MAURA T. HEALEY
GOVERNOR

KIMBERLEY DRISCOLL
LIEUTENANT GOVERNOR

KATHLEEN E. WALSH
SECRETARY

ROBERT GOLDSTEIN, MD, PhD
COMMISSIONER

Methods, Best Practices, and Standards for Achieving Green and Healthy Schools in the Commonwealth of Massachusetts

March 31, 2025

Table of Contents

Table of Tables

Table of Figures

Abbreviations and Acronyms

A/E	Architecture and engineering
AARST	American Association of Radon Scientists and Technologists
AC	Air conditioning
ACCA	Air Conditioning Contractors of America
ACGIH	American Conference of Governmental Industrial Hygienists
ACM	Asbestos-containing material
ACT	Accelerating Clean Transportation
ADA	Americans with Disabilities Act
AHEM	Advancing Health Equity in MA
AHERA	Asbestos Hazard Emergency Response Act
AMI	Advanced metering infrastructure
AMP	Asbestos Management Plan
ANSI	American National Standards Institute
APCP	Asthma Prevention and Control Program, MA Department of Public Health
ASABE	American Society of Agricultural and Biological Engineers
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
ASTM	American Society for Testing and Materials
ATF	Artificial turf field
BABA	Build America, Buy America
BAS	Building automation system
BCEH	Bureau of Climate and Environmental Health, MA Department of Public Health
BESS	Battery energy storage systems
BPS	Building performance standards
CAN	Shorthand for a standard developed by Canadian Standards Association
CDC	U.S. Centers for Disease Control and Prevention
CFI	Charging and Fueling Infrastructure
CFR	Code of Federal Regulations
CHDV	Clean Heavy Duty Vehicle
CHPS	Collaborative for High Performance Schools
CMR	Code of Massachusetts Regulations
CSB	Clean School Bus
DC	Direct current
DERA	Diesel Emission Reduction Act
DESE	MA Department of Elementary and Secondary Education
DOE	U.S. Department of Energy
DLS	MA Department of Labor Standards
DOER	MA Department of Energy Resources
DOR DLS	MA Department of Revenue, Division of Local Services
DPH	MA Department of Public Health
EEA	MA Executive Office of Energy and Environmental Affairs
EECFs	Early education and care facilities
EMIS	Energy Management Information Systems

EMS	Energy Management Services
EOHHS	MA Executive Office of Health and Human Services
EPA	U.S. Environmental Protection Agency
EPHT	MA Environmental Public Health Tracking Tool
ERG	Eastern Research Group, Inc.
ERM	Emissions reduction measure
ERP	Emissions reduction plan
ESB	Electric school bus
ESCO	Energy services company
ESPC	Energy savings performance contract
ESPM	ENERGYSTAR Portfolio Manager
EUI	Energy use intensity
EV	Electric vehicle
EVIP	Electric Vehicle Incentive Program
EVITP	Electric Vehicle Infrastructure Training Program
EVSE	Electric vehicle supply equipment
FAPE	Free and appropriate public education
F	Fahrenheit
FAQ	Frequently asked question
FCA	Facility condition assessment
FCU	Fan coil unit
FEMA	U.S. Federal Emergency Management Agency
FEMP	Federal Energy Management Program
FLB	Fluorescent light ballast
GHG	Greenhouse gas
gpm	Gallons per minute
GSHP	Ground-source heat pump
HEPA	High-efficiency particulate air
HFPO-DA	Hexafluoropropylene oxide dimer acid
HP	Heat pump
HPWH	Heat pump water heater
HVAC	Heating, ventilation, and air conditioning
IAQ	Indoor air quality
ICE	Internal combustion engine
IEP	Individualized education plan
IPM	Integrated pest management
IRA	Inflation Reduction Act
IRS	U.S. Internal Revenue Service
ITC	Investment Tax Credit
LCCA	Lead Contamination Control Act
LEA	Local Education Agency
LEED	Leadership in Energy and Environmental Design
LED	Light-emitting diode
LRE	Least restrictive environment
MAAP	Massachusetts Asthma Action Partnership
MAPC	Metropolitan Area Planning Council

MassCEC	MA Clean Energy Center
MassDEP	MA Department of Environmental Protection
MassEVIP	Massachusetts Electric Vehicle Incentive Program
MCL	Maximum contaminant level
MCLG	Maximum contaminant level goals
MDAR	MA Department of Agricultural Resources
MEI	MassEnergyInsight
MEMA	MA Emergency Management Agency
MERV	Minimum efficiency reporting value
M.G.L.	MA General Law
MMTCO2e	Million metric tons of carbon dioxide equivalent
MOR-EV	MA Offers Rebates for Electric Vehicles
MSBA	MA School Building Authority
MSBC	MA State Building Code
MSDS	Material safety data sheet
MVP	Municipal Vulnerability Preparedness
NAAQS	National Ambient Air Quality Standards
NE-CHPS	Northeast Collaborative for High Performance Schools
NEEP	Northeast Energy Efficiency Partnership
NESHAP	National Emission Standards for Hazardous Air Pollutants
NEVI	National Electric Vehicle Infrastructure
NIOSH	National Institute for Occupational Safety and Health
NREL	National Renewable Energy Laboratory
NRPP	National Radon Proficiency Program
NRSB	National Radon Safety Board
NSF	National Sanitation Foundation
NZE	Net zero emissions
O&M	Operations and maintenance
OCPP	Open Charge Point Protocol
OEM	Original equipment manufacturer
OSHA	U.S. Occupational Safety and Health Administration
OVS	Offer versus Serve
PCBs	Polychlorinated biphenyls
pCi/L	Picocuries per liter
PEL	Permissible exposure level
PFAS	Per- and polyfluoroalkyl substances
PFBS	Perfluorobutane sulfonate
PFHxS	Perfluorohexanesulfonic acid
PFNA	Perfluorononanoic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonic acid
PM	Particulate matter
$PM_{2.5}$	Fine particulate matter
PPE	Personal protective equipment
ppb	Parts per billion
ppm	Parts per million

PV	Photovoltaic
RAU	Radon Assessment Unit
RCRA	Resource Conservation and Recovery Act
RCx	Re-commissioning/retro-commissioning
REL	Recommended exposure limit
RfD	Reference dose
RFP	Request for proposal
RPS	Renewable Energy Portfolio Standard
RTU	Rooftop unit
SDOH	Social determinants of health
SDWA	Safe Drinking Water Act
SOI	Statement of Interest
SVOCs	Semi-volatile organic compounds
SWIG	School Water Improvement Grants
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total dissolved solids
TLV	Threshold limit value
TSCA	Toxic Substances Control Act
USDA	U.S. Department of Agriculture
USGCRP	U.S. Global Change Research Program
UD	Universal design
UDL	Universal design in learning
USGBC	U.S. Green Building Council
V2G	Vehicle-to-Grid
V2L	Vehicle-to-Load
VOCs	Volatile organic compounds
VRF	Variable refrigerant flow
WUI	Water use intensity
ZEV	Zero Emission Vehicle

Legislative Mandate

The following report is hereby issued pursuant to Chapter 179 of the Acts of 2022, Section 83 as follows:

SECTION 83. (a) The Massachusetts School Building Authority shall conduct an assessment of elementary and secondary school buildings relative to energy efficiency, building conditions, safety, and public health. The assessment shall include cataloging the age and condition of any building systems relying on the on-site combustion of fossil fuels. The assessment shall be conducted in coordination with ongoing assessments or surveys of the authority. The authority shall determine the means of conducting the assessment which may include a representative sample of schools. In planning said assessment, the authority shall consult with the department of public health, the department of elementary and secondary education and the department of energy resources.

Following completion of the assessment, the department of public health, in consultation with the Massachusetts School Building Authority, the department of elementary and secondary education, and the department of energy resources, shall develop, and report on, methods, best practices, and standards for achieving green and healthy schools strategies to for (sic) the students of the commonwealth. Methods, best practices, and standards may involve, but shall not be limited to: (i) increasing energy efficiency, increasing electrification, and shifting to fossil-free fuels; (ii) efficiently using resources, including, but not limited to, low flow water fixtures; (iii) improving water and air quality, ventilation, and air circulation systems; (iv) maintaining thermal comfort, humidity, and temperature controls; and (v) taking other actions the department may determine.

The department of public health shall issue a report on the methods, best practices and standards and may include recommendations to prioritize schools with the greatest needs, consider the unique environmental differences of schools located in urban, industrial, rural and other areas facing site challenges, and consider the need to address historic patterns of inequity in education and schools including, but not limited to, patterns of inequity involving students in special education programs. The report shall include a projected cost estimates (sic) for implementing its recommendations in a cost-effective manner.

(b) The report shall be published on the website of the department of public health and submitted to the house and senate committees on ways and means, the joint committee on telecommunications, utilities and energy, the joint committee on public health, and the joint committee on education not later than December 31, 2024.

(c) Any findings or recommendations may be used to guide the department of elementary and secondary education in its implementation of item 1599-2055 of section 2A of chapter 102 of the acts of 2021.

Executive Summary

As the oldest public school system in the United States, the Commonwealth of Massachusetts has a unique history that helped establish the fundamental basis for the current universal public education system across the United States. This history is incomplete without also acknowledging the legacy of profound injustices based on race and ethnicity, gender, abilities, faith/spirituality, and more.

Chapter 179 of the Acts of 2022, Section 83, charged the Massachusetts Department of Public Health (DPH) with identifying methods, best practices, and standards for achieving green and healthy schools across the Commonwealth. Given its mission and vision statement, DPH has included a specific focus on equity so that all students can access and fully appreciate the numerous and far-reaching benefits associated with green and healthy schools—regardless of their race and ethnicity, gender, abilities, faith/spirituality, and family income.

DPH developed this report to serve as a resource for individual schools, school districts, municipalities, and others who share a goal of implementing cost-effective strategies that create sustainable, healthy, and equitable learning environments for all students across the Commonwealth. This report outlines strategies to help Massachusetts schools incorporate sustainable design, construction, and operations and provide a healthy learning environment for all students. One recurring theme throughout the report is the ability of certain strategies to produce co-benefits that cut across numerous objectives. For example, the installation and optimization of heating, ventilation, and air conditioning (HVAC) systems enables schools to improve energy efficiency, enhance thermal comfort and climate resilience, and provide healthier learning environments through improved indoor air quality. Another cross-cutting best practice is to incorporate health equity and environmental justice principles and data into decision making to address disease, race, economic, and environmental burdens in the schools and communities.

Implementing the strategies in this report requires both financial and human resources. While many can be implemented at relatively low cost, others would require large capital improvement projects and significant funding and human resources to champion, initiate, plan, and manage. School districts could use additional resources for items such as professional environmental building assessments and capital improvement projects for HVAC systems, workforce training, technical assistance to prepare grant applications or develop Statements of Interest for Massachusetts School Building Authority funding, hazard removal, building envelope/window repairs, vehicle electrification, and other building energy efficiency improvements. Similarly, cities and towns may benefit from outdoor air quality monitoring to determine how to improve indoor air quality in schools and, consequently, the health of staff and students in those buildings.

I. Introduction

Massachusetts Department of Public Health – Our Mission and Vision

The mission of the Massachusetts Department of Public Health (DPH) is to promote and protect health and wellness and prevent injury and illness for all people. DPH prioritizes racial equity in health by improving equitable access to quality public health and health care services and partnering with communities most impacted by health inequities and structural racism.[1]

DPH envisions a Commonwealth with an equitable and just public health system that supports optimal well-being for all people in Massachusetts, centering those with systemically and culturally oppressed identities and circumstances.

DPH Resources for Schools

DPH has subject matter and inspectional expertise as well as data resources for numerous topic areas covered in this report, including indoor air quality, lead, and radon. DPH manages and maintains numerous programs and resources to ensure and promote healthy learning environments across the Commonwealth, including the following:

- 2022–2026 Strategic Plan for Asthma in Massachusetts
- Asthma Prevention and Control Program
- Childhood Lead Poisoning Prevention Program
- Environmental Toxicology Program
- Food Protection Program
- Indoor Air Quality Program
- Occupational Health Surveillance Program
- Massachusetts Environmental Public Health Tracking Tool
- Population Health Information Tool

Addressing Structural Racism

DPH's Strategic Plan to Advance Racial Equity acknowledges that to advance health equity, DPH must use an intersectional, equity-centered lens to focus on addressing the persistent racial inequities impacting the health access, treatment, outcomes, and overall well-being of people across the Commonwealth, specifically those who identify as Black, Indigenous, Hispanic/Latino, and/or Asian/Pacific Islander. The COVID-19 pandemic brought into painful, undeniable public view the clear, present, and ongoing health inequities perpetuated by systemic racial inequities across the public health infrastructure, health care delivery systems, and social determinants of health (SDOH) in Massachusetts. Understanding the ways that systems of oppression create and perpetuate structural inequities supports DPH in making system-level changes to advance health equity. DPH seeks to understand how the structures it designs, operates, and builds perpetuate inequities. By embracing an understanding of the ways that state and national public service systems have been built upon racialized policies, practices, and institutions, DPH aims to lead health equity efforts across the agency, the secretariat, and the Commonwealth using a structural analysis of how systemic racism works. In leading racial-equity-centered change, DPH notes the imperative for a shared approach to equity across all public agencies since racial inequities are also replicated in educational systems, housing and built environments, carceral systems, economic systems, climate response, and public workforce systems.

Systemic Racism Exacerbates Climate Impacts on Human Health

Established by Congress in 1990, the U.S. Global Change Research Program (USGCRP) coordinates federal research to increase our understanding of and inform our responses to global environmental change. USGCRP is mandated to produce and deliver to Congress and the President a National Climate Assessment not less frequently than every four years. In the Human Health Chapter of the Fifth National Climate Assessment, USGCRP concluded that the impacts from climate change "disproportionally harm communities and people who have been marginalized," and "structural racism and discrimination against groups that have been marginalized play a direct role in health inequities and are public health crises."

The Healey Administration's Advancing Health Equity in Massachusetts (AHEM) initiative has two initial key focus areas: maternal health and SDOH that impact cardiometabolic disease. SDOH are nonmedical factors—i.e., conditions in which people are born, grow, work, live, and age—that influence health outcomes and may make a person more vulnerable to diseases. SDOH are a key priority area for the U.S. Department of Health and Human Services' Healthy People 2030, with objectives to set data-driven policy within the areas of health care access and quality, education access and quality, social and community context, economic stability, and neighborhood and built environments. While more research is needed, asthma in young people has been linked to an increased risk of cardiovascular disease.[2]

In our country, **a person's zip code is more predictive of one's life expectancy than one's own genetic code**. As a result, around the country, credible, serious efforts to address health disparities have all prioritized developing a granular, "place-based" understanding of where disparities in the community are most profound.

Inequities in Asthma Burden in Massachusetts

Like many other New England States, Massachusetts has a high prevalence of asthma compared to national rates. Among those living with asthma in the Commonwealth, there are significant disparities in asthma outcomes by race/ethnicity. Following are notable details contributing to and related to these disparities:

- Various forms of discrimination and racism have created long-standing structural health inequities for people of color and lower-income individuals. These populations have historically been excluded from meaningful participation in decisions that impact their communities' environmental health. For example, people of color and people with limited incomes are more likely to live near toxic waste sites, in areas with high air pollution, and in low-quality housing because of the inequitable distribution of these high-polluting sites.
- Structural inequities result in fewer health care providers, limited access to transportation options, and limited access to community health information due to inaccessible health communications and lack of access for non-English speakers.
- As of 2020, the rates of asthma-related ***hospitalization*** and ***emergency department visits*** for Black non-Hispanic and Hispanic residents are three-to-four times higher than those of White non-Hispanic residents.

Source: DPH [3]

Acknowledging the SDOH and the broader structural factors that have led to historic disinvestment in communities of color, DPH's 2022–2026 Strategic Plan for Asthma in Massachusetts strives to address the significant racial disparities in asthma burden that exist in Massachusetts through the "leading with race and racism explicitly but not exclusively" framework. The 2022–2026 Strategic Plan for Asthma in Massachusetts is the result of a comprehensive planning process undertaken virtually in the summer and fall of 2020, in accordance with the COVID-19 guidance at the time, by the DPH's Asthma Prevention and Control Program (APCP) and the Massachusetts Asthma Action Partnership (MAAP), in collaboration with asthma partners, stakeholders, and thought leaders across Massachusetts. It is meant to highlight opportunities for cross-collaboration and collective impact in how programs and organizations address asthma, specifically the inequitable burden of asthma across the Commonwealth of Massachusetts and identified priority areas of schools, housing, community and clinical coordination, and outdoor air quality. The 2022–2026 Strategic Plan for Asthma in Massachusetts is also grounded in the principles of environmental justice and equitable distribution of environmental benefits—that all people have a right to be protected from environmental pollution and live in and enjoy a clean environment. It is within this context that it specifically identifies air quality and pollution as asthma triggers that disproportionately exist in underserved communities and affect people of color. The data-driven Strategic Plan for Asthma makes a commitment to center asthma efforts within the 11 communities of focus that DPH identified as experiencing the highest burden of asthma inequities in Massachusetts at the time of the development of the Strategic Plan in 2020.

DPH identified 11 communities of focus based on the following indicators of asthma burden:

- Asthma hospitalization rates that are significantly higher than the state average (all ages)
- Asthma emergency department rates that are significantly higher than the state average (all ages)
- Index of the Concentration at the Extremes score that is lower than the state average, a measure of privilege and disadvantage examining both racial/ethnic and economic segregation

See Figure 1 for a map illustrating the 11 communities of focus.

Figure 1. 11 Communities of Focus Experiencing the Highest Burden of Asthma Inequities in Massachusetts in 2020

Table 1 presents racial and income data for the 11 communities of focus based on data from the Massachusetts Health Data Tool.[4] An overwhelming majority of these communities have higher percentages of their populations who are Black non-Hispanic,

Hispanic or Latino, and living below the federal poverty rate as compared to the statewide percentages.

Table 1. 2018–2022 Racial and Poverty Data for 11 Communities of Focus Experiencing the Highest Burden of Asthma Inequities in Massachusetts

State/Community	Percent of Total Population: Black Non-Hispanic	Percent of Total Population: Hispanic or Latino	Percent of Total Population: Living Under the Federal Poverty Rate
Massachusetts	9.92%	12.59%	9.93%
Boston	28.85%	19.57%	17.47%
Brockton	51.41%	12.30%	12.87%
Chelsea	33.67%	67.42%	21.40%
Holyoke	8.15%	51.67%	26.01%
Lawrence	10.30%	81.96%	19.42%
Lowell	11.55%	17.77%	16.62%
Lynn	18.38%	42.94%	14.08%
New Bradford	11.74%	23.45%	18.76%
Southbridge	7.69%	36.01%	17.94%
Springfield	25.69%	48.30%	25.32%
Worcester	16.36%	24.59%	19.46%

Similarly, the Healey Administration's AHEM initiative identified **10 priority geographies** for focused improvements and investments. These 10 geographies encompass the communities in Massachusetts that are experiencing the **largest health disparities** across a broad range of measures. Not surprisingly, each of the communities identified in the 2022–2026 Strategic Plan for Asthma in Massachusetts are also communities that experience adverse health outcomes in maternal and cardiometabolic health, forming a **subset of AHEM** communities with a higher asthma burden. In alignment with the AHEM initiative, DPH supports using health data and an equity approach to reduce asthma triggers in schools, address SDOH for students and staff, and mitigate the development of cardiovascular disease later in life.

AHEM Communities

The AHEM communities are listed below, with the subset of communities of focus from the 2022–2026 Strategic Plan for Asthma in Massachusetts listed **in bold**.

- North Adams
- Pittsfield
- **Boston**
- **Brockton**
- Holbrook
- Rockland
- **Chelsea**
- **Lynn**
- Attleboro
- Fall River
- **New Bedford**
- Wareham
- **Lawrence**
- **Lowell**
- Dennis
- Falmouth
- Yarmouth
- Athol
- Ayer
- Fitchburg
- Gardner
- Orange
- Winchendon
- Chicopee
- **Holyoke**
- **Springfield**
- **Southbridge**
- Ware
- Webster
- **Worcester**

As another example of how DPH uses data to advance health and racial equity and prioritize services, DPH initiated an "Asthma in Schools: Data to Action" pilot project in 2022 to connect schools with a high student asthma prevalence with DPH resources on indoor air quality and asthma prevention during the 2023–2024 school year. To address long-standing inequitable distribution of resources among these highest-need communities and schools, DPH identified schools based on age-specific (5–14) pediatric asthma prevalence,[a] hospitalization, and emergency department visit data and community characteristics, such as the Vulnerable Health Environmental Justice classification. See Objective 3c. Use Available Data to Identify and Equitably Prioritize Schools of Greatest Need and

[a] Pediatric asthma prevalence used for the pilot project came from the 2014–2015 to 2017–2018 Pediatric Asthma and Diabetes Survey, collected annually for children in grades K–8 from all public, charter, and private schools in Massachusetts. These were the most recent years of data available at the time of analysis.

Advocate for Additional Funding Priorities for more about using these data tools within school districts.

For the first year of the pilot, DPH invited five public K–8 schools—each located in a different school district—to participate. Of these, schools in Chicopee, Gardner, Holyoke, and Lowell agreed to participate. DPH conducted comprehensive indoor air quality assessments in the schools and provided school-specific and best practice recommendations to improve indoor air quality, technical assistance, and educational materials and resources. DPH plans to continue this initiative for the 2024–2025 school year and to expand the pilot to additional districts based on more recent pediatric asthma surveillance data.

Additionally, DPH and the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) are leading numerous other racial equity initiatives that address racism as a serious public health threat, including:

- DPH's Community Health Equity Initiative
- DPH's Determination of Need Community Health Initiatives
- DPH's Racial Equity Data Roadmap
- DPH's Root Cause Solutions Exchange
- EEA's 2024 Environmental Justice Strategy

Overview of Public Schools in Massachusetts

Home to the oldest public school system in the United States, Massachusetts has a long and unique history of planning, constructing, and operating taxpayer-funded public schools, evidenced by the following timeline of notable historical facts:

- **1635** – Puritan settlers established the first public school, Boston Latin School, in Boston Massachusetts, in what would eventually become the United States.[5]
- **1643** – The Town of Dedham, Massachusetts, unanimously voted to authorize the first taxpayer-funded public school in the United States.[6]

- **1647** - The General Court of the Massachusetts Bay Colony decreed that every town of 50 families should have an elementary school and that every town of 100 families should have a Latin school.[7]
- **1821** – The English High School in Boston is established as the first public high school in the United States.[8]
- **1827** – The Commonwealth of Massachusetts passed legislation making public education free to all and requiring all towns in the Commonwealth with more than 500 families to operate a public high school open to all students.[9]
- **1837** – Massachusetts created the first state Board of Education in the United States. Appointed as Secretary of this new body, Horace Mann promoted ideas that have become the fundamental basis for our current universal public education system across the nation.[9]

Land Acknowledgement

DPH acknowledges that we are located on the ancestral lands of the Massachusett Tribe. Indigenous Peoples were the traditional stewards of this land. Despite many atrocities related to colonization, they continue to have deep, enduring connections. With gratitude and humility, we honor the many Indigenous Peoples connected to this land.

We also acknowledge that the Commonwealth's public schools are rooted in colonization. This has resulted in systemic erasure of Indigenous history and modes of education. It has also resulted in profound injustices based on race and ethnicity, gender, abilities, faith/spirituality, and more. As a corrective action, in this report, we identify best practices to improve equity in public school infrastructure.

For more information about our racial equity initiatives, see the Addressing Structural Racism section.

With this legacy, Massachusetts is home to four of the five oldest U.S. public high schools still in use[10] and 28 of the 100 oldest high schools in America.[11] Over the nearly 400 years since the founding of the first public school, the Commonwealth of Massachusetts has seen its public school system grow to its current collection of more than 1,800 public schools spread across nearly 400 public school districts.[12] Table 2 provides a closer look at some of the key characteristics of the Commonwealth's portfolio of public school buildings.

Table 2. Massachusetts Public Schools–A Look at the Numbers

Total number of public schools (2023–2024)	1,827
Total number of public school districts (2023–2024)	399
Total enrollment at public school buildings (2023–2024)	914,959

Total full time equivalent educators in public schools (2023–2024)	147,655
Statewide average annual expenditure per student at public school buildings	$20,133.67

Environmental Differences and Challenges by Location

The Commonwealth's 399 school districts, which collectively operate 1,827 public elementary and secondary schools,[13] are dispersed across a range of geographic locations, including those defined as urban, rural, and close to industrial activity. Each of these geographic categories presents a unique collection of environmental challenges and considerations that impact the extent to which students can thrive in an environmentally sustainable and healthy learning environment.

Urban Regions

There are numerous ways to define urban regions. Qualitatively, an urban area can refer to large cities, towns, and suburbs.[14] The U.S. Census Bureau defines urban areas as geographic areas of 50,000 or more people.[15] It further defines urban clusters as geographic areas of 2,500 to 50,000 people. Urban areas are typically characterized by a high density of people, human structures (including older buildings that may have environmental hazards such as lead-based paint and asbestos), transportation infrastructure (including impervious surfaces that absorb heat and prevent the natural percolation of rainwater to underground aquifers), and traffic congestion. Urban regions in the Commonwealth experience numerous environmental challenges, including the following:

- Degraded air quality resulting from higher emissions of criteria and toxic air pollutants from both stationary and mobile sources
- Long-duration elevated ambient temperatures resulting from the heat island effect[16]
- Flash flooding resulting from the higher concentration of impervious surfaces
- Increased likelihood of pediatric exposure to lead (on interior painted surfaces and in the soil) as a result of older building stocks that commonly used lead-based paint prior to federal regulations restricting its use and proximity to emissions from vehicles that use leaded gasoline[17]

Rural regions

The Massachusetts State Office of Rural Health considers a municipality in Massachusetts as rural if it meets at least one of the following criteria:[15]

- Meets at least one of the following three federal rural definitions at the sub-county level:

  - U.S. Census Bureau: Urban areas are geographic areas of 50,000 or more people. Urban clusters are geographic areas of 2,500 to 50,000 people. Any area not categorized as an urban area or urban cluster is considered rural.[18]
  - Office of Management and Budget: Designates counties as metropolitan (metro), micropolitan (micro), or neither (as summarized in Table 3.[19]

Table 3. Office of Management and Budget's Definition of Rural

Area Description	Rural or Not Rural
Metro area (urban core of 50,000 or more people)	Not rural
Micro area (urban core of 10,000–49,999 people)	Rural
Counties outside metro or micro areas	Rural

  - Economic Research Service of the U.S. Department of Agriculture: Utilizes the U.S. Census Bureau's urban areas and urban clusters definitions with information on work commuting.[20]
- Has a population of less than 10,000 people and a population density below 500 people per square mile
- Has an acute care hospital in the town that meets the state hospital licensure definition of a small rural hospital, or is a certified Critical Access Hospital

Rural communities comprise 59 percent of the land area in the Commonwealth yet only 13 percent of the total statewide population.[21] There are 170 communities in Massachusetts that meet the state definition of rural and are primarily located in western and central Massachusetts, with additional clusters in the northeast, southeast and the Cape.

Rural areas in Massachusetts do not experience many of the same environmental challenges noted above for urban areas; however, they do still encounter other environmental challenges, such as a reduction in the supply of clean water, particularly for communities reliant on well water.[22] In addition, rural areas in Massachusetts often face financial challenges that negatively impact the learning environment and outcomes, such as:[23]

- Significant student enrollment decline, which contributes to:
  - Higher per-pupil operating costs
  - Substantially reduced course offerings, student support services, and extracurricular activities
- Locations farther away from economic opportunities concentrated in more populated areas of the Commonwealth, which contributes to:
  - An insufficient and stagnant tax base
  - A greater proportional share of local government budgets to fund school operating budgets

Regions Close to Industrial Activities

Across the United States, there are 12,000 schools located within a mile of a hazardous chemical facility.[24] In Boston, almost one in three public schools is located within one mile of such a facility.[25] Schools in close proximity to industrial activities and industrial and chemical waste sites may experience impaired indoor air quality via infiltration of outdoor air pollutants to the indoor environment through vents and open windows. Schools in these locations may also experience vapor intrusion, which is a chemical transport process by which vapor-forming chemicals migrate from a subsurface source into an overlying building.[26] Students and school personnel may also be exposed to outdoor air pollutants while outside the school. See the Mitigate Occurrences of Vapor Intrusion discussion and Objective 2a(7). Reduce Exposure to Outdoor Air Pollutants for additional details.

Massachusetts School Building Authority (MSBA)

In 2004, the State Legislature established the MSBA as a quasi-independent government authority to reform the process of funding capital improvement projects in public schools across the Commonwealth. The MSBA collaborates with municipalities and school districts to provide competitive grant funding to create safe and sustainable learning environments using right-sized, fiscally responsible, and educationally appropriate solutions.[27] A seven-member Board of Directors oversees the MSBA, and the State Treasurer serves as the MSBA's chair.

Source of MSBA Funding

The MSBA funds capital improvement projects in public schools across the Commonwealth using a dedicated revenue stream of one penny of the state's 6.25 percent sales tax, known as the School Modernization Trust Fund ("SMART Fund").

Proud History of Greening Schools in Massachusetts

As noted in the October 2023 Office of the Governor's *Recommendations of the Climate Chief*, Pursuant to Section 3(b) of Executive Order No. 604:

Since its formation, the MSBA has been an advocate of 'green' sustainable building design for all MSBA-funded public K-12 school buildings and has regularly adjusted its Green Program Policy since then to promote increasing levels of energy efficiency in school design… to decarbonize buildings. In the last ten years, 95 percent of the MSBA-funded schools have exceeded MSBA's base project requirements with one school achieving 'Platinum' in the U.S. Green Building Council's (USGBC's) Leadership in Energy and Environmental Design (LEED) certification program, 27 schools achieving LEED 'Gold,' and 47 schools achieving LEED 'Silver.' As of June 2023, the MSBA has funded 20 all-electric schools and 18 schools employing ground-source heat pumps.

The MSBA is required to perform periodic school surveys of all public elementary and secondary schools in the Commonwealth to observe and assess numerous key parameters, including building systems conditions, the general physical environment, and space utilization. The surveys provide important information that enables the MSBA to better understand the unique needs of individual schools and their respective school districts and assist the MSBA in providing equitable funding for school construction, renovation, and repair projects across the Commonwealth.[28] To date, the MSBA has completed three cycles of school surveys: in 2005, 2010, and 2016. The MSBA expects to complete its next survey and publish the accompanying report by the end of 2025.

The MSBA provides competitive grant funding through two main programs:

- **Core Program**: provides grant funding for new construction, additions, and major renovation projects
- **Accelerated Repair Program:** provides grant funding for buildings that need roof and/or window/door replacements but are otherwise structurally sound. Boiler replacements were last included for invitation in 2022. The MSBA is completing a study with a consultant in anticipation of adding heat pump conversions to the Accelerated Repair Program for existing buildings beginning in 2025.

To be considered for MSBA grant funding, school districts must submit a Statement of Interest (SOI) during the MSBA's established open submittal period each year. Following the closing of the SOI submittal period, MSBA staff conduct due diligence and recommend SOIs for the MSBA Board of Directors' review and approval of invitations into the grant program based on demonstrated need and urgency. Per legislative mandate,[29] the MSBA approves SOIs in accordance with the priority criteria established in MA General Law (M.G.L.) 70B, including but not limited to the eight priority criteria outlined in §8 (outlined in the following text).[30]

Priority Criteria for the Approval of MSBA-Funded Projects

- **Priority 1:** Priority shall be given to school projects needed in the judgment of said board to replace or renovate a building which is structurally unsound or otherwise in a condition seriously jeopardizing the health and safety of school children, where no alternative exists.
- **Priority 2:** Priority shall be given to school projects to eliminate existing severe overcrowding.
- **Priority 3:** Priority shall be given to school projects needed in the judgment of said authority to prevent loss of accreditation.
- **Priority 4:** Priority shall be given to school projects needed in the judgment of said authority to prevent severe overcrowding expected to result from increased enrollments which must be substantiated.
- **Priority 5:** Priority shall be given to projects needed in the judgment of said authority for the replacement, renovation, or modernization of the heating system in any schoolhouse to increase energy conservation and decrease energy related costs in said schoolhouse.
- **Priority 6:** Priority shall be given to any school project needed in the judgment of said authority for short-term enrollment growth.
- **Priority 7:** Priority shall be given to school projects needed in the judgment of said authority to replace or add to obsolete buildings in order to provide for a full range of programs consistent with state and approved local requirements.
- **Priority 8:** Priority shall be given to projects needed in the judgment of said authority to transition from court-ordered and authority approved racial balance school districts to walk-to, so-called, or other school districts.

Following the evaluation and approval of SOIs using the statutorily mandated priority criteria, the MSBA calculates the value of each grant. For grants approved through the Core Program, the MSBA determines the grant value by utilizing the reimbursement rate formula outlined in M.G.L., 70B, §10[30,31] (presented in Table 4).

Table 4. Components of Reimbursement Rate for Projects Funded Through the MSBA's Core Program

	Component	Description
	Base Rate (31 points)	Applied to all grants
+	Community Income Factor	District's per capita income as a percentage of statewide average per capita income
+	Community Property Wealth Factor	District's per capita equalized property valuations as a percentage of statewide average per capita valuations
+	Community Poverty Factor	District's proportion of low-income students (federal eligibility for free/reduced price lunch) as a percentage of the statewide average proportion of low-income students students
+	Incentive Points (if any)	Six categories of incentive percentage points possible: (1) Newly Formed Regional School District (up to 6 incentive percentage points) (2) Green School Program – Energy Efficiency (up to 3 incentive percentage points) (3) Green Schools Program – Indoor Air Quality (up to 1 incentive percentage point) (4) Best Practices for Routine and Capital Maintenance (up to 2 incentive percentage points) (5) Overlay Zoning (M.G.L. 40R or 40S) (up to 1.5 incentive percentage points) (6) Renovation/Re-use of Existing Facilities (up to 5 incentive percentage points)

= MSBA Reimbursement Rate (Percent of eligible costs)*
**No MSBA grant can exceed 80 percent of eligible costs.*

Acts of 2022, Chapter 179, Section 83

Chapter 179 of the Acts of 2022 is a comprehensive climate-focused bill that will help Massachusetts toward its goal of net zero greenhouse gas (GHG) emissions by 2050 via clean energy production, battery storage, and electrification of buildings and the transportation sector.[32] Section 83 specifically focuses on creating sustainable and healthy learning environments in public elementary and secondary schools across the Commonwealth. Section 83, in particular, requires two primary actions:

1. The MSBA is required to "conduct an assessment of elementary and secondary school buildings relative to energy efficiency, building conditions, safety, and public health" that includes "cataloging the age and condition of any building systems relying on the on-site combustion of fossil fuels. The assessment shall be conducted in coordination with ongoing assessments or surveys of the authority. The authority shall determine the means of conducting the assessment which may include a representative sample of schools. In planning said assessment, the authority shall consult with the department of public health, the department of elementary and secondary education and the department of energy resources."
2. DPH is required to draft and issue a report on "methods, best practices, and standards for achieving green and healthy schools strategies to for (sic) the students of the commonwealth" and include cost estimates for implementing its recommendations cost-effectively. The legislation provides DPH latitude to optionally include the following content as part of the report:
    a. Increasing energy efficiency
    b. Increasing electrification
    c. Shifting to fossil-free fuels
    d. Efficient use of resources (e.g., low-flow water fixtures)
    e. Improving water and air quality
    f. Improving ventilation and air circulation systems
    g. Maintaining thermal comfort, humidity, and temperature controls
    h. Recommendations to prioritize schools with the greatest needs
    i. Unique environmental differences of schools located in urban, industrial, rural, and other areas facing site challenges
    j. The need to address historical patterns of inequity in education and schools, including, but not limited to, patterns of inequity involving students in special education programs
    k. Other actions DPH may determine

The Critical Need for Green and Healthy Schools

The numerous methods and best practices for achieving green and healthy schools outlined in this report are interconnected and promote vibrant, just, inspiring, engaging, healthy, and high-performing schools and surrounding communities.[33] Many of the strategies for achieving green schools provide critical support to the Commonwealth's goal of net zero GHG emissions by 2050. Additionally, by applying an equity lens to the implementation of the strategies in this report, school districts can address disparities in the health and educational outcomes of students from underserved and marginalized communities that have resulted from historical structural racism.

While the path ahead is filled with opportunities, there are numerous challenges that school districts will likely face. There are many strategies that schools can implement with relatively low costs and human resource burdens. Many of the more impactful strategies, however, will require significant financial resources, technical expertise, and human resources to initiate, plan, implement, and sustain.

Purpose

DPH identified its Bureau of Climate and Environmental Health (BCEH) to lead the development of this report to respond to and comply with the requirements outlined in the Acts of 2022, Chapter 179, Section 83. In addition to responding to this legislative requirement, DPH also aims to use this report to provide actionable information for schools, school districts, municipalities, and other interested parties who share an interest in creating and fostering sustainable, healthy, and equitable learning environments for all students in the Commonwealth.

Scope

The scope of this report is "traditional" public elementary and secondary schools and attempts to cover the topics most relevant to the most significant portion of public elementary and secondary schools in the Commonwealth. This report does not provide methods, best practices, or standards tailored specifically to childcare/early education and care facilities (EECFs), regional vocational/technical/agricultural schools, or schools offering ancillary community services, each with additional unique considerations and challenges.

Methods

BCEH and its support contractor, Eastern Research Group, Inc. (ERG), conducted the following activities to compile the content included in this report:

- Conducted engagement with a broad technical working group comprised of staff from the following organizations and programs within DPH:
    - Bureau of Climate and Environmental Health
        - Environmental Epidemiology Program
        - Environmental Toxicology Program
        - Indoor Air Quality Program
    - Bureau of Community Health and Prevention
        - Asthma Prevention and Control
        - Occupational Health Surveillance Program
        - School Health Services
        - State Office of Rural Health

  - Bureau of Infectious Disease and Laboratory Sciences
  - Office of Local and Regional Health
  - Office of Health Equity
- Conducted focused engagement sessions with the following partner agencies to collect input about existing resources and additional thoughts and recommendations about content to include in the report:
  - Department of Energy Resources (DOER)
  - Department of Elementary and Secondary Education (DESE)
  - Department of Environmental Protection (MassDEP) – BCEH and ERG conducted numerous engagement sessions with MassDEP staff to talk more in-depth about the following topics:
    - Artificial turf fields/crumb rubber
    - Chemical spills
    - Lead in drinking water
    - Solid waste management
    - Vapor intrusion
    - School bus idling and electrification
  - Massachusetts School Building Authority (MSBA)
- Participated in the following virtual public forums:
  - White House Summit for Sustainable and Healthy Schools (April 26, 2024)[34]
  - Making the Honor Roll with K–12 Waste Reduction (May 29, 2024)[35]
  - Decarbonizing School Buildings—the Building Electrification Technology Roadmap (June 27, 2024)[36]
  - Overview of Massachusetts Clean Energy Center's Green School Works Program (July 17, 2024)[37]
- Performed additional desktop research to supplement information compiled from direct engagement sessions with DPH and staff from partner agencies.

Multiple best practices and recommendations in this report draw from DPH's 2022–2026 Strategic Plan for Asthma in Massachusetts. The 2022–2026 Strategic Plan for Asthma in Massachusetts is the result of a comprehensive planning process undertaken by DPH's APCP and MAAP in collaboration with asthma partners, stakeholders, and thought leaders across Massachusetts in the summer and fall of 2020. Extensive outreach efforts to existing and previously engaged partners, as well as targeted outreach and leveraging networks, resulted in the participation of a wide range of stakeholders across the state in the development of the strategic plan.

Organization of Report

Immediately following this introduction, the report presents information and details to help school districts and municipalities achieve green and healthy schools across three goal categories. Each goal category includes a set of specific objectives supporting the stated purpose of this report, as outlined in Table 5.

