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A. SIGNIFICANCE

1. National Significance of the Proposed Project

In 2015, United Way of Massachusetts Bay and Merrimack Valley (UWMB) partnered with Boston After School & Beyond (BASB) to launch BoSTEM, an innovative partnership to ensure that every middle-school student in Boston Public Schools (BPS) has the opportunity to participate in science, technology, engineering, and mathematics (STEM) learning experiences to **increase postsecondary preparedness (Priority 4)** among **high-need students (Priority 1)**. EIR will refine and scale BoSTEM and has national significance based on two interwoven threads.

◆**The first thread** is the ever-increasing national need for scientists, engineers, technicians, and skilled workers in STEM and STEM-connected fields. A 2010 report published by the National Academy of Sciences called for improvements in K-12 science and mathematics education and promotion of postsecondary educational pathways because of low STEM retention rates, a relative decline in the number of U.S. citizens enrolling in science and engineering graduate programs, and lower percentages of STEM graduates in the U.S. as compared to other industrialized countries (NAS, 2010). Similarly, a 2015 National Science Board report contended that the ever-growing pervasiveness of technology in our society has made STEM fields central to our nation's economic growth across a significant portion of the U.S. workforce. The STEM workforce now includes many types of STEM-capable workers both above and below the bachelor's degree level, including scientists and engineers who further scientific and technological breakthroughs in research and development, and workers in a myriad of industries who use STEM knowledge and skills to accomplish everyday work tasks in fields such as healthcare, information technology, software development, cybersecurity, engineering, and advanced manufacturing (National Science Board,

2015). Within the next decade, our nation will need one million more STEM professionals than it can produce (U.S. Congress, Joint Economic Committee, 2014). Americans are losing ground in STEM degree attainment. While national demand for STEM skilled workers is rising, U.S. students continue to fall behind key skill attainment in STEM subject areas such as math and science. The 2015 Program for International Student Assessment (PISA) found that U.S. students ranked 38th in math and 24th in science out of 71 advanced industrialized nations (OECD, 2015). The most recent test scores from the National Assessment of Educational Progress indicate only 40% of 4th graders, 33% of 8th graders, and 25% of 12th graders nationally were identified as proficient or advanced in math (NAEP, 2016). Student achievement was equally dismal in NAEP science scores with just 38% of 4th graders, 34% of 8th graders, and 22% of 12th graders rated as proficient or better in science (NAEP, 2017). As these NAEP scores indicate, while many students may express an interest and ability in math and science in the early years, as they advance through their academic trajectory, this interest often wanes and their academic achievement declines. This negative trend holds true for students in the Boston area. One study determined that the percentage of students who identified math or science as their favorite subject in 8th grade was only half that of 4th graders (Boston STEM Network, 2013). Identifying ways to engage and prepare students to successfully attain their high school diplomas and pursue postsecondary education is critical to the future economic prosperity of our nation: by 2020, 65% of all U.S. jobs will require some type of postsecondary education and training beyond high school (Carnevale, et al., 2014) and a majority of these jobs will be in STEM-specific or STEM-connected industries (NSB, 2015).

◆**The second thread** is the challenge for first-generation, low-income, and minority students to access and thrive in postsecondary education overall, and in STEM careers specifically. The 2016-17 academic year marked a turning point in public education in the U.S.: 51.4% of students

enrolled in K-12 were minority group members (NCES, 2016). By 2032, it is predicted that the majority of the labor force will also be comprised of minorities (Wilson, 2016). This has major implications for our economic stability and long-term future as several minority groups lag behind their Caucasian and Asian counterparts in secondary and postsecondary attainment as seen below.

Table 1. 2015-16 Educational Attainment by Subgroup (Kena, 2016)				
Attainment Level	**Asian**	**Caucasian**	**African-American**	**Hispanic**
High School	89%	87%	73%	76%
Bachelor's or Higher	63%	43%	21%	16%
Master's or Higher	22%	10%	5%	3%

For students pursuing postsecondary education, the National Governors Association notes that between 40-60% of first-year college students need remediation in English, math, or both, which significantly reduces the likelihood that these students will attain a postsecondary credential (Jimenez, et al., 2016). Despite an overall increase in minority enrollment in postsecondary students, several groups continue to be underrepresented in both STEM degree attainment and STEM careers, including minorities, females, and students from economically disadvantaged backgrounds (Bidwell, 2015). One study found that the percentage of minorities in STEM careers remains virtually unchanged since 2001 (Change the Equation, 2016). Additionally, while African Americans make up 11% of the U.S. workforce, just 6% of STEM workers are African-American (U.S. ED, 2016). According to the U.S. Department of Commerce, African Americans and Hispanics make up 48% of the overall U.S. workforce, yet they fill only 24% of STEM jobs (Change the Equation, 2016). Given the disproportionately low numbers of minorities represented in the STEM workforce, promoting interest in STEM careers and recruiting, retaining, and graduating minority students with STEM degrees are essential to diversifying the STEM workforce (NSB, 2015). To meet the projected workforce need of one million additional STEM

graduates by 2022, the U.S. must do more to increase academic achievement of all students, particularly our high-need, minority students who are underrepresented in STEM majors and career fields (Handlesman & Smith, 2016). ◆**The BoSTEM Program** is our response to the national need for projects focusing on STEM education, particularly for members of underrepresented groups. Described in detail below (Section 2), BoSTEM integrates culturally responsive STEM out-of-school programming, aligned with in-school curricula, to prepare high-need middle-school students, academically and social-emotionally, for STEM postsecondary education and careers. The BoSTEM EIR Project will provide a scalable, replicable, community-driven program to address this national need both in Boston and across the nation. ◆**BoSTEM serves high-need students [Absolute Priority 1]** in the Boston Public Schools (BPS), a district comprised predominantly of minority students, with a purposeful emphasis on high-need youth who otherwise would be unlikely to achieve academically—and less likely to access hands-on STEM learning opportunities on their own. BoSTEM serves 1,294 middle-school students from 26 schools, all of whom are economically disadvantaged, and will expand to 2,000 students by Year 5 while maintaining the rate of high-need students. Further, more than half of our students are African American; one-third are Hispanic; and one of every five are English Learners (EL), as indicated in Table 2. Students are relatively equally distributed across gender.

