Known for excellence.
Built on trust.

GEOTECHNICAL
ENVIRONMENTAL
ECOLOGICAL
WATER
CONSTRUCTION MANAGEMENT

144 Elm Street
Amesbury, MA 01913
T: 781.278.4800
F: 978.834.6269
www.gza.com

April 16, 2020
File No. 18.0174585.00

Mr. Robert Pryor, P.E., L.S.
Director of Site Planning & Engineering
518 Riverside Avenue
Stratford, CT

Re: Draft - Floodplain Modeling for 4 Hockanum Road
Westport, CT

Dear Mr. Pryor,

GZA GeoEnvironmental, Inc. (GZA) is pleased to present to LANDTECH (the Client) the following memorandum summarizing GZA's hydraulic modeling for Willow Brook at 4 Hockanum Road, Westport, CT (the Site). This memorandum was prepared in accordance with our proposal, which was signed by LANDTECH on February 20, 2020. The memorandum summarizes hydraulic simulations performed by GZA to evaluate the effects of adding fill along Willow Brook at 4 Hockanum Road (see **Figure 1**). Our services and memorandum are subject to the Limitations provided in **Appendix A**.

BACKGROUND

The homeowner at 4 Hockanum Road reportedly experiences frequent flood inundation of their 2-car garage located near Willow Brook. As a result of the frequent flooding of the garage, the homeowner proposes to abandon the garage and add fill to the lower area of the driveway to protect it from flooding and add an at-grade parking area to the eastern end of the house. GZA was contracted to model the 100-year flood elevation/extents in this area to evaluate if there is an increase in flood elevation as a result of the construction.

Numerous water bodies in the United States have flood area mapping from the Federal Emergency Management Agency (FEMA). FEMA maps different flood area zones such as Special Flood Hazard Areas Zone A and AE, and the Regulatory Floodway. FEMA defines the zones as follows:

Zone A: the base floodplain mapped by approximate methods (also called an unnumbered A Zone or an approximate A Zone).

Zone AE: the base floodplain where base flood elevations are provided.

Regulatory Floodway: the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height.

GZA checked the FEMA Flood Insurance Study (FIS) and Flood Insurance Rate Maps[1] (FIRM) for Fairfield County. Willow Brook at 4 Hockanum Road is not mapped by FEMA.

GZA previously performed hydrologic and hydraulic analysis of eight streams within the Town of Westport for a separate report titled "Study 1: Hydrologic and Hydraulic Study of Eight Major Streams", published in May 2018. The study included Willow Brook. GZA used and updated the hydraulic model from Study 1 to evaluate the effect of the proposed changes at 4 Hockanum Road. Note that GZA's Study 1 included an evaluation of the base floodplain for Willow Brook but did not include an evaluation of the Regulatory Floodway.

Elevations in this report reference the vertical datum NAVD88.

REGULATORY CRITERIA

The Town of Westport Zoning Regulations Section 31 provides provisions for land, building, structure, and uses located within the 100-year flood area. Section 31-11.2 states the 100-year flood area should be identified by the Fairfield County FEMA FIS, the accompanying FIRMs, and other supporting data applicable to the Town of Westport. Willow Brook at 4 Hockanum Road is not included in the FEMA FIS nor FIRMs. For the purposes of this study, the 100-year flood area and base flood elevations were developed by GZA on behalf of the Town as part of "Study 1: Hydrologic and Hydraulic Study of Eight Major Streams," dated 2018.

The Regulations state different provisions for FEMA Special Flood Hazard Areas Zone A and Zone AE. Section 31-11.3.3 of the Zoning Regulations states requirements for Zone A. The section states no new construction, substantial improvement or other development (including fill) be permitted which would increase base flood elevations more than one foot along any point along the watercourse.

