APPENDIX A - UTILITIES MASTER PLAN

Babson College
Babson Park, Massachusetts

Utilities Master Plan

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EXECUTIVE SUMMARY

This Utilities Master Plan has been developed to addresses Babson College's present and future campus sanitary sewer, potable water, natural gas and high voltage electric power service and distribution needs. The future conditions were determined based on the Near Term and Intermediate Term projects identified in the Babson College Campus Facilities Plan 2000, as amended by an April 13, 2001, memo from Miller Dyer Spears, Inc., to Babson College.

This master planning project has found the potable water distribution system on the Babson College campus to be operating at or near its design capacity under the current conditions, using a 35 psi minimum residual pressure criteria. The results were found to be essentially the same for both no-flow and average-flow conditions. The most marginal residual pressures were found in the Woodland Hill complex. One notable finding about the system's performance is that the fire pump located near Park Manor South is functioning as a booster pump on a regular basis. It is intended to start only under a fire flow condition.

Adding the Near Term projects to the potable water system model yielded results similar to those obtained for the current conditions. Adding the Intermediate Phase projects to the potable water system model identified some concerns beyond those identified under the current conditions and the Near Term project conditions. The results for four existing Woodland Hill units below the minimum 35 psi limit. This is also true for the four Near Term graduate housing facilities and the three Intermediate Phase graduate housing units proposed for the Woodland Hill. The results were the same for the no-flow and average-flow scenarios.

The modeling showed the system was capable of meeting the minimum NFPA fire fighting water supply required delivery rate of 1,000 gpm. However, the demands of future sprinkler systems will be in addition to this required delivery rate. The model of the water system indicates that when upgraded as recommended in this Utilities Master Plan, the water system will be able to supply the demands for these future sprinkler systems.

The recommended improvements to the water system piping include increasing the size of several segments of the system, the addition of one new link in the system, and the complete review and possible re-setting of the controls on the existing fire pump. These recommended improvements, when completed as a group, will allow the on-campus water system to meet the daily average demands without the fire pump being engaged to boost the pressure. The fire pump remains necessary to meet the high flow demands of a fire situation.

The modeling results indicate that the on - campus sanitary sewer collection system is operating within its design capacity under both current average and peak conditions. No capacity restrictions in the on - campus system were identified when the Near Term and

Intermediate Phase proposed projects were added to the sanitary sewer system. An area of the Town of Wellesley's system between the Babson campus and the nearest trunk sewer has been identified as operating at its maximum capacity. This area extends from the intersection of Forest Street and Abbott Road to the north and east to the intersection of Inverness and Lincoln Roads. In accordance with Town of Wellesley policies, to receive approval to connect it's planned Near Term and Intermediate Phase projects, Babson College will be required to remove from the sanitary sewer system existing flows equal in volume to the flows anticipated to be produced by the proposed projects. Currently, Babson College is pursuing an infiltration and inflow study of its on-campus sanitary sewer system. The goal of this work is to identify a sufficient volume of unnecessary flow that can be removed from the sanitary sewer system to balance the new flows anticipated from the planned projects.

KeySpan Energy Delivery, the natural gas supplier, has determined the upgrades to the natural gas distribution system necessary to support the proposed Near Term and Intermediate Phase projects. KeySpan has not yet made this information available. When the information is available it will be incorporated directly into this Utilities Master Plan and an appropriate addendum issued.

1.0 INTRODUCTION

Babson College is located on an 370 acre campus in the Towns of Wellesley and Needham, MA. The campus currently consists of approximately 46 buildings which service the population of approximately 1750 full time undergraduate students, 450 full time graduate students, 1200 part time graduate students, and 670 faculty and staff. Figure 1 shows the current layout of the campus. The campus, which is situated in a residential area, is bordered by several major streets and extends across the Town of Wellesley border into the Town of Needham.

Babson College was established on September 3, 1919, in Roger Babson's home on Abbott Road in Wellesley Hills. Five of the existing buildings on the current campus predate the establishment of Babson College, extending back to 1904 (Sullivan and Forest Halls). Since its beginnings in the early 1900's the campus has expanded to its current configuration shown in Figure 1. Twelve buildings were constructed in the 1920's, and then no buildings were added to the campus until Malloy Hall was built in 1954. Trim Hall was added in 1963, and then eight buildings were constructed in the 1970's. Four more buildings were added in the 1980's and six in the 1990's.

Babson College's Campus Facilities Plan 2000, a separate master plan addressing buildings, is attached as Appendix A. That plan calls for the addition of multiple buildings to the campus in the near future, but not the expansion of the student body. The campus' utilities are not addressed in the facilities plan. Babson is aware that utility upgrades may be required to support the new buildings planned for the campus. However, a comprehensive master plan for Babson College's utilities does not currently exist.

