Comments on:

"Middlesex School East Fields Athletics – Drainage Calculations"
Samiotes Consultants, Inc., 16 November 2004

submitted to

Massachusetts Department of Environmental Protection

by

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1. I am submitting comments on the above-referenced drainage plan (Plan) as a citizen of Concord interested in preserving the unique natural and community resources that would be irreversibly impacted by this development. My experience in hydrology, water quality, and stormwater management is summarized at http://www.wwwalker.net.

2. The proposed development is located in a portion of the Estabrook Woods designated by the Commonwealth as a "Priority Site" under National Heritage & Endangered Species Program. This priority is reflected by the fact that NHESP designations and Mass-GIS data layers for "Estimated Habitats for Rare Wildlife", "Biomap Core Habitat", "Certified Vernal Pools", "Contiguous Open Space" all intersect the site (Figure 1). The site has "bordering vegetated wetlands" on at least three sides.

3. Despite evolution of the proposed development plan over the past 10 years to reduce its environmental impact, many in our community are concerned about impacts that remain. Recent changes to the Plan pose new hydrologic and water quality concerns that are not addressed. My comments are based upon review of the above document and the associated site plans.

4. The Plan describes drainage calculations comparing peak flows from a portion of the current site plan with peak flows from a portion of the previous plan for various storm sizes. There is no direct presentation of the net impacts of the current plan relative to the undeveloped condition. The previous plan is irrelevant. The entire drainage system should function as a unit. Potential interactions between different components are ignored when the Plan is evaluated in a piecemeal fashion, especially considering questionable assumptions and factors ignored in the analysis discussed below. I recommend that the current plan be systematically evaluated and reviewed in relation to the existing undeveloped condition and regardless of its long history or any previous "approvals" that may have been granted to plans that are no longer relevant. In my opinion, the proposed drainage system may not function as depicted and the development may have hydrologic and water quality impacts on the adjacent wetlands that are not addressed.

5. The proposed development extends approximately one-quarter mile into Estabrook Woods from the edge of the Middlesex campus (Figure 2). It is cut into the side of a hill with an average grade of ~6-7% (Figure 3). The maximum depth of the cut (in the southeastern corner of the Practice Field) is ~15 ft; i.e., the base of the field drainage system is ~15 ft below the existing land surface. The cut depth decreases to ~6 ft at the NE corner of the main soccer field. Maximum cut depths are 3-5 ft for the tennis courts. Based upon the topography and Plan geometry, I estimate that more than 40,000 yd^3 of forest soil will have to be moved from the uphill sides of the fields & courts in order to create a level base. Presumably, this material will either be removed from the site altogether or used to fill the western downhill field sections. It is not clear whether the foundation for the fields (compacted base & stone) will be brought in from elsewhere or "mined" on site.

6. To offset the impacts of the new tennis courts (modification from previous plan), the Plan relies on a somewhat elaborate and exotic design for an infiltration basin. The Engineer should provide assurance to the DEP that such designs have been successfully used elsewhere in Massachusetts. This would include documentation that high infiltration rates can be maintained for the lifetime of the project. Infiltration devices are generally subject to failure because of accumulated particles and debris. Despite all of the hardware, stone, and storage volume, infiltration capacity is ultimately limited by the adjacent and underlying geology. The Plan (Page 2) indicates that site soils have "hardpan" layers with "moderately slow" to "very slow" infiltration

capacities. There is no assurance that the device will function as assumed to infiltrate all of the drainage. Instead, static water levels in the device may be high and cause frequent overflows that will eventually enter the downstream detention ponds. Such overflows were not considered in the previous drainage analysis, upon which this analysis is based. This is an example of interactions that invalidate a piecemeal evaluation of the Plan (See 4).

7. The Plan (Page 4) mentions the high permeability of the artificial turf (60 inches/hr). I disagree that assuming a runoff coefficient equal to that of natural turf is “cautious” or “conservative”. Potential runoff from the fields/courts would depend critically on initial water levels in the drainage system underlying them. The system will be constructed on compacted soil and filled with crushed stone. As a consequence of groundwater interception (see 9) and/or residual standing water from antecedent storms, the system could be saturated at the start of any given storm event. In such a case, the fields/courts would be effectively impervious. This would significantly increase the volume of runoff relative to values computed in the Plan. A true “conservative” analysis would treat the fields as impervious, in absence of a definitive hydrologic analysis demonstrating that the under-drain systems will have sufficient storage capacity prior to each major storm.