Section 31-11.3.4 states additional requirements for Zone AE. The section includes additional no-rise provisions for areas within the Regulatory Floodway. A Regulatory Floodway has not been published at the site by either FEMA or in the Study 1. FEMA notes the following about Regulatory Floodways: "*Communities must regulate development in these floodways to ensure that there are no increases in upstream flood elevations. For streams and other watercourses where FEMA has provided Base Flood Elevations (BFEs), but no floodway has been designated, the community must review floodplain development on a case-by-case basis to ensure that increases in water surface elevations do not occur, or identify the need to adopt a floodway if adequate information is available.*"

METHODOLOGY

For the Study 1 hydrologic evaluation, GZA used the Army Corps of Engineers' HEC-HMS (version 4.1) computer program and Snyder Unit Hydrograph methodology to simulate the rainfall/runoff processes. See Study 1 for the inputs and outputs of the model. The runoff from Willow Brook's contributing watershed is an input to the Study 1 hydraulic evaluation.

[1] 4 Hockanum Road is located on Flood Insurance Map Number 09001C0411F, effective 6/18/2010.

For the Study 1 hydraulic evaluation, GZA used the US Army Corps of Engineers (USACE) Hydrological Engineering Center – River Analysis System (HEC-RAS) Version 5.0.3 model to simulate the transient and maximum extent of flooding along eight streams in Westport. GZA developed a transient, unsteady, two-dimensional (2D) flow model for each stream.

GZA revised the Study 1 HEC-RAS model of Willow Brook for the purposes of evaluating the effect of the proposed changes at 4 Hockanum Road. GZA updated the model to HEC-RAS Version 5.0.7 which includes improved program functionality.

LANDTECH conducted a site survey of 4 Hockanum Road on March 14, 2019 in the datum NGVD29. GZA requested additional surveying data on March 16, 2020, which LANDTECH provided on March 18, 2020. GZA applied a conversion of NGVD29 - 1.1 ft to convert the survey elevations to NAVD88 because the Study 1 hydraulic model is in NAVD88. GZA used the survey data, provided in AutoCAD files, to create a 3D surface using AutoCAD Civil3D. GZA combined the 3D surface with Town of Westport digital terrain data (from Study 1) using RAS Mapper, a mapping tool that is part of the HEC-RAS software. GZA added the 4 Hockanum Road house and existing stone retaining walls off the driveway as 2D Connectors in HEC-RAS. 2D Connectors are used in HEC-RAS to block flow until the top of the connector is overtopped. GZA revised the Hockanum Road culvert, also a 2D connector, based on top of wall and culvert invert elevations identified during the site survey. A schematic view of the existing conditions HEC-RAS model is shown in **Figure 2**.

LANDTECH provided proposed site changes in AutoCAD files. Changes to the site include filling the lower driveway area (which thereby covers the stone retaining walls) and adding an at-grade parking area to the eastern end of the house. GZA created a 3D surface of the proposed conditions using AutoCAD Civil3D. GZA combined the 3D surface with the Town of Westport digital terrain data (from Study 1) using RAS Mapper. GZA added the at-grade parking area using a 2D Connector. A schematic view of the proposed conditions HEC-RAS model is shown in **Figure 3**.

GZA simulated the 100-year flow through the existing and proposed conditions.

RESULTS

Results from GZA's HEC-RAS model are shown in **Table 1**, below, and **Figures 4 and 5**. See **Figures 4 and 5** for where the **Table 1** water surface elevations were extracted. The peak flow in Hockanum River was extracted between Locations 4 and 5. The peak flow is 310 cfs during existing conditions and proposed conditions. There is a less than 0.1 ft increase in water surface elevation (WSEL) at Location 2 (Hockanum Road) and Location 3 (downstream of Hockanum Road within the stream). Further upstream and downstream from the site, the increase in water surface elevation is insignificant.

Table 1: Results for 100-Year Storm

Location	Description	Peak WSEL - Existing Conditions (ft)	Peak WSEL - Proposed Conditions (ft)	**Incremental Change in Water Depth (Ft)**
0	House	(Dry)	(Dry)	0
1	50 ft Upstream of Property Line	46.19	46.20	0.01
2	Hockanum Road	45.38	45.43	0.05
3	Downstream of Hockanum Road within the Stream	44.56	44.64	0.08
4	Middle of Site within the Stream	44.36	44.36	0
5	Downstream of Site within the Stream	44.32	44.32	0

CONCLUSION

The modeling results show that the proposed modifications to 4 Hockanum Road are expected to result in less than a 0.1 ft increase in water surface elevation. GZA notes that the Site is located in an area without FEMA flood mapping; therefore, there is no designated Special Flood Hazard Area and no Regulatory Floodway. GZA used a hydraulic model from our previous Study for the Town of Westport to evaluate the increase in 100-year flood elevations. The anticipated effects of the proposed construction on the 100-year floodplain are consistent with the Town's Zoning Regulations for a Zone A mapped property, since the resulting increase in flood elevations are expected to be less than one foot.