Table 2. District and BoSTEM Students' High-Risk Indicators (MA DOE, 2016)

High-Risk Indicators	BPS	BoSTEM
Free and Reduced Lunch Rate	56%	100%
African American and Hispanic Students	87%	92%
English Learners	31%	23%

Additional risk factors for students in our target schools include academic failure and low levels of persistence in school and are displayed in Table 3. In each of the past three years, none of BPS

8th graders earned a top score of Advanced on the Science, Technology, and Engineering (STE) portion of the Massachusetts Comprehensive Assessment System (MCAS) state standardized achievement test. The achievement gaps in STEM studies are evident when comparing BPS to state performance. For both 5th and 8th grade MCAS testing, BPS student achievement was nearly 30 percentage points lower than students statewide. The Partnership for Assessment of Readiness for College and Careers (PARCC) math assessment confirms more than half of BPS middle school students fail to meet or exceed expectations and a District Accountability Report shows that over half of high-need students did not meet student growth and performance targets (BPS, 2016).

Table 3. Performance Gaps for Academic Risk Factors (MA DOE, 2016)

Student Performance Indicators	Students	BPS	State
Do Not Meet Proficiency MCAS Science/Technology/Engineering	Grade 5	82%	53%
	Grade 8	87%	59%
Do Not Meet or Exceed Expectations PARCC Mathematics	Grade 6	67%	N/A*
	Grade 7	53%	N/A*
	Grade 8	65%	N/A*
Four-Year Graduation Rate	2016 Cohort	72.4%	87.5%
High School Dropout Rate (2015-16)	Grades 9-12	4.5%	1.9%
**MA does not provide statewide PARCC comparison data for 2016, a transition year.*			

2. Development or Demonstration of Promising New Strategies

These issues pose significant barriers to the academic and long-term vocational success of an entire generation of Boston students. The need for effective programming to support and improve student learning is dire, and our proposed program will respond directly to these challenges, by attracting, engaging, and retaining a new generation of students traditionally underrepresented in STEM fields. Achieving these goals in Boston requires increased access to STEM learning opportunities, greater alignment across a community of practitioners, and enhanced documentation and

dissemination of effective program practices. BoSTEM will improve the lives of Boston's highest-risk students through a shared commitment to support student academic success and postsecondary readiness and resilience by providing high quality and engaging STEM out-of-school programming for middle-school students. ◆**BoSTEM builds on successful afterschool program strategies** and incorporates the characteristics of high-quality afterschool programs identified by research including: goal setting, strong management, and sustainability; quality afterschool staffing; enriching learning opportunities; linkages between school day and afterschool personnel; evaluation of program progress and effectiveness; and effective partnerships with community-based organization (Afterschool Alliance, 2015; Greene, Lee, & Hynes, 2012; Sacks, Beltz, Beckwith, & Anderson-Moore, 2015). Research confirms that children who participate in structured out-of-school programs offered with significant intensity and duration gain higher grades in school, attend school more often, and have more positive attitudes toward education than their peers (Afterschool Alliance, 2015). Moreover, out-of-school-time learning opportunities, both afterschool and summer-learning, have been shown to have a positive impact on academic and behavioral development (Afterschool Alliance, 2011). ◆**BoSTEM incorporates successful factors contributing to minority students' decisions to major in STEM fields.** BoSTEM provides culturally responsive training and STEM programming customized to our specific high-need, high minority students as academic experiences at the elementary and secondary levels and self-efficacy in STEM-related concepts have been identified as factors influencing minority students' decisions to pursue STEM fields (Hossian & Robinson, 2012; Wang, 2013). Experiences prior to college enrollment in STEM areas have been shown to shape minority and underrepresented students' desire to pursue a related major and persist, once enrolled in college (Hossain & Robinson, 2012). Students who perceive their coursework as enjoyable are also more

likely to persist in the program of study (Crisp & Nora, 2012). ◆**BoSTEM aligns with the *Massachusetts Plan for Excellence in STEM Education***, a blueprint for expanding the STEM pipeline for students statewide. This plan has four main themes including: 1) reducing gaps in STEM achievement, interest, and skill; 2) creating and maintaining a skilled STEM educator workforce; 3) exploring diverse and innovative instructional strategies; and 4) scaling across Massachusetts (Governor's STEM Advisory Council, 2013). Aligned to this plan, BoSTEM aims to prepare high-need middle-school students, academically and social-emotionally, for STEM postsecondary education and careers by increasing engagement and interest, using hands-on instructional strategies, and scaling our model. ◆**The BoSTEM EIR Project expands on our program success** in providing out-of-school academic services and enrichment activities to address the widening achievement gap. These activities focus on cultivating a learning ecosystem connecting students to opportunities to practice STEM and critical-thinking skills outside the classroom while developing a real-world context for the concepts they learn in school. Our program made significant strides in 2015-16, with demonstrated impact on strengthening student interest, engagement, and persistence in STEM studies. At the end of the program year (spring 2016), 72% of students reported positive gains in STEM interest, 65% reported positive gains in STEM career interest, 76% reported positive gains in their critical-thinking skills, and 80% reported positive gains in their perseverance skills.

