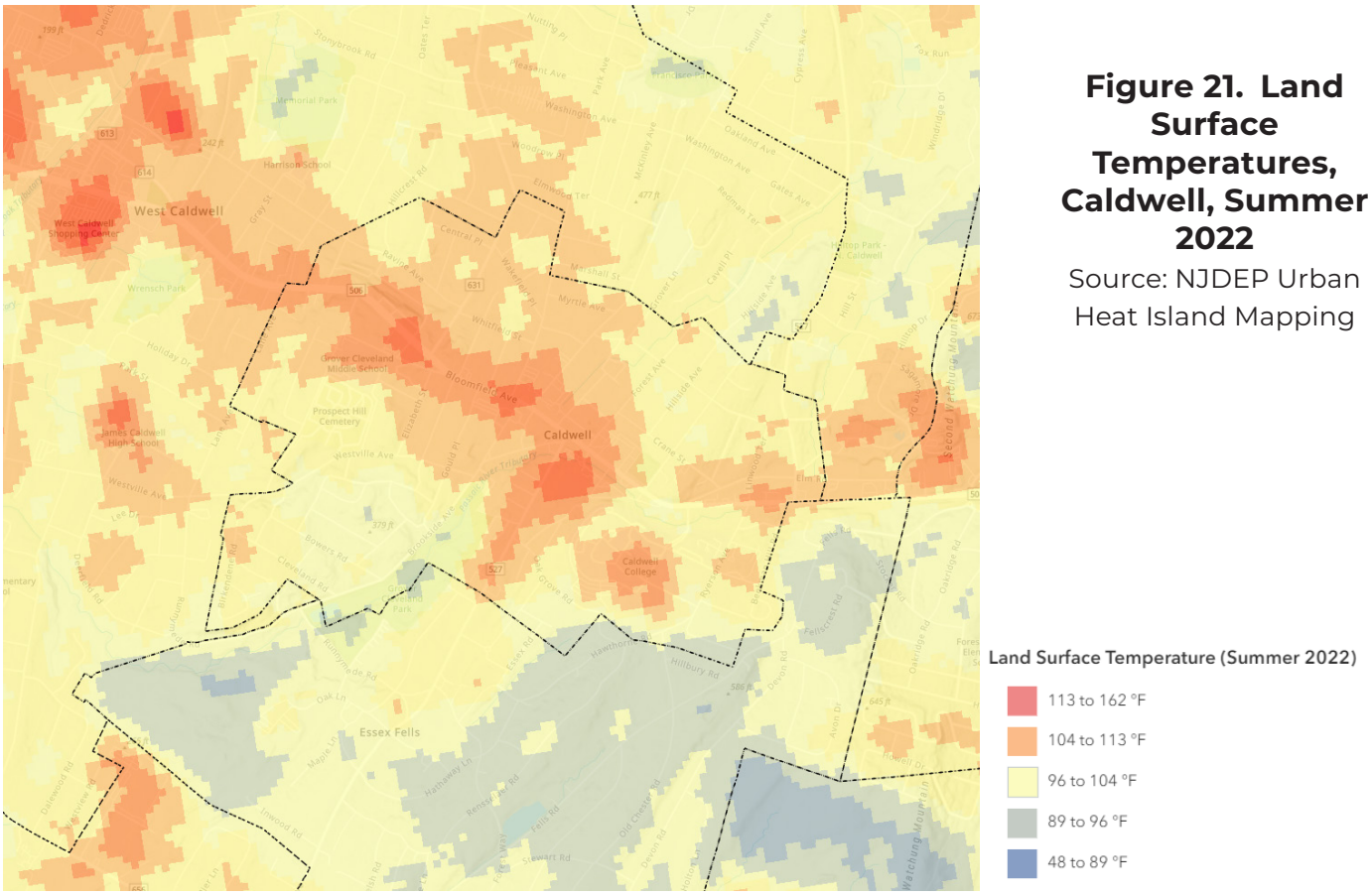


Figure 21. Land Surface Temperatures, Caldwell, Summer 2022

Source: NJDEP Urban Heat Island Mapping

the core, this effect is mitigated by a stronger presence of street trees and vegetation. The coolest locations are found in parks and areas of heavy tree canopy, such as Grover Cleveland Park, and neighborhoods along the border of Essex Fells.

The effects of severe heat islands can be curbed through green infrastructure and urban design interventions. Some strategies to reduce urban temperatures while improving community health and wellbeing include: the addition of vegetation and street trees to increase canopy cover and shade, light-colored roof surfaces, green roof projects, and reduction of paved impervious surface where possible.[132]

Health Effects of Heat

The increased frequency and severity of heatwaves pose direct risks to human health and wellbeing, increasing rates of heat stress and air pollution in the summer, and causing higher spread of disease in winter.[133] These risks are higher in densely populated urban areas that tend to be warmer and have fewer sources of shade to mitigate temperatures. It is estimated that within the 2020s, climate change could lead to a 55% increase in summer heat-related mortality.[134]

Heat Hub NJ is a comprehensive online portal of resources regarding extreme heat in New Jersey. While there is not an official network of cooling centers in the state, the Chill Out NJ initiative provides an interactive map of public indoor spaces that can provide relief from the heat.

The Rutgers Climate and Energy Institute (RCEI) was formed in 2023 to combine the expertise of Rutgers' Climate Institute, Energy Institute, and Institute of Earth, Ocean, and Atmospheric Sciences.

The RCEI website is a hub for up-to-date climate data, news, and research.

Populations who may be more vulnerable to heat risks include infants and children, older adults, workers, athletes, and individuals with existing health conditions or disabilities. Vulnerability can be exacerbated by socio-economic conditions when people are unable to improve their living or working conditions during times of extreme heat. Heat stress can cause short- and long-term damage to physical, mental, and behavioral health. Cardiovascular and respiratory problems are known to worsen with exposure to extreme heat.

The Heat Vulnerability Index (HVI) was created at the NJ Climate Change Resource Center at Rutgers University. The HVI accounts for population demographics such as age, health status, and overburdened community indicators, in addition to environmental factors like tree canopy cover and air pollution exceedances. **Figure 22** shows census tracts with the highest heat vulnerability in Caldwell.

Several New Jersey-based initiatives, including the Interagency Council on Climate Resilience, are working to mitigate extreme heat risks in

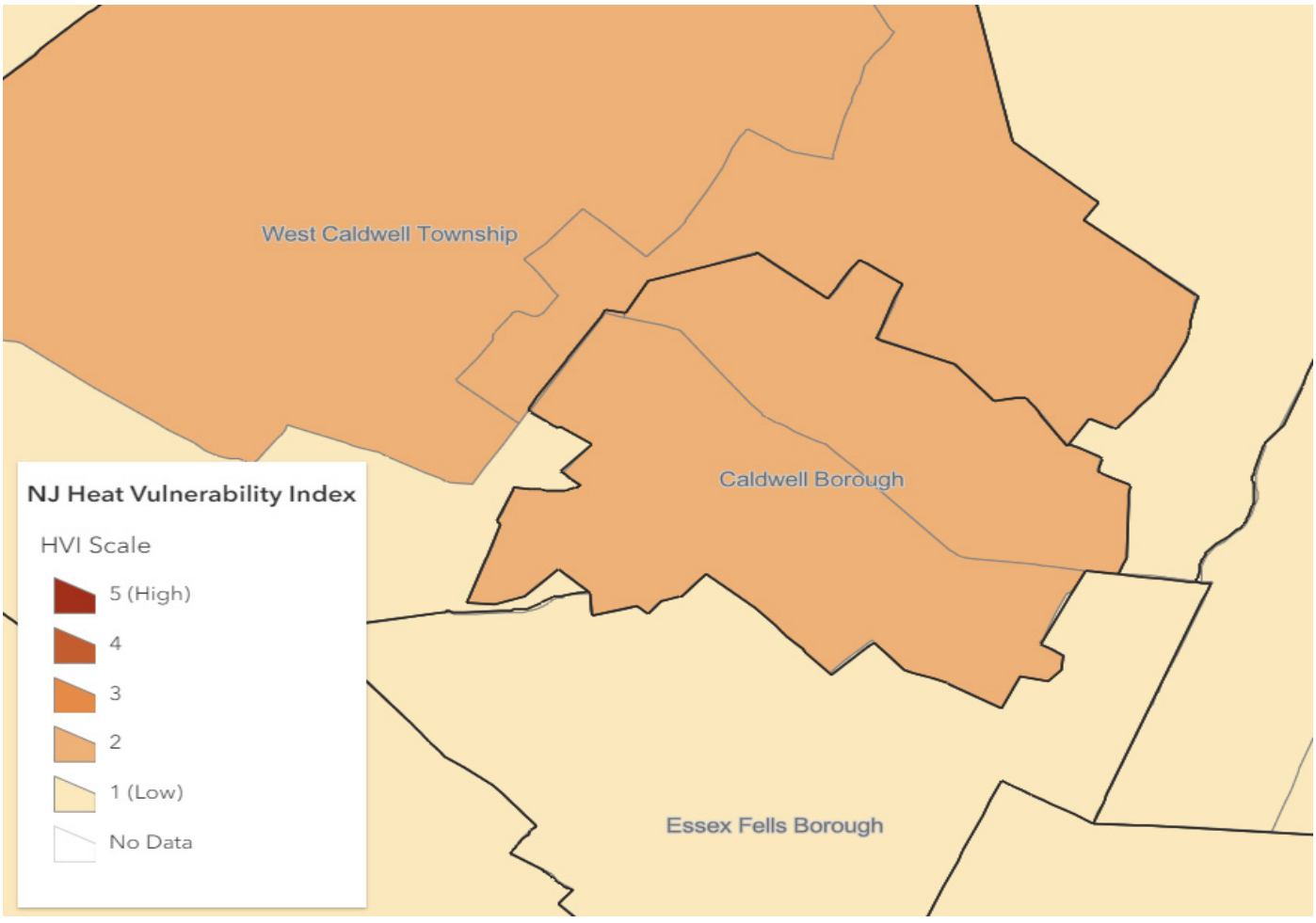
communities and increase protective measures for vulnerable populations. Heat mitigation is built into the State of New Jersey's Climate Change Resilience Strategy, which advocates for heat-resistant infrastructure adaptations, the deployment of urban greening, and community forestry.[135]