The proposed construction would create a minor rise in the 100-year flood elevation within and adjacent to the property limits of 0.1 foot or less. While this degree of localized increase in the 100-year flood elevation is judged to be minor (e.g., on the order of one inch), GZA also notes that this small increase would be inconsistent with the "no rise" criteria if a Regulatory Floodway existed at the Site. The Town of Westport should assess the impacts of this small increase in the 100-year flood elevation in its application of the Zoning Regulations.

Should you have any questions or require additional information, please contact Samuel Bell at (781) 223-7091 or samuel.bell@gza.com.

Sincerely,

GZA GEOENVIRONMENTAL, INC.

Christine E. Suhonen, P.E.(MA)
Project Manager

Daniel Stapleton, P.E.
Senior Principal

Samuel J. Bell
Senior Hazard Mitigation Specialist

David M. Leone, P.E.
Associate Principal; Consultant/Reviewer

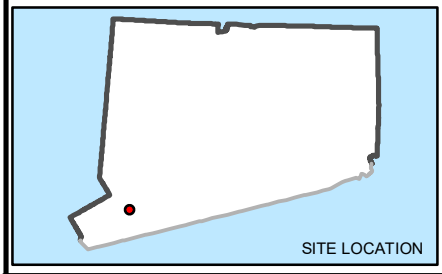
Attachments:

Figures

Appendix A: Limitations

\\GZAAMESBURY\Jobs\174500's\18.0174585.00 Landtech Westport - Modeling Asst\Report\Memo.docx

FIGURES



Data Supplied by : esri

SOURCE : THIS MAP CONTAINS THE ESRI ARCGIS ONLINE USA WORLD IMAGERY SERVICE, PUBLISHED DECEMBER 12, 2009 BY ESRI SERVICES AND UPDATED AS NEEDED.

0 125 250 500
Feet

N
W E
S

GZA	PROJ. MGR.: SJB DESIGNED BY: BCL REVIEWED BY: CHS OPERATOR: BCL DATE: 04-13-2020	LOCATION MAP 4 HOCKANUM ROAD WESTPORT, CONNECTICUT	JOB NO. 18.0174585.00 FIGURE NO. 1