3. Project Represents an Exceptional Approach to the Priorities

◆**BoSTEM** is a coalition of high-performing nonprofits and a growing list of local corporations who are committing time, expertise, and resources to close achievement and opportunity gaps for students who are traditionally underrepresented in STEM learning and to inspire and prepare Boston youth to succeed in 21st century careers. To accomplish this, our goal is to ensure that every

Boston middle-school student has the opportunity to participate in STEM learning experiences, which give students the chance to apply hands-on math and science skills in exciting, real-world contexts in out-of-school settings. ◆**Our EIR Project** will address critical local and national needs for quality STEM education and college or career readiness, by refining, scaling, and studying our successful BoSTEM program as an emerging best practice for **Increasing Postsecondary Preparedness [Absolute Priority 4]**. BoSTEM will increase culturally responsive STEM out-of-school programming, aligned with in-school curricula, to prepare high-need middle-school students, academically and socially, for STEM postsecondary education and careers by: 1) Employing a collaborative, continuous performance feedback cycle to encourage innovative, customized site-based strategies and supports within a framework for quality implementation; and 2) Implementing culturally responsive STEM programming to increase students' college- and career-STEM aspirations. Our rationale or **theory of action** states that IF students have exposure to 1) innovative strategies and supports through a continuous feedback cycle, 2) culturally responsive STEM programming with hands-on, experiential learning, and 3) effective educators through high-quality professional learning, THEN this change will lead to increased postsecondary preparedness and subsequent enrollment in college or other career technical education. ◆**BoSTEM will employ a collaborative, continuous performance feedback cycle to encourage innovative, customized, site-based strategies and supports within a framework for quality implementation.** Our program is unique in that we have a common, feedback cycle for quality program implementation

Figure 1. Feedback Cycle

(Figure 1); however, the strategies and supports provided to our middle-school students within this cycle are flexible and customized to specific site and student needs making it easily replicable in other settings. ◈**1.** Our BoSTEM Leadership Team will convene at least quarterly to analyze needs assessment data from each implementation site to inform program and professional learning needs. Tools to facilitate the needs assessment are described in Table 4.

Table 4. Needs Assessment Rubrics

Assessment Tool	Purpose and Items Examined	Frequency
Dimensions of Success (PEAR, 2017)	Observation tool developed by the Program in Education, Afterschool, and Resiliency (PEAR) that examines 12 indicators of STEM program quality in out-of-school time across 4 domains: Features of the Learning Environment, Activity Engagement, STEM Knowledge & Practices, and Youth Development in STEM. Results identify program strengths and areas needing improvement.	Annually
Survey of Academic and Youth Outcomes (SAYO) - TEACHER (MADOE, 2017)	Teacher survey developed and field tested by the National Institute on Out-of-School Time in collaboration with the Massachusetts DOE to capture changes in student academic and social emotional learning over time. The teacher survey examines components including: Homework/Learning Skills, Critical Thinking, Self-Regulation, Leadership, Perseverance, and Relationships with Adults.	Semi-annually
Survey of Academic and Youth Outcomes (SAYO) - YOUTH (MADOE, 2017)	The student SAYO survey measures outcomes focusing on: Program Experiences (engagement, autonomy, environment, relationships, and leadership); Sense of Competence (reading, writing, math, science); Future Expectations (planning, aspirations, and expectations).	Semi-annually
Common Instrument (PEAR, 2015)	This youth survey, developed by PEAR, uses 10 items to assess student interest and engagement in science.	Semi-annually

◈**2.** Based on the results of the needs assessments, each site, in collaboration with BoSTEM staff, will develop an Action Plan tailored to the specific needs of its students. This plan will be developed based on performance feedback, aligned with school curricula, and will inform professional learning and programming. Action plans will: a) identify student and site needs, b) detail community partner linkages, c) outline steps necessary for aligning STEM programming

with school curricula, d) identify who is responsible for each activity and the timeframe for completion, e) specify resources needed, and f) list indicators of success. The BoSTEM Leadership Team will meet with each site semi-annually to discuss progress on the plan, celebrate successes, and identify areas for improvement. ◈**3**. Action Plans will then drive our program-wide and site-specific professional learning and coaching. We will provide professional learning opportunities for BoSTEM educators and the classroom teachers who collaborate with them to refine and facilitate curricula and activities that allow students to further connect the STEM concepts learned in the classroom to real-world settings. Educators will also receive at least two annual individual coaching sessions provided by the Project Director, STEM Coach, BASB Staff, and/or VISTA liaisons and tailored to their specific needs. All BoSTEM site staff and classroom teachers involved will also receive culturally responsive training designed to create more inclusive learning environments and support students traditionally underrepresented in STEM; teachers and site staff often lack concrete professional learning to understand racially, culturally, or linguistically diverse students' unique learning needs which hinders them in providing appropriate instruction or interventions and can negatively impact students' academic achievement and eventual degree attainment (Aceves & Orosco, 2014). To gauge effectiveness of our professional learning, we will track the number of staff who implement strategies reflective of the professional learning and the percentage indicating positive impact. ◈**4.** Communities of Practice will build on our Boston STEM Network—a cross-sector communication and collaboration with partners from K-12 education, higher education, industry, out-of-school programs, and philanthropy, all working in STEM education to address the need for systemic change. They will be comprised of Boston After School & Beyond staff, implementation sites, professional learning trainers, BoSTEM staff, and UWMB leaders, to review data and feedback for the purpose of developing data-informed

programming. To support our Communities of Practice, two AmeriCorps VISTA (Volunteer in Service to America) staff placed at UWMB and BASB will serve as the liaisons between BoSTEM and the district, schools, and partners. VISTAs will develop, plan, and implement volunteer engagement events to support student learning in BoSTEM programs; refine systems for soliciting, documenting, analyzing, and communicating stakeholder learning gleaned from BoSTEM programming; and work to scale the Communities of Practice and shared-learning work by researching prospective partners, the STEM learning needs of Boston students, and best approaches to teaching and learning STEM to refine professional learning offerings. As founding members of the STEM Ecosystems Initiative Community of Practice, BoSTEM leaders will share our systems-building success at semi-annual collaborative meetings with communities using similar ecosystem approaches to connecting youth with opportunities to practice STEM. Additionally, BoSTEM is a member of US2020's City Network—a national movement to change the trajectory of STEM education in America by dramatically scaling the number of STEM professionals engaged in high-quality STEM mentoring with youth. Through this collaborative, BoSTEM will continue sharing strategies for engaging partners and individual STEM professional volunteers in its Communities of Practice. These Communities of Practice are a key ingredient in building BoSTEM's momentum to inspire and prepare Boston youth to thrive in the 21st century workforce and will be a platform for disseminating program findings and scaling our initiative.

