June 14, 1971

The Great Meadow Hydrology and Land Use Study

The Arlington-Lexington Great Meadow Study Committee announces the completion of the hydrology and land use study of this area. The results of the study are presented in detail and indicate the importance of keeping the Great Meadow available to Arlington and Lexington as a natural open space area with some emphasis on flood control. Copies of the final report have been presented to the Boards of Selectmen of both towns. Copies have also been given to the Town Managers and town agencies concerned with land use: including Town Planners, the Town Engineers, the Conservation Commissions and the Finance Committees. Several copies will be available in the reference room of Cary Memorial Library in Lexington and Robbins Library in Arlington.

Camp, Dresser & McKee, the consulting engineers, have compiled a summary with recommendations for possible land use. Included in the body of the report are graphs, charts, and maps, as well as an appendices of the ecological study, subsoil investigation and legislation relating to the Great Meadows beginning with the Acts of the General Court, 1871.

Cooperation and assistance was received from officials and employees of the two towns. The Committee is particularly appreciative and indebted to those citizens of Lexington who volunteered to supervise the water gages at key points in the hydrology study. Arlington members are Mr. Aubrey C. Tobey, Dr. Herbert M. Meyer, and Mr. John Ashton; Lexington members are Mrs. Angela E. Frick, Dr. Howard M. Kassler, and Dr. Manfred P. Friedman.

This report is only the beginning. The Joint Committee will submit its appraisal and recommendations for implementation to the Boards of Selectmen for their consideration and action. These end use recommendations based on the findings of Camp, Dresser & McKee will be ordered to reflect the understood needs and cooperative potential for sustained support by the two towns.

Meanwhile, the report should provide fundamental and valuable information for determining use of land contiguous to and within the Great Meadow watershed.

JOINT ARLINGTON - LEXINGTON GREAT MEADOW COMMITTEE

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December 8, 1970

Mr. Aubrey C. Tobey, Chairman
Joint Arlington-Lexington
Great Meadows Study Committee
Arlington, Massachusetts 02174

Report on Hydrology and
Land Use of the Great
Meadows
CDM 489-1

Dear Mr. Tobey:

In compliance with the terms of our contract dated September 8, 1969, we have made an engineering investigation of the hydrology and land use of the Great Meadows and its watershed.

The results of our studies are presented in detail in the following report, including recommendations for land use of the Great Meadows proper and of the watershed that constitutes the headwaters of Mill Brook, in order to alleviate the flooding potential in the area. The more significant recommendations are summarized below.

RECOMMENDATIONS

1. Only very limited development should be permitted on those areas of the Munroe Brook watershed which have flood retardation valve.

2. Use of the Arlington Reservoir as a flood control structure should be considered, even at the expense of sacrificing recreational uses to an increasing degree.

3. The Great Meadows area should be kept for open space use; it should also be used for flood retardation purposes for short periods of time.

4. The capacity of the Mill Brook channel downstream of Arlington Reservoir should be investigated and the necessary corrective measures accomplished to minimize flood damages during major storms.

5. The Great Meadows area should be subjected to land use criteria that are of such a type and extent that they:

- are not objectionable to surrounding areas due to noise, smoke, dust or odors and do not pollute the land, air, water, or environment;

- are compatible with the surrounding area and provide for the needs of both Arlington and Lexington giving the greatest benefit with the least cost;

- do not increase the flood potential either downstream or upstream and do not change the water table to deleteriously affect surrounding structures or the ecologic environment.

- aid in the prevention of floods, pollution and the depletion of the natural resources.

6. The Great Meadows should be maintained as a natural wildlife preserve and such flora and fauna as presently exist should be preserved.

7. The contamination of Munroe Brook and the Arlington Reservoir by seepage from the Arlington Sanitary Landfill area, should be eliminated by conveying the contaminated seepage into the municipal sewer line.

SUMMARY

Background

The Great Meadows area consists of about 183 acres of land owned by the Town of Arlington (although entirely located in the Town of Lexington), approximately one-half mile northwest of the Arlington-Lexington boundary line and between Lowell Street, Maple Street and the Boston and Maine railroad embankment. The land was acquired by the Town of Arlington in 1872 in order to provide adequate water supply to the town. When the Arlington Reservoir was built, about 175 acres of the Great Meadows were taken to provide a storage basin in which the surplus waters of Munroe and Fessenden Brooks could be stored in the spring and used to supplement the storage at Arlington Reservoir.