For more information on extreme heat, urban heating, health risks, and mitigation in New Jersey, see the Extreme Heat Resilience Action Plan. (https://dep.nj.gov/wp-content/uploads/climatechange/extreme_heat_rap_071924-screen-version.pdf)

Extreme Weather Events

Climate change is associated with the increased frequency and severity of tropical storms, thunderstorms, hailstorms, windstorms, and tornadoes. New Jersey's location on the northeastern coast exacerbates the risk of tropical storms and exposure to high-speed winds. Northern New Jersey's 1971-2000 precipitation average was over five inches higher than the average from 1895-1970[136], and the average annual precipitation in the region is projected to increase by 4 to 11% by the 2050s.[137] Higher temperatures and humidity can bring about more severe storms whose effects pose threats to people and property. The Borough of

Figure 22. NJ Heat Vulnerability Index, Caldwell
Source: Rutgers ArcGIS Online



Caldwell is susceptible to flooding during extreme weather events. For a detailed account of the Borough's flood history and the mitigation strategies that have been introduced, refer to **Chapter 8, Riparian & Flood Zone**s.

Wildfires

With increased temperatures and frequency of drought conditions, wildfires are worsening across North America. In 2023, the scientific nonprofit Climate Central issued the report Wildfire Weather: Analyzing the 50-year shift across America. It identifies three weather elements that are key factors in fire risk weather: relative humidity, hot temperatures, and wind.[138]

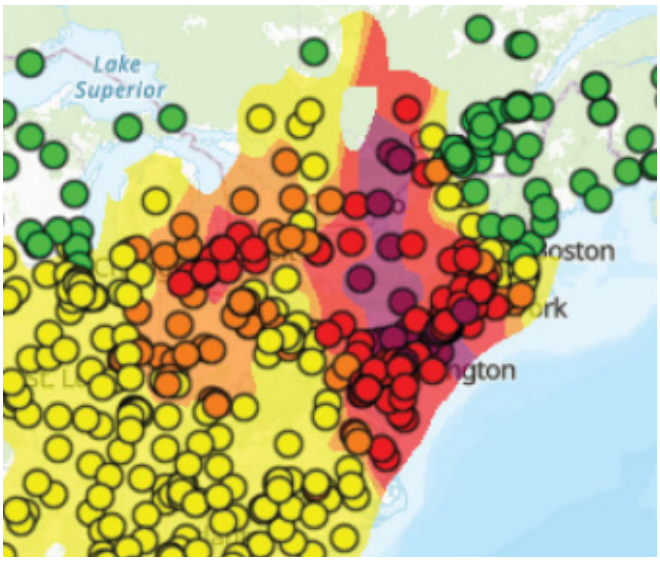
Wildfires are regular occurrences in the woodlands of New Jersey, even in the urban-suburban landscapes of Essex County. Most recently, on April 22, 2025, a wildfire broke out in Eagle Rock Reservation in West Orange (4.5 miles from Caldwell). It was contained but required the services of local fire departments, the County, and the NJ Forest Fire Service.[139]

In 2023, major wildfires in Canada burned over 32 million acres of land over the course of May and June.[140] Several fires grew out of hot temperatures and dry conditions, and one was triggered by a lightning strike, spreading rapidly due to dry, hot temperatures and strong southeasterly winds. Smoke from these wildfires was carried southeastward over New Jersey, causing severe levels of particulate matter in the air and reduced visibility. The USEPA reported "very unhealthy" air quality levels on several days (**Figure 23**).

Wildfires affect human health when particulate matter enters the lungs.

Figure 23. PM2.5 Air Quality Index in Northeastern US, June 7, 2023

Source: NJ State of the Climate 2023



AQI Number:	Level of Health Concern:	Color:
0-50	Good	Green
51-100	Moderate	Yellow
101-150	Unhealthy for Sensitive Groups	Orange
151-200	Unhealthy	Red
201-300	Very Unhealthy	Purple
301-500	Hazardous	Maroon

Especially in people prone to illness, smoke has potential to trigger asthma attacks, heart attacks, strokes, and mortality. Wildfires can also cause exposure to carbon monoxide and black carbon (soot), as they release several greenhouse gases into the air.

About 85% of wildfires in the United States are caused by human activity, such as burning debris, unattended campfires, improper disposal of cigarettes, or other irresponsible fire uses. In New Jersey, nearly 99% of wildfires are attributed to human causes. Wildfires can be expected to cause future risks to human health, property, and ecosystems.

Ecosystem Impacts

Climate change will have a wide range of impacts on the health and integrity of natural ecosystems. Changes in temperature and weather patterns cause shifts in species populations as they migrate and adapt to new conditions. Loss of critical habitat and resources may cause species to fall into threatened conditions. The USDA Forest Service modeled the impacts that climate change will have on forests and trees of the Mid-Atlantic region, which spans from Maryland to New York State.[141]

The Forest Service predicts that forestland will continue to be affected by increased temperature and precipitation, drought, and wildfire risk; and that these risks will increase over time. Changing conditions will alter patterns of tree regeneration and recruitment, while increasing suitability of southern species and decreasing suitability for northern species. Damage to forest ecosystems from invasive plants, pests, and pathogens is anticipated to increase.

The remaining forest of Essex County could see substantial changes to its character under long term climate change. Alteration and loss of forest habitat may threaten the survival of species that rely on these ecosystems.

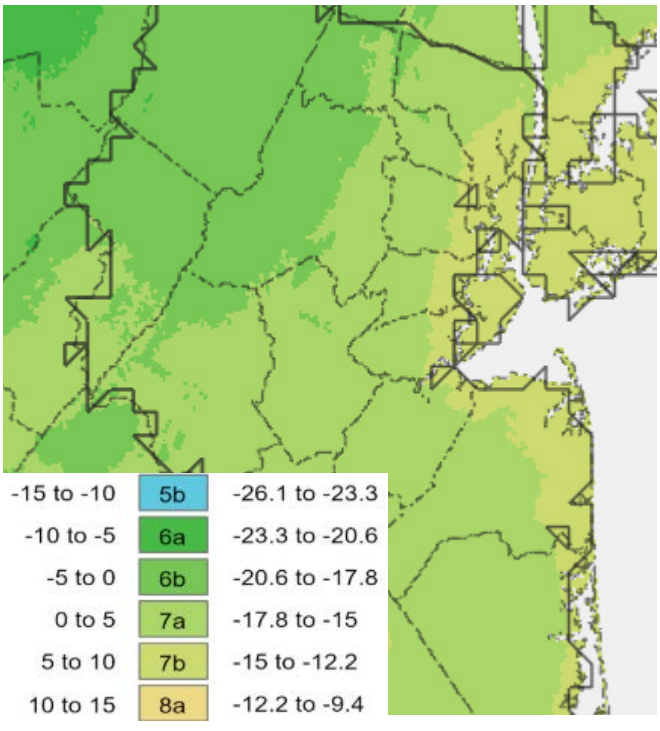
The USDA defines geographic areas into Plant Hardiness Zones, which indicate the extent of overwintering stress that plants can survive in a given area. These zones are based on average annual extreme minimum temperatures and are used by horticulturists to assess the cold hardiness of plants and their suitability for specific regions. The USDA divides the country into 11 zones, each separated by increments of 10°F (5.56°C).

Due to warming temperatures, these zones have shifted, altering the geographic ranges where different plant varieties can thrive. In 2023, the USDA released an updated Plant Hardiness Zone Map (**Figure 24**), which reclassified Caldwell from Zone 6b (-5 to 0°F) to Zone 7a (0 to 5°F). This change reflects a general temperature increase of approximately 3°F. The new Zone 7a designation should be considered when choosing plant varieties for gardens and parks, ensuring that they are suited to the region's updated climate conditions.

