Appendix B:

Naugatuck River Floodplain Analysis

1.0 NAUGATUCK RIVER FLOODPLAIN AT FREIGHT STREET

1.1 Watershed Description

The project site is located within the Naugatuck River Basin. This watershed forms the Naugatuck Regional Basin within the Housatonic Major Basin, identified as Regional Basin 6900 on the Connecticut Department of Environmental Protection *Atlas of Public Water Supply Sources and Drainage Basins*. The Naugatuck River forms in Torrington and flows in a southerly direction through the towns of Thomaston, Watertown, Waterbury, Naugatuck, Beacon Falls, Seymour, and Ansonia and discharges into the Housatonic River in Derby at tidewater. The watershed area of the entire Naugatuck River Basin encompasses an area of approximately 311.2 square miles. The main channel length is 39 miles with a drop of 540 feet, providing a relatively uniform, moderately steep gradient of 13 feet per mile.

The steep channel gradient leads to swift flow velocities with many riffles and pools. In many areas, the high flow velocities have eroded the fine-grain particles from the riverbed, leaving a layer of larger gravel and cobble material that armors the bed and provides favorable habitat for cold-water fish.

Most of the watershed is underlain by old metamorphic bedrock consisting of schist, gneiss, and granite, forming low rolling hills with steep sides. The bedrock is overlain by shallow glacial till, frequently less than 10 feet deep. The larger valley bottoms tend to have glacial outwash deposits of sand and gravel with limited modern alluvial terraces.

The shallow, low permeability soils, steep hillsides, and limited floodplains all contribute to high runoff rates. Major floods occurred in the Naugatuck River Basin in November 1927, March 1936, September 1938, December 1948, August 1955, and October 1955. With the exception of the August 1955 flood, the peak discharges of the other events generally ranged from 22,000 to 32,000 cubic feet per second (cfs) (New England Floods of 1955) in the Naugatuck River at Naugatuck, with estimated frequencies in the general range of 100 years. The August 1955 event was the greatest flood of record by far, with a flow in the Naugatuck River at Naugatuck of 105,000 cfs, with an estimated return period of 250 years (Naugatuck Flood Insurance Study).

Following the 1955 flood, the U.S. Army Corps of Engineers (USACE) has constructed a system of reservoirs in the basin that modify flood flows. In a repeat of historic flood events, the system would generally reduce flows on the Naugatuck River at Waterbury by 60 to 75 percent, depending on storm orientation (Waterbury Flood Insurance Study). Farther downstream in Ansonia near the river's mouth, it has been estimated that the flood control dams would have reduced historic peak flood flow rates to one-half of previous unregulated natural flood flow rates.

The remnants of Hurricane Irene passed near Connecticut in 2011, but the peak flows were regulated successfully by the upstream dams.

1.2 Flood Control Dams

Peak flow rates in the Naugatuck River are regulated by a series of flood control dams constructed and operated by the USACE following the destructive flooding of August 1955. In addition to the dams, the USACE also constructed improved channels and floodwalls in Ansonia, Derby, Waterbury, and Torrington.

TABLE 1
Flood Control Dams

Flood Control Dams	Location	Drainage Area (sq. mi.)	Flood Control Storage (ac. ft.)	Completion Date
Hall Meadow Brook	Hall Meadow Brook	17.2	8,620	1962
East Branch	East Branch, Naugatuck	9.3	4,350	1964
Thomaston	Naugatuck	97.0	42,000	1960
Northfield Brook	Northfield Brook	5.7	2,430	1966
Black Rock	Branch Brook	20.4	8,700	1970
Hancock Brook	Hancock Brook	12.0	4,030	1966
Hop Brook	Hop Brook	16.4	6,970	1968
	Total	151.5*		

* The Hall Meadow and East Branch dams are upstream of, and tributary to, the Thomaston dam, so they are not accounted for separately as part of the total regulated area.

The net result of these flood control reservoirs in the Naugatuck River Basin is to store all their runoff up to a 100-year storm and provide for its release at a rate that can be handled by the channel downstream. These flood control reservoirs will decrease the flood stage (Thomaston Flood Insurance Study). The former Freight Street and Anaconda dams in Waterbury were not flood control dams and provide no attenuation of floodwaters. They were removed in 1999 to improve water quality and fish passage.

1.3 Stream Flow Gauge Data

Stream gauge data from the United States Geological Survey (USGS) surface water discharge stations was obtained for the Naugatuck River. Two of the gauges were determined appropriate in the analysis of the dams on the Naugatuck River. The selected gauges are the Naugatuck River at Thomaston, USGS gauge 01206900, and the Naugatuck River at Beacon Falls, USGS gauge 01208500. The period of record for Thomaston extends from 1955 to present, and Beacon Falls extends from 1920 to present. The seven USACE flood control dams constructed between 1960 and 1970 created a discontinuity in the gauge records of peak flow because the flows are modified by upstream storage.