◆**BoSTEM will implement culturally responsive STEM programming to increase students' STEM college and career aspirations** by using the performance feedback cycle. ◈**1.** We will target 8 sites and 1,294 students to begin the research study and scale to 12 sites in Year 2 and a total of 2,000 students per year by Year 4. Each site will implement a customized STEM-focused curriculum tailored to the specific needs of their students as outlined in Table 5. Organizations

interested in replicating our model can select a STEM-focused curriculum that works best for their specific student population. To ensure strong linkages between the school and out-of-school STEM curricula, our BoSTEM staff will work with BPS to align content through Communities of Practice and joint professional learning activities.

Table 5. STEM-Focused Programming at Year-1 Target Sites
Citizen Schools: Students in grades 6-8 participate in programming built into an extended school day four days a week at partner schools. Apprenticeships engage students in hands-on learning experiences led by local professionals and community members in robotics, microbiology, and financial literacy. Students also receive academic support from VISTAs in math and English language arts.
CitySprouts: This garden-based learning program cultivates and manages school gardens for educational purposes. Grades 6-8 students meet weekly after school to work and learn in school gardens, study plants and food science, and analyze global food systems and their effects on communities. Classroom teachers may use gardens during the school day.
Community Boat Building: Students work in small teams to realize seaworthy rowboats from a set of blueprints. Following boat completions, students paddle into Fort Point Channel to test water quality and complete other marine science experiments. Students are bussed in small groups from school to the Community Boat Building Workshop for activities.
Latino STEM Alliance: This afterschool robotics program for grades 6-8 meets weekly for students to undertake a series of design challenges that teach students engineering, robotics, and programing principles with Lego Robots. After building, testing, assessing, and redesigning their robots, students reflect on their application of the design process to form an understanding of how real engineers work to find solutions. A team robot is developed to compete in a Lego competition.
Lena Park Community Development Corporation: This affordable housing development residence recently opened a state-of-the-art youth center that offers STEM-focused programs such as Black Girls Code, Resilient Coders, and Technovation. They also offer computer literacy courses, arts, and music classes, and a fab-lab with 3D printers, laser cutters, a vinyl cutter, and 3D design and modeling software.
Massachusetts General Hospital (MGH): The Science Fair Mentor Program pairs students in grades 7-8 with MGH mentors to help them complete science fair projects. Pairs meet bimonthly, September to March. Mentors help students define research questions, collect, and analyze data, and present their results. Most mentors are clinical researchers and lab technicians. After the science fair, students can stay connected to their mentor via Big Brothers Big Sisters. Graduating grade 8 students may participate in paid summer internships at MGH.
Sociedad Latina: Students in grades 6-8 participate in STEAM service-learning experiences based on current community issues and student interests. For example, during one unit students participated in an engineering design challenge in which they developed models of energy efficient homes. The program offers homework help via college tutors.

Table 5. STEM-Focused Programming at Year-1 Target Sites
Thompson Island Outward Bound Education Center: Situated on the Boston Harbor Islands National Park, the Education Center offers place-based science learning experiences to students in grades 6-8 and integrates curriculum into partner schools. During the program, staff members visit classrooms and conduct 11-15 days of instruction to prepare students for island visits. On the island, students study the wildlife, biodiversity, geology, and agents of erosion. Students spend 11 days on the island, including overnight in grades 7-8 and receive 11-15 days of classroom instruction.

❖**2.** While each site has a unique STEM curriculum, all BoSTEM sites use the Achieve-Connect-Thrive Skills Framework (ACT), illustrated in Figure 2 below, to unite Boston's out-of-school-time programs around a common youth agenda outlining the skills that research and practice tell us are important for youth to have to be prepared and successful in school, careers, and life (BASB, 2017). Commissioned by our Mayor and UWMB, with the support of The Wallace Foundation, the framework provides a common vocabulary to bridge education and youth development, as well as school, after-school and summer learning. The framework also acts as a guide to help youth programs articulate outcomes and define how they are measured.