Species Migration

The natural ranges of species and ecosystems are shifting, with complex effects on local plants and wildlife. Rising temperatures, altered weather patterns, and extended growing seasons are driving a northward migration of many plant and animal species. These changes are also accelerating the spread

Figure 24. Updated USDA Plant Hardiness Zones, 2023



of invasive species, which are often highly adaptable and capable of out-competing native species. In some cases, warmer temperatures and elevated CO_2 levels create favorable conditions for these invaders.

Climate Mitigation

Reducing Green House Gas Emissions

New Jersey is especially vulnerable to the impacts of climate change due to its coastal geography and population density. Curbing these impacts will require significant permanent reductions in global GHG emissions in the coming years. The effects of lowered emissions will take time to show, however; even in the case of moderate emission reductions, the Intergovernmental Panel on Climate Change (IPCC) estimates a 5.4°F (3.0°C) rise in global temperatures by 2100.

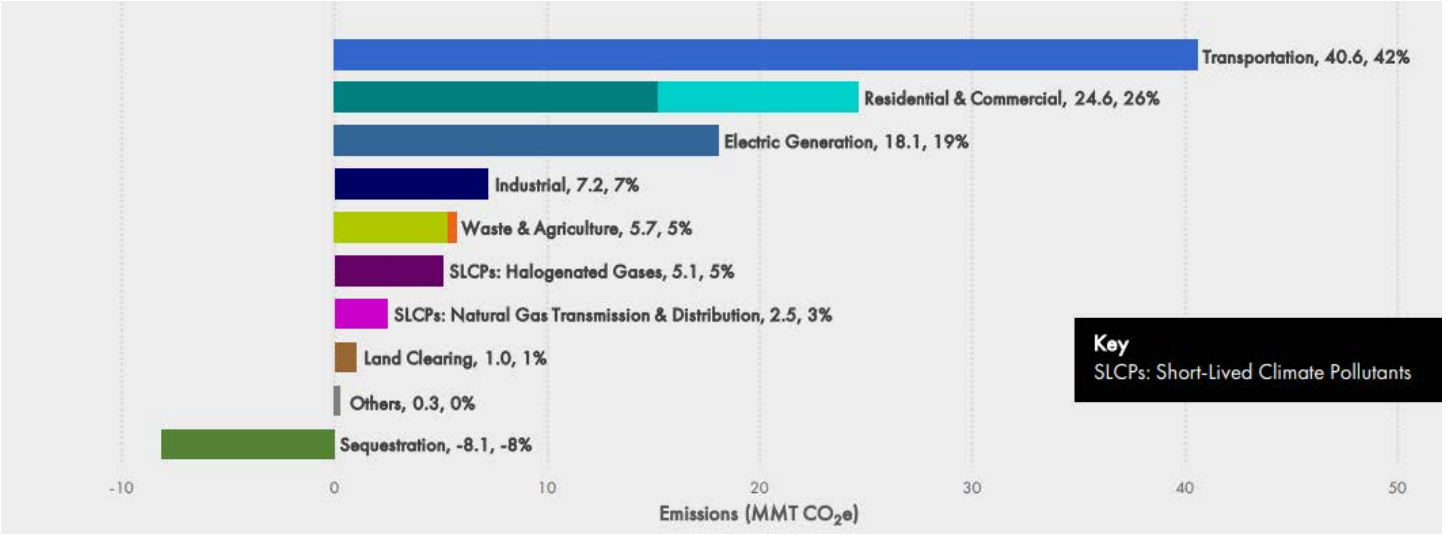
New Jersey Legislature enacted the Global Warming Response Act (GWRA) in 2007 to address the need to reduce GHG emissions. The GWRA establishes the aim to reduce statewide greenhouse gas emissions to 80% below the 2006 level by the year 2050 (the "80x50" goal). In 2006, New Jersey's net CO2 emissions totaled 120.6 million metric tons (MMT), which sets the 80x50 net emission goal at 24.1 MMT CO2 by 2050.

In 2020, the State of New Jersey published the 80x50 Report to illustrate current emission levels and promote reduction strategies across sectors. **Figure 25** shows the breakdown of GHG emissions by sector. The largest source of GHG emissions in New Jersey is transportation (42%), followed by residential and commercial sectors (26%) and electric generation (19%). The 80x50 Report identifies strategies and opportunities for reduction in each sector.

More information on New Jersey's greenhouse gas emissions can be found in the NJDEP 2024 Greenhouse Gas Inventory Report (Years 1990-2021).

Figure 25. New Jersey GHG Emissions Inventory for 2018 (MMT CO_2, Sector %)

Source: 2020 New Jersey 80x50 Report



The sequestration value (-8%) reflects the amount of carbon that is absorbed by natural carbon sinks. Ecosystems such as forests, grasslands, wetlands, and the ocean remove carbon from the atmosphere and store it as a part of natural processes. Carbon sequestration will continue to play an important role in offsetting carbon emissions. The NJDEP estimates that land management to conserve and protect carbon sinks could increase carbon sequestration to 10.8 MMT CO2e by 2050. This would require the use of all currently available open space for carbon sequestration.

Climate policies are continuing to push New Jersey in the direction of GHG reduction goals. The Energy Master Plan: Pathway to 2050 was released in 2019, outlining strategies to transition New Jersey's electrical grid to 100% renewable by 2050. These include steps to reduce reliance on fossil fuels, expedite the deployment of wind and solar energy generation, amend building codes to promote electrification, and facilitate the adoption of electric vehicles.

Protecting Against Climate Threats
In 2020, Governor Murphy signed Executive Order 100: Protecting Against Climate Threats (PACT), which authorizes the NJDEP to make regulatory reforms to pursue the state's climate goals. The PACT initiatives is is comprised of two main parts: Climate Pollutant Reduction (CPR) and Resilient Environments and Landscapes (REAL).

Climate Pollutant Reduction. CPR is a targeted regulatory reform effort to make changes to air emissions and environmental land use. Several rules were adopted during Phase I:

- Greenhouse Gas Monitoring and Reporting Rule (GHGMR)
- Advanced Clean Truck (ACT) Program and Fleet Reporting Requirements
- Mobile Cargo Handling Equipment at Ports and Intermodal Rail Yards
- Control and Prohibition of Carbon Dioxide Emissions from Stationary Sources.

Resilient Environments & Landscapes. REAL is in the process of adoption as of November 2025. It proposes rules to address seal-level rise, coastal storm surge, flooding, and stormwater management concerns while improving water quality, protecting natural resources, and streamlining permitting processes to expedite investments in resilience. Key points of the REAL proposal include:
Adjust Coastal Flood Hazard Areas

- Create an Inundation Risk Zone for residential building and critical structures
- Improve water quality and reduce flooding through stormwater management practices
- Encourage nature-based solutions
- Support renewable energy
- Improve State alignment with FEMA's National Flood Insurance Program
- Improve NJDEP permitting processes

Clean Energy Initiatives
Renters, homeowners, and businesses in New Jersey can take advantage of state rebates and energy-efficiency partnerships through their local utility. Residents in Caldwell can participate in Residential Energy Efficiency Outreach Campaign through a partnership between Sustainable Jersey and PSE&G. Households can sign up for a free assessment to improve their home's

energy efficiency. During the assessment, professionals evaluate energy usage and may install complimentary upgrades such as smart thermostats, LED light bulbs, faucet aerators, efficient-flow showerheads, shower head adapters, advanced power strips, and water heater pipe insulation.[142]

Community Adaptation

While climate change is a global issue, the impacts are experienced locally. Priority 1 of the New Jersey Climate Change Resilience Strategy is to build sustainable and healthy communities by integrating resilience into local and regional planning. The State will continue to provide technical and financial support for municipalities to invest in resilient infrastructure, community development programs, and public health initiatives aimed at environmental, social, and economic resilience.

Local Sustainability Planning

Caldwell has been involved with the Sustainable Jersey program since 2009 and earned their third Bronze Certification from Sustainable Jersey in 2024. Sustainable Jersey certifies actions taken by municipalities in New Jersey to reduce waste, cut greenhouse gas emissions, and improve environmental equity. The certification program allows participating municipalities to score points based on their sustainability achievements and gain Bronze, Silver, or Gold status. Of the 564 municipalities in New Jersey, 466 are currently registered with Sustainable Jersey.

The Caldwell Environmental Commission and Green Team have led numerous initiatives, including Earth Day events, pollinator garden workshops, and native tree giveaways.

Environmental Justice

In the pursuit of climate resilience, the State of New Jersey has identified environmental justice as a priority concern for funding and policy initiatives, to be supported by the establishment of the Environmental Justice Advisory Council (EJAC) in 2016. Its purpose is to ensure that communities who have been disproportionately affected by environmental harms and risks, including pollution and climate change hazards, will be fairly protected in the future. It promotes climate adaptation measures that are healthy, sustainable, and resilient as well as equitable. In September 2020, Governor Murphy signed the Environmental Justice Law, which authorizes the NJDEP to deny or condition certain permits based on an assessment of a facility's contribution to environmental and public health stressors in the state's overburdened communities.