8. Snow & ice cover would also render the artificial turf surfaces essentially impervious under winter/spring rains, regardless of groundwater levels. While snow & ice also enhance runoff potential from the existing forest, forest runoff is reduced by depression storage associated with variations in topography (i.e. puddles). Depression storage would be totally eliminated in the leveled fields & courts. The Plan’s drainage computations do not account for this factor.

9. The Plan indicates that soils have perched seasonal high water tables ranging from 14 to 24 inches (Page 2). Given these geologic features and depth of the cuts (up to 15 ft, See 5 above & Figure 3), there is a high probability that the cuts will intersect existing groundwater tables. The drainage trenches beneath the fields may intercept this groundwater, but the amounts are not quantified. Therefore, there is no assurance that the drainage system (field/court under-drains, detention ponds, swales, infiltration basin, outlets) is designed to accommodate intercepted groundwater sufficiently to control peak discharge rates below the existing condition.

10. Aside from groundwater interception, the reduction in evapotranspiration rate associated with artificial turf will tend to

increase average water levels in the drainage system and total discharge from the site. Evapotranspiration rates in eastern Massachusetts average ~20 inches/year, as estimated by the difference between precipitation and streamflow (~43 inches/yr, ~23 inches/yr). Evapotranspiration is largely mediated by plant interception (leaves, roots), evaporation, and photosynthesis. These processes occur in the forest and natural turf, but would be eliminated with artificial turf. Direct evaporation from the artificial turf may occur to some degree but is likely to be small because of high permeability and maintenance to avoid standing water. Based upon typical regional precipitation and evapotranspiration rates, average discharge from the fields could increase from ~23 in/yr up to ~43 in/yr because of this mechanism. The Plan does not consider this change or its impact on the bordering wetlands.

11. As consequences of groundwater interception and loss of evapotranspiration, it is likely that the total annual volume of flow leaving the site in surface runoff and/or subsurface drainage will increase relative to the existing condition. Neither of these factors is addressed in the Plan. Potential impacts of increases outflow include:

a. The field/court under-drains may be saturated and detention pond water levels may be higher than assumed; this would invalidate peak flow calculations presented in the Plan, which assume that field under-drains, detention ponds, and the infiltration basin are empty at the beginning of each simulated storm. There is no calculation or other documentation presented to support these assumptions.

b. Bordering wetlands, particularly those north of the site, may be drained or otherwise adversely impacted by lower groundwater levels.

c. Changes in average flows and flow frequency distributions would alter depth regimes in the downstream wetlands, including a reduction in dry-out frequency resulting from an increase in base flows. To my knowledge, associated impacts on wetland ecological function and wildlife habitat have not been evaluated.

d. An increase in average and peak flows would increase erosion hazards associated with surface discharges from the detention ponds, overflows from the infiltration basin, swales, overland runoff, and erosion of natural drainage channels west of the site discharging into wetlands designated as endangered species habitat.

12. Erosion hazards would be highest during construction when trees and vegetation are stripped, especially given the steep slopes and extensive grading involved. There should be provision for complete containment of all runoff from site during this period. A few silt curtains and hay bales tacked here and there would be insufficient. A single erosion event could have irreversible impacts on bordering wetlands, downstream wetlands, and Bateman's Pond.

13. The drainage plan apparently relies upon grassed swales adjacent to the road to handle road runoff and detention pond discharges. No assurance is provided that the swales will not erode, especially given steep slopes and potential increases in site drainage.

