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EXPERT REPORT

WARREN TOWNSHIP

STORMWATER RUNOFF AND EROSION CONTROL HIGH DENSITY DEVELOPMENT SITES

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EXPERT REPORT

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HIGH DENSITY DEVELOPMENT SITES

I. INTRODUCTION

This report provides an overview of drainage conditions in Warren Township and particularly how these conditions impact the severity of existing flooding and erosion and the potential for future aggravation of these problems. Particular emphasis within this report is given to portions of the Township which may be developed more densely, in particular those areas which the Township has selected for higher density zoning have been reviewed and also the parcels which have been proposed by AMG Reality Company, Skytop Land Corporation, and Timber Properties have been reviewed in greater detail.

This firm prepared a two volume "Report Upon Drainage and Storm Water Runoff Within Warren Township" during 1975 and 1976. The preparation of this report required the investigation of the various streams within the Township which investigation included field investigations and inspection of the various streams, review of topographic mapping and drainage calculations as necessary to assess drainage conditions within the Township. The purpose of these reports were to provide recommendations, guidelines and suggestions that would allow the Township to remedy existing problems and avoid future problems with runoff and erosion.

The majority of Warren Township consists of a portion of the Second Watchung Mountain. The ridgeline of this mountain generally bisects the Town in a east to west direction. Runoff north of the ridgeline flows in a northerly direction by overland flow and in relatively small streams to the Dead

River or Passaic River which form the northern boundary of the Township. In nearly all cases these streams could be characterized as steeply sloped natural channels. The slope of the streams typically flattens abruptly as they approach the floodplain of the Dead and Passaic Rivers. Many of the streams cross under two or more roadways where culverts have been constructed to pass the flow. In many cases the culverts were constructed many years ago at a time when the extent of development which the Township as since experienced was not envisioned. The additional runoff generated by development was also not anticipated in the design of these culverts and in a many cases they are severely inadequate to handle storms of even nominal intensity, other culverts have been constructed over the years in conjunction with development and in many cases, these too are inadequate for major storms.

The portion of Warren Township south of the ridgeline of the Second Watchung Mountain has characteristics almost identical of that of the northern portion of the Township. Again, steeply sloped natural channels drain the mountain conveying the flow to the East Branch of the Middle Brook which runs generally parallel to the southern boundary of the Township. The East Branch of the Middle Brook is a more gently sloped water course having, in areas, a wide flood plain. Because of these factors a large portion of the Township has severe development restraints, that is, it is either steeply sloped or floodplain/wetland which is not conducive to most forms of development.

The report prepared by this office in 1975 and 1976 evaluated whether zoning modifications might serve to abate runoff and erosion problems which prevailed in the Township. Consideration was given to either reducing the zoning density from 1 1/2 acres per unit to 2 acres per unit or perhaps

requiring the clustering of development in portions of a particular parcel of land in order to avoid the more sensitive areas and reduce the total area of impermeable surfaces. As evaluated, clustering would not increase or decrease the development density or the number of units which could be developed on a particular parcel. It was assumed that clustering would consist of 3/4 acre lots with half of the parcel devoted to open space. It was found that each of the alternatives would result in some improvement of runoff and erosion conditions. The degree of improvement was found to depend upon conditions peculiar to the particular watershed (degree and location of existing development, existing culvert capacity, etc.).

The drainage reports advised the Township of the severe erosion problems which are prevalent along many of the streams which drain both the northern and southern slopes of the Second Watchung Mountain. In addition to the loss of soil, the erosion results in the loss of trees and the undermining and clogging of drainage structures. The inadequacy of the culverts in the Township generally results in localized flooding problems in the vicinity of these culverts. Severe erosion further aggravates the flooding problems since eroded material tends to collect in culverts encroaching on their capacity.