Overburdened Communities

Using Census tract data, the NJDEP has identified populations of overburdened communities (OBC) in New Jersey. These include those who have historically risked disproportionate environmental and public health stressors, while lacking environmental and public health benefits. Stressors include concentration of air pollution, contaminated sites, waste facilities, water quality issues or combined sewer overflows, maternal and prenatal health stressors, and vulnerability to climate change stressors, such as high temperatures, heat, and sea level rise. Areas are defined as OBC if they meet one of the following criteria:

- At least 35% low-income households.
- At least 40% of the residents identify as minority or as members of a state-recognized tribal community.

- At least 40% of the households have limited English proficiency.

Census tracts of Caldwell are identified as OBC for the proportion of minority residents and/or low-income households. **Figure 26** shows tracts that meet the minority criteria. OBCs are prioritized by state planning and climate adaptation policies, making additional resources available for improving environmental health in these areas.

Resilient NJ

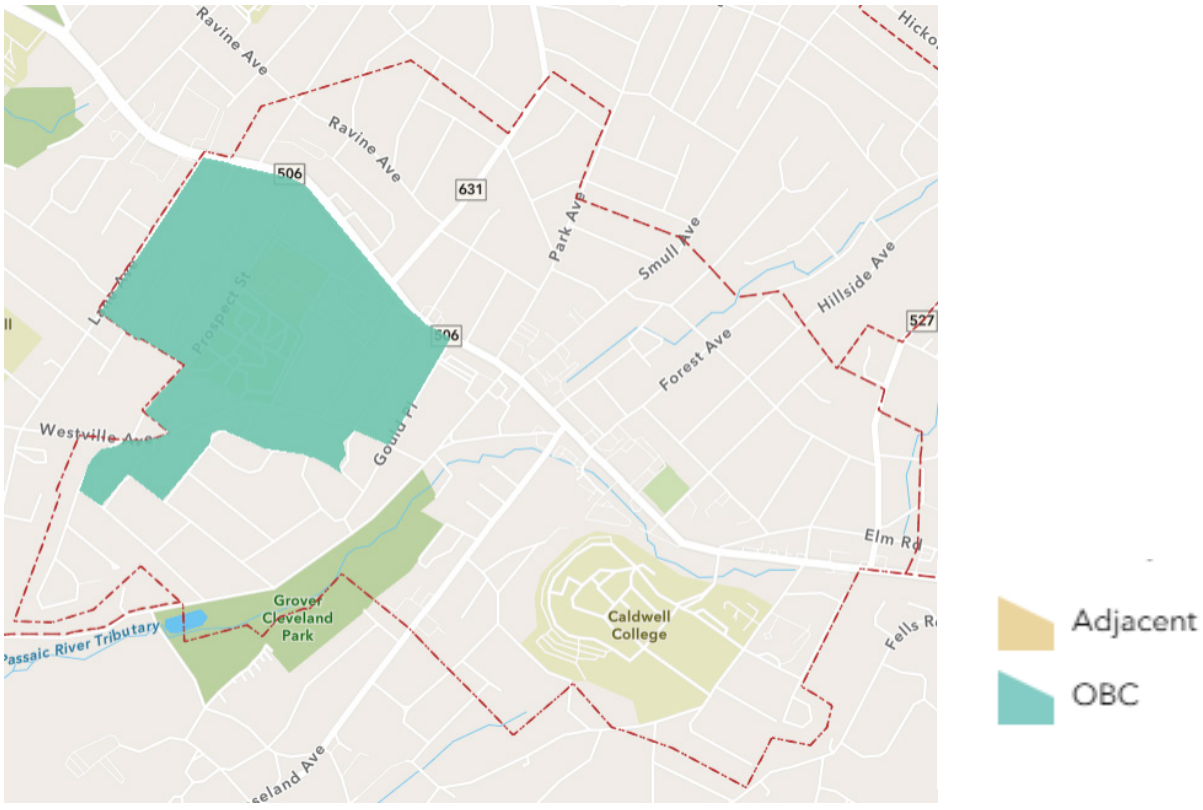
The NJDEP offers an assistance program to support local and regional climate resilience planning. Impacts of climate change can vary based on decisions around zoning, redevelopment, housing, open space, and other investment decisions by local and regional governments. Resilient NJ helps communities assess local risks and plan accordingly. The Local Planning for Climate Change Toolkit is available to help municipalities assess vulnerability and develop appropriate strategies for building resilience.

The Resilience Action Matrix contains 300 examples of resilience and adaptation projects from around the country that can be adapted for local use. Categories of actions include Local Planning & Regulations, Economic Tools & Incentives, Advancing Health & Social Resilience, Green Infrastructure & Nature-Based Solutions, and Building & Infrastructure Projects.

The Climate Resilience Funding Directory is a platform that compiles key funding opportunities for improving climate resilience, including state and federal grants. The directory simplifies the process of identifying funding for local and state governments and community organizations.

Figure 26. Overburdened Communities, Caldwell, NJ

Source: NJDEP Environmental Justice





Pollinator Garden
Photo: The Land Conservancy

Chapter 11.

Air Quality

Meteorology and Pollution

Pollution levels are affected by wind speed and direction, temperature, and solar radiation.[196] Meteorology is an important factor in the levels of ozone, as it is a secondary pollutant created from the chemical reaction of other pollutants in the presence of heat and sunshine. Particulate matter and sulfur dioxide, can reach elevated levels across the state due to downwind sources such as coal-fired power plants in the Midwest and wildfires in Canada. Nitrogen dioxide, on the other hand, is a localized problem occurring where there is heavy traffic and other use of internal combustion.

Air quality is monitored by the NJDEP Division of Air Quality. Levels of pollutants are measured to ensure that air quality levels meet national standards set by the federal Clean Air Act as well as state laws and local regulations. As of January 2025, there are 29 air quality monitoring stations across the state.[143] The recorded levels of many pollutants can vary greatly across seasons and even from day to day, depending on weather conditions and traffic patterns. Local monitoring stations help the NJDEP to assess the:

- Impacts of major pollution sources.
- Population's exposure to pollution.
- Background levels of pollutants.
- Regional pollutant transport.
- Secondary impacts in rural areas.

National Clean Air Standards

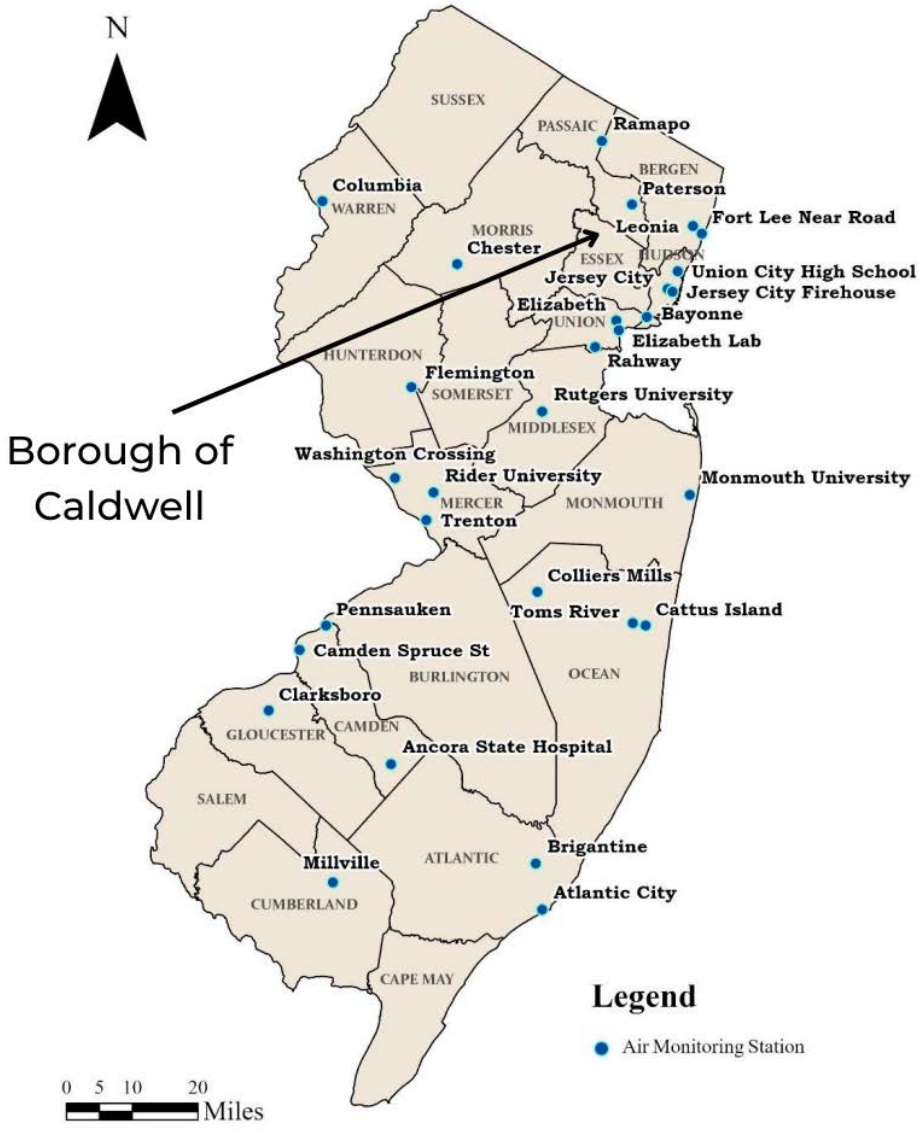
In 1970, the Clean Air Act was passed, which set air quality standards to be met throughout the country.[144] The act was amended in 1990, with a focus on four specific areas of pollution:

- Acid rain.
- Urban air pollution.
- Toxic air emissions.
- Stratospheric ozone depletion.