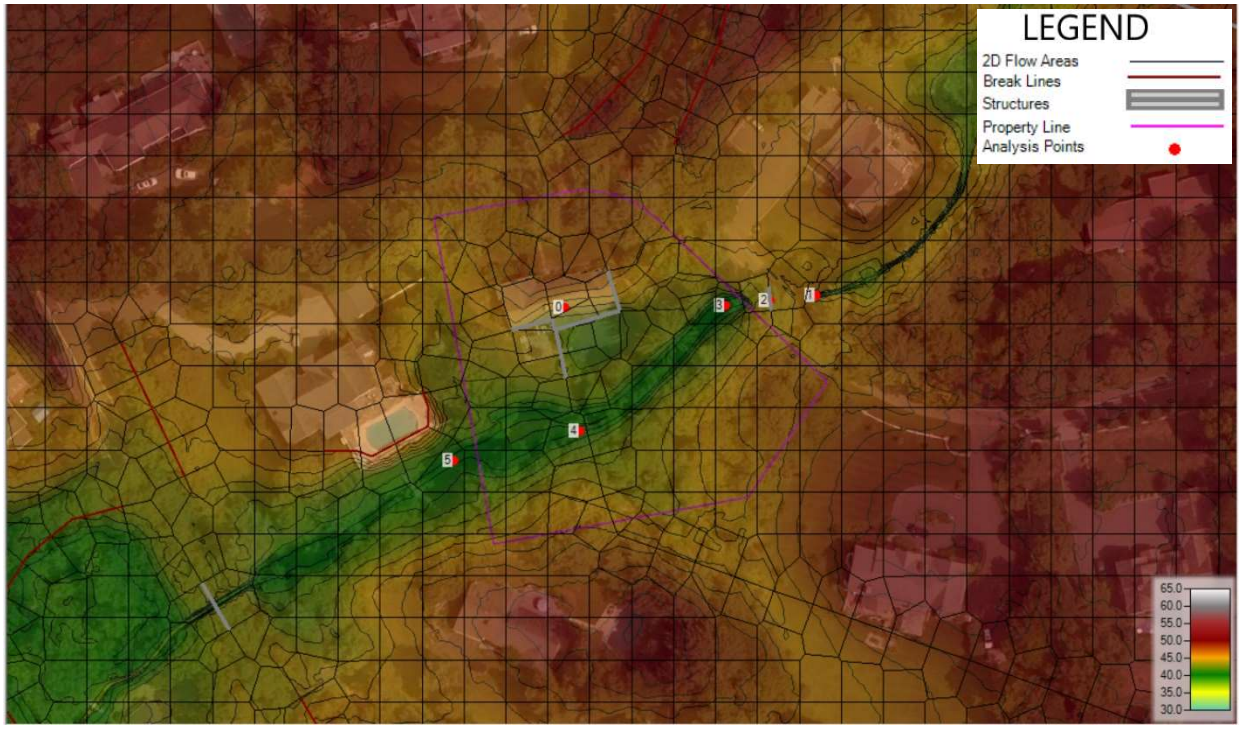


Figure 2: Schematic view of 2D HEC-RAS Model (Existing Conditions)

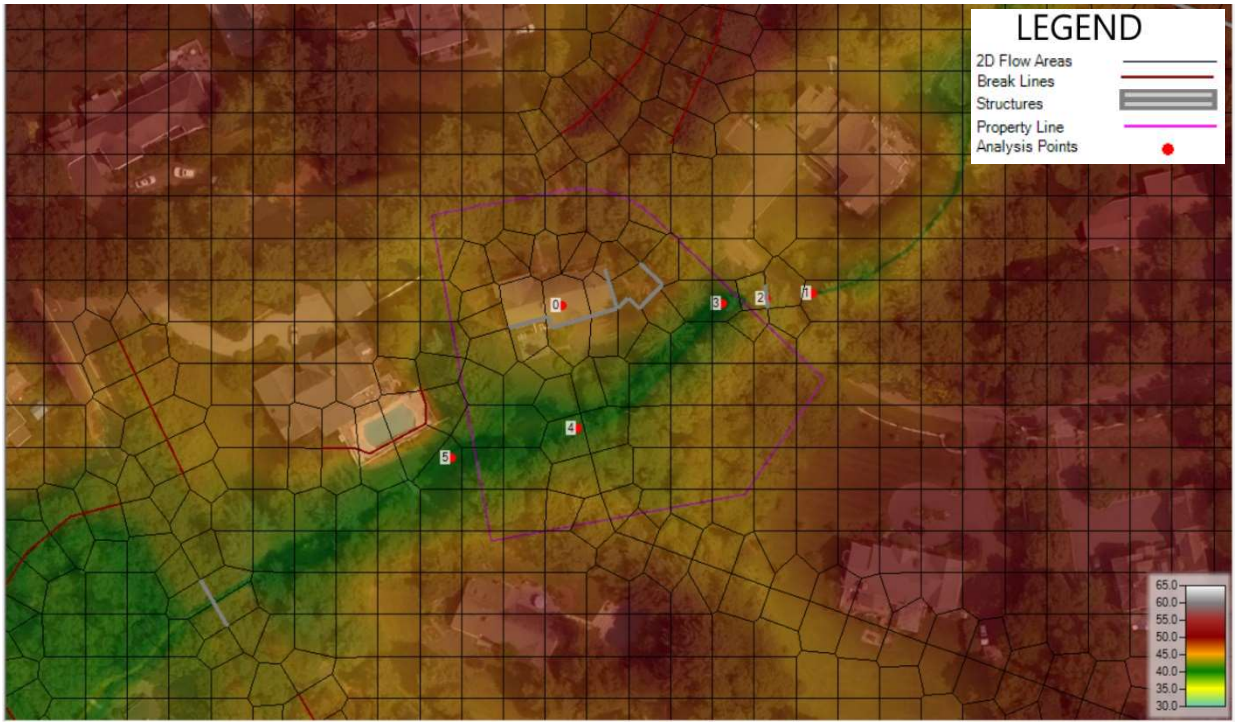


Figure 3: Schematic view of 2D HEC-RAS Model (Proposed Conditions)