II. GENERAL CONSIDERATIONS REGARDING RUNOFF AND EROSION

Runoff is a portion of rainfall which is not absorbed by the ground or otherwise intercepted by vegetation, puddling, etc., and later evaporates into the atmosphere. Runoff is the portion which travels over the ground to a stream or storm sewer system. Accordingly, the amount of runoff both in terms of overall volume and peak rate are influenced by the characteristics of the watershed including the permeability of the soils, type of groundcover and slope of the ground. The types of soil effects the ability of rainfall

to be absorbed or percolate into the ground and the rate at which it percolates. Sandy soils would have greater permeability and accordingly reduce runoff rates and volumes, clay and rocky soils have slow percolation rates resulting in higher rates of runoff. The denser vegetation is on a site the more rainfall that will be intercepted by leaves and branches to be later evaporated also the more dense the groundcover the more slowly runoff will flow over the ground giving rainfall a greater opportunity to percolate. Similarly, the flatter the slope of the land the slower will be the flow of runoff accross the ground surface, again giving a greater opportunity to percolate. Steeply sloped areas provide little opportunity for rainfall to percolate into ground resulting in higher peak rates and total volumes of runoff. The various formulas used to compute the peak rate of runoff use these factors in addition to the acreage of the drainage basin and the intensity and duration of the rainfall.

Soil erosion is a direct result of runoff passing across the ground and along streams, drainage ditches, etc. The extent of erosion is affected by the rate and volume of runoff as well as the velocity of flow. Flow velocity in a stream is primarily controlled by the channel slope. The steeper the channel slope the greater the velocity, and therefore the greater the potential for erosion.

Stormwater management has the purpose of reducing volume and/or peak rate of runoff. The major objective is to induce more of the runoff to recharge into the ground reducing the total volume of runoff. Also retention and detention basins are used to store portions of the runoff and allow discharge over longer periods of time at a reduced peak rate.

Detention basins do not necessarily reduce the amount of erosion as the streams are subjected to elevated stream flow rates over a longer period

of time. Typically, methods of controlling erosion include lining the streams with reinforced concrete or similar structures or enclosing them within storm sewers. Check dams in conjunction with channel improvements have also been used to reduce the rate of erosion by reducing the slope at the channel and thereby the velocity of runoff. These types of improvements were recommended in our 1975-1976 drainage study as facilities that could aid the Township in avoiding runoff and erosion problems.

This study did not anticipate high density development in Warren Township. The thrust was to provide recommendations which would allow the Township to develop approximately as zoned (generally 1 1/2 acre per lot) without experiencing severe runoff and erosion problems. Accordingly, it follows that dense development in portions of the Township would result in impacts in excess of those discussed within the report and provisions to minimize these impacts would be more extensive, if feasible.

II. PROPOSED HIGH DENSITY DEVELOPMENTS

Three high density developments have been proposed in Warren Township which is the subject of this report. All of these are located in the western portion of the Township generally along Martinsville Road. These developments include properties owned by: 1) AMG Realty Company, 2) Skytop Land Corporation and 3) Timber Properties, Inc. These developers have proposed residential developments consisting of 6.08 units per acre, 8.8 units per acre and 11.64 units per acre respectively. Obviously, these densities are significantly higher than the .67 unit per acre density which is predominent in the area and the other zones allowing 1 unit per acre and 2 units per acre in this general vicinity. The substantially higher density development would have a significant impact on the rate of runoff caused by the development of the property. This increase in runoff (to the extent that it is not

artifically reduced by artifical recharge and detention, etc.) results from changes in surface characteristics. Greater amount of impervious surface and also the changes in the vegetative types (wooded areas having minimum runoff potential vs. improved lawns which have substantially higher runoff potential) cause increased runoff. Each of the proposed development sites will be discussed in the following subsections.