14. While the design change from natural grass to artificial turf reduces risk of water quality impacts associated with fertilizers and pesticides, a net increase in export of nutrients and other water quality components from the artificial turf relative to the undeveloped forest is still expected, as consequences of increased flows (9,10) and elimination of filtration through soils. Potential water quality impacts include:

   a. Increase in nutrient input to adjacent wetlands. Phosphorus export from undeveloped areas in the Northeast typically averages 5-10 mg/m^2-yr, as compared with atmospheric deposition rates of 20-30 mg/m^2-yr. The natural ecosystem (and natural grass to a lesser extent) traps phosphorus in vegetation and soils. This trapping function would be lost with installation of artificial turf and rock under-drain system. Despite occasional field sweeping, a portion of the leaf and pollen deposition to the field surface will decompose and release soluble nutrients in the field under-drainage. These factors suggest that there will be an increase in nutrient export relative to the existing condition, despite the seemingly inert artificial surface. An increase in nutrient inputs to the adjacent wetlands, especially in combination with the hydrologic changes discussed above, could have dramatic ecological effects, as observed in other wetlands across the country.

   b. The artificial turf/rock under-drain system will eliminate interception of rainfall by the tree canopy and filtration thru soils. This will eliminate the function of the existing watershed as a buffer for downstream water bodies against harmful effects of acid deposition. Unless a calcareous rock is utilized, the buffering capacity of the artificial turf and rock under-drains would be minimal. The change from natural to artificial turf eliminates buffering capacity otherwise provided by turf liming. Some rock fill materials could add to acidity problems.

c. Physical and photo-degradation of the artificial turf (typically made from recycled rubber tires or other plastics) may release trace metals and other toxic substances in the drainage.

d. Depending on the chemical composition of the rock materials used in the field drains and infiltration basin, leachate from the rocks may alter the inorganic chemical composition of site drainage and have adverse water quality impacts on the downstream wetlands and pond.

To my knowledge, none of the above mechanisms for water quality impact has been addressed and each poses a potential threat to the adjacent wetlands.