Table 5. Goal Areas and Objectives Covered in this Report

Goal 1: Achieve Green Schools
a. Decarbonize buildings
b. Optimize water efficiency
c. Optimize solid waste reduction and diversion
d. Electrify school bus fleets
e. Provide electric vehicle charging stations for school staff and public use
f. Enhance climate resilience
Goal 2: Achieve Healthy Schools
a. Improve air quality
1. Reduce airborne transmission of disease
2. Prevent exposure to asbestos
3. Reduce exposure to carbon monoxide
4. Reduce exposure to mold and moisture
5. Reduce exposure to polychlorinated biphenyls (PCBs)
6. Reduce exposure to radon
7. Reduce exposure to outdoor air pollution
b. Improve water quality
1. Reduce exposure to lead in drinking water
2. Reduce exposure to PFAS in drinking water
c. Maintain thermal comfort
d. Use integrated pest management
e. Procure and use green cleaning supplies and chemicals
f. Reduce exposure to hazardous substances
1. Reduce exposure to lead in paint and soil
2. Reduce exposure to mercury
g. Safely procure, use, and dispose of crumb rubber
h. Create a safe environment for students with life-threatening food allergies
i. Create a productive learning environment for all students
1. Optimize lighting
2. Optimize acoustic performance
j. Design the built environment to foster a peaceful school community
Goal 3: Achieve Equitable Outcomes for All Students
a. Optimize space to equitably meet special education needs
b. Prioritize universal accessibility
c. Use available data to identify and equitably prioritize schools of greatest need and advocate for additional funding opportunities

Because of the significant breadth and scope of the report and the potential need for either a high-level or more in-depth understanding of the goal areas, objectives, co-benefits, and potential disadvantages of approaches needed, the report is divided into two distinct modules:

Module 1: High-Level Overview of Methods and Best Practices includes a discrete section for each paired goal and objective (Sections II-IV) that includes the following content:

- Background information to provide helpful context
- A high-level tabular summary of methods and best practices for achieving the paired goal and objective that includes the following information for each method and best practice:
    - *Capital cost* – This cost category covers an estimated range of costs for tangible goods or services expected to have lasting benefits. Objective 1a. Decarbonize Buildings uses a different range of costs, as compared to other report sections, because of the higher capital intensity of project types.
    - *Operating cost* – This cost category covers an estimated range of the costs a school can expect to outlay on a recurring basis to keep baseline operations running smoothly; note that negative costs (presented in green and with a negative sign) suggest a measure will likely contribute to reduced operating costs.
    - *Implementation timeframe* – This represents an estimate of the duration over which a school will likely need to complete implementation.
    - *Ease of implementation* – This represents the relative ease for a school to complete implementation.
- Discussion of notable barriers and challenges that schools are likely to face in implementing the suggested methods and best practices

Given the variability and uncertainty related to the cost of goods and construction, the persistence of tax credits/rebates, and the range of possible implementation scenarios across schools, this report does not include precise cost estimates. Rather, this report communicates projected cost estimates for implementing recommendations by presenting a ***range of estimated costs*** for each method and best practice, split into capital costs and operating costs.

Section V provides a high-level overview of possible funding strategies that school districts can consider for implementing the outlined methods and best practices.

Module 2: In-Depth Discussion of Methods, Best Practices, Statutes, Regulations, Standards, and Relevant Resources includes the following three in-depth sections that provide additional detail to supplement the content outlined in Module 1:

- Section VI: Additional details related to Goal 1: Achieve Green Schools:
  - Detailed descriptions of the methods and best practices included in the tabular summary in Section II
  - A narrative and tabular summary of relevant state and federal statutes and regulations and standards
  - A tabular summary of relevant resources
- Section VII: Additional details related to Goal 2: Achieve Healthy Schools:
  - Detailed descriptions of the methods and best practices that are included in the tabular summary in Section III
  - A narrative and tabular summary of relevant state and federal statutes, regulations, and standards
  - A tabular summary of relevant resources
- Section VIII: Additional details related to Goal 3: Achieve Equitable Outcomes for All Students:
  - Detailed descriptions of the methods and best practices included in the tabular summary in Section IV
  - A narrative and tabular summary of relevant state and federal statutes, regulations, and standards
  - A tabular summary of relevant resources

> Sections VI through VIII in Module 2 present state statutes, regulations, and standards before federal statutes, regulations, and standards. The report does not include details of municipal statutes, regulations, bylaws, or ordinances. Readers are encouraged to separately identify and review their respective local statutory/regulatory requirements.

Lastly, Appendix A presents the full list of references cited throughout the document.

This report outlines best practices to help Massachusetts schools incorporate sustainable design, construction, and operations and provide a healthy learning environment for all students. Implementing these best practices requires financial and human resources. While many can be implemented at low cost, others require large capital improvement projects and significant funding and human resources to champion, initiate, plan, and manage. School districts might require resources for comprehensive, professional environmental building assessments and capital improvement projects for heating, ventilation, and air conditioning (HVAC) systems, workforce development, health equity data reviews, technical assistance to prepare grant requests or SOIs for MSBA funding, hazard removal, building envelope/window repairs, vehicle electrification, installation of green technology, and other building energy efficiency improvements. Similarly, cities and towns may benefit from outdoor air quality monitoring to determine how to improve indoor air quality in schools and the health of staff and students in those buildings.

Co-benefits and Disbenefits

There are numerous cross-cutting methods and best practices presented throughout this report that not only address a primary goal area and/or objective, but also produce positive outcomes, or co-benefits, in one or more other goal areas and/or objectives. One example that this report frequently highlights is the ability of optimized HVAC systems to produce both green and healthy co-benefits related to building energy efficiency, enhanced climate resilience, and improved indoor air quality—including helping to mitigate exposure to radon, PCBs, carbon monoxide, and mold.

Conversely, there are also some methods and best practices (often those that are more "short-term" in nature) that produce disbenefits. That is, they mitigate concerns in one goal area and/or objective, but further exacerbate concerns in one or more goal area and/or objective. For example, short-term increases in ventilation rates to improve indoor air quality can increase facility energy consumption and associated GHG emissions.

Local Public Health Departments as Partners

Local and regional public health departments are essential partners to school districts wishing to implement the strategies outlined in this report, including addressing health equity, identifying environmental justice concerns, reviewing possible sites for new buildings, and providing health data for local funding requests.

Local public health officials should be at the table for local policy changes and to support the school district in prioritizing buildings to meet equity goals by collaboration on data analysis and community outreach.

Module 1: High-Level Overview of Methods and Best Practices

II. Goal 1: Achieve Green Schools

East Veterans Elementary School, Gloucester, MA. Photo courtesy of the MSBA.

> This report prioritizes Massachusetts- and school-specific standards where they are available, while also acknowledging widely used national standards.

Designing, constructing, and operating green schools has long been a goal of school district and municipal sustainability programs across the country, often defined by achieving formal LEED certification through USGBC, the Northeast Collaborative for High Performance Schools (NE-CHPS) verification, Green Ribbon Schools recognition from the U.S. Department of Education, or other metrics related to the design and operation of schools. More recently, the pursuit of green schools has included a prominent emphasis on building decarbonization—the process of reducing (or eliminating) GHG emissions associated with the construction and operation of buildings. Green schools also pursue goals and implement best practices related to water efficiency, solid waste diversion, electrification of school vehicle fleets, optimized climate resilience, and other operational areas.

Following teacher salaries, school utilities (i.e., energy and water) and services (e.g., waste management, transportation) represent some of the largest operating costs to school districts. Efficiency improvements in each of these areas can offer financial savings and help school districts meet their fiduciary duty while also offering numerous co-benefits to school district staff, the enrolled student body, and the surrounding community. School districts are increasingly considering and implementing strategies that address these areas so that schools can continue to operate reliably in the face of a changing climate.

This section presents a brief background, a tabular summary of the methods and best practices that can help school districts across the Commonwealth achieve green schools, and a brief discussion of notable barriers and challenges that schools are likely to face. Content is provided across the following six objectives:

a. Decarbonize buildings
b. Optimize water efficiency
c. Optimize solid waste reduction and diversion
d. Electrify school bus fleets
e. Provide electric vehicle charging stations for school staff and public use
f. Enhance climate resilience

Section VI provides a more detailed narrative description of the methods and best practices, details related to the relevant statutory/regulatory framework and notable standards, and relevant resources across each of the six objectives.

Objective 1a. Decarbonize Buildings

Background

Schools Represent Significant Opportunity for GHG Emissions Reductions

Massachusetts' approximately 1,800 schools emit approximately 880,000 metric tons of GHGs annually and will play a significant role in Massachusetts achieving the statewide goal of net zero GHG emissions by 2050.

Building decarbonization is the process of reducing or eliminating GHG emissions associated with the construction and operation of buildings (i.e., reducing both the "embodied" carbon of building materials and the "operational" carbon resulting from the routine operation of buildings). Defining the goal of decarbonizing buildings is important for establishing clear expectations for building design and performance. The Massachusetts specialized energy code defines net-zero buildings as those that are consistent with achieving the Commonwealth's 2050 net-zero emission goals; specifically, these buildings: (1) incorporate highly energy efficient design; (2) are all-electric (where fossil fuels are used, are fully pre-wired with sufficient electrical service for future electrification); and (3) generate solar power on-site.[38] This report considers net zero emissions (NZE) buildings to be those that meet the specialized energy code definition while also generating or procuring renewable electricity that produces zero GHG emissions.

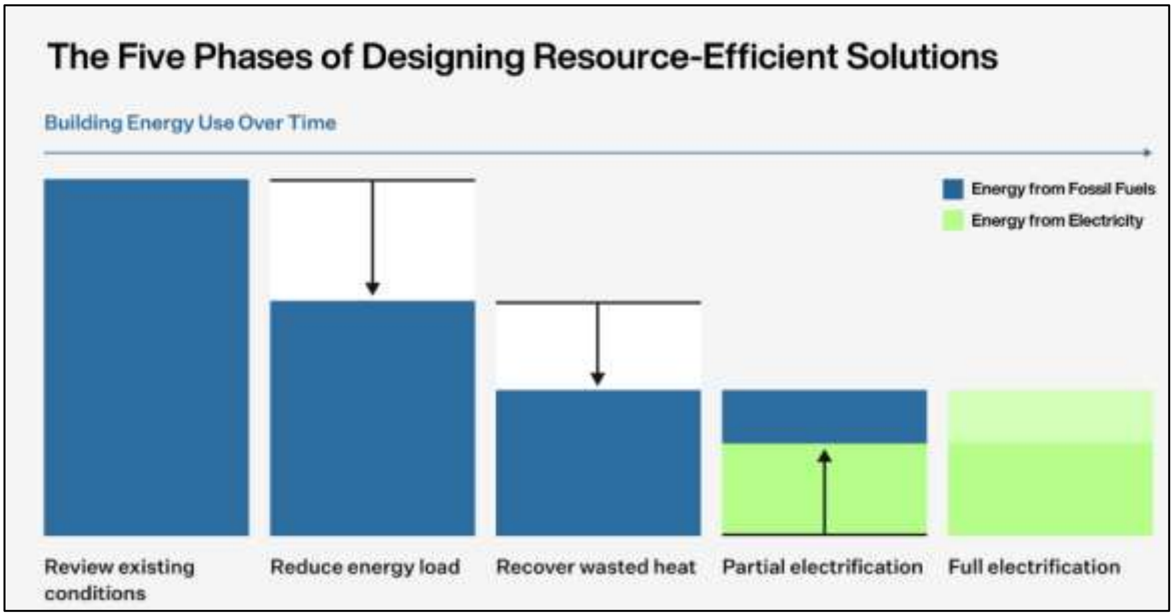
This report is tailored for a non-technical audience that is familiar with school facilities and may work with technical decarbonization experts at architectural and engineering (A/E) firms, HVAC vendors, maintenance contractors, or others. The following sections provide links to additional technical resources that can support project implementation.

Building decarbonization is one of the most impactful and cost-saving strategies to mitigate the drivers of climate change because buildings are a major source of GHG emissions. The Massachusetts Climate Report Card for 2020 found that the buildings sector contributed 35 percent of all GHG emissions,[39] the majority of which came from heating in buildings.[40]

While approximately 79 percent of Massachusetts households heat their homes using fossil fuels, the MSBA found during its 2016 School Survey that 97 percent of assessed school buildings relied on fossil fuel heating systems. With expectations for the Massachusetts government to lead by example[41] and nearly 300 municipalities across the Commonwealth designated as Green Communities by DOER, decarbonizing schools—which make up the largest portion of most municipal building footprints—is a natural point of focus for climate change mitigation. Projects to decarbonize school buildings also offer an opportunity to achieve several other health-related co-benefits, including improving air quality through optimized ventilation, improving occupant thermal comfort by adding air conditioning, and other benefits described in this section.

The pathway and process to decarbonizing school buildings will vary at the building and school district level depending on existing conditions, school program requirements, available funding, and various other infrastructural and operational factors described in this section. The core strategies for building decarbonization promoted by the Commonwealth of Massachusetts include: (1) electrifying non-electric energy uses; (2) decarbonizing the electric grid; and (3) reducing energy costs and the costs of transition by increasing the efficiency of transportation and energy systems.[40] Figure 2 depicts an example pathway for how this process can occur over time in existing school buildings.

Figure 2. Example Pathway to Decarbonizing School Buildings



Source: RMI [42]

For many school districts, funding pressures present a recurring challenge for basic operations; consequently, planning significant investments can feel daunting. Utility expenditures can, however, represent both a budget pressure and an opportunity for savings. After accounting for salaries, energy costs often represent a school's largest expense.[43] Reducing facility energy consumption also offers additional budget stability through reduced exposure to energy price volatility. Over time, realized energy cost savings can be redirected to other school district priorities.

Methods and Best Practices

There are a number of methods and best practices that have been implemented to successfully decarbonize schools across Massachusetts. These are organized in the following sections in order of implementation:

- Conduct analysis and planning
- Implement strategies to achieve energy efficiency and building decarbonization
- Operate and maintain schools
- Procure decarbonized electricity

Table 6 provides a summary of methods and best practices for decarbonizing schools. For each method and best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VI, Objective 1a for additional narrative descriptions of each of the methods and best practices.

Table 6. Methods and Best Practices for Decarbonizing Buildings

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
Conduct Analysis and Planning				
(1) Compile and analyze facility energy data	0	$	1	1
(2) Perform facility condition assessments and energy/emissions audits	0	$	2	2
(3) Prepare and routinely update an Emissions Reduction Plan	0	$	1	1
Implement Strategies to Achieve Energy Efficiency and Building Decarbonization				
(4) Implement NZE new construction and major modernization	$$$	-$$	3	3
(5) Implement deep energy retrofits	$$$	-$$	2	3
(6) Improve building envelopes	$$	-$	1	2
(7) Optimize and electrify component retrofits	$	0	1	2
(8) Electrify whole system retrofits	$$	0	2	3
(9) Electrify cafeteria kitchens	$$	0	1	2
Operate and Maintain Schools				
(10) Operate and maintain NZE schools	0	$$$	1	1
(11) Utilize building automation systems to optimize building performance and energy efficiency	0	$	1	1
(12) Establish and train an NZE workforce	0	$	2	1
Procure Decarbonized Electricity				
(13) Install and use onsite renewable energy systems	0-$$$[2]	$	2	2
(14) Procure bundled renewable electricity from the grid	0	$$	1	1

Key:
Capital Cost[3]: 0 = no cost; $ = low cost (<$300k), $$ = medium cost ($300k-5M), $$$ = high cost (>$5M)
Operating Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (<12 months); 2 = medium-term (1-3 years); 3 = long-term (>3 years)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement

Note: -$ (presented in green and with a negative sign) = Cost savings (a measure will likely contribute to reduced operating costs)

Barriers and Challenges

Barriers to decarbonizing buildings are listed below:

- Significant investments are required to make improvements to school infrastructure and augment operation and maintenance staffing. Future resource needs are compounded by current and historical inequities in school and community resources. Varying access to the financial and human resources required to do this work is likely to lead to further inequities between school districts.
- While there is a diverse array of commercially available technologies today, some space-constrained or urban sites may have fewer options and need to identify design alternatives as outlined in the component and whole system retrofit strategy sections.
- Staff that have a long track record of safe operations of boilers (high pressure, combustion steam vessels) will be required to become experts in the vapor compression refrigeration cycle used by all heat pump technologies and increasingly computerized operations. This transition will require significant training initiatives, technical assistance/support, updates to hiring practices, and in some cases major changes to operations and maintenance (O&M) programs.
- As with any retrofit project, there is an abatement risk that is not fully known before a complete assessment is conducted. Older buildings that are anchors of communities may also have legacy toxins (e.g., asbestos, PCBs) that require an unknown amount of expensive abatement to implement many of the projects described in this section. See Objective 2a. Improve Air Quality for additional details about reducing exposure to these toxins.

There are already a number of successful all-electric schools and net zero school projects across Massachusetts that can offer helpful case studies on how these challenges have been successfully addressed.

Objective 1b. Optimize Water Efficiency

Background

Even though 70 percent of the Earth is covered by water, only 1 percent is available for human use.[44] As the impacts of climate change increase, optimizing water efficiency is vital to managing intermittent and recurring drought conditions in Massachusetts and ensuring water supply for future generations. Optimizing water efficiency can also help

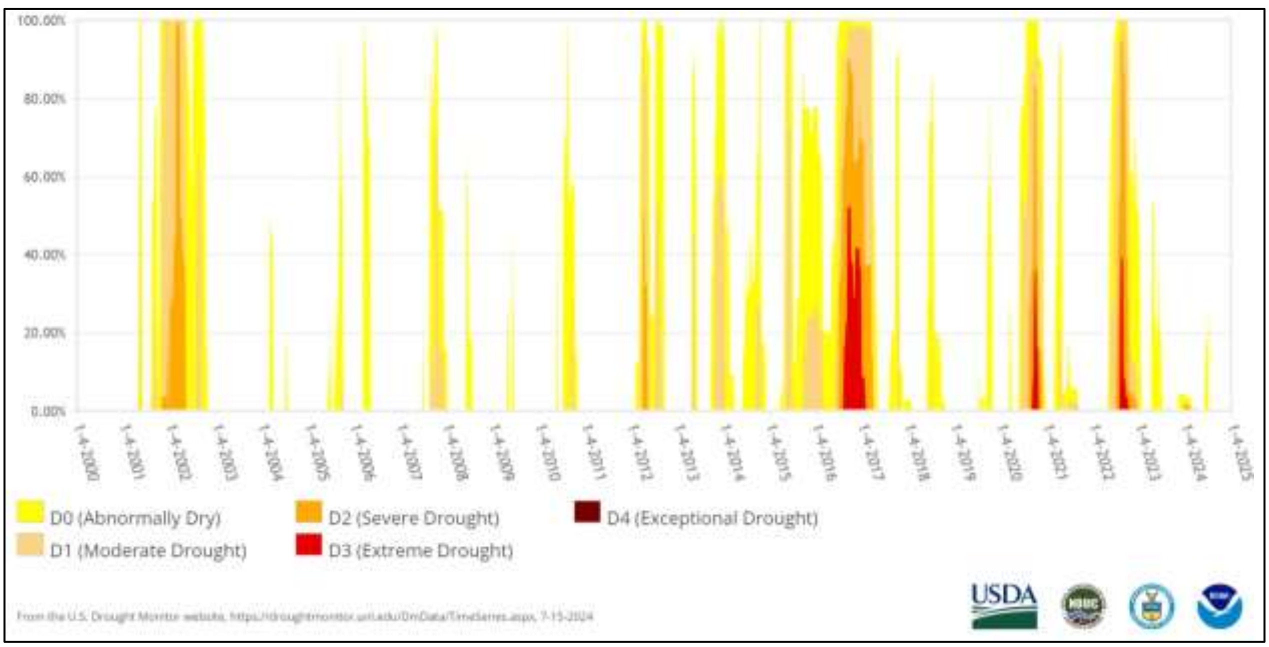
[2] The capital cost for installing onsite renewable energy systems will be highly dependent on the funding strategy(ies) used to implement the project. For example, if a school utilizes the Energy Management Services procurement method, the school could complete the project using no capital funding. See the Funding Strategies section for additional information about funding strategies for decarbonization project implementation.

[3] The cost estimate scale in this section differs from other sections due to the higher capital intensity of projects.

reduce the burden on aging infrastructure. Reduced demand for potable water, in turn, reduces the need for water extraction, pumping, treatment, and delivery by existing systems. In addition, since extracting, pumping, treating, and delivering water and treating wastewater also consumes energy, decreased potable water consumption also reduces energy use and associated GHG emissions.

In recent decades, Massachusetts has regularly experienced varying degrees of drought conditions, ranging from abnormal dryness to extreme drought, as illustrated in Figure 3.[45] Annual precipitation amounts in Massachusetts have been increasing in recent decades and are expected to continue to rise due to climate change.[46] However, according to the Massachusetts State Climate Summary 2022, scientists predict that precipitation events over this century will be fewer more extreme events rather than multiple smaller storms; extreme events often don't translate to groundwater replenishment or steady stream flows.[47] In addition, scientists predict that the expected warmer temperatures will increase evapotranspiration and decrease snowpack.[47] Scientists project these conditions, when combined, may increase Massachusetts' frequency and severity of droughts, prompting a need for optimizing water efficiency across the state.[46]

Figure 3. Massachusetts Percentage of Area in U.S. Drought Monitor Categories, 2000 to 2024



Source: U.S. Department of Agriculture, et al[45]

The Alliance for Water Efficiency's 2022 U.S. State Policy Scorecard for Water Efficiency and Sustainability evaluates and scores states by their adoption of policies and laws that advance water efficiency, conservation, and sustainability.[48] On the 2022 scorecard, Massachusetts scored the most points for incorporating water efficiency in plumbing fixture standards and codes and providing state funding for water efficiency programs; however, the Commonwealth scored low on water conservation planning and drought preparedness planning, among other things. If Massachusetts schools collectively increase their focus on optimizing water efficiency, they can help the state better prepare for drought and manage its water resources.

Schools use water in restrooms and cafeterias and can use water for building and process cooling, irrigation, pools, laundries, and laboratories. Methods and best practices to optimize water use overall and by specific end use are discussed in this section.

Methods and Best Practices

There are many methods and best practices for optimizing water efficiency in schools, including monitoring and managing water use, optimizing water efficiency of end uses and systems, and using alternative water sources. Table 7 summarizes methods and best practices for optimizing water efficiency in schools. For each method/best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VI, Objective 1b for additional narrative descriptions of each of the methods and best practices.

Table 7. Methods and Best Practices for Optimizing Water Efficiency

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
Monitor and Manage Water Use				
(1) Meter and track water use	0-$	0	1	1
(2) Benchmark water use	0-$	0	1	1
(3) Conduct water assessments	$	$	2	1
Optimize Water Efficiency of End Uses and Systems				
(4) Install WaterSense labeled, ENERGY STAR certified, and other high-efficiency products in restrooms and cafeterias	$-$$	-$	2	1
(5) Implement water-efficient operations, maintenance, and user education in restrooms and cafeterias	0-$	-$	1	1
(6) Eliminate irrigated non-functional turf and install water-efficient landscaping	$-$$	-$	3	3
(7) Optimize irrigation systems and install WaterSense labeled irrigation products	$-$$	-$	2	1
(8) Eliminate single-pass cooling	$-$$	-$	2	1
(9) Optimize cooling towers and steam boilers	$-$$	-$	1	1
(10) Optimize water efficiency of uncommon end uses, where applicable (pools, laundries, laboratories)	$-$$	-$	1-3	1
Use Alternative Water Sources				
(11) Use onsite alternative water sources for irrigation, cooling towers, and toilet and urinal flushing	$-$$$	-$	3	3

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement
Note: Negative costs (presented in green and with a negative sign) suggest a measure will likely contribute to reduced operating costs.

Note: -$ (presented in green and with a negative sign) = Cost savings (a measure will likely contribute to reduced operating costs)

Barriers and Challenges

The two primary barriers and challenges to optimizing water efficiency in schools are necessary funding and staff availability. Schools and school districts may not have funding for some of the larger-scale water efficiency projects identified in this section, but they may be able to implement the lower-cost projects more easily.

Some water efficiency methods and best practices require trained and knowledgeable staff. For example, facility water assessments and irrigation system audits require trained professionals to accurately and efficiently evaluate buildings and systems and identify efficiency opportunities. Some schools may not have the resources to hire these professionals and, further, do not have full-time facility management staff on site to do the work themselves. Where facility management staff are present, they can be trained on water-using systems and water efficiency to implement the methods and best practices to optimize water efficiency identified here.

Objective 1c. Optimize Solid Waste Reduction and Diversion

Background

Virtually all human activities, including the construction, day-to-day operation, and disposition of school facilities, generate some form of waste. Solid waste, also commonly referred to as “trash” or “garbage,” consists of both municipal solid waste (items that consumers dispose of after use, including food; organic materials; plastic, glass, and aluminum containers and consumer packaging; corrugated cardboard; furniture; electronics; and appliances)[49] and non-municipal solid waste, which includes construction and demolition debris.

Solid waste can have detrimental impacts on the environment. Municipal solid waste landfills utilized to dispose of solid waste release methane gas as organic waste decomposes. The release of this methane contributes to global climate change. Landfills represent the third largest source of human-related methane emissions in the United States.[50] Landfills also produce leachate, which forms when rainwater passes through waste materials in a landfill and leaches chemicals from the various materials. If not properly collected and treated, leachate can find its way into and contaminate groundwater.[51] An alternative to sending solid waste to landfills, waste incineration (also referred to as “energy recovery” or “waste-to-energy”) releases harmful pollutants such as particulate matter (PM), lead, mercury, per- and polyfluoroalkyl substances (PFAS), and dioxins, which enter the air, water, and food supply near waste incinerators.[52]

In 2022, Massachusetts disposed of 6 million tons of solid waste, of which 3.4 million tons were disposed of in-state (the remaining 2.6 tons were exported for disposal out-of-state).[53] Of the portion of solid waste disposed of in-state, nearly 86 percent of the Commonwealth’s solid waste is incinerated in waste-to-energy facilities, while the remaining 14 percent goes to landfills.[6] In 2020, the incineration and disposal of solid waste in landfills in Massachusetts generated 1.44 million metric tons of carbon dioxide equivalent (MMTCO$_2$e), representing 2.2 percent of Massachusetts’ gross GHG emissions in 2020.[54] In the Commonwealth’s 2030 Solid Waste Management Plan, MassDEP has established a goal of reducing annual solid waste disposal by 30 percent by 2030 and by 90 percent by 2050, relative to a 2018 baseline. MassDEP has identified food waste as the largest single material category found in the

Commonwealth's solid waste, representing the greatest opportunity for solid waste reduction.[55]

Methods and Best Practices

Table 8 summarizes methods and best practices for optimizing solid waste reduction and diversion in schools across two categories: reducing solid waste generation and effectively managing the solid waste that schools generate through routine operations. For each method/best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VI, Objective 1c for additional narrative descriptions of each of the methods and best practices.

Table 8. Methods and Best Practices for Optimizing Solid Waste Reduction and Diversion

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
Reduce Solid Waste Generation				
(1) Reduce cafeteria waste	$	$	1	1
(2) Educate staff and students to transform habits	0	$	2	2
(3) Institute item exchange opportunities	0	$	1	2
Effectively Manage Generated Solid Waste				
(4) Establish an electronic waste recycling plan for electronic learning tools	0	$	2	1
(5) Designate staff members and students to implement and manage implement waste programs	0	$$	2	3
(6) Collect divertible waste	$	$$	2	3
(7) Optimize bin location and labeling	$	$	1	1
(8) Process organic waste on site	$$	$	2	2
(9) Leave lawn clippings in place or compost	0	0	1	1
(10) Use smart waste monitoring technology	$	-$	1	1

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement
Note: Negative costs (presented in green and with a negative sign) suggest a measure will likely contribute to reduced operating costs.

Note: -$ (presented in green and with a negative sign) = Cost savings (a measure will likely contribute to reduced operating costs)

Barriers and Challenges

Schools face several challenges in pursuing zero-waste operations. Namely, many schools lack professional oversight over organics management. In this absence, students often volunteer to staff smaller-scale composting programs, which, while educational for the student, do not provide the long-term staffing that waste management requires. Schools may not have dedicated waste diversion professionals but rather depend on district or county-level support. Negotiations with janitorial or custodial unions are often cited as bottlenecks that derail progress toward implementing a compost program because janitors or custodians may view composting as an additional responsibility outside of their agreed responsibilities. Roles and responsibilities must be mutually agreeable, and an effectively implemented compost program should not require significant additional labor from janitorial or custodial staff since the total amount of waste produced does not change.

Zero-waste options are sometimes seen as being costly because of upfront capital costs or increased labor costs. However, savings from lower procurement costs, decreased hauling fees, and potential rebates or incentives can make zero-waste cost-saving.

Objective 1d. Electrify School Bus Fleets

Background

Historically, the most frequent passengers of school buses are students from Black households and low-income backgrounds.[56,57] While school buses provide a crucial service to families who may otherwise be unable to get their children to school due to working schedules or other circumstances, these vehicles are not without their drawbacks. Emissions from internal combustion engine (ICE) school buses have been linked to worsening air quality, increased GHG emissions, and adverse health effects.[58] Diesel exhaust, a known carcinogen, has been associated with respiratory illness, heart disease, and low attendance rates.[58,59] Furthermore, the passengers on school buses are children, who—along with those having pre-existing conditions—are most affected by diesel exhaust.[60] The negative effects of these fossil fuel-burning buses are experienced not only by the communities in which the buses operate but also by those students riding the bus, where a lack of ventilation often leads to high levels of pollution within the vehicle cabin.[61]

Electric school buses (ESBs) offer a zero-emission alternative to legacy ICE vehicles. These buses not only release zero direct emissions and have a smaller carbon footprint than traditional school buses but also generally have a lower total cost of ownership as compared to ICE school buses.[62] Despite a higher upfront price, owners of ESBs experience lifetime savings in lower fuel and mechanical costs.[63] These savings are realized in part because of the simplicity of an electric power train. While a traditional ICE vehicle can have more than 200 moving parts, an electric vehicle usually has only about 17.[64] With fewer parts at risk of failure, ESB owners find their vehicles spend less time undergoing maintenance. Additionally, it is less expensive (on average) to charge an ESB than it is to fully fuel an ICE vehicle. A study by school bus manufacturer Blue Bird found that while it costs 49 cents per mile to operate a diesel school bus, it only costs about 14 cents per mile to operate an electric school bus.[65] Estimates have determined that owners of electric school buses save around $100,000 throughout the vehicle's lifetime.[63]

Reports from ESB operators suggest that the vehicles are performing well. All ESBs have at least 100 miles of driving range per charge, and some buses can travel up to 210 miles on a single charge.[66] Drivers cite the vehicle's smooth handling and quiet operation as major benefits of the technology.[67] Some drivers even suggest that the reduced noise from the ESB's electric traction motor has had positive impacts on student behavior.[67]

A favorable policy environment has increased the presence of these vehicles on the road. A December 2023 estimate found that 8,570 ESBs are either on the road, on order, or have been awarded.[68] In addition, numerous states such as New York and California have passed mandates that all purchased or leased school buses be electric or zero-emission in the near future.[69,70] Momentum for similar legislation is growing within Massachusetts. In February 2024, electric school bus supporters delivered a letter signed by dozens of elected officials across the state to the Massachusetts governor calling for the funding of statewide ESB programs.[71] The Massachusetts Clean Energy Center has created the Accelerating Clean Transportation Program (ACT) as a way of addressing the increasing interest in electric school buses.[72] This program partners with recipients of federal funding to provide both technical and financial assistance to the ESB planning and deployment process. Additionally, DOER offers rebates for zero-emission trucks through the MA Offers Rebates for Electric Vehicles (MOR-EV) program.[73] This program includes rebates valued up to $90,000 for all-electric and hydrogen fuel cell school buses.[74]

Multi-State ZEV Task Force

The Commonwealth of Massachusetts is one of 19 jurisdictions that comprises the Multi-State Zero Emission Vehicle (ZEV) Task Force, which created a Multi-State Medium- and Heavy-Duty Zero Emission Vehicle Action Plan for the deployment of medium- and heavy duty electric vehicles (EVs). Among these recommendations are strategies to achieve 100 percent zero-emission school bus purchases and contracts by 2040.

Methods and Best Practices

Table 9 summarizes methods and best practices for electric school bus adoption in schools related to planning, acquisition, and operations. For each method/best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VI, Objective 1d for additional narrative descriptions of each of the methods and best practices.

Table 9. Methods and Best Practices for Electrifying School Bus Fleets

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
Planning Considerations				
(1) Engage with electrical utilities early and often	0	$	1	2
(2) Consider microgrids for charging	$$$	$	1	2
(3) Explore Vehicle-to-Grid/Vehicle-to Load (V2G/V2L) technology	$$$	$	2	3
Electric School Bus Acquisition				
(4) Leverage available funding programs	0	0	1	2
(5) Work with a local vehicle dealer	0	0	1	2
(6) Purchase vehicle warranties	$	$	2	1
Electric School Bus Operations				
(7) Deploy telematics	$	$	2	1
(8) Implement operator training	0	$	2-3	1

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement

Barriers and Challenges

One of the most frequent concerns for school bus operators is the effect that cold weather can have on vehicle performance. This concern is valid as the range of an electric school bus can decrease in cold temperatures as the vehicle pulls energy from the battery to heat the cabin and the vehicle battery itself.[75] Districts have reported a 10–15 percent decrease in battery capacity during winter months.[75] Studies of electric transit buses have reported a 33 percent decrease in range when temperatures dropped below 25˚ Fahrenheit (F).[76] Despite this, ESBs are present in cold weather climates. In fact, 49 states have electric school buses either operating or committed.[68] There are even electric school buses as far north as Alaska, where Tok Transportation has been successfully operating an ESB in temperatures as low as -40˚ F since 2019.[77] Some districts have gone as far as to say that they prefer their ESBs in the winter since they start more reliably and their comparatively heavier weight makes the vehicles more stable on icy roads.[78] To combat the decrease in the cold weather range, districts have installed auxiliary diesel heaters to warm the vehicle cabins. Other districts have found preconditioning, a process where the vehicle is warmed while still connected to the charger, a successful strategy to avoid losing battery capacity to cold weather.

Extreme heat can also affect the ESB battery range to a lesser extent. A study of electric transit buses determined that energy used by the vehicle's HVAC and ventilation reduced the vehicle's range.[79] While there isn't available data to quantify this loss for buses specifically, studies that have analyzed EVs generally found that when temperatures climb above 95˚ Fahrenheit, the range decreases by around 4 percent.[80] Similar strategies can be used to limit the effect of heat on the ESB range, such as preconditioning. Furthermore, some fleets find storing their vehicles and chargers in shaded or covered areas helpful in reducing range loss.

Some districts are hesitant to pursue ESBs due to range anxiety. Fears of electric buses losing power and needing to be towed while on routes have slowed the adoption of the technology. However, with careful planning, these scenarios can be avoided. All ESB models on the market can travel at least 100 miles on a single charge, and some models can travel 210 miles or more.[66] Districts that place ESBs on routes within their actual range or account for range loss by utilizing mid-day charging have found electric school buses to be a reliable alternative to ICE buses.[66]

The costs associated with ESBs are a common deterrent to the technology. The initial purchase price of an electric school bus can be about three times more expensive than an ICE bus, with some models going for as much as $400,000.[81] In addition, fleets that are just beginning their electrification journey can expect $10,000 to $30,000 in infrastructure expenses per bus.[82] While initial costs may be higher for an electric vehicle, ESB owners can expect to save $100,000 in lifetime fuel and maintenance costs.[63] Additionally, numerous tax credits and funding programs are offered by federal, state, and local governments, as well as electrical utilities. On average, this leads to ESBs having a lower total cost of ownership than ICE buses.[63]

Objective 1e. Provide Electric Vehicle Charging Stations for School Staff and Public Use

Background

The federal government has provided record funding for electric vehicle (EV) projects in recent years. The Bipartisan Infrastructure Law (2021) and the Inflation Reduction Act (2022) offer a combined $100 billion in EV project-eligible funding.[83] Generally, this funding has been met with enthusiasm as annual EV sales surpassed 1 million for the first time in 2023.[84] To support this influx of EVs on the road, robust EV charging infrastructure is needed. Research suggests that roughly 45 million EV charging stations will need to be operational by 2032, with a suggested 3.7 million Level 2 chargers at public locations and workplaces alone.[85]

The three most common EV charger levels are level 1, level 2, and direct current (DC) fast chargers. Level 1 and level 2 chargers deliver energy in an alternating current while DC fast chargers deliver energy in a direct current. Level 1 chargers are usually used for long charging sessions with light-duty vehicles (such as overnight charging). These chargers are commonly found in residential settings for personal use. Level 2 chargers, in turn, can charge a light-duty vehicle in 4 to 10 hours and a heavy-duty vehicle (such as an ESB) in 6 to 11 hours.[86,87] These chargers may be more common in shared residential spaces, workplaces, or facilities housing EV fleets. Finally, DC fast chargers offer the ability to charge a light-duty EV in 20 minutes to an hour and a heavy-duty vehicle in 1 hour to 4.5 hours.[86,88] These chargers are most common along major roadways or with EV fleets.

Making electric vehicle supply equipment (EVSE) accessible in school parking lots for use by staff and the public presents opportunities to expand EV utilization, reduce local air pollution, and potentially create revenue for school districts. School districts that install EVSE will need to establish policies regarding permissible users of the charging stations.

Some schools choose to allow only district fleet vehicles to access charging stations. The benefit of this approach is that chargers are available when needed and are properly maintained. Additionally, there would likely be no need to have payment systems installed in the chargers; a digital key can be issued to eligible vehicles that will allow them to access the charger while preventing unauthorized users.

Other schools prefer to allow their staff to access the chargers to charge their personally owned vehicles. Doing so helps incentivize the staff to adopt EVs. Additionally, the inclusion or exclusion of payment systems can make the chargers either a revenue creator for the school or a free perk for district employees.

Finally, some districts may choose to make the chargers accessible to the general public. Doing so presents the opportunity to create revenue through payment systems and incentivizes the presence of EVs on campus.

As EVs become more common near schools, there will likely be local air quality improvements. According to the U.S. Environmental Protection Agency (EPA), vehicle emissions have been linked to certain cancers, as well as "neurological, cardiovascular, respiratory, reproductive and/or immune system damage."[89]

Recognizing the benefits of EVSE at workplaces, the Massachusetts government has offered numerous incentive programs to encourage their deployment. Most of these funding opportunities are offered through the Massachusetts Electric Vehicle Incentive Program (MassEVIP). The following are recent MassEVIP opportunities that school districts might qualify for:

- MassEVIP Public Access Charging
- MassEVIP Multi-Unit Dwelling & Educational Campus Charging
- MassEVIP Workplace and Fleet Charging Program Requirements
- MassEVIP Direct Current Fast Charging

These programs offer various funding amounts and have different eligibility requirements. Prior to applying to any program, it is important that projects meet all eligibility requirements.

Methods and Best Practices

Table 10 summarizes methods and best practices for EV charger installation in schools related to planning, acquisition, and operations. For each method/best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VI, Objective 1e for additional narrative descriptions of each of the methods and best practices.

Table 10. Methods and Best Practices for Providing Electric Vehicle Charging Stations for School Staff and Public Use

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
Planning Considerations				
(1) Engage with the utility provider early and often	0	$	1	2
(2) Confirm the onboard charger capacity of fleet vehicles	0	0	1	2
(3) Determine the charger rating needs of vehicles	0	0	1	2
(4) Explore V2G/V2L technology	$$$	$	2	3
(5) Utilize networked and managed charging	$$	$	1	2
(6) Evaluate parking locations of EVs	0	0	1	1
(7) Explore potential liability concerns	0	$	3	3
Acquisition and Installation				
(8) Leverage available funding programs	0	0	1	2
(9) Plan for long lead times	0	0	1	1
(10) Deploy charger retractors	$	$	2	1
(11) Purchase charger warranties	$	$	2	1
Operations and Maintenance				
(12) Develop a maintenance plan	0	$	1	2
(13) Create expectations for charger use etiquette	0	0	3	2

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement

Barriers and Challenges

When procuring new EVSE, an important first step in the commissioning process is testing the compatibility of an EV and the charger together. If the technologies have an issue, the fix can require a range of actions. The resolution could involve quick on-site adjustments or could require sending the charger back to the original equipment manufacturer (OEM) for a repair. To avoid this scenario, schools should consult the OEM of the charger and the OEM of the primary vehicle it will be charging (if applicable) to ensure compatibility.

Depending on the charger type, EVSE can have a high upfront cost. While there are grant programs to help defray these costs, not every school district may qualify. In particular, DC fast chargers can be expensive from both an acquisition and operational standpoint. To address this, some EVSE owners choose to install payment platforms on their chargers as a means of collecting revenue to help offset operational costs. This may be a suitable strategy for reducing some of the upfront cost barriers.

A common concern for EVSE owners is how their monthly energy bill will be impacted by vehicle charging. This is an especially important consideration for districts that plan to charge vehicles during peak energy demand hours when many utilities will use dynamic pricing and increase the rate at which they are charging for electricity. While peak electrical demand hours will vary by location, the grid is typically the busiest anywhere from 9 a.m. to 9 p.m.[90] Many school districts have found managed charging to be a helpful strategy to reduce the impact of vehicle charging on monthly utility expenditures. This technology allows vehicle owners to schedule their vehicle charging sessions to occur at times when electricity is comparatively cheaper, such as in the middle of the night. While managed charging is not a feasible solution for every district (such as those that need to utilize mid-day charging), it can help minimize charging costs when implemented.

Because EVSE is high-voltage equipment, some charger owners run into issues finding electricians who are certified to service them. Many EVSE funding programs require that electricians performing work on chargers purchased with grant funding be certified through the EVITP. Because this is a newer certification, many electricians may not yet be certified to work on EV charging stations. Service contracts and warranties can help connect EVSE owners to qualified technicians.

EV chargers that are left exposed in winter conditions may experience issues such as the charger handle freezing to the charger body or a vehicle. The process of removing a frozen charger handle can be difficult and time consuming. Districts in especially cold weather climates should consider installing EVSE in covered areas.