The amendment also introduced a permit program and strengthened the enforcement of regulations. Under the Clean Air Act, it is the responsibility of the USEPA to set National Ambient Air Quality Standards (NAAQS) for six common pollutants: ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, fine particulates, and lead. It is the responsibility of each state to develop State Implementation Plans (SIPs) to attain and maintain the established standards. In New Jersey, that role is assigned to the Department of Air Quality (DAQ).

Figure 27. New Jersey Air Monitoring Sites

Source: NJDEP 2023 Air Quality Report



When NAAQS are established or revised, the USEPA formally assesses all areas of the country as in attainment or in nonattainment.[145] Nonattainment areas for ozone, carbon monoxide, and particulate matter are classified by the magnitude of ambient air pollution in an area. Nonattainment designations may be used to specify what pollution reduction measures must be adopted in order to reach attainment.

Regional/Local Statistics

The state uses air quality data from the monitoring network to determine which areas are compliant with NAAQS and to see overall trends in air pollution levels. The NJDEP produces the yearly Air Quality Reports and provides real-time reporting through the Air Quality Index website, which draws data from air quality monitoring stations across the state.

Figure 28. NJDEP Air Quality Index Guide

Source: NJDEP 2023 NJ Air Quality Report

AQI Level of Health Concern	Numerical Value	Meaning	Color Code
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk.	Green
Moderate	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.	Yellow
Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.	Orange
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.	Red
Very Unhealthy	201 to 300	Health warnings of emergency conditions. The entire population is more likely to be affected.	Purple
Hazardous	301 to 500	Health alert: everyone may experience more serious health effects.	Maroon

The locations of air quality monitoring stations in New Jersey are shown in **Figure 27**. Since the sudden closing of the Newark Firehouse station in 2022, there are no air monitoring sites in Essex County, but sites in nearby counties can provide similar estimates. Air quality data is often aggregated, as no one site monitors all pollutants. The Elizabeth Lab Station has the most comprehensive monitoring in the area, tracking carbon monoxide (CO), nitrogen dioxide ($NO_{2)}$, sulfur dioxide (SO_2), particulate matter ($PM_{2.5}$), air toxics, mercury, and urban pollutants. Ozone (O_3) is monitored at Bayonne to the southeast and Leonia to the northeast.[146]

2022 Essex County Health Report

The borough's air quality conditions reflect broader trends seen in Essex County and northern New Jersey. Like many communities in the region, Caldwell is impacted by vehicle emissions, regional ozone formation, and fine particulate matter transported from sources both within and beyond municipal boundaries. While Caldwell does not contain any major industrial facilities, typical suburban stationary sources and nearby traffic corridors contribute to local air emissions. The 2022 Essex County Health Report identifies the presence of several "point stationary sources" in the borough; however, these are limited in scale compared with industrial centers elsewhere in the county.[147]

Air Quality Index

The Air Quality Index (AQI) produces a value that reflects overall air quality at a given time. The index is calculated from the NAAQS, accounting for ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide. The AQI uses a scale of 0 to 500, where 500 is most hazardous (**Figure 28**).

An AQI value of 100 corresponds to the NAAQS threshold for a specific principal pollutant. AQI values from 101 to 150 are unhealthy for sensitive populations, such as asthmatics, children, and the elderly. AQI values above 150 are unhealthy for

the general public.[148]

In 2023, there were 20 individual days which exceeded NAAQS. There were 17 days which exceeded the standards for ozone, with 15 days being unhealthy for sensitive groups, and 2 days being unhealthy. There were 9 days which exceeded the NAAQS for fine particulate matter, with 4 days being unhealthy for sensitive groups, 4 days being unhealthy, and 1 day being very unhealthy.[149]

2020 saw the healthiest AQI values in recent years, likely reflecting the decrease in polluting activity during the COVID-19 pandemic. That year saw reduced traffic flows and limited business

Figure 29. National Ambient Air Quality Standards (NAAQS)

Source: USEPA[183]

Pollutant [links to historical tables of NAAQS reviews]		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)		primary	8 hours	9 ppm	Not to be exceeded more than once per year
			1 hour	35 ppm	
Lead (Pb)		primary and secondary	Rolling 3 month average	0.15 µg/m^3 (1)	Not to be exceeded
Nitrogen Dioxide (NO_2)		primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		primary and secondary	1 year	53 ppb (2)	Annual Mean
Ozone (O_3)		primary and secondary	8 hours	0.070 ppm (3)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution (PM)	$PM_{2.5}$	primary	1 year	9.0 µg/m^3	annual mean, averaged over 3 years
		secondary	1 year	15.0 µg/m^3	annual mean, averaged over 3 years
		primary and secondary	24 hours	35 µg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24 hours	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)		primary	1 hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	1 year	10 ppb	annual mean, averaged over 3 years

operations. At the annual public hearing of the New Jersey Clean Air Council in April 2022, data was presented to show that COVID-19 measures most strongly affected concentrations of ozone, nitrogen dioxide, and particulate matter. However, AQI returned to pre-pandemic levels in 2021.[150]

Number of days where AQI values exceeded 100:

- 20 in 2023
- 9 in 2022
- 15 in 2021
- 6 in 2020
- 14 in 2019

Criteria Pollutants

The six pollutants which are targeted by the NAAQS (ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, fine particulates, and lead) are known as criteria pollutants. The concentration of air pollutants has declined significantly over the last fifty years, since the enactment of the Clean Air Act in 1970. While there are periodic exceedances of NAAQS, New Jersey has generally maintained good air quality in recent years, in attainment with all criteria pollutants with the exception of ozone.[151] NAAQS for the six criteria pollutants are listed in **Figure 29**.

Ozone, O_3

Ozone (O_3) is a gas consisting of three oxygen atoms. It occurs naturally in Earth's upper atmosphere, where it protects from harmful ultraviolent rays. Since the late 1980s, ozone has been the subject of environmental protections to restore the atmospheric ozone layer, which plays an important role in Earth's climate regulation.[152] However, when found at the ground level, ozone can have serious adverse health effects. The NAAQS for ozone is marked by an 8-hour daily maximum average concentration of 0.070 parts per million (ppm).[153]

In 2023, the ozone monitoring season (March 1st- October 31st) had 17 days that exceeded NAAQS. This included 15 days that were unhealthy for sensitive groups and 2 that were unhealthy for the general public. The highest 8-hour average concentration of ozone recorded at Bayonne was 0.096 ppm.

The NAAQS value that determines attainment or nonattainment for ozone standards is set in a two-step process using data from the most recent three-year period. It is taken from the fourth highest daily maximum 8-hour average concentration for each monitoring site in the state for each year. These values are then used to calculate a three-year average. If this average exceeds the NAAQS at any site, the state is determined to be in nonattainment.

The entire state of New Jersey is currently designated as nonattainment for ozone NAAQS. New Jersey's designation is measured in two separate areas; Essex County falls in the Northern NJ-NY-CT nonattainment area.[154]

The effort to lower ozone concentrations has focused on reducing emissions of volatile organic compounds (VOCs), but further improvements will require additional reductions in both VOCs and NO_x. New Jersey falls within the USEPA's Ozone Transport Region, where local ozone levels are particularly impacted by the regional transport of ozone-forming NO_x. Continued interstate cooperation may be required to achieve further reductions in New Jersey's ozone levels.[155]

Sulfur Dioxide, SO2

Sulfur dioxide (SO_2) is a heavy, colorless gas with a suffocating odor that easily dissolves in water to form sulfuric acid. SO_2 gases are often formed when fuels that contain sulfur are burned, or when gasoline is extracted from crude oil. Most of the sulfur dioxide released into the air comes from the combustion of fossil fuels in power plants and industrial processes. It is particularly associated with the burning of coal.[156]

> As the northeastern United States has phased out the use of coal, the regional average concentration of SO_2 has decreased by 90% since 2000 and been well in attainment of the NAAQS standard for over 10 years.

SO_2 and its dissolved forms are harmful to the health of people and the environment. SO_2 irritates mucous membranes and can cause trouble breathing, especially among sensitive groups. SO_2 reacts with other gases and particulates in the air to form sulfates, which are the primary cause of reduced visibility when air quality is poor. Acids formed from SO_2 become precipitation, falling to the earth as acid rain or snow. Acid rain damages forests and crops, acidifies lakes and streams, and accelerates the decay of buildings.