Figure 4: Inundation Boundary (Existing Conditions)

Note: The figure shows water inside the 4 Hockanum Residence. This is due to cell leakage from flows to the northwest of the house. The cell leakage does not impact the results of this analysis.

Figure 5: Inundation Boundary (Proposed Conditions)

APPENDIX A – LIMITATIONS

USE OF REPORT

1. GZA GeoEnvironmental, Inc. (GZA) prepared this report on behalf of, and for the exclusive use of LANDTECH (Client) for the stated purpose(s) and location(s) identified in the Report. Use of this Report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not identified in the agreement, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to GZA.

STANDARD OF CARE

2. Our findings and conclusions are based on the work conducted as part of the Scope of Services set forth in the Report and/or proposal, and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. Conditions other than described in this report may be found at the subject location(s).

3. The interpretations and conclusions presented in the Report were based solely upon the services described therein, and not on scientific tasks or procedures beyond the scope of the described services. The work described in this report was carried out in accordance with the agreed upon Terms and Conditions of Engagement.

4. GZA's flood evaluation was performed in accordance with generally accepted practices of qualified professionals performing the same type of services at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made. The findings of the risk characterization are dependent on numerous assumptions and uncertainties inherent in the risk assessment process. The findings of the flood evaluation are not an absolute characterization of actual risks, but rather serve to highlight potential sources of risk at the site(s).

5. The study included analysis of information from Federal Agencies, including NOAA Precipitation Data and FEMA Reports, developed using the data and methodologies available when the study was completed. The development of recurrence interval precipitation depths by NOAA relied on readably available historical flow data. Future precipitation events that impact the project area may result in changes to the precipitation estimates.

6. Unless specifically stated otherwise, the flood evaluations performed by GZA and associated results and conclusions are based upon evaluation of existing and historic data, trends, references, and guidance with respect to the current climate. Future climate change may result in alterations to inputs which influence flooding at the site (*e.g*. rainfall totals, storm intensities, *etc*.). Such changes may have implications on the estimated peak flows, flood elevations, and/or other parameters contained in this report.

RELIANCE ON INFORMATION BY OTHERS

7. In conducting our work, GZA has relied upon certain information made available by public agencies, Client and/or others. GZA did not attempt to independently verify the accuracy or completeness of that information. Any inconsistencies in this information which we have noted are discussed in the Report.

GENERAL

8. Observations were made of the site and of structures on the site as indicated within the report. Where access to portions of the site, or to structures on the site was unavailable or limited, GZA renders no opinion as to the condition of that portion of the site or structure.

9. In reviewing this Report, it should be realized that the reported condition of stormwater infrastructure is based on observations of field conditions during the course of this study along with data made available to GZA. It is important to note that the condition of stormwater systems depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the stormwater systems will continue to represent the condition of the stormwater systems at some point in the future. Only through continued inspection and care can there be any chance that unsafe conditions be detected.

ADDITIONAL INFORMATION

10. In the event that the Client or others authorized to use this report obtain information on conditions at the site(s) not contained in this report, such information shall be brought to GZA's attention forthwith. GZA will evaluate such information and, on the basis of this evaluation, may modify the opinions stated in this report.

11. Additional analyses are required to refine the analysis of the stormwater systems on and adjacent to the project site(s) to evaluate system capacity to convey stormwater flows and inlet capacity to capture stormwater.

ADDITIONAL SERVICES

12. GZA recommends that we be retained to provide services during any future investigations, design, implementation activities, construction, and/or property development/ redevelopment at the Site. This will allow us the opportunity to: i) observe conditions and compliance with our design concepts and opinions; ii) allow for changes in the event that conditions are other than anticipated; iii) provide modifications to our design; and iv) assess the consequences of changes in technologies and/or regulations.