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SITE DEVELOPMENT PRECONSTRUCTION PLAN

Enclave at Boxborough
700-800 Massachusetts Avenue
Boxborough, Massachusetts

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OBJECTIVE

To present procedures which proposed rock excavation at the Enclave at Boxborough site development will incorporate to protect local water resources.

Site Conditions

The site is located in the southwest quadrant of the intersection of Stow Road and Massachusetts Avenue in the Town Center area of the Town of Boxborough. The combined land area of 700 Massachusetts Avenue and 800 Massachusetts Avenue is 58.1 acres. The local relief of the site ranges from el 300 in a central bordering vegetated wetland area which extends from southwest to northeast across the site, to el 364 at the southern tip of the site between 539 Burroughs Road and 571 Burroughs Road (from sheets C2.1 - C2.3 of the site plans dated 4/16/19). The site is drained from the east, south and west to the center of the property, which then drains into a pond at the north end of the site, adjacent to Massachusetts Avenue. There is a smaller bordering vegetated wetland on the northwest side of the site which is topographically separated from the main central wetland at el 320. The drainage of the area is poorly integrated, which is typical of recently glaciated landscapes.

According to the Bedrock Geologic Map of Massachusetts (1983) the substrate consists of Nashoba Formation Schist and Gneiss. This rock is a metamorphic and derived from preexisting sedimentary rocks which were subjected to extreme heat and pressure deep within the earth approximately 450 million years before present. The rock types found in the Nashoba Formation include sillimanite schist and gneiss, amphibolite, biotite gneiss, calc-silicate gneiss and marble. According to the Quaternary Geologic Map of the Boston 4º X 6º Quadrangle, United States and Canada (1991), overburden on the site consists of ice-contact sand and gravel between 15 and 60 feet in thickness, although there are areas along the southern perimeter of the site where rock is exposed. Tree cover on the site is a mixture of pine and a variety of hardwoods.

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Proposed Site Development

The proposed development consists of an entry road common with the entrance to Tisbury Meadow Condominium and Sheriffs Meadow Condominium on Stow Road. The road would extend to the west of Sheriffs Meadow, then would complete a circle to the west of 145 Stow Road with one spur road extending from the southwest of the circular development to the north of 657 Burroughs Road. The construction of homes will take place in the southeastern corner of the site, in an area of locally highest elevation which comprises approximately 30% of the 58 acre site. The development will have 25 duplex buildings (50 dwellings) and a recreation house. The development is reserved for occupants over the age of 55 years. There is a pair of drilled wells on the site located on the south side of the bordering vegetated wetland described in Site Conditions above in the northwest side of the site.

The excavation for roads and yard grades will require ten feet, or less depth of excavation to meet a finish grade in the areas that are cut. The utility trenches and basements will require six foot of excavation below yard and road grades.

Blasting Regulations

It is unclear whether blasting will be employed for the purpose of rock excavation at the Enclave site, as the surface rock is weathered and may be removed by mechanical means. Should it be necessary to blast, the Commonwealth of Massachusetts has the most comprehensive set of regulations governing commercial blasting operations in the nation.

In the Commonwealth of Massachusetts, regulations 527 CMR 1.00 is enforced in conjunction with NFPA-1 Fire Code, which is the National Fire Prevention Association guidance document. The transportation, handling and use of explosives are locally enforced by the Massachusetts Board of Fire Prevention at the State Fire Marshal’s Office.

Massachusetts requires that preblast inspections be offered prior to acquisition of a blasting permit. The blasting contractor is obligated to demonstrate that the blasting operations are not damaging to nearby homes and other structures. The inspection is an interior/exterior documentation of the condition of improved property prior to blasting. Conditions are examined and existing defects in the brittle materials which comprise structures on the property are documented. The offer of the inspections is extended to the owners of all structures which are withing 250 feet of anticipated areas of blasting. The blasting contractor is responsible for the inspections and bears the expense of performing them.

The following residences are found to be within 250 feet of areas of rock excavation at the Enclave site:

109 - 133 Stow Road
145 Stow Road
155 Stow Road
181 Stow Road
197 Stow Road
511 Burroughs Road
539 Burroughs Road
571 Burroughs Road

In addition to offering preblast inspections of the structures on the properties, water quality tests of the wells on the same properties can be offered prior to start of construction. These tests can be performed regardless of means of rock excavation to demonstrate that the excavation activity is not producing a change in local water quality. The analytes which should be tested include turbidity, nitrate/nitrite and coliform bacteria. Rock excavation at the Enclave project will be maintained in a manner that will not damage water wells regardless of method of excavation, as the work be performed in a manner that site activities will not infringe on the surrounding properties. Research in blasting seismology has addressed the issue of well water quality and performance, and has determined that there is no direct evidence of a change in either resulting from blast vibrations.

