VIII. SIMULATION AND SITE ANALYSES RESULTS

A-BEST Simulation Results

This section presents and discusses the data derived from A-BEST disease modeling for simulated communities of Tyngsborough, MA; Peterborough, NH; and Boston-BUMC, MA for each of four diseases of interest (Ebola HF, Brazilian HF, Monkeypox and Rift Valley Fever. Infections caused by the Ebola virus, Sabia virus and the Rift Valley Fever virus may result in hemorrhagic disease that is associated with increased mortality. Monkeypox virus causes a disease very similar to smallpox however the consequences of disease caused by monkeypox are not as serious. In examining these data it is important to remember that the scenarios that drove these results were designed to "force" or ensure community infection so that disease occurrence in the three communities could be compared to determine if there were disproportionate impacts on Environmental Justice Communities. In order to "force" or ensure results to allow the necessary comparisons, assumptions were used that do not necessarily represent, and in fact, overstate the real risks that may be associated with the events described in Section VII. The following general approaches were used during development of the scenarios.

- Scenarios were highly contrived but based on fact and the scientific literature where possible.
- Where information was not available, arbitrary conservative decisions were made but held constant across the three communities in keeping with the intent to overstate the risks.
- Scenarios were designed to "force" or ensure an infection beyond the laboratory so that the threat to the three communities could be compared. (See Section V)
- Each laboratory accident or event leading to a simulated infection was given a probability of 1.0 (100%); not subjected to the Monte Carlo approach and more realistic probabilities used in the rest of the A-BEST model simulations. (See Section V)
- Probabilities were assigned to events that have not occurred in nature (e.g., Sabia transmission by close contact) to favor transmission of simulated disease into the three communities.
- No public health interventions were included in the simulations (e.g. insect repellents, immunizations, "sharp safe" or needleless medical devices, etc).

In addition to the general approach described above for scenario development, scenario-specific assumptions that far overstated the real risks were applied to each of the four selected diseases to further "force" simulated infection into the communities of Tyngsborough, Peterborough and Boston-BUMC. The purpose of these scenario-specific assumptions was to, again, overstate the risks and to ensure that simulated disease did indeed occur at each location so that the impacts on the three distinct communities could be compared.

Table VIII-1 presents the results of A-BEST simulation modeling of the scenarios presented in Section VI of this report for Ebola virus, Monkeypox, Sabia virus and Rift

Valley Fever Virus. Table VIII-1 presents the average number of infections (with or with out disease expression) and the average number of simulated fatalities occurring in each of the communities for each scenario.

Table VIII-1. Comparisons of the average number of simulated infections and subsequent fatalities across three communities in A-BEST Simulations.

Scenario	Tyngsborough	Boston-BUMC	Peterborough
Sabia virus Centrifuge Accident **infections/deaths**	**3.43/0**	**7.09/0**	**3.48/0**
Rift Valley Fever Transportation Accident **infections/deaths**	**1787/78.2**	**61.78/2.99**	**2490.86/112.53**
Ebola virus Percutaneous exposure **infections/deaths**	**2.95/1.55**	**3.76/2.17**	**3.07/1.71**
Recombinant Monkey-pox Lab Accident/School Introduction **infections/deaths**	**6/0.64**	**5.08/0.69**	**4.92/0.67**

The data presented in Table VIII-1 clearly show that the presence of disease, caused by the four exotic agents, was not directly proportional to the number of people living in each community. In other words, the degree of disease seen upon simulation was independent of population size. The communities in Block Groups surrounding BUMC **was not at greater risk** of disease because of its large population of 284,805; and Tyngsborough and Peterborough **were not at less risk** because of their smaller Block Group population sizes, 30,022 and 8,941, respectively. Ebola virus, Sabia virus, monkeypox virus and Rift Valley Fever virus, while infectious and capable of being transmitted from person-to-person under the right circumstances, are not highly contagious.

Tables VIII-2 through VIII-4 summarize and compare the agent-specific data for Ebola, Sabia and monkeypox, respectively. Two hundred simulations for each disease in each community were conducted. These data clearly show that there are no discernable differences in the level of disease caused by these three agents related to population. Examining the range (identification of the minimum number of cases and the maximum number of cases) of disease caused over 200 simulations was similar in each community. The mode of disease caused (the number of infections that occurred with the greatest

frequency) in each community and disease specific group of simulations also did not vary with the size of the population.

Large differences in the number of infections caused by RVF virus were seen, however, upon comparison of data from the three communities. The differences, again, cannot be attributed to population size of the community; in fact, the Boston-BUMC community exhibited the least number of infections among the three communities. This result was seen even though 10,000 infected mosquitoes per acre of appropriate water habitat were introduced into the A-BEST simulations to overstate risks and ensure that RVF virus was circulating in the environment at high enough levels that human disease, should it occur, would be identified.

Two readily apparent differences are seen in the communities that are being compared, as described in Section IV. Both Tyngsborough and Peterborough have significant wetlands surrounding the proposed alternative sites, providing suitable habitat for the *Aedes canadensis* species of mosquito. *Ae. canadensis* has been shown in laboratory studies (Gargan 1988) to be capable of being a vector of RVF virus. Also in Tyngsborough and Peterborough, livestock are present that serve as amplification hosts for the virus; that is, RVF virus grows to very high levels in the blood of these animals (ruminants) when they are bitten by an infected mosquito. This high level of virus in the blood (titer) allows efficient infection of other mosquitoes that in turn may bite a human, spreading RVF into the human population in these two communities. Unlike Tyngsborough and Peterborough, the Boston-BUMC community has no livestock that can serve as amplification hosts for RVF (Massachusetts State and County Data-2002 Census of Agriculture -Vol. 1, Geographic Area Series, Part 21). Tyngsborough and Peterborough, because of variety of wetlands present and the presence of livestock that can amplify RVF virus, are at greater community risk if RVF virus is accidentally introduced into their environments. This association is clear from the data presented in Table VIII-5.

The RVF infections seen as a result of A-BEST modeling were “forced” or ensured by establishing a population of infected mosquitoes (10,000 infected mosquitoes per acre of appropriate water habitat) in each community prior to launching the simulations. This was a scenario-specific underlying assumption that greatly **overestimated the risk** to the communities. To simulate the risk to the three communities resulting from the introduction of one RVF infected mosquito into each, the MLAB-ST modeling tool was used. See the simulation outcomes in the section entitled ***Results of MLAB-ST Modeling of Rift Valley Fever Transportation Accident***, Table VIII-6.

Table VIII-2. Comparison of the prevalence Ebola Hemorrhagic Fever and subsequent mortality for three communities after simulated accidental release. See release scenarios in Section VII. Data derived from A-BEST Modeling.

Summary of Ebola Hemorrhagic Fever A-BEST Simulations (N=200)						
Community (population)	**Infected**			**Fatalities**		
	Mean (SEM)	**95% CI**	**Range (Mode)**	**Mean (SEM)**	**95% CI**	**Range (Mode)**
Tyngsborough (30,022)	2.95 (0.06)	2.83-3.07	2-5 (3)	1.55 (0.06)	1.43-1.66	0-4 (1)
Peterborough (8,941)	3.07 (0.06)	2.93-3.20	2-6 (3)	1.71 (0.07)	1.58-1.84	0-5 (0)
Boston-BUMC (284,805)	3.76 (0.09)	3.58-3.94	2-8 (2)	2.17 (0.09)	2.0-2.33	0-6 (2)

Table VIII-3. Comparison of the prevalence of Brazilian Hemorrhagic Fever (Sabia) and subsequent mortality for three communities after simulated accidental release. See release scenarios in Section VII. Data derived from A-BEST Modeling.

Summary of Brazilian Hemorrhagic Fever (Sabia) A-BEST Simulations (N=200)						
Community (population)	**Infected**			**Fatalities**		
	Mean (SEM)	**95% CI**	**Range (Mode)**	**Mean (SEM)**	**95% CI**	**Range (Mode)**
Tyngsborough (30,022)	3.43 (0.04)	3.35-3.54	3-5 (3)	0	0	0
Peterborough (8,941)	3.48 (0.04)	3.39-3.56	3-5 (3)	0	0	0
Boston-BUMC (284,805)	7.09 (0.15)	6.79-7.38	3-14 (5)	0	0	0

Table VIII-4. Comparison of the prevalence of Recombinant Monkeypox and subsequent mortality for three communities following simulated accidental release. See Section VII for release scenarios. Data derived from A-BEST modeling.

Summary of Recombinant Monkeypox A-BEST Simulations (N=200)						
Community (population)	**Infected**			**Fatalities**		
	Mean (SEM)	**95% CI**	**Range (Mode)**	**Mean (SEM)**	**95% CI**	**Range (Mode)**
Tyngsborough (30,022)	4.87 (0.08)	4.71-5.03	3-10 (5)	0.64 (0.06)	0.53-0.75	0-3 (0)
Peterborough (8,941)	4.92 (0.09)	4.75-5.09	3-9 (5)	0.67 (0.05)	0.56-0.77	0-4 (0)
Boston-BUMC (284,805)	5.08 (0.1)	4.89-5.27	3-10 (4)	0.69 (0.06)	0.57-0.81	0-5 (0)

Table VIII-5. Comparisons of prevalence of Rift Valley Fever and subsequent mortality for three communities after simulated accidental release. See Section VII for release scenarios. Data derived from A-BEST modeling.

Summary of Rift Valley Fever A-BEST Simulations (N=200)						
Community (population)	**Infected**			**Fatalities**		
	Mean (SEM)	**95% CI**	**Range (Mode)**	**Mean (SEM)**	**95% CI**	**Range (Mode)**
Tyngsborough (30,022)	1750.87 (2.78)	1745.40-1756.34	1648-1865 (1760)	78.2 (0.65)	76.93-79.47	49-106 (82)
Peterborough (8,941)	2490.86 (3.07)	2484.81-2496.90	2352-2604 (2439)	112.53 (0.74)	111.08-113.98	86-140 (117)
Boston-BUMC (284,805)	61.78 (0.57)	60.65-62.90	47-88 (58)	2.99 (0.11)	2.77-3.21	0-8 (2)

A-BEST simulation provides information about the total number of infections that occur within a community; when they occur; where they occur; and can identify who was infected in a given simulation. An example of the temporal simulation output is provided for the diseases of interest in Figures VIII-1 through VIII-4, below. A complete example set of data from each of the three communities is presented in both spatial (where) and temporal (when) fashion and identifying the individuals infected is provided in Appendix 1. Additionally, Appendix 2 provides the complete statistical data sets characterizing the numbers of individuals who became infected within his/her household; at a workplace; or in a past time or service place; and the outcome of those infections.

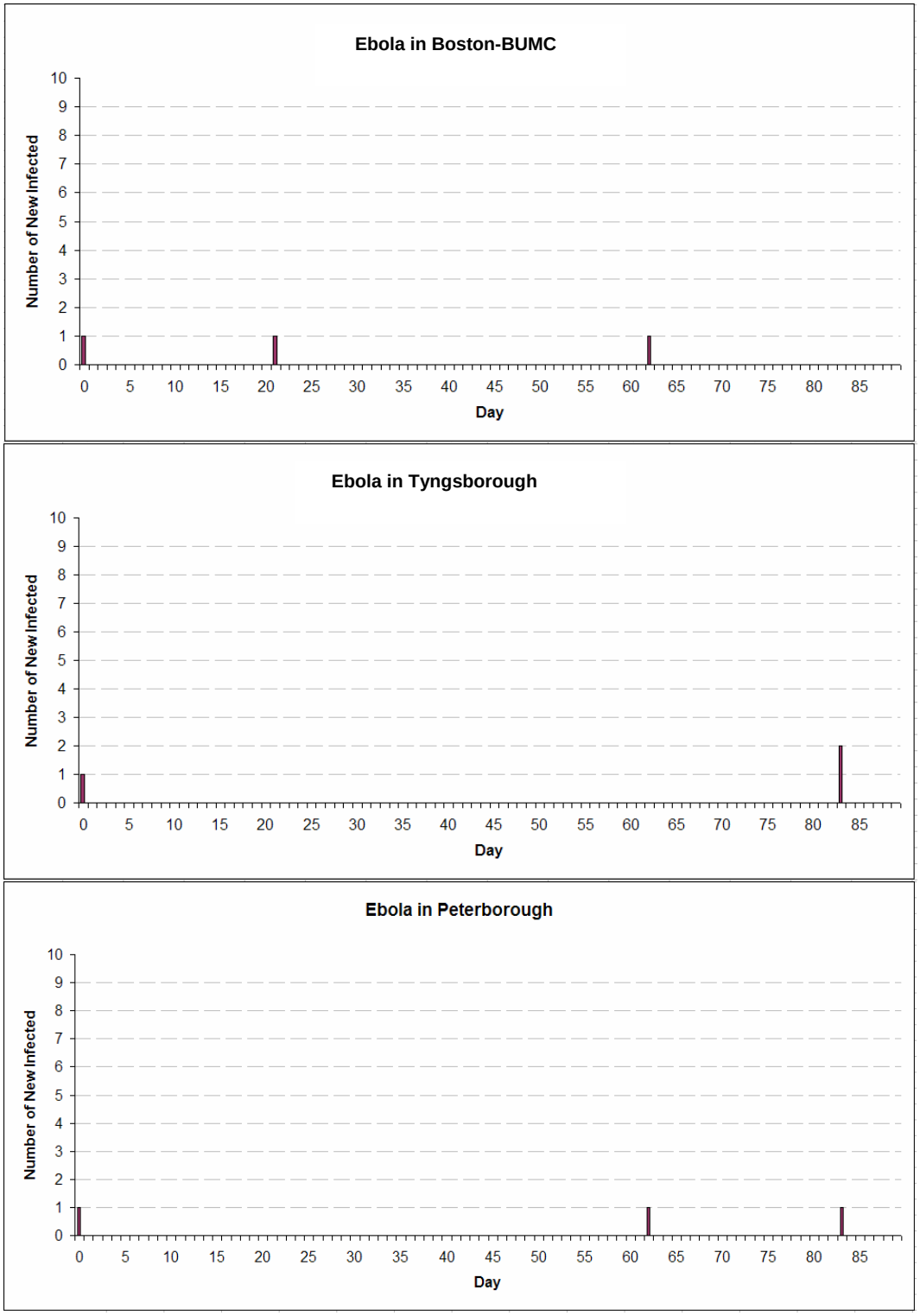

Figure VIII-1. Temporal display of simulated Ebola cases in the three communities (Example from one simulation).

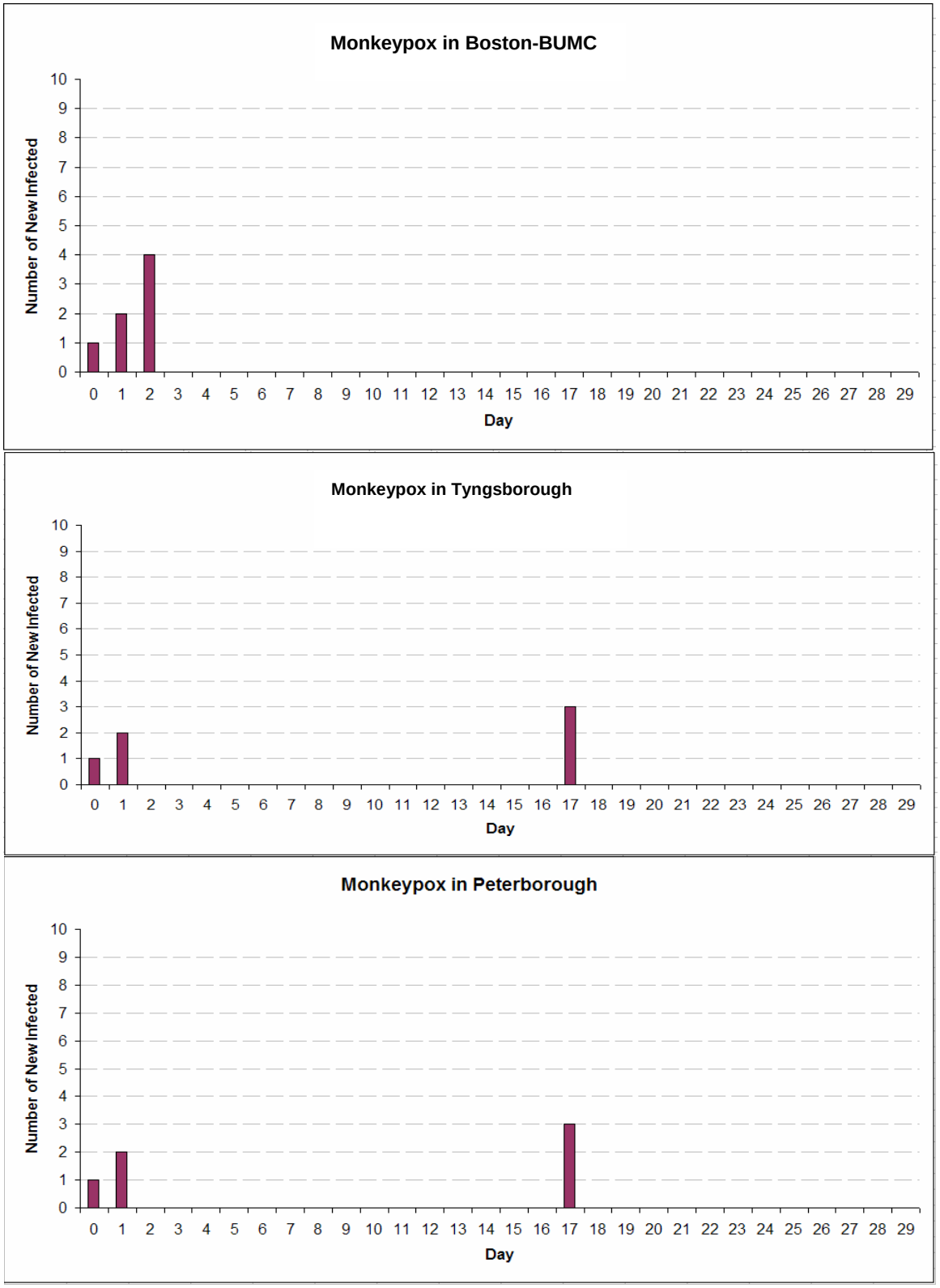

Figure VIII-2. Temporal display of simulated monkeypox cases in the three communities. (Example from one simulation)

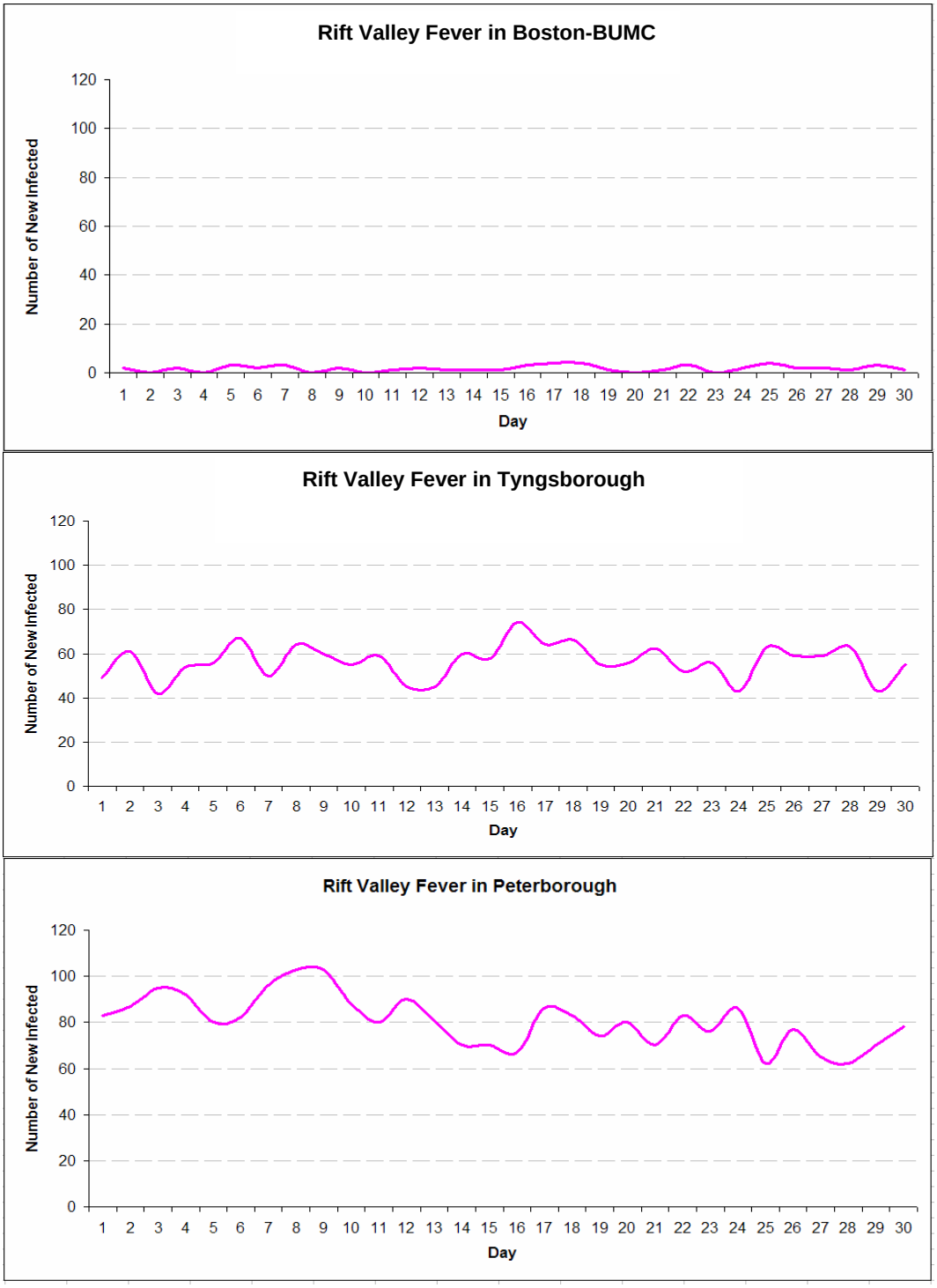

Figure VIII-3. Temporal display of simulated Rift Valley Fever cases in the three communities. (Example from one simulation)

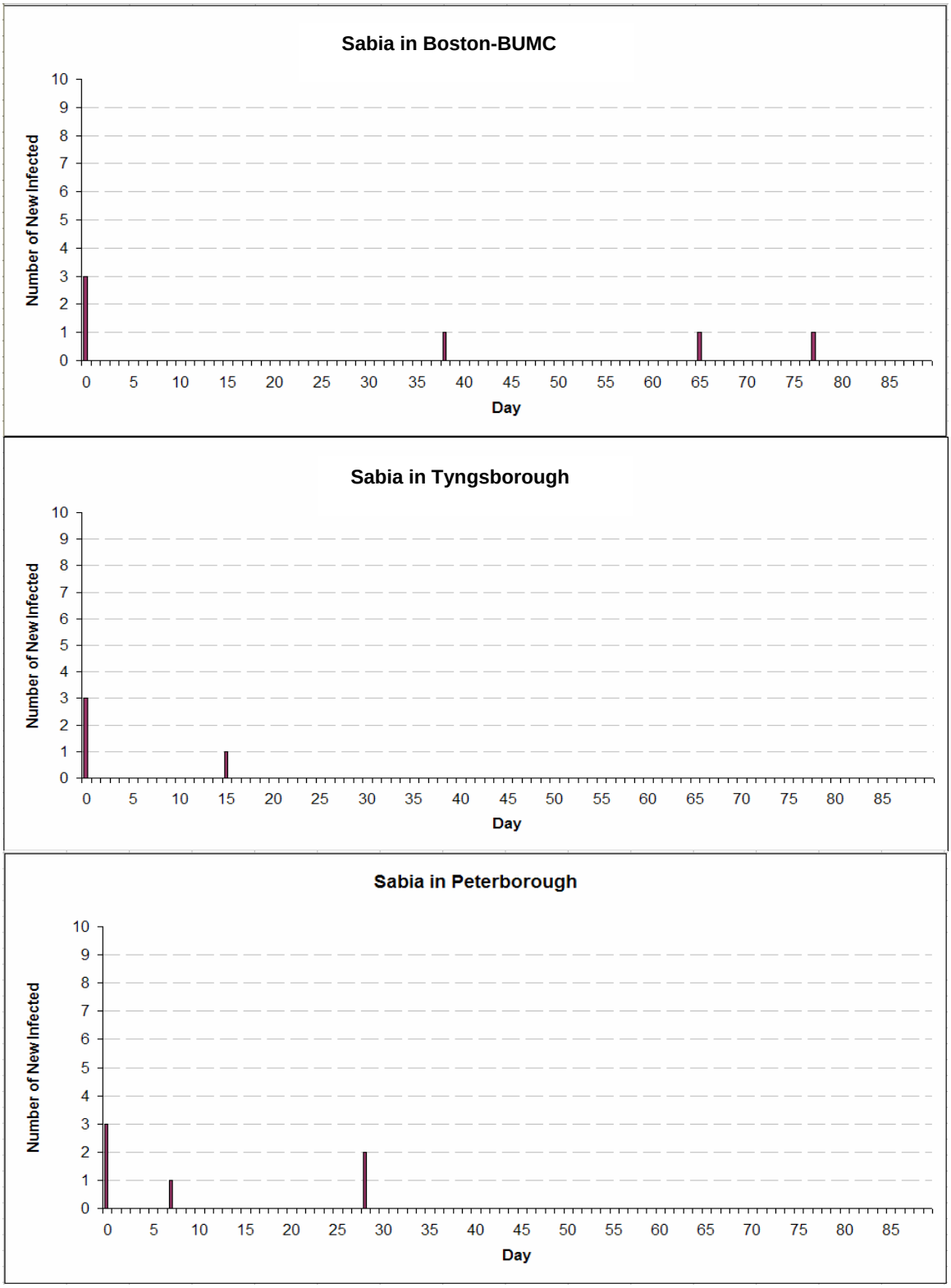

Figure VIII-4. Temporal display of simulated Sabia virus cases in the three communities. (Example from one simulation)

A complete example set of A-BEST spatial and temporal modeling data is included in Appendix 1.

Results of MLAB-ST Modeling of Rift Valley Fever Transportation Accident.

The data from MLAB-ST simulation modeling for the Rift Valley Fever transportation accident scenario is presented in Table VIII-5. These data represent the introduction of Rift Valley Fever virus into each community beginning with the accident and a single mosquito that took a blood meal from an infected individual.

Table VIII- 5. Comparisons of prevalence of Rift Valley Fever and subsequent mortality for three communities after simulated accidental release. See Section VII for release scenarios. Data derived from MLAB-ST modeling.

Summary Rift Valley Fever MLAB-ST Simulations (N=100)						
Outcome	**Infected**			**Fatalities**		
	Mean (SEM)	**95% CI**	**Range (Mode)**	**Mean (SEM)**	**95% CI**	**Range (Mode)**
Tyngsborough	193.4 (8.38)	176.51-209.77	58-330 (142)	0.37 (0.05)	0.27- 0.47	0-1 (0)
Peterborough	107.82 (4.51)	98.88-116.76	31-180 (143)	0	0	0
Boston-BUMC	0	0	0	0	0	0

These data clearly demonstrate that without an amplification host present in the community upon which multiple mosquitoes can feed, RVF will not be sustained and human infection will not occur.

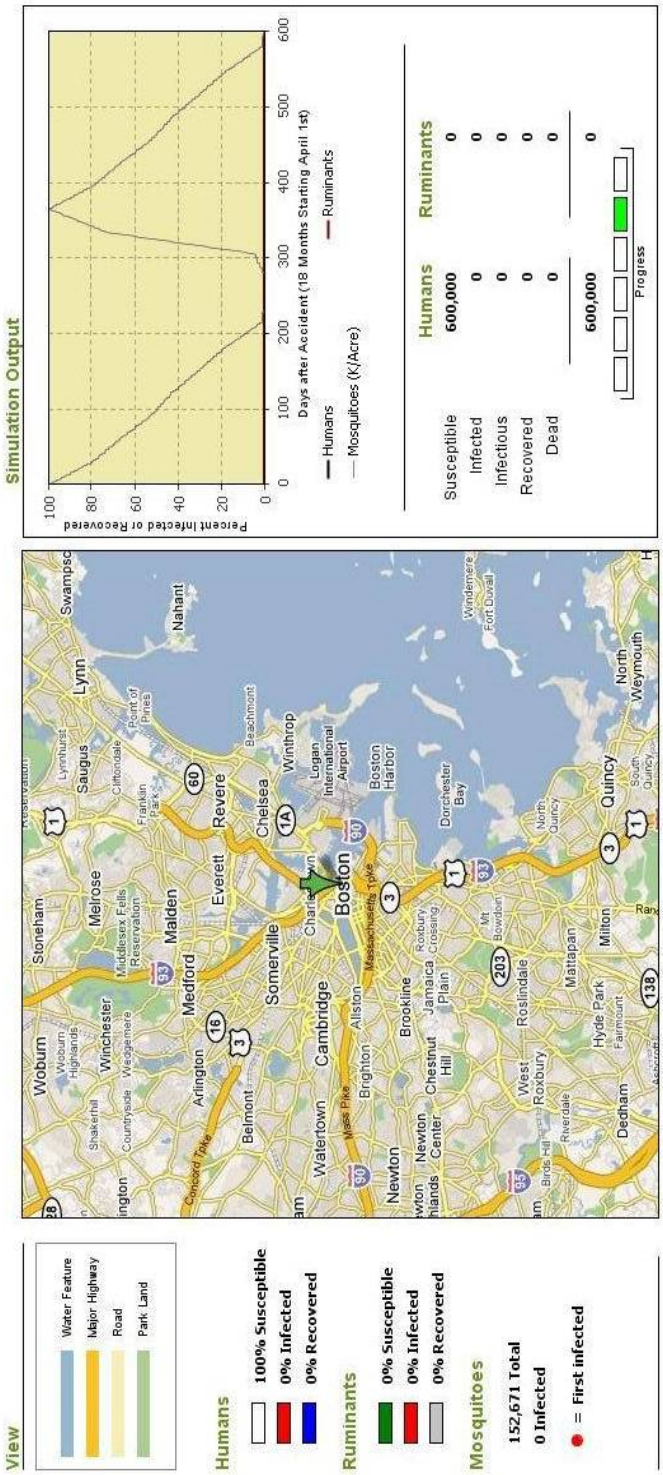

Figure VIII-5. Example of Results from one MLAB-ST Simulation of Rift Valley Fever – Boston University Medical Center

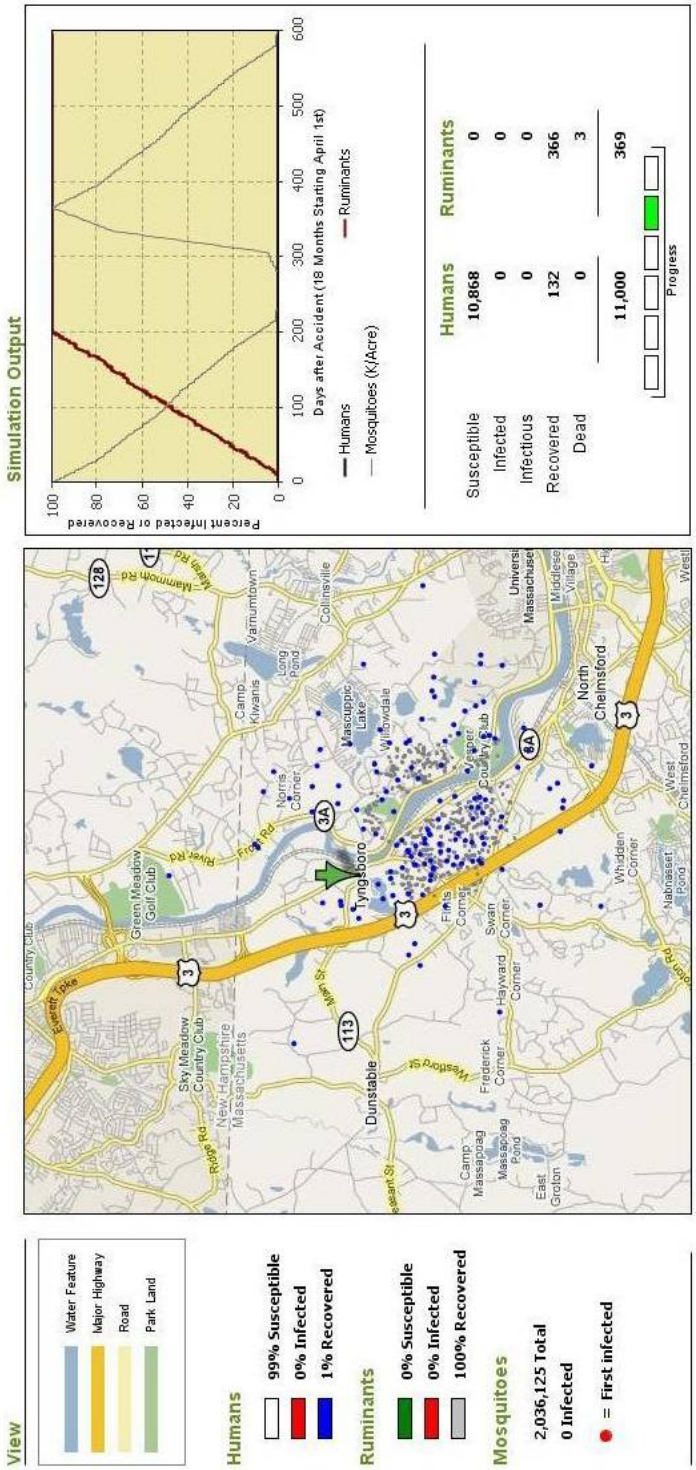

Figure VIII-6. Example Results of one MLAB-ST Simulation Rift Valley Fever – Tyngsborough, MA.

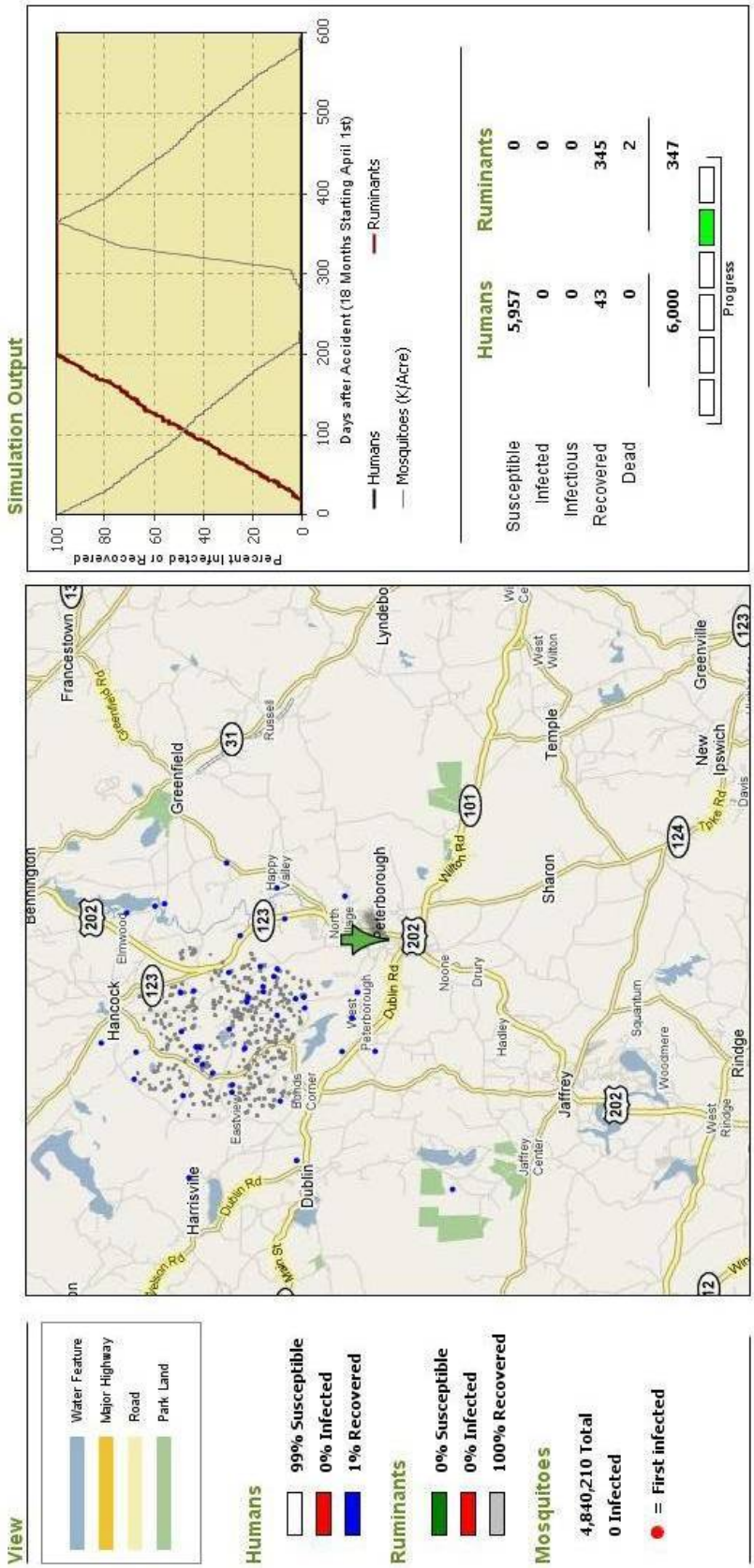

Figure VIII-7. Example Results from one MLAB-ST Simulation -Rift Valley Fever – Peterborough, NH.

Validation of the Simulation Models

Comparing A-BEST simulation results, for the four release scenarios with known outcomes of actual outbreak situations or cases, is very instructive. Even considering the vast over statement of risk, widespread disease outbreaks of Ebola, Sabia, and monkeypox were not seen in the A-BEST simulations.

The two known cases of laboratory-acquired Ebola virus infection, the first in England in 1977 (Emond 1977) and the second in Russia reported in 2005 (Akinfeeva 2005) resulted in no secondary infections. In the second case, in Russia, where extraordinary patient care efforts, invasive procedures and novel treatments placed the healthcare team at even higher risk of bloodborne exposures, no secondary infections occurred. In Africa where sporadic outbreaks of Ebola hemorrhagic fever still occur, secondary transmission is all but eliminated when appropriate barrier precautions as out lined in *Infection Control for Viral Haemorrhagic Fevers in the African Health Care Setting* (CDC/WHO 1998) are used. In 200 simulations of the scenario involving two initial "forced" infections of EHF and extraordinary assumptions that far over stated the real risks involved, very little secondary infection was seen. The average number of cases seen for Tyngsborough, Peterborough and Boston were 2.9, 3.07 and 3.76, respectively (See Table VIII-1). Two of cases in each location were the index case of the scientist and the woman in Town B. In each location, there was no outbreak and when transmission was seen, it was limited to the HCW who sustained a needle stick and a partner of the Woman in Town B. Even under the extraordinary and unrealistic modeling parameters, the outcomes associated with the scientist's activities during convalescence were consistent with the findings of Rowe and co-workers (1999) who prospectively studied a cohort of convalescent EHF patients and their household contacts (HHCs) to determine if convalescent body fluids contain Ebola virus and if secondary transmission occurs during convalescence. Twenty-nine EHF convalescents and 152 household contacts were monitored for up to 21 months. No direct evidence of convalescent-to-HHC transmission of EHF was found even though data suggest that the patients were probably shedding virus early in their convalescence after release from the hospital (Rodriguez 1999). Other investigators have also used SEIR based modeling incorporating Markov chain Monte Carlo (MCMC) methods for understanding of the dynamics of the spread Ebola virus (Lecone and Finkenstadt, 2006).

In the case of the Yale researcher infected with Sabia virus, Armstrong and co-workers (1999) followed the case contacts of the patient in a large 900-bed tertiary care hospital. The case-contacts consisted of healthcare workers, co-workers, friends, and relatives of the researcher. No cases of secondary infection occurred among 142 case-contacts. Admittedly, enhanced isolation precautions for treatment of a viral hemorrhagic fever patient were implemented in the clinical laboratory and patient-care setting to prevent nosocomial transmission (CDC 1988, 2005). The enhanced precautions included preventing aerosol spread of the virus from the patient or his clinical specimens. In the A-BEST simulation none of these precautions were implemented; even so disease was limited to a very small number of contacts. No widespread disease was seen nor was there any tertiary spread at all. See Table VIII-1.

The results of A-BEST modeling were also consistent with outcomes seen in the U.S. monkeypox outbreak in June of 2003 resulting from the importation of Gambian giant rats as pets. There were 72 confirmed or suspected cases in that outbreak in six States. There were no fatalities and no instances of secondary transmission of disease in the U.S. outbreak. Even using unrealistic assumptions in A-BEST modeling that far overstated the risks and incorporated no public health interventions (immunizations, antiviral therapy, vaccinia immunoglobulin -VIG, etc.) there was no widespread disease outbreak; no secondary transmission and no fatalities. These results are also consistent with those of other investigators using a stochastic model to predict interhuman spread of monkeypox (Jezek 1987). They also used a computerized stochastic model of the Monte Carlo type to assess risk. Similar to the results of A-BEST simulation, they too, found cessation in disease transmission.

Two types of simulations were used to investigate the risks associated with the introduction of Rift Valley Fever into the communities from the laboratory, A-BEST modeling and MLAB-ST modeling. In both simulations, RVF virus required an animal amplification host to establish itself in the environment. In MLAB-ST modeling, no human disease could be elicited at all without the tripartheid interaction of ruminants, mosquitoes and humans with the virus. There is a complex cycle of enzootic maintenance and epizootic transmission of the virus by different mosquito species. Transovarial transmission within the *Aedes* species allows a single generation of infected mosquitoes to emerge after flooding. In the A-BEST simulations, *Ae. canadensis* filled this role. These mosquitoes infect some livestock, and if the pools created by the floodwater do not disappear then other mosquito species breed rapidly and act as secondary vectors. There are two different types of secondary cycles by which the virus is transmitted to humans: the sylvatic cycle and the urban peridomestic cycle. Both of these cycles were considered in the A-BEST simulations. In the sylvatic cycle, which affects people working in the livestock industry, humans become infected through contact with animals to whom the virus has been transmitted by zoophilic (animal preferring) mosquitoes. The second type of secondary cycle is the urban peridomestic cycle, in which humans become infected with RVF through the bites of anthropophilic (human preferring) mosquitoes. The large number of human cases in Egypt in 1977 and 1978 (Meegan 1979) occurred largely as a result of this type of transmission (Gerdis 2004). *Ae. canadensis* was selected as the vector in both A-BEST and MLAB-ST modeling because it was both anthropophilic and zoophilic; could serve as a vector for RVF (Gargan et al. 1988) and is present in both Massachusetts and New Hampshire. The key to the generation of a RVF outbreak is the obligatory presence of flood conditions and large numbers of mosquitoes. Both of these conditions exist in Tyngsborough and Peterborough and the added presence of amplification hosts boosts the risk of disease outbreak even higher. Both A-BEST and MLAB-ST modeling accurately portrayed this picture. The work of Hartley and co-workers (2005) coincides with the results of both the A-BEST and MLAB-ST simulations for RVF.

Results of Additional Site Analyses

Location and Site Description

The Peterborough, NH site, the Sargent Center for Outdoor Education (SCOE), is remote, pristine, forested and devoid of any existing infrastructure to support a large, advanced high containment laboratory such as the NEIDL.(See Section III). The Peterborough area does not have any other biomedical research resources; research universities with animal facilities or scientific enterprises nearby or easily accessible that would make this site feasible for placement of a National Biocontainment Laboratory for emerging and re-emerging infectious diseases research.

The Tyngsborough, MA site, the Boston University Corporate Education Center (BUCEC), is heavily forested, immediately adjacent to a quiet residential neighborhood; and within 0.2 miles of a river. The BUCEC, an educational entity owned by Boston University, supports no life science activities and does not have the necessary infrastructure to support a high containment laboratory.

The Boston, MA, site at the BioSquare Research Park, adjacent to the Boston University Medical Center (BUMC) campus in Boston's South End and within the Greater Boston academic hub, allows for dynamic collaborations among investigators at multiple research entities such as the Boston University School of Medicine, Harvard Medical School, Massachusetts Institute of Technology, Massachusetts General Hospital, Brigham and Women's Hospital, University of Massachusetts Medical Center, the Massachusetts Biological Laboratories, Tufts University, New England Medical Center, and Brandeis University. The immediate area is comprised of commercial, industrial, transportation and industrial uses. See the Land Use Map in Section V, Page V-117).

With regard to location site and ability to successfully support a large biomedical research enterprise, the BUMC NEIDL site is clearly superior.

Visual Quality

The alternative BUCEC and SCOE sites are heavily forested with an abundance of wildlife and natural habitats. Additionally, the BUCEC is subject to open land use planning and restrictions (See Section V). Placing the NEIDL at either of these sites would clearly have a negative impact on the visual quality of the site,

The proposed BUMC NEIDL site is surrounded by other facilities and structures similar in nature and appearance. It's closest neighbor, the Boston Flower Exchange, is a low-lying industrial appearing building. The NEIDL facility is similar to the surrounding area in appearance and is therefore consistent with the visual quality of the area.

Conclusion. Construction of the NEIDL at the BUMC site at BioSquare Research Park on Albany Street will not adversely impact the visual quality of the site.

Historic Resources

Of the three sites, only the BUCEC site has a structure listed on the *National Register of Historic Places*.

There are at least five properties in Peterborough listed on the *National Register of Historic Places*; however, construction of the NEIDL at the SCOE would not negatively impact any of these historical resources.

In Boston, portions of the South End are included in the South End National Register District. The proposed NEIDL site is not located within the South End National Register District or within the South End Landmark District. The site is located within the South End Harrison/Albany Protection Area. The Proposed Action would construct a building within the commercial, industrial and institutional area near the South End National Register District. The NEIDL would be visible from within the District, but would be consistent with the architecture of surrounding commercial and institutional buildings and would have no direct effect on the District.

Conclusion. Due to there being a structure at the BUCEC site in Tyngsborough listed on the *National Register of Historic Places* only the BUMC Albany Street site and the Peterborough SCOE site would be acceptable for construction of the NEIDL with regard to historical resources impacts.

Noise Impacts

The Peterborough zoning ordinance (§245-33) prohibits on-site activities that will result in sound levels that commonly exceed the background levels by more than 10 decibels or exceed the ambient level at any time by more than 15 decibels. Sound not discernible with normal human hearing two hundred (200) feet beyond a point on the boundary of the premises is presumed not to exceed the ambient level by more than 10 decibels at that point. Vehicles parked on the premises and idling are subject to this standard, but traffic on streets is not. Construction and operation of the NEIDL on the proposed SCOE site would exceed the current background levels of noise by more that 10 dBA.

The Town of Tyngsborough regulates noise within the town limits through the Zoning By-Laws (Town of Tyngsborough Zoning By-Law, Revision B, 24 June 2003). No noise is permitted within the Town of Tyngsborough which would cause nuisance or hazard to persons or property. Exemptions from this town ordinance are vehicles that are not controlled by an owner or occupant of property within the Town; temporary construction activities occurring during the hours of 7 A.M. to 6 P.M. on weekdays; occasionally used safety signals, warning devices, emergency pressure relief valves, or other such temporary activity; and the use of power tools and equipment such as lawn mowers, snow-blowers, chain saws, tractors, and similar equipment for the maintenance of property. At the lot line of an adjacent or nearby residence or institutional use, weekdays during the hours of 7 a.m. to 6 p.m. there are exceptions for intermittent noise. The levels (dBA) specified in the bylaws may be exceeded by 10 dBA for *20 minutes* per weekday

during the hours of 7 A.M. to 6 P.M., but not at any other time. Impact noise such as from a punch press, drop forge hammer, or similar equipment, cannot not exceed 60 dBA by more than 10 dBA at the residential lot line. It is clear that both zoning and noise ordinance exemptions would be required from the Town before construction of the NEIDL could be approved. Depending on the final site selection at BUCEC, operation of the NEIDL may well exceed the limits set at the residential lot lines.

At the proposed BUMC site, noise analyses demonstrate that the existing sound levels in the area currently exceed the City's noise criteria. The proposed NEIDL project will generate building sound levels that are below the existing sound levels. It is important to note that even with the best mitigation techniques to reduce sound levels, the future sound levels at the study area receptor locations will continue to exceed the City's noise criteria with the proposed project; however operation of the NEIDL will not significantly add to noise in the area.

Conclusion. In terms of noise impacts, the BUMC Albany Street site is the most appropriate for construction and operation of the NEIDL.

Utility Availability and Impacts

The BUCEC site is supplied by the municipal water system and sewage is disposed of through an on-site sanitary disposal system with a leaching field. Municipal water service is available at the site. Municipal sewer service is not available from the town of Tyngsborough. Water for fire suppression is obtained from a fire pond on the property. The exact siting of the NEIDL may be problematic as Tyngsborough has a number of Interim Wellhead Protection areas that are intended to protect water supplies. A radius based on the flow rate of the well defines these areas. Certain land uses may be either prohibited or restricted in these areas (310 CMR 22.00 the Massachusetts Drinking Water Regulations).

The SCOE site, has electric power supplied by Northeastern Utilities. Two diesel-fired back-up generators (150 kW each), one each for the north circle and the south circle, are provided for back up power generation because power failure is fairly routine in the area. Heat is provided by a combination of liquid propane gas and fuel oil, both stored underground. On-site water provided via wells from an aquifer running under the property and septic fields and a sewage lagoon complete the utilities. The Town of Peterborough does have a municipal sewage collection and treatment system; however, the SCOE is not served by the sewerage system and is more than three miles away at its closest point. Peterborough has a public water distribution system, but it does not serve the SCOE site.

All required utilities are available at the BUMC site. Existing services are adequate to support construction and operation of the NEIDL though extension of the looped water services through the site. Creation of new connections to the service water mains in Albany Street will be necessary.

Conclusion. The BUMC Albany Street site has all required utilities to support the NEIDL with sufficient service that will have little or no impact on the surrounding enterprises.

Transportation and Access

The Peterborough SCOE currently receives complaints about buses bringing groups to the site. Construction and vehicular traffic would only increase the volume of large vehicles on this road with associated noise and potential air quality impacts.

Tyngsborough has highway and rail facilities linking major cities and towns to each other and to the port, airport, and intermodal facilities of Boston. Principal highways are U.S. Route 3 running North-South between Nashua, New Hampshire and the Boston region, and State Route 113. Tyng Road, the main access road to the property is a collector street/quiet residential road with limited traffic. It is a country road with no lines and no shoulder (See Section V). The existing road infrastructure may not be ideal for the types and volume of construction, operational, and service related traffic that would be required to construct the building and then operate it. The impact would be a higher volume of construction traffic on this unlined road. Changes may need to be made to Tyng Road to handle this traffic, and also the intersection of Tyng Rd and 3A may need to be upgraded. This would change the character of these local roads for area residents and add an increase in traffic and traffic-generated noise on these roads. There are no direct mass transportation opportunities to the site. It is anticipated that most employees would arrive via personally owned vehicles.

Boston is New England's leading port; a regional rail, bus, and truck terminal center; and an important air transport center. Boston is a hub from which many highways extend to serve the city to the north, west and south and already adequately supports a number of medical center and large biomedical research enterprises. Logan International Airport, easily accessible from downtown Boston, is the busiest Primary Commercial Service facility in New England and will more than adequately support the NEIDL's construction and operational supply needs with minimal impact on other transportation activities.

Conclusion. The BUMC site is the best choice for the placement of the NEIDL with regard to transportation access and impacts.

Air Quality

The state of New Hampshire currently has 4 counties which are in moderate non-attainment for the 8 hour ozone standard. Hillsborough County, where Peterborough is located, is one of the 4 counties listed as being in moderate non-attainment (www.epa.gov/air/data). Hillsborough County is classified by the EPA for terms of hazardous air pollutant production as an urban area. According to the EPA Hillsborough County produces approximately 10,500,000 pounds of hazardous air pollutant emissions per year. This amount of hazardous air emissions accounts for approximately 22% of the state of New Hampshire's hazardous air pollutant emissions.

In Peterborough it would be reasonable to expect that there would be impacts to the immediate air quality of Peterborough and Hillsborough County. Hillsborough County is currently in moderate non-attainment for the 8 hour ozone standard. If the facility were to be sited in Peterborough this would lead to a substantial increase in car and truck traffic to Peterborough. The facility is anticipating approximately 660 permanent positions in the facility and approximately 1,300 temporary construction jobs to be created. It is reasonably expected that the majority of these positions would be filled by people living in the immediate area of Boston. If the facility were to be sited in Peterborough there would be a highly substantial addition of people driving to Peterborough from the Boston area. Also, with the new amounts of traffic that would be generated in the Peterborough area it would be possible that a substantial increase in carbon monoxide emissions would be experienced. Currently the county is in attainment for carbon monoxide but an increase of this magnitude could change the status based on the amounts and duration of vehicle traffic in the area.

In Tyngsborough, the air quality impacts associated with operation of the NEIDL would be similar to those seen in Boston due to the relative proximity of the two cities.

The NEIDL will provide approximately 660 permanent positions in the facility and approximately 1,300 temporary construction jobs are expected. It is reasonably expected that the majority of these positions would be filled by people living in the Boston area. If the facility were to be sited in Tyngsborough there may be a substantial increase in the number of people driving to Tyngsborough from the Boston area. Also, with the new amounts of traffic that would be generated in the Tyngsborough area it would be possible that a substantial increase in carbon monoxide emissions would be experienced.

The City of Boston is currently classified as being in attainment (i.e. compliance) with the National Ambient Air Quality Standards (NAAQS) for all criteria air pollutants except ozone.

In 2004, the U.S. EPA designated Eastern Massachusetts as moderate nonattainment for 8-hour ozone NAAQS. However, data from the ozone air monitor closest to the project site at Harrison Avenue shows that 8-hour ozone levels in the project area for the past three years have been in compliance with the NAAQS for ozone. Additionally, information from air monitoring data for 2004, recently made available, also show compliance with the 8-hour ozone standard at the Harrison Avenue monitor. Major sources producing ozone precursor air pollutants in urban areas include power plants and motor vehicles. Ozone concentrations in the BUMC area are made up of natural ozone; locally generated ozone; and ozone transported from upwind urban areas. Emissions of VOC and NOx in the study areas have almost no effect on local ozone levels due to their relatively small size and are insignificant when compared to emissions from the entire region and urban areas upwind (such as Providence, RI; Hartford, CT; and New York City), and do not have a significant impact on ozone levels in the project area.

The availability of mass and public transit in the Boston Metropolitan area and the current traffic congestion in the city (responsible for the locally generated ozone) will

limit the number of privately owned vehicles arriving at the site each day. It is not expected that the NEIDL will appreciably impact the air quality in this complex urban environment.

Conclusion. Construction of the NEIDL in an urban environment with adequate public transportation, such as the BUMC site on Albany Street, will impact local air quality less than siting the NEIDL in more rural area with limited or no public transportation.

Economics, Income and Demographics

The main industry in Peterborough is publishing including McGraw-Hill, IDG and Yankee magazine. The other major employers are New Hampshire Ball Bearing, Peterborough Basket Company, Eastern Mountain Sports and the Millard Group. Peterborough is also well known for the performing arts such as the McDowell Colony, the Peterborough Players and the New England Marionettes.

The population for the Block Group (BG) in which the SCOE is located is 1747; of which 1444 are white. No Blacks reside in this BG; 9 individuals who identify themselves as being of mixed race; 42 Hispanic/Latinos and 67 Asians reside in the BG where SCOE is located. Approximately 6.4% of the families in Peterborough exist below the poverty line. The per capita, median family and median household incomes are $26,154, $ 54,375, and $47,381, respectively.

None of the BGs in the area surrounding the alternative SCOE site qualify for an environmental justice determination based on either race or income.

In Tyngsborough, the median household income range within the BG is $38,202-$45,633. Only a small number of individuals within this BG have incomes that fall below the poverty line. As of the census of 2000, there were 11,081 people, 3,731 households, and 2,947 families residing in the town of Tyngsborough. The racial and ethnic makeup of the town was 95.63% White, 0.50% African American, 0.23% Native American, 2.48% Asian, 0.04% Pacific Islander, 0.14% from other races, and 0.99% from two or more races. Hispanic or Latino of any race were 1.11% of the population.

The population for the BGs in which the BUCEC is located is 1332. No Blacks, Asians or Hispanics reside in this BG; 59 individuals who identify themselves as being of mixed race reside in the BG where BUCEC is located. None of the BGs in this area qualify for a social justice determination based on either race, income or by virtue of being foreign-born.

In Boston, during 2000, educational, health and social services made up the greater Boston region's largest industry sector in terms of employment. This was followed by retail trade; manufacturing; and finance, insurance, and real estate (FIRE). The industry mix changed during the economic expansion between 1993 and 2000. Notable changes were the increases in services and FIRE, at the expense of manufacturing and some government employment. Overall, regional employment grew 20.7% during this period,

with services growing 30.7%, retail trade 15.4%, and construction 67.5%. According to the Boston Redevelopment Authority's South End 2000 Census of Population and Housing Report #576, there are a total of 14,300 individual households in the South End with a median household income of $41,590. The South End per capita income level for the year 2000 is $36,038 or 1.2% above the national level. This is a significant change compared to the South End's 1990 per capita income level of $17,824. In the City of Boston, the 2000 poverty levels were 19.5%, while in the South End the levels were higher at 23.9%. The South End poverty level and above average median income level provide an indication of the area's economic diversity. According to the 2000 U.S. Census, 28,160 people reside in the South End, comprising 5% of the population of Boston. Of that population, 50% are minority.

Conclusion. The alternative sites in Tyngsborough, and Peterborough are not in neighborhoods having any Environmental Justice areas. The proposed site, BUMC, while having several Environmental Justice areas, will have no impact on the local population. Since there will be no impact on the local population at the BUMC site there can be no disproportionate impact on Environmental Justice communities. Therefore, the proposed site and the two alternative sites are equally acceptable sites in terms of environmental justice.

Healthcare Facilities, Social Assistance and Emergency Response

The town of Peterborough has only three full time administrative employees; a Town Administrator, Assistant Administrator, and Town Clerk. The Town has a volunteer fire and rescue service department with only one full-time employee. The Peterborough fire station is located a 4.8 mile (13 minute) drive southeast of the site. The Hancock fire station is located a 3.9 mile (9 minute) drive north of the site. The town has twelve fulltime police officers. The local Board of Health is made up of volunteers who may not necessarily be trained to address health and safety issues associated with a research facility. The nearest medical facility is Monadnock Community Hospital, a 25 bed inpatient facility, in Peterborough, a 7.4 mile (14 minute) drive from the alternative NEIDL site. Peterborough does not have the administrative, emergency response or healthcare resources to provide service to a large BSL-4 research facility such as the NEIDL.

Tyngsborough has professional police and fire departments and a professional staff assisting the Board of Health. The police department employs 25 full-time officers. The fire department employs 45 call firefighters, rotated through 4 full-time slots. The nearest fire station is 1.7 miles (approximately a 3 minute drive) north of the site. The small, local department may be challenged to respond to the safety and security requirements of a major research facility. Tyngsborough does not have a hospital within the town limits but is served by Lowell General Hospital (LGH) located approximately eight miles away across the Merrimack River but has now existing infectious disease physician available to evaluate a potential exposure or ill worker from the NEIDL. Access to the hospital is limited by one bridge crossing the Merrimack River.

Tyngsborough and the surrounding area have 17 elementary and secondary schools located in BGs within a three mile radius of the BUCEC site. The student population in Tyngsborough is expected to continue growing. Each year since 1998 actual enrollment has surpassed the projected numbers. The new 40B housing projects will result in yet more students. There is a need for new enrollment projections to determine whether or not the schools have the capacity to absorb new growth especially taking into account 40 b housing developments. The influx of families due to construction and operation of the NEIDL, which was not considered during master planning, in Tyngsborough will further stress the school system.

The BUMC, in Boston, is located with some of the finest institutions of higher education in a region has generated a tremendous concentration of science- and technology-related research and development (University of Massachusetts, 2004). There are 22 hospitals and 35 colleges and universities within Boston's city limits (BRA, 2002). Social programs and assistance is widely available with ample primary and secondary schools. Many are located within the BGs surrounding the proposed NEIDL site. Boston has a sophisticated, cooperative, multi-agency emergency response system including the Boston Metropolitan Medical Response System. Emergency response is supported by the Boston Police Department. The new headquarters is equipped with perhaps the most advanced ID imaging and ballistics identification technology in the country; a DNA laboratory (one of only 18 departments in the country with in-house DNA testing capacity; and an enhanced 9-1-1, and a Computer-aided Dispatch system linked to Mobile Date Terminals. The Boston Fire Department has over 1400 uniformed personnel providing coverage for about 47 square miles and the Boston Emergency Medical Service has 300 emergency medical technicians providing state of the art pre-hospital care.

The South End has a large number of elementary and secondary schools, junior colleges, colleges, universities, and professional schools, business schools and computer and management training, technical and trade Schools, as well as educational support services. The additional 660 personnel expected to staff the NEIDL will have virtually no impact on the educational or other social resources available in the city.

Conclusion. Boston is better prepared to handle any emergencies originating at the NEIDL and has adequate schools and services to support the needs of the additional personnel who will be working in the facility.

Floodplains

Peterborough is one of the most flood-prone areas in the state and has been included in three disaster declarations since 1987. It is subject to a variety of natural hazards including riverine flooding, wildfires, ice storms and river ice jams. The town has more than forty dams, two of which have been classified as high hazard dams. Specifically, the SCOE property is encompassed by a Special Flood Hazard Area (SFHA) designated as Zone A, a 100 year floodplain. Additionally, the site is adjacent to easements to the Army Corps of Engineers and to the spillway for the MacDowell Lake. In the event of an

emergency, the spillway will be opened to prevent the town of Peterborough from flooding; resulting in flooding of the SCOE site.

Flooding is not a major problem in Upper Basin (Chelmsford, Dunstable, Groton, Littleton, Harvard, Tyngsborough, Westford) watershed area, but localized incidents caused by beaver activity are prevalent sources of complaints. The Merrimack River shoreline in Tyngsborough is occasionally subject to erosion due to operation of the Pawtucket Dam, which can generate water level fluctuation. This however should not affect the site at BUCEC that is being considered for the NEIDL.

The BUMC site is not located in a floodplain.

Conclusion. In accordance with Executive Order 11988 – Floodplain Management, May 24, 1977, 42 F.R. 26951, the NIH must consider alternatives to avoid adverse effects and incompatible development in the floodplains. Floodplain impacts would only be experienced if the Peterborough alternative site was selected.

Wetlands, Riparian Areas and Surface Waters

The BUCEC site contains wetlands, a pond, small brooks, and abandoned quarries that appear they may be wetlands. Promoting groundwater recharge is an issue of great importance to the community of Tyngsboro. Approximately 40% of residents receive their water via wells. Signs are posted throughout the BUCEC site to remind people that this area is a drinking water area.

Peterborough, and specifically the SCOE, is surrounded by a variety of wetland types including emergent freshwater wetlands; freshwater forested/shrub wetlands; freshwater ponds; and lakes. Wetlands are found throughout the SCOE and notably ring the developed portion of the site, the Sargent Center. In the main campus the water table ranges from 0 (wetlands) to approximately 7 feet.

The BUMC Albany Street site is located in a developed area and there are no surface water bodies or wetland areas in the general vicinity.

Conclusion: Executive Order 11990, Protection of Wetlands, 42 CFR 2691 (1977) as amended by Executive Order 12608, 52 F 34617 (1987), and 42 U.S. Code 4321 direct each federal agency to minimize destruction, loss or degradation of wetlands and to preserve and enhance such wetlands in carrying out their program responsibilities. The BUCEC and SCOE sites both contain wetlands which could potentially be impacted while the BUMC contains to wetlands and no related impacts.

Impacts on Habitat, Wildlife and Vegetation

The Contoocook River corridor, in which the SCOE is located, provides habitat for a number of threatened or endangered bird, mammal, fish, reptile, and plant species. *A Natural History and Trail Guide to Sargent Camp* by Thomas Kunz documents the

abundance of water, dense forest, and wildlife found at the site. Flora and fauna found at the site are typical of that for the region as described above. The proposed project would remove vegetation and destroy habitat for wildlife in the area of its footprint (See Section V).

The three protected core habitats in Tyngsborough are comprised of a diverse mix of fresh marsh, wet meadows, wooded and shrub swamps, forested uplands, scattered small fields, and many Certified and Potential Vernal Pools. These areas include important habitats for Blanding's, Spotted, and Wood Turtles, as well as for Blue-spotted Salamanders. Unkety Brook and its associated wetlands and uplands support a significant population of Blanding's Turtles. Habitats here may also be used by Wood Turtles. Spotted Turtle populations may be widely distributed throughout this Core Habitat. Protection of undeveloped habitats may also represent an excellent opportunity for the long-term preservation of Blue-spotted Salamander populations, especially at several locations where multiple vernal pools and wooded swamps are present. The small streams and bordering wetlands in Tyngsborough also provide habitats for a known population of Southern Bog Lemmings. This elusive little field vole travels slowly but is active year-round. Southeastern Tyngsborough, has a relatively pristine, unfragmented habitat for rare dragonflies. Most of the habitat is within the Lowell-Tyngsborough-Dracut State Forest, and is protected; other lands within this area should also be protected to increase the amount of contiguous protected habitat and decrease its fragmentation, thus helping to ensure the long-term viability of the dragonflies and other rare species inhabiting the area.

No wildlife or vegetation surveys have been conducted at the site. The vegetation primarily consists of mixed hardwood and pine wood forests. Vegetation and wildlife for the site would be typical of that found in the region as described above. Prior to the initiation of any development, the area would be surveyed to determine the presence of any endangered or threatened species, or species of special concern. The impact to vegetation would consist of the removal of trees and other vegetation in the footprint of development.

Of the open space on the BUMC site, roughly 50% is asphalt-paved and 50% is hard-packed gravel. The site is currently used for vehicle parking. The site’s limited vegetation consists of weeds. The BUMC Albany Street site is not located near any surface waters and thus would have no impact on fish resources. It is located in an urban area and does not contain any natural vegetation or landforms.

Conclusion. The BUMC site does not pose any potential threat to threatened or endangered plant, animals, or insects. There are potential impacts to threatened or endangered plants and animals at the BUCEC and SCOE alternative sites. BUMC is the preferred site for the NEIDL with respect to the presence of threatened or endangered species.

Agriculture and Livestock

According to the Massachusetts State and County Data-2002 Census of Agriculture (Vol. 1, Geographic Area Series, Part 21), Middlesex County, in which Tyngsborough is located, has a significant number of livestock animals in the county inventory. According to the 2002 agricultural census, there were 2,872 cattle and calves present in the county. The most recent available data regarding dairy products (1997) reveals that sales equaled $2,143,000. The county inventory also includes 4,724 hogs and pigs resulting in $662,000 in sales (1997). Middlesex also has a small number of milk and angora goats in the county agricultural inventory.

According to the New Hampshire State and County Data-2002 Census of Agriculture (Vol. 1, Geographic Area Series, Part 21), Hillsborough County in which Peterborough is located has a significant number of livestock animals in the county inventory. According to the 2002 agricultural census, there were 2,325 cattle and calves; 3,774 goats; and 461 bison present in the county.

According to the Massachusetts State and County Data-2002 Census of Agriculture (Vol. 1, Geographic Area Series, Part 21), Suffolk County in which Boston is located has no livestock animals in the county inventory.

Conclusion: In the rare event of accidental release of a zoonotic agent, or infected arthropod the SCOE and BUCEC sites may be more vulnerable providing potential amplification hosts for the agent (e.g. Rift Valley Fever). See results of A-BEST and MLAB-ST modeling for vector-borne disease in this Section.

A graphical representation of the findings of the additional site analyses follows. Negative impacts are colored in red and favorable responses are colored green.

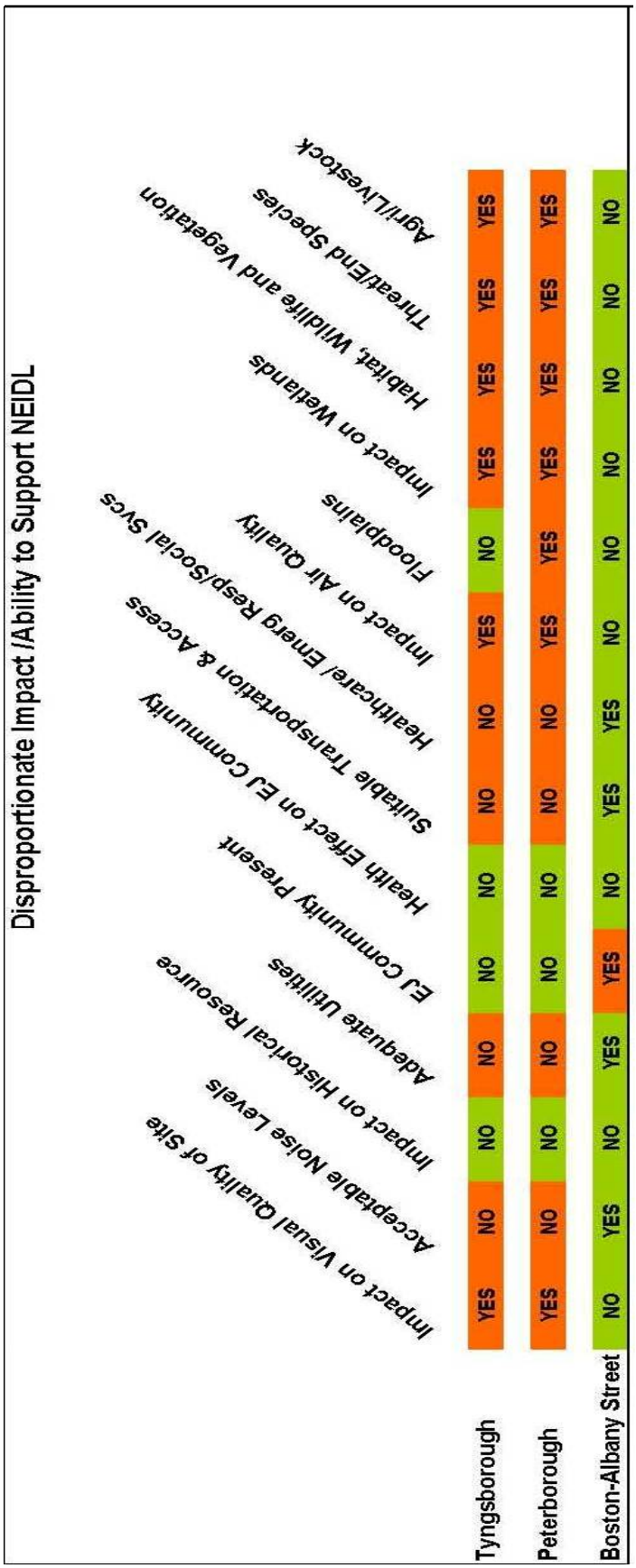

Figure VIII-9. Figure VIII-8. Summary chart comparing the suitability of the three locations considered for construction and operation of the NEIDL. Potential negative impacts are highlighted in red. The comparison clearly shows that the Boston-BUMC site is superior and in all cases most appropriate location for the NEIDL