

December 15, 2016

EXHIBIT RECEIVEDGrafton Conservation Commission
Grafton Conservation Office
30 Providence Road
Grafton, MA 01519

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DEC 16 2016

**PLANNING BOARD
GRAFTON, MA**RE: 104 Creeper Hill Road, Grafton MA
DEP File #164-0926

Dear Commission Members:

Pursuant to the initial public hearing held on December 6, 2016 for the project located at 104 Creeper Hill Road we offer the following information to address comments and additional information requested by the Commission. The proposed Site Plan set has been revised and submitted to the Conservation Commission, Planning Board and Graves Engineering for review.

Mounding Analysis for Infiltration Basin

An analysis, using the Hantush methodology, has been performed to analyze the temporary mounding of water under the proposed infiltration basin. The analysis reveals the temporary rise of groundwater elevations under the basin of approximately 1.25-feet to a maximum high groundwater elevation of 359.5-feet. The bottom of the basin is elevation 362.0-feet, leaving approximately 2.5-feet of separation between the bottom of the infiltration basin and the high groundwater elevation. The basin therefore maintains greater than a two-foot offset to the water table even during the peak mounding period. Moreover, the mound will rapidly dissipate following the cessation of the storm due to the high hydraulic conductivity of the glacial outwash deposits.

LID Measures*Rain Garden*

A rain garden has been added to the site plan and is located northeast of the proposed building. The rain garden will store and infiltrate runoff from the easterly half of the proposed roof.

Gravel Access Driveway

The proposed access driveway for the northerly abutters and the cell tower site is a 20-foot wide gravel driveway with a centerline crown pitching to each gutter line and a four-

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foot wide shoulder. The left and right shoulders contain a 12-inch wide by 30-inch deep infiltration trench for the capture and storage of runoff from the proposed gravel driveway. The approach to drainage for the proposed gravel driveway is similar to a country drainage ditch located off the edges of pavement and promotes recharge of runoff along the entire length of the access driveway.

FEMA Food Zone A Elevation Determination

The FEMA Flood Insurance Rate Map (FIRM) depicts the 100-year flood elevation as encroaching upon the easterly side of the property. The Zone-A is not, however, defined by elevation, only by a solid line on the map and can only be established by scaling. Such depictions indicate that a detailed hydraulic study of the design storm has not been performed in the subject area, and the map provides only an approximate location of the extent of flooding. Standard engineering practice is then to scale the map location onto a site plan. This approach may, however, lead to conflicts with actual field conditions, as the scaled FIRM location of the Zone-A can be grossly inaccurate, due both to the scale of the FIRM (one inch to 400-feet) and the fact that a detailed hydraulic study was not performed. In order to correlate the scaled location to the actual site conditions, physical site conditions must then be evaluated, including hydraulic boundary conditions and actual site topography. Additionally, historic information on previous flooding events are considered within the context of on-site flooding.

Considering the physical site features that influence the extent of flooding, most prominent are the hydraulic controls associated with Flint Pond. Water levels in Flint Pond are controlled by the Irish Dam hydraulic structures, located approximately one-half mile from the locus. The Irish Dam spillway is controlled by a weir with a length of 60-feet and a crest elevation of 356.3-feet. The dam embankment is approximately 350-feet long and has a top elevation of 361.8-feet. Given these hydraulic conditions, should an extreme flooding event occur that surpasses the spillway capacity (approximately 2577 CFS), flow over the top of the dam will occur. Given the length of the dam, once over-the-top flow begins, a very small incremental rise in water flow results in significant increases in discharge capacity. For example, with a depth of flow of 1.2-feet over the top of the dam, the discharge rate (spillway and over the dam) is 4,097 CFS. At a depth of flow of 2.2-feet over the dam, the discharge rate increases to 6,362 CFS. More importantly, at a flow depth of 1.2-feet over the embankment, flow velocities exceed 3-feet per second, well-above the erodible channel threshold¹². Once a flow depth over the embankment of one-foot is approached, a dam breach will be imminent and water levels will begin to recede.

With this as background, a reasonable maximum water surface elevation for Flint Pond during extreme events (100-year to 500-year event) is one foot over the dam top elevation (361.8-feet), or 362.8-feet. On the subject site, this extreme event elevation places the Zone-A Hazard line along the slope leading to Flint Pond. This is a more realistic

¹ See Open-Channel Hydraulics, by Ven Te Chow, McGraw Hill, 1959

² See Threshold Velocities in Erodable Channels, ASCE, 1979

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depiction of the likely limit of the Zone A hazard zone, than is scaled location from the FEMA Map, as the scaled location traverses across the slope, providing for a non-uniform flood elevation, which conflicts with the physical conditions both at the site and at the hydraulic controls at the Irish Dam.

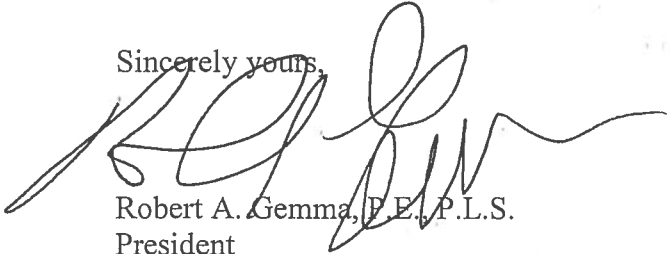
In addition to our physical review of the site and the hydraulic flood controls, we also contacted both the City of Worcester and Town of Shrewsbury Engineering Departments and conducted a search for historical information of flooding at Flint Pond and Lake Quinsigamond. No published or anecdotal information was discovered that contradicted our analysis, as no records of overtopping of the Irish Dam were discovered. The methodology for approximating flood zone elevations in lacustrine areas as defined in FEMA publication Managing Floodplain Development in Approximate Zone A Areas was also analyzed. This method was inconclusive as the flood zone boundary superimposed on the USGS Quadrangle spanned 3 contours where a half contour interval limit is required.

We therefore believe that we have, using the physical data for the hydraulic controls and accepted engineering practice, established a conservative but realistic elevation and location for the 100-year flood elevation.

We request a waiver from the Local Bylaw requirement to show corresponding 25-foot No-Alteration Zone and 100-foot Buffer from the edge of the approximate flood zone boundary as the flood zone boundary in the area surrounding Flint Pond is not consistent with existing topography. The spillway elevation and top of adjacent bank of the Irish Dam would most likely regulate the 100-year flood elevation surrounding Flint Pond as flow from the pond would not be controlled above the top of bank elevation of 361.8-feet.

Please feel free to contact me should you have any questions or if you require any additional information.

Sincerely yours,



Robert A. Gemma, F.E., P.L.S.
President



Brian Nelson
Project Engineer