A state is considered in attainment for sulfur dioxide in a given year if its 1-hour SO_2 concentration does not exceed 25 parts per billion (ppb). The value is taken from a three-year average of annual 99th percentile daily maximum concentrations. Portions of New Jersey which were previously in nonattainment were re-designated to attainment status in 2021, putting the entire state in attainment for SO_2 NAAQS. Regulations which require the use of low sulfur fuels have been effective in lowering SO_2 concentrations, along with the closing of coal-fired electric generating units.[157]

Carbon Monoxide, CO

Carbon monoxide (CO) is a colorless, odorless, poisonous gas formed when the carbon molecules in fuel are not burned completely. The primary sources of CO emissions in New Jersey are on-road and off-road vehicles, boilers, incinerators, and forest fires. Outdoor CO levels can reach dangerous levels in cases of a weather inversion, where a layer of air becomes trapped at the earth's surface, allowing pollutants to build up without the usual circulation.[158]

> 90% of New Jersey's CO comes from internal combustion engines.

Carbon monoxide reduces the oxygen-carrying capacity of blood, slowing the flow of oxygen to critical parts of the body. CO does not occur in outdoor air at the lethal concentrations that can be recorded in indoor air. However, even at lower concentrations, exposure to CO can result in headaches and nausea. CO is often more harmful to individuals with cardiovascular disease, causing chest pain and reducing the ability to exercise.

There are two primary health-based NAAQS for carbon monoxide: a 1-hour standard of 35 ppm, and an 8-hour standard of 9 ppm. These values are not to be exceeded more than once in a given year, so standards are calculated using the

second-highest 1-hour and 8-hour values. New Jersey has been fully in attainment with carbon monoxide levels since 2002, though many counties achieved attainment/maintenance in 1996.[159] There were no recorded exceedances of any CO standards at any New Jersey monitoring site in 2023.[160]

The highest average concentration of CO at any time or location in 2023 was recorded at the Fort Lee Near Road station, with a 1-hour average concentration of 3.1 ppm. The highest 8-hour average concentration was recorded at Jersey City as 2.6 ppm. The highest CO concentration recorded at Elizabeth Lab was a 1-hour concentration of 2.4 ppm and 8-hour concentration of 1.5 ppm.

Though unhealthy levels of CO used to be recorded on a regular basis, levels in outdoor air have improved dramatically since 1990. This reduction is primarily due to cleaner-running cars and other vehicles. The last violation of the 8-hour NAAQS was recorded in 1994.

Nitrogen Dioxide, NO_2

Nitrogen dioxide (NO_2) is a reddish-brown, highly reactive gas that is formed in the air through the oxidation of nitric oxide (NO). When it reacts with other chemicals, it can form ozone, particulate matter, and other pollutant compounds. NO_2 is generally used as an indicator for the group of gases known as nitrogen oxides (NO_x), which are emitted by the combustion of fossil fuels in vehicles, power plants, home heating and cooking, and industrial processes.[161]

Since NO_x is released by motor vehicles, concentrations tend to peak during and immediately after the morning and evening rush hours. Concentrations are likely to be higher near major roadways, such as NJ Route 280. Concentrations of NO_2 also tend to be higher in the winter due to weather conditions and emissions from building heating systems.[162]

> Nitrogen oxides can also cause decreased visibility and react in the air to form both ozone and particulate matter.

NO_2 can aggravate and cause respiratory illness, and prolonged exposure can cause permanent damage to the lungs. NO and NO_2 can also irritate the eyes, nose, throat and lungs, and cause nausea and tiredness. It is known to cause health problems especially for sensitive individuals, such as children, the elderly, and people with asthma.

Environmental effects of NO_x can include:

- Acidification of freshwater bodies
- Eutrophication of coastal waters
- Increases in levels of toxins that are harmful to fish and aquatic life

New Jersey has long been in attainment with NAAQS for NO_2.[163] The primary standards in a 1-hour averaging period are 100 ppb NO_2, calculated using a 3-year average of the annual 98th percentile daily maximums. The annual measurement requires a calendar year average concentration below 53 ppb. Nitrogen dioxide is monitored at 10 sites in New Jersey. In 2023, the highest daily maximum concentration of NO_2 was 75 ppb, recorded at Elizabeth Lab.[164]

New Jersey began monitoring NO_2 in 1966. The last year in which the average annual NO_2 concentration exceeded the NAAQS

was 1974. Although concentrations have been well within the NAAQS, there is concern regarding the role of nitrogen oxides in the formation of other pollutants such as ozone and particulate matter, which still reach problematic levels. Reductions of NO_2 levels are likely necessary to reduce levels of ozone and fine particulate matter.

Particulate Matter

Particulate air pollution consists of any artificial or natural particles suspended in the air which may affect the environment.[165] Some key terms for the assessment of particulate matter are:

- **Total suspended particulates (TSPs)** refer to the total of all particulates of any size.
- **Inhalable particulate matter (PM_{10})** includes particles less than 10 micrometers in diameter that can be inhaled and accumulated in the respiratory system. PM10 can irritate the eyes, nose, and throat.
- **Fine particulate matter ($PM_{2.5}$)** are particulates less than 2.5 micrometers in size that are believed to pose the greatest health risks. With the potential to penetrate into the lungs, heart, and bloodstream, fine particulates can exacerbate heart and lung diseases and cause heart attacks.

The NAAQS for $PM_{2.5}$ were established 1997 and have been revised several times, as we become more knowledgeable of the harms of fine particulate matter. As of 2024, the primary annual standard for $PM_{2.5}$ is 9 µg/m3 (micrograms per cubic unit of air), measured by taking the three-year average of annual means. The 24-hour standard is 35 µg/m3, taking the three-year average of the annual 98th percentile values.[166]

On February 7, 2024, the USEPA announced that the annual standard for fine particulate matter is being lowered from 12 µg/m^3 to 9 µg/m^3. Each state is expected to submit a SIP for achieving more stringent standards. Focus will be on Overburdened Communities, who on average are subject to higher levels of particulate matter in the air.

New Jersey is typically in attainment/ maintenance of $PM_{2.5}$ standards. In 2022, the annual mean concentrations of $PM_{2.5}$ ranged from 5.1 µg/m3 at the Chester monitoring site to 8.7 µg/m^3 at the Elizabeth Lab monitoring station. There was one exceedance of the 24-hour standard, captured by the Brigantine monitor station, that is attributable to smoke from a nearby wildfire.

In June of 2023, New Jersey was declared Code Red for AQI due to high concentrations of particulate matter.[167] This event saw wildfire smoke carried across the northeastern United States due to atmospheric conditions and the proximity to the burning in Quebec. transport of smoke from Canadian wildfires over the northeastern United States. The smoke caused $PM_{2.5}$ concentrations to reach unhealthy and very unhealthy levels, with several days of exceedance. On June 7, NAAQS exceedances were recorded at 15 air monitoring stations, with a highest recorded value of 187.1 µg/ m3 at Flemington.[168]

For inhalable particles (PM_{10}), the primary NAAQS are 150 µg/m^3 for a 24-hour period and 50 µg/m^3 for an annual period.[169] This

value is derived from the 2nd highest annual average over three years These values are recorded by the stations at Camden Spruce Street, Jersey City Firehouse, and until September 2022, the Newark Firehouse. The state of New Jersey is has been in attainment with standards of PM_{10} for more than a decade.

Lead

Lead is hazardous to the health of humans and the environment, whether it is found in the air, in materials such as paint, in water, or in soils.[170] Though action standards are defined for lead exposure, there is a consensus that no level of lead exposure can be considered safe. Lead has its main impacts on the nervous system, particularly in children. Exposure to lead is linked with learning disabilities, mood issues, and lowered IQ. In adults, lead exposure can also impact the cardiovascular system, and it is considered a probable human carcinogen. Lead present in the air or water may accumulate in soils and sediments.

> Nationwide, since 1980, phase-out of leaded gasoline has led to a 99% decrease in the average lead air concentration.

Before the 1970s, lead was a common air pollutant due to its use as an additive in gasoline. New Jersey no longer has any significant industrial sources of lead, however, small airplanes continue to use leaded gasoline. In 2017, planes were estimated to release over four tons of lead annually into New Jersey's skies.[171] In 2008, the NAAQS level for lead was set at 0.15 µg/m3 for a rolling 3-month average. As of 2022, there are 21 areas nationwide that are in non-attainment. The closest location is in Berks County, Pennsylvania.

Since 2012, there was only one lead monitoring station in New Jersey, at the Newark Firehouse. The measurements taken in 2021 ranged between 0.001 and 0.003 µg/m3, well below the NAAQS level. And as of September 2022, this site was closed. NJDEP expects to have a site reestablished in Newark, where lead monitoring will resume.

Air Toxics

Air pollutants that are not criteria pollutants but may still cause adverse health effects are known as air toxics, or Hazardous Air Pollutants (HAPs).[172] There are almost 200 different air toxics included in the list of HAPs maintained by the EPA.[173] The USEPA compiles a National Emissions Inventory (NEI) every three years which collects information on criteria pollutants as well as HAPs.