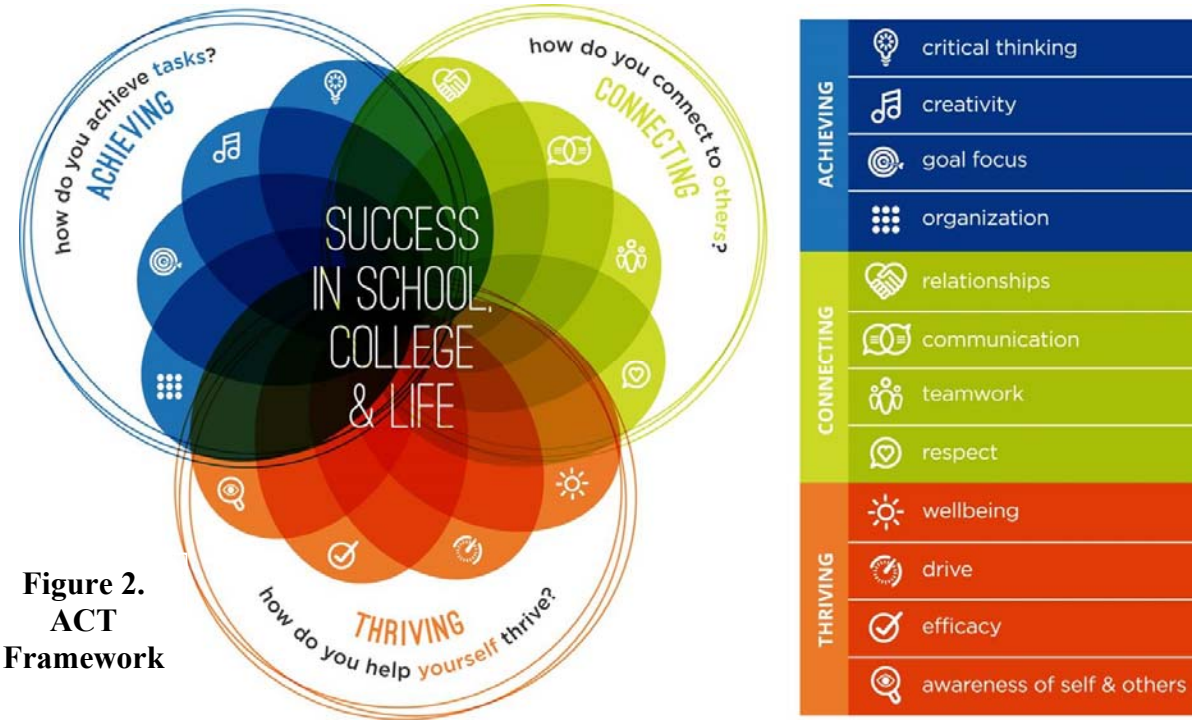

Figure 2. ACT Framework

◈3. Within the ACT Framework, each site provides out-of-school project-based, hands-on, experiential STEM learning experiences to build students' social-emotional learning skills proven to increase students' academic success and postsecondary preparedness (Valla & Williams, 2012). Students will participate in semi-annual field trips to STEM businesses to observe STEM careers in action and learn from experts in the field. Each site will be linked to professionals in the STEM field, recruited, trained, and placed by UWMB. These professionals will provide at least quarterly mentorships and onsite program participation in STEM activities. For example, a microbiologist may engage students by facilitating a unit about the role microorganisms play in fixing the nutrients consumed by the vegetables in their garden, and subsequently, by the people who eat them. By creating these connections between programs and STEM professionals, BoSTEM exposes students to careers in which they could apply the skills that they are learning. Students will also work in small-group settings to develop hypotheses, design experiments, and test their theories to address real-world challenges. Each site will also utilize Defined STEM, which will provide staff with tools to implement engaging lessons assisting students with building their social-emotional learning skills through real-world videos and tasks that bring industry concepts to them. Project-based, hands-on work is shown to build social-emotional skills including teamwork, communication, relationship building, critical thinking and perseverance–all critical to postsecondary preparedness and success (ASCD, 2015).

B. Quality of the Project Design and Management Plan

1. Goals, Objectives, and Outcomes to Be Achieved Are Clearly Specified and Measurable.

BoSTEM will increase culturally responsive STEM out-of-school programming, aligned with in-school curricula, to prepare high-need middle-school students, academically and socially, for STEM postsecondary education and careers as specified in Table 6 below.

Table 6. BoSTEM Goals and Objectives
Goal 1: Employ a collaborative, continuous performance feedback cycle to encourage innovative, customized site-based strategies and supports within a framework
1.1 Beginning in Year 1, the BoSTEM Leadership Team will convene at least quarterly to conduct needs assessments that will inform professional learning and programming. **Measure/Timeline:** Meeting minutes, reported quarterly.
1.2 Beginning in Year 1, the BoSTEM Leadership Team will convene Communities of Practice at least quarterly to review data and feedback for the purpose of developing data informed programming. **Measure/Timeline:** Meeting minutes, reported quarterly
1.3 Beginning in Year 1, at least 75% of targeted staff in BoSTEM sites will receive at least two individual coaching sessions from the BoSTEM Partnership. **Measure/Timeline:** Coaching Logs, reported quarterly and BoSTEM Staff Survey, administered annually.
1.4 In Years 1-5, at least 95% of targeted staff at BoSTEM sites will receive professional learning quarterly. **Measure/Timeline:** Training attendance records, reported quarterly.
1.5 Beginning in Year 1, the BoSTEM Leadership Team will collaborate with site staff at least quarterly to develop/review/revise Action Plans that are developed based on performance feedback and aligned with school curricula and will inform professional learning and programming. **Measure/Timeline:** Meeting minutes, reported quarterly.
1.6 In Year 1, at least 95% of targeted staff at BoSTEM sites will participate in at least two BoSTEM-sponsored culturally responsive professional learning opportunities; at least one training in Years 2-5. **Measure/Timeline:** Training attendance records, reported quarterly.
1.7 In Years 1-5, 100% of sites will collaborate with a VISTA quarterly to ensure site curricula is aligned with school curricula. **Measure/Timeline:** VISTA contact logs, compiled monthly.
Goal 2: Implement culturally responsive STEM programming to increase students' college- and career-STEM aspirations
2.1 By the end of Year 1, at least 70% of participants will express a strong interest in pursuing a STEM-related career; 75% in Years 2-3; and 80% in Years 4-5. **Measure/Timeline:** College and Career Ready Aspirations Student Survey, administered and reported annually.
2.2 By the end of Year 1, at least 70% of 8th grade participants will be able to identify the classes needed to take in high school to prepare for a STEM-related career; 75% in Years 2-3; and 80% in Years 4-5. **Measure/Timeline:** Student Survey, administered and reported annually.
2.3 By the end of Year 1, at least 70% of participants will report a strong interest in STEM; 75% in Years 2-3; and 80% in Years 4-5. **Measure/Timeline:** Student Survey, administered and reported annually. Common Instrument (PEAR), administered and reported annually.
2.4 By the end of Year 1, at least 20% of participants will demonstrate growth on the MCAS STE test and on the PARCC math test; increasing 5% each year in Years 2-5. **Measure/Timeline:** MCAS STE assessment and PARCC math assessment scores, reported annually.
2.5 By the end of Year 1, at least 70% of site staff will indicate positive changes in students' social-emotional behavior; increasing by 5 percentage points in Years 2-5. **Measure/Timeline:** Teacher SAYO, administered and reported annually.

Table 6. BoSTEM Goals and Objectives
2.6 By the end of Year 1, at least 70% of students will indicate increased engagement, improved relationships, and leadership skills; increasing by 5 percentage points in Years 2-5. **Measure/Timeline:** Student SAYO, administered and reported annually.