Later on, to improve the quality and quantity of the Arlington water supply, 25 tubular wells were driven in a bank of coarse gravel at the edge of the Great Meadows near the East Lexington Railroad Station. A pumping station was built, with a nominal capacity of 500 gallons per minute. Water was pumped into a stand pipe in the center of the Park at the top of Arlington Heights.

Since January 1899, when Arlington was admitted to the Metropolitan District Commission Water Supply, the storage in the Great Meadows area and the pumping from the wells have been discontinued. In later years, the Great Meadows area was drained for mosquito control.

While both towns have been concerned about the use of this land, for many years it has remained idle and of little use to either town except for the abutters. In 1965, each town appointed a Great Meadows Study Committee to study the potential of this area for use beneficial to both towns taking into consideration its development in terms of flood control as well as the recreational and conservation needs of both towns.

Hydrology of the Great Meadows Area

Since there were no runoff records in the area under study, gages were installed in Munroe Brook at Maple Street and Lillian Road, in Sickle Brook at Massachusetts Avenue and in Mill Brook at the outlet from Arlington Reservoir. Two raingages were installed, one at 17 Smith Avenue, Lexington and one at 3 Rolling Lane, Burlington. The intention was to obtain at least one year of hydrologic records. The gaging program started on November 1, 1969 and ended on October 31, 1970.

Discharge measurements were made during the wet and dry seasons to develop stage-discharge relationships of stream flow and to compare the runoff with the precipitation in the area.

The climate of the study area is characteristic of the northeastern part of Massachusetts, with fairly uniform monthly precipitation, warm summers and cold winters. The mean annual temperature in Arlington (1942-1950) is 51.4°F.

The average rainfall in the Arlington-Lexington area is 46.16 inches, (1942-1956) as compared to 42.40 inches in Boston, 45.52 inches for Spot Pond in Stoneham and 40.94 inches for Reading, Massachusetts. The total rainfall during the study period (Nov. 1969-Oct. 1970) at the Lexington raingage was 37.95 inches and at the Burlington raingage 51.04 inches. December was the wettest month during the study period; total precipitation was 13.87 inches at Lexington, 10.32 inches at Burlington and 10.55 inches at Reading. At the Reading station, December, 1969 had the highest precipitation for this month since observations started in 1899, exceeding the previous record of 8.24 inches set in 1937.

The total runoff during the study period at the Arlington Reservoir gaging station was 35.43 inches and at Lillian Road it was 35.57 inches. The high ratio of the rainfall to the runoff for the year is due to the fact that most of the runoff occurred during the wet winter months, when the ground conditions produced high runoff coefficients. Under normal conditions, and with a potential evapotranspiration of 14.0 inches, there should be enough water for basin recharge.

Flood Problems

Based on the hydrologic characteristics of the watershed we have estimated the peak flows that might occur in the Munroe Brook and the Sickle Brook watersheds. From our estimates we have concluded that there is definite flood potential

in both watersheds that can be aggravated by developments in the areas that are acting at the present time as flood retardation zones. In Munroe Brook there are at the present time some developments taking place in the wet lands which if left in their present state could otherwise reduce the magnitude of peak flows to be expected downstream from Lillian Road. If the available land in this watershed is developed from its former natural condition to a highly developed area - such as apartments - the magnitude of the peak flows to be expected from a 10-yr. frequency storm might change to those expected from a 100-yr. frequency storm.

The same flooding conditions are expected to occur in Sickle Brook if the watershed and the Great Meadows are developed extensively. If no changes are made in the status of the Great Meadows, development of other vacant areas in the watershed alone can increase the magnitude of the peak flows from those expected in a 10-yr. frequency storm to those expected from a 15-yr. frequency storm. Substantial increases are to be expected if the Great Meadows is developed to a type of development similar to suburban housing. If a large impervious surface is introduced in the Great Meadows, as a parking lot for example, the flood potential downstream would become even more critical than it already is.

An investigation of the channel capacities of Munroe Brook and Sickle Brook discloses that there are some areas that presently can be flooded at peak flow conditions higher than a 10-yr. flood. In Munroe Brook the channel capacity, especially between Lillian Road and the reservoir, is somewhat controlled by the operating levels of Arlington Reservoir. Upstream of Lillian Road a narrow flood plain dampens the effect of peak discharges, the same as the marshy area north of Maple Street. Any encroachments on the flood plain or the flat swampy areas adjacent to Munroe Brook and Fessenden Brook will, as discussed above, increase the peak flows from the watershed into Arlington Reservoir and consequently in Mill Brook.