Another concern for EVSE located in public areas is vandalism. The vandalism of EV charging stations can include anything from graffiti, the theft of charger cables (likely for the copper inside), or purposefully short-circuiting the charger.[91] There can also be issues with users not treating the equipment well, such as someone who charges their vehicle but then leaves the cord on the ground when they leave. Solutions to curbing vandalism include protecting chargers behind cages and the use of retractable cables, bollards, and security cameras.[92]

Objective 1f. Enhance Climate Resilience

Background

Resilience refers to "the capacity of individuals, communities, businesses, institutions, and governments to adapt to changing conditions and prepare for, withstand, and rapidly recover from disruptions to everyday life, such as hazard events."[93] Nationwide, schools are faced with increases in lost learning time from closures due to extreme heat, wildfires, flooding, and other extreme weather events that are exacerbated by climate change.[94] Aging facilities and infrastructure, building conditions, and lack of sufficient long-term maintenance and investments have forced school districts to make difficult decisions regarding learning disruption to protect students and staff from unhealthy conditions related to hazards. In addition to providing critical education facilities, schools serve the broader community in times of need as emergency shelters, food and aid distribution sites, cooling centers, and resilience hubs. These roles servicing the broader community require close coordination between schools and local municipal programs working on climate resilience. To reduce educational disruptions associated with natural hazards, an increasing number of school districts have passed climate resilience resolutions to encourage comprehensive planning and associated infrastructure improvements.

ResilientMass is the statewide initiative led by the Massachusetts Emergency Management Agency (MEMA) in conjunction with EEA; it covers resilience and climate adaptation programs, policies, and initiatives. BCEH provided data metrics on negative health impacts associated with climate change to inform and coordinate DPH's support for this initiative. The ResilientMass Plan is an integrated and comprehensive climate adaptation and hazard mitigation plan that includes a risk assessment of the vulnerability of people, infrastructure, natural resources, economy, and governance to climate change impacts throughout the Commonwealth. In response to vulnerabilities, the ResilientMass Plan identifies actions, adaptation, and hazard mitigation strategies to protect the most vulnerable populations from the impacts of climate change. The Commonwealth has had great success with implementing climate adaptation actions at the local level through the Municipal Vulnerability Preparedness (MVP) Program, which provides grant funding and climate adaptation planning resources to communities.

Impacts to Schools Noted in the 2022 Massachusetts Climate Change Assessment

1. Missed school days (and missed work for caretakers)
2. Early closures due to extreme heat
3. Decreased test performance due to extreme heat
4. Shifting enrollment from climate migration
5. Budget pressures from climate hazard damage

Figure 4 presents a framework from the ResilientMass Plan for ranking the magnitude of consequences for various hazards as informed by the risk assessment. While this framework is a helpful reference at the statewide level, individual school districts and schools may face hazards at differing magnitudes of consequences depending upon their geographic location and adaptation capacity and, thus, are encouraged to evaluate risk at the local or facility level using the methods described below. At a minimum, the hazards associated with extreme heat should be a priority consideration for planning purposes. The 2022 Massachusetts Climate Change Assessment notes that researchers estimated that "at least 40 percent and as much as 100 percent of classrooms in Massachusetts counties lack air conditioning, compared to 0 to 20 percent of classrooms in southeastern U.S. states that are better adapted to extreme heat." These same researchers estimated that—on a national scale—each 1ºF increase in school year temperature without air conditioning reduced the amount learned that year by one percent, as measured by test performance.[22]

Figure 4. Ranking the Magnitude of Consequences from Climate Hazards

	Human	*Economic*	*Natural Environment*
Average/Extreme Temperatures	Very high	Medium	Very high
Changes in Groundwater	High	Medium	High
Coastal Erosion	High	Medium	High
Coastal Flooding	High	High	High
Drought	High	High	High
Earthquakes	High	Medium	Low
Flooding from Precipitation	Very high	High	Medium
- *Dam Overtopping*	High	Medium	Low
Hurricanes/Tropical Cyclones	Very high	High	Medium
Invasive Species	Medium	High	Very high
Landslides/Mudflows	High	Low	Medium
Other Severe Weather	High	Low	Low
Severe Winter Storms	Very high	Low	Low
Tornadoes	High	Medium	Medium
Tsunamis	Very high	High	Very high
Wildfires	High	Medium	Medium

Source: ResilientMass Plan (Table 5.1-4)

Methods and Best Practices

School districts can build on state-level efforts presented in the ResilientMass Plan by conducting planning activities and implementing school-level resilience projects by using the methods and best practices described in Table 11. For each method/best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VI, Objective 1f for additional narrative descriptions of each of the methods and best practices.

Table 11. Methods and Best Practices for Enhancing Climate Resilience in Schools

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
(1) Conduct vulnerability assessments	0	$$	1	1
(2) Prepare a comprehensive climate action plan	0	$$	2	1
(3) Incorporate resilience into new construction and modernization projects	$$$	-$$	3	2
(4) Implement retrofit projects targeting resilience	$$$	-$$	2	3
(5) Perform resilient O&M	0	$	2	2

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement

Note: -$ (presented in green and with a negative sign) = Cost savings (a measure will likely contribute to reduced operating costs)

Barriers and Challenges

While larger school districts may have the capacity to perform vulnerability assessments and develop climate action plans, smaller school districts may be more resource-constrained. Where planning efforts do move forward, this can lead to a more limited engagement process with environmental justice and other priority populations, which can have disproportional negative impacts on these underserved communities.[95] In the absence of planning, school districts may only begin to consider implementing resilience strategies after a hazard event damages assets or otherwise disrupts school operations, as opposed to proactively developing plans and strategies to mitigate impacts from hazards. Some projects described in this section have significant capital costs and may not result in operating cost savings, hampering the ability to use some alternative financing options such as Energy Management Services (EMS. This can make the upfront investment challenging, even while school districts may recognize the potential for avoided costs from a partial or total loss of assets or operational disruptions.

Assessing the exposure to certain hazards can also be challenging due to limitations in available data. As an example, the Metropolitan Area Planning Council (MAPC) released a report analyzing data on the 2010 flood event in the Greater Boston area and found that the Federal Emergency Management Agency (FEMA) Flood Maps did not reflect where stormwater flooding occurred during the event.[96]

III. Goal 2: Achieve Healthy Schools

Children, teachers, and other school staff spend approximately 1,000 hours inside schools each year and possibly more for extracurricular activities. Children are exposed to building conditions—both healthful and hazardous—for much of their lives and are biologically more susceptible to certain environmental hazards than adults because of their smaller size and developmental stage. Many students also have asthma, which increases their susceptibility to respiratory irritants. During the 2022–2023 school year, **9.9 percent of all enrolled students** in Massachusetts had confirmed instances of asthma.[97] Given children's constant exposure to school buildings and their susceptibility, achieving a healthy school free of hazardous substances and with clean air and water is essential.

New buildings are not always free from environmental hazards. In recent years, newer environmental health concerns have arisen in schools, such as exposure to airborne infectious diseases and possible exposures from the use of artificial turf fields. Not only should schools be free from hazards, but schools should also strive for proactively healthy environments, which includes maintaining a comfortable learning environment and properly designing spaces. Both existing and future buildings can be retrofitted or designed to achieve a healthy and productive learning environment for all.

This section presents a tabular summary of the methods and best practices that can help school districts across the Commonwealth achieve healthy schools and a brief discussion of notable barriers and challenges that schools are likely to face. Content is provided across the following 10 objectives:

a. Improve air quality
b. Improve water quality
c. Maintain thermal comfort
d. Use integrated pest management
e. Procure and use green cleaning supplies/chemicals
f. Minimize exposure to hazardous substances
g. Safely procure, use, and dispose of crumb rubber
h. Create a safe environment for students with life-threatening food allergies
i. Create a productive learning environment for all students
j. Design the Built Environment to Foster a Peaceful School Community

Local Public Health Departments

Local and regional public health departments are essential partners to school districts wishing to implement the strategies outlined in this report, including addressing health equity, identifying environmental justice concerns, reviewing possible sites for new buildings, and providing health data for local funding requests.

Local public health officials should be at the table for local policy changes and to support the school district in prioritizing buildings to meet equity goals by collaboration on data analysis and community outreach.

Section VII provides a more detailed narrative description of the methods and best practices, details related to the relevant statutory/regulatory framework and notable standards, and relevant resources across each of the 10 objectives.

Objective 2a. Improve Air Quality

Improving air quality is a key aspect of achieving a healthy school. Exposure to many environmental hazards occurs through the air, and children breathe more air relative to their size than adults. This section presents background information and a high-level summary of methods and best practices for mitigating the following seven indoor air quality exposure hazards:

1. Airborne transmission of disease
2. Asbestos
3. Carbon monoxide
4. Mold and moisture
5. PCBs
6. Radon

7. Outdoor air pollutants

Addressing this range of airborne hazards can help improve air quality in schools and reduce acute and chronic illnesses among children and school staff.

2a(1) Reduce Airborne Transmission of Disease

Background

Infections can spread in schools through numerous pathways, such as physical contact, touching shared objects, or breathing air with infectious particles.[98] While different diseases are spread by different transmission pathways, this section focuses on reducing transmission of diseases that can spread via airborne transmission. SARS-CoV-2 (which causes COVID-19), influenza viruses, and respiratory syncytial virus are some of the major pathogens that spread in schools through airborne transmission. Reducing airborne transmission of disease can reduce illness among students and staff, as well as illness-related absenteeism.[98]

Methods and Best Practices

The first category of recommendations are practices that schools can use in their daily operations to reduce the airborne transmission of disease. The second category is steps for when an individual is sick or when rates of disease are high in a school community. Table 12 summarizes the methods and best practices for reducing airborne transmission of disease/illness in schools. For each method and best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VII, Objective 2a(1) for additional narrative descriptions of each of the methods and best practices.

Table 12. Methods and Best Practices for Reducing Airborne Transmission of Respiratory Disease/Illness

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
In Everyday Operations				
(1) Increase ventilation to bring more outdoor air to indoor spaces	0	$	1	1
(2) Filter indoor air	$	$	1	2
(3) Move large gatherings to outdoor spaces	0	0	1	2
(4) Teach and reinforce respiratory etiquette	0	0	1	1
During Times of Illness				
(5) Encourage students and staff to stay home when sick	0	0	1	1
(6) Take additional steps to minimize transmission during times of elevated rates of illness	$	$	3	2

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement

Barriers and Challenges

One major barrier to reducing airborne transmission of infectious diseases through ventilation and air filtration is the costs associated with updating many school ventilation systems and purchasing and maintaining portable air filters. While lower in cost, moving large events outdoors can create a logistical challenge, depending on the space available at a given school, and the feasibility of outdoor events may not be possible due to weather, particularly in the winter when rates of respiratory infections are generally highest. Another challenge may be implementing more rigorous infection control measures during outbreaks or epidemics. For example, very young children often have difficulty wearing masks properly, and modifying class size, establishing cohorts, or changing schedules may be constrained by the size of school buildings.

2a(2) Prevent Exposure to Asbestos

Background

Asbestos is a group of naturally occurring minerals. Historically, asbestos was used extensively in diverse products due to its strength, flexibility, and resistance to heat and chemicals. Asbestos-containing material (ACM) can be found in most primary, secondary, and charter schools, with building materials and insulation often being the most common ACMs.[99,100] Building materials are considered ACMs if they are made of over 1 percent asbestos.[100] When ACMs deteriorate over time or are disturbed, they can release asbestos fibers, which can stay suspended in the air for hours or even days, posing an exposure risk.[99–101] Exposure to asbestos fibers can cause serious health problems, including lung cancer, mesothelioma, and asbestosis.[99,101] Generally, materials containing asbestos do not pose a health risk if they are maintained intact and undisturbed.[101]

Methods and Best Practices

Table 13 summarizes the methods and best practices for preventing asbestos exposure in schools across three areas: preparation; continual monitoring and exposure mitigation; and exposure mitigation during renovations or abatement. For each method and best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VII, Objective 2a(2) for additional narrative descriptions of each of the methods and best practices.

Table 13. Methods and Best Practices for Preventing Exposure to Asbestos

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
Preparation (Education and Planning)				
(1) Develop an Asbestos Management Plan (AMP) in accordance with the Asbestos Hazard Emergency Response Act (AHERA)	$	0	1	1
(2) Provide easy access to training for the effective implementation of the AMP	$	0	1	1
Continual Monitoring and Exposure Mitigation				
(3) Inspect schools for asbestos every one to three years	0	$	1	1
(4) Label all ACM	0	$	1	1
(5) Train staff to report any asbestos exposure risks to the building administrator	0	$	1	1
(6) Conduct asbestos response actions to reduce exposure risk in accordance with AHERA	0	$	1	1
Exposure Mitigation During Renovations				
(7) Minimize disturbance of ACM during renovations or conduct appropriate abatement actions	0	0	1	2
(8) Schedule renovations or asbestos abatement activities when students and staff are not in the building	0	0	1	1
(9) Confirm safe air quality sampling results prior to allowing students and staff to return to the building	$	0	1	1

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement

Barriers and Challenges

Challenges to asbestos abatement can be both financial and logistical. Schools often lack funding to inspect for, test, and remove ACM.[102] Asbestos abatement can be disruptive to normal school activities since asbestos must be removed by professionals and must comply with safety measures required by state and federal regulations.[102]

Considerations for Renovations

Massachusetts has many older school buildings that periodically need renovations to maintain functionality. Older buildings are also likely to have harmful substances contained within legacy building materials, such as asbestos, PCBs, lead, and mercury. In addition, mold may be revealed by renovation projects, and renovations that change air flow or the building envelope may impact radon levels. Many of these materials only become a health risk when they are disturbed, which includes renovation projects. When disturbed, these substances can become airborne and accumulate in dust. Without proper renovation controls, school occupants can become exposed to these materials through inhalation and ingestion pathways.

There are several steps that schools can take to mitigate these risks:

1. Schools should create and maintain an inventory of materials that contain asbestos, PCBs, lead, and mercury along with where they are found within the school.
2. Do not disturb any of these materials unnecessarily. Many building components which contain these chemicals only become dangerous to health when they are exposed or moved. For example, building occupants will not be exposed to asbestos within insulation until a wall is opened and the insulation is disturbed.
3. Use the inventory of materials to routinely check to make sure that building components containing these materials are in good condition. If they need repair, it is more likely that these substances will be released into the environment. If building components need repair, plan to do so with the proper controls in place.
4. When renovating, consider the risks of disrupting any of these materials before starting the project. Plan to implement mitigation strategies to protect building occupants. Mitigation strategies are specific to the contaminant of concern, but cordoning off the area under renovation, keeping renovation areas clean, and planning renovation projects for times when the building has fewer occupants (i.e., summer) are good practices.
5. Before a renovation project starts, create a communication plan for informing staff, parents, students, and other involved community members. The plan should provide details about the extent of the health risks posed by the project, as well as an outline of the mitigation procedures that will be used to protect those on the school campus. The communication plan should also include contact information and can direct interested parties to further resources explaining the risk posed by legacy building materials.

2a(3) Reduce Exposure to Carbon Monoxide

Background

Carbon monoxide is a colorless, odorless, tasteless gas that can be deadly at high concentrations. Exposure to carbon monoxide can also produce symptoms such as headache, nausea, dizziness, confusion, fainting, and unconsciousness, or can mimic flu symptoms.[103] Carbon monoxide is one of the leading causes of poisoning deaths in the United States.[103] It is produced through incomplete combustion of fuels such as gas, oil, kerosene, or wood. Older or poorly maintained combustion-based appliances are more likely to produce excess carbon monoxide. Proper ventilation can prevent the accumulation of carbon monoxide in enclosed spaces.[101,104] Carbon monoxide should not be detectable in a typical indoor environment unless detected outdoors, in which case indoor levels should be less than or equal to those measured outdoors.

Methods and Best Practices

Table 14 summarizes the methods and best practices for reducing carbon monoxide exposure in schools in two areas: planning and management; and technical interventions. For each method/best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VII, Objective 2a(3) for additional narrative descriptions of each of the methods and best practices.

Table 14. Methods and Best Practices for Reducing Exposure to Carbon Monoxide

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
Planning and Management				
(1) Annually inventory and inspect all gas-burning appliances	0	$	2	1
(2) Install carbon monoxide alarms near fossil fuel-fired appliances	$	$	1	1
(3) Enforce anti-idling regulations and post signage to provide notice	0	$	1	1
Technical Interventions				
(4) Ensure negative pressure in rooms where carbon monoxide is likely to be generated	$	$	2	2
(5) Remove or replace any unvented gas or kerosene space heaters	$	0	1	1
Key: Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k) Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months) Ease of Implementation: 1= easier to implement; 3 = more difficult to implement				

Barriers and Challenges

Because carbon monoxide is a colorless, odorless gas, it is difficult to detect without alarms. Prevention of carbon monoxide exposure in school buildings relies on monitoring carbon monoxide levels and proper ventilation. Potential barriers to preventing carbon monoxide exposure include a lack of financial resources to install or maintain a carbon monoxide monitoring and alarm system or a lack of financial resources or expertise to maintain one properly. The biggest challenge to reducing carbon monoxide exposure in schools is the location of schools, as proximity to major roadways will increase the likelihood of elevated carbon monoxide.

2a(4) Reduce Exposure to Mold and Moisture

Background

All types of molds have the potential to cause health effects, although some are more harmful than others. Health effects can include irritation of the eyes, skin, and respiratory system.[101] Many people are allergic to mold, and mold can exacerbate asthma.[101] Molds can be found almost everywhere, and they thrive in moist areas.[101]

The key to controlling mold exposure is to prevent excessive moisture, repair leaks, address condensation promptly, and use the appropriate cleaning methods and products.

Methods and Best Practices

Table 15 summarizes the methods and best practices for reducing exposure to mold in schools during construction, O&M, and remediation. For each method and best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VII, Objective 2a(4) for additional narrative descriptions of each of the methods and best practices.

Table 15. Methods and Best Practices for Reducing Exposure to Mold

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
Construction				
(1) Choose materials that will control moisture	$$	0	3	1
(2) Seal unwanted openings and leaks in the building envelope	$	$	1	1
(3) Keep building materials dry to prevent the growth of mold and bacteria	0	$	1	1
O&M				
(4) Maintain interior relative humidity levels below 60 percent	0	$	1	1
(5) Maintain a properly balanced HVAC system	0	$$	3	2
(6) Clean any wet or damp areas within 48 hours and promptly repair all observed leaks	0	$	1	1
(7) Perform regular checks for condensation, wet spots, and signs of mold	0	$	1	1
(8) Consider using dehumidifiers	$	$	1	1
Remediation				
(9) Contain and do not disturb areas with significant mold until they can be remediated	$	0	1	1
(10) Clean small areas of mold with proper cleaning supplies	0	$	1	1
(11) Repair or replace moldy ceiling tiles and carpet	$	0	1	1

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement

Barriers and Challenges

Mold can present significant challenges in school buildings in Massachusetts. Massachusetts has months with high humidity and temperatures, and precipitation year-round. Climate change and an increase in extreme heat and humidity will inevitably exacerbate mold problems for schools. Many of the schools in Massachusetts are older buildings with systems that are inadequate for removing humidity and need repair to prevent leaks and water intrusion. These repairs and system updates carry significant costs, which is one of the greatest challenges in preventing mold in Massachusetts schools. There is also significant misinformation about the need for or efficacy of mold testing or sampling that can potentially result in spending unnecessary resources for sampling that should have instead been directed towards mitigation.

2a(5) Reduce Exposure to Polychlorinated Biphenyls (PCBs)

Background

PCBs are a class of human-made organic chemicals that consist of over 200 unique compounds (commonly referred to as congeners) that make up numerous mixtures.[105] At certain levels, PCBs can be hazardous to human health.[106] Numerous U.S. and international health agencies have determined that PCBs are a probable human carcinogen.[105] Research in humans has found that PCBs are also associated with immune system suppression, reproductive effects, neurological effects in children exposed *in utero*, altered thyroid hormone levels, and cardiovascular effects.[105]

PCB exposure can be an issue in school buildings, as PCBs were widely used in building materials found in construction and renovations circa 1950 to 1979.[106,107] PCBs have been widely detected in schools in the northeast region, leading to legislation in Vermont, for example, requiring all schools in the state built or renovated prior to 1980 to have their air tested for PCBs by 2027.[108] PCBs are most commonly found in fluorescent light ballasts (FLBs), caulking, and mastic (plant-based resin); it was also used in tiles or carpets, window glazing, and some adhesives and paints.[106,109] Although PCB production was banned in 1979, they are still in the building materials that were installed before 1979 and represent potential sources of PCB exposure in schools.[106,110] If caulking with PCBs is deteriorating, or light ballasts with PCBs are in disrepair, they may release PCBs into the air, which could be directly inhaled or may settle onto dust. Dust poses both an inhalation risk (when recirculated back into the air) and an ingestion risk (when people touch dusty surfaces then touch their mouth or food).[106,109]

Methods and Best Practices

Table 16 summarizes the methods and best practices for reducing exposure to PCBs in schools across three areas: identifying and removing PCBs from schools; considerations during renovations and repairs; and simple steps to reduce exposure to PCBs found in air and dust. For each method and best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VII, Objective 2a(5) for additional narrative descriptions of each of the methods and best practices.

Table 16. Methods and Best Practices for Reducing Exposure to PCBs

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
Identify and Remove Sources of PCBs				
(1) Conduct an inventory of possible locations of PCB-containing materials	0	$	2	1
(2) Conduct PCB sampling to confirm presence of PCBs	$$$	0	3	2
(3) Remove building materials with PCBs ≥50 ppm	$$$	0	3	3
(4) Replace and properly dispose of PCB-containing light ballasts	$$	0	2	2
(5) Consider encapsulation of PCBs to reduce exposure	$$	0	2	2
Renovations and Repairs				
(6) Remove PCB-containing materials disturbed during renovations and repairs and minimize PCB exposure	$$	0	2	3
(7) Follow EPA recommended steps for cleanup and decontamination if a PCB-containing FLB leaks, smokes, or catches fire	$$	0	1	2
(8) Follow EPA recommended steps when performing a retrofit for non-leaking PCB-containing FLBs	$$	0	2	2
Reduce PCB Exposure Through Air and Dust				
(9) Regularly inspect and maintain ventilation systems for proper operations	0	$	2	2
(10) Wash hands with soap and water, particularly before eating and drinking	0	0	1	1
(11) Reduce dust while cleaning	0	0	1	1

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement

Barriers and Challenges

Even before remediation, one challenge to reducing PCB exposure is pinpointing the exact sources of PCBs.[111] Locating PCB sources can require lengthy and expensive testing; alternatively, the building manager can assume all materials suspected to contain PCBs do contain PCBs and treat them as such. However, a survey found that a lack of awareness of what PCBs are was the most commonly cited impediment to PCB testing in school buildings.[111]

Two major barriers to PCB remediation in schools are logistics and cost. PCB remediation requires, at a minimum, cordoning off portions of a school building.[111] At most, it can require temporarily shutting down or completely razing a school building.[111] Both the moving of students and staff within a building or to another location and paying for remediation and renovations can become extremely expensive.[111,112] As a result, school districts with greater financial resources tend to take steps to mitigate PCB exposure, while school districts with limited financial resources are often unable to undertake the necessary renovations, exacerbating health inequities and perpetuating structural racism.[112]

2a(6) Reduce Exposure to Radon

Background

Radon is a naturally occurring radioactive element that is released when rocks and soil break down. During that process, this colorless, odorless, tasteless gas can migrate through the soil to the ground surface.[113] Radon can enter buildings such as schools through cracks, joints, and gaps in basement flooring and walls. Long-term inhalation of radon can increase the risk of lung cancer, making radon the second leading cause of lung cancer after smoking. Among smokers, lung cancer risk from radon exposure is even greater, as exposure to tobacco and radon interact synergistically.[113] Smoking and radon exposure can increase risk of lung cancer up to 10-fold compared to radon exposure alone.[113] Radon is a relevant issue across all of Massachusetts.[113] An estimated 650,000 homes in Massachusetts have radon levels that exceed EPA's action guideline of 4 picocuries per liter (pCi/L).[114]

Methods and Best Practices

Table 17 summarizes methods and best practices for reducing radon exposure in schools related to planning and management and technical interventions. For each method/best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VII, Objective 2a(6) for additional narrative descriptions of each of the methods and best practices.

Table 17. Methods and Best Practices for Reducing Exposure to Radon

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
Planning and Management				
(1) Consider radon in the design and construction of new school buildings	$$	$	3	1
(2) Have certified personnel test all occupied rooms for radon	0	$$	1	1
(3) Develop and implement a radon reduction plan	0	0	1	1
(4) Take action to mitigate radon if levels are above or approaching EPA Action Levels	$$	$	2	2
(5) Educate and communicate information to parents, students, and staff	0	0	2	1
(6) Periodically retest areas of the school after mitigation	0	$	3	1
(7) Maintain records of ongoing radon testing and radon mitigation system	0	0	1	1
(8) Maintain continuity of the school's radon mitigation plan	0	$	3	1
Technical Interventions				
(9) Install a radon mitigation system	$$	$	2	1
(10) Seal cracks and joints in concrete floors	$	0	1	1
(11) Provide ventilation using a properly balanced HVAC system	0	$-$$	2	2
Key: Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k) Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months) Ease of Implementation: 1= easier to implement; 3 = more difficult to implement				

Barriers and Challenges

The greatest barrier to addressing radon in schools is the cost of mitigation. The cost of mitigation, or fear of a potentially high cost, can discourage school administrators from testing for the presence of radon because if they were to detect it, they would face pressure to install a mitigation system. Because testing is not required, radon testing may be more likely to be deprioritized. Another barrier is the associated cost of radon testing equipment and its routine maintenance, as well as maintaining and operating the HVAC system to reduce radon exposure, which may also pose a challenge for some school districts.

Mitigating Occurrences of Vapor Intrusion

Vapor intrusion occurs when vapor-forming chemicals from a subsurface source migrate into a building. Basements are more prone to higher levels of chemicals from vapor intrusion given that they are underground and have more entry points. Some substances that enter a building through vapor intrusion have harmful health effects, including volatile organic compounds (VOCs) such as trichloroethylene and benzine, semi-volatile organic compounds (SVOCs) such as naphthalene, some PCBs and pesticides, and elemental mercury. However, not all buildings are likely to be affected by vapor intrusion of harmful substances.

Existing schools located near (<100 yards) past or present industrial or commercial facilities may consider testing indoor air for VOCs using EPA Method TO-15. Since the vapor intrusion pathway relies on chemicals coming up from the subsurface, floor drains, particularly in bathrooms, are common subsurface vapor entry points.

In the siting and construction phase of building a new school in an urban area or any area with historical use of VOCs, school districts should conduct a thorough subsurface and groundwater investigation to identify potentially harmful chemicals that may enter through vapor intrusion. This information is used to determine the appropriate design elements to include as part of a vapor barrier and potential sub-slab soil vapor collection system. If school districts are utilizing state funding for new construction projects (e.g., via a grant from the MSBA), the project will be subject to the Massachusetts Environmental Protection Act, which requires that state agencies use all practicable means and measures to minimize a proposed project's potential damage to the environment.

Sources: U.S. EPA,[115] MassDEP[116]

2a(7) Reduce Exposure to Outdoor Air Pollutants

Background

Students and staff are exposed to outdoor air pollution at schools during outdoor activities such as recess and during pickup and drop-off times. It can also impact the quality of indoor air at the school as HVAC systems draw in outdoor air to ventilate indoor spaces. The quality of outdoor air near schools is greatly impacted by proximity to roadways and industrial areas. While air quality impacts everyone, children with developing respiratory systems are particularly susceptible to the impacts of poor air quality. [101]

A major source of outdoor air pollution is emissions from motor vehicles; vehicle emissions having harmful health effects include fine particulate matter ($PM_{2.5}$), carbon monoxide, nitrogen oxides, and benzene, among other substances.[117,118] Idling school buses can be a major source of vehicle emissions near schools, particularly when buses have older engines. In addition to upgrading vehicle fleets, exposure to exhaust can be reduced by parking idling vehicles where exhaust is less likely to enter the school and by reducing idling time for all vehicles in close proximity to the school. Vehicle emissions will also be higher if a school is located in a busy urban area or sited near a major roadway or highway.

Another source of outdoor air pollution that is of increasing concern in Massachusetts is wildfire smoke.[119] This type of smoke consists of a mix of gasses and $PM_{2.5}$ that is unhealthy to breathe and can be dangerous for vulnerable populations, including children.[119] In Massachusetts, wildfire smoke events are sporadic and intermittent. These events are, however, expected to increase in frequency as a result of climate change.[22] There are several measures that schools should take to prepare for providing a safe and healthy learning environment for students during these events.

Methods and Best Practices

Table 18 summarizes the methods and best practices for reducing exposure to outdoor air pollution in schools across two areas: policy and education; and infrastructure. For each method and best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VII, Objective 2a(7) for additional narrative descriptions of each of the methods and best practices.

Table 18. Methods and Best Practices for Reducing Exposure to Outdoor Air Pollutants

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
Policy and Education				
(1) Educate staff about how outdoor air quality impacts indoor air quality	0	$	1	1
(2) Enforce a vehicle anti-idling policy	0	0	1	1
(3) Create a wildfire smoke readiness plan	0	$	1	1
Infrastructure				
(4) Replace or retrofit legacy school buses	$$$	$	3	3
(5) Establish anti-idling zones	0	0	1	2
(6) Locate passenger pickup and drop-off areas away from air intakes and classroom windows	$	0	2	2
(7) Maintain HVAC systems and filter indoor air	0	$	2	2
(8) Consider sources of outdoor air pollution when siting a new school	$	0	3	3
(9) Consider community- and building-level design elements that mitigate infiltration of outdoor air pollutants from roadways and industrial areas	0-$$$	0	1-3	1-3

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement

Barriers and Challenges

Schools must be aware of the many sources of outdoor air pollution that could impact the health of those learning and working at the school. Certain interventions are easier than others; for example, the cost of electrifying or upgrading school bus fleets can be a significant challenge for many school districts. While electric school buses have lower maintenance costs, the price of new electric buses is significantly higher than new diesel buses. Reconfiguring pickup and drop-off zones at existing schools can also pose design challenges.

In addition, wildfire smoke events have historically been relatively uncommon in Massachusetts, and schools may not have experience preparing for and reacting to them. Creating a wildfire smoke plan may be new to school administration, as may routinely checking outdoor air quality

Objective 2b. Improve Water Quality

2b(1) Reduce Exposure to Lead in Drinking Water

Background

Since clean drinking water is essential for the health and well-being of all people, water with levels of heavy metals such as lead and copper can be particularly damaging. Lead and other metals can leach into drinking water from pipes, solder, and even the interior components of drinking fountains.[99,101] Further, improper treatment of public water systems and poor maintenance of or malfunctioning plumbing systems can also lead to detectable lead levels in drinking water.[120] There is no safe level of lead in drinking water. Lead can have long lasting impacts to health, including damage to the brain, nervous system, kidneys, and more.[99] Exposure to lead in drinking water can cause serious health effects in all age groups, but children are most vulnerable to health effects from lead exposure since their growing bodies can absorb more lead than the average adult.[101] Lead can be especially harmful to children's cognitive function due to its neurotoxic effects; reduced attention span, verbal skills, and overall IQ can be attributed to lead exposure.[120] Thus, it is essential to provide children with access to water without detectable levels of lead, especially in schools, by conducting testing, issuing awareness statements, and implementing remediation efforts.

Many schools are supplied by public water systems; others have their own water supply and are themselves classified as public water systems under the Safe Drinking Water Act (SDWA). [121,122] In both cases, they are regulated by MassDEP for lead under the Lead and Copper Rule and are required to do varying amounts of limited testing. However, there is no federal or state requirement to test every outlet in schools nor is there a federal or state regulatory standard for lead in school drinking water. MassDEP regulations require that community public water systems test two outlets at two schools or EECFs every six months, annually, or every three years depending on the required monitoring schedule of the public water system. In addition, MassDEP has established a guideline level of lead in school and EECF drinking water of 1 part per billion (ppb), which is the laboratory detection limit. When levels above 1 ppb are detected, MassDEP recommends taking remediation actions and provides guidance and resources on methods to reducing levels.

MassDEP's Water-Smart Program (formerly called the Lead in Schools Assistance Program) offers a free comprehensive approach to testing for lead in schools (and EECFs) and provides resources to take action when lead is detected above 1 ppb. The Program is funded by EPA's Water Infrastructure Improvements for the Nation grants. The Water-Smart Program is a component of the Lead Contamination Control Act (LCCA) Program, which offers additional ongoing support to schools concerning addressing lead in drinking water.

Methods and Best Practices

Table 19 summarizes the methods and best practices for reducing exposure to lead in drinking water in schools. For each method and best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VII, Objective 2b(1) for additional narrative descriptions of each of the methods and best practices.

Table 19. Methods and Best Practices for Reducing Exposure to Lead in Drinking Water

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
(1) Be familiar with the school's water source and condition of the school's plumbing system*	0	0	2	1
(2) Create a communication plan to notify stakeholders and build partnerships*	0	$	2	2
(3) Implement a water sampling plan in compliance with state guidance*	0	$$$	3	3
(4) Remediate sources of contamination and establish routine practices to minimize future contamination*	$$$	$$	3	3

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement
*****MassDEP's Water-Smart Program, LCCA Program, and SWIG Program offer many of these services.

Barriers and Challenges

The most significant barriers to improving water quality by reducing lead levels are the mostly voluntary nature of testing and the cost associated with remediation actions. Schools should prepare to develop communication, sampling, and testing plans over time and to work with community organizations and state agencies to identify the necessary resources to act.

2b(2) Reduce Exposure to PFAS in Drinking Water

Background

PFAS are a class of compounds characterized by their strong chemical bonds and non-stick, stain-resistant, and waterproof properties.[123] PFAS have been used extensively in products since the 1940s, including food packaging, cooking materials, clothing, furniture, carpets, cosmetics, and more.[124–126] They've also been commonly used in various industrial and military practices, leading to widespread contamination of water, soil, and air.[126,127] PFAS are commonly referred to as "forever chemicals" because they do not readily break down and can accumulate throughout the environment and up the food chain.[127] Exposure to these chemicals is associated with various health effects, including reduced immunity, organ dysfunction, reproductive and developmental harm, and cancer.[123–127] Impacts on children include reduced response to vaccinations, onset of asthma, reduced kidney function, and abnormal puberty, among others.[125,127] Thus, schools should take steps to minimize PFAS exposure in children, particularly in drinking water, by confirming the presence of PFAS in drinking water and providing an alternative source of drinking water if necessary. Schools should also purchase certified PFAS-free products.

Other Contaminants of Concern

MassDEP requires all public water suppliers, including those that are schools, to perform ongoing tests for bacteria, lead and other heavy metals, herbicides and pesticides, industrial solvents, and radionuclides. If testing reveals contaminants at levels above the respective federal standard, the water supplier is required to notify customers. If suppliers detect bacteria or chemicals at levels that pose a threat to human health, suppliers must treat the public water supply to remove the contaminants. If the supplier is unable to resolve the problem immediately, the supplier is required to restrict service and provide information about alternate sources of water.

Schools receiving their drinking water from a public water supplier should receive or have access to an annual water quality report. Schools can also contact their public water supplier to request more information. MassDEP has compiled a comprehensive list of public water supplier contact information.

If a school is a public water supplier (i.e., has its own well as its drinking water source), the school is required to routinely test its drinking water and report the results to MassDEP. Schools can find and download monitoring schedules compiled by MassDEP.

Methods and Best Practices

Table 20 summarizes the methods and best practices for reducing exposure to PFAS in drinking water in schools. For each method and best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VII, Objective 2b(2) for additional narrative descriptions of each of the methods and best practices.

Table 20. Methods and Best Practices for Reducing Exposure to PFAS in Drinking Water

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
(1) Identify whether the school's drinking water source contains PFAS and conduct additional testing to determine the source of contamination whenever possible	0	$	3	3
(2) Remediate sources of contamination and establish routine practices to minimize future contamination (long-term mitigation)	0-$$	0-$$	2-3	2-3
(3) Remediate sources of contamination and establish routine practices to minimize future contamination (short-term mitigation)	0	$	1	1
(4) Procure certified PFAS-free items as part of the school's green purchasing program	$	$	1	1

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement

Barriers and Challenges

There are many challenges related to reducing exposure to PFAS, as these are widespread chemicals. All public water suppliers in Massachusetts are required to test for PFAS, whether the supplier is a community system or a school with its own well. If schools are part of a larger community public water system, it is the responsibility of the public water system to test for PFAS. Thus, schools must build local partnerships to assess potential contamination, address exceedances of drinking water standards, and reduce sources of PFAS where feasible.

Objective 2c. Maintain Thermal Comfort

Background

Massachusetts school buildings experience a wide range of temperatures making maintaining thermal comfort for students and staff both challenging and necessary. All school buildings in Massachusetts have heating, though the system may not always operate consistently throughout classrooms. However, many schools do not have air conditioning, which is becoming a concern for student and staff health, given the increase in hot and humid days during the school year resulting from climate change.[128,129] Schools may also lack other strategies to keep classrooms cool, such as windows that can open and window shades.[130] Extreme heat in schools with no cooling can harm human health and academic attainment. Specifically, effects include reduced cognitive function, learning, and academic performance; exacerbation of asthma, bronchitis, and other respiratory conditions; increased incidence of heat stroke and heat exhaustion; and loss of school time due to school closures or early dismissals.[104,129–131] One analysis estimates that, since 1970, the number of days above 80°F, the threshold identified as requiring air conditioning, has increased by nine to 13 days per school year, depending on the Massachusetts school district.[128]

Methods and Best Practices

Table 21 summarizes the methods and best practices for improving thermal comfort in schools. For each method and best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VII, Objective 2c for additional narrative descriptions of each of the methods and best practices.

Table 21. Methods and Best Practices for Improving Thermal Comfort

Methods/Best Practices		Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
(1)	Establish and implement an extreme heat policy aligned with a completed climate vulnerability assessment	0	$	1	2
(2)	Keep classrooms at a comfortable temperature and humidity for learning	0-$$$	0-$	1	1-3
(3)	Install air conditioning if temperatures regularly get above recommended levels	$$$	$	3	3
(4)	Maintain mechanical HVAC systems and balance systems as needed	0	$-$$	2	2
(5)	Consider heating and cooling in new construction	$$$	0	3	3
(6)	Take simple steps to mitigate the effects of heat on health and learning	$	$	1	1

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement

Barriers and Challenges

The major challenges to maintaining thermal comfort in schools are the age of school buildings and HVAC systems in Massachusetts and the cost of installing or updating air conditioning systems. Massachusetts public school buildings, some over 100 years old, were built when there were fewer extreme heat days during the school year.[128,132]

Objective 2d. Use Integrated Pest Management

Background

Pest management in schools is important because certain pests can trigger allergies (e.g., cockroach dust) and may contaminate food and transmit disease. Integrated pest management (IPM) is a sustainable approach to managing pests that combines biological, cultural, physical, and chemical tools to minimize economic, health, and environmental risks. IPM strategies focus on long-term prevention and suppression of pests, ultimately reducing the use of potentially hazardous chemical pesticides. IPM approaches prioritize reducing or mitigating conditions that make facilities vulnerable to pests through pest-preventive building design and repairs, building occupant education, and proactive pest population monitoring. The Massachusetts Pesticide Control Act (M.G.L., c.132B) restricts the use of most pesticides in schools.

Methods and Best Practices

Table 22 summarizes methods and best practices for implementing IPM in schools. For each method/best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VII, Objective 2d for additional narrative descriptions of each of the methods and best practices.

Table 22. Methods and Best Practices for Using Integrated Pest Management

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
(1) Create an IPM plan	0	0	2	2
(2) Perform routine and proactive pest service	0	$$	1	2
(3) Field pest complaints from building occupants	0	$	1	1
(4) Physically exclude pests	$	$	1	2
(5) Perform pest sealing before final acceptance of new construction projects	$	0	1	1
(6) Conduct pest-preventative repairs	0	$	1	1
(7) Inspect buildings for conducive conditions	0	$	1	1
(8) Educate building occupants on best practices	0	$	1	1

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement

Barriers and Challenges

Perceived pest threats often do not align with the real threats that pests pose. For instance, many families are worried about lice transfer at school, whereas mosquito bites are far more prevalent and pose more significant risks. Building occupants may have varying levels of tolerance for pest presence. Education and communication are critical to establishing shared expectations and clarifying the important role that students and staff play in maintaining pest-free facilities.

Objective 2e. Procure and Use Green Cleaning Supplies and Chemicals

Background

Thousands of chemicals are used as part of daily practices in schools, including those used in laboratory settings or as art supplies, cleaning agents, and tools for building O&M.[99] Students and staff can be exposed to unnecessary risks when hazardous or mismanaged chemicals are present in schools.[101] Further, exposure to certain chemicals can lead to serious health effects, including cancer, reproductive disorders, organ damage, and irritation to the eyes, nose, and throat.[99,101] Thus, it is essential that schools have a robust chemical management system to prevent the improper use, storage, and disposal of chemicals. Additionally, schools should procure green chemicals to reduce the amount of hazardous and toxic chemicals stored onsite.

Methods and Best Practices

Table 23 summarizes the methods and best practices for procuring and using green cleaning supplies/chemicals in schools across two areas: implementing a chemical management system; and utilizing green chemicals to protect the health and safety of staff and students using chemicals in schools. For each method and best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VII, Objective 2e for additional narrative descriptions of each of the methods and best practices.