2. Adequacy of the Project Management Plan

Founded in 1935, UWMB is the 10th largest United Way in the U.S., managing a portfolio of over 200 agencies and serving 142 cities and towns across Eastern Massachusetts, the Seacoast region of New Hampshire, and Southern Maine. As the EIR applicant and fiscal agent, UWMB will ensure proper and efficient management of the project by granting the BoSTEM Project Director sufficient authority to effectively implement the project. ◆**The BoSTEM Leadership Team,** comprised of three UWMB Senior Directors (Evaluation, Community Engagement, and Grants-Finance), the Project Director, two AmeriCorps VISTAs, and leadership from BASB and BPS, will convene weekly to provide administrative oversight, fiscal responsibility, and guide day-to-day program implementation and continuous improvement. They will convene Communities of Practice at least quarterly to review data to refine data informed programming. ◆**The BoSTEM Advisory Council** will be comprised of representation from UWMB, BASB, STEM Director, BPS Superintendent's Cabinet, Mayor's Education Cabinet, CEOs of implementation sites, and corporate partners. Meeting quarterly, this Council will guide and inform STEM best practices for incorporation into our project-based, hands-on learning activities and professional learning experiences. ◆**BoSTEM Site Teams**, coordinated by the STEM Director, include project- and school-day teachers, parents, local partners, principals, and other stakeholders. Bimonthly communications from the Leadership Team for all stakeholders will provide a means for ongoing review and timely adjustments that may be needed. ◆**BoSTEM Project staff** include: four full-time positions, the Project Director, STEM Director, and two in-kind AmeriCorps VISTAs and

seven part-time staff including three BASB managers, two in-kind BASB Student Interns, and two in-kind UWMB Senior Directors. An overview of full-time staff roles and responsibilities is offered in Table 7; resumes and position descriptions for key staff are provided in *Appendix C.*

Table 7. Overview of BoSTEM Project Staff

Project Director Responsibilities and Requirements:

- Provide project leadership and manage project staff.
- Manage day-to-day requirements of EIR grant and all reporting to U.S. ED.
- Attend Leadership Team and Advisory Council meetings with project updates.
- Work with evaluator to coordinate data and reporting from program partners.
- Develop recruitment, training, and retention strategies for community volunteers.
- Regularly review evaluation reports for timely presentation to stakeholders.
- Work in collaboration with BoSTEM partners BASB and BPS.
- Disseminate information via Communities of Practice and other forums.
- Past experience leading large initiatives.
- Background in Education and/or a STEM field.

STEM Director Responsibilities and Requirements:

- Manage partnerships among STEM sites.
- Coordinate professional learning for teachers and program staff.
- Engage evaluators to observe and measure the implementation of STEM practices.
- Work with BASB and UWMB to refine data sharing and collection practices.
- Lead BoSTEM Site Teams.
- Facilitate Communities of Practice for continuous improvement across partners.
- Provide professional learning and individual coaching sessions.
- Link STEM activities to real-world applications.
- Past experience serving in an instructional coaching capacity.
- Background in a STEM field.

AmeriCorps VISTA Responsibilities and Requirements:

- Ensure stakeholders are involved in the creation and dissemination of best practices.
- Solicit insights from partners to identify prospective STEM learning partners.
- Engage stakeholders in identification of programs that are exemplars in quality.
- Refine or develop learning practices and knowledge communities to share insights.
- Convene STEM leaders from across sectors to analyze current progress and set goals.
- Research STEM learning needs and promising practices in teaching and learning.
- Measure progress in provision of STEM education to inform discussions.
- College graduate who is fluent in English.
- Background in education and/or STEM fields.

UWMB will use the strength of our staff, facilities, and long-standing partnerships with the sites, target middle schools, and partners to accomplish our goals. We have secured written

commitments from program sites and partners as outlined in Table 8 and *Appendix D*.

Table 8. Overview of BoSTEM Key Stakeholders and Contributions	
Boston After School & Beyond	**Lead:** Chris Smith, President and Executive Director ◆ Provide in-kind contribution VISTA (1.0 FTE) ◆ Provide BASB personnel who will support project implementation, including: Director of Measurement and Improvement at 40% effort who will oversee data collection, analysis, and presentations across the project; Data Partnership Manager at 50% effort in Years 1-4 will recruit and on-board STEM partners; Director of Policy and Communication at 20% effort will document and share lessons at various convenings ◆ Support dissemination, scaling, replication, and sustainability efforts ◆ Assign a representative for Leadership Team and Advisory Council
Boston Public Schools	**Lead:** Dr. Tommy Chang, Superintendent ◆ Support the research study of BoSTEM at various implementation sites ◆ Allow teachers to participate in needs-based professional learning and annual program planning and implementation ◆ Support program evaluation including data collection ◆ Support dissemination, scaling, replication, and sustainability efforts ◆ Provide matching funds and in-kind contributions
Boston STEM Network	**Lead:** Hilary Brayton Hutchison, STEM Manager ◆ Support the research study of BoSTEM at various implementation sites ◆ Provide project public-private collaborative infrastructure ◆ Support dissemination, scaling, replication, and sustainability efforts ◆ Assign a representative for Advisory Council
Boston Mayor's Office	**Lead:** Turahn Dorsey, Chief of Education ◆ Assign a representative for Advisory Council ◆ Support dissemination, scaling, replication, and sustainability efforts

Our established timeline (Table 9) will accomplish the critical elements of our EIR project.