The Sickle Brook channel from Fottler Avenue to the Arlington Reservoir is capable of handling high frequency flows within the main channel. Flooding, if any, will be restricted to certain areas of the Great Meadows, which naturally acts as a flood retarding area. The elimination of this area by developments that would alter its retardation value will increase the flood potential downstream.

We are of the opinion that Mill Brook downstream from Arlington Reservoir presents a very serious flooding problem, since many developments have been constructed in Arlington adjacent to the banks and the channel appears to be constricted by some undersized structures. It seems probable that extensive flooding might occur from a 25-year storm.

Flood Protection

Since considerable development is taking place in the Munroe Brook watershed and more available land will be developed in the future, serious consideration should be given to the flooding potentials in the Munroe Brook drainage system.

Since flood-producing storms can be expected to occur at any time during the year, the possibility of using the Arlington Reservoir as a flood control structure at the cost of temporarily sacrificing some of its recreational uses should be considered.The present practice of lowering the reservoir water level just prior to an intense summer storm or prior to a hurricane threat should be continued.

The peak flows in Mill Brook downstream of Arlington Reservoir are the result of the combination of peak flows from Munroe Brook and Sickle Brook. Some dampening effect is obtained in Arlington Reservoir by keeping its level as low as possible. An additional degree of protection from flood hazards could be obtained if a retardation structure could be introduced in the system. It appears feasible to obtain a substantial dampening effect of peak flows in Sickle Brook if a flood retardation reservoir is created by building a low dam at Fottler Avenue. If the full capacity of the Meadows is utilized, we have estimated that a 10-yr. flood (150 cubic feet per sec - cfs) would be dampened to about 30 cfs. This reservoir would be drained immediately after the flows have reached a reasonable level in Mill Brook, and would be empty most of the time. We are of the opinion that such a flood retardation reservoir would not interfere with an open space use of the Great Meadows.

Groundwater

Based on the subsoil investigations made in the Great Meadows area, we have estimated that the hydraulically connected kames and outwash deposits that constitute the aquifer have a capacity of approximately 300,000,000 cubic feet. The safe yield of such an aquifer, based on the storage-yield relationship of water supply watersheds, has been estimated to be in the approximate range of 0.75 to 0.90 million gallons per day (mgd). Such a draft, even if continuous during drought periods, would not seriously deplete the groundwater level in the Great Meadows and the groundwater storage would be replenished annually by natural recharge.

While 0.75 to 0.90 mgd. is insignificant with relation to the present or projected municipal water supply needs of either Arlington or Lexington, even for emergency purposes, it would be more than ample for irrigation of an open type development such as a park or golf course which might be built in the Great Meadows.

Water Uses

We have studied the possibility of augmenting the Mill Brook flows using waters from the Arlington Reservoir, Sickle Brook and groundwater from Great Meadows, to alleviate any pollution problems in Mill Brook. As will be discussed later under "Ecology", the major sources of pollution in the watershed can be controlled by properly connecting those sources to the Metropolitan District Commission sewers. Therefore, we are of

the opinion that no substantial quantities of water from the watershed need to be devoted to pollution control.

The sustained use of water from the study area for emergency municipal supply requires the addition of storage to the system. We estimate that to supply in an emergency about 21,500 people it would be necessary to build a reservior of about 20 million cubic feet in Great Meadows, and a 44 million cubic feet reservoir if the required withdrawal rate is increased to supply about 30,000 people. Such reservoirs are ruled out by the necessity of building expensive structures to protect the railroad embankment and existing developments. Furthermore, the existence of such reservoirs would interfere with any type of open space development that could be built in the area. Since provisions would have to be made to treat the supplied waters to some extent, we are of the opinion that such use is not profitable for either one of the municipalities involved.

Based on the hydrological findings, we recommend that the following steps should be taken to alleviate the flood problems of the study area:

1. Permit only very limited development in the areas of Munroe Brook that have a flood retardation value.

2. Consider the possibility of using the Arlington Reservoir as a flood control structure, sacrificing recreational uses if necessary.

3. Keep the Great Meadows area as an open space use and plan on using the area for flood retardation purposes for short periods of time. It should be kept in mind that dense vegetation in the slopes of the Great Meadows introduces a time-lag effect that increases the retardation capacity.

4. Investigate the existing capacities of the Mill Brook channel downstream of Arlington Reservoir and take the necessary corrective measures if the channel and structures prove to be insufficient.