In New Jersey, on-road mobile sources (vehicles) account of 23% of air toxics emissions, and non-road mobile sources (airplanes, trains, construction equipment, lawnmowers, boats, offroad vehicles, etc.) contribute 31%. Another 43% of air toxics are emitted from nonpoint sources, including residential, commercial, and small industrial sources. The remaining 3% come from point sources, which include factories and power plants. In 2020, Essex County had more air toxics emitted from non-point sources than any other source type.[174]

There are four sites that monitor air toxics in New Jersey: Rutgers University, Elizabeth Lab, Chester, and Camden

Spruce Street. While the other three are located in urban areas, the rural Chester station acts as a sort of background monitor. Each of these sites measures volatile organic compounds (VOCs), carbonyls (a subset of VOCs that includes formaldehyde, acetaldehyde and other related compounds), and toxic metals.

The EPA has developed health benchmarks for HAPs, representing the concentration generally considered safe to breathe on a daily basis. NJDEP calculates a Risk Ratio by dividing annual average concentrations of each HAP by its health benchmark. Risk ratios greater than one indicate that the level of a given pollutant may be of concern to human health. In 2023, several monitored pollutants were above health benchmarks with risk ratios greater than one. These measurements were captured at all four monitoring sites. Air toxics with risk ratios greater than one for at least one monitoring site are detailed in **Table 15**.

Acrolein and formaldehyde were measured with the highest risk ratio statewide. Acrolein is a colorless or yellowish liquid that is used to make tear gas, drugs, and plastics.[175] It is irritating to the eyes, skin, and lungs if inhaled. It is to be handled with extreme caution. Formaldehyde is a colorless gas with a strong odor that is sold commercially in a methanol and water solution. It is used in making resins, textiles, and as an intermediate in the synthesis of other chemicals. It is also used as a disinfectant, fertilizer, fungicide, and embalming solution. It is a known carcinogen. Both chemicals are listed on the NJ Department of Health's Hazardous Substance List.[176]

Radon

Radon is an invisible and odorless radioactive gas resulting from the breakdown of naturally occurring uranium in soil and rock. Unlike other air pollutants, radon is primarily a concern for indoor air quality. It builds up in

Table 15. Air Toxics Above Health Benchmark in 2023

Pollutant	Health Benchmark (µg/m³)	Annual Average Risk Ratios (Concentrations)			
		Camden	Chester	Elizabeth	Rutgers
Acetaldehyde	0.45	4.6	3.3	3.9	2.2
Acrolein	0.02	31.4	29.3	36.4	30.8
Benzene	0.13	5.5	3.2	6.2	4.1
1,3-Butadiene	0.033	1.3	0.4	1.7	0.7
Carbon Tetrachloride	0.17	2.9	2.9	2.9	2.9
Chloroform	0.043	2.8	2.3	3.4	3.1
Chloromethane	0.56	1.8	1.8	1.8	1.9
1,2-Dichloroethane	0.038	2.4	1.8	1.8	1.9
Formaldehyde	0.08	36.4	45.2	35.1	20.4
Source: 2023 New Jersey Air Quality Report					

homes as it seeps out of bedrock and through cracks or openings in a home's foundation. Radon releases radioactive energy, causing lung damage and lung cancer.[177]

NJDEP estimates radon risk by municipality based on real occurrences of radon contamination. In the 2015 potential map, the Borough of Caldwell is identified as having moderate radon potential. This means that at least 25 homes were tested with 5 to 24% having radon concentrations greater than or equal to 4 pCi/L (picocuries per liter).[178,179]

The EPA recommends action in homes with a radon level of 4 pCi/L or more. However, it also notes that there are no safe levels of radon, and that it may be appropriate to take action for detected levels above 2 pCi/L. As residents better insulate and seal their homes to reduce energy usage, they may cause elevated levels of radon to accumulate. Although testing for radon is only required at the time a home is sold, improving the structure's insulation or doing foundation work, may change the radon level in a home.[180]

In the United States, radon is the second main cause of lung cancer and kills at least 15,000 people per year.

Odors

The NJDEP classifies odor as air pollution when it is severe enough to unreasonably interfere with the enjoyment of life or property.[181] In many cases, odor pollution is an indicator of chemicals described above, which are regulated separately by the NJDEP. However, there is also a procedure for odor issues, based on complaints and inspection by an NJDEP official. Fines range from $150 to $1,400 for a first offense. The U.S. Center for Disease Control notes that the best strategy for addressing odor issues is prevention zoning, time of day operating restrictions, filtering, and emission control. [182]

Meteorology and Pollution

Chapter 9: Climate outlines climate patterns and statistics in the area around Caldwell, which impact pollution levels. Of note is the effect of dominant westerly winds, which carry weather patterns and pollution from states to the west over and across New Jersey. In New Jersey, these winds migrate substantially from north to south, bringing in different levels of pollution from outside the state. This causes substantial variation in air quality in the state from day to day.



Cannon Monument
Photo: The Land Conservancy

Chapter 13.

Known Contaminated Sites

How does contamination occur?

Sites can be contaminated by improper handling or disposal of toxic and hazardous materials and wastes, such as in manufacturing or mining; by accidental release of toxic or hazardous materials; or by inadvertent deposit of hazardous materials, such as by natural disasters.[197]

Remediation of a contaminated site under New Jersey's cleanup programs include identifying the source, nature, and extent of contamination of a site, and conducting appropriate cleanup work.[198]

Contamination of soils can travel to groundwater and surface water, causing a range of effects. Some contamination is low-level, with minor risk of exposure to contaminants, while other cases pose dangerous risks to human and environmental health. Chemicals may be highly toxic, present in high concentrations, or have a high propensity to move or persist in the environment. Contaminants can be taken up by plants and animals, ingested by humans in the water supply, or volatilized in the air.[184] Soil and groundwater contamination is tracked by state and federal governments at varying degrees of contamination or potential contamination. Categories of land contamination include:

- Point source occurrence of pollution that are specific and limited (Known Contaminated Sites).

- Point source facilities that require continuous monitoring (Community Right to Know).

- Brownfields, which require long-term of extensive remediation.

Known Contaminated Sites

The Known Contaminated Sites (KCS) list for New Jersey includes properties within the state where contamination of soil or groundwater has been confirmed at levels equal to or greater than applicable standards. KCS may include:

- **Active Sites** are those with confirmed contamination that have one or more active cases ore remedial action permits and any number of pending and/or closed cases;

- **Pending Sites** are those with one or more pending cases, no active cases, and any number of closed cases; and

- **Closed Sites** are those with only closed cases and no active or pending cases.

The Brownfield and Contaminated Site Remediation Act (N.J.S.A. 58:10-23.16-17) requires the preparation a list of sites affected by hazardous substances in the state.[185] Maintenance of the KCS list also meets obligations set by the New Jersey New Residential Construction Off-Site Conditions Disclosure Act (N.J.S.A. 46:3C1 et seq.).[186] The Site Remediation Reform Act, N.J.S.A. 58:10C-1 et seq. (SRRA) was enacted in 2009 to improve the process of site remediation in New Jersey. It establishes the program of Licensed Site Remediation Professionals (LSRPs) who have oversight of environmental investigation and cleanup.[187]

Contaminated sites can undergo a wide variety of remedial activities, ranging from relatively simple "cut and scrape" cleanups to highly complex cleanups. Sites with more complex contamination issues often have several sources of contamination affecting multiple media, including soil and groundwater.

Contaminated sites in Caldwell that are active, pending, or closed are shown in **Table 16**. More detailed information on active sites is included on the following page.

Active contamination sites are given a ranking from B to D based on the Site Remediation Program's 1989 Case Assignment Manual:

- **B**: Remedial level associated with emergency response, simple removal activities of contaminants usually no impact to soil or groundwater.

- **C1**: Remedial levels are associated with simple sites, one or two contaminants localized to soil and the immediate spill or discharge area.

- **C2**: Remedial levels are associated with more complicated contaminant discharges, multiple site spills and discharges and more than one contaminant, with both soil and groundwater impacted or threatened.

Table 16. Known Contaminated Sites, Caldwell

Category	Status			Total
	Active	Pending	Closed	
Homeowner	0	0	70	70
Non-Homeowner	4	0	34	38
Total	4	0	104	108

Source: NJDEP Data Miner

- **C3**: Remedial levels are associated with high complexity and threatening sites; multiple contaminants, some at high concentrations with unknown sources continuing to impact soils, groundwater, and possibly surface waters and potable water resources. These sites are dangerous for direct contact with contaminated soils.

- **D**: Same conditions as C3; often dedicated as Federal Superfund sites.[188]

Sites with documented groundwater contamination may also include a Classification Exception Area (CEA) in cases where "constituent standards are not being met or will not be met in a localized area due to: natural quality; localized effects of discharge approved through a NJPDES permit action; pollution caused by human activity within a contaminated site as defined by the Department of an applicable regulatory program (e.g., Site Remediation Program); or an ACL (Alternative concentration limit) as approved by the Department pursuant to NJPDES."[189]

Active contaminated sites in Borough of Caldwell are detailed in **Table 17** and located in **Map 17**.