This Utilities Master Plan has been developed to address the present and future needs of the campus for sanitary sewer, potable water, natural gas and high voltage electric power service and distribution. ENSR International has developed the included information and analysis for the sanitary sewer and potable water. KeySpan Energy Delivery is the natural gas supplier and has provided the information concerning the natural gas service and distribution system. The information concerning high voltage electric power was developed by Shooshanian Engineering, Inc., for Babson College under a separate contract. All of this information combines to provide the College with a well prepared approach to the construction of its planned expansion of facilities on the campus.

2.0 METHODOLOGY

2.1 Project Methodology

The primary goal of this Utilities Master Plan was to identify utility improvements that will be required to support the Near Term and Intermediate Phase projects proposed in Babson College's Campus Facilities Plan 2000, as amended by an April 13, 2001, memo from Miller Dyer Spears, Inc., to Babson College (presented in Appendix B). The sanitary sewer and potable water pipe networks were investigated for existing and potential future substandard conditions due to hydraulic limitations. This was accomplished by first researching and assembling all of the existing record data for both the potable water distribution system and the sanitary sewer collection system. This research was focused on the on-campus system, but extended out into the Town of Wellesley systems as needed to provide a complete understanding of these utility systems servicing the campus. The model of the water system was extended to include the Town pipelines connecting the campus to the nearest storage tanks. The Town's sanitary sewer system connecting the campus to the nearest trunk sewer was investigated using traditional engineering calculations. Knowledgeable members of Babson College's facilities staff and the Town of Wellesley Department of Public Works staff were questioned about the completeness and accuracy of the record information as it was assembled. Several iterations of data gathering were required before a complete description of the two systems was assembled.

KeySpan Energy Delivery, the natural gas supplier, was supplied the information describing the Near Term and Intermediate Phase projects. KeySpan reports that they have analyzed this information and determined the upgrades to the natural gas distribution system necessary to support the proposed projects. This information is to be provided to ENSR, but has not yet been made available by KeySpan. When the information is available it will be incorporated directly into this Utilities Master Plan and an appropriate addendum issued.

The high voltage electric power system was investigated by Shooshanian Engineering, Inc., under contract directly to Babson College. That work effort produced a separate document which addresses high voltage electric power only. Readers interested in details of the high voltage electric power system should refer to that independent document directly. This Utilities Master Plan references that independent work for high voltage electric power issues, addressing it directly only from the perspective of utility conflicts.

This master plan also endeavors to begin the coordination of the construction of the identified utility upgrades. The goal of this effort is to avoiding unnecessary reconstruction of utilities and surface treatments, minimizing the number of times a given area is disturbed for subsurface utility construction. For this purpose, all of the proposed projects were reviewed for their potential impact on the subsurface utilities, regardless of their impact on the utility loadings or demands. Some of the proposed projects that do not affect the loadings or demands on the utilities can affect them by

physically disrupting them during construction. As the designs of the utility upgrades are completed, making greater detail of the proposed construction known, this construction coordination issue will need to be revisited.

2.2 Modeling Methodology

For this master plan computer based models of the potable water distribution system and the on-campus sanitary sewer collection system were developed. The Town of Wellesley sanitary sewer system that connects the campus to the nearest trunk sewer was investigated through traditional engineering calculations and physical inspections. The computer models were based on record information of the systems. These models were used to predict the performance of the systems under both current and future conditions. The future conditions were determined from the Near Term and Intermediate Phase projects identified in the Babson College Campus Facilities Plan 2000, as amended.

Potable Water System

The computer model of the potable water distribution system on the Babson College campus was developed using Cybernet® Version 3 software. The model consists of a complete three-dimensional drawing of the potable water distribution system, and a related data base. Within the data base all of the information needed to predict the performance of the system is stored. This includes pipe size and material of construction, service connection locations, and demand loadings. The model includes all of the on-campus system and was extended to include the Town of Wellesley storage tanks that supply the campus, and the Town's pipelines that connect the storage tanks to the campus. This allowed the performance of these Town pipelines to be incorporated directly into the model.

The model is calibrated so that it accurately reproduces the results of standard hydrant flow tests. The Town of Wellesley was not able to supply sufficient hydrant flow test data to properly calibrate the potable water system model. New hydrant flow data and static pressure data was obtained by Babson and supplied to ENSR to allow this computer model to be calibrated. This hydrant flow data is presented in Appendix C.

Once the model is fully constructed and calibrated, the software calculates the flow volumes and residual pressures for each run of pipe in the model in response to applied water usage demands. The model provides the information needed to assess how the system is performing under the applied demands and to identify areas of the system that are insufficient for those demands. The demand loads applied to the system represented the average water usage throughout the system and the fire flow requirements. The average demands were derived from historic water usage records, presented

in Appendix D. Meter readings were available for a continuous 14 month period. A review of these readings showed that for a few of the on-campus facilities the water usage was dominated by summer months irrigation activities, and dropped to nearly zero for the winter months. For these facilities, an average of the May through August water usage was used as the average demand to be applied to the model. This was done so that the demand applied to the model for these facilities would not be artificially lowered by the very low winter months usage. For the remainder of the facilities, the operation of the facilities indicates that the water usage during the September to April time period should be dominant, so the average of the water usage from this time period was used in the model. These calculated averages are presented in Appendix E. For the average flow scenario, following applicable American Water Works Association (AWWA) guidelines, a minimum residual pressure of 35 psi was considered acceptable.