It seems advisable also to continue reading some of the staff gages, especially the one at Arlington Reservoir, to gather a long term record of hydrological information that will prove to be very valuable for future studies and planning of the area.

Land Use

If physical limitations and the effect of the ecology and the surrounding areas is neglected, it would be possible to develop the Great Meadows area for any number of uses ranging from highly inadvisable extensive use (residential, commercial, light industrial, public buildings) to the more preferred open area use (parks, playfields, golf course, wildlife and vegetation natural conservation area).

Major constraints on the use of the Great Meadows area are the soil conditions in the large flat section underlain with peat and the need to alleviate flood potential downstream. The natural environment of the area is considered to have intrinsic value as a natural wildlife preserve and as an outdoor ecologic classroom.

Many previous studies and reports originated locally by the regional planning agency (MAPC), the State Department of Natural Resources, the Metropolitan District Commission, the State Department of Public Works and the Massachusetts Bay Transit Authority have had reference to the use of the Great Meadows area. For the most part, these references recommended the retention of the area for an open space use as a natural environment and golf course. Other references such as the proposed Route 3 and mass transit proposals would have developed the Great Meadows area with large areas of pavement and structures. At the present time, the mass transit terminus and Route 3 have been shelved and are not considered likely.

The following land use selection criteria was developed for the use of the Great Meadows:

The uses of the land shall be of a type and extent that they:

-are compatible with the surrounding area in terms of safety and health;

-are not objectionable to surrounding areas due to noise, smoke, dust or odors or pollute the land, air, water, or environment;

-provide for the needs of both communities (Arlington and Lexington), giving the greatest benefit with the least cost;

-do not increase the flood potential downstream or upstream;

-do not change the water table to the extent that deleteriously affects surrounding structures or the ecologic environment (plants, animals, or other desirable living creatures);

-aid in preventing safety hazards such as floods, pollution, and depletion of natural resources.

Based on the findings and implications of the soils, hydrologic and ecologic studies we found that the most critical need was for flood protection. By constructing a small dam at Fottler Avenue, a flood storage reservoir can be created in the Great Meadows area which would dampen peak flows and alleviate to a considerable degree potential flooding downstream. Any development which would add fill in the low sections or increase the runoff in the Great Meadows area would reduce the amount of protection that could be afforded by such a storage and reservoir. The use of the area for certain open space uses such as athletic fields or a golf course would require some filling in part of the area.

We therefore recommend that the preferred land use of the Great Meadows area be retention in its natural state, a small dam to be constructed at Fottler Avenue on Sickle Brook to create a flood storage reservoir and the use of the Great Meadows be limited to ecological education, passive and limited active recreation (such as walking, picnicking, ice skating). Appropriate legislative action should be sought to protect this land for conservation purposes so that future pressures for more intensive development can be combatted.

It is strongly recommended that no extensive development such as housing, industry, business, transit terminus or public buildings which would require structures and extensive paved areas be permitted in the Great Meadows area.

If downstream flood potential can be alleviated significantly by some other means such as utilizing the Arlington Reservoir for flood control all year and temporarily curtailing its recreation use, it may be possible to sacrifice some of the flood storage capacity of the Great Meadows and permit a combination of uses therein including a natural undeveloped area and a low intensity use such as a golf course on part of the area. It should be kept in mind, however, that additional development in the watershed outside of the Great Meadows is expected, and the flood protection need is expected to increase and there are no flood retarding opportunities equal to the Great Meadows available.

In regards to areas outside of the Great Meadows it is recommended that development of the remaining vacant and wetland areas along the Munroe Brook be closely followed and reviewed. Any proposals that would reduce the wetlands further and/or increase peak runoff flows should also include flood retardation measures such as ponds, lagoons or other appropriate devices. Any future developments in the Mill Brook watershed should avoid concentration of large pavement, roof or sloped areas which would increase or hasten runoff.

Ecology of the Great Meadows

While the Great Meadows does not support an abundance of wildlife, the area, nevertheless, has a sufficient diversity of flora and fauna to justify its preservation.