Figure 1 – NHESP Classifications

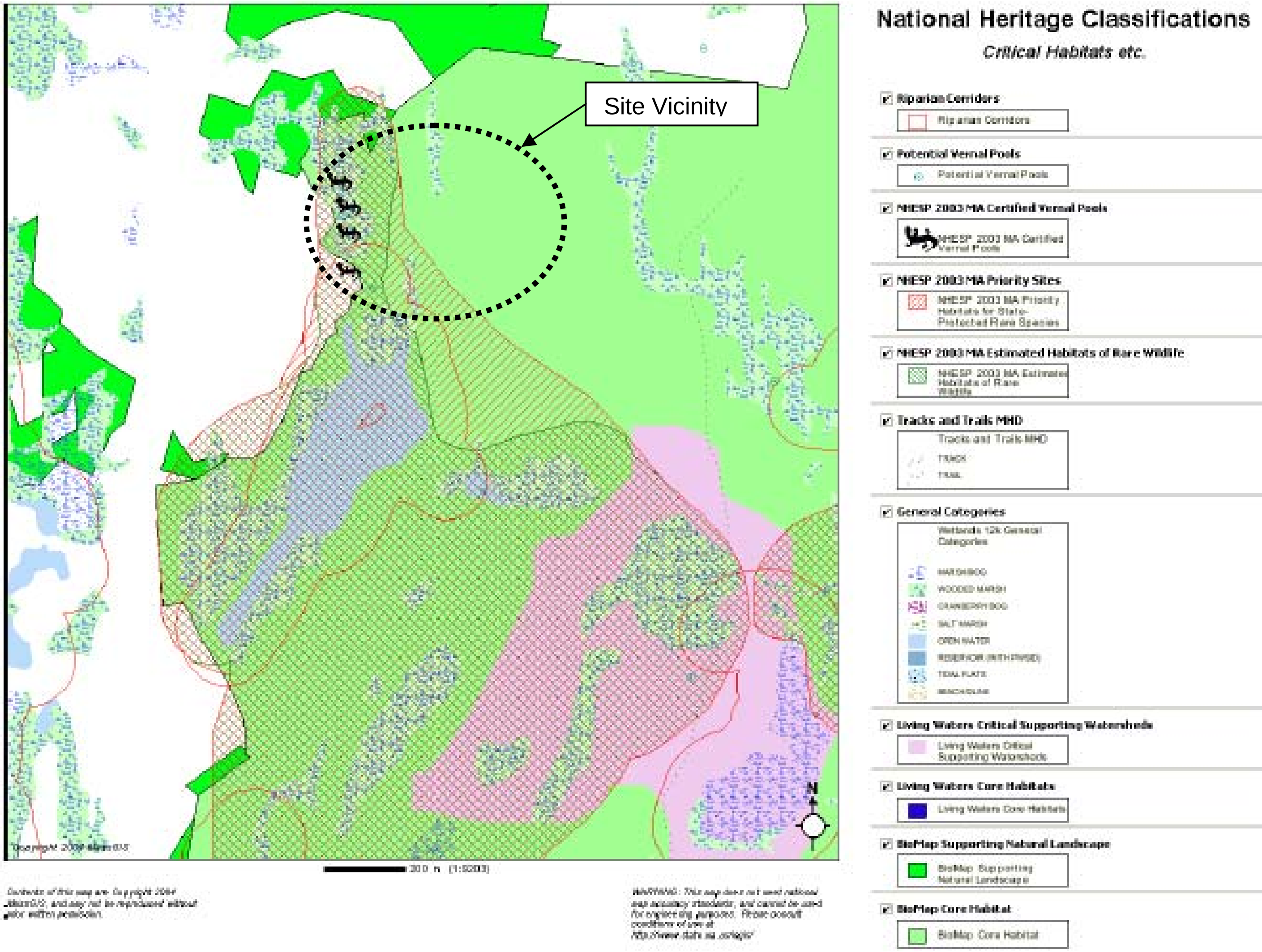


Figure 2 – Site Plan

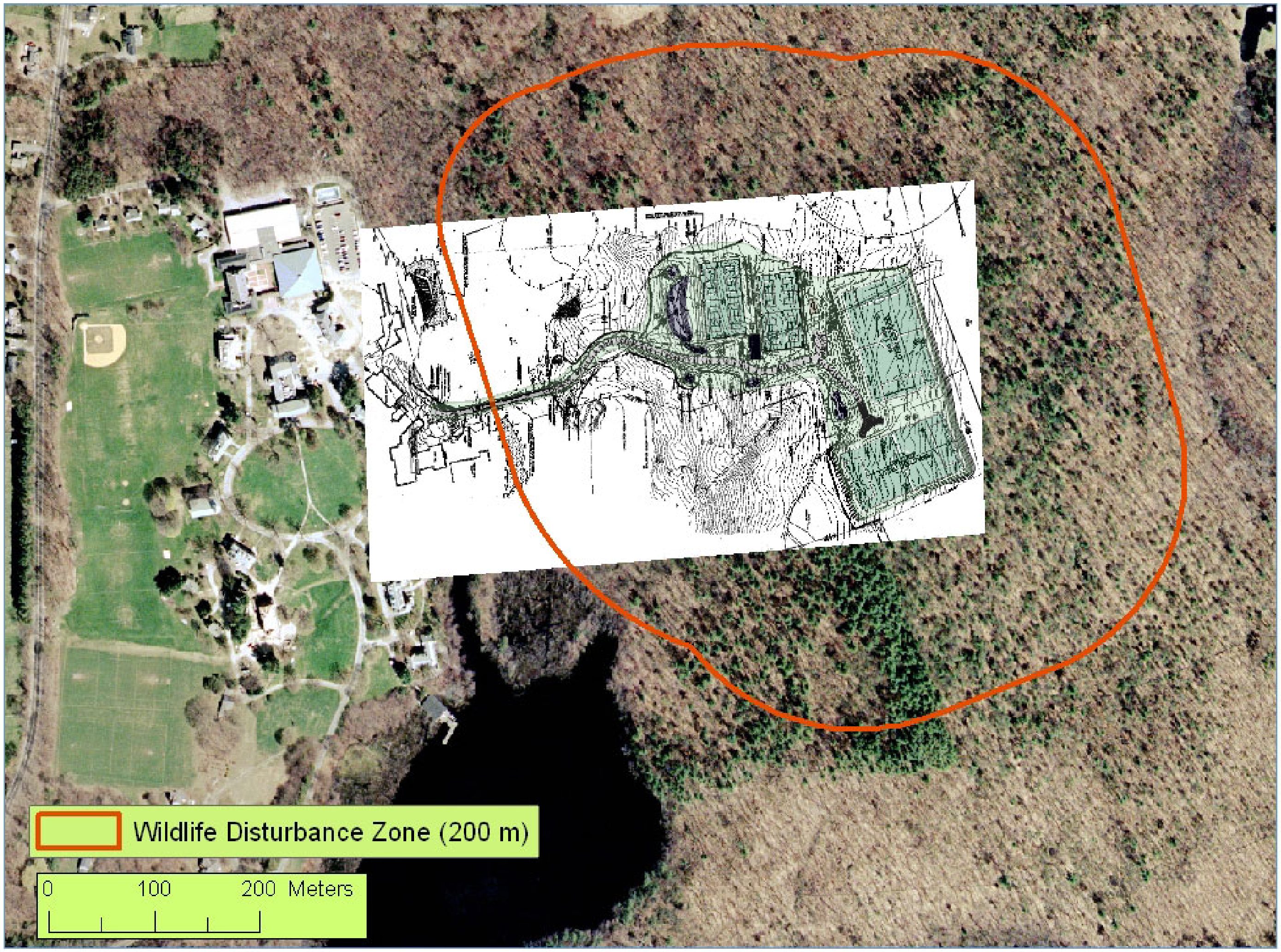
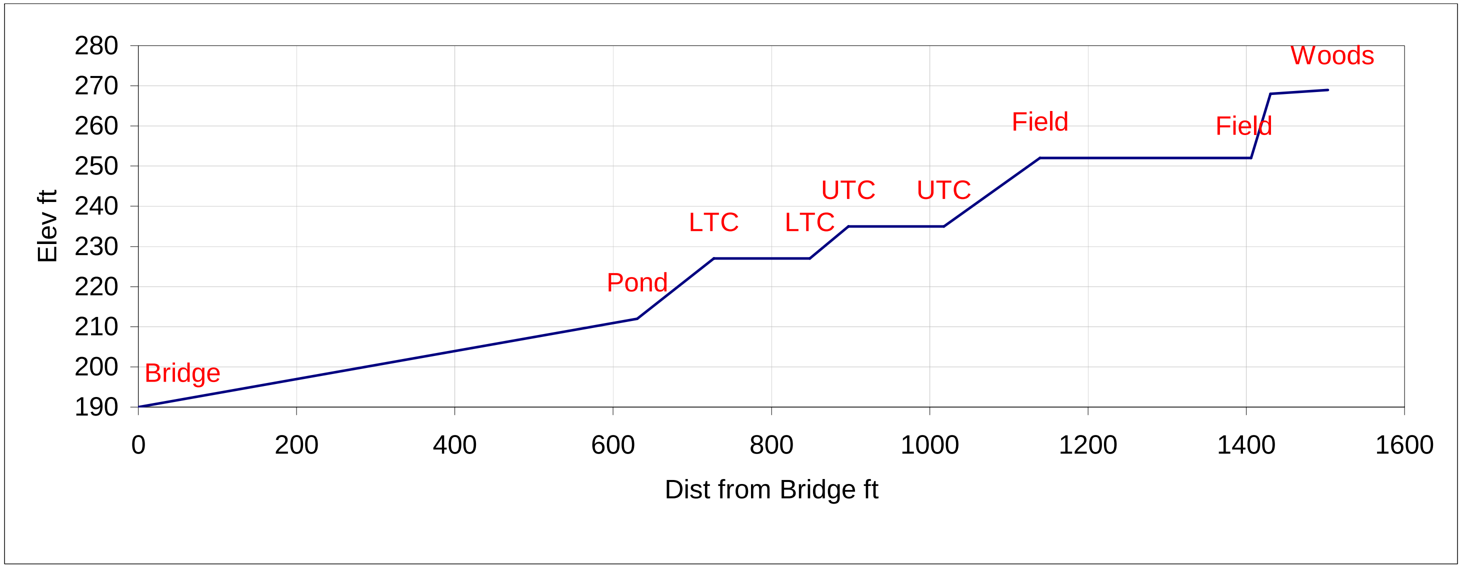


Figure 3- Site Elevation Profile



Vertical Scale = 5X Horizontal Scale

Shows approximate grade from bridge to eastern border of soccer fields.
Estimated from site development plan