Well performance tests are potentially disruptive to wells. The act of opening a well risks damage to plumbing and electric wires. Inserting wires and transducers into the well bore can dislodge loose scale from the inside of the well case and well bore, causing siltation of the water column inside the well.

It is disingenuous to attempt to establish the degree to which the diminution of water well performance might be caused by construction activity. A well performs optimally when it is first completed, and the performance slowly degrades with time for multiple reasons. The well is drilled into saturated rock, then water is regularly drawn from the well several times for completion testing, sanitation, then for its service life. This causes a diminution of hydraulic gradient in a circumference of the rock around the well bore, commonly known as a cone of depression. The desaturation of the rock leads to the introduction of air into the well bore, oxidizing the well casing and rock surface in the bore. Bacteria, found in all ground water, flourish in the well bore. The bacteria die, then their bodies teem through the water column in the well bore, clinging to the sides of the well and the wires, pipe and pump.

The build of bacterial slime on the wall of the well bore inhibits recharge from fractures the well bore originally encountered which are now coated. This condition is commonly addressed by a periodic sanitization with bleach or hydraulic fracturing in an attempt to restimulate well production. The well performance never returns to the relatively pristine condition that it was in when the completion test was performed. The diminution of well performance in all wells will occur with time.

The excavation and construction activity will have no effect on well water quality and performance. The Commonwealth of Massachusetts has imposed storm water and hazardous materials protocols to protect water supplies from construction operations. These protocols are uniformly imposed across the Commonwealth due to the brisk pace of development which has occurred over the past several decades.

The Enclave construction site will be fitted with sideline storm water protections in a plan known as SWPPP (storm water pollution prevention plan). The site perimeter is barricaded with a continuous barrier of nylon silt fence and hay bales staked into the ground to prevent breakouts (leakage) of site waters to the surroundings. Furthermore, the Enclave site is disposed topographically in a manner that the development is located in the highest elevations of the site property, and the ground surface gradient is pitched away from adjacent neighboring residential properties to the south and east, and toward the central bordering vegetated wetland.

Conversely, daily household activities are unregulated and can directly impact well water quality. Sources of potential pollution around the residential well head include lawn mowers and automobiles which can leak gasoline, oil and antifreeze. Professional and self-applied pesticides, herbicides, fertilizers are commonly applied directly to the ground surface across the entirety of a residential property. Other pollutants include pet waste, automobile and aircraft exhaust.

The local water resource is visibly abundant at this site, as there are a multitude of wetlands in close proximity to the site as well as a number of perennial streams which originate from the local hillsides. These streams represent locations where saturated fractures in the substrate are in contact with overburden, and groundwater persistently flows on to the ground surface. The perennial nature of these streams betrays the elevation of persistent saturation in the rock beneath.

ROCK EXCAVATION VIBRATION STANDARDS

The act of breaking rock is a highly technical occupation, from the use of mechanical means such as hydraulic breakers and splitters to blasting. Mechanical excavation is safe and effective, but may not produce consistent results. In some cases, it becomes necessary to blast to remove material to the depth stipulated in the construction plans as dictated in building codes.

The Commonwealth of Massachusetts has established very strict standards to protect people and property as they relate to blasting operations, and the following are imposed as regulation.

Ground Vibration and Airblast Limits

Standards for ground vibration produced by blasting in the Commonwealth of Massachusetts are based on United States Bureau of Mines Report of Investigations No. 8507 Structure Response and Damage Produced by Ground Vibration from Surface Mine Blasting, issued in 1980. This report recommends limits on ground motion which are based on maximum levels of ground vibration which are insufficient to cause damage to the weakest of common construction materials, plaster on lath. The recommended limits are based on peak particle velocity (speed of particle oscillation) and the frequency of the oscillation. Frequency is expressed in cycles of oscillation per second (Hz). In the range of 2.7 to 40 Hz., or more, the particle velocity limits range from 0.50 inch per second to 2.00 inches per second. These limits apply to the most significant measurement on any one of three mutually perpendicular components of ground vibration; transverse, vertical or longitudinal (radial).