TABLE 2
FEMA Flood Insurance Study Data

Town	Date	Location	Watershed Area* (sq. mi.)	Peak Flood Flows, cfs			
				Q_{10}	Q_{50}	Q_{100}	Q_{500}
Waterbury	5/79	Chase Brass Bridge	137	5,300	5,400	8,000	21,600
		U/S Steele Brook	155	5,500	5,600	8,580	23,200
		Freight Street Bridge	175	5,700	9,600	13,350	33,100
		U/S Mad River	179	5,800	10,850	15,100	36,800
		D/S Mad River	205	6,650	15,100	21,100	49,100
		D/S Town Line	206	6,900	15,700	21,900	50,900

* As reported by the Federal Emergency Management Agency (FEMA)

Our 2017 review of the USGS gauge data in Beacon Falls reveals that the annual peak flows are very uniform at less than 20,000 cfs since the flood control dams were constructed in the 1960s. Consequently, the present FEMA peak flow rates are unlikely to change.

2.0 CHANNEL IMPROVEMENTS

The Naugatuck River is largely channelized as it flows through Waterbury. Portions of it have been dredged, straightened, and confined by retaining walls. From Freight Street to West Main Street, the west bank consists of the earth road embankments for Connecticut Route 8. Closer to the channel are the northbound lanes of Riverside Street. The east bank has a mixture of earth embankment and old retaining walls.

The only known channel work in the past 20 years consists of the removal of the former Freight Street dam that was immediately upstream of the Freight Street bridge. This low concrete dam was built to impound and direct water for a stream-powered generating plant. The dam was only 2 feet high and 158 feet long. It was operated in the "run of the river mode," without regulatory river flows. Its goal was to maintain a river water depth adequate to submerge the power plant inlet pipes.

The dam was constructed about 1910 by the early predecessor of CL&P and deeded back to the city in 1927 when it was abandoned. The dam was removed by the city and CTDEP in 1999 to enable fish passage along the river.

3.0 MMI MODELING

In preparation of the Freight Street dam removal and the regulatory permit applications, MMI conducted hydrology and hydraulic analysis of the river. The USGS gauge data was reviewed and compared with FEMA, with similar results. Then the individual town hydraulic analyses were combined into one long Naugatuck River model and converted to HEC-RAS (see attached). The FEMA and MMI model had similar results and were used for permitting.

The hydraulic analysis of existing conditions for flood with average return frequencies of 10, 50, and 100 years found the water profiles submerge the weir and have little influence on resulting water elevations. New field-surveyed cross sections would be needed to discover if dam removal altered channel geometry.

4.0 REGULATORY FLOOD ELEVATIONS

The FEMA Flood Insurance Rate Map effective December 17, 2010, identifies the elevation of the 100-year frequency base flood and the 500-year frequency flood along the Naugatuck River corridor. At Freight Street, the base flood used for most regulatory purposes is elevation 260, then rising to elevation 261 at the site of the former Freight Street dam, which was removed in 1999. The base flood profile then slowly rises to elevation 263 near West Main Street.

The Freight Street District topographic map with detailed 1-foot contours defines the subject property as lying between elevations 265 and 275, thus the entire property is above the 100-year regulatory base flood analysis. The 1999 removal of the Freight Street dam lowers the base flood elevation by just 1 foot, so it would not affect the floodplain, which is already above the base flood.

The elevation of the 500-year flood at Freight Street is at 270.0 on the downstream side of the bridge and then rises to 273.5 due to the bridge and then 275.5 after the Freight Street dam. The review of the project site indicates that most of the area is between elevation 265 and 275, so it would not be impacted by the 500-year frequency event.

Updating the FEMA Flood Insurance Study with a map revision would slightly lower the elevation of both the 100- and 500-year frequency floods but would not reduce the floodplain area.

5.0 POTENTIAL PHYSICAL IMPROVEMENTS

It has been found that the property along the east bank of the Naugatuck River between Freight Street and West Main Street is mapped as a high level floodplain above the elevation of the 100-year frequency event but below and inundated by the 500-year event. Reducing flood inundation hazards generally involve either lowering flood elevations, installing barriers, raising the land with fill, or floodproofing individual buildings.

A careful review of the floodwater profiles and land elevations reveals that correcting the FEMA study with a map revision would not appear to decrease the floodplain size. The new Light Detection and Ranging (LIDAR) topography map with its 1-foot contour interval clarifies the inundation areas. The site is already above the elevation of the critical 100-year event and below the 500-year event.

The FEMA floodwater profiles (sheet 311, station 104,000) indicate there is a minor rise at the bridge and former dam. The comparison with the LIDAR topography map indicates there would be little benefit in physical channel improvements. In addition, riverbank levees would not be helpful as water would still get behind the levees from the West Main Street area.

The property is outside of the regulatory floodway. Therefore, fill material could be used to raise ground elevations for redevelopment. It could also be used to cap areas with potential contaminants.

6.0 LOMR

There is no need or reason for a FEMA map amendment at this time.