The critical operating scenario is the fire flow situation. The flows required to meet the fire fighting requirements are the largest demands placed on the system. For this Master Plan, ENSR used the Cybernet model to predict the fire flows available without reducing the residual pressure in the system below 20 pounds per square inch (psi). Such a fire flow is referred to as the Q_{20} flow. This fire flow could then be compared to typical fire flows required for this type of a campus. The National Fire Prevention Association's (NFPA) Codes and Standards were used to determine the required fire flows.

The ability of the distribution system to supply the proposed future projects was assessed based on a comparison of the current conditions modeling results and the anticipated demands of the proposed projects. The Babson College facilities plan, as amended, identifies 13 Near Term projects and 11 Intermediate Phase projects. Table 1 and Figure 2 describe the Near Term projects and show their locations on the campus. Table 2 and Figure 3 provide this information for the Intermediate Phase projects. All projects were reviewed for their potential to impact other utilities through construction disruptions. Not all of these projects will impact the water usage demands placed on the potable water system. Some of the projects call for the renovation of existing space for new uses, and some involve only parking lot up-grades.

Sanitary Sewer System

The model of the on-campus sanitary sewer was developed using the pipeworks element of desktop LandDevelopment (AutoCAD® 2000, Release 2). This model consists of a complete three-dimensional drawing of the sanitary sewer system, and a related database. Within the database all of the information needed to predict the performance of the system is stored. This includes pipe size, slope and material of construction, lateral connection locations, and flow loadings.

Once the model is fully constructed, the software calculates the flow volumes and pipe capacities for each run of pipe in the model. The model assumes the sewer system to be operating at atmospheric pressure. In this condition no individual pipe in the system is completely full. This approach is

consistent with accepted engineering design practices. If the flow loadings provided cause a run of pipe to become completely full, a condition known as surcharging, then the model calculations are terminated. For this master planning project, no surcharging of the sanitary sewer pipes will be accepted under either average or peak flow conditions. Any pipe which is predicted to experience surcharging will be considered sub-standard. The model, therefore, provides the information needed to assess how the system is performing under the loadings applied and to identify areas of the system that are insufficient for those loadings.

An allowance of 95% of the potable water usage in a building was taken as the probable average daily discharge to the sanitary sewer. The basis of the potable water usage was described above under the potable water system modeling methodology. For the sewer model, use of the winter average water usage as a basis for the sanitary sewer flows prevents counting the water used for irrigation purposes as a sewer flow. This is an important adjustment to the record information because the irrigation water volume can be substantial compared to the true domestic water usage but this flow is not discharged to the sewers. In this scenario, not adjusting out the irrigation flows could substantially over-state the anticipated sewage flows being discharged to the system. Under a separate contract, a one-month period of continuous monitoring was conducted in the eight manholes where the Babson College sanitary sewers discharge to the Town of Wellesley sanitary sewers. This work provided a second source of information to use to determine the average flows in the sanitary sewers. The 95% of average water usage allowances were compared to actual flow measurements obtained. Reasonable agreement was found between the two sources of data; the 95% allowances were retained for use in the modeling as the average flow.

The instantaneous flow rate in a sanitary sewer is known to vary widely. Due to this, sanitary sewers are designed for both average and peak flows, and the Babson College system was modeled for both scenarios. The peak flows are determined by multiplying the average flow by a peaking factor which can be selected based on physical measurements of the flows over time or selected from technical references which base the peaking factor on the type of facilities and total population contributing flow to the sewer in question. A detailed description of the work done to select a peaking factor for this modeling effort is included in section 4.1.

The ability of the collection system to transport the flows from the proposed future projects was assessed based on a comparison of the current conditions modeling results and the anticipated flows from the proposed projects. The sewage flows were taken as 95% of the predicted water consumption, the same as under the current conditions. The peaking factor determined for the current conditions was also be applied to the future conditions flows. All of the projects were reviewed for their potential impact on the sanitary sewer system. Not all of these projects will impact the sanitary sewer loadings. Some of the projects call for the renovation of existing space for new uses, and some involve only parking lot up-grades.

3.0 POTABLE WATER SYSTEM

3.1 Description of Existing Potable Water Distribution System

The Babson College on-campus potable water system includes approximately 42 water meters located at individual buildings and a fire booster pumping station. The system includes a total of approximately 29,450 linear feet of supply piping varying in diameter from 1.5 inches to 12 inches. The most prevalent pipe size is 6 inch diameter, with approximately 14,700 linear feet of this being present in the system. The present average daily water consumption for the entire campus, based on the available meter readings, is 107,131 gallons per day (see Appendix D). There is no on-campus storage nor any centralized back flow prevention separating the on-campus system from the Town of Wellesley system. The existing potable water distribution system is shown on Figures 4 A through D.

The Babson College potable water distribution system consists of two pressure zones that deliver water to the College's facilities from the Town of Wellesley municipal system. One pressure zone, which services the Woodland Hill complex, the Center for Executive Education, and several facilities along the perimeter of the campus, is connected directly to the Town of Wellesley system and relies on that system entirely for pressure and supply. The Town of Wellesley system is supplied from storage tanks located approximately 3,500 feet north of the campus. The tank's water surface operates at an average elevation of 332 feet, which is not appreciably higher than the highest elevations on the campus of approximately 260 feet.

The second pressure zone is supplied by the Town of Wellesley system but is provided with supplemental pressure by a fire pump located on the campus. The fire pump station consists of a single 25 horsepower pump that is functioning as a booster pump, providing increased pressure to the on-campus water piping downstream of it. Approximately one-half of the total campus is serviced by this fire pump.

3.2 Prediction of Future Potable Water Demands

The proposed Near Term and Intermediate Phase projects are described in Tables 1 and 2 respectively. Table 3 shows the estimated water consumption for these projects. The water consumption was estimated based on the square footage of the new project and current water usage in similarly used spaces at the campus.

4.0 SANITARY SEWER SYSTEM

4.1 Description of Existing Sanitary Sewer System

The Babson College sanitary sewer system consists of a total of 19,750 linear feet of sewer pipe distributed over eight sub-systems which convey sewage to the Town of Wellesley municipal system. The system contains four, six and eight inch diameter pipes, with the majority (12,790 linear feet) being eight inch diameter. Sanitary sewer service is provided to all of the College's facilities. Figures 5 A through D show the basic layout of the existing on-campus sanitary sewer collection system and its connections to the Town of Wellesley public system.

This "on-campus" system appears to be functioning satisfactorily. The facilities staff reported that they knew of no chronic problems with the system. The Town of Wellesley system which receives the flows from the campus has experienced on-going operational problems. These consists of surcharging in the trunk sewers that ultimately receive the Babson College sewer discharges.

The instantaneous flow volume in sanitary sewers is known to vary widely. Due to this, sanitary sewers are designed for both average and peak flows. The peak flows are determined by multiplying the average flow by a peaking factor which can be selected based on physical measurements of the flows over time or selected from technical references which base the peaking factor on the type of facilities and total population contributing flow to the sewer in question. The Recommended Standards for Wastewater Facilities, 1997 Edition, yields a peaking factor for a residential population approximately equal to the student body of Babson College of 3.5. An Impact Analysis prepared by BVH integrated services in August 2000 for submission to the Town of Wellesley Planning Board as part of the approval process for additions and renovations to the Center for Executive Education quotes a peaking factor expected for that proposed development of 5.6. The difference between these two values is significant; it requires the development of some additional information or explanation.

At the same time as this modeling work was being completed, one month of continuous flow monitoring was conducted at the eight locations where the sub-systems of the Babson College sanitary sewer system connect to the Town of Wellesley system. This work was conducted as a part of an infiltration and inflow study of the Babson College sanitary sewer system. From this monitoring data the actual peaking factor occurring in seven of the eight sub-systems was determined. No data was available for the eighth location due to an equipment failure. For four of these seven sub-systems the peaking factor estimated was very high, ranging from 19.0 to 14.1. Peaking factors such as these indicate that the sub-system discharging to that location was functioning more as a sewer lateral than as a general sewer collection system. A review of the buildings discharging to these sub-systems identified that three of these four sub-systems were servicing a single building only. The forth sub-system serviced two buildings only. The very high numeric value is the result of near-zero low flows,

typically occurring during the early morning period of 2:00 AM to 5:00 AM, and very large, but short duration, peak flows, occurring as the result of some coordinated activities, such as the changing of classes in an academic building that generates heavy restroom use for only a few minutes. These peaking factors are too high to use to evaluate the over-all sewer collection system.

Two of the remaining three sub-systems serviced five or six buildings, and these buildings do not represent a complete cross-section of the types of buildings and activities at the campus. The peaking factor estimated for these two sub-systems were 11.9 and 18, essentially the same as discussed above for the other four sub-system. The remaining sub-system services 17 buildings which represent most of the activities that occur on the campus. This sub-system, therefore, provides the best representation of the peaking factor actually occurring at the campus. The peaking factor estimated for this sub-system was 5.4. This estimated peaking factor agrees with the 5.6 peaking factor used in the Impact Analysis prepared for the Town of Wellesley for the Center for Executive Education renovations. Given that it was developed from actual flow measurements, and agreed with the site specific historic reference, the 5.4 peaking factor was used in the sanitary sewer model.

4.2 Prediction of Future Sanitary Sewer Flows

Table 3 shows the estimated sewer flows for the proposed future projects; these flows are 95% of the estimated water consumption. This allowance is the same as used for the current conditions. The estimated water consumption was described in section 3.2. The same 5.4 peaking factor was applied to the future anticipated loads as was used for the current conditions.

5.0 RESULTS OF THE POTABLE WATER AND SANITARY SEWER MODELING

5.1 Potable Water Distribution System

5.1.1 Current Conditions

This master planning project has found the potable water distribution system on the Babson College campus to be operating at or near its design capacity under the current conditions, as defined by the 35 psi minimum residual pressure criteria. Specific results for each building and fire hydrant for the average flow scenario are presented in Appendix F. The results for the static, or no flow, scenario are virtually the same as for the average flow scenario. Figures 6 A through D show the pressure contours predicted by the modeling for the existing system. One notable finding about the systems performance under the current conditions is that the fire pump is being started by the automatic equipment due to low pressures. This pump, therefore, is functioning as a booster pump on a regular basis. It is not, as intended, only being started under a fire flow condition.

The portions of the existing system found to be operating at or near the minimum acceptable residual pressure supply portions of the Woodland Hill residential complex. The worst situation occurs at Woodland Hill 6, at which a residual pressure of only 37.6 psi is maintained in the watermain during average-flow conditions. A detailed review of the modeling results and the physical arrangement of the campus indicated that the elevation of the Woodland Hill complex is the major cause of the marginal residual pressures found in that area. Small diameter water services appear to play a secondary role in causing these marginal residual pressures. All of the Woodland Hill buildings are supplied from a water main loop that connects on both ends to the public water main located in Wellesley Avenue.

The ability of the existing system to deliver sufficient fire flows was also investigated. The NFPA fire fighting water supply requirements (minimum supply volume and delivery rate) were calculated for each building on campus. These requirements are presented in Table 4, NFPA Water Supplies For Suburban and Rural Fire Fighting. This calculation has a maximum delivery rate requirement of 1,000 gallons per minute (gpm), which proved to be the requirement for approximately half of the existing buildings and proposed future projects. The modeling showed the system was capable of the maximum required delivery rate of 1,000 gpm. The results of the delivery rate modeling are presented on Figure 7, Modeled Hydrant Fire Flows. At the higher elevation locations on the campus, however, the reserve capacity above this 1,000 gpm requirement is limited.

5.1.2 Future Conditions

The Near Term projects are described in Table 1 and depicted on Figure 2. Adding these Near Term projects to the potable water system model yield results essentially identical to the current conditions. The four new graduate student housing buildings planned for the Woodland Hill complex are predicted to have a residual pressure approximately equal to the existing Woodland Hill 6. For the Near Term condition this predicted residual pressure was 37.6 psi. Specific results for each building and fire hydrant are presented in Appendix F. The results for the static, or no flow, scenario are virtually the same as for the average flow scenario.

The Intermediate Phase projects are depicted on Figure 3. Adding these Intermediate Phase projects to the potable water system model identified some concerns beyond those identified under the current conditions and the Near Term project conditions. The results for the existing Woodland Hill units 2a, 3, 5 and 6 all dropped below the minimum 35 psi limit, as does the result for one existing fire hydrant located next to Woodland Hill 8. This is also true for the four Near Term graduate housing facilities planned for the Woodland Hill complex. Three Intermediate Phase graduate housing units proposed for the Woodland Hill complex are also predicted to be serviced with less than the minimum 35 psi residual pressure. Specific results for each building and fire hydrant are presented in Appendix F. The results were the same for the no-flow and average-flow scenarios.

The additional graduate housing buildings, both Near Term and Intermediate Phase, proposed in for the Woodland Hill area would be serviced by the existing water main servicing that housing complex. This water main has been shown to be marginal for servicing the existing Woodland Hill buildings and proposed Near Term units. The Intermediate Phase results show that the development of seven (four Near Term and three Intermediate Phase) planned new housing units that will be serviced by this same main would exceed its total capacity.

The existing system of fire hydrants will service the proposed projects without significant changes. Therefore, new modeling was not required. Several of the existing buildings have sprinkler systems. Determining the design demands of these systems requires more information than is available at this time. Typical sprinkler systems require up to approximately 600 to 700 gallons per minute; this demand is in addition to the required hydrant fire flows. The modeled hydrant flows available near the existing sprinkled buildings were reviewed to assess the water supply system's ability to meet both the sprinkler demand and hydrant flow demand. No locations with obvious capacity short-comings were identified.

New buildings constructed in the future will be required to have sprinkler systems. It is also anticipated that at some as of yet undetermined future date, existing buildings will be required to be retrofitted with sprinkler systems. This was taken into account when reviewing the water

system for needed improvements. The recommended improvements to the water system were added to the model to predict their effectiveness. With the recommended improvements to the water system, which are described in detail in Section 6.1, the water system is predicted to be able to meet the fire flow and sprinkler flow demands throughout the campus.

5.2 Sanitary Sewer Collection System

5.2.1 Current Conditions

The modeling results indicate the majority of the on-campus sanitary sewer collection system is operating at a small fraction of its maximum capacity. Approximately 74% of the sanitary sewer segments modeled are using less than 5% of their maximum capacity to carry the peak flow rate. This is presented in Appendix G in the column titled "Peaked % Full". The peak flow referenced is the average flow multiplied by the 5.4 peaking factor, as described in Section 4.1. Only 1% of the sewer segments are using more than 50% of their maximum capacity to carry the peak flow rate. These consist of two sewer segments in the pipeline conveying sewage from the cluster of buildings including Trim Hall, Forest Hall and the various operations buildings to the public system located in Forest Street. Specific results for each sewer segment are presented in Appendix G, Sanitary Sewer Modeling Results, Existing Conditions. The modeling results show that there is no surcharging currently occurring in the on - campus system.

5.2.2 Future Conditions

The Near Term projects are described in Table 1 and depicted on Figure 2. Adding these proposed future projects to the sanitary sewer system did not identify capacity concerns for the on-campus system. However, the Town of Wellesley requires that the developer of a new facility demonstrate that the sanitary sewer system, both private and public, between the project and the nearest trunk sewer has the capacity to carry the predicted additional flows. This requirement could impact the development of the College's proposed projects as the Town's system is known to have some capacity restrictions.

The capacity of the Town's system between the Babson campus and the nearest trunk sewer was investigated under a separate project. This investigation consisted of conducting physical inspections of selected manholes, calculating the average and peak flows anticipated to occur in

the sewer system for each segment of the sewer, and calculating the maximum capacity of each sewer segment. The manhole inspections found one manhole near the intersection of Inverness and Lincoln Roads with evidence of surcharging. The calculations identified one location near the intersection of Forest Street and Abbott Road where surcharging is expected to occur. This intersection is approximately two blocks to the south and west from the intersection of Inverness and Lincoln. These findings indicate that the Town of Wellesley system in the general area between these two intersections is operating at, or slightly above, its design capacity. The remainder of the Town's system appears to have sufficient capacity to carry the loads being discharged to it.

6.0 Recommended Action

6.1 Potable Water Distribution System

The recommended improvements to the on-campus potable water distribution system are shown on Figure 8. The improvements consist of increasing the size of selected sections of water main and adding one section of new water main. These recommended upgrades to the system will increase both the volume of water available and the pressure at which it is delivered. It is recommended that these proposed water system improvements be made prior to the addition of the Near Term buildings.

The first section of water main to be increased in size is the approximately 85 linear feet of 6" diameter pipe that connects the Babson College system to the Town of Wellesley system at the intersection of Student Avenue and Wellesley Avenue. The new water main recommended will connect the existing 12" diameter water main in Student Avenue directly to the Town of Wellesley system with a 12" diameter main. This length of water main will need to include a check valve, and a service tap to supply Bryant Hall. The existing 6" diameter water main, which continues up Student Avenue to a 12" diameter water main located in College Drive, will be abandoned. There are improvements to the storm sewer system proposed for the intersection of Student Avenue and Wellesley Avenue which will need to be coordinated with this water main improvement.

The second section of water main to be increased in size is the existing 6" diameter main which makes up one side of the loop that services the Woodland Hill residential buildings. The recommended upgrade to this loop consist of replacing the 6" diameter main in the area between the Woodland Hill buildings with a 12" diameter main which will connect to the existing 12" water main half of the existing loop at both ends. The 6" diameter connection from Woodland Hill to Wellesley Avenue would then be fitted with a check valve and connected into the new 12" water main. The detailed design of this project should also consider enlarging the size of the services from the water main to several of the Woodland Hill buildings. No storm sewer, sanitary sewer or high voltage electrical system upgrades have been identified for this area. The proposed new buildings for the Woodland Hill complex are all proposed to be located outside of the current cluster of buildings. Therefore, there is no currently identified conflicting proposed construction in the location of this water main improvement.

The recommended addition to the on-campus water system is a 12" diameter water main to run from Woodland Hill along Woodland Hill Drive to the existing 12" diameter water main at the entrance to the Center for Executive Education (CEE) parking lot. This connection will place the Woodland Hill complex, which under the existing conditions has the worst hydrant flow results, on the pressure side of the campus fire pump. Doing this will rectify the low fire flows available in the Woodland Hill complex. Making this connection will require the addition of a check valve to the

existing 12" diameter water main that connects Woodland Hill to Wellesley Avenue. The record drawings available for the underground utilities on the campus do not indicate the presence of other underground utilities along this proposed path. Further, no other underground utility improvements have been identified for this proposed path. However, it has been suggested that this piece of Woodland Hill Drive may be rebuilt to improve the storm drainage in the area. This proposed water main installation should be coordinated with the rebuilding of the street, if that reconstruction is pursued.

The completion of the recommended improvements noted above will upgrade the on-campus so that it can supply the typical average water demands without the fire pump being called upon to provide supplemental pressure. Anecdotal evidence indicates that under current conditions the fire pump is routinely starting and pressurizing the system. This information does not correlate with the results of the water system modeling. This disagreement between the apparent actual operation of the system and the model indicates that the fire pump controls may not be operating as believed. Therefore, it is recommended that a complete physical inspection and testing of the fire pump be completed to determine how the pump is currently operating, and to identify any corrections to that operation that need to be made given the upgrades to the water system made else where on the campus.

The last upgrade to the on-campus water system that warrants consideration addresses the dual water main that connects to Forest Avenue near Millea Hall. Currently, there is an 8" water main and a 10" diameter water main in this area, both connect College Drive to the Town of Wellesley's 8" diameter water main in Forest Avenue. These two water mains run parallel to each other up to approximately Park Manor South, where they diverge. The 10" diameter water main is the supply to the on-campus fire pump. The two water mains feed multiple services that cross the other main, have a confusing array of valves, and multiple bends and fittings that reduce their efficiency. The water system model shows that these two water mains are sufficient. However, given the confusing installation of the two water mains, it is recommended that if other work in the area offers an opportunity to economically replace this pair of water mains with a single 12" diameter water main, than that upgrade should be made. A substantial portion of the length of these water mains is in close proximity to proposed storm sewer improvements. This may present the opportunity to cost effectively upgrade these water mains. This upgrade will not, based on the model of the existing water system, substantively improve the performance of the system. However, it will eliminate an area of confusion and sub-standard installation from the system.

6.2 Sanitary Sewer Collection System

The on-campus sanitary sewer system is functioning satisfactorily under the current conditions and is predicted to continue to do so under the Near Term and Intermediate Phase conditions. Therefore, no improvements to this system are recommended.

The Town of Wellesley sanitary sewer system is known to have some operational problems. The investigation of that system has identified one area that appears to be experiencing surcharging under peak flow conditions. This area extends from the intersection of Forest Street and Abbott Road to the north and east and the intersection of Inverness and Lincoln Roads. The Town of Wellesley has a policy of requiring the developer of a new project to demonstrate that the public utilities to service the project have the capacity to do so. If that capacity does not exist, the project developer must develop the necessary capacity before proceeding with its project. In the case of the sanitary sewer, it has been common practice in the Town for project developers to pursue infiltration and inflow remediation projects to eliminate unnecessary flow from the sanitary sewer. The capacity captured by this elimination of unnecessary flow can then be used by the proposed project.

Babson College is currently completing an infiltration and inflow study of its on-campus sanitary sewer system. We recommend that this study be completed and the possible reductions in sanitary sewer flows that can be realized from correcting cross connections and sources of inflow be compiled. The correction of identified cross connections and sources of inflow on the Babson campus should be the first improvement to the sanitary sewer to be pursued. If this effort captures sufficient sewer capacity to allow the connection of the proposed Near Term and Intermediate Phase projects, then Babson College should have met its obligation to the Town of Wellesley concerning this issue. If sufficient capacity is not captured, then further work would need to be pursued. This further work could take many forms, including the remediation of infiltration both on-campus and off, the redirection of flow to different receiving sewers both on-campus and off, or the construction of a new relief sewer along an new alignment to transmit the Babson College sewage flows directly to the nearest trunk sewer. The precise work to be pursued will depend on many things that are not yet known, and will need to be pursued in close coordination with the Town of Wellesley.

6.3 Natural Gas Distribution System

KeySpan Energy Delivery, the natural gas supplier, was supplied the information describing the Near Term and Intermediate Phase projects. KeySpan reports that they have analyzed this information and determined the upgrades to the natural gas distribution system necessary to support the proposed projects. This information is to be provided to ENSR, but has not yet been made available by KeySpan. When the information is available it will be incorporated directly into this Utilities Master Plan and an appropriate addendum issued. Figures 9 A through D show the existing natural gas distribution system.

6.4 High Voltage Electrical Power Distribution System

Independent of this Utilities Master Planning effort a similar effort to address the on-campus high voltage electrical power distribution system has been pursued. The master plan for high voltage electrical power distribution contains the detailed information concerning the high voltage electrical power distribution system and the proposed up-grades to that system. This document can be obtained from the Babson College facilities staff. The high voltage electrical power distribution system master planning effort has found that the existing system requires significant up-grades to meet the future needs of the College. These proposed upgrades, included here for informational purposes only, are shown on Figures 10 A through D. There are also substantial storm sewer improvements recommended for the general route of the electrical system upgrades, notably along College Drive from the entrance to the Nichols parking lot to Map Hill Drive. The record maps of the existing utilities shows this area to be relative clear of existing underground utilities.

7.0 SUMMARY AND CONCLUSIONS

This Utilities Master Plan addresses Babson College's present and future sanitary sewer, potable water, natural gas and high voltage electric power service and distribution needs. The future conditions were determined based on the Near Term and Intermediate Term projects identified in the Babson College Campus Facilities Plan 2000, as amended by an April 13, 2001, memo from Miller Dyer Spears, Inc., to Babson College. ENSR Corporation has developed the included information and analysis for the sanitary sewer and potable water. KeySpan Energy Delivery is the natural gas supplier and is scheduled to provided information concerning required improvements to the natural gas distribution system. This information concerning the natural gas system was not available at the time this Master Plan was completed. It will be added to the plan when it is made available and an appropriate addendum to the Master Plan will be issued. The information concerning high voltage electric power was developed by Shooshanian Engineering, Inc., for Babson College under a separate contract. All of this information combines to provide the College with a well prepared approach to the construction of its planned expansion of facilities on the campus.

This master planning project has found the potable water distribution system on the Babson College campus to be operating at or near its design capacity under the current conditions, as defined by the 35 psi minimum residual pressure criteria. The results were found to be essentially the same for both no-flow and average-flow conditions. The most marginal residual pressures were found in the Woodland Hill complex. One notable finding about the systems performance under the current conditions is that the fire pump is being started by the automatic equipment due to low pressures. This pump, therefore, is functioning as a booster pump on a regular basis. It is not, as intended, only being started under a fire flow condition.

The NFPA fire fighting water supply requirements (minimum supply volume and delivery rate) was calculated for each building on campus. This calculation had a maximum delivery rate of 1,000 gallons per minute (gpm), which proved to be required flow for approximately half of the existing buildings and proposed future projects. The system was shown by the modeling to be capable of supplying this 1,000 gpm requirement.

Adding the Near Term projects to the potable water system model yielded results similar to those obtained for the current conditions. The results for the existing facilities remained unchanged from those described above. Four new graduate student housing buildings, proposed to be added to the Woodland Hill complex, are predicted to have the same marginal residual pressures as the worst of the existing Woodland Hill units. The results were the same for the no-flow and average-flow scenarios.

Adding the Intermediate Phase projects to the potable water system model identified some concerns beyond those identified under the current conditions and the Near Term project conditions. The results for the existing Woodland Hill units 2a, 3, 5 and 6 all dropped below the minimum 35 psi limit, as does

the result for one existing fire hydrant located next to Woodland Hill 8. This is also true for the four Near Term graduate housing facilities and the three Intermediate Phase graduate housing units proposed for the Woodland Hill complex. The results were the same for the no-flow and average-flow scenarios.

The recommended improvements to the water system piping include increasing the size of several segments of the system, the addition of one new link in the system, and the complete review and possible re-setting of the controls on the existing fire pump. These recommended improvements, when completed as a group, will allow the on-campus water system to meet the daily average demands without the fire pump being engaged to boost the pressure. The fire pump remains necessary to meet the high flow demands of a fire situation.

The existing system of fire hydrants will service the proposed projects without significant changes. Therefore, no new modeling was required. However, new buildings constructed in the future will be required to have sprinkler systems. Further, it is anticipated that at some future date, existing buildings may be required to be retrofitted with sprinkler systems. The demands of these sprinkler systems will be in addition to the required hydrant fire flows. The model of the water system indicates that when upgraded as recommended in this Utilities Master Plan, the water system will be able to supply the demands for these future sprinkler systems.

The modeling results indicate that portions of the sanitary sewer collection system on the Babson College campus are operating at or near typical design capacity under the current conditions. The modeling results show that there is no surcharging currently occurring in the on - campus system.

Adding the Near Term and Intermediate Phase proposed projects to the sanitary sewer system does not appear to present capacity concerns for the on - campus system. However, the investigation of the Town of Wellesley system between the Babson campus and the nearest trunk sewer has identified some capacity restrictions. It appears that the Town of Wellesley system is operating at maximum capacity. In accordance with Town of Wellesley policies, to receive approval to connect it's planned Near Term and Intermediate Phase projects, Babson College will be required to remove from the sanitary sewer system existing flows equal in volume to the flows anticipated to be produced by the proposed projects. Alternatively, Babson College could make improvements to the Town's system to increase its capacity. Currently, Babson College is pursuing an infiltration and inflow study of its on-campus sanitary sewer system. The goal of this work is to identify, and then remove, cross connections and sources of inflow that are adding unnecessary flow to the sanitary sewer system. If a sufficient volume of flow can be removed from the system in this manner to balance the new flows anticipated from the planned projects, then Babson College will have met its obligation to the Town of Wellesley.

KeySpan Energy Delivery, the natural gas supplier, has analyzed the information concerning the Near Term and Intermediate Phase projects and determined the upgrades to the natural gas distribution system necessary to support the proposed projects. This information has not yet been made available by KeySpan. When the information is available it will be incorporated directly into this Utilities Master Plan and an appropriate addendum issued.

APPENDIX A

CAMPUS FACILITIES PLAN 2000