Community Right to Know Sites

The Community Right to Know (CRTK) program is responsible for collecting and disseminating data on hazardous substances produced, stored, or used at companies in New Jersey.[190] Companies or organizations which store certain hazardous substances in levels above specific threshold amounts are required by state and federal law to file annual reports.

The Release and Pollution Prevention Report (RPPR) is used to collect information for the NJDEP CRTK and Pollution Prevention programs. The Emergency Planning Community Right-to-Know Act (EPCRA) is a federal regulation that establishes requirements regarding emergency planning and CRTK reporting on hazardous toxic chemicals to increase public knowledge and information about chemical uses.

In 2024, there were 6 active sites that met the State thresholds for CRTK. All are regulated under CRTK/RPPR (**Table 18**).

Brownfields

A brownfield is any former or current commercial or industrial site, currently

Table 17. Active Sites with Confirmed Contamination, Borough of Caldwell

Site ID	PI Number	PI Name	Address	CEA Status	Remedial Level
9146	7191	LEBELL	554 BLOOMFIELD AVE	Active	C2
50083	31467	CALDWELL BORO HALL	1 PROVOST SQ	Active	
36557	1019372	CALDWELL CLEANERS	381 383 BLOOMFIELD AVE	Active	
199618	498637	FALONI CINDI & JAMES	5 KNOLLWOOD TERRACE	Active - Post Rem	

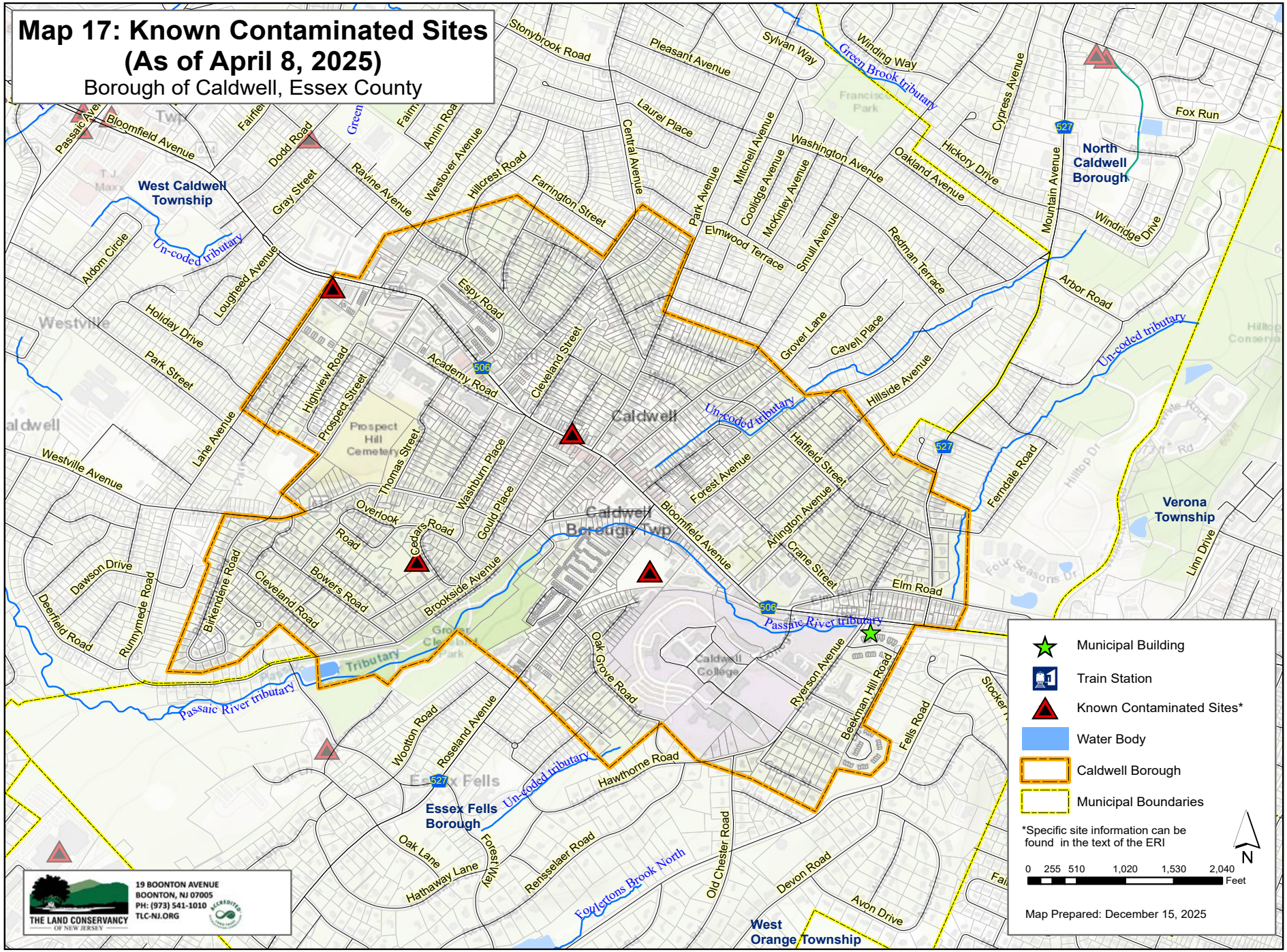
Source: NJDEP Data Miner; NJDEP Bureau of GIS

Table 18. Community Right to Know Sites, Borough of Caldwell			
PI Number	Facility Name	Physical Address	Status
00000009911	SMINE CLEANERS INC	155 ROSELAND AVE	CRTK/RPPR
00000055004	AB CALDWELL ENTERPRISES INC	250 BLOOMFIELD AVE	CRTK/RPPR
00000060327	NEW CINGULAR WIRELESS PCS, LLC - USID4775	512 BLOOMFIELD AVE	CRTK/RPPR
00244304663	VERIZON NEW JERSEY, INC. (NJ00663)	9 FOREST AVE	CRTK/RPPR
00585211245	PUBLIC SERVICE ELECTRIC & GAS CO	640 PASSAIC AVE	CRTK/RPPR
01495500013	NJLG UST 1, LLC (NJ0106)	226 BLOOMFIELD AVE	CRTK/RPPR
Source: NJDEP Data Miner			

vacant or underutilized and on which there has been, or there is suspected to have been, a discharge of a contaminant. The State of New Jersey encourages municipalities and counties to redevelop brownfields as part of Smart Growth initiatives.[191]

The NJDEP Brownfield Development Area (BDA) program enables communities to coordinate initiatives for remediation and reuse of clustered brownfield sites.[192] Funding is available from the state and federal government to support brownfield site remediation and redevelopment.

There are no brownfield sites monitored within the Borough of Caldwell.[193] The nearest brownfield sites in Essex County are located between the City of Orange and West Orange Township.[194]


Map 17: Known Contaminated Sites
(As of April 8, 2025)
Borough of Caldwell, Essex County
West Caldwell Township
North Caldwell Borough
Verona Township
Essex Fells Borough
West Orange Township
Caldwell
Caldwell Borough Twp
Un-coded tributary
Passaic River tributary
Green Brook tributary
Tributary
Foxtertons Brook North
Stonybrook Road
Pleasant Avenue
Sylvan Way
Winding Way
Fox Run
Laurel Place
Central Avenue
Park Avenue
Mitchell Avenue
Coolidge Avenue
McKinley Avenue
Washington Avenue
Oakland Avenue
Hickory Drive
Cypress Avenue
Mountain Avenue
Windridge Drive
Arbor Road
Redman Terrace
Smull Avenue
Elmwood Terrace
Grover Lane
Cavell Place
Hillside Avenue
Ferndale Road
Linn Drive
Bloomfield Avenue
Passaic Ave
Dodd Road
Gray Street
Ravine Avenue
Westover Avenue
Hillcrest Road
Farrington Street
Aldom Circle
Lougheed Avenue
Holiday Drive
Park Street
Lane Avenue
Westville Avenue
Highview Road
Prospect Street
Espy Road
Academy Road
Cleveland Street
Prospect Hill Cemetery
Thomas Street
Washburn Place
Gould Place
Overlook Road
Cedars Road
Forest Avenue
Hatfield Street
Arlington Avenue
Crane Street
Elm Road
Brookside Avenue
Bowers Road
Cleveland Road
Birkendene Road
Dawson Drive
Deerfield Road
Runnymede Road
Oak Grove Road
Ryerson Avenue
Beekman Hill Road
Fells Road
Hawthorne Road
Woolton Road
Roseland Avenue
Oak Lane
Hathaway Lane
Forestway
Rensselaer Road
Old Chester Road
Devon Road
Avon Drive
Municipal Building
Train Station
Known Contaminated Sites*
Water Body
Caldwell Borough
Municipal Boundaries
*Specific site information can be found in the text of the ERI
0 255 510 1,020 1,530 2,040 Feet
N
Map Prepared: December 15, 2025
THE LAND CONSERVANCY OF NEW JERSEY
19 BOONTON AVENUE
BOONTON, NJ 07005
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