Aquatic and terrestrial forms are found in an ecological pattern which corresponds to the hydrological conditions present within this natural area. Aquatic and semi-aquatic plants and animals inhabit the wet lowlands while corresponding forms of wildlife can be found throughout the grassy dry mesic zone and the high ridge of the xeric zone. The Great Meadows, therefore, represents a typical senile peat bog whose moisture content is of significance throughout the year. In its original state, the watershed comprised of much more wetlands similar to the Great Meadows in which considerable wildlife flourished. The gradual filling in of the wetlands along Munroe, Fessenden and Sickle Brooks has decreased the water-holding capacity of these flood plains and increased

the rapidity of surface runoff. Correspondingly, the natural habitat for waterfowl and other marshland species has been depleted.

Based on the data accumulated during this study, it would appear that continued development of the wetlands adjacent to Munroe and Fessenden Brooks will only lead to further degradation of the environment. Also, the destruction of natural forested areas and the filling of wetlands will increase the threat of flooding along Munroe Brook.

Another serious problem which faces the residents of the Town of Arlington, is the continued contamination of Munroe Brook by the highly polluted waters of Reeds Brook. This small but highly significant water course receives the drainage from the Arlington Sanitary Landfill area above Summer Street. It is doubtful that the seepage of water through the landfill area can be controlled adequately enough to prevent the continuous drainage of contaminants into Munroe Brook and the Arlington Heights Reservoir. It would appear that the only corrective measure available, at present, would be to divert Reeds Brook into the Municipal sewerline as other means of water processing would not appear to be economically feasible.

The Arlington Reservoir itself is of significant value, not only as a water resource, but also as a recreational facility for the Town of Arlington. The contamination of the Arlington Reservoir by Reeds Brook is most likely the major cause of the high algae and aquatic weed population found present each year. Even with the installation of an aeration device to reduce the chemical and biological oxygen demand, the water quality of the Reservoir will remain marginal until the up-stream pollution is abated.

Sickle Brook, which later becomes Mill Brook, is subject to a wide range of environmental pollution. The water in this stream is gradually degraded by sub-division and agricultural enrichment in Lexington, as well as by combined sewer overflows and chloride/sand deposition in Arlington.

The maintenance of the present boundaries around the Great Meadows and the prohibition of construction within its confines would appear to be a vital first step towards the preservation of this area. Dredging and permanent flooding of the Great Meadows lowlands is not feasible. Problems of turbidity, dense coloration and aquatic vegetation will inevitably preclude any apparent recreational advantages.

The utilization of the Great Meadows as a natural wildlife preserve and as an outdoor classroom has intrinsic values which are considerable in terms of the environmental quality of both communities.

Geology of the Great Meadows

The subsurface exploration program for the study has included a geological reconnaissance of the site, plus test borings, rod probings

and test pits. In addition a sample of groundwater was recovered for chemical analysis, after pumping from a test well. The present topographic features in the Great Meadows Study Area are all the direct result of continental glaciation. Most are excellent examples of glacial landforms. No bedrock was observed during the reconnaissance or encountered in any of the subsurface explorations. Soil types encountered included glacial till and glacial outwash in the periphery of the Great Meadows, and an accumulation of about 24 feet of peat underneath the Great Meadows. The Great Meadows is far from ideal in regard to subsurface and foundation conditions. Due to the presence of the peat deposits, special construction procedures will be required for site development and building foundations. These procedures will add considerably to the cost of development, compared to those at a site with good bearing soils, and may require a longer than normal construction period. Detailed engineering and economic studies will be required in order to determine the most satisfactory method of developing the site. Filling for site development, including athletic fields, parking lots and roadways, will cause settlements of large magnitude and long duration. A stabilization program will probably be required in order to reduce residual settlements after construction to tolerable values. The stabilization program may require filling, surcharing, the installation of settlement observation devices, and a lengthy waiting period prior to placing the drainage system and final surfaces.

Consultants

The Land Use section of this Report was developed by our consultants, John Brown Associates of Boston, Massachusetts. The Ecological Study, appended to this report, was developed by Jason M. Cortell and Associates of Wellesley Hills, Massachusetts. The subsoil investigations for the Great Meadows Study were done by Haley and Aldrich of Cambridge, Massachusetts.

Acknowledgements

We wish to acknowledge with thanks the cooperation and assistance we received from the members of the Great Meadows Study Committee, and the many town officials, both of Arlington and Lexington, who assisted us in this study. We are indebted, also, to the Engineering Department of Arlington, which took care of the operation of the Arlington Reservoir gaging station; the Engineering Department of Lexington which provided us maps and valuable information; the Town Planners of Arlington and Lexington, and the voluntary observers which made the hydrological study possible.

Very truly yours,

CAMP, DRESSER & McKEE

Darrell A. Root