1. AMG Realty Property

The property proposed to be developed by the AMG Realty Company is located within the Dock Watch Hollow Brook Watershed. The Dock Watch Hollow Brook Watershed conveys flow from the ridgeline of the Watchung Mountain in a southerly direction along the south slope of the mountain to the East Branch of Middle Brook. AMG Realty Property is located in the headwaters of this brook and accordingly drainage from this property flows down essentially the full length of Dock Watch Hollow Brook. The report prepared in 1975 addressed several severe drainage and erosion problems along Dock Watch Hollow Brook and reported the substantial improvements would have to be made to correct these problems. The drainage basin at that time was nearly fully developed in accordance with the existing zoning and the Township was advised that little could be accomplished by modifying zoning regulations to minimize widespread runoff and erosion problems. The Township was further advised that only a ban on further development in this drainage basin would have a significant effect on future rates of runoff.

The AMG Realty property on which 544 units is proposed includes land that is relatively steeply sloped a large portion in the range of 10-15% slope and some property in excess of 15% slope. The development plan proposes 24 townhouse clusters, 17 of which will occupy areas in excess of 10% slope, and 2 will be in areas where the existing slope is greater than 15%.

Development of this site as proposed would entail extensive clearing and regrading to make construction practical. This would further increase the potential for erosion from loss of vegetation and also substantially modify the percent of impervious area and the nature of the pervious areas. It is estimated, based upon the development layout, that impervious areas would increase from 0% to approximately 28% of site and that the majority of the remaining site would be cleared resulting in increased runoff from these areas also.

Our 1975-1976 report recommended that units be clustered in portions of the site that are more gently sloped and that the more steeply sloped sites, particularly those in excess of 15%, not be developed. The proposed development plan does not incorporate this concept. The development plan indicates that a retainage basin would be constructed where the runoff leaves the site. A basin in this location could control the peak rate of runoff, however, it would not reduce the erosion along Dock Watch Hollow Brook. It is also probable that flooding problems along Dock Watch Hollow Brook would be aggravated even if the peak rate of runoff is maintained at its current level since these culverts would be subjected to flows in excess of their capacity for longer periods of time.

Retention basins can effectively alleviate flooding where erosion is controlled and downstream culverts are adequate, however, where deficient culverts exist further development will result in further backup and flooding because of the extended period of discharge to inadequate and/or sediment clogged culverts.

2. Skytop Land Corporation Property

Skytop Land Corporation proposes to construct a development consisting of 1,936 units on a 220 acre site located in the vicinity of Martins-

ville Road and Mt. Horeb Road. This site straddles the ridge of the Second Watchung Mountain with the smaller portion of the site draining south to Dock Watch Hollow Brook and the majority of this site flowing north to a tributary in the Dead River. It is noted that the development plan does not provide for a retention basin to be constructed on the portion of the site tributary to Dock Watch Hollow Brook. Obviously, this would tend to aggravate problems along Dock Watch Hollow Brook to even a greater extent.

With respect to the portion of the Skytop property tributary to the Dead River it is noted that ponds are proposed at the northern extremity of the site where drainage from the site would enter the unnamed tributary of Dead River which flows in a northerly direction down the face of the Second Watchung Mountain across MountainView Road to the Dead River. The development plan proposes 60 townhouse complexes of 24 units each and approximately 42 apartment buildings. Approximately 10 of the townhouse complexes are in areas where the prevailing slope is in excess of 10% and 12 of the apartment buildings are in areas where the slope exceeds 10%. As was the case for AMG Realty substantial earthwork and clearing will be necessary to construct this number of units planned. As part of this it may be necessary to construct embankments, retaining walls, etc., in order to generally flatten the slope of the land in the vicinity of the units as would be necessary to provide adequate access. This results in higher development costs which is attributable basically to the steepness of the site. If rock is encountered during these operations the cost of construction would increase considerably.

Downstream from this site flow from the proposed retention basin would discharge to a natural stream (erosion prone) and continue to the MountainView Road culvert. Between the site and MountainView Road the

tributaries drain is steeply sloped and severe erosion exists. As previuosly mentioned the detention basin may do little to alleviate the erosion problem and increased duration of elevated runoff rates would tend to aggrevate the erosion problem and result in the deposition of eroded material in the vicinity and within MountainView Road culvert where the channel slope begins to flatten. Lining the channel, providing check dams or enclosing the stream in pipe, between the development and MountainView Road could address these concerns, however, this could be only done at substantial cost and would have the potential for further aggrevating erosion during the course of this construction and thereafter due to difficult restoration on steep sloped land.