Table 23. Methods and Best Practices for Procuring and Using Green Cleaning Supplies/Chemicals

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
Chemical Management System				
(1) Develop a school chemical management program	$$	$$-$$$	3	2
(2) Create an emergency and spill response plan	$	$$	2	2
(3) Form a chemical safety team and conduct adequate staff training	$-$$	$-$$	2	2
Green Cleaning Supplies/Chemicals				
(4) Implement a green chemical purchasing policy	$$$	$$$	3	3
(5) Design a plan for green cleaning, sanitizing, disinfecting, and other daily practices plan	$	$$	2	2
Key: **Cost:** 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k) **Implementation Timeframe:** 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months) **Ease of Implementation:** 1= easier to implement; 3 = more difficult to implement				

Barriers and Challenges

Schools may face challenges when trying to implement a chemical management system or procure green chemicals. Some notable challenges in regard to school chemical management systems may be the lack of environmental, health, and safety staff onsite or protective systems such as personal protective equipment (PPE), medical monitoring, control mechanisms for hazardous chemical releases, etc.[133] Additionally, challenges regarding the procurement of green chemicals may include lack of knowledge on which chemicals are considered hazardous and which are considered safer alternatives, as well as limited financial resources to purchase such alternatives.[133,134] Thus, it is essential that schools build a team of partners and a long-term plan that can assist in working towards these goals.

Objective 2f. Reduce Exposure to Hazardous Substances

2f(1) Reduce Exposure to Lead in Paint and Soil

Background

Lead is a naturally occurring metal once used in various products, including paints and primers.[100] Lead is considered highly toxic and is associated with adverse effects for both children and adults.[101] Outside of lead in drinking water, people can be exposed by inhaling dust or ingesting particles via hand-to-mouth contact, where lead-based paint is one of the most common sources of contamination.[100] There is no safe level of lead exposure, with associated health effects including anemia, decreased kidney function, high blood pressure, reproductive harm, and damage to the brain and nervous system.[99,100] Children under the age of six are the most vulnerable to long-lasting damage from lead exposure due to its neurotoxic capabilities, where health effects such as behavioral and learning problems, low IQ, hyperactivity, slowed growth, hearing issues, and more have been identified.[99–101]

Methods and Best Practices

Table 24 summarizes the methods and best practices for reducing exposure to lead in paint and soil at schools. For each method and best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VII, Objective 2f(1) for additional narrative descriptions of each of the methods and best practices.

Table 24. Methods and Best Practices for Reducing Exposure to Lead in Paint and Soil

Methods/Best Practices		Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
(1)	Examine for lead paint and conduct renovations	$$-$$$	$$	3	3
(2)	Implement a hand-washing routine after recess breaks and before eating	$	$	1	1

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement

Barriers and Challenges

A major barrier to minimizing exposure to lead from paint is the need for renovations. Renovating buildings with lead-based paint can be challenging since it is not only a costly venture but may also require that the building remain unoccupied throughout the renovation process. As a result, schools must be prepared to handle these issues if lead-based paint is identified.

2f(2) Reduce Exposure to Mercury

Background

Mercury is a naturally occurring element traditionally used in many products due to its advantageous properties, such as high density, liquid state at room temperature, ability to conduct electricity, and more.[135] While mercury can be a helpful substance, exposure to high levels by breathing in vapors, touching mercury in its liquid state, or eating contaminated food sources is associated with damage to the brain, heart, kidney, lungs, and immune system.[99,136] Further, it is considered a neurotoxic substance that can be particularly harmful to children.[101]

Methods and Best Practices

Table 25 summarizes the methods and best practices for reducing exposure to mercury in schools. For each method and best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VII, Objective 2f(2) for additional narrative descriptions of each of the methods and best practices.

Table 25. Methods and Best Practices for Reducing Exposure to Mercury

	Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
(1)	Develop a mercury spill response plan	0	$-$$	3	2
(2)	Maintain a mercury spill kit	$	0	1	1
(3)	Properly dispose of all mercury-containing items and replace with alternatives where possible	$-$$$	$-$$	3	3

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement

Barriers and Challenges

The greatest barrier to reducing exposure to mercury in schools is replacing mercury-containing products; however, replacing products is more cost-effective than paying to clean up a mercury incident. One challenge is that, despite the best efforts of school leaders, students may bring an item containing mercury to school. As a result, schools must be prepared to address mercury incidents, even if they do not use or maintain an inventory of mercury-containing products on-site.

Objective 2g. Safely Procure, Use, and Dispose of Crumb Rubber

Background

Artificial turf fields (ATFs) for school sports are popular alternatives to natural grass.[137] ATFs are often cheaper—or perceived as cheaper—to maintain, and can be used during and immediately after rain, which enables more playing time.[138,139] ATFs commonly comprise three core components: padding and backing materials at the bottom, infill in the middle, and artificial grass blades at the top. The grass blades are made of plastic, and the infill layer is typically composed of a mixture of sand and what is referred to as "crumb rubber," often made from recycled car and truck tires.[137] Alternatives to recycled tires for crumb rubber include ethylene propylene diene terpolymer, thermoplastic elastomer, and waste athletic shoe materials, among many other materials.[138] Mineral-based and plant-derived materials such as sand, cork, coconut hulls, and walnut shells can also be used and may provide lower chemical alternatives to crumb rubber.[138]

While DPH has found that scientific research generally concludes that adverse health effects from ATFs are unlikely, there are no existing studies that have specifically examined the relationship between exposure to crumb rubber and disease outcomes.[137] Communities have raised concerns about potential exposure to chemicals that may be found in the crumb rubber infill layer, which include PFAS, VOCs, SVOCs, and metals such as lead.[137,140] Exposure to chemicals in ATFs could occur through inhalation of VOCs or particles released by the ATF during use, swallowing crumb rubber while playing on fields, and skin contact with crumb rubber and plastic blades.[137] [138] [137,138]

In response to concerns about ATFs, the U.S. Centers for Disease Control and Prevention (CDC)/Agency for Toxic Substances and Disease Registry, EPA, and the Consumer Product Safety Commission conducted a multi-year research effort to understand the constituent chemicals in tire crumb rubber and how people may be exposed while playing on ATFs.[141] Only small amounts of chemicals were found to be released into the air from tire crumb. For many chemicals measured, concentrations measured near ATFs were no different than background levels; for some chemicals, however, measured concentrations were higher near the ATF. Less than 1 to 3 percent of metals were released from tire crumb rubber into simulated biological fluids. Concentrations of metals in the blood of people who played on ATFs were similar to those of the general population. There was no difference in polycyclic aromatic hydrocarbon metabolites found between people playing on ATFs and those playing on grass.[141]

Beyond possible exposure to hazardous chemicals, there are additional health-related concerns about using ATFs as an alternative to natural grass fields, including more frequent skin abrasions, higher risk of heat-related illness during exercise, higher incidence of joint injuries, and potentially more significant risk of head injuries.[137,139] Various studies have found ATFs to be anywhere from 35°F to 86°F hotter than natural grass, which can contribute to heat-related illness and burns.[138] Heat can also lead to increased emissions of VOCs and SVOCs from the plastic and rubber materials that make up ATFs.[138]

ATFs have a limited lifespan, and they can become unsafe to play on beyond that timeframe.[139] Disposal and replacement of fields represent additional costs that schools often overlook when deciding whether or not to install an ATF. While some cities in Massachusetts have developed rules related to the use of ATFs, there are currently no state regulations related to ATFs.[140] When considering the installation of ATFs or when playing on an ATF, school leaders can take numerous steps to weigh their options and reduce children's exposure to chemicals or particles from ATFs while playing sports.

Methods and Best Practices

Table 26 summarizes the methods and best practices for procuring, using, and disposing of ATFs containing crumb rubber in schools. For each method and best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VII, Objective 2g for additional narrative descriptions of each of the methods and best practices.

Table 26. Methods and Best Practices Related to Procuring, Using, and Disposing of Crumb Rubber

Methods/Best Practices		Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
Considerations and Practices for School Decision Makers and Field Maintenance Staff					
(1)	Consider the pros and cons of ATFs and natural grass when planning for field upgrades	NA	NA	3	NA
(2)	Plan for and implement routine ATF maintenance	0	$	3	2
(3)	Plan for and conduct proper disposal of ATFs at end of lifespan	$	0	3	2
Considerations and Practices for Students, Staff, and Families Playing on ATF					
(4)	Wear shoes on ATFs at all times	0	0	1	1
(5)	Do not swallow or allow small children to swallow crumb rubber	0	0	1	1
(6)	Increase ventilation at indoor ATF facilities	0-$$	0-$$	1	2
(7)	Raise awareness of and protect against extreme heat exposure	0	$	1	2
(8)	Minimize passive recreation on ATFs	0	0	1	1
(9)	Clean hands, clothing, equipment, and turf burns after playing on ATFs	0	0	1	1

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement

Barriers and Challenges

One particular challenge regarding the use of ATF is the lack of definitive research on the safety or health effects of playing on ATFs. While research suggests that chemical exposure while playing on an ATF is not much greater than background exposure, not all chemicals in ATFs are always known and characterized, and numerous routes of exposure exist. Both ATF and natural grass fields cost money to maintain; disposal costs and methods for ATF at the end of their useful life span will need to be accounted for in school district budgets.

Objective 2h. Create a Safe Environment for Students with Life-Threatening Food Allergies

Background

Food allergies affect about 8 percent of children in the United States.[142] People can be allergic to any food, but the nine most common food allergens in the United States are milk, eggs, fish, shellfish, wheat, soy, peanuts, tree nuts, and sesame.[142] Food allergies can be life-threatening, and some people with severe reactions may not have experienced them in the past. Avoidance is the best way to keep children safe. Individuals with life-threatening food allergies may be prescribed epinephrine auto-injecting pens in the event of exposure to allergens. During the 2021–2022 school year in Massachusetts, 259 students and 27 other individuals were treated for anaphylaxis at school, and 39.5 percent of these anaphylactic shock events were among individuals with no history of anaphylaxis.[143] Most of these reactions (65.7 percent) were caused by food, and in 159 of the 188 food allergen anaphylactic events, the reaction was caused by ingesting a food allergen.[143]

Schools can help students avoid food allergens by creating allergy- or food-free spaces outside of designated eating areas, keeping and understanding ingredients in each of the food items being served (especially if the items are prepared and do not have visible labels), ensuring proper food preparation practices, and avoiding cross-contact in food preparation and service areas, including in kitchens and eating areas. Schools must also be able to respond to anaphylactic shock events in the case of cross-contact or in the case of previously unknown allergies.

In Massachusetts, public and private schools, educational institutions, summer camps, childcare facilities, and other childcare programs approved to participate in U.S. Department of Agriculture (USDA) Child Nutrition Programs are exempt from DPH regulations 105 CMR 590.000 regarding food allergens, provided that they have written policies and procedures for identifying, documenting, and accommodating students with food allergies. Documentation is also required to verify participation in food allergen training recognized by DESE and DPH. These institutions must also train their employees in food allergy awareness as it relates to their assigned duties.

Methods and Best Practices

Table 27 summarizes the methods and best practices for creating a safe environment for students with life-threatening food allergies in schools related to developing written protocols, ensuring preparedness, and implementing prevention measures. For each method and best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VII, Objective 2h for additional narrative descriptions of each of the methods and best practices.

Table 27. Methods and Best Practices Related to Creating a Safe Environment for Students with Life-Threatening Food Allergies

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
Develop Written Protocols				
(1) Develop an allergy management and prevention plan	0	0	1	1
(2) Develop and maintain individual health care plans	0	0	1	1
Facilitate Preparedness				
(3) Conduct training on life-threatening allergies and emergency response	0	$	1	1
(4) Maintain a supply of epinephrine auto-injectors in a secure location	0	$	1	1
Implement Prevention Measures				
(5) Prohibit eating food on school buses or in classrooms	0	0	1	1
(6) Prevent cross-contact of foods	0	$	1	2
(7) Display a food allergen awareness poster	0	0	1	1

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement

Barriers and Challenges

By the time children are in elementary or secondary school, many life-threatening allergens are already known. A significant percentage of school epinephrine administrations, however, involve individuals who did not have a previously recognized allergy. For example, between 2004 and 2010, 23 percent of epinephrine administrations in Massachusetts schools were to individuals without a previously recognized allergy.[144] This means that regardless of prevention efforts, schools will always need to be prepared to respond to serious allergic reactions. Additionally, while food is not typically an asthma trigger, children with both food allergies and asthma are at greater risk of a serious reaction.

Maintaining allergy-free zones can be difficult when physical space is limited, such as in cafeterias and kitchens. This is especially true for existing older buildings, though it can and should be done regardless of the space limitations.

Objective 2i. Create a Productive Learning Environment for All Students

2i(1) Optimize Lighting

Background

Students are engaged in various visual tasks throughout the day, from reading printed materials up close to blackboards at a distance.[145] Studies show that children are sensitive to light exposure and that low levels of light indoors can be associated with an increased risk of nearsightedness.[120] Further, bright lighting is associated with greater alertness and can enhance a student's performance at school.[120] Thus, school classrooms with high-quality lighting promote effective learning and teaching.

Methods and Best Practices

Table 28 summarizes the methods and best practices for optimizing lighting in schools. For each method and best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VII, Objective 2i(1) for additional narrative descriptions of each of the methods and best practices.

Table 28. Methods and Best Practices Related to Optimizing Lighting

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
(1) Integrate both natural and artificial lighting throughout schools	$	$	1	2
(2) Consider illuminance, color temperature, and glare	$	$	1	1

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement

Barriers and Challenges

Barriers associated with lighting as a means of creating a productive learning environment may include the cost of artificial lighting with appropriate illuminance and color temperature and building-specific constraints that may limit available natural light. Schools should strive to balance artificial and natural lighting based on their current lighting system and available resources.

2i(2) Optimize Acoustic Performance

Background

Ensuring that classrooms have appropriate noise levels and listening conditions is essential for students to clearly understand the instruction delivered by teachers.[146] Children younger than 15 years old are more sensitive to disruptive listening conditions, where excessive noise can cause cognitive distress and reduced performance in school.[145,146] Thus, schools should focus on improving the acoustic environment in the classroom to enhance the learning experience for all students.

Methods and Best Practices

Table 29 summarizes the methods and best practices for optimizing acoustic performance in schools. For each method and best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VII, Objective 2i(2) for additional narrative descriptions of each of the methods and best practices.

Table 29. Methods and Best Practices Related to Optimizing Acoustic Performance

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
(1) Reduce sound reverberation time and minimize background noise in classrooms	$$	$	2	1-2

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement

Barriers and Challenges

The main barrier to creating a productive learning environment by enhancing acoustic performance is ensuring that building materials have good sound-absorbing capabilities. While new construction and modernization projects can seamlessly incorporate these materials into the design and construction, this can require more work to implement as a retrofit measure in an existing building. Further, background noise from sources outside of the school (e.g., vehicular traffic from nearby roadways) can also impact student learning yet are challenging to control. Thus, schools should focus on minimizing noise from sources they can control, such as HVAC systems, and invest in materials that effectively reduce sound reverberation times.

Objective 2j. Design the Built Environment to Foster a Peaceful School Community

Background

In Massachusetts, students and staff spend long days in school buildings. The design of these buildings can play an important role in creating conditions that foster a peaceful school community. High-traffic areas that force crowding and jostling can lead to stress and increased violence, whereas specific and intentional design elements can support positive mindsets and interactions.

Methods and Best Practices

Table 30 summarizes the methods and best practices for designing the built environment to foster a peaceful school community across three categories: reducing stressors resulting from the built environment; designing spaces in school buildings to promote overall well-being; and designing spaces that facilitate positive social interactions at school. For each method and best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VII, Objective 2j for additional narrative descriptions of each of the methods and best practices.

Table 30. Methods and Best Practices Related to Designing the Built Environment to Foster a Peaceful School Community

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
Reduce Stressors				
(1) Reduce crowding	0-$$$	0	3	2
(2) Reduce environmental stressors	0-$$$	$	2	2
Design Spaces to Support Wellbeing				
(3) Provide spaces to support neurocognitive balance	$-$$$	0	2	2
(4) Incorporate access to both indoor and outdoor nature	0-$	$	1	1
(5) Use colors and textures that promote a peaceful environment	$	0	1	1
Design Spaces to Facilitate Positive Social Interaction				
(6) Provide diverse communal spaces	0-$$$	0	2	1
(7) Design spaces for easy movement	0-$$$	0	3	2

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement

Barriers and Challenges

The greatest challenge to designing schools that foster a peaceful school community lies in the existing infrastructure of Massachusetts school buildings. School building layouts tend to be static. Changing built environment features such as room and hallway layouts to reduce crowding and facilitate easy movement of students and staff may only be possible with costly renovations. Additionally, many schools face crowding challenges and might not have the physical space to provide students with options for calming and activation without extensive renovations. Environmental stressors can also be a challenge for older school buildings to address. See Objective 2a. Improve Air Quality, Objective 2c. Maintain Thermal Comfort, and Objective 2i. Create a Productive Learning Environment for All Students for additional relevant barriers and challenges.

IV. Goal 3: Achieve Equitable Outcomes for All Students

Achieving equitable outcomes for all students is essential to accomplishing the goal of having green and healthy schools throughout the Commonwealth of Massachusetts. For too long, inequitable distribution of funding and resources has led to inequitable outcomes for marginalized students, including those with special education needs. These inequities are the result of intentional choices that have been made by policymakers and school districts since public schools first entered the Commonwealth.[147–149] To mitigate the inequities previously inherent in school systems, policymakers and school districts must be intentional about centering equity when dispersing funding and resources for capital improvement projects.

Segregation of Black and Latino students is a growing issue throughout Massachusetts.[148] This is evident in the number of schools experiencing racial isolation and in the over-placement of Black and Latino students in more restrictive learning environments.[148,149] As school districts move toward a more green and healthy school model, it is their responsibility to provide students with equitable access to inclusive and healthy learning environments—regardless of race, gender, disability, or any other identity. Just as every student has the right to receive an education in the least restrictive learning environment, every student has a right to attend accessible, inclusive schools free of environmental and health hazards.

This section presents a tabular summary of the methods and best practices that can help school districts across the Commonwealth achieve equitable outcomes for all students and a brief discussion of notable barriers and challenges that schools are likely to face. Content is provided across the following three objectives:

a. Optimize space to equitably meet special education needs
b. Prioritize universal accessibility
c. Use available data to identify and equitably prioritize schools of greatest need and advocate for additional funding opportunities

Section VIII provides a more detailed narrative description of the methods and best practices, details related to the relevant statutory/regulatory framework and notable standards, and relevant resources across each of the three objectives.

Objective 3a. Optimize Space to Equitably Meet Special Education Needs

Background

Federal and state regulations guarantee all students in the Commonwealth of Massachusetts access to a free and appropriate public education (FAPE) in the least restrictive environment (LRE), regardless of disability.[150–152] This guarantee is especially important for historically excluded students from underserved and marginalized communities. Integrating students with disabilities into school communities is essential for their behavioral, social, and academic well-being. Optimizing learning spaces to meet the needs of all learners equitably must be a top priority for schools and school districts to guarantee students' access to FAPE in the least restrictive learning environment possible.

A review of special education in Massachusetts examined the identification, placement, and performance of students with disabilities throughout Massachusetts' school districts.[149] The study developed four key findings:

- Low-income and non-low-income students with disabilities experience substantial differences in identification, placement, and performance.
- Students with disabilities placed in full inclusion settings outperformed peers with similar disabilities who spent less time in the general education setting.
- Secondary schools offer limited inclusive options for students with disabilities.
- Special education identification, placement, and performance varied significantly from district to district.

In addition to the four key findings, the study also found that Black and Latino students were disproportionately excluded from the general education setting.[149] This was especially evident in secondary schools where Black students were twice as likely as their White peers to be placed in a substantially separate setting, even though Black and White students have similar rates of inclusion at the elementary level.[149] These disparities are a result of historical and systemic practices limiting access to special education services in underserved and marginalized communities. Student placement should always be based on individual needs rather than available space.[153] To accomplish this, schools and school districts must evaluate the availability of and access to special education services and inclusion classrooms.

There is no one-size-fits-all solution to educating students with disabilities. However, in Massachusetts, students with disabilities placed in inclusion settings are five times more likely to graduate in five years or less than peers of similar ability excluded from the general education setting.[149] Adequately placing students in the least restrictive environment, most appropriate to serve their individual needs, is paramount to their success. Schools and school districts across Massachusetts must deploy a wide variety of strategies to mitigate the disparities found in special education services. Optimizing learning spaces to meet the needs of all students equitably requires existing schools to rethink and revise their current classroom compositions. In contrast, schools undergoing new construction and/or renovations can integrate universal design (UD) and other design principles to plan for a more inclusive environment from the start. Sufficiently designing spaces to meet the programmatic needs of all students receiving special education takes thoughtful consideration and intentional planning.

Methods and Best Practices

Table 31 summarizes methods and best practices for optimizing space to meet special education needs equitably in schools. For each method/best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VIII, Objective 3a for additional narrative descriptions of each of the methods and best practices.

Table 31. Methods and Best Practices for Optimizing Space to Equitably Meet Special Education Needs

Methods/Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
(1) Design inclusive classrooms	0	0	1	1
(2) Avoid clustering special education spaces	0	0	1	1
(3) Prioritize principles of universal design	$-$$$	0	1	2
(4) Collaborate within and across districts	0	$	1	1

Key:
Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k)
Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (>12 months)
Ease of Implementation: 1= easier to implement; 3 = more difficult to implement

Barriers and Challenges

Optimizing space to meet special education needs more equitably is essential; however, optimizing space alone will not fix the special education disparities in Massachusetts schools. Proper identification of students and adequate staffing are also essential elements in equitably meeting special education needs. This document addresses how schools and school districts can optimize space while assuming appropriate identification and staffing.

Not every school and school district are able to meet the individual needs of every student. Out-of-district placements and Education Collaboratives can help ease the challenges that come with serving students with the greatest educational needs. School districts in urban and suburban areas have a greater concentration of resources, allowing them to place most students in an appropriate setting within a reasonable distance from their home. Rural districts are more likely to face challenges placing students in the proper settings because resources are more dispersed than in urban and suburban areas. For this reason and many others highlighted earlier in the report, rural districts face more challenges when trying to meet the needs of every student.

Transportation can be an issue for students in urban and rural areas. Though students with transportation listed on their Individualized Education Plan (IEP) are entitled to transportation to out-of-district placements, this transportation can be unreliable. Students without transportation on their IEP and placed out of district will face even greater challenges since transportation falls on the parents. Parents that work long hours, have other children, lack transportation, or in many other circumstances may struggle or be unable to transport their child to a school out of their district, further exacerbating inequities. Teachers, parents, and everyone on a student's IEP team should consider potential transportation barriers before placing a student.

Objective 3b. Prioritize Universal Accessibility

Background

Massachusetts is home to some of the oldest schools in the country, with many school buildings more than 70 years old.[154] Historically, schools were not designed to guarantee access for disabled students and were not welcoming to students of all genders or races. Black and Latino students are more likely to attend older, out-of-date schools. Schools are mandated to protect students from discrimination based on disability, gender identity, sexual orientation, and race by state and federal laws and regulations.[155,156] To accomplish this, school facilities need to adopt more inclusive and accessible policies. Disabilities are only disabling if they limit people from achieving what they want and need to do. Increasing the accessibility of school facilities and learning environments creates more opportunities for students to thrive in their school communities.

Methods and Best Practices

Table 32 summarizes methods and best practices for universal accessibility in schools. For each method/best practice, the table presents the approximate capital and operating costs, implementation timeframe, and ease of implementation. See Section VIII, Objective 3b for additional narrative descriptions of each of the methods and best practices.

Table 32. Methods and Best Practices for Prioritizing Universal Accessibility

Methods and Best Practices	Capital Cost	Operating Cost	Implementation Timeframe	Ease of Implementation
Physical Disabilities: Design Physically Accessible Spaces				
(1) Evaluate barriers to physical access	0	$-$$$	1	2
(2) Prioritize universal access to school buildings				
(2a) Update signage	$	$	1	1
(2b) Update door handles	$	0	1	1
(2c) Update doors (i.e., remove heavy doors, add automated openers, etc.)	$-$$	0	1	1
(2d) Add ramps and chair lifts	$-$$$	0	2	2
(2e) Update bathroom infrastructure	$-$$$	0	3	3
Transgender, Non Binary, and Intersex Experience: Design Gender Inclusive Spaces				
(3) Evaluate gender-based rules, policies, and practices	0	$	1	1
(4) Prioritize access to gender-inclusive restrooms, locker rooms, and changing facilities	$-$$$	0	1-3	1-3
Neurodivergence: Design Neuro Inclusive Spaces				
(5) Evaluate the school's sensory landscape	0	$	1	1
(6) Design with sensory experiences in mind	$-$$$	$-$$	1	2
Key: Cost: 0 = no cost; $ = low cost (<$25k), $$ = medium cost ($25-100k), $$$ = high cost (>$100k) Implementation Timeframe: 1 = near-term (0-3 months); 2 = medium-term (4-12 months); 3 = long-term (12 months) Ease of Implementation: 1= easier to implement; 3 = more difficult to implement				

Barriers and Challenges

Schools and school districts must constantly decide how to best utilize limited funds and resources. This often means that funding is directed to the most pressing needs that impact the most students. For older buildings, this means that structural and safety fixes take priority. Prioritizing universal accessibility is important and, in some cases, required by law; however, deciding which aspects of improving accessibility to address first can be difficult. Each school faces different challenges and serves students with a wide range of needs. In many cases, schools and school districts will have to use discretion when deciding which elements of accessibility to prioritize.

Another challenge in prioritizing universal accessibility is the impact of segregation and the inequitable distribution of resources throughout schools in the Commonwealth. White, affluent communities have more resources, receive more funding, and often contain more updated, accessible schools.[154] This results in inequalities that must be addressed beyond the three categories of methods and best practices outlined in Table 32. School districts that serve low-income, Black and Latino, and rural students face greater challenges.[23,148] Systemic changes to funding and school placement must be a part of the conversation around prioritizing universal accessibility.

Existing schools may face challenges when providing gender-neutral bathrooms to students. If the nurse's office or a staff bathroom is the best option for a student, the student may have to spend more time out of class to access the bathroom. This can also result in students feeling "othered" or isolated, especially if they are facing the issue alone. Schools should enable students to access gender-neutral bathrooms with ease to minimize time out of class and create an inclusive environment. This will be less of a barrier for new schools and schools undergoing renovations, as they will typically have greater flexibility to determine the placement of gender-neutral bathrooms.

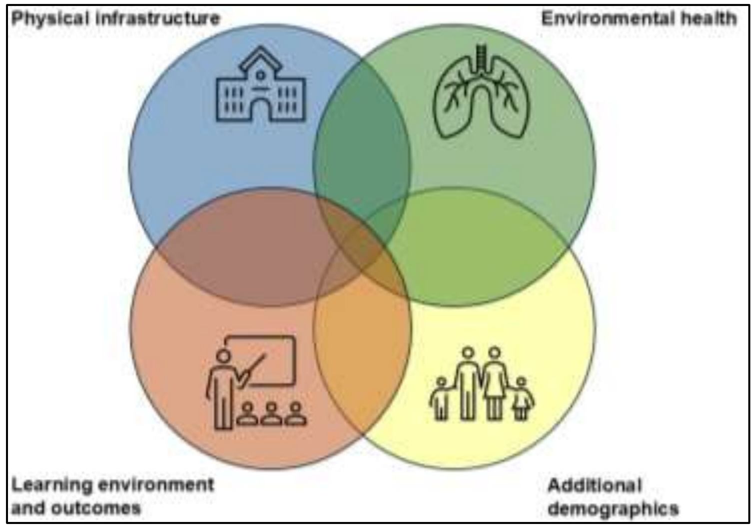
Objective 3c. Use Available Data to Identify and Equitably Prioritize Schools of Greatest Need and Advocate for Additional Funding Priorities

Many of the best practices outlined in this report require little or no funding; therefore, school districts can readily adopt many of these strategies across all schools in their respective district. There are also many best practices that can be very costly to implement; for these best practices, school districts will need to determine which school(s) in their respective district have the greatest need. There is no "one-size-fits-all" approach for a school district to identify those schools having the greatest need and to develop a corresponding prioritized plan for project funding and implementation across its portfolio of schools. As noted in prior sections, the many school districts within the Commonwealth of Massachusetts vary across many characteristics, including geographic location, facility portfolio (number, size, and type of buildings), student enrollment, racial and demographic composition of the student body, student performance, annual capital and operating budgets, and amount of annual state aid received. A small rural school district with one elementary school will likely take a very different approach to selecting and prioritizing projects as compared to a large urban school district with dozens of elementary, middle, and high schools in its portfolio.

The objective of this section is to call attention to a collection of readily available data sources that school districts can consider when thinking about how to identify the schools having the greatest needs. School districts can then prioritize projects in an equitable manner to advocate for and work towards green and healthy schools across their district. Districts can also use this data to demonstrate need and potential health co-benefits as part of grant applications.

This section presents data sets across the following two categories:

- **Tier 1** represents the primary data that school districts should evaluate to identify schools of greatest need.
- **Tier 2** represents additional data for school districts that have additional time/resources available and are interested in examining data at a deeper level.



Within each Tier 1/Tier 2 category, this section presents data sets pertaining to the following four categories:

- Physical infrastructure
- Environmental health
- Learning environment and outcomes
- Additional demographics

Tier 1 Data Sets

Physical Infrastructure

Perhaps the most obvious factor to consider when identifying schools having the greatest need is the existing condition of a school's physical infrastructure. School districts should consider evaluating the following three data sources from the MSBA to evaluate the physical infrastructure of the schools in their portfolio:

- MSBA School Survey Report
- MSBA School-Level Summary Reports
- MSBA District-Level Summary Reports

MSBA School Survey Report

As noted in the Introduction, the MSBA has thus far performed School Surveys in 2005, 2010, and 2016, and expects to complete its next survey and publish the accompanying report by the end of 2025. The information outlined in this section is based on the MSBA's most recently completed and published 2016 School Survey Report (see the "School Summaries" section on page 44). Table 33 outlines notable details and recommendations for school districts to evaluate the schools in their district having the greatest need.

Table 33. Notable Details and Recommendations for the Evaluation of the MSBA's 2016 School Survey Report

Data of Interest	Description/Notes	Recommendations
Building Condition Rating	• Evaluates seven site and 18 building systems • Rating scale: 1 to 4; a rating of 1 indicates the best conditions and a 4 indicates the poorest	Prioritize schools with ratings of 4 or 3, which require extensive or moderate renovations, respectively.
Capacity Rating	• Based on each school's Capacity Utilization (a measure of student enrollment divided by the building's capacity) • Rating scale: – Under Utilization (less than 80 percent capacity utilization) – Average Utilization (between 80 and 125 percent capacity utilization) – Over Utilization (equal to or greater than 125 percent capacity utilization)	Prioritize schools that are over utilized.
General Environment Rating	• An overall rating that reflects the school building's Learning Environment, Building Safety, Universal Accessibility, Academic Sufficiency, Program Sufficiency, and Instructional Technology • Rating scale: 1 to 4; a rating of 1 indicates the best environment and a 4 indicates the poorest	Prioritize schools with a rating of either: • 4 (indicating the overall physical environment is poor and may present obstacles to teaching and learning); or • 3 (physical environment is not sufficient and may be negatively affecting teaching and learning)
Year Founded (i.e., Originally Constructed)	• The building code in place at the time of construction informs building construction type and can be considered to subdivide schools. • Districts should account for "Addition/Renovation Year" provided in the accompanying MSBA School-Level Reports (see below).	Prioritize older schools

Data of Interest	Description/Notes	Recommendations
Type of School	• Projects targeting the optimization of environmental health implemented in PreK/Kindergarten and elementary schools result in health benefits earlier in a student's life. • There are pressures to maintain accreditation for high schools • Important to balance considerations	N/A; individual school districts will need to evaluate this factor based on the unique circumstances of its district.

Figure 5 presents a screenshot of a sampling of 2016 School Survey Summary Findings with the five data elements of interest from Table 33 highlighted in yellow.

Figure 5. Screenshot of Sampling of 2016 School Survey Summary Findings

MSBA 2016 School Survey Summary Findings (Sorted By District and School)

** denotes schools in Grant Program not assessed in 2016*

District	School	Type	Year Founded	2016/2017 Enrollment	Total GSF	SF/ Student	Classroom Count	Students/ Classroom	Building Condition Rating	Capacity Rating	General Environment Rating
Abington	Abington High	HS	1962	452	132,000	292.0	*	*	*	*	*
Abington	Beaver Brook Elementary School	ES	1952	580	67,000	115.5	29	20.0	1	Average	1
Abington	Center ES	PreK / K	1952	203	19,800	97.5	*	*	*	*	*
Abington	Frolio Jr Hs	MS	2017	328	51,000	155.5	24	13.7	*	*	*
Abington	Woodsdale	Int	1958	353	56,000	158.6	17	20.8	1	Over	2
Acton-Boxborough	Acton-Boxborough Reg High	HS	1963	1864	386,000	207.1	97	19.2	1	Average	1
Acton-Boxborough	Blanchard Memorial	ES	1949	413	68,000	164.6	29	14.2	1	Average	1
Acton-Boxborough	Douglas	ES	1966	456	46,000	100.9	22	20.7	1	Average	2
Acton-Boxborough	Gates	ES	1968	404	52,000	128.7	22	18.4	2	Average	1
Acton-Boxborough	Luther Conant	ES	1971	451	58,000	128.6	24	18.8	2	Average	1
Acton-Boxborough	McCarthy-Towne	ES	2002	475	30,880	65.0	*	*	*	*	*
Acton-Boxborough	Merriam	ES	2002	517	39,020	75.5	*	*	*	*	*
Acton-Boxborough	Raymond J Grey JH	MS	1955	911	146,000	160.3	63	14.5	1	Under	1
Acushnet	Acushnet Elementary School	ES	1971	538	95,709	177.9	35	15.4	1	Average	1
Acushnet	Albert F Ford Middle School	MS	1960	417	109,848	263.4	32	13.0	1	Under	1
Adams-Cheshire	Cheshire Elementary	ES	1923	244	61,000	250.0	18	13.6	2	Average	1
Adams-Cheshire	Hoosac Valley High	MS / HS	1971	622	174,370	280.3	52	12.0	1	Under	1
Adams-Cheshire	Plunkett Elementary	ES	1923	451	88,300	195.8	25	18.0	3	Over	2
Agawam	Agawam High	HS	1955	1222	266,892	218.4	74	16.5	1	Average	1
Agawam	Agawam Junior High	MS	1973	562	131,000	233.1	48	11.7	1	Under	1
Agawam	Benjamin J Phelps	ES	1938	385	57,425	149.2	21	18.3	1	Average	1
Agawam	Clifford M Granger	ES	1950	293	49,750	169.8	16	18.3	1	Average	1

MSBA School-Level Summary Reports

In addition to publishing School Survey Reports, the MSBA also prepares School-Level Summary Reports that schools and school districts can request from the MSBA. Table 34 outlines notable details and recommendations for school districts to evaluate the schools in their district having the greatest need.

Table 34. Notable Details and Recommendations for the Evaluation of the MSBA's School-Level Summary Reports

Data of Interest	Notes/Considerations	Recommendations
Year Built and "Addition/Renovation Details"	• "Year Built" should be consistent with the "Year Founded" field in the MSBA School Surveys • The "Addition/Renovation Details" field will indicate if school has had recent additions/renovations since original construction	Prioritize older schools based on "Year Built" that have not had recent additions/renovations
Asset-Level Data ("Building Systems" section)	• The 2024 MSBA Accelerated Repair Program includes minimum age thresholds for windows (30-years) and roofs (25-years). • Schools should consider the qualitative context in the building system notes. • Schools should consider the qualitative information in the "Electrical Services and Distribution" field (e.g., circuits trip regularly).	• Prioritize buildings with multiple, older systems for more comprehensive projects (modernization, new construction, deep energy retrofits). Buildings with individual, older systems can be prioritized for component retrofits. • Single pane windows should be prioritized for upgrades. • Boiler: Oil boilers should be prioritized for replacement. • "HVAC Heating Type" = "Steam" should be prioritized for replacement. • "HVAC – Ventilation/AC Type" =

Data of Interest	Notes/Considerations	Recommendations
		"None" should be prioritized. • "HVAC – Ventilation/AC Coverage" = "Partial" should be prioritized. • "HVAC – Ventilation/AC Type" = "DX/Package" and "DX/Split" should be prioritized for component retrofit since they do not rely on a central plant and may be able to offer heating (in addition to cooling) with an electric heat pump retrofit. • Prioritize schools with higher "Amperage of the main breaker" for electrification.

Figure 6 through Figure 9 present screenshots from various sections of a sample MSBA School-Level Summary Report that illustrate the data elements summarized in Table 34.

Figure 6. Screenshot from Sample MSBA School-Level Summary Report Illustrating Year Built and Addition/Renovation Details

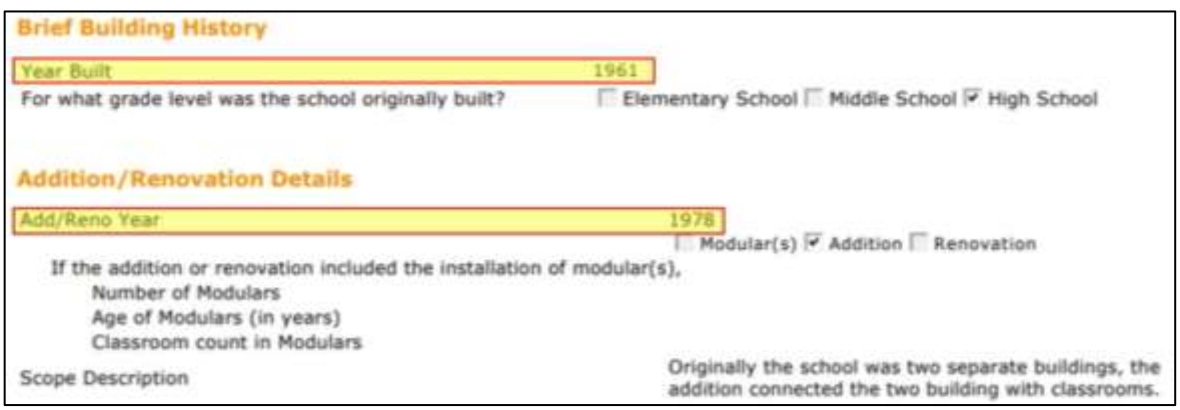

Brief Building History
Year Built 1961
For what grade level was the school originally built? Elementary School Middle School High School
Addition/Renovation Details
Add/Reno Year 1978
Modular(s) Addition Renovation
If the addition or renovation included the installation of modular(s),
Number of Modulars
Age of Modulars (in years)
Classroom count in Modulars
Scope Description Originally the school was two separate buildings, the addition connected the two building with classrooms.

Figure 7. Screenshot from Sample MSBA School-Level Summary Report Illustrating Asset-Level Data in "Building Systems" Section

Building Systems(Tier I)

Roof	
Total SF of all roof sections (per building)	69448
Oldest Roof Section - Year	2011
Oldest Roof Section - Square Footage	69448
Oldest Roof Section - Type	Single Ply
2nd Oldest Roof Section - Year	
2nd Oldest Roof Section - Square Footage	
2nd Oldest Roof Section - Type	Please Select
Exterior Windows	
Oldest Windows - Year	1978
Percent of total Windows	10
Oldest Windows - Type	Single Pane Aluminum
2nd Oldest Windows - Year	2002
Percent of total Windows	90
2nd Oldest Windows - Type	Insulated Aluminum
Boilers	
Oldest Boiler - Year	1973
Oldest Boiler - Fuel Type	Oil
2nd Oldest Boiler - Year	

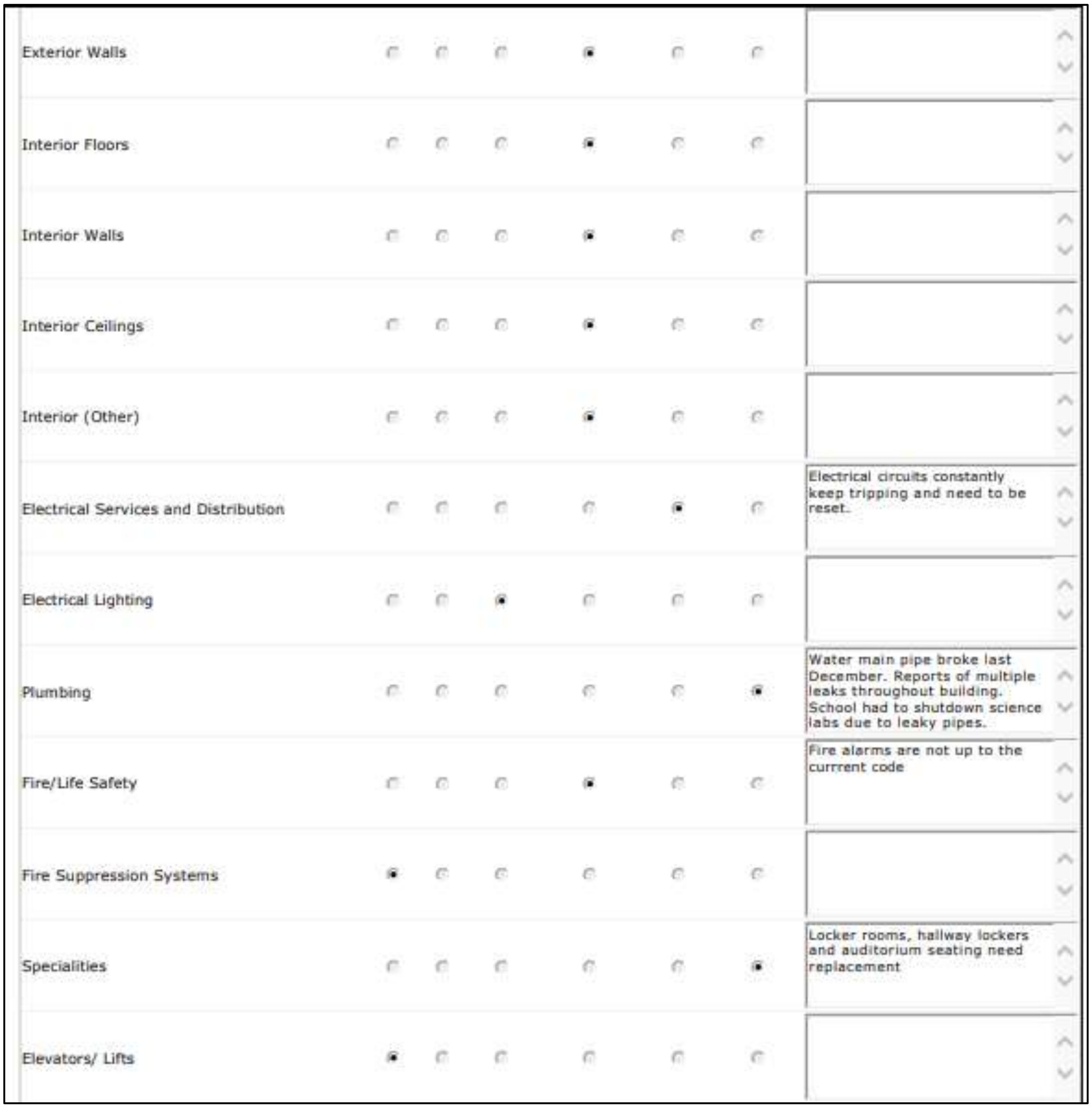
Figure 8. Screenshot from Sample MSBA School-Level Summary Report Illustrating Asset-Level Data in "Building Systems" Section (Continued)

2nd Oldest Boiler - Fuel Type	Please Select
HVAC	
Oldest HVAC - Year	1961
HVAC Heating Type	Hot water
HVAC - Ventilation/AC type	Displacement Ventilation
HVAC - Ventilation/AC Coverage	● Full ○ Partial ○ None
Electrical	
Amperage of the main breaker A?	1201-1600
Voltage of the main breaker A?	120/208 three phase
Amperage of the main breaker B?	Please Select
Voltage of the main breaker B?	Please Select
Amperage of the main breaker C?	Please Select
Voltage of the main breaker C?	Please Select
Elevators	
How many elevators in this building?	0
How many chair lifts in this building?	0

Building Systems(Tier II)

	N/A	GMO	Minor	Moderate	Major	Replace	Notes
Roof Oldest Section	○	○	●	○	○	○	
Roof Second Oldest Section	●	○	○	○	○	○	
Exterior Windows - Oldest	○	○	○	○	○	●	Windows are unable to open. Window frames are deteriorating.
Exterior Windows - Second Oldest	○	○	○	●	○	○	
Boilers - Oldest	○	○	○	●	○	○	
Boilers - Second Oldest	●	○	○	○	○	○	
HVAC	○	○	○	○	●	○	Unit vents are in bad condition. Some UV leaked and flooded the classrooms.
Structural Soundness	○	○	●	○	○	○	
Exterior Doors	○	○	○	○	●	○	Most exterior door are rusted and require replacement.

Figure 9. Screenshot from Sample MSBA School-Level Summary Report Illustrating Asset-Level Data in "Building Systems" Section (Continued)



MSBA District-Level Summary Reports

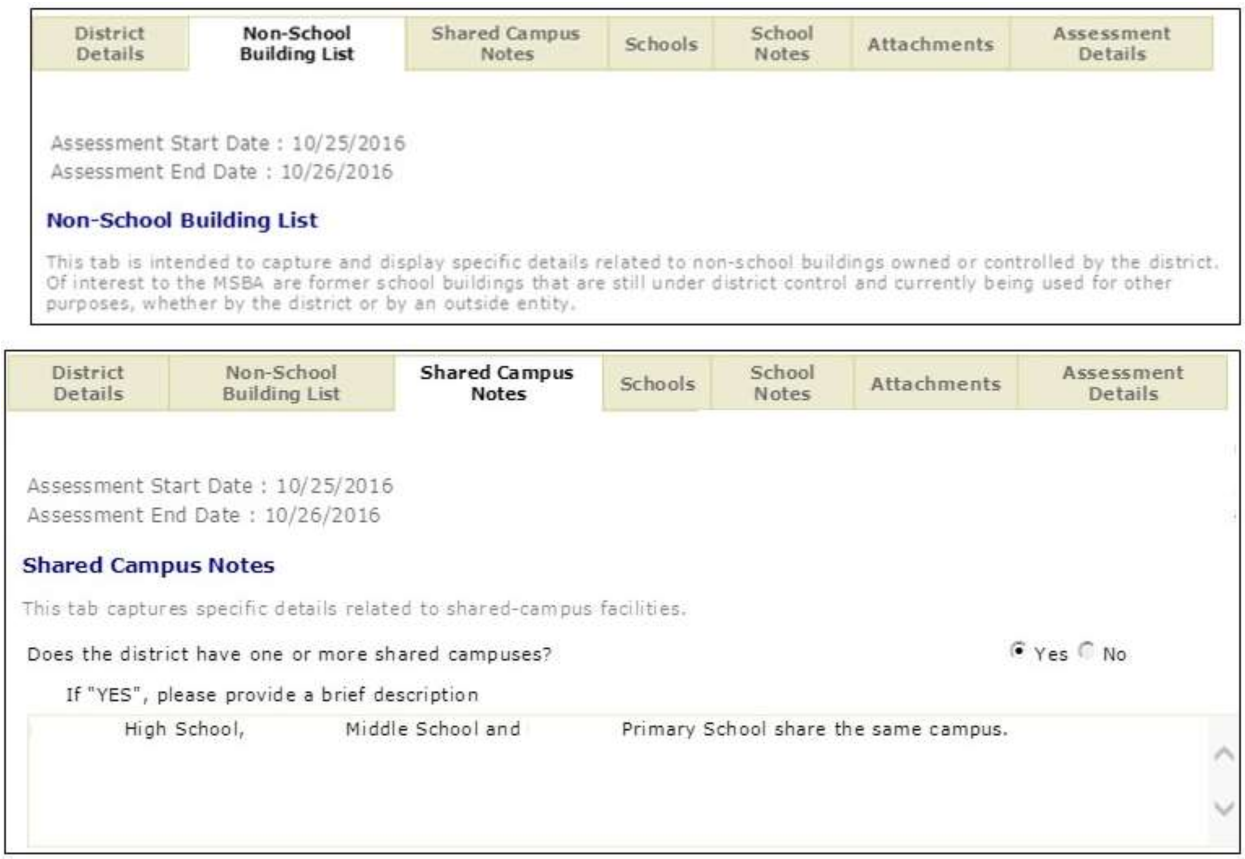
The MSBA also prepares District-Level Summary Reports that summarize data for all schools within a school district. School districts can also request a copy of these reports from the MSBA. Table 35 outlines notable details and recommendations for school districts to evaluate the schools in their district having the greatest need.

Table 35. Notable Details and Recommendations for the Evaluation of the MSBA's District-Level Summary Reports

Data of Interest	Notes/Considerations	Recommendations
"Non-School Building List"	N/A	Consider non-school buildings where projects may impact other municipal facilities
"Shared Campus Notes"	N/A	Consider shared campuses where projects may impact and offer benefits to multiple school buildings

Figure 10 presents screenshots from two sections of a sample MSBA District-Level Summary Report that illustrate the data elements summarized in Table 35.

Figure 10. Screenshot from Sample MSBA District-Level Summary Report Illustrating Qualitative Data in the "Non-School Building List" and "Shared Campus Notes" Sections



Environmental Health

Beyond consideration of the physical infrastructure of each district's portfolio of school buildings, DPH suggests that school districts also evaluate publicly available environmental health and disease data for communities where their students live. This will help districts identify schools that may experience disproportionally high rates of childhood lead poisoning and/or pediatric asthma. Both of these health outcomes are directly linked to future school performance, increased learning disabilities, and, consequently, an increased burden on schools. School districts should consider evaluating the following two sources from DPH to evaluate relevant environmental health indicators that will help increase awareness of and identify schools having the greatest needs:

- DPH Annual Childhood Lead Poisoning Surveillance Reports
- Massachusetts Environmental Public Health Tracking Tool

DPH Annual Childhood Lead Poisoning Surveillance Reports

DPH's Childhood Lead Poisoning Prevention Program publishes an Annual Childhood Lead Poisoning Surveillance Report. In each of these reports, DPH identifies a list of communities within the Commonwealth that DPH has determined to be at high risk of having childhood lead poisoning based on the following factors:

- Rates of newly poisoned children
- Age of housing
- Income levels
- At least 15 cases of lead poisoning in the previous five years

Figure 11 presents the list of 16 communities that DPH identified in 2023 as having a high risk of childhood lead poisoning. In addition, for rural communities that may not meet the 15-case threshold but may exhibit high prevalence of childhood lead exposure, the report provides special analyses and mapping to identify areas of high risk. In particular, many rural areas in the central and western parts of the state have a higher prevalence of elevated blood lead levels compared to the state overall and children in rural level 2 communities are twice as likely to have elevated blood lead levels. While the Annual Childhood Lead Poisoning Surveillance Report does not provide a school district the means to differentiate levels of risk between specific schools within its district, the annual list of high-risk communities contributes to general awareness of the prevalence of this health indicator within a community.

Figure 11. Communities Identified as High Risk for Childhood Lead Poisoning in 2023

2023 High-Risk Communities[1]

1. **New Bedford**
2. **Springfield**
3. **Brockton**
4. **Fall River**
5. **Lowell**
6. **Lynn**
7. **Everett**
8. **Lawrence**
9. **Pittsfield**
10. **Worcester**
11. **Chelsea**
12. **Chicopee**
13. **Westfield**
14. **Boston**
15. **Malden**
16. **Taunton**

[1]The high-risk communities are listed in order from highest to lowest high-risk score.

Massachusetts Environmental Public Health Tracking Tool

DPH maintains the Massachusetts Environmental Public Health Tracking Tool (EPHT), which includes a wealth of environmental and health data for communities across the Commonwealth. The EPHT enables users to query comprehensive health data sets and produce custom map overlays with vulnerability criteria to identify areas where public health mitigation actions should be implemented. DPH encourages school districts to evaluate the following two particular areas within the tool, each of which is covered in more detail in this section:

- Prevalence of pediatric asthma
- Community profiles

Prevalence of Pediatric Asthma

Since 2003, DPH has tracked the occurrence of pediatric asthma using health record data reported by school nurses from all public and private K-8 schools. Within the EPHT's Health Module, school districts can explore pediatric asthma maps and data tables from the 2009–2010 school year to the present. Table 36 outlines notable details supporting the evaluation of the EPHT's pediatric asthma prevalence data to assist school districts in identifying schools of greatest need.

Table 36. Notable Details Supporting the Evaluation of the EPHT's Pediatric Asthma Prevalence Data

Data of Interest	Notes/Considerations	Options for Viewing Output
Prevalence of Pediatric Asthma	• Data available at school level or town of residence • 10 school years of data currently available • Pandemic-related gap in data from 2019–2022	• Map view • Table view • Chart view • Raw data export

Data of Interest	Notes/Considerations	Options for Viewing Output
	• Numerous means of viewing output • Data represent children *ever* diagnosed with asthma (as compared to active asthma)	

Figure 12 presents a screenshot of the EPHT module in which users input their query parameters to view pediatric asthma prevalence data. DPH suggests school districts structure the query to capture multiple years of data and include data for both males and females (select “Total” in the “Select Sex” field).

Figure 12. EPHT Query Parameters for Pediatric Asthma Prevalence by Community and School

Figure 13 illustrates a sample screenshot of the EPHT's map view output of pediatric asthma prevalence data. This view presents circles of varying colors for each school reporting asthma data to DPH. Each color corresponds to a specified asthma prevalence category, which enables users to quickly focus on schools with higher prevalence.

Figure 13. EPHT's Map View Output of Pediatric Asthma Prevalence Data

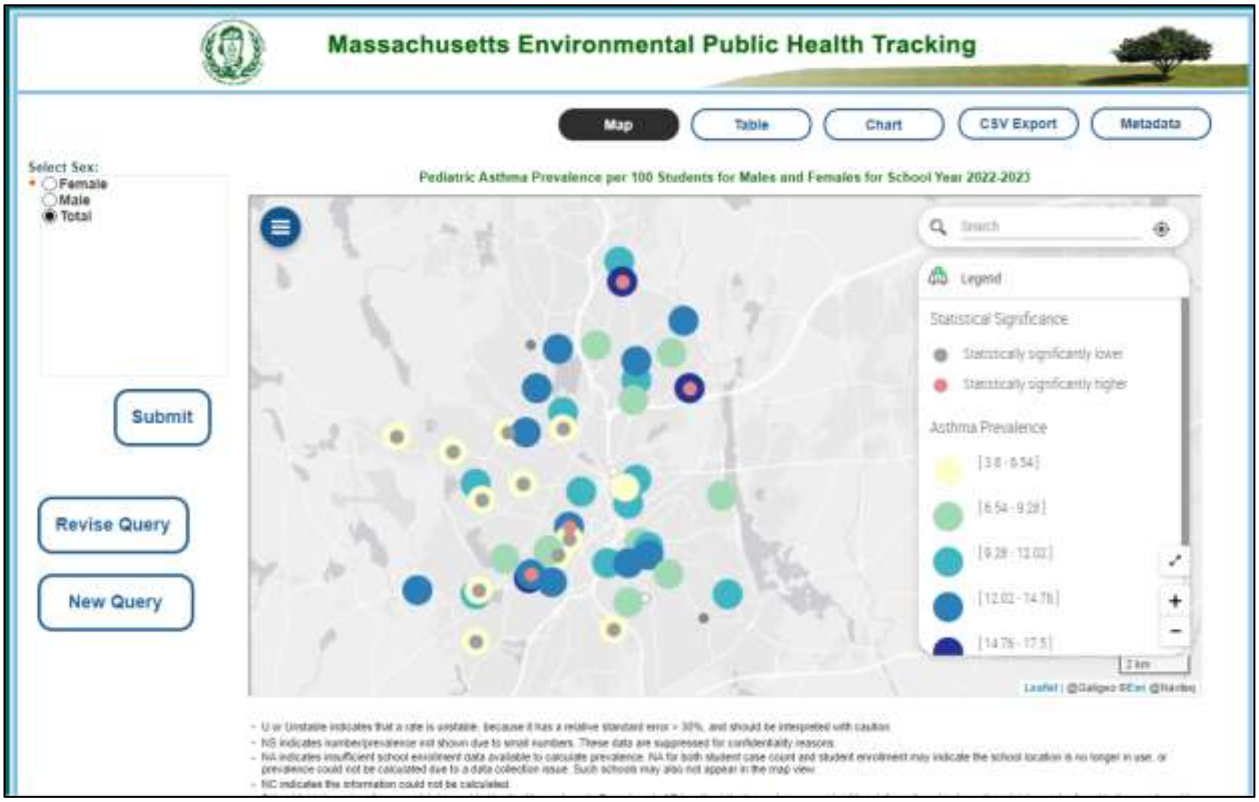
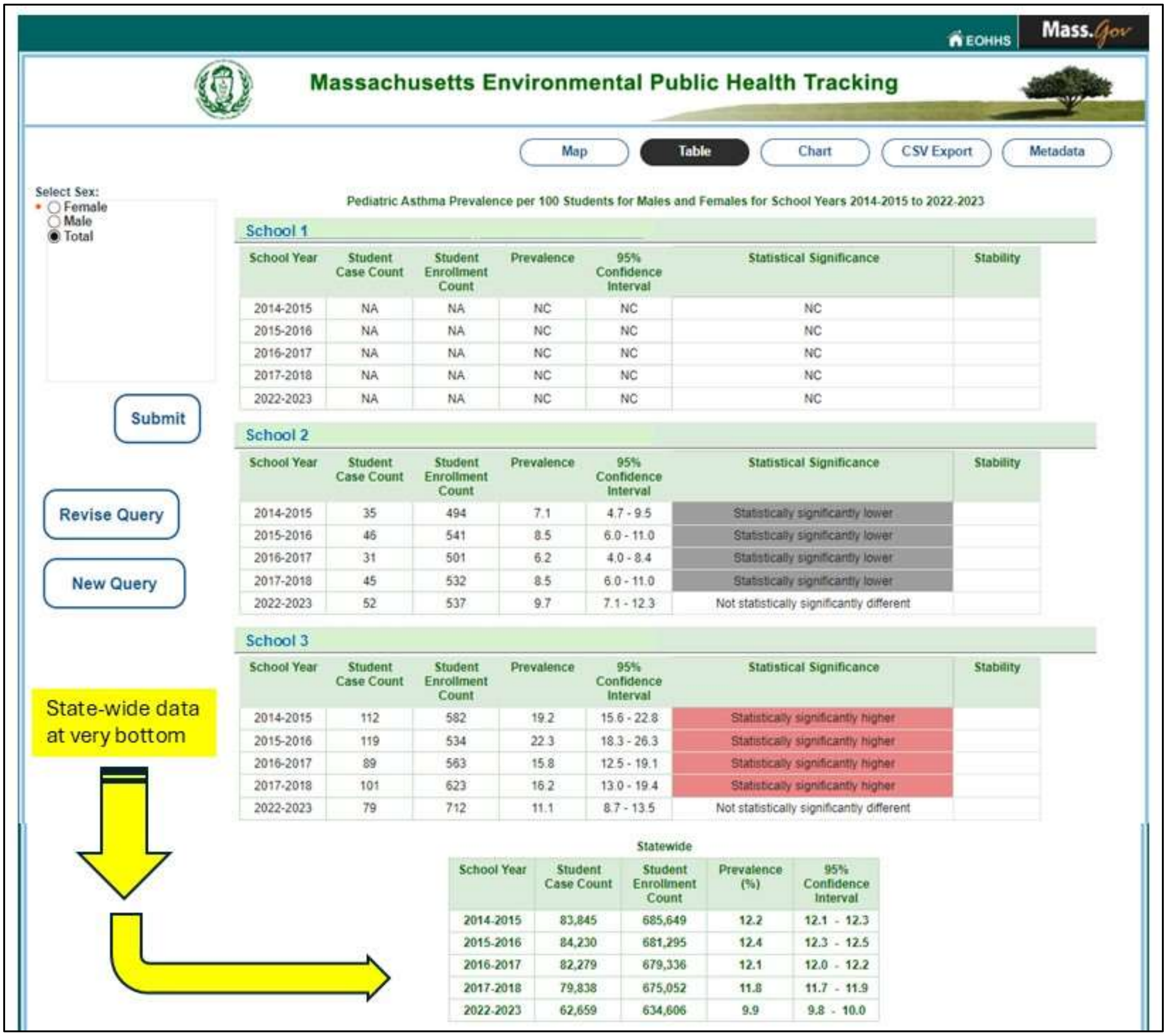


Figure 14 illustrates a sample screenshot of the EPHT's table view output of pediatric asthma prevalence data. This output presents annual data for each participating school in the selected community, as well as aggregated statewide data at the very bottom of the screen.

Figure 14 EPHT's Table View Output of Pediatric Asthma Prevalence Data



School 1

School Year	Student Case Count	Student Enrollment Count	Prevalence	95% Confidence Interval	Statistical Significance	Stability
2014-2015	NA	NA	NC	NC	NC	
2015-2016	NA	NA	NC	NC	NC	
2016-2017	NA	NA	NC	NC	NC	
2017-2018	NA	NA	NC	NC	NC	
2022-2023	NA	NA	NC	NC	NC	

School 2

School Year	Student Case Count	Student Enrollment Count	Prevalence	95% Confidence Interval	Statistical Significance	Stability
2014-2015	35	494	7.1	4.7 - 9.5	Statistically significantly lower	
2015-2016	46	541	8.5	6.0 - 11.0	Statistically significantly lower	
2016-2017	31	501	6.2	4.0 - 8.4	Statistically significantly lower	
2017-2018	45	532	8.5	6.0 - 11.0	Statistically significantly lower	
2022-2023	52	537	9.7	7.1 - 12.3	Not statistically significantly different	

School 3

School Year	Student Case Count	Student Enrollment Count	Prevalence	95% Confidence Interval	Statistical Significance	Stability
2014-2015	112	582	19.2	15.6 - 22.8	Statistically significantly higher	
2015-2016	119	534	22.3	18.3 - 26.3	Statistically significantly higher	
2016-2017	89	563	15.8	12.5 - 19.1	Statistically significantly higher	
2017-2018	101	623	16.2	13.0 - 19.4	Statistically significantly higher	
2022-2023	79	712	11.1	8.7 - 13.5	Not statistically significantly different	

Statewide

School Year	Student Case Count	Student Enrollment Count	Prevalence (%)	95% Confidence Interval
2014-2015	83,845	685,649	12.2	12.1 - 12.3
2015-2016	84,230	681,295	12.4	12.3 - 12.5
2016-2017	82,279	679,336	12.1	12.0 - 12.2
2017-2018	79,838	675,052	11.8	11.7 - 11.9
2022-2023	62,659	634,606	9.9	9.8 - 10.0

Figure 15 illustrates a sample screenshot of the EPHT's chart view output of pediatric asthma prevalence data. This output presents annual data for each participating school in the selected community in a bar chart. This enables users to both identify schools with greater prevalence relative to other schools and visually observe year-to-year trends in asthma prevalence for a single school.

Figure 15 EPHT's Chart View Output of Pediatric Asthma Prevalence Data

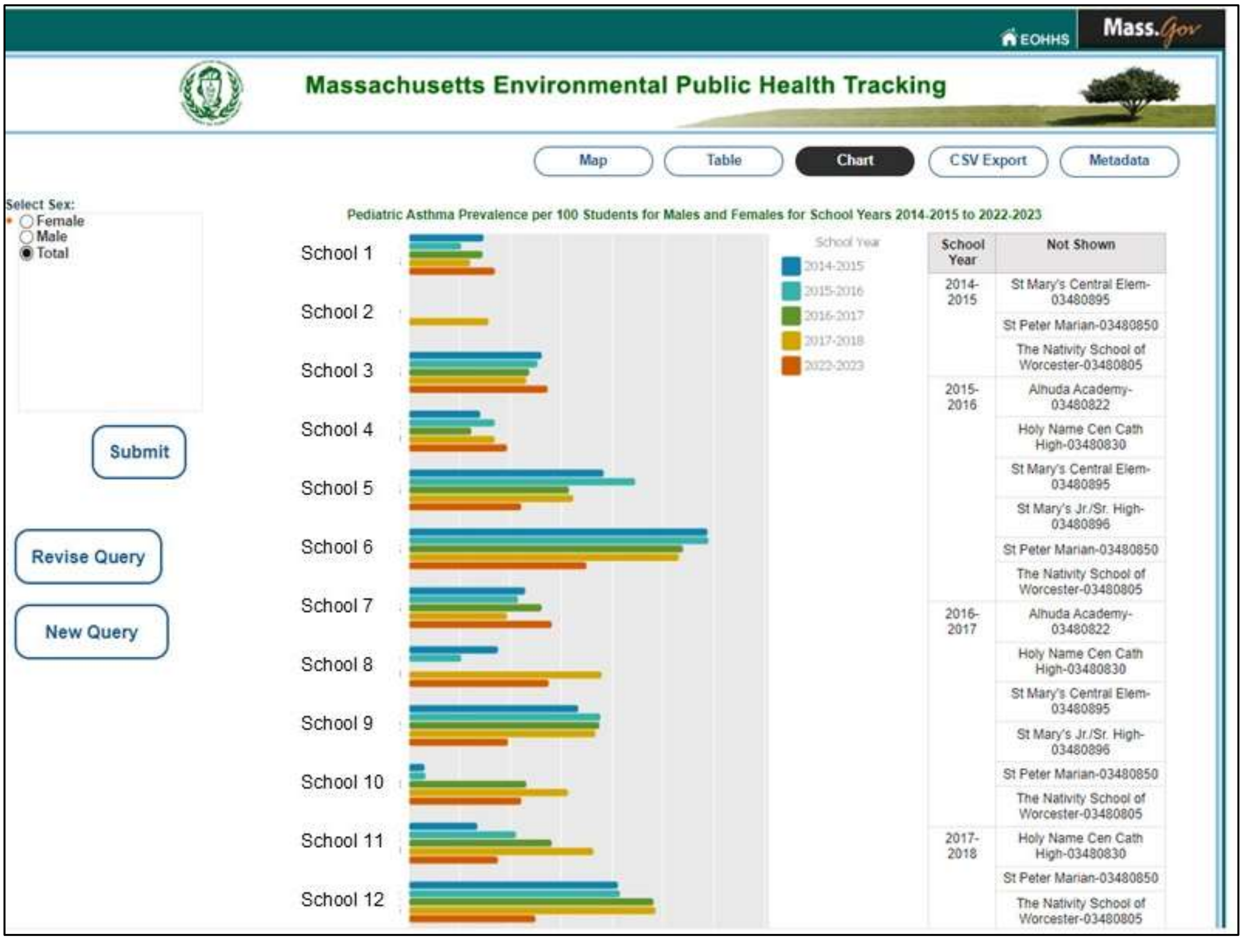
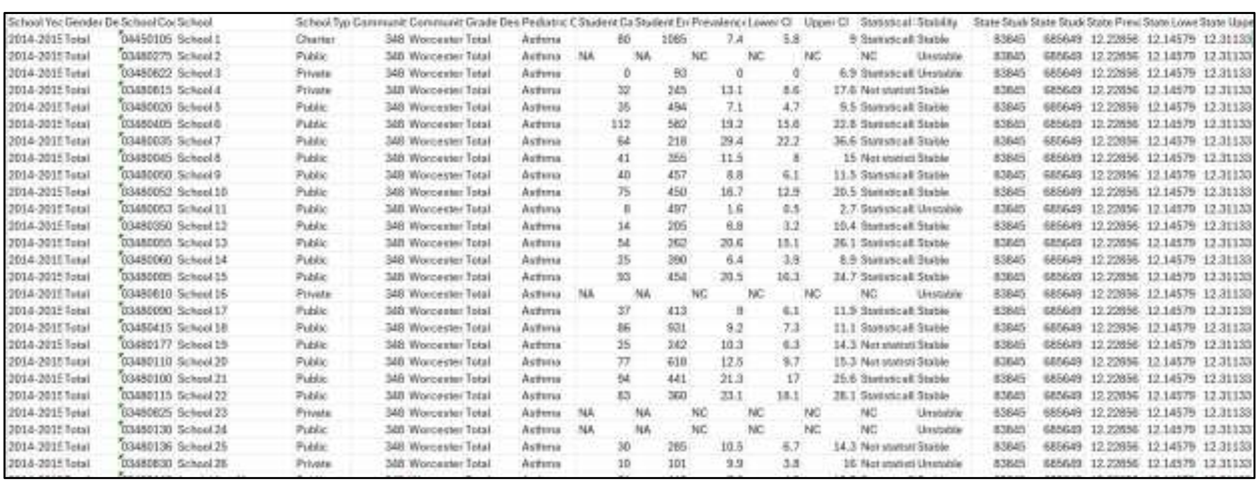


Figure 16 presents a screenshot of a sample export of pediatric asthma prevalence data into a CSV file, enabling users to perform additional custom analysis.

Figure 16. Screenshot of Sample Export of Pediatric Asthma Prevalence Data from the EPHT

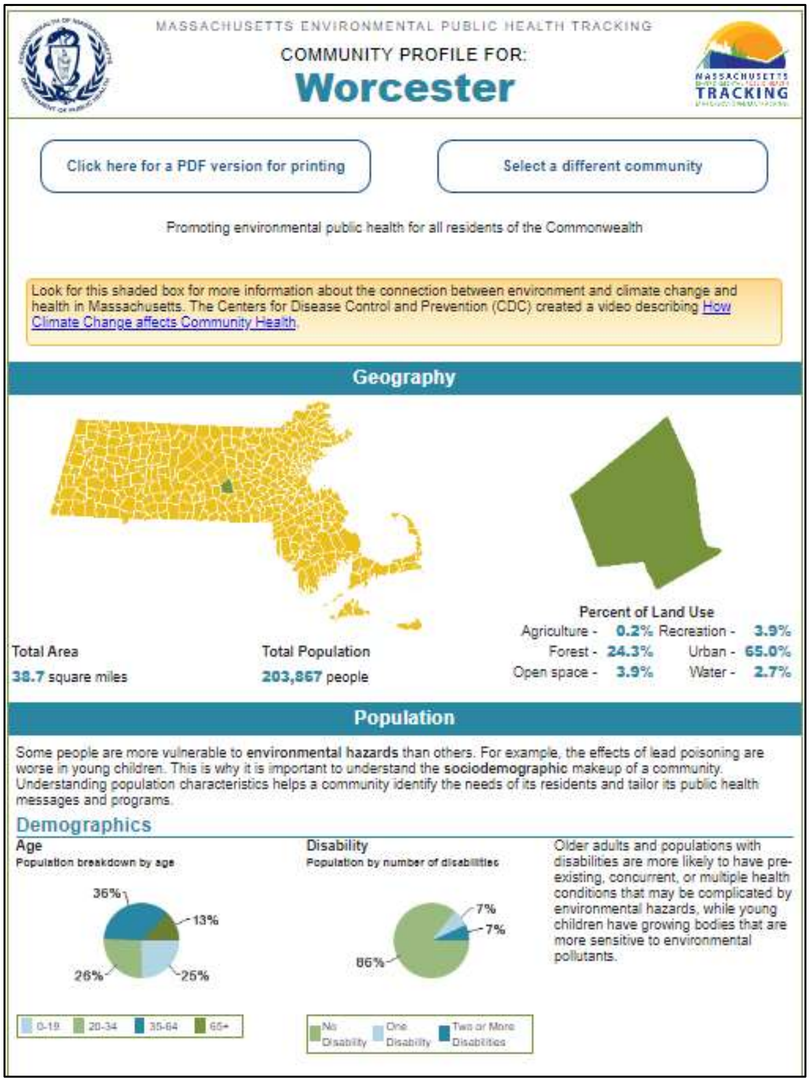


School Yea	Gender De	School Co	School	School Typ	Communit	Communit	Grade Des	Pediatric C	Student Ca	Student En	Prevalenc	Lower CI	Upper CI	Statistical	Stability	State Stud	State Stud	State Prev	State Lowe	State Uppe
2014-2015	Total	04450105	School 1	Charter	348	Worcester	Total	Asthma	80	1065	7.4	5.8	9	Statisticall	Stable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480275	School 2	Public	348	Worcester	Total	Asthma	NA	NA	NC	NC	NC	NC	Unstable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480622	School 3	Private	348	Worcester	Total	Asthma	0	93	0	0	6.9	Statisticall	Unstable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480615	School 4	Private	348	Worcester	Total	Asthma	32	245	13.1	8.6	17.6	Not statisti	Stable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480020	School 5	Public	348	Worcester	Total	Asthma	35	494	7.1	4.7	9.5	Statisticall	Stable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480405	School 6	Public	348	Worcester	Total	Asthma	112	582	19.2	15.6	22.8	Statisticall	Stable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480035	School 7	Public	348	Worcester	Total	Asthma	64	218	29.4	22.2	36.6	Statisticall	Stable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480045	School 8	Public	348	Worcester	Total	Asthma	41	355	11.5	8	15	Not statisti	Stable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480050	School 9	Public	348	Worcester	Total	Asthma	40	457	8.8	6.1	11.5	Statisticall	Stable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480052	School 10	Public	348	Worcester	Total	Asthma	75	450	16.7	12.9	20.5	Statisticall	Stable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480053	School 11	Public	348	Worcester	Total	Asthma	8	497	1.6	0.5	2.7	Statisticall	Unstable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480350	School 12	Public	348	Worcester	Total	Asthma	14	205	6.8	3.2	10.4	Statisticall	Stable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480055	School 13	Public	348	Worcester	Total	Asthma	54	262	20.6	15.1	26.1	Statisticall	Stable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480060	School 14	Public	348	Worcester	Total	Asthma	25	390	6.4	3.9	8.9	Statisticall	Stable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480065	School 15	Public	348	Worcester	Total	Asthma	93	454	20.5	16.3	24.7	Statisticall	Stable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480610	School 16	Private	348	Worcester	Total	Asthma	NA	NA	NC	NC	NC	NC	Unstable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480090	School 17	Public	348	Worcester	Total	Asthma	37	413	9	6.1	11.9	Statisticall	Stable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480415	School 18	Public	348	Worcester	Total	Asthma	86	931	9.2	7.3	11.1	Statisticall	Stable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480177	School 19	Public	348	Worcester	Total	Asthma	35	342	10.3	6.3	14.3	Not statisti	Stable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480110	School 20	Public	348	Worcester	Total	Asthma	77	618	12.5	9.7	15.3	Not statisti	Stable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480100	School 21	Public	348	Worcester	Total	Asthma	94	441	21.3	17	25.6	Statisticall	Stable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480115	School 22	Public	348	Worcester	Total	Asthma	83	360	23.1	18.1	28.1	Statisticall	Stable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480625	School 23	Private	348	Worcester	Total	Asthma	NA	NA	NC	NC	NC	NC	Unstable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480130	School 24	Public	348	Worcester	Total	Asthma	NA	NA	NC	NC	NC	NC	Unstable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480136	School 25	Public	348	Worcester	Total	Asthma	30	265	10.5	6.7	14.3	Not statisti	Stable	83845	685649	12.22856	12.14579	12.31133
2014-2015	Total	03480630	School 26	Private	348	Worcester	Total	Asthma	10	101	9.9	3.8	16	Not statisti	Unstable	83845	685649	12.22856	12.14579	12.31133

Community Profiles

Within the Planning and Tools Module of the EPHT, school districts can view Community Profiles, which present a comprehensive synopsis of community-specific health, demographic, and environmental data, including how each pertains to climate change, all in a single, easy-to-use report. Figure 17 illustrates a screenshot of a sample Community Profile in the EPHT. The Community Profiles in the EPHT do not provide a school district the means to differentiate health indicators between specific schools within its district; however, the Community Profiles in the EPHT further contribute to general awareness of environmental health indicators within a community.

Figure 17. Screenshot of a Sample Community Profile from EPHT



Learning Environment and Outcomes

In addition to considering the physical infrastructure of each district's portfolio of school buildings and environmental health data from DPH, school districts should also evaluate data from DESE's School and District Profiles, which provide insights into individual school learning environments and outcomes. This will help districts identify schools having greater percentages of non-white students, who have been historically marginalized; schools that have greater percentages of students with disabilities, high needs, low-income backgrounds, and for whom English is not their first language; and schools that have lower graduation rates relative to other schools. School districts should consider evaluating the following three reports in DESE's School and District Profiles to evaluate relevant learning environment and outcome indicators that will help increase awareness of and identify schools having the greatest needs:

- Enrollment by Race/Gender
- Selected Populations
- Graduation Rate

Enrollment by Race/Gender Report

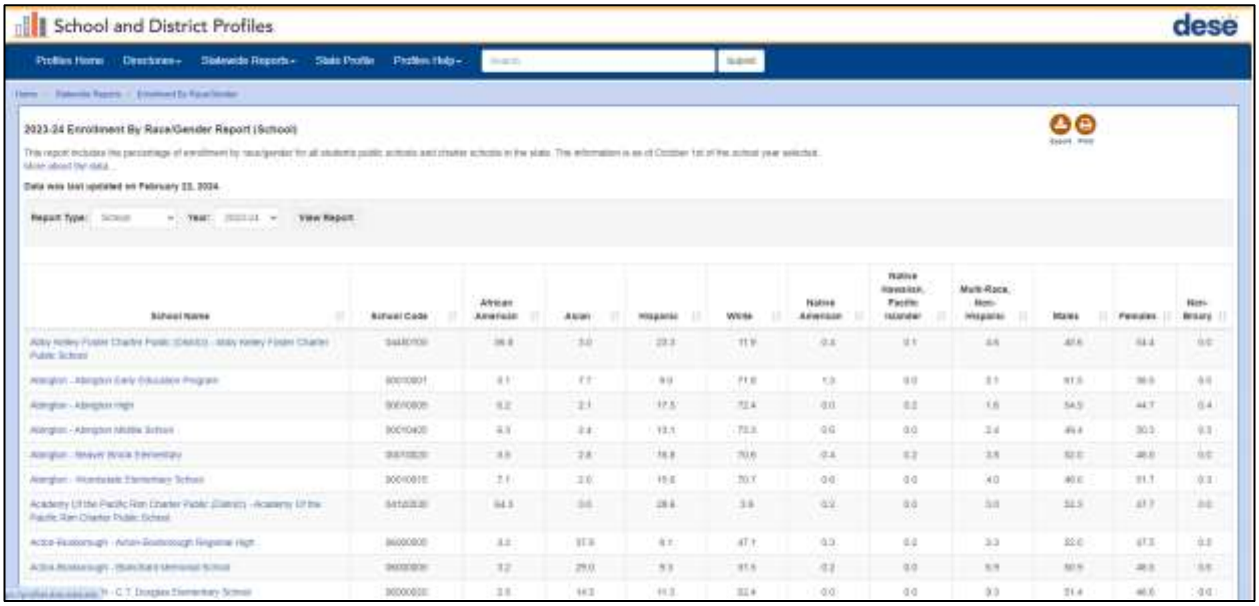
Table 37 outlines notable details supporting the evaluation of DESE's Enrollment by Race/Gender Report to assist school districts in identifying schools of greatest need.

Table 37. Notable Details Supporting the Evaluation of DESE's Enrollment by Race/Gender Report

Data of Interest	Notes/Considerations	Recommendations
Composition of student body by race • African American • Asian • Hispanic • White • Native American • Native Hawaiian, Pacific Islander • Multi-Race, Non-Hispanic	• Indicator of schools having greater percentages of non-white students, who have been historically marginalized	Prioritize funding for project implementation in schools with higher rates of students of color

Figure 18 presents a screenshot of DESE's Enrollment by Race/Gender Report. Note that school districts are encouraged to select "School" in the "Report Type" field to differentiate racial data at the individual school-level. For this and all other District Profiles, users are able to dynamically sort the data by any column header, save the output to a PDF, and export the data to a Microsoft Excel file for additional custom analysis.

Figure 18. Screenshot of the DESE's Enrollment by Race/Gender Report



Selected Populations Report

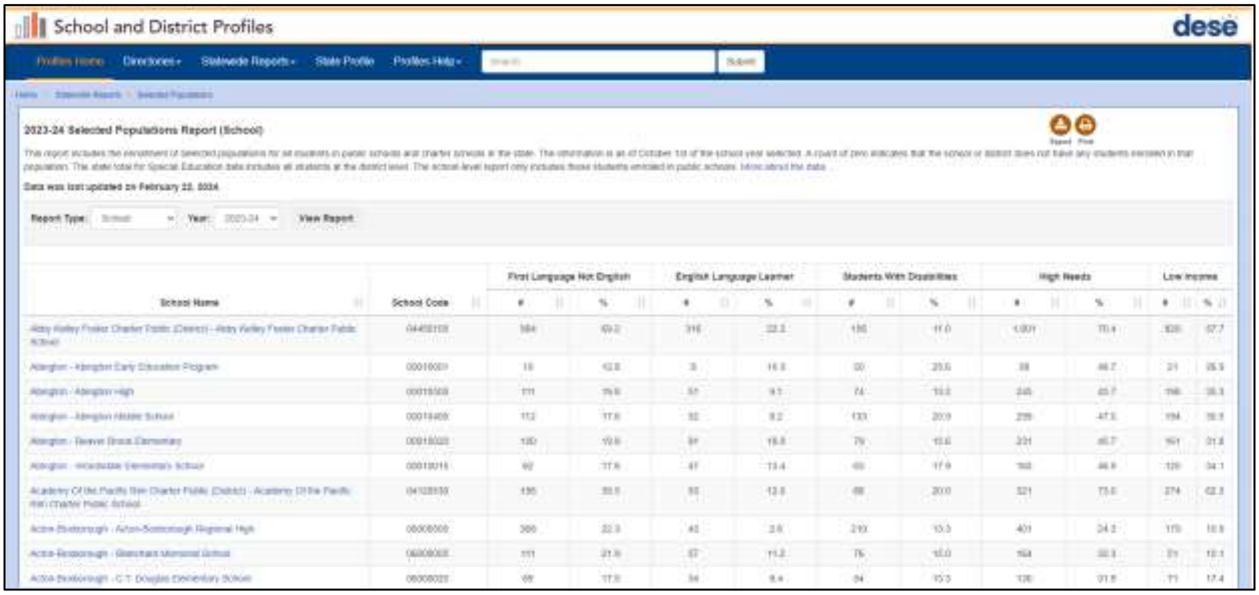
Table 38 outlines notable details supporting the evaluation of the DESE's Selected Populations Report to assist school districts in identifying schools of greatest need.

Table 38. Notable Details Supporting Evaluation of the DESE's Selected Populations Report

Data of Interest	Notes/Considerations	Recommendations
Composition of student body by the following characteristics: • First language not English • English language learner • Students with disabilities • High needs • Low income	• Further indicator of schools having greater percentages of students that have historically been marginalized	Prioritize funding for project implementation in schools with higher rates of the following characteristics: • First language not English • English language learner • Students with disabilities • High needs • Low income

Figure 19 presents a screenshot of DESE's Selected Populations Report.

Figure 19. Screenshot of DESE's Selected Populations Report



Graduation Rate Report

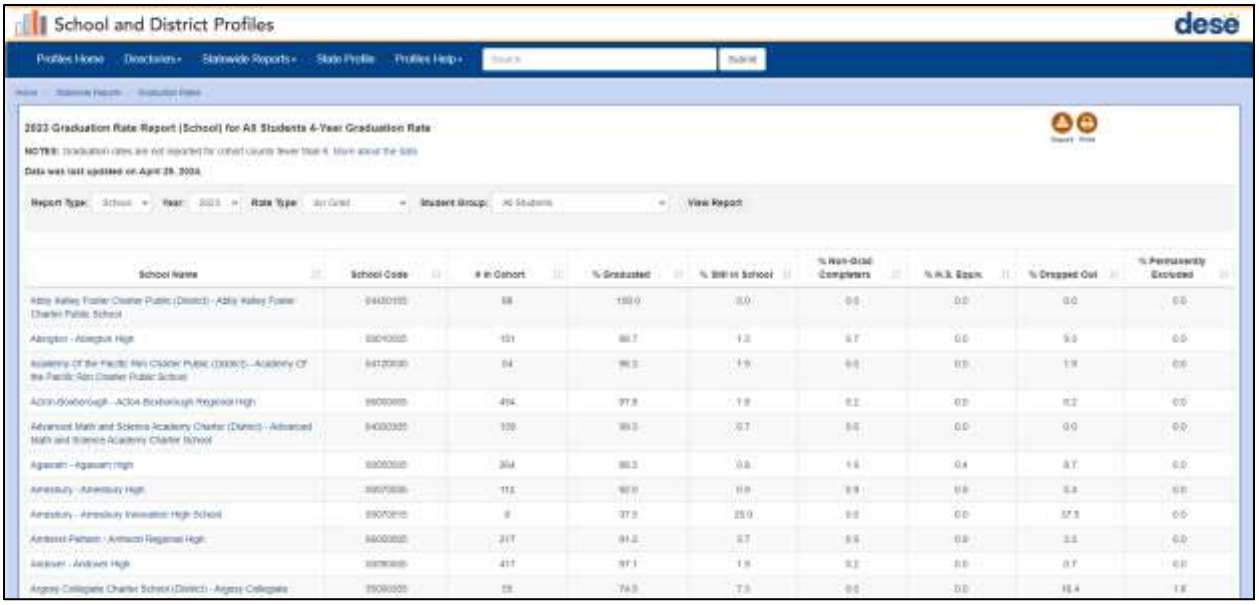
Table 39 outlines notable details supporting the evaluation of DESE's [Graduation Rate Report for All Students] to assist school districts in identifying schools of greatest need.

Table 39. Notable Details Supporting the Evaluation of DESE's Graduation Rate Report

Data of Interest	Notes/Considerations	Recommendations
• Percent graduated	• Possible indicator of student performance and/or need for improved learning/social environment	Prioritize funding for project implementation in schools with lower graduation rates

Figure 20 presents a screenshot of DESE's Graduation Rate Report.

Figure 20. Screenshot of DESE's Graduation Rate Report



Additional Demographic Data

DPH's geographic information system-based [Massachusetts Health Data Tool](#) supplements the school-specific learning environment data in DESE's School and District Profiles. The Tool provides school districts a means of visually evaluating additional community-specific demographic data and overlaying the locations of individual schools. These additional demographic data will help school districts better understand the broader community context influencing student health and education outcomes and further prioritize schools having the greatest needs.

The Massachusetts Health Data Tool is a suite of reporting and mapping platforms designed to help visitors find community- and state-specific data quickly and easily. With access to more than 100 indicators, the Community and State Reporting tools provide access to up-to-date data on SDOH, as well as health behaviors, health outcomes, and healthcare delivery.

When viewing data from the Massachusetts Health Data Tool, users may see differences among population groups. The differences are especially noticeable between white people and people of color. These differences exist because of structural racism. These differences are **not** because of an individual's choices, behaviors, or identity. Systems of oppression, such as racism, cause harm to everyone. They also influence the SDOH, which impact health outcomes (see Figure 21.)

Figure 21. Health Equity Framework

Source: Massachusetts Health Data Tool

If sharing these data, it is important to use racial equity context and framing. The DPH Racial Equity Data Road Map is one resource that can help.

Additionally, the datasets from the Massachusetts Health Data Tool currently have limited (or no) data broken down by sexual orientation, gender identity, and intersex status. Many of the indicators in the State Health Assessment report data by gender; however, the data made available reflects gender as the sex assigned by birth (male/female). This binary framework of reporting does not capture the full spectrum of gender identity. Gender is a multi-dimensional construct that includes identity and expression. By maintaining binary language, data sources can be exclusionary and render transgender and non-binary populations invisible. By gathering information around gender identity, sex assigned at birth, and sexual orientation, DPH can provide opportunities to monitor population health and the impact of policies and other macro-level changes and interventions on population health and health inequities.

As described in the beginning of this report, DPH's Strategic Plan to Advance Racial Equity acknowledges that, to advance health equity, DPH must use an intersectional, equity-centered lens to focus on addressing the persistent racial inequities impacting the health access, treatment, outcomes, and overall well-being of people across the Commonwealth, specifically those who identify as Black, Indigenous, Hispanic/Latino, and/or Asian/Pacific Islander. The COVID-19 pandemic brought into painful, undeniable, public view the clear, present, and ongoing health inequities perpetuated by systemic racial inequities across public health infrastructure, health care delivery systems, and SDOH in Massachusetts. Understanding the ways that systems of oppression create and perpetuate structural inequities supports DPH in making systems-level changes to advance health equity. DPH seeks to understand the ways that the structures it designs, operates, and builds perpetuate inequities. By embracing an understanding of the ways that state and national public service systems have been built upon racialized policies, practices, and institutions, DPH aims to lead health equity efforts across the agency, the secretariat, and the Commonwealth using a structural analysis of how systemic racism works. In leading racial-equity-centered change, DPH notes the imperative for a shared approach to equity across all public agencies as racial inequities are also replicated in educational systems, housing and built environments, carceral systems, economic systems, climate response, and public workforce systems

Table 40 outlines notable details and recommendations for the evaluation of data in the Massachusetts Health Data Tool to assist school districts in identifying schools of greatest need.

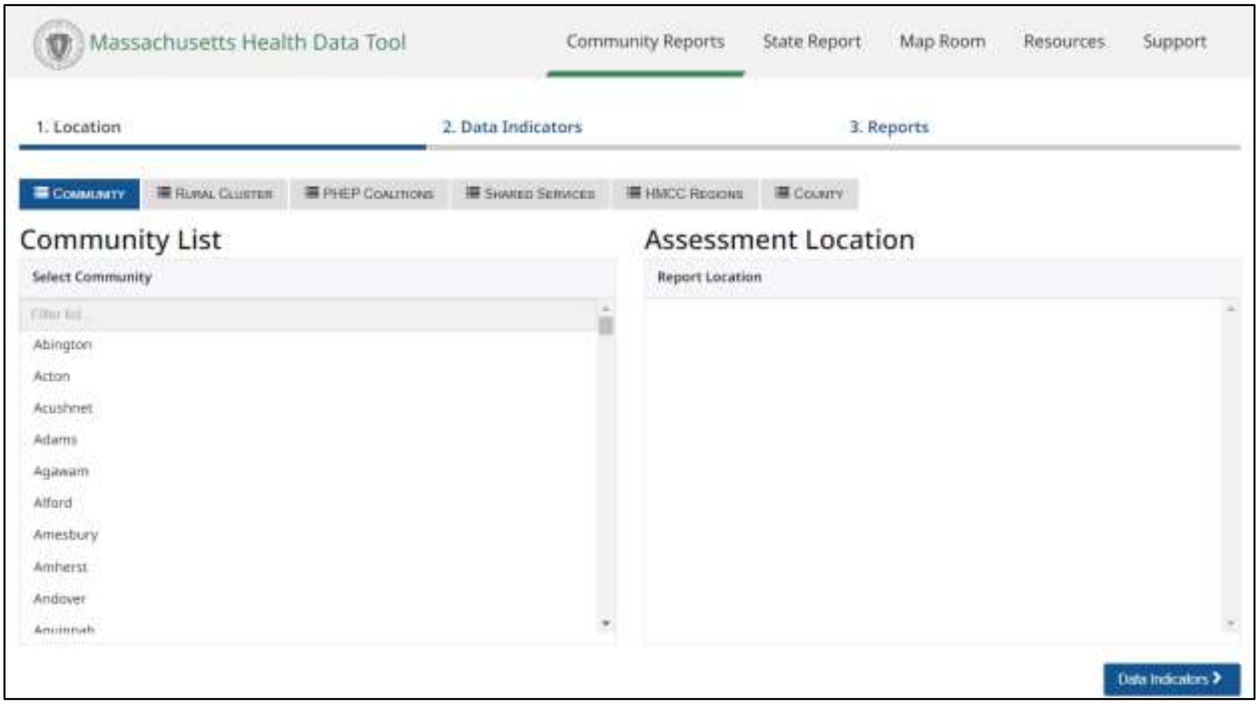
Table 40. Notable Details and Recommendations for the Evaluation of Data in the Massachusetts Health Data Tool

Data of Interest	Notes/Considerations	Recommendations
Income: poverty rate	Enables users to view data in map output with schools overlaid	Prioritize funding for project implementation in schools with greater poverty rates
Environmental concerns: Environmental Justice Index—Neighborhood Details	Enables users to view data in map output with schools overlaid	Prioritize funding for project implementation in schools located in census tracts that are more vulnerable to social and environmental factors

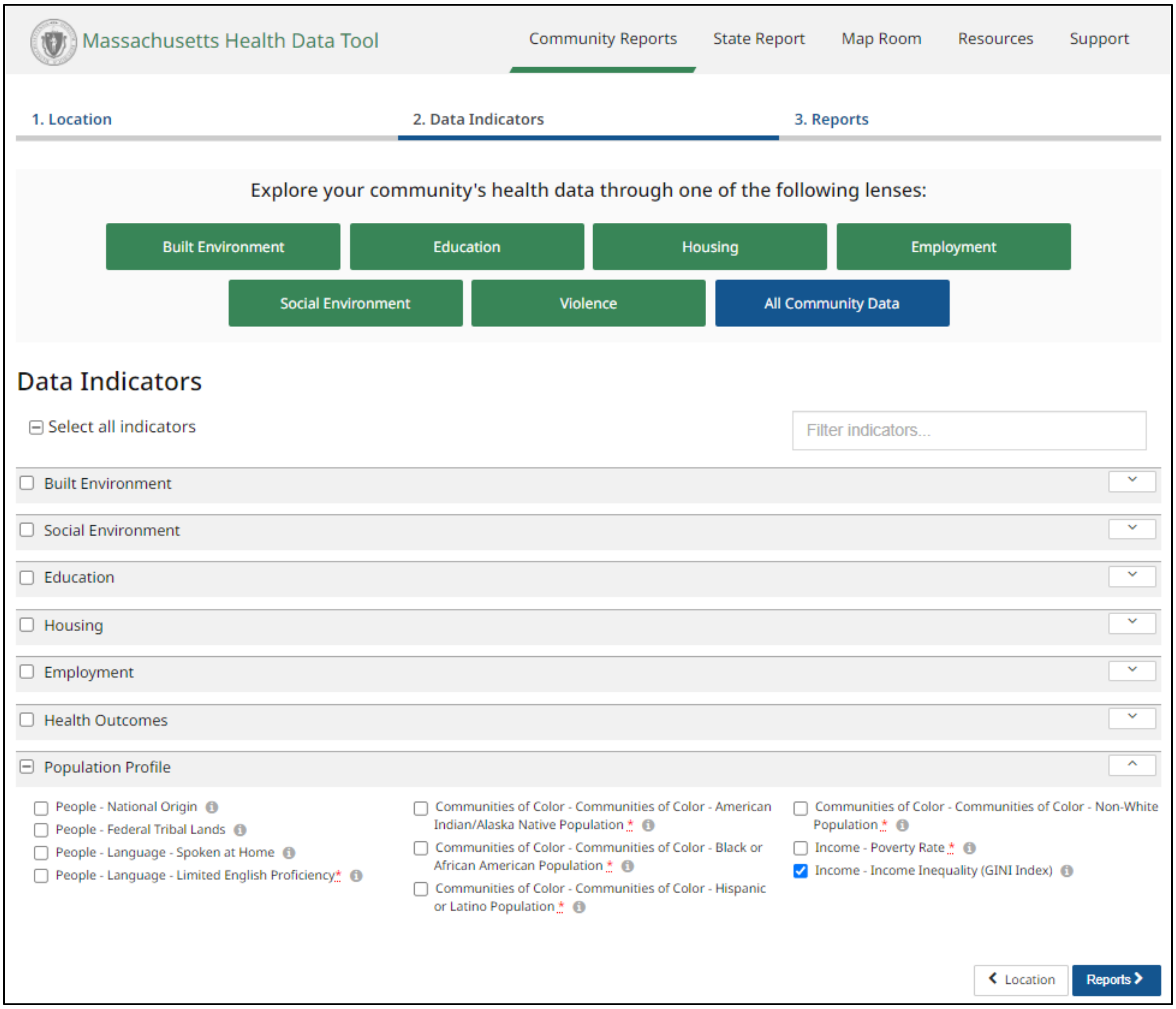
Income – Poverty Rate

The Massachusetts Health Data Tool is an extremely powerful and dynamic tool that presents users with an extensive collection of data and mapping capabilities. Following are the suggested steps for one particular approach that school districts can take to visualize the intersection of individual schools with varying degrees of poverty levels in their respective communities. School districts are encouraged to explore the diverse capabilities this Tool offers.

Step 1: Select the appropriate community(ies) from the "Community List" in the left column and click the "Data Indicators" button in the bottom right of the screen.



Step 2: Expand the "Population Profile" section, select the "Income – Poverty Rate" data indicator, and click the "Reports" button in the bottom right of the screen.



Step 3: In the "Population Profile" section of the Community Health Assessment, click the "View larger map" link beneath the thumbnail image of the map, which will open a new window in the Tool's Map Room module.

Population Profile

Population Profile

Where individuals, families, and communities live, age, work, and play shapes their health. Disparities in health outcomes are linked with socioeconomic status, race/ethnicity, gender, immigration, and other social characteristics. Understanding how these factors shape health is necessary to identify areas for improvement.

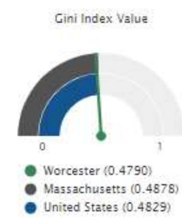
DPH acknowledges the ongoing work it needs to do as a public agency to address the institutional and structural racism that perpetuates racial/ethnic inequities. The majority of data comes from national sources such as the American Community Survey. Limited DPH data is also included. The language for race and ethnicity breakouts is based on national sources. DPH recognizes that the way race and ethnicity breakouts are depicted, particularly around our American Indian and Native Alaskan populations has limitations. DPH is dedicated to improving this data inequity.

A full list of sources is in the 'Support' tab or here: healthdatatool.mass.gov/data-list/.

Income - Income Inequality (GINI Index)

This indicator reports income inequality using the Gini coefficient. Gini index values range between zero and one. A value of one indicates perfect inequality where only one household has any income. A value of zero indicates perfect equality, where all households have equal income.
Note: Index values are acquired from the 2018-22 American Community Survey and are not available for custom report areas or multi-county areas.

Report Area	Total Households	Gini Index Value
Worcester	78,977	0.4790
Massachusetts	2,740,995	0.4878
United States	125,736,353	0.4829



Note: This indicator is compared to the state average.
Data Source: US Census Bureau, American Community Survey. 2018-22. → *Show more details*

View larger map

Income Inequality (GINI), Index Value by Tract, ACS 2018-22

- Over 0.460
- 0.431 - 0.460
- 0.401 - 0.430
- Under 0.401
- No Data or Data Suppressed
- Worcester

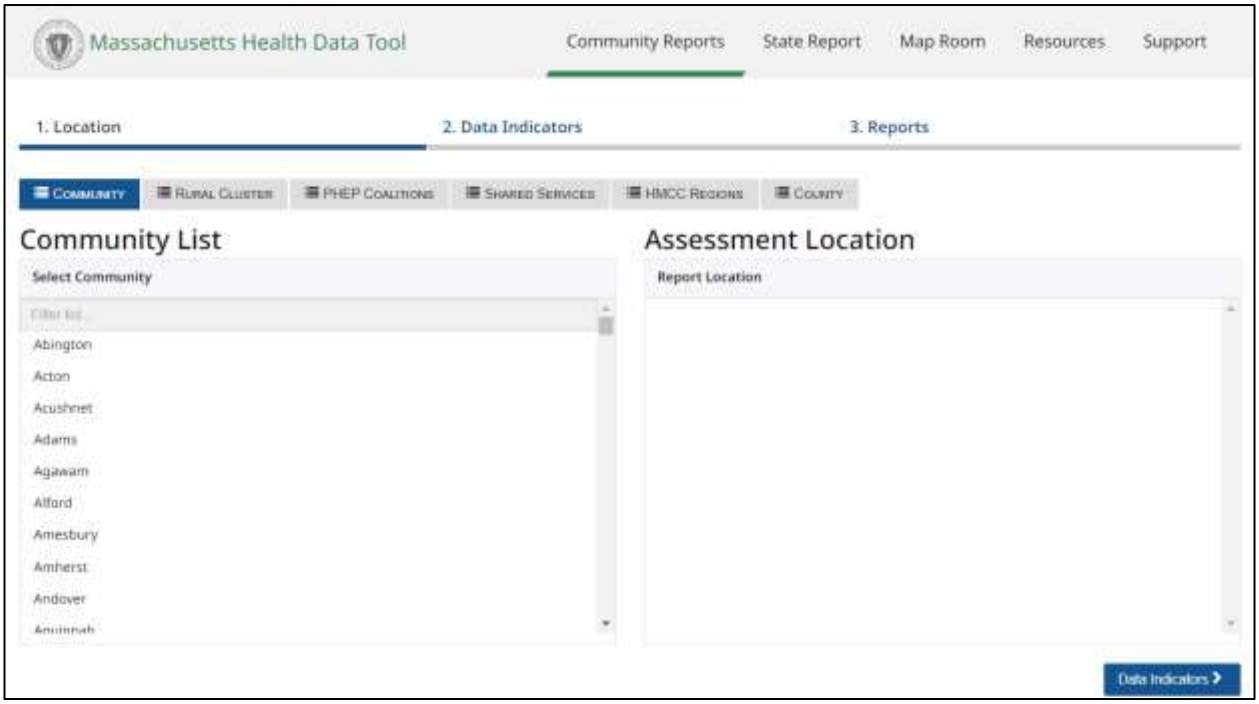
Step 4: Overlay school locations by clicking the "Add Data" tab along the left banner, expanding the "Mass GIS Layers" section, and selecting the "Schools PK-12, MassGIS" box within the "Education" section.

Users can hover over and click on any of the school icons to identify the school's name, address, and list of grades served.

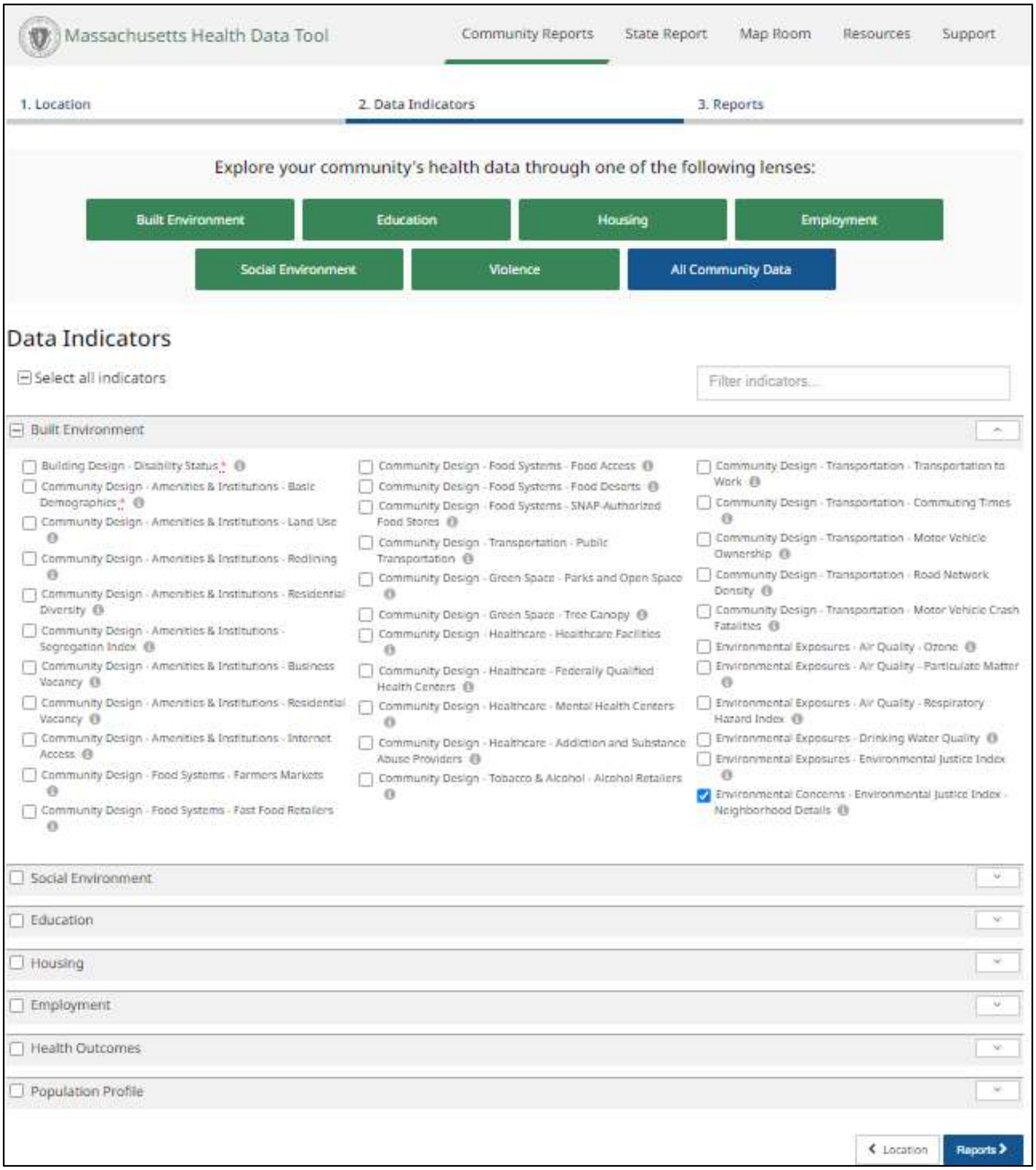
Environmental Justice Index – Neighborhood Details

Following are the suggested steps for one particular approach that school districts can take to visualize the intersection of individual schools with census tracts displaying varying degrees of vulnerabilities using data from the MA Health Data Tool.

Step 1: Select the appropriate community(ies) from the "Community List" in the left column and click the "Data Indicators" button in the bottom right of the screen.



Step 2: Expand the "Built Environment" section, select the "Environmental Concerns – Environmental Justice Index – Neighborhood Details" data indicator, and click the "Reports" button in the bottom right of the screen.



Step 3: In the "Built Environment" section of the Community Health Assessment, click the "View larger map" link beneath the thumbnail image of the map, which will open a new window in the Tool's Map Room module.

Built Environment

The Built Environment and Health

The built environment represents the places and spaces that are made by people; those in which we live, work, learn, visit, and play every day.[1] It includes buildings, parks, and all the things humans have made or changed, like roads and bridges.

How good or bad the built environment is in your community can affect public health.[2] Places and spaces can be built, designed, or set up to encourage healthy behaviors and support physical, mental, and social health. A good built environment can make it easier for people to access resources and places, stay safe, afford living costs, meet the community's special needs, and highlight what's great about where they live. All this can make people healthier and happier.[2]

Every community should have a high-quality built environment that supports health and healthy behaviors. But not every community has a strong built environment. Sometimes, because of discriminatory history and policies, some places don't get as much money and attention. As a result, there are large disparities in the quality of the built environments across the country and within Massachusetts.

Environmental Exposures

Environmental exposures include water quality, air quality, noise pollution, and contaminated sites. When people interact with the air, water, or soil, they can be exposed to pollutants. Community design is important to reduce pollutants.

Environmental Concerns - Environmental Justice Index - Neighborhood Details

The Environmental Justice Index (EJI) is the first national, place-based tool designed to measure the cumulative impacts of environmental burden through the lens of human health and health equity. The EJI scores census tracts using a percentile ranking which represents the proportion of tracts that experience cumulative impacts of environmental burden and injustice equal to or lower than a tract of interest. The indicator summary data displays the number of neighborhoods (census tracts) within the report area exceeding the 90th percentile ranking for environmental justice social criteria or health criteria.

Report Area	Total Population	Number of Neighborhoods in Report Area	Neighborhoods Meeting Environmental Justice Social Criteria	Population in Neighborhoods Meeting EJ Social Criteria (%)	Neighborhoods Meeting Environmental Justice Health Criteria	Population in Neighborhoods Meeting EJ Health Criteria (%)
Worcester	185,186	46	18	38.35%	33	67.50%
Massachusetts	6,873,003	1,620	472	26.18%	961	56.63%
United States	326,569,308	85,019	32,953	36.79%	45,692	53.46%

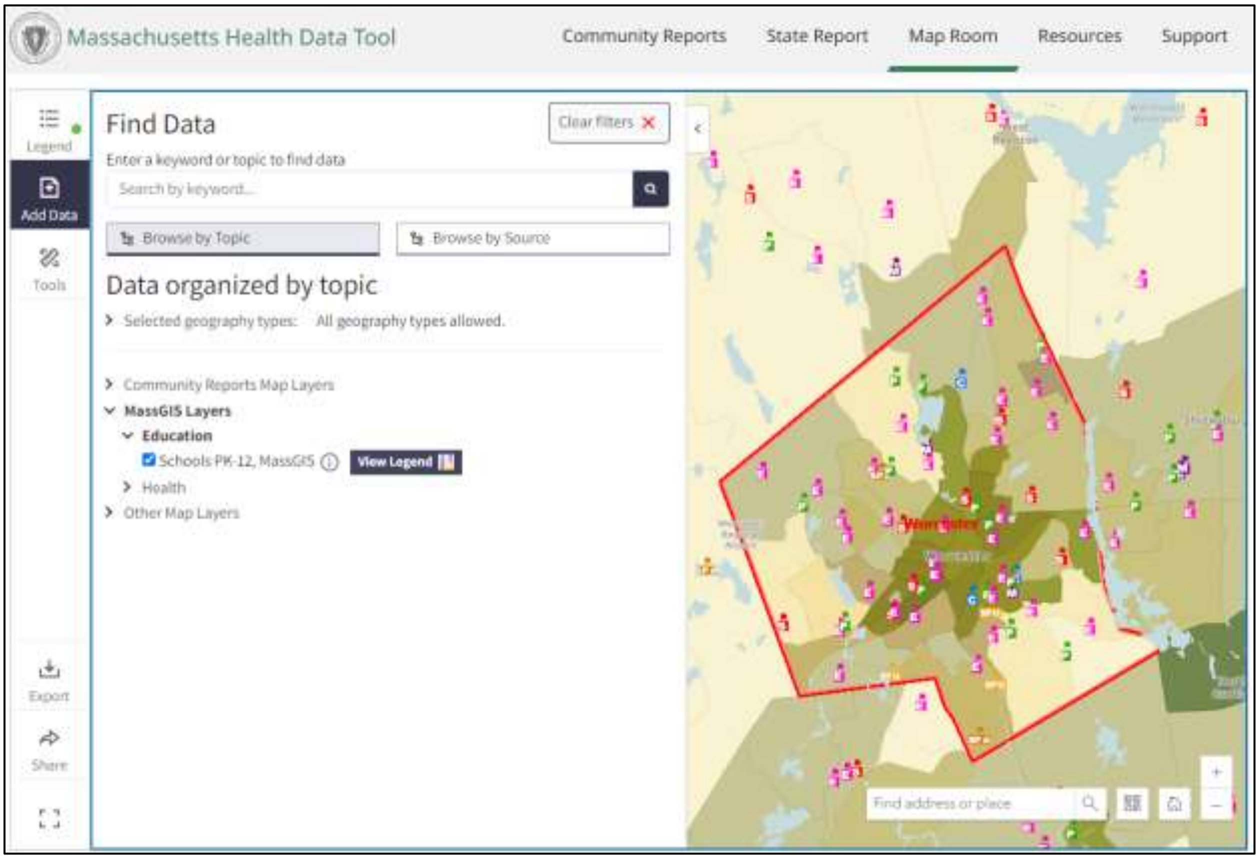
Data Source: Centers for Disease Control and Prevention, CDC - Agency for Toxic Substances and Disease Registry. Accessed via CDC National Environmental Public Health Tracking. 2022. → *Show more details*

View larger map

Vulnerable Neighborhoods, Social and Environmental Factors, Number of Factors in the Scoting 80th Percentile or Higher by Tract, EPA EJ-Screen 2022

- 11 or More
- 7 - 10
- 4 - 6
- 1 - 3
- 0
- No Data
- Worcester

Step 4: Overlay school locations by clicking the "Add Data" tab along the left banner, expanding the "Mass GIS Layers" section, and selecting the "Schools PK-12, MassGIS" box within the "Education" section.



Users can hover over and click on any of the school icons to identify the school's name, address, and list of grades served.

Cumulative Impact Analysis Mapping Tool

To supplement the Massachusetts Health Data Tool, school districts can also utilize MassDEP's Cumulative Impact Analysis Mapping Tool, which provides data on environmental justice populations, sensitive receptors, and MassDEP-regulated facilities.

Tier 2 Data Sets

Environmental Health

To supplement the Tier 1 environmental health data, schools with available time and resources should also consider evaluating the EPHT's blood lead level data. These additional environmental health data will help school districts better understand the broader community context influencing student health and further prioritize schools having the greatest needs.

Table 41 outlines notable details and recommendations for the evaluation of blood lead level data in the EPHT to assist school districts in identifying schools of greatest need.

Table 41. Notable Details Supporting the Evaluation of the EPHT's Blood Lead Level Data

Data of Interest	Notes/Considerations	Options for Viewing Output
Blood Lead Levels—Estimated Confirmed ≥5µg/dL (Elevated)	• Data not available at school-level (only available by census tract); requires users to associate school locations with census tracts • 10 years of data currently available • Numerous means of viewing output	• Map view • Table view • Raw data export
Blood Lead Levels—Confirmed ≥10µg/dL (Poisoned)	• Data not available at school-level (only available by census tract); requires users to associate school locations with census tracts • 20 years of data currently available • Numerous means of viewing output • Enables users to identify and further differentiate census tracts with evidence of more significant health issues related to lead poisoning (beyond elevated blood lead levels)	• Map view • Table view • Raw data export

Figure 22 presents a screenshot of the EPHT module in which users input their query parameters to view blood lead level data. DPH suggests school districts structure the query to capture multiple years of data.

Figure 22. EPHT Query Parameters for Blood Lead Level Data

Figure 23 illustrates a sample screenshot of the EPHT's map view output of blood lead level data. This view presents the prevalence of blood lead levels at the selected threshold by census tract. Census tracts with a red arrowhead pointing upward indicate observed blood lead levels that are statistically significantly higher than the aggregated statewide prevalence. This map enables users to quickly identify portions of a community with higher prevalence of elevated or poisoned blood lead levels.

Figure 23 EPHT's Map View Output of Blood Lead Level Data

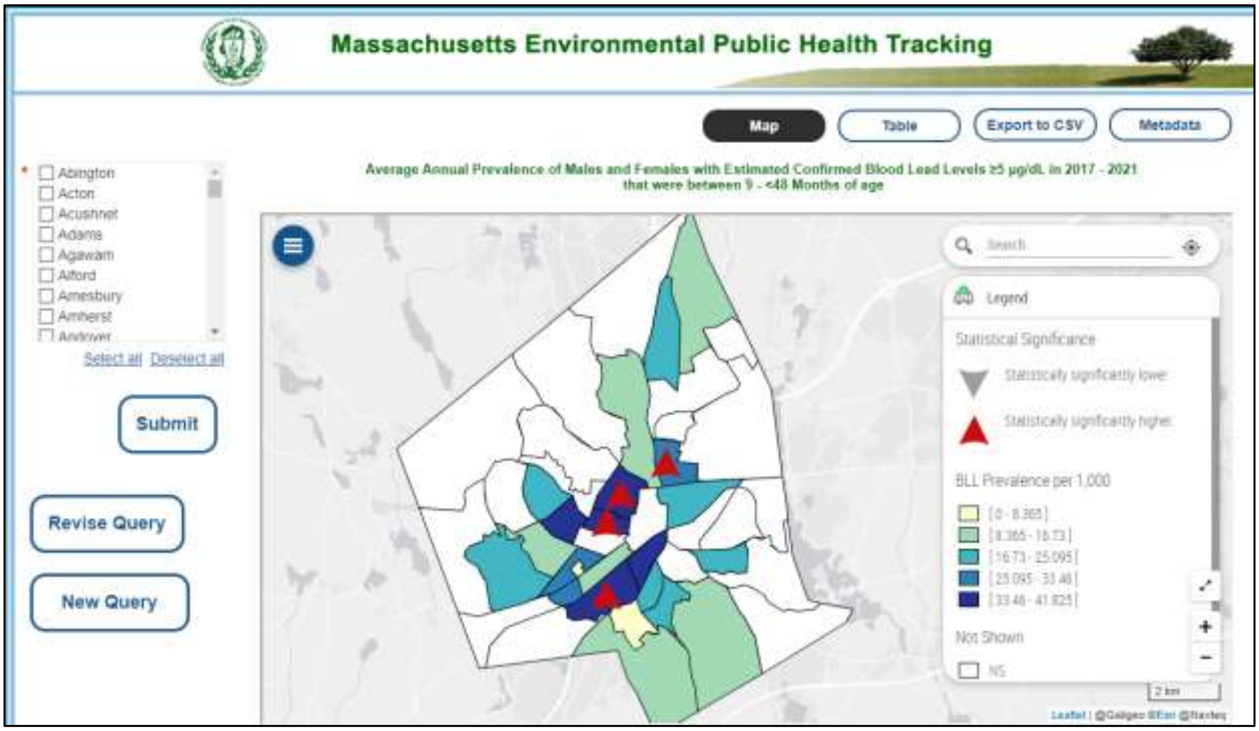
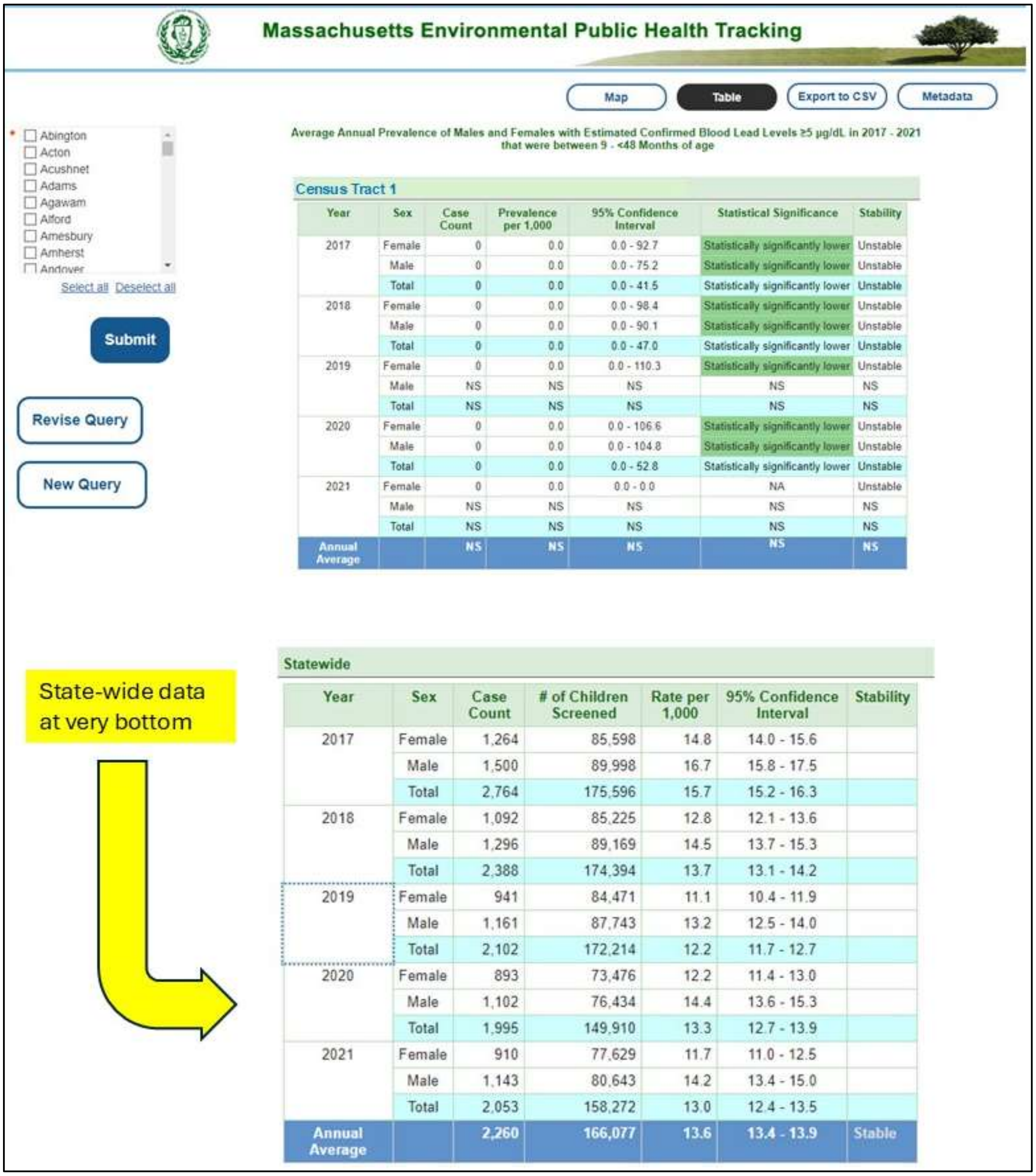


Figure 24 illustrates a sample screenshot of the EPHT's table view output of blood lead level data. This output presents annual data for each census tract in the selected community, as well as aggregated statewide data at the very bottom of the screen.

Figure 24 EPHT's Table View Output of Blood Lead Level Data



Average Annual Prevalence of Males and Females with Estimated Confirmed Blood Lead Levels ≥5 µg/dL in 2017 - 2021 that were between 9 - <48 Months of age

Census Tract 1

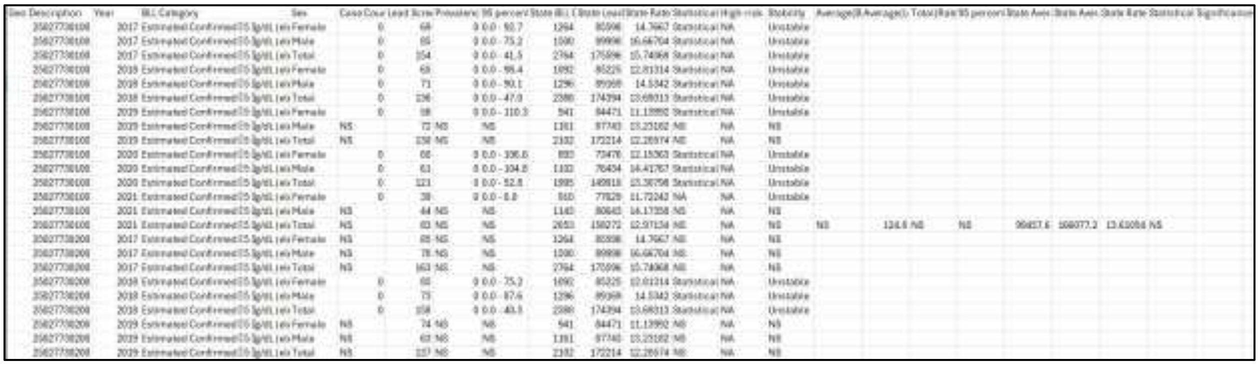
Year	Sex	Case Count	Prevalence per 1,000	95% Confidence Interval	Statistical Significance	Stability
2017	Female	0	0.0	0.0 - 92.7	Statistically significantly lower	Unstable
	Male	0	0.0	0.0 - 75.2	Statistically significantly lower	Unstable
	Total	0	0.0	0.0 - 41.5	Statistically significantly lower	Unstable
2018	Female	0	0.0	0.0 - 98.4	Statistically significantly lower	Unstable
	Male	0	0.0	0.0 - 90.1	Statistically significantly lower	Unstable
	Total	0	0.0	0.0 - 47.0	Statistically significantly lower	Unstable
2019	Female	0	0.0	0.0 - 110.3	Statistically significantly lower	Unstable
	Male	NS	NS	NS	NS	NS
	Total	NS	NS	NS	NS	NS
2020	Female	0	0.0	0.0 - 106.6	Statistically significantly lower	Unstable
	Male	0	0.0	0.0 - 104.8	Statistically significantly lower	Unstable
	Total	0	0.0	0.0 - 52.8	Statistically significantly lower	Unstable
2021	Female	0	0.0	0.0 - 0.0	NA	Unstable
	Male	NS	NS	NS	NS	NS
	Total	NS	NS	NS	NS	NS
Annual Average		NS	NS	NS	NS	NS

Statewide

Year	Sex	Case Count	# of Children Screened	Rate per 1,000	95% Confidence Interval	Stability
2017	Female	1,264	85,598	14.8	14.0 - 15.6	
	Male	1,500	89,998	16.7	15.8 - 17.5	
	Total	2,764	175,596	15.7	15.2 - 16.3	
2018	Female	1,092	85,225	12.8	12.1 - 13.6	
	Male	1,296	89,169	14.5	13.7 - 15.3	
	Total	2,388	174,394	13.7	13.1 - 14.2	
2019	Female	941	84,471	11.1	10.4 - 11.9	
	Male	1,161	87,743	13.2	12.5 - 14.0	
	Total	2,102	172,214	12.2	11.7 - 12.7	
2020	Female	893	73,476	12.2	11.4 - 13.0	
	Male	1,102	76,434	14.4	13.6 - 15.3	
	Total	1,995	149,910	13.3	12.7 - 13.9	
2021	Female	910	77,629	11.7	11.0 - 12.5	
	Male	1,143	80,643	14.2	13.4 - 15.0	
	Total	2,053	158,272	13.0	12.4 - 13.5	
Annual Average		2,260	166,077	13.6	13.4 - 13.9	Stable

Figure 25 presents a screenshot of a sample of exported blood lead level data imported into a CSV file, enabling users to perform additional custom analysis.

Figure 25. Screenshot of Sample Export of Blood Lead Level Data from EPHT



Learning Environment and Outcomes

To supplement the Tier 1 learning environment and outcomes data, schools with available time and resources should also consider evaluating the following two DESE School and District Profile Reports to evaluate relevant learning environment and outcome indicators that will help increase awareness of and identify schools having the greatest needs:

- Dropout Report
- Graduates Attending Institutes of Higher Education Report

Dropout Report

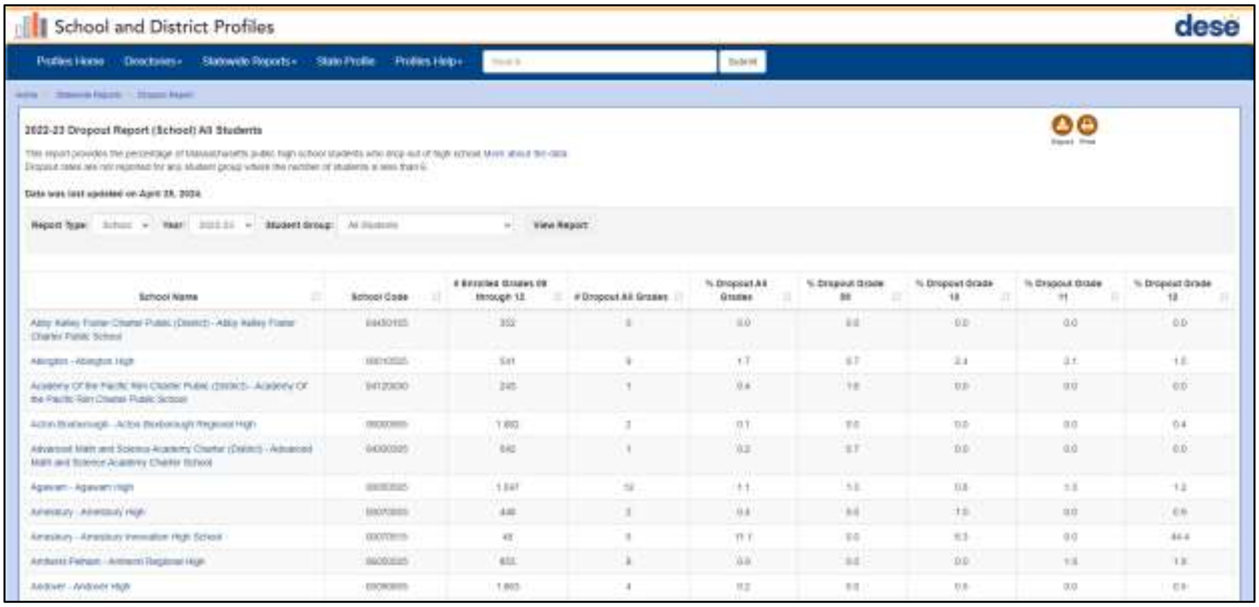
Table 42 outlines notable details supporting the evaluation of DESE's Dropout Report to assist school districts in identifying schools of greatest need.

Table 42. Notable Details Supporting Evaluation of DESE's Dropout Report

Data of Interest	Notes/Considerations	Recommendations
Percent dropout all grades	Represents an additional possible indicator of student performance and/or need for improved learning/social environment	Prioritize funding for project implementation in schools with higher dropout rates

Figure 26 presents a screenshot of DESE's Dropout Report. Note that school districts are encouraged to select "School" in the "Report Type" field to differentiate dropout rate data at the individual school-level.

Figure 26 Screenshot of DESE's Dropout Report



Graduates Attending Institutions of Higher Education Report

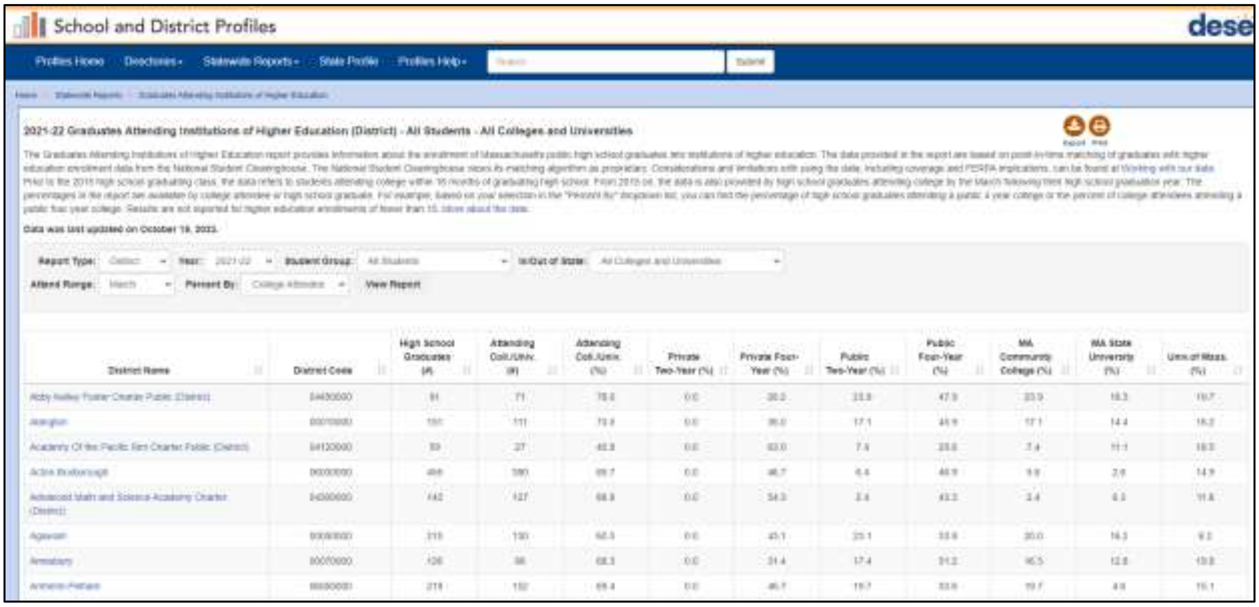
Table 43 outlines notable details supporting the evaluation of DESE's [Graduates Attending Institutions of Higher Education Report] to assist school districts in identifying schools of greatest need.

Table 43. Notable Details Supporting the Evaluation of DESE's Graduates Attending Institutes of Higher Education Report

Data of Interest	Notes/Considerations	Recommendations
Attending Coll./Univ. (percent)	Represents an indicator of future success	Prioritize funding for project implementation in schools with lower percentage of students attending college/universities

Figure 27 presents a screenshot of DESE's Graduates Attending Institutes of Higher Education Report. Note that school districts are encouraged to select "School" in the "Report Type" field to differentiate data at the individual school-level.

Figure 27. Screenshot of DESE's Graduates Attending Institutes of Higher Education Report



V. Funding Strategies

Among other things, the Massachusetts Education Reform Act of 1993 increased the Commonwealth's role in funding public education.[157] Most notably, it introduced the concept of an annual "foundation budget" — a unique minimum budget for each school district in the Commonwealth required to provide constitutionally adequate education. Each school district's foundation budget is calculated annually based on a collection of factors, including enrollment size and demographic data.[158] School districts fund their annual foundation budgets using a combination of state education aid (commonly referred to as "Chapter 70" aid) and local dollars.[158] State funding for local aid and K-12 education represents the second largest category of investment in the Commonwealth's budget.[159]

School districts often plan, track, and account for annual budgets and expenditures across two separate categories:

- **Operating budgets/expenses** include the expenses required for day-to-day school operations, including salaries, utilities, administrative costs, and maintenance expenses.
- **Capital budgets/expenditures** cover longer-term investments in the infrastructure, facilities, and equipment for a district's schools.

Both operating and capital funding are necessary to implement the collection of strategies included in this report.

> *Schools across the Commonwealth have an estimated capital expenditure gap of $1.39 billion.*

Schools often operate in funding constrained environments and compete against other schools for grant funding and other limited resources. Among other impacts, this limitation of financial resources can result in significant deferred maintenance of school buildings. A 2021 report by the Office of the State Auditor noted that schools across the Commonwealth have an estimated capital expenditure gap of $1.39 billion.[160] Organizations often use lifecycle cost analyses to understand the relationship between upfront capital costs and expected operational savings over the life of a project. While many schools strive to implement lifecycle cost-effective projects to meet their fiduciary duty, limited capital funding at the time of project implementation often results in projects that do not realize the full benefit of ongoing operational savings.

This section provides an overview of the following categories of funding sources and strategies that help Massachusetts school districts achieve green and healthy schools:

- Local contribution to municipality’s foundation budget
- Chapter 70 state aid
- Rural school aid
- Municipal debt
- Grants
- No-cost technical support
- Incentives/rebates/tax credits
- Third-party financing

ocal Contribution to Municipality’s oundation Budget

As previously noted, each Massachusetts school district has its foundation budget calculated annually. This annual foundation budget is then funded by a combination of local contributions by the municipality and Chapter 70 aid from the Commonwealth. Each community’s local contribution is unique and based on the community’s respective property values and resident incomes.[161] Annual local contributions are calculated using a progressive formula whereby municipalities having greater fiscal resources contribute a larger share of their foundation budgets, while municipalities having fewer fiscal resources contribute a smaller share. The maximum local contribution is set at 82.5 percent of the foundation budget.

Chapter 70 State Aid

Chapter 70 state aid represents the quantity of annual funding that the Commonwealth provides to each school district to make up the difference between each district's annual foundation budget and the local contribution provided from the community.

Rural School Aid

The state legislature has appropriated rural school aid since fiscal year 2020.[162] DESE determines funding to eligible school districts based on each district's student density and per capita income. School districts are permitted to use rural school aid for a variety of purposes to support district operations, including increasing regional collaboration, consolidation, and improving long-term operational efficiency and effectiveness.[163]

Municipal Debt

Municipal general obligation bonds are the traditional funding source for many capital projects and allow municipalities to issue long-term debt. There are additional options for municipalities with marginal credit ratings (State Qualified Bonds) or for smaller communities (State House Notes Program).

Municipal Debt Guidance and Best Practices

The Massachusetts Department of Revenue's Division of Local Services (DOR DLS) offers a Capital Improvement Planning Guide for municipalities that outlines funding options, including municipal debt, local funding strategies, state sources, and federal funding sources.

DOR DLS's Understanding Municipal Debt white paper provides guidance to municipalities on the debt issuance process, and also recommends using the services of a Massachusetts-based financial advisor.

Grants

There are numerous state and federal competitive grant programs that can help Massachusetts school districts across a range of initiatives, including new construction, renovations and repairs, energy audits, building decarbonization planning, climate hazard identification and resilience planning, and lead mitigation in drinking water. Below are some high-level details for a sampling of current grant programs.

- The MSBA Core Program offers grant funding for new construction, additions, and major renovation projects. Funding levels are based on a reimbursement rate calculation that considers community income, property wealth, poverty, along with project-specific incentive points. See the Introduction for additional details about the MSBA grant award process and determination of funding levels.
- The MSBA Repair Program funds retrofits of building systems. Projects are categorized as either major repairs, which cover a broad scope and follow a similar process to the Core Program, or accelerated repairs, which cover buildings in need of roof and/or window/door replacements, but that are

otherwise structurally sound. Boiler replacements were last included for invitation in 2022. The MSBA is completing a study with a consultant in anticipation of adding heat pump conversions to the Accelerated Repair Program beginning in 2025.

- The EEA Municipal Vulnerability Preparedness (MVP) Program provides grant support to define climate-related hazards, identify existing and future vulnerabilities, and develop and prioritize community-level actions to reduce risk and build resilience.
- The DOER Green Communities Grant Program funds energy efficiency measures, clean energy projects, and other decarbonization strategies in qualifying communities.
- The MA Clean Energy Center's (MassCEC's) Green School Works provides wraparound services including bridge loans, grant funding, and strategic technical assistance to schools for decarbonization projects, make-ready projects, portfolio decarbonization planning, and project planning.[164] Preference is given to schools serving low-income and environmental justice populations.
- The MassDEP School Water Improvement Grants (SWIG) Program provides funding to schools for lead mitigation in drinking water by installing filtered water bottle filling stations. SWIG builds on the Lead in School Drinking Water assistance program that pays for schools to test their drinking water.[165]
- The Massachusetts Federals Funds & Infrastructure Office tracks federal opportunities and supports successful applications for Massachusetts projects.
- DOE's Renew America's Schools Program is a highly competitive grant program to promote clean energy improvements in schools. Districts can apply for funding and technical assistance for strategic planning, energy audits, and project implementation.
- EPA's Clean School Bus Program provides grant funding to replace existing school buses with zero emission and clean school buses

No-cost Technical Support

In addition to grant funding, there are also state programs that provide no-cost technical support to school districts, including the following examples:

- DOER's Green Communities Division awards **Municipal Energy Technical Assistance grants** to school districts to support decarbonization and energy resilience of public facilities. Projects can include feasibility studies, auditing, and assistance with solar development.
- The MassDEP Water-Smart Program offers schools no-cost drinking water lead sampling, post-sampling analysis, and development of outreach materials.

- MassSave Building Energy Assessments offers no-cost in-person or virtual assessments for schools, where energy consultants will perform assessments and provide a customized energy savings report.

Incentives/Rebates/Tax Credits

There are numerous incentives, rebates, and tax credits that are also available to Massachusetts school districts that can greatly improve the cost-effectiveness of the many of the best practices outlined in this report. Below is a brief summary of options in this category of funding sources.

- MassSave offers a variety of incentives to schools, including decarbonization roadmap services and project implementation for component retrofits up to new construction and modernizations. Retrofit incentives include building insulation and weatherization, abatement of hazardous materials (asbestos, vermiculite, knob and tube wiring), HVAC, lighting and controls, building automation systems (BAS), specialty equipment, water heating, and pipe insulation. New construction and modernization incentives offer multiple pathways based on establishing aggressive energy use intensity (EUI) targets.
- MassSave's ConnectedSolutions Active Demand Reduction Initiative can further improve project economics by allowing for compensation from demand response activities. School districts can contact a curtailment service provider to determine school- or district-level potential for reducing electricity demand at peak times. This provides additional grid resilience benefits to the surrounding community.
- The Inflation Reduction Act (IRA) Investment Tax Credit (ITC) provides taxable entities non-competitive cash reimbursements with no funding limit. The IRA ITC is established by law and extends through 2032-2035. The IRA added a direct pay (also referred to as elective pay) option, which allows non-taxable entities (e.g., school districts) to receive the ITC as cash payments. The ITC provides school districts with the ability to plan over a long-time horizon to install eligible clean energy technologies—often at lower costs than the conventional alternative. Eligible technologies include ground-source heat pumps (GSHP), wastewater energy recovery, solar, battery energy storage systems, ESBs, light duty battery electric vehicles, and EVSE. MassCEC Green School Works bridge loans can cover the initial project costs, or municipalities may be able to issue Federal and State Aid Anticipation Notes.[166] Below are some additional points regarding the IRA ITC:
    - ITC funds are intended to be stacked with other funding sources discussed in this section; however, the use of tax-exempt bonds (e.g., general obligation bonds) to finance an energy project reduces the ITC by 15 percent. Districts can consider using cash on hand to finance discrete energy projects while using tax-exempt bonds to finance the balance of the project.
    - Taking advantage of the full value of the ITC requires upfront coordination with a variety of project stakeholders, including general council, a municipal tax advisor, capital construction project managers, contracts and

procurement, and an energy services company (ESCO), if applicable. The project team should review and incorporate all applicable ITC requirements into the project requirements, including domestic content, prevailing wage, and apprenticeship requirements. While stakeholders may offer input or support, the school district is the tax filing entity and has ultimate responsibility to comply with ITC requirements.

Third-Party Financing

Energy management services (EMS), also referred to as energy savings performance contracts (ESPC), allow for third-party investment by an energy services company (ESCO) in school buildings with no upfront cost to the school district. The ESCO will bring in energy professionals to conduct an investment-grade assessment of the facility and propose cost-effective retrofit measures that meet the school district's stated goals. Once the retrofit measures are agreed upon, the ESCO will install and commission the systems. The ESCO performs measurement and verification throughout the life of the contract to ensure that the systems operate as intended and that utility savings are maintained. The ESCO's upfront investment is paid back over the life of the contract (up to 20 years) through a portion of the savings that the school realizes on its utility bills, making the project budget-neutral. Given that EMS are based on utility cost savings as opposed to emission reductions, the initial statement of objectives should specify the school district's decarbonization goals, environmental health goals, and school program needs.

EMS projects can include a variety of energy and water conservation measures and often seek to bundle measures that have short and long paybacks to allow for a larger overall investment. For example, light-emitting diode (LED) retrofits with quick payback periods will help offset the costs of larger capital equipment, such as a new HVAC system. Bundling multiple buildings in a single EMS contract can improve the overall project economics and allow for deeper emission reductions. School districts can identify candidate buildings for an EMS through the emissions reduction plan (ERP) and facility condition assessment (FCA) processes (see Objective 1a. Decarbonize Buildings for more details). Good candidates are often buildings that are in good condition (e.g., envelope, finishes) with modern electrical, HVAC, and plumbing distribution systems but with mechanical equipment that is nearing the end of useful life. EMS contracts can also incorporate third-party O&M services for newly installed systems, which can be helpful when existing staff and resources are at capacity or do not have expertise on the new systems.

The Massachusetts DOER Green Communities Division provides information and assistance to local jurisdictions on the use of EMS, including draft request for proposals (RFPs) and request for quotes with language that includes guarantees of savings, maximum cost, and energy generation (where applicable for onsite clean energy). The MSBA has issued guidance to clarify that EMS costs are separate from any reimbursable MSBA project costs. An EMS project will not result in the school being eliminated from consideration for an MSBA grant award, and schools can still submit an SOI for buildings undergoing an EMS for any projects that are not covered by the EMS.

Module 2: In-Depth Discussion of Methods, Best Practices, Statutes, Regulations, Standards, and Relevant Resources

VI. Additional Details Related to Goal 1: Achieve Green Schools

This section presents the following content:

- A more detailed narrative description of the methods and best practices presented in Goal 1: Achieve Green Schools (Section II)
- A narrative and tabular summary of the relevant statutory/regulatory framework and notable standards
- A tabular summary of relevant resources that can help school districts across the Commonwealth achieve green schools

Content is provided across the following six objectives:

a. Decarbonize buildings
b. Optimize water efficiency
c. Optimize solid waste reduction and diversion
d. Electrify school bus fleets
e. Provide electric vehicle charging stations for school staff and public use
f. Enhance climate resilience

Objective 1a. Decarbonize Buildings

Methods and Best Practices

There are a number of methods and best practices that have been implemented to successfully decarbonize schools across Massachusetts. These are organized in the following sections in order of implementation, starting with analysis and planning activities and followed by implementation strategies, operational best practices, and procurement strategies for decarbonized electricity.

Conduct Analysis and Planning

Analysis and planning provide the foundation for successfully decarbonizing schools by gathering data to understand the current conditions, establishing goals, developing interim milestones, and prioritizing strategies at both the school district portfolio level and for individual schools. This is especially important given the variability in school conditions and the high capital cost of many decarbonization strategies. Some strategies can be completed via low-cost desktop analysis, while others require more time-intensive on-site analysis. To conduct analysis and planning, schools should compile and analyze facility energy data, perform facility condition assessments and energy/emissions audits, and prepare and routinely update an Emissions Reduction Plan.

(1) Compile and analyze facility energy data

The ability to quickly capture energy data and reliably generate actionable insights to manage building energy use is key to building decarbonization. There are many different types of systems and commercial off-the-shelf software options that vary in utility and value based on the size and complexity of a school district’s portfolio. The U.S. Department of Energy (DOE) broadly refers to this suite of technologies as energy management information systems (EMIS).[167]

Utility bill management systems are some of the most common types of EMIS and allow users to view, validate, and track various metrics related to energy consumption and corresponding utility payments. Increasingly, municipal and state energy disclosure ordinances require building owners to compile, document, and report energy data annually. Among other end goals, the resulting comprehensive data set allows an organization to compare or “benchmark” the energy performance of its buildings to other buildings of similar type (see text box below for more details about statewide building energy disclosure requirements in Massachusetts).

Statewide Building Energy Disclosure Requirements

Chapter 179 of the Acts of 2022 requires the annual reporting of energy use data for all buildings in the Commonwealth of Massachusetts larger than 20,000 square feet. Electric, natural gas, and steam utility providers are required to report this information to DOER; individual building owners must report annual usage data for all delivered fuels (e.g., fuel oil, propane). DOER is developing draft regulations and intends to finalize them in preparation for the first disclosure period in 2025. Similar ordinances have already been implemented by some municipalities, including Boston and Cambridge.

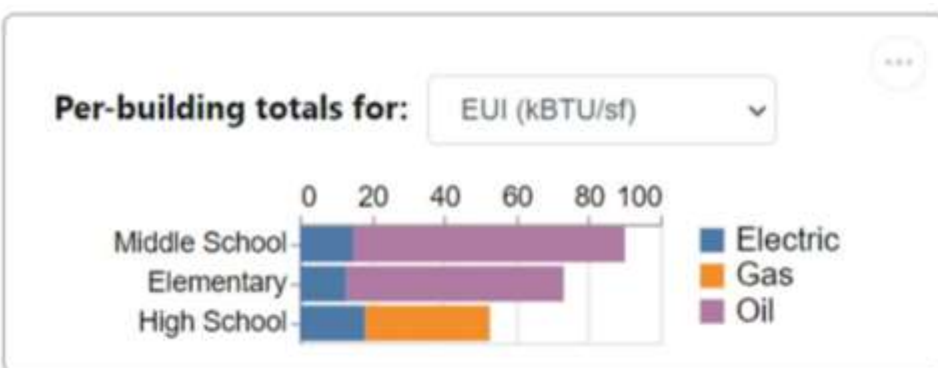
Source: DOER[168]

Benchmarking is commonly done via free, government-provided platforms such as EPA's ENERGY STAR Portfolio Manager (ESPM). In Massachusetts, Green Communities share data with DOER via the MassEnergyInsight Platform (MEI). Many of these systems enable automatic data transfers to allow seamless and efficient reporting by an energy manager, sustainability manager, utility billing specialist, or other school district staff charged with tracking and analyzing building energy use and cost data.

In addition to meeting benchmarking requirements, ESPM and MEI offer other powerful tools, including:

- **ENERGY STAR Score for K–12 Schools** provides a 1 to 100 score that accounts for and normalizes numerous factors such as weather, number of building staff, standard operating hours, the presence of cooking facilities, school type, and the percent of floor area that is heated and cooled. A higher score indicates better energy performance.[169]
- **MEI Buildings to Target Report** allows users to compare energy use intensity (EUI), total energy consumption, cost, and total emissions by fuel type for all of their schools (see Figure 28).

Figure 28. User Interface in MEI to Help Users Identify Appropriate Buildings to Target



Source: DOER's MassEnergyInsight

Additional EMIS functionality can include interval metering, weather data, BAS, and other connected devices. Some more advanced functions are discussed in greater detail in the O&M section below (methods and best practices 10–12).

The availability of building energy use and other data in an EMIS can greatly benefit project implementation (methods and best practices 4–9) by allowing A/E firms to use real-world operational data (e.g., utility billing, equipment run time/load, occupancy, equipment submetering) to inform project concepts and designs.

(2) Perform facility condition assessments (FCAs) and energy/emissions audits

FCAs are commonly used across industries and building types to better understand the attributes and condition of an organization's assets for planning and budgeting for O&M and capital expenditures. The MSBA shall conduct a periodic needs survey of schools across the Commonwealth and may ascertain the capital construction, reconstruction, maintenance, and other capital needs. The MSBA School Survey can be generally understood as an FCA with the supplemental inclusion of school-specific programs, security, and information technology infrastructure data.

ASTM International (formerly known as American Society for Testing and Materials) Standard E2018-15 provides a *Standard Guide for Property Condition Assessments: Baseline Property Condition Assessment Process* for commercial real estate, which includes schools. Organizations often expand the scope of FCAs beyond base building systems to include additional audits and assessments. This approach takes advantage of having an assessment professional onsite. Examples of additional assessments include energy audits, building floor plan mapping, analytical measurements (e.g., indoor air quality, blower door testing, functional testing), environmental compliance audits, and health and safety audits. The American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) Standard 211 establishes the scope of a level two energy audit.

To maximize the benefit of FCAs and facility energy audits, schools and school districts should engage staff to understand their objectives and goals for using the outputs from these activities. Boston Public Schools publishes an FCA Dashboard to transparently display data resulting from completed FCAs, which will inform decision making for repairs, replacements, and renovations. DOER's MEI Blueprint module offers FCA database functionality in a tool that many Massachusetts communities already use regularly.

School district staff may already perform informal auditing as part of their daily duties. Anecdotal information that district staff members routinely observe and document can help identify buildings to prioritize for a more focused audit. Common examples of anecdotal information that staff might notice include:

- **Open windows during the heating or cooling season**. While school districts may encourage the opening of windows (where feasible) during the more temperate "shoulder" seasons (spring and fall), this practice is a sign of poor temperature control during the winter (heating) and summer (cooling) seasons.

Finding and Selecting an Energy Auditor

Districts may use the statewide contract PRF74 to select an energy auditor qualified through the state's competitive procurement process.

- **Steam exhaust during the cooling season.** The observation of steam exhaust in warmer spring/summer months may indicate inefficient simultaneous heating and cooling loads that can be corrected.
- **Abnormal window air conditioning unit operations.** Window air conditioning units that operate loudly and/or during the heating season are likely an indication of performance degradation and/or inefficient simultaneous heating and cooling loads that can be corrected.

(3) Prepare and routinely update an emissions reduction plan (ERP)

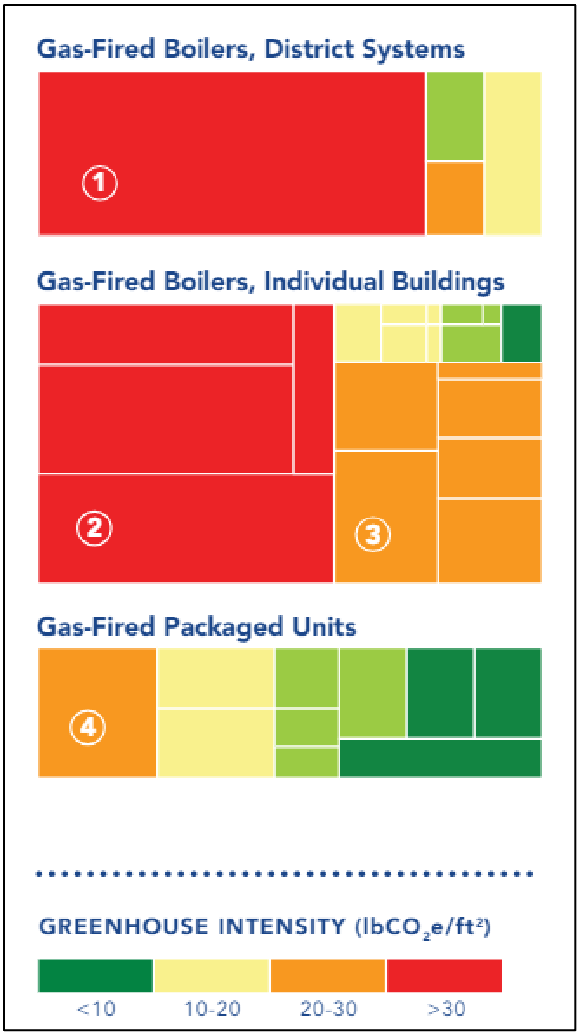
An ERP helps organizations establish an actionable and phased roadmap to identify, prioritize, plan, and implement emissions reduction measures (ERMs)—discrete or bundled projects resulting in GHG emissions reductions.[170] School districts, municipalities, and other regional entities can make use of the ERP framework to:

1. Establish a GHG emissions inventory and emissions reduction targets. At a minimum, school districts should strive to prepare a GHG emissions inventory that calculates and documents GHG emissions associated with energy consumption (including both onsite combustion of fuels for heating and emergency backup power generation, purchased grid electricity, and all other purchased utilities) across the district's facility portfolio.
2. Categorize and prioritize the building portfolio (e.g., by school type, HVAC type, year of last major investment, etc.). Figure 29 offers an example of categorizing an organization's buildings by HVAC system type and GHG intensity (a means of normalizing GHG emissions on a per-square-foot basis). In viewing this example, a school district may decide to prioritize a single high-impact project to retrofit a district system or establish a program to address the distributed emissions via less disruptive retrofits to individual packaged units.

Driving GHG Emission Reductions Through Building Performance Standards

To support aggressive GHG emissions reduction targets, numerous states and municipalities are leveraging existing energy disclosure requirements and adopting building performance standards (BPS), which drive GHG emission reductions at the building and portfolio level. Numerous municipalities in Massachusetts have adopted BPS, including Boston and Cambridge.

Figure 29. Example Method for Categorizing Buildings



Source: U.S. Department of Energy[170]

3. Complete audits (method and best practice 2, Figure 29) and select ERMs. Schools can combine multiple ERMs into a more comprehensive project to more aggressively reduce GHG emissions. Numerous examples of ERMs are provided in the following sections.
4. Develop emissions reduction scenarios demonstrating how ERMs can be combined and phased across the organization's portfolio. Scenarios illustrate the potential emissions reductions relative to the targets that an organization has established.
5. Summarize the results of the above four steps, outline an implementation plan, and identify possible funding sources in a comprehensive ERP document. As resources permit, school districts should update ERPs periodically to reflect implementation progress, changes to the building portfolio, and external trends (e.g., new legislative and/or regulatory requirements that might influence the scope and/or prioritization of ERMs).

Implement Strategies to Achieve Energy Efficiency and Building Decarbonization

Once districts complete the initial analysis and planning, they can turn towards implementation using the strategies covered in this section. While new construction and major modernization projects have demonstrated a clear path to deliver NZE schools, many district buildings that exist today will still be in operation in 2050.[171] As a general best practice for all project types, districts should consider projects that optimize energy efficiency first and then seek to electrify the remaining building loads. As with any program, the results of implemented projects should be tied back to ongoing planning efforts and inform future projects. For example, energy efficiency projects may include make-ready infrastructure or design drawings for future electrification projects to show a clear path forward for building decarbonization.

(4) Implement NZE new construction and major modernizations

The process of building a new school or modernizing an existing one is a major undertaking for a community that often spans multiple years. The MSBA provides modules that outline the process for districts seeking grant funding and the collaborative process following an invitation to the MSBA's capital pipeline. The Northeast Energy Efficiency Partnership (NEEP) Zero Energy Schools Toolkit outlines a general process for building a new school or modernizing an existing one:[172]

1. **Pre-Design**: Establish educational specifications and conduct community engagement.
2. **Design**: Select an architect, complete the schematic design, and select a general contractor to lead construction.
3. **Construction**: Complete site work, building construction, and landscaping.
4. **Occupancy**: Conduct occupant engagement and training before the school's opening and on an ongoing basis.

The comprehensive nature of new construction and modernizations allows districts to establish decarbonization goals at the pre-design project phase. Most commonly, these goals are communicated to project teams by establishing site EUI (energy consumption measured at the meter) and source EUI (includes the fuel required to generate and deliver the energy) targets. The targets in

Table 44 are included as a 2019 reference based on MA's location in climate zone 5A.[173] It is important to understand the current market landscape as targets are being set, given that efficiencies improve over time. These EUI targets are more aggressive than others defined for K–12 schools in Massachusetts.[174] Other new construction and modernization goals should consider the environmental health, sustainability, and equity programs discussed in more detail in other sections.

Table 44. EUI Targets for Massachusetts Schools

Site EUI[173]		Source EUI	
Primary School	Secondary School	Primary School	Secondary School
19.2	19.1	57.1	56.9

For new construction and modernization projects, a DOE study found that net zero schools have comparable capital costs to traditional school projects, and there is no correlation between project capital costs and EUI. Instead, a fixed budget and target EUI were found to be key determinants for a successful, cost-effective project by providing firm boundaries that allow project teams to find creative solutions.[43]

While both new construction and modernization projects decrease operational emissions, they differ in their relative embodied carbon intensities, which impacts a building's overall carbon footprint. In this context, embodied carbon refers to the emissions generated during the resource extraction, manufacturing, transportation, replacement, and disposal of building materials. Construction projects result in a significant generation of emissions from embodied carbon, separate from the operational emissions that result from using a school over the building's useful life. Reducing a project's embodied carbon results in immediate climate mitigation benefits in the present. Modernization projects generally have lower embodied carbon intensities because they reuse structural components that include the majority of the high carbon intensity materials, like concrete and steel. Modernization projects also retain school resources in the existing community and require less land disturbance. The MSBA incentivizes building reuse with up to five points towards a selected project's calculated reimbursement rate (see the Introduction section for additional details on this reimbursement rate formula). Modernization projects can, however, be challenging to execute because of the need to mitigate the exposure of occupied spaces to airborne pollutants generated by construction activities or to identify swing space to house school operations during the project that meets program, community, and environmental health requirements. New construction projects can use design strategies to mitigate their embodied carbon, including reducing the amount of concrete and steel used or procuring concrete and steel with lower embodied carbon intensities.

Deep Energy Retrofits: A Key Strategy for Building Decarbonization

The significant inventory of existing Massachusetts school buildings presents a much larger near-term GHG emissions reduction opportunity than the relatively slower rate of new construction and modernization in most districts. The comprehensive design process associated with deep energy retrofits allows districts to take a phased approach to replacing and modernizing building systems over time to realize cumulative EUI reductions of at least 40 percent.

(5) Implement deep energy retrofits

Deep energy retrofits achieve 40 percent or greater reductions in an existing building's site EUI through a comprehensive design process that considers improvements to all building systems.

Deep energy retrofits can be achieved as part of a larger modernization project that also includes updates to finishes, school programming, site work, and other non-energy areas. Later sections address individual building systems and retrofit strategies in more detail.

In addition to optimizing a building's energy efficiency, deep energy retrofits also help enable the electrification of building heating systems. A critical step to efficient electrification is understanding a building's heating requirements and identifying opportunities to reduce heating loads to more effectively maintain occupant comfort while right-sizing new, all-electric equipment. For example, designing a system based on the total capacity of all existing fan coil units (FCUs) in a building may result in a heating system size that is challenging to electrify cost-effectively. By looking at trend data for the actual heating load of all FCUs over a range of conditions, designers may find that all but the FCUs serving the coldest zones operate at 35 percent capacity. Thus, the central system capacity can be reduced while still providing supplemental heat to the coldest zones when needed.

Critically, gaining a better understanding of and reducing heating loads can lower supply hot water temperatures and expand the options of available, efficient, all-electric systems.[175]

(6) Improve building envelopes

The building envelope refers to the windows, walls, and roofs that provide a barrier between indoor and outdoor spaces and accounts for approximately 30 percent of the primary energy consumed in typical commercial buildings.[176] Improving the building envelope can reduce the building's overall heating and cooling loads, reducing the necessary size and cost of the HVAC system. For example, a Virginia elementary school invested an additional $200,000 in the school's envelope, resulting in savings of about $500,000 in HVAC first costs.[43] Building envelopes serve the following purposes:

- **Maintain thermal comfort** by reducing radiant heat and drafts. In the case of a power outage, a well-designed envelope can help a building maintain indoor temperatures over a more extended period; this is referred to as "passive survivability." With lower heating and cooling loads, it is increasingly important to confirm that sufficient ventilation is provided to all spaces. See Goal 2: Achieve Healthy Schools, Objective 2c. Maintain Thermal Comfort for additional details.
- **Air and vapor barriers** maintain indoor air quality (IAQ) and appropriate humidity levels and prevent moisture damage to building materials. Tighter envelopes allow the HVAC system to supply only filtered and conditioned outdoor air, addressing the concern of outdoor air pollutants resulting in degraded IAQ (see the Reduced Exposure to Outdoor Air Pollutants section for more details),

as well as minimizing excess moisture, which can lead to mold growth, a known allergen and asthma trigger.

- **Insulation and removal of thermal bridges** separate interior conditions from exterior conditions for both temperature and sound attenuation.
- **The window-to-wall ratio** is a measure of the relative prevalence of windows in the envelope and is used to balance the benefits of daylighting with the low insulating value of windows as compared to walls. Operable windows can offer natural ventilation.
- The envelope is the **primary visual interest** that the school community and general public interact with.

Improving Building Envelopes Through Weatherization

Weatherization is the process of improving the building envelope and systems; it includes numerous strategies for existing buildings to improve air sealing, add insulation, and control moisture. Strategies vary in cost and level of disruption based on the types of envelope assemblies present at a given school. Some building types, such as mass masonry buildings that are common in older buildings, may require more comprehensive envelope retrofits to achieve modern performance. A common envelope retrofit is adding insulation as part of reroofing projects.

(7) Optimize and electrify component retrofits

Component retrofits refer to the replacement of individual pieces of equipment, some of which may be part of a larger system, or equipment that operates independently of a central plant. In all retrofits, schools should strive to improve upon energy efficiency and electrify any existing components that currently combust fossil fuel. DOE's *Decarbonizing HVAC and Water Heating in Commercial Buildings* provides building owners and facilities engineers with a valuable resource when conducting the technical, economic, and feasibility assessment for converting to all-electric solutions.[175] The DOE report demonstrates how building owners can retrofit a variety of existing system types to alternative systems that rely on electric heat pump (HP) technology. These systems are often classified by their heat source (e.g., air-, water-, and ground-source) and thermal distribution method in the building (e.g., air for packaged rooftop units, water for hydronic heat pumps, and refrigerant for variable refrigerant flow solutions). Examples of component retrofits are outlined below.

- **Rooftop units (RTUs)** are individual pieces of equipment that are often used to provide heating and cooling to large open spaces, including a school's gymnasium, cafeteria, auditorium, and library. Conventional RTUs that combust fossil fuel (typically natural gas) to provide space heating can often be replaced in-kind by a HP RTU that uses the existing electrical service to provide both heating and cooling. Furthermore, if there is an existing supply line for natural gas, a school can use this natural gas service to provide second-stage heating to supplement heating from the HP RTU on the coldest days. This can result in greater than 80 percent electrification of heating for the given zone. The retrofit project requires a crane to move equipment to and from the roof and can be completed during school breaks.

- **Water heaters** provide domestic hot water for small applications such as bathrooms and locker rooms. Heat pump water heaters (HPWHs) are available in sizes ranging from 40 to 120 gallons and some available models can operate using a standard 110V wall outlet, reducing the need for electrical work ahead of the installation. HPWHs extract heat from the air in the room in which they are located, which has the added benefit of dehumidifying the room.
- **Lighting retrofits** frequently install LED fixtures in existing fluorescent lighting troffers and in space types where the existing lighting fixture may need to be replaced (gymnasiums, outdoor site lighting). Schools should consider keeping lighting controls simple so that untrained users can quickly and easily use them.[177] Lighting retrofits often provide quick financial paybacks, making them a good candidate to bundle with other ERMs to improve overall project economics. Existing FLBs that contain PCBs should be properly handled and disposed of as part of a retrofit. See Goal 2: Achieve Healthy Schools, Objective 2a. Improve Indoor Air Quality for additional details about reducing exposure to PCBs.

Realizing Indoor Air Quality Co-benefits

Updated HVAC equipment (e.g., RTUs) can provide numerous IAQ co-benefits, including:

- The installation of air filters that have a minimum efficiency reporting value (MERV) of 13 or higher.
- The use of demand control ventilation increases ventilation rates when a setpoint (e.g., 800 parts per million [ppm] carbon dioxide) is reached. This ensures that both a crowded gymnasium with high school physical education classes and an elementary school library are appropriately ventilated based on occupancy levels and activity types.
- The installation and use of carbon dioxide, carbon monoxide, and PM sensors that can help building engineers monitor and quickly resolve any identified air quality issues. See the Reduce Exposure to Mold and Moisture section for additional details about the use of sensor technology to monitor IAQ parameters.

(8) Electrify whole system retrofits

Whole system retrofits most often refer to HVAC retrofits that include the central plant equipment, the terminal equipment serving individual classrooms and zones, and in some cases, the distribution system connecting the two. A key use case in Massachusetts, as climate change is expected to increase the number of high-heat days, is to add air conditioning to buildings that currently only provide heating or use window air conditioning units. The more comprehensive nature of these projects allows engineers to consider a wider range of available technologies, including:

- **Variable refrigerant flow (VRF) systems** use heat pumps in each zone to provide heating and cooling by modulating the amount of refrigerant sent to each unit and moving heat between rooms. VRF systems are a common retrofit option in buildings that use window air conditioning units or provide only heat. These projects require significant redesign since the refrigerant-distribution system is fundamentally different compared to an existing hydronic or steam boiler.[175] Additionally, these systems generally do not provide ventilation by introducing outdoor air and, therefore, may need to include a separate dedicated outdoor air system to meet ventilation requirements.
- **Ground-source heat pumps (GSHPs),** also referred to as geothermal or geo-exchange heat pumps, represent a whole system retrofit option and are a common approach in school new construction projects. GSHPs have a successful track record in Massachusetts schools by taking advantage of the stable year-round ground temperature to provide heating and cooling at 3 to 6 times the efficiencies of legacy fossil fuel systems, even in cold climates.[178] GSHP systems require an appropriately sized wellfield that houses the vertical bores, which circulate a fluid before returning to the building. Wellfields can be installed under parking lots, athletic fields, or other adjoining open spaces. GSHPs are a well-established technology that have compelling lifecycle costs. A study conducted by the Town of Arlington, MA, across six schools found that GSHP systems have lower first cost and lifecycle costs when accounting for federal and state incentives.[179]

Networked Geothermal in Massachusetts

As of 2024, National Grid and Eversource, two Massachusetts natural gas utilities, are piloting community energy networks where multiple buildings are connected to a GSHP loop, demonstrating how natural gas utilities can offer their customers clean heat.

- **Wastewater energy recovery**, another established technology, uses sanitary sewer infrastructure as a heat source/sink. Wastewater is diverted to a heat exchanger, which transfers energy to a heat pump system that serves the building. This technology can support electrification in space-constrained urban environments that may not be able to support a GSHP wellfield.

The co-benefits described in the component retrofit section also apply to the above technologies but across a larger portion of the school.

(9) Electrify cafeteria kitchens

After space and water heating, cafeteria kitchens are often the next largest consumer of fossil fuels in schools. In addition to the kitchen equipment that combusts fossil fuels (e.g., ovens, cooktops, fryers), the combustion activity releases toxic chemicals into the air and requires significant ventilation, which contributes to electricity consumption through exhaust fan power and conditioning the outdoor makeup air. Traditional kitchens are loud (ventilation) and hot (open combustion inefficiently transferring heat) environments that can provide significant workplace improvements by electrifying equipment. Another co-benefit of all-electric kitchens is the reduction of asthma triggers.

Like space heating systems, a variety of options are available to efficiently electrify kitchen operations. The type of kitchen operations occurring at a given school (full-service kitchen, commissary serving multiple schools, reheat kitchen) and the food program (food served, single use vs. reusable service ware, lunch seatings and throughput) will determine the requirements for an all-electric alternative design. It is important to engage with the district's food and nutrition group to understand and document kitchen requirements.

All-electric kitchens have been demonstrated to meet or exceed the throughput of traditional kitchen lines and can often do so using a smaller footprint. Where there are concerns about equipment performance or power availability, installing an induction cooktop is a good entry point to demonstrate proof of concept. Schools can install additional electric kitchen equipment as they replace existing fossil fuel-fired equipment.[180]

Operate and Maintain Schools

O&M refers to all the daily and ongoing tasks performed by school staff and contractors to prioritize that schools continue to operate as they are intended to. Staff members with a deep understanding of the school facility are critical to schools achieving the goals of any of the implementation methods and best practices described above, from project inception through the end of life of the school. When conducting O&M, schools should take care to operate and maintain NZE schools, utilize building automation systems, and establish and train an NZE workforce.

Changing Air Filters

As part of maintaining a school's HVAC system, facilities staff perform regular filter changes. Where available from a BAS, schools can utilize real-time data showing the pressure drop across the filter (indicating that air flow is being restricted) to determine the appropriate time for filter replacement. Alternatively, schools can rely on the air filter manufacturer's specification (typically 2 to 4 times per year). Equipment should be cleaned during filter changes to prevent air flow from bypassing the filter. This process is critical to maintaining good IAQ. See Goal 2: Achieve Healthy Schools, Objective 2a. Improve Indoor Air Quality for additional details about improving IAQ.

(10) Operate and maintain NZE schools

All-electric buildings often have increasingly decentralized systems and advanced controls. This can present an asset management challenge but also allows designs that are more similar in scale and technology to residential systems. As buildings transition to all-electric systems, existing O&M best practices become increasingly important, including:

- **Preventive maintenance**, which helps support reliable operation of equipment. A preventive maintenance plan outlines the frequency of maintenance tasks for all pieces of equipment. A lack of preventive maintenance can lead to an increase in emergency replacements, which often necessitate in-kind replacements with equipment available from existing inventory. This often results in a project missing a critical opportunity to thoughtfully electrify systems.

Re-commissioning/retro-commissioning (RCx), which involves a process of examining and recalibrating an existing building's equipment and systems to better meet the building's operational needs. The term "re-commission" is used for buildings that were properly commissioned following original construction; the term "retro-commission" is used for existing buildings that were never properly commissioned following original construction. Schools should conduct RCx every five years or when there are significant changes in operations (e.g., a change of occupancy greater than 20 percent). This practice confirms that equipment is performing according to the original design intent and can include the recalibration or replacement of sensors and other minor repairs to control systems.

Computerized maintenance management systems, which help manage all maintenance activities across a portfolio of buildings. Larger school districts responsible for maintaining a greater number of buildings should consider using these systems to more efficiently manage and coordinate maintenance activities across facilities staff and contractors.

Engaging O&M staff in capital projects, which prioritizes their expertise in operating building systems and addressing existing pain points so they are appropriately accounted for in the design phase. O&M staff often provide a unique perspective regarding the feasibility of proposed design options, including an awareness of zones that have trouble maintaining setpoints and knowledge of system access points that enable preventative maintenance without disrupting classrooms.

(11) Utilize BAS to optimize building performance and energy efficiency

A BAS provides automatic controls, visualizations, and trend data for the operation of various building systems. BAS support reliable building operations while also reducing energy and water consumption. ASHRAE *Guideline 36-2021* outlines best-in-class HVAC control sequences and should be used to establish requirements for new BAS or to conduct RCx for existing systems. Examples of BAS best practices follow.

- **Setpoints and schedules** helps to balances the thermal comfort of building occupants (see Goal 2: Achieve Healthy Schools, Objective 2c. Maintain Thermal Comfort for additional details) and energy-efficient operations by reducing system runtime during unoccupied periods. Both should be established by district policy and allow for room-level adjustments by occupants (rooms with southern exposure may feel warmer) and special events (after-school uses of specific spaces).

- **Demand Controlled ventilation** is a best practice for ensuring sufficient ventilation is provided in an energy-efficient manner.

- **Optimal start and stop** refers to the use of trend data to understand how long the building takes to warm up or cool down based on weather conditions and schedules the HVAC system to turn on at a specific time based on current conditions. The alternative is using a static startup time that is often overly conservative (resulting in excessive equipment run time and energy waste) and may not be updated to account for sporadic, extreme conditions.

- **Central monitoring and control** of BAS can be a beneficial strategy for larger districts. Trained operators can remotely monitor building conditions across multiple schools, perform fault detection and diagnostics, and find energy savings (e.g., utility load curtailment or demand response programs).[181]

- **Preventive maintenance** such as front-end software updates (what the user interacts with), controller firmware updates, and sensor calibration all help support the proper operation of and interpretation of the data from the BAS.

Co-benefits of improved building performance via BAS optimizations include controlling humidity and excess moisture in schools, which in turn can decrease mold growth, reducing allergens and asthma triggers. See the Reduce Exposure to Mold and Moisture section for additional information.

(12) Establish and train an NZE workforce

Massachusetts has identified expanding the clean energy sector workforce as a key strategy to achieving the Commonwealth's climate goals. This includes trades relevant to school O&M staff, including HVAC and smart building technicians, as well as other trade partners with whom schools are likely to contract.[182] While Massachusetts continues to build out equitable pathways to bring more people into the clean energy trades, districts can consider the following for existing staff and new hires:

- The **existing workforce** benefits from continued investment in job training such as those offered by MassCEC through the Clean Energy Careers Training and Education Directory, Massachusetts' 15 community colleges, and Building Operator Certification (discounted rates available to registrants served by Eversource Massachusetts or National Grid).[182]
- Evaluate the **job descriptions and required licensing/certifications** of new hires. For example, as districts electrify schools, roles that traditionally required boiler plant operator licenses will require an HVAC technician skillset to understand the vapor compression refrigerant cycle used by heat pumps. There is also an increasing need for computer skills so that BAS-connected systems run automatically based on the original design intent and are only overridden for manual operation briefly and when necessary.

Procure Decarbonized Electricity

The procurement and use of decarbonized electricity is the final pillar of decarbonization following efficiency improvements and electrification projects. Using decarbonized electricity is a key step to decarbonization, especially as more building systems are electrified and building electricity consumption increases. By nature, decarbonized electricity also keeps district money in the regional community as a school's utility budget transitions from being spent on fuels that are most often brought in from outside of the community to electricity that is generated within the region. To pursue decarbonized electricity, schools should consider both the installation and use of onsite renewable energy systems and the procurement of bundled renewable electricity from the grid.

(13) Install and use onsite renewable energy systems

Onsite renewable energy systems allow schools to generate and consume their own electricity, while still being connected to the broader electrical grid to support reliable operations and to export power when it is not needed. Solar photovoltaic (PV) arrays are the most common onsite renewable energy systems and can take advantage of the large flat roofs installed on many schools. Districts can use DOER's Technical Solar Potential Map to help prioritize schools with the greatest solar potential. To the maximum extent possible, schools should coordinate the installation of onsite solar PV arrays to coincide with roof replacements to help make certain 20 to 25 years of uninterrupted generation from the array. Other project types (such as roof replacements) can include PV make-ready infrastructure (home run conduit from the roof to the electrical room) to lower the cost of future installation. Systems that require dedicated structures (carports) are more costly to install but can offer additional benefits such as shading and supporting electric vehicle charging. See Objective 1e. Provide Electric Vehicle Charging Stations for School Staff and Public Use for additional information about electric vehicle charging infrastructure and Objective 1f. Enhance Climate Resilience for additional information for how solar PV arrays can incorporate battery energy storage systems (BESS) to optimize a school's resilience to climate change.

NE-CHPS defines zero energy capable design as having PV generation equal to or greater than 100 percent of annual electricity consumption, covering a minimum of 65 percent of the roof area. This highlights the benefit of project designs that minimize rooftop equipment to maximize PV capacity.[183]

(14) Procure bundled renewable electricity from the grid

Massachusetts is a retail choice electricity market served by ISO New England—the independent regional transmission organization that oversees the operation of the grid in New England. In a retail choice market, organizations can participate in competitive procurements and select their own electricity supply, which is delivered to facilities by the serving distribution utility (the company that owns the wires to the building, owns the meter, and bills the customer). Massachusetts' Renewable Energy Portfolio Standard

(RPS) ensures that the amount of grid-supplied clean electricity that a facility receives by default increases over time.

Bundled renewable electricity (also known as “delivered green power”) refers to a customer’s purchase of physical electricity flowing from the grid to the customer’s site paired with the underlying environmental attributes associated with the electricity generated from a renewable source, for which the customer pays a premium. These attributes are commonly referred to as renewable energy credits or energy attribute certificates. PowerOptions is an organization that manages competitive utility procurements for non-profit and public sector entities in Massachusetts, Connecticut, and Rhode Island, helping schools in these states meet their goals and reduce utility price volatility by locking in stable long-term electricity rates.

Statutes, Regulations, and Standards

Massachusetts has been a national leader in policy for the decarbonization of buildings and energy systems. Statutes, regulations, and standards that apply to schools follow.

Summary of Relevant Statutes

Acts of 2016, Chapter 75: Solar Massachusetts Renewable Target Program directs DOER to establish a long-term sustainable solar incentive program to promote cost-effective solar in the Commonwealth.[184]

Acts of 2021, Chapter 8: An Act Creating a Next-Generation Roadmap for Massachusetts Climate Policy establishes comprehensive policies to address climate change; the statute required the EEA Secretary to adopt a statewide GHG emissions limit and sector-specific sub-limits for 2050.[185]

Acts of 2022, Chapter 179: An Act Driving Clean Energy and Offshore Wind, Section 20 requires owners of buildings greater than 20,000 square feet to report annual energy usage to DOER.[32]

M.G.L c, 25A § 11F: Renewable Energy Portfolio Standard directs DOER to establish an RPS for all retail electricity suppliers selling electricity to end-use customers in the Commonwealth.[186]

M.G.L c, 70B: School Building Assistance Program established the MSBA; the statute provides the MSBA’s purview and operating authority.[30]

Summary of Relevant Regulations

225 Code of Massachusetts Regulations (CMR) 10.00: Energy Management Services (EMS) Contracts RFP Process sets forth the guidelines and procedures that public entities in Massachusetts must follow when seeking to procure energy management services through the RFP process, ensuring that these contracts contribute to the state’s energy efficiency and sustainability goals.[187]

225 CMR 19.00: Energy Management Services (EMS) Contracts Requests for Qualifications Process provides the framework for conducting the request for qualification process for EMS contracts in Massachusetts, guiding how public entities can pre-qualify vendors based on their qualifications before proceeding to the detailed proposal stage.[188] This helps in selecting vendors who are best suited to meet the energy management needs of the state's public sector entities.

225 CMR 23: Commercial (and all other) Construction Stretch Energy Code establishes enhanced energy efficiency standards for non-residential buildings beyond the requirements of the base energy code.[189]

225 CMR 23 Appendix CC: Commercial (and all other) Construction Specialized Energy Code outlines specialized energy code provisions for commercial and other non-residential construction projects in Massachusetts, complementing the broader Stretch Energy Code to prioritize that a wide range of building types and systems meet energy efficiency standards.[189]

310 CMR 7.75: Clean Energy Standard establishes targets and requirements aimed at reducing GHG emissions from the power sector and advancing Massachusetts' goals for clean energy and climate action.[190]

780 CMR: Massachusetts State Building Code governs the construction and renovation of buildings throughout the state, ensuring they meet minimum standards for safety, health, accessibility, and energy efficiency.[191]

963 CMR 2.00: School Building Grant Program was promulgated by the MSBA pursuant to rulemaking authority conferred by M.G.L. c. 70B and St. 2004, c. 208 for the implementation of that statute and the school building grant program it establishes.[192]

Summary of Relevant Standards

Massachusetts Appliance Energy and Water Efficiency Standards sets water efficiency standards for plumbing fittings, plumbing fixtures, commercial ovens, commercial dishwashers, commercial steam cookers, and spray sprinkler bodies.[193]

NE-CHPS is a regional adaptation of the CHPS criteria specifically tailored for schools in the Northeastern United States. Its primary goal is to promote the design, construction, and operation of K–12 schools that are healthy, comfortable, environmentally sustainable, and energy efficient.[194]

Appliance and Equipment Standards Program is operated by DOE and, among other things, establishes national minimum energy efficiency standards.[195] The standards currently cover more than 60 types of appliances and equipment that collectively represent 60 percent of commercial building energy use.

ASHRAE Standard 211 – Standard for Commercial Building Energy Audits defines the procedures and practices for conducting energy audits for commercial buildings, including the distinction between Level 1, 2, and 3 audits.[196]

ASTM E2018-15 is the industry standard for baseline property condition assessments of commercial buildings.[197]

USGBC's LEED v4.1 Building Design + Construction is designed to guide and recognize the design and construction of high-performance, environmentally sustainable buildings.[198] It emphasizes strategies that improve energy efficiency, reduce water consumption, promote indoor environmental quality, and incorporate sustainable materials and practices.

Table 45 summarizes the statutes, regulations, and standards related to decarbonizing schools.

Table 45. Statutory/Regulatory Framework and Notable Standards for Decarbonizing Buildings

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Statutes			
Act of 2016 Chapter 75: Solar Massachusetts Renewable Target Program	X		
Act of 2021 Chapter 8: An Act Creating a Next-Generation Roadmap for Massachusetts Climate Policy	X		
Act of 2022 Chapter 179: An Act Driving Clean Energy and Offshore Wind	X		
M.G.L c, 25A § 11F: Renewable Energy Portfolio Standard	X		
M.G.L c, 70B: School Building Assistance Program	X		
Regulations			
225 CMR 10.00: Energy Management Services (EMS) Contracts RFP Process	X		
225 CMR 19.00: Energy Management Services (EMS) Contracts Requests for Qualifications Process	X		
225 CMR 23: Commercial (and all other) Construction Stretch Energy Code	X		
225 CMR 23 Appendix CC: Commercial (and all other) Construction Specialized Energy Code	X		
310 CMR 7.75: Clean Energy Standard	X		
780 CMR: Massachusetts State Building Code	X		
963 CMR 2.0: School Building Grant Program	X		
Standards			
Massachusetts Appliance Energy and Water Efficiency Standards			X
NE-CHPS			X
Appliance and Equipment Standards Program			X
ASHRAE Standard 211–Standard for Commercial Building Energy Audits			X
ASTM E2018-15			X
USGBC's LEED v4.1 Building Design + Construction			X

Relevant Resources

Table 46 provides a summary of key resources related to decarbonizing school buildings.

Table 46. Resources for Decarbonizing School Buildings

Resource	Author	URL
Affordable Zero Energy K–12 Schools: The Cost Barrier Illusion	National Renewable Energy Laboratory (NREL)	https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/80766.pdf
A Guide to Zero Energy and Zero Energy Ready K–12 Schools	NREL	https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/NREL_ZE_K12_Study.pdf
Decarbonization Roadmap Guide: For School Building Decision Makers	New Buildings Institute	https://newbuildings.org/resource/decarbonization-roadmap-guide-for-school-building-decision-makers/
Emission Reduction Planning Framework	DOE	https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/ERP_Framework_Building_Portfolios.pdf
HVAC Choices for Student Health and Learning	RMI, Undaunted K–12	https://rmi.org/insight/hvac-choices-for-student-health-and-learning/
Technical Solar Potential Map	DOER	https://www.mass.gov/info-details/technical-potential-of-solar-study
Wastewater Energy Recovery	MassDEP	https://www.mass.gov/info-details/wastewater-energy-recovery
Working With Us	MSBA	https://www.massschoolbuildings.org/Working_With_Us/districts
Zero Energy Schools Toolkit	NEEP	https://neep.org/ma-zero-energy-schools-toolkit

Objective 1b. Optimize Water Efficiency

Methods and Best Practices

There are many methods and best practices for optimizing water efficiency in schools, including monitoring and managing water use, optimizing water efficiency of end uses and systems, and using alternative water sources. Each of these methods and best practices are described in more detail below.

Resources to Jump Start Water Efficiency in Schools

Schools can begin optimizing water efficiency by reviewing WaterSense's Best Management Practices, the Massachusetts Water Conservation Standards, and the Schools, Recreation and Facilities Managers web page offered by the Commonwealth's Water Resources Commission.

In general, schools should consider reviewing the EPA WaterSense® program's best management practices, collectively known as *WaterSense at Work*.[199] *WaterSense at Work* is a comprehensive guide developed to help commercial and institutional facility owners and managers understand and better manage their water use. It is designed to provide guidance to help establish an effective facility water management program and identify projects and practices that can reduce facility water use and associated operating costs. It includes best practices and O&M, retrofit, and replacement recommendations for most if not all water end uses that may be found in Massachusetts schools, and provides a compilation of additional resources on each topic.

In addition, *Massachusetts Water Conservation Standards* provides best practices and recommendations for optimizing water efficiency for water suppliers and water users, including schools.[200] Specifically, schools should consider reviewing Section 7.0, which provides recommendations for schools, and Section 9.0, which provides recommendations on outdoor water use. Recommendations for schools are also summarized on the School, Recreation, and Facilities Managers web page offered by the Water Resources Commission.[201]

Monitor and Manage Water Use

When monitoring and managing water use, schools should consider metering and tracking water use, benchmarking water use against other schools, and conducting individual facility water assessments.

(1) Meter and track water use

Metering and tracking water use can help schools identify leaks and other abnormalities in water use, identify areas for targeted reductions, help measure progress from implementing water efficiency best practices, and allow for benchmarking.

At a minimum, schools should consider regularly tracking their building- or campus-level metered water consumption using bills provided by their water utility. Schools should strive to meter all water uses, including all indoor and outdoor water use, as well as both utility-supplied sources and onsite alternative water sources (e.g., rainwater, graywater).[200] Schools should consider entering data into ESPM or another similar utility management program.[202] ESPM is a free, interactive tool for managing energy, water, waste, and GHG emissions of any building type. ESPM has tools to help understand metrics, monitor trends, and generate reports of metered data. Schools should use graphs of water use data to help identify potential leaks or other water use abnormalities and fix them immediately.[203]

Some schools may be able to access advanced metering infrastructure (AMI) data from their water utility, if their utility uses advanced meters. Advanced water meters record water meter data at least hourly and automatically transmit data regularly to a central collection point. School facility managers can learn more about how to use AMI data by reviewing WaterSense's *Improving Water Management Using Advanced Metering Infrastructure Data: A Guide for Facility Managers*.[204]

In addition to metering and tracking building- or campus-level water use data, schools should consider submetering high water end uses, including cooling towers, steam boilers, single-pass cooling systems, irrigation systems, pools, and any product, system, or process predicted use 1,000 gallons of water or more per day or 100,000 gallons of water or more per year.[205]

For more information about how to optimize water efficiency by metering and tracking water use, schools should review *WaterSense at Work Section 2.1: Metering and Submetering*.[199]

(2) Benchmark water use

To further optimize water efficiency, Massachusetts schools should consider benchmarking school water use. Benchmarking is the process of measuring a building's water use and comparing it to its own historical usage, the water use of similar facilities, or a reference performance level. Similar to metering and tracking water use, benchmarking can be as simple as measuring and comparing one school's water consumption over time (e.g., gallons per year). However, benchmarking can be more powerful when water use data is normalized so that it can be compared across similar facilities of the same type.[206]

Normalizing Water Consumption Data

To compare schools of all sizes and populations to one another, water use data should be normalized. To normalize water use data, schools can select a metric to help best compare water use data among schools, such as by facility size (e.g., gallons per square foot per year) or by population served (e.g., gallons per student per year).

Massachusetts schools can benchmark building water consumption by:

- Metering and tracking water use (as described in best practice 1)
- Selecting a metric to normalize water use data, such as gallons per square foot per year (also known as water use intensity [WUI]) or gallons used per student per year
- Comparing normalized water use data across schools within individual school districts or municipalities

Individual school districts or municipalities throughout the Commonwealth could use normalized water use data to compare schools within their district to one another to identify the schools in greatest need of efforts to increase water efficiency. School districts/municipalities could choose to focus efforts on the highest water-using schools, potentially deciding to conduct water assessments (as described in best practice 3) on those schools first.

In addition to comparing schools within a municipality or across the state, schools might also compare building water performance to other schools across the nation. EPA has developed a technical reference on median WUI values and other metrics observed in a variety of facility types based on water use data entered into ESPM, which schools could review to compare themselves against other schools in the United States.[207] For select building types in ESPM, there is an EPA Water Score (from 1 to 100) that allows a facility to compare itself relative to the national population of buildings with similar characteristics. For example, a building receiving a score of 75 indicates the building performs better than 75 percent of similar buildings nationwide. While this EPA Water Score rating system is not yet available for schools in ESPM, schools should continue to report water use data into it to support this functionality in the future.

Some Massachusetts municipalities, including Boston[208] and Lexington,[209] currently require large commercial buildings such as schools to report energy and water use data annually using ESPM. Schools and school districts should be sure to report water use where required and should consider tracking and reporting water data in ESPM, even if not required.

For more detailed information on optimizing water efficiency by benchmarking water use, review *WaterSense at Work Section 2.3: Benchmarking*.[199]

(3) Conduct water assessments

Understanding how water is used in each school individually is critical to optimizing water efficiency across the portfolio of schools in Massachusetts. An individual facility water assessment can:[210]

- Provide a comprehensive account of all water end uses at a school
- Identify leaks and potential simple operations and maintenance changes (unique to each school) that could reduce water use
- Establish a school's water use baseline
- Prioritize a list of water efficiency projects and improvements at a school, including potential water and energy savings, project cost, and return on investment

Schools should consider hiring water efficiency professionals with specific water assessment experience to conduct school building water assessments. Alternatively, existing facility management staff can educate themselves to conduct water assessments using tools and resources developed by EPA's WaterSense program and other organizations. School facility managers can begin to train themselves to assess their schools by reviewing *WaterSense at Work Section 1.2 Water Management Planning*,[199] watching EPA's latest "Conducting a Water Assessment from Start to Finish" webinar,[211] and familiarizing themselves with additional tools and resources available to help conduct a water assessment.[212]

WaterSense recommends that facilities conduct water assessments every four years to continue to identify O&M practices, retrofits, and replacements that may optimize water efficiency at a facility.[210]

Optimize Water Efficiency of End Uses and Systems

To optimize water efficiency of end uses and systems, schools should consider installing WaterSense® labeled, ENERGY STAR® certified, and other high-efficiency products in restrooms and cafeterias; implementing water-efficient O&M and user education in restrooms and cafeterias; eliminating non-functional irrigated turf and installing water-efficient landscaping; optimizing irrigation systems and installing WaterSense labeled irrigation products; eliminating single-pass cooling; optimizing cooling towers and steam boilers; and optimizing the water efficiency of other uncommon end uses where applicable.

(4) Install WaterSense labeled, ENERGY STAR certified, and other high-efficiency products in restrooms and cafeterias

Whenever possible, schools should install WaterSense labeled, ENERGY STAR certified, and other high-efficiency water-using products in restrooms and cafeterias.

248 CMR 10.00 Uniform State Plumbing Code specifies maximum flow rate requirements for residential and non-residential lavatory faucets; residential kitchen or bar faucets; and non-residential sink faucets, showerheads, tank-type toilets, flushometer-valve-type toilets, and urinals that align with current WaterSense specifications, where applicable.[213] Further, *225 CMR 9.00 Appliance Energy-Efficiency Standards, Testing and Certification Program* requires that commercial dishwashers and steam cookers sold in Massachusetts be ENERGY STAR certified.

WaterSense labeled restroom products use at least 20 percent less water than standard models and are independently certified for efficiency and performance. Because WaterSense labeled products have maximum flow rates aligned with Massachusetts plumbing code and are independently tested and certified, Massachusetts schools should use the WaterSense Product Search Tool to look for WaterSense labeled products specifically when replacing or purchasing new bathroom fixtures and fittings.[214] These products include:

- WaterSense labeled flushometer-valve and tank-type toilets
- WaterSense labeled urinals
- WaterSense labeled showerheads
- WaterSense labeled private lavatory faucets (intended for private bathrooms not available to walk-in traffic)

WaterSense does not label public lavatory faucets (i.e., those installed in public restrooms open to walk-in traffic). New lavatory faucets in public restrooms should either be 0.5 gallons per minute (gpm) public-use lavatory faucets or 0.25 gallons per cycle metering faucets to align with Massachusetts plumbing code.[213]

Similarly, WaterSense does not label kitchen faucets. Instead, schools should install 1.8 gpm kitchen sink faucets with a 2.2 gpm maximum temporary override for classrooms and other areas with residential-style kitchen sinks to align with requirements in *225 CMR 9.00 Appliance Energy-Efficiency Standards, Testing and Certification Program.*[215]

ENERGY STAR specifies energy- and water-efficiency criteria for several water-using commercial kitchen products and appliances. Massachusetts regulations require that commercial dishwashers and steam cookers sold in the Commonwealth be ENERGY STAR certified.[215] To align with these regulations and to save energy and water across all water-using cafeteria equipment, Massachusetts schools should use the ENERGY STAR Product Finder to look for ENERGY STAR certified commercial kitchen products, specifically when replacing or purchasing new water-using kitchen equipment.[216] These products include:

- ENERGY STAR certified commercial ice makers
- ENERGY STAR certified dishwashers
- ENERGY STAR certified combination ovens
- ENERGY STAR certified steam cookers

WaterSense and ENERGY STAR do not label commercial pre-rinse spray valves used for rinsing dishes prior to dishwashing in cafeterias. Instead, schools should install 1.28 gpm commercial pre-rinse spray valves to align with the final rule that DOE published in the Federal Register in 2016.[217]

In addition, schools should consider retrofit and replacement options for steam kettles, dipper wells, wash-down sprayers, food disposals, and other commercial kitchen equipment, where applicable, as described in *WaterSense at Work Section 4.0*.[199]

(5) Implement water-efficient operations, maintenance, and user education in restrooms and cafeterias

When schools do not replace or have a need to install new restroom and cafeteria equipment (per the recommendations outlined in best practice 4), schools should consider implementing O&M and user education recommendations for restroom fitting and fixtures and cafeteria equipment as described in *WaterSense at Work Section 3: Sanitary Fixtures and Equipment* and *WaterSense at Work Section 4.0 Commercial Kitchen Equipment*.[199] These best practices provide simple, often low-cost operational and user-focused changes that can help schools use existing fittings, fixtures, and equipment as efficiently as possible.

(6) Eliminate irrigated non-functional turf and install water-efficient landscaping

In general, water-efficient landscaped plant beds require less water than turfgrass. Where possible, schools should consider eliminating irrigated non-functional turf and replacing it with water-efficient landscaping—ideally, landscaping that does not require supplemental irrigation. In addition to reducing a school's water consumption, this practice can also create additional outdoor spaces with shade that provide relief for students and staff participating in outdoor activities. Non-functional turf includes turf areas that are decorative and have no other functions. Functional use includes—but is not limited to—turf for sports fields, picnic areas, and outdoor classrooms.

Schools should review *WaterSense at Work Section 5.1: Landscaping* for further O&M and user education best practices and retrofit and replacement options to optimize the water efficiency of landscaping.[199]

(7) Optimize irrigation systems and install WaterSense labeled irrigation products

Where supplemental irrigation is needed to maintain school landscapes, schools should confirm that irrigation systems are optimized and should consider using WaterSense labeled irrigation products.

EPA recommends a full audit of an irrigation system every three years by a qualified irrigation auditor certified by a WaterSense labeled program, if possible.[218] An irrigation system audit evaluates the irrigation system's performance and schedule, identifies deficiencies, and provides suggestions for water efficiency improvements. Schools can identify irrigation professionals certified by a WaterSense labeled program using WaterSense's Find a Pro tool.[219] For schools that would prefer to use in-house staff for this purpose, existing facility managers can begin training themselves to conduct an irrigation systems audit by reviewing the American National Standards Institute (ANSI)/American Society of Agricultural and Biological Engineers (ASABE) *Standard S626: Landscape Irrigation System Uniformity and Application Rate Testing*, which provides guidelines for conducting an irrigation audit.[220]

Finding an Irrigation Professional

Schools can identify irrigation professionals certified by a WaterSense labeled program using WaterSense's Find a Pro tool.

Following an irrigation audit, schools should implement recommended improvements to the irrigation system. If a full irrigation audit isn't performed, schools should consider reviewing WaterSense at Work Section 5.2: Irrigation and implementing the recommended O&M and user education best practices and/or retrofit and replacement options to optimize the water efficiency of irrigation systems.[199]

When possible, schools should consider installing WaterSense labeled irrigation products, which can be found using the WaterSense Product Search Tool, including:[214]

- WaterSense labeled irrigation controllers, which include weather- or soil-moisture-based control technology
- WaterSense labeled spray sprinkler bodies where spray irrigation is used, as required by *225 CMR 9.00 Appliance Energy-Efficiency Standards, Testing and Certification Program*

Further, schools should ensure that all newly installed or renovated irrigation systems override and suspend programmed operation during periods of sufficient moisture. Schools should also inspect system interruption devices at least every three years by an irrigation contractor as required in *M.G.L c 21, § 67: System Interruption Devices Requirement for New Irrigation Systems*.[221] Schools can meet this requirement by using WaterSense labeled irrigation controllers or otherwise installing rain sensors that suspend irrigation upon the detection of rain.

Schools with irrigation systems should consider the water-smart irrigation principles outlined in *Massachusetts Water Conservation Standards* Section 9.0 Outdoor Water Use.[200] In addition, schools should follow state guidance for limiting nonessential outdoor water use during droughts as outlined in the *Guidance on Nonessential Outdoor Water Use Amended Water Resources Management Program Regulations 310 CMR 36.00* and the *Massachusetts Drought Management Plan Preparedness & Response*.[222,46]

(8) Eliminate single-pass cooling

Single-pass cooling systems use approximately 40 times more water to remove the same heat load than a cooling tower operating at five cycles of concentration (see best practice 9 for more details about cycles of concentration).[223] Many types of equipment cooled with single-pass cooling can be replaced with air-cooled systems.

Schools should identify any instances of single-pass cooling and minimize or eliminate them where possible. Types of equipment that may use single-pass cooling and may be present in Massachusetts schools include:

- Ice makers
- Point-of-use chillers for HVAC and other refrigeration systems
- Air compressors
- Welding machines
- Vacuum pumps

Ice makers are likely the most common type of single-pass cooled equipment found in schools. Schools should consider replacing water-cooled ice makers with ENERGY STAR certified commercial ice makers using the ENERGY STAR Product Finder.[216]

For recommendations on how to minimize or eliminate single-pass cooling identified elsewhere, schools should review *WaterSense at Work Section 6.2: Single-Pass Cooling*.[199]

(9) Optimize cooling towers and steam boilers

Some schools may use cooling towers to dissipate heat from recirculating water that is used to cool chillers, air conditioning equipment, or other process equipment. By design, cooling towers consume large volumes of water, as the cooling towers use evaporation to remove heat from the recirculated water loop. The operation of cooling towers can, however, be optimized for water efficiency.

When water evaporates from a tower, dissolved solids are left behind. Eventually the total dissolved solids (TDS) concentration gets too high for optimal performance and some water must be removed, or blown down, from the system. Make-up water is added to the system to replace the blowdown and decrease the concentration of TDS. The ratio of make-up to blow down is known as cycles of concentration.

To optimize a cooling tower's water use, a facility should maximize the tower's cycles of concentration without increasing TDS such that it impacts the tower's water quality and performance. A school's BAS can offer visibility and help optimize cooling tower performance both by monitoring TDS and by implementing control strategies described in best practice 11 of the "Objective 1a. Decarbonize Buildings" section. Schools with cooling towers may have water chemistry vendors that can help optimize their tower's cycles of concentration. Otherwise, a school's facility manager can review *WaterSense at Work Section 6.3: Cooling Towers* for more information on how to monitor and optimize water efficiency in cooling towers.[199]

Some schools may use steam boilers in building heating systems. As water is converted to steam, TDS increases. Similar to cooling towers, steam boilers require blow down to control TDS and the addition of make-up water to replace water lost during blow down. In addition, when steam is distributed, its heat is transferred to the ambient environment, and it recondenses to water. From a water efficiency standpoint, schools should consider capturing steam condensate and returning it to the boiler for reuse since this will decrease the amount of make-up water needed and reduce the frequency of blowdown. Steam boiler systems without condensate capture may need to add cold water to the hot steam condensate before it can be discharged to the sewer system, so steam condensate capture systems eliminate the need for this tempering water, as well. For further information on how to optimize steam boiler water use, schools should review *WaterSense at Work Section 6.5 Boiler and Steam Systems*.[199]

As schools work to electrify HVAC systems (following the best practices outlined in the "Objective 1a. Decarbonize Buildings" section), some boilers and cooling towers may be replaced with alternative heat pump technologies. Many of these all-electric alternatives can significantly lower water demand by using closed-loop systems in the case of GSHPs or by using refrigerants to transfer heat in place of water.

(10) Optimize water efficiency of uncommon end uses, where applicable (pools, laundries, laboratories)

Although not as ubiquitous as water use in restrooms and cafeterias, some schools may have swimming pools; laundry equipment supporting athletics, family, and consumer science classrooms, or daycares; and/or water-using laboratory equipment. Schools should consider all end uses of water that may be present and estimate the total water use of each end use when conducting a water assessment (as described in best practice 3). Schools can then determine if these uncommon end uses are significant and the extent to which they can optimize the efficiency of these end uses.

Where applicable, schools should consult appropriate sections in *WaterSense at Work* for recommendations on O&M and user education, retrofit options, and replacement options for uncommon end uses like swimming pools, laundries, and laboratories.[199]

Use Alternative Water Sources

Schools should also consider using onsite alternative water sources for some end uses, where feasible as discussed below.

(11) Use onsite alternative water sources for irrigation, cooling towers, and toilet and urinal flushing

Where potential water sources meet needs, schools should consider collecting and reusing water on site. For example, existing schools with irrigation systems could consider collecting and using rainwater for irrigation. Some treatment may be needed to confirm the water is safe for landscape application, but water doesn't need to be potable-level quality for irrigation system use. In addition, existing schools with cooling towers could consider collecting and reusing air handler condensate for cooling tower make-up water. Air handler condensate is typically produced during hot, humid months when cooling towers are operating closest to peak and need the most make-up water. This is an example of an alternative water source that matches the need well.

It is likely not cost-effective for existing school buildings to be re-plumbed to use graywater or rainwater for toilet and urinal flushing, but schools undergoing major renovations or new schools could be designed to implement these systems. Newly designed schools could consider water sources including graywater from lavatory sinks, laundries, and showers; rainwater; and air handler condensate. Newly designed schools should also consider reusing onsite alternative water for irrigation systems and cooling towers as described previously.

For more information on collecting and using onsite alternative water sources, schools should review *WaterSense at Work Section 8.0: Onsite Alternative Water Sources* and the Federal Energy Management Program's (FEMP's) Alternative Water Sources web page, which provides tools for determining the viability of rainwater harvesting and air handler condensate capture.[199,224]

Statutes, Regulations, and Standards

Statutes, regulations, and standards that include a focus on water efficiency and apply to schools are detailed below.

Relevant Statutes

Act of 2021 Chapter 8, Section 51: An Act Creating a Next-Generation Roadmap for Massachusetts Climate Policy establishes comprehensive policies to address climate change and promote sustainability within the state, including energy and water efficiency standards for appliances.[225]

M.G.L. c. 25B, §§ 3-10: Massachusetts Appliance Efficiency Standards Act establishes the testing, certification, and enforcement of efficiency standards for new appliances.[226]

M.G.L. c. 21, § 67: System Interruption Devices Requirement for New Irrigation Systems directs DOER to require that all newly installed or renovated irrigation systems override and suspend programmed operation during periods of sufficient moisture and that system interruption devices be inspected at least every three years by an irrigation contractor.[227]

M.G.L. c. 21G: The Water Management Act authorizes MassDEP to regulate the quantity of water withdrawn from both surface and groundwater supplies and establishes potential provisions for water emergency declarations (e.g., drought emergencies).[228]

Energy Policy Act of 2005, Public Law 109-58 directs the Secretary of Energy to set maximum water use requirements for commercial ice makers, residential-style dishwashers, residential-style clothes washers, and commercial prerinse spray valves, among other products, but those are covered with more strict water efficiency requirements under Massachusetts statutes and regulations.[229]

Relevant Regulations

225 CMR 9.00: Appliance Energy-Efficiency Standards, Testing and Certification Program establishes standards, testing, and certification requirements for water-using appliances.[215]

248 CMR 10.00: Uniform State Plumbing Code establishes the Massachusetts state plumbing code and provides maximum flow rates for faucets, showerheads, toilets