Table 9. BoSTEM Timeline and Management Plan			
Strategies	**Activities**	**Timing**	**Responsible**
Ensure effective program implementation and grant	Create and convene BoSTEM Leadership Team	Weekly	Project Director
	Create and convene Advisory Council	Quarterly	Project Director
	Create and convene BoSTEM Site Teams	Monthly	STEM Director
	Compile baseline data for program evaluation	Year 1	Evaluator

Table 9. BoSTEM Timeline and Management Plan			
Strategies	**Activities**	**Timing**	**Responsible**
management	Submit Institutional Review Board application	Year 1	Evaluator
	Develop Evaluation Plan and Fidelity Index	Year 1	Evaluator
	Conduct formative and summative evaluation	Ongoing	Evaluator
	Provide evaluation findings and feedback	Quarterly	Evaluator
	Hire and train grant staff	Year 1	UWMB
	Complete and submit EIR Management Plan	Annually	Project Director
	Confirm matching funds and in-kind resources	Year 1	Project Director
	Complete Annual Performance Report	Annually	Project Director
	Create and maintain program website	Year 1	Project Director
	Provide communication and updates to sites	Bimonthly	Project Director
	Participate in EIR Project Director's Meeting	Annually	Project Director
	Complete impact evaluation and share findings	Year 5	Evaluator
	Close out grant and submit final report	Year 5	UWMB
Employ a collaborative, continuous performance feedback cycle to encourage innovative, customized site-based strategies and supports within a framework for quality implementation	Conduct needs assessments at each site	Annually	BoSTEM staff
	Create needs-based PL schedule for sites	Ongoing	STEM Director
	Procure vendors to facilitate PL sessions	Ongoing	Project Director
	Conduct needs-based PL at each site	Quarterly	BoSTEM staff
	Provide individual semi-annual coaching sessions at each site	Ongoing	BoSTEM staff
	Convene Communities of Practice to review data and provide feedback on implementation	Quarterly	Leadership Team, STEM Director
	Disseminate findings and share best practices at the STEM Ecosystems Initiative Community of Practice and the US2020 City Network	Semi-Annually	UWMB, Leadership Team
	Refine program model and disseminate at state, regional, and national conferences and meetings	Year 2-5	Project Director
	Collaborate with site staff to develop, review, and revise Action Plans	Semi-Annually	BoSTEM staff
	Offer culturally responsive professional learning for all project sites	Semi-Annually	BoSTEM staff
	Employ culturally responsive techniques	Ongoing	Site staff

Table 9. BoSTEM Timeline and Management Plan			
Strategies	**Activities**	**Timing**	**Responsible**
Implement culturally responsive STEM programming to increase students' STEM college and career aspirations	Align site curricula to school curricula	Quarterly	VISTA staff
	Provide liaisons between program and: district, schools, and local businesses	Annually	VISTA staff
	Confirm local STEM partners and schedule and host STEM field trips	Semi-Annually	STEM Director
	Confirm and engage STEM partners for onsite, hands-on STEM learning opportunities and career pathways	Quarterly	VISTA staff
	Purchase supplies to implement hands-on STEM activities aligned to curricula	Annually	BoSTEM staff
	Expand STEM programs to serve more students	Annually	BoSTEM staff
	Recruit additional STEM program sites	Annually	Project Director

3. Performance Feedback and Continuous Project Improvement

BoSTEM's success relies heavily on continuous high-quality performance feedback for program refinement and improvement. ◆**The independent evaluator**—identified through an open and competitive procurement process that complies with the requirements of 2 CFR 200.317-200.326 and UWMB policies—is The Evaluation Group who will participate in Leadership Team meetings quarterly to build consensus on critical evaluation questions, methods, instruments, data collection protocols, and reporting formats. This participatory approach to evaluation will ensure data is used strategically on a regular basis to provide feedback to refine implementation and make programmatic changes as needed. Through continuous monitoring, the evaluator will provide periodic feedback to each site and will triangulate the data to provide a synthesis of program-wide, evidence-based data. Evaluation results will be shared through interim and annual reports, survey and focus-group snapshots, and in-person briefings provided by our evaluator to the Advisory Council, Leadership Team, Site Teams, and Communities of Practice. This participatory approach builds stakeholder ownership, increasing the likelihood that results will be used to improve the

program and achieve positive outcomes. ◆**Our logic model** (*Appendix B*) ensures that evaluation guides both continuous quality improvement and program enhancement. The model has a built-in feedback loop to provide timely and useful information to stakeholders for informed decision-making relative to needed changes in program activities. Short-term performance indicators will be used to assess progress toward long-term outcomes. Annual benchmarks are established and embedded in our outcomes listed in Table 6 above and will be used to graphically chart actual progress against targeted progress. ◆**The BoSTEM Leadership Team** will meet weekly to engage in program planning, assessment, review, and sustainability strategies with the goal of continuously improving and sustaining our initiative. UWMB and our partners will use an established review cycle to conduct and interpret site-level assessment and evaluation results quarterly. This process will foster a solid, quality-based management structure to oversee program operations and make modifications consistent with grant goals and requirements. BoSTEM is built on a total quality approach of "Continuous Improvement Management" to: systematically monitor student outcomes; determine what strategies work and why; and adjust activities and strategies to reflect student needs more accurately and to achieve program outcomes more effectively.

4. Project Dissemination to Support Further Development or Replication

BoSTEM will bring together resources and partners across the region to support program success and long-term sustainability using existing and new mechanisms to support dissemination, further development, and replication. ◆**The Boston STEM Network,** convened by the Boston Private Industry Council and led in partnership by BPS, UWMB, and BASB, is a cross-sector communication and collaboration with partners from K-12 education, higher education, industry, out-of-school-time programs, and philanthropy—all working in STEM education to address the need for systemic change. The Boston STEM Network will continue to provide a robust

infrastructure of public-private collaboration and resources to support this project and disseminate findings. ◆**The US2020 City Network** and **STEM Ecosystems Initiative** both provide avenues for BoSTEM to share strategies for engaging corporate partners and individual STEM professional volunteers in its communities of practice. ◆**A BoSTEM website** will be created to share program news, action plans, and evaluation updates and also to disseminate our replication strategies. To raise awareness for STEM and our program, we will disseminate this website broadly within the education and STEM communities. ◆**STEM presentations** will be conducted at BPS meetings, meetings with local community organizations (e.g., community-service and faith based), Massachusetts DOE functions, the Governor's STEM Advisory Council, and the Massachusetts STEM Summit. In addition, UWMB will work with our independent evaluator to share evaluation findings with the U.S. Department of Education, other grantees, and What Works Clearinghouse.