3. Timber Properties

Timber Properties, Inc., proposes to develop a 73 acre site at a density of 11.64 units per acre. This particular site was one of the areas which was proposed by the Township to be zoned at a rate of 6 to 7 units per acre. This particular site abuts MountainView Road which is the point at which the stream tributary to Dead River flattens prior to entering the Dead River. The site is drained by the number of small streams which drain towards the Dead River. The proposed development plan provides for a storm water management pond along only one of the streams which drain just a portion of the site. A large portion of the site would not be tributary to this retention basin. Accordingly, it is proposed to discharge the runoff from the majority of the site without stormwater retention facilities. This would obviously substantially increase the rate of discharge to culverts crossing MountainView Road. This is undesirable and contrary to all recognized stormwater management practices. Detention facilities should be provided at all locations where runoff discharges from developed portions of the site. This

would appear to require retention facilities at, at least two additional locations. The Timber Property site includes substantial land that is steeply sloped. A review of the development plan indicates that 68 condominum structures are proposed. Of these, 10 are located in areas with slopes greater than 10%, and 3 of these are on land having slopes in excess of 15%. In addition, Timber Property proposes 17 low and moderate income housing structures, 8 of which occupy slope areas in excess of 10%, and 6 of these are on land which has a slope in excess of 15%.

The slope of the property would tend to necessitate the construction of embankments, retaining walls, etc., to terrace the site in such a way that the residential structures could be constructed and access provided. Steeply sloped sites typically result in a greater length of roadway and generally greater disturbance throughout the site as compared to sites of mild slope - less than 10%. Accordingly, from the standpoint of drainage facilities and general site work it is typically more costly to develop a site which is steeply sloped. The greater increase in runoff requires that the stormwater detention basin(s) must be larger to control the peak rate of runoff. Substantial earth work and clearing is necessary and costly retaining walls or embankments may have to be constructed. Site restoration is more difficult as vegetation is more difficult to re-establish on steeper slope land and because of this continued erosion can exist for an extended period of time until vegetation is established on slopes and embankments.

The Timber Property site is adjacent to MountainView Road which is approximately the point at which the stream slope flattens and flows through the floodplain of the Dead River. Accordingly, flooding and erosion problems downstream of this site is of less a concern provided peak runoff from the

site itself can be controlled by properly located and designed stormwater retention basins. Nevertheless, development on the more steeply sloped portions of this site should be precluded. It would appear that development of the site at approximately 6 to 7 units per acre as proposed by the Township could be accomplished with the development located predominently in the more gently sloped portions of the site. This would be advantageous from the standpoint of erosion control and site development cost.

High Density Development Sites Proposed by the Township

The Warren Township Planning Board proposed that three sites within the Township be rezoned to allow 6-7 per acre unit development. The review of these sites indicated that some consideration was given to the drainage when these zones were selected. It should be recognized that land characteristics in Warren Township are somewhat unusual because of the extreme topographical variations within the Township, that is, a great portion of the Township consists of the steeply sloped north and south faces of the Second Watchung Mountain and other substantial portions of the Township consist of the floodplains of the Passaic River, Dead River and East Branch of Middle Brook. High density development in any of these areas would be unacceptable.

General areas that are not floodplain or steeply sloped consist of property essentially along the ridge of the Second Watchung Mountain where the slope flattens. Other areas along MountainView Road at the base of the north slope of the Second Watchung Mountain and areas generally along Mountain Boulevard and Washington Valley Road at the base of the south slope of the Second Watchung Mountain are also midly sloped. The area along the ridge of the mountain, although not steeply sloped or floodplain does have the draw back that development in this area would result in increased stream flows, erosion and adverse loading effects on drainage facilities.

In general, the site selected by the Township included one site which is near the base of the south slope of the Second Watchung Mountain, one site which is near the base of the north slope of the Second Watchung Mountain and a third site in the Stony Brook Watershed. These sites will be discussed in further detail as follows:

1. Stony Brook Watershed Site

This site is located generally between Stirling Road and Stiles Road. A branch of Stony Brook runs through this site and it would be necessary to improve Stony Brook through the site in conjunction with the development of this property. It was reported in the 1975 drainage report that "downstream of Stiles Road, culverts and channels have steeply sloped banks which contain storm waters very effectively. As previously mentioned, the Stiles River bridge has adequate capacity to pass major storms". Accordingly, it appears that development of this site requires the West Branch of the Stony Brook through the site and possibly the replacement of the Stiles Road culvert but no long term flooding or erosion problems would appear evident as a result of the development of this site.

2. East Branch of Middle Brook Site

The second site proposed for higher density zoning is located north of Mountain Boulevard and east of Mount Bethel Road, this land comprises of a portion of the south slope of the Second Watchung Mountain and lies in an upstream portion of the East Branch of Middle Brook. The northern limit of the property lies at the base of an extremely steep portion of the mountain (approximately 25% slope). This slope diminishes abruptly and the slope across the majority of the proposed zone varies between 10% to approximately 5% at the southern perimeter. Drainage on the site is presently carried in a number of small streams running from north to south crossing Mountain Boule-

vard at culverts, and thereafter entering the East Branch of Middle Brook. The moderate slope of this property (5-10%) would allow development on the order of 6-7 units per acre to occur without substantial regrading of the site. This steeply sloped land to the north of development should remain undeveloped and preserved as open space. The topography of the site is also conducive to the construction of retention basins to mitigate increased run-off that will occur. The stream slopes downstream of the property are not particularly severe and accordingly it is not anticipated that erosion problems would be significantly aggravated by high density development on this site.

3. Dead River Drainage Basin Site

As previously mentioned, the tract owned by Timber Properties was proposed as the third high density site. This site is primarily located along small tributaries identified as Branch D-2A in the 1976 drainage report. Development of this track would necessitate the replacement of the existing severely inadequate culvert crossing MountainView Road. Downstream of Mountainview Road, drainage and erosion conditions are not severe and are mainly controlled by the Dead River which is a large tributary of the Passaic River. Upstream of MountainView Road Branch D-2A would have to be improved and stabilized as part of the on-site and off-site development plan. The portion of the site further to the north has slopes in the neighborhood of 5-10% whereas the more southern portion of the site is more steeply sloped and accordingly the development would be best concentrated in the vicinity of MountainView Road allowing the existing wooded area to the north to be preserved as open space.

Conclusion

Based upon a review and comparison of the sites proposed by developers and the sites proposed by the Township for higher density zoning it appears clear that the sites proposed by the Township would minimize the downstream and off-site impacts resulting from these developments. It must be anticipated that under all circumstances the volume of runoff will be increased by a higher density development and generally the higher the density the greater the increase in runoff. The proximity of the tracts, zoned by the Township, to large downstream drainage corridors makes them superior to the sites proposed by AMG Realty Company and Skytop Land Corporation which have proposed developments in the headwaters of streams. These developments would result in aggravation of existing drainage problems and potentially additional problems and increased erosion along the full length of streams to which these sites are tributary. It is also apparent that the proposed developments do not plan to preserve the more steeply sloped portions of the sites, resulting in substantial need to regrade these sites to permit the practical construction of the units as shown. This will result in higher development costs as compared to development on the more gently sloped sites proposed by the Township. More extensive runoff control facilities will also be necessary including downstream culvert improvements and more extensive stormwater retention facilities because of the higher runoff rates attributable to steeply sloped land. Accordingly, from the standpoint of storm water management and erosion control the sites selected by the Township could be developed more economically then those proposed by the developers.