The Commonwealth of Massachusetts has adopted airblast limits for blasting from the United States Bureau of Mines Report of Investigations No. 8485 Structure Response and Damage Produced by Airblast From Surface Mining, issued in 1980. This report recommends limits which are designed to prevent damage to the materials in common construction which are most sensitive to airblast: plate glass windows and plaster on lath. The publication recommends that an air overpressure of 0.0129 pounds per square inch (psi) be used as a limit to prevent damage to plate glass, measured with a peak linear, 2 Hz., high pass sound pressure level monitoring system. This corresponds to an airblast of 133 dBL. Safe levels of airblast have been determined through studies of structure response and damage from sonic booms of aircraft, accidental explosions in air, active surface blasting sites and laboratory studies. It has been found that the likelihood of damage to plate glass increases with increased surface area of the plate itself. The limit is determined regardless of window dimension.

ROCK EXCAVATION STANDARDS (continued)

The following are blast vibration standards established by government and industry interests beyond those which are imposed by the Commonwealth of Massachusetts.

Water Wells

The former United States Bureau of Mines engaged a study by competent professionals in the field of blasting seismology to address the issue of damage to water wells from blasting. In the minerals research contract report Survey of Blasting Effects on Ground Water Supplies in Appalachia (1980) by Robertson and others, data was gathered on water wells prior to and after blasting at four test sites. Wells were drilled for the purpose of scientifically determining the potential for damage to water wells from blasting. Vibrations measured at the ground surface next to the test wells and at depth within the wells were obtained from surface mine blasting with observations made of the static water levels and water quality before and after the blasting was performed. Ground vibrations as high as 5.44 inches per second were measured at the ground surface, and it was found that vibrations were considerably reduced with depth inside the wells. No direct evidence was found indicating a change in water quality or well performance. Lateral stress relief caused by the removal of rock near the well did result in an improvement in well recharge, as fractures intersected by the well bore were relieved.

Fragmentation of Bedrock

Fragmentation in rock is a function of the rock composition and energy content of the explosive charge. The rock will only fracture a short radius around the circumference of the charge hole. The maximum radius of fragmentation around a charge hole drilled in soft (sedimentary) rock is 26 to 29 times the radius of the borehole and 20 to 23 times the radius of the bore hole in hard rock (igneous and metamorphic). The rock at the Enclave property is comprised of schist and gneiss, which are metamorphic rocks. The charge holes used in construction blasting are typically 3 inches, or less in diameter. Any blasting activity at the Enclave property will not result in opening of new fractures more than 35 inches in length, which is primarily the intended fracture radius needed to break the rock sufficiently to effectively excavate the loosened rock. No new pathways for groundwater to migrate between the site and surrounding water wells and basements will be created, only the rock withing the intended area of excavation will be fractured.

The use of mechanical rock excavation apparatus will not cause any radial fragmentation of rock.

Masonry

According to Crawford and Ward Dynamic Strains in Concrete and Masonry Walls, a vibration limit of 3.00 inches per second is recommended to prevent damage to masonry. This limit is independent of masonry type.

Poured Concrete

According to Aikins and Dixon, Concrete Structures and Construction Vibrations, published in the American Concrete Institute Publication SP-60, in order to prevent damage to concrete which is older than seven days, peak particle velocity should not exceed 4.00 inches per second.

Buried Pipes and Other Structures

Buried utility lines and septic systems are highly resistant to blast vibrations. Buried structures must be able to withstand the strains imposed by burial, transient loads from vehicle traffic, lawn maintenance machinery and frost. Peak particle velocity specifications for buried utility lines are generally set at 4.0 inches per second, independent of pipe composition. The design criteria imposed by state regulations to protect the soft, brittle interior linings of surrounding homes are at least one-half the limits imposed to protect subsurface utilities from breakage. Underground concrete structures such as gunite pools and septic tanks are constructed incorporating steel reinforcement mesh and/or bars, and are resistant to vibrations with measured peak particle velocities in excess of 10.0 inches per second.

In conclusion, the failure thresholds from ground vibration for rock and solid construction materials are substantially higher than the limits imposed by the Commonwealth of Massachusetts for blast vibrations. The regulatory protections afforded in the Massachusetts Fire Code are sufficient to protect water resources and wells.

Respectfully submitted,

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