C. Quality of the Project Evaluation

1. Evidence that Would Meet WWC Evidence Standards with Reservations

The BoSTEM evaluation will test the impact of our program on students' academic achievement, STEM career aspirations, and postsecondary preparedness. ◆**The three evaluation questions** our study will answer are: (1) What is the impact of BoSTEM on improving students' academic performance? [Objectives 1.1-1.7; 2.4] (2) What is the impact of BoSTEM on students' behavior? [Objectives 2.5, 2.6] (3) What is the impact of BoSTEM on students' STEM postsecondary education or employment aspirations? [Objectives 2.1-2.3] To answer these questions, we will conduct a rigorous, longitudinal impact study beginning in Year 1. ◆**Our evaluation design** will use a multiple cohort, quasi-experimental design to determine program impact. Cohort One, with 8 BoSTEM sites and 16 comparison sites, will be tracked Years 1-5; Cohort Two, with 4 BoSTEM sites and 8 comparison sites, will be tracked Years 2-5. Combined data from Cohorts One and Two

will allow for assessment of three-year program effects on the pooled sample of approximately 4,800 treatment and comparison students. We will match BoSTEM students to a comparison group of students in BPS. Propensity score matching (PSM) using a 1:2 nearest neighbor match without replacement will be used to ensure BoSTEM students and comparison students are equivalent on key background and demographic variables, including grade, ethnicity, English Learner, gender, free and reduced-price lunch status, and student academic achievement. PSM will strengthen the estimate of program impact by statistically controlling for differences in observed variables. Program and comparison students will be compared annually, using two-level hierarchical linear modeling (HLM) to test for differences in the following outcomes: state standardized assessments in math and science; and student STEM aspirations. Baseline equivalence of the analytic samples will be tested by comparing baseline characteristics (such as state standardized math and science assessments; race; gender, and poverty status) of the intervention and comparison groups. We anticipate little-to-no attrition and expect high numbers for recruitment. By accounting for clustering and statistically controlling for group differences, the proposed study designs meet the WWC Standards Evidence Standards with Reservations, providing a moderate level of evidence of the effectiveness of our intervention. Table 10 summarizes the study parameters.

Table 10. BoSTEM Study Design Parameters	
Program Years	◆ Years 1-5
Unit of Analysis	◆ Site
Sample Size	◆ 36 sites (12 treatment, 24 comparison) ◆ 4,800 students (1,600 treatment and 3,200 comparison)
Primary Outcomes	◆ State standardized math and science achievement data ◆ Student STEM Survey data
Exploratory Outcomes	◆ Student STEM Survey data
PSM Variables	◆ Math and science achievement; race; English Learner; gender; poverty status
Covariates	◆ Dosage (years of exposure to intervention)

Table 10. BoSTEM Study Design Parameters	
Baseline Equivalency Variables	◆ State standardized math and science achievement data
Statistical Analysis	◆ Confirmatory and exploratory: Two-level HLM

2. Effective Strategies Suitable for Replication or Testing in Other Settings

◆**Our process evaluation** will support replication and testing in other settings by pursuing three overarching questions: 1) To what extent was BoSTEM implemented with fidelity at participating sites? 2) What active components of the BoSTEM model are most suitable for replication or testing in other settings? 3) What are the strengths of and barriers to implementation of BoSTEM? Beginning in Year 1, we will launch a comprehensive longitudinal fidelity of implementation study to systematically track, document, and assess the extent to which actual project implementation aligns with proposed project implementation. ◆**The BoSTEM Fidelity Index**, developed in partnership with our leadership team and evaluator and described in *Appendix G*, will consist of two key strategies aligned with the eight primary activities presented in the BoSTEM logic model *(Appendix B).* Within each component, fidelity scores will be based on quantitative and qualitative indicators of Adherence, Exposure, Quality, and Responsiveness (Nelson, et al., 2012). Thresholds will be established a priori for each indicator using baseline data, scaling targets, and input from subject-area experts. Beginning in Year 2, we will use findings from the prior implementation year to support replication in the Cohort 2 schools. Our evaluator will chart actual progress against our targets quarterly to support continuous improvements and iterative development.

3. Evaluation Methods to Provide Valid, Reliable Performance Data on Relevant Outcomes

◆**Evaluators will use a mixed-methods approach,** combining multiple qualitative and quantitative data sources (Table 6) for data triangulation, thereby significantly enhancing the validity and reliability of the evaluation. ◆**Quantitative data** sources include: Massachusetts Comprehensive Assessment System (MCAS) Science, Technology, and Engineering (STE) data

and Partnership for Assessment of Readiness for College and Careers (PARCC) math data; SAYO Teacher and Student data; the Common Instrument; Dimensions of Success; attendance data; coaching logs; and staff- and student-survey data. Quantitative data will be analyzed using descriptive statistics; parametric and non-parametric inferential statistics; and effect sizes disaggregated by subgroups. ◆**Qualitative data** to assess the implementation fidelity of the project include: key informant interviews with site personnel, service providers, and partners; student focus groups; meeting minutes; and open-ended items on evaluator-developed staff and student BoSTEM surveys. Qualitative data analysis will be guided by code development (Saldaña, 2016) and informed by scholarly literature and stakeholder review panels (Frierson, et al., 2010).

◆**Responsible records management** will be ensured by maintaining a roster of de-identifiable student data, secured throughout the year. Records of participants' progress, annual evaluations completed by teachers and staff will be filed by program year. We will also maintain copies of the annual performance reports submitted to the Department of Education.

4. Key Components, Mediators, and Outcomes

◆**The BoSTEM Logic Model** in *Appendix B* provides a theoretical foundation to guide our program, evaluation, and interpretation findings (Nelson, et al., 2012). The model articulates our key program components (strategies, activities), mediators (outputs, outcomes), and long-term impact. The logic model *(Appendix B)*, goals, and objectives (Table 6) articulate the measurable thresholds for acceptable implementation. If our research design provides evidence that BoSTEM is an effective model for advancing students' postsecondary preparation, academically and socially, others will be able to replicate our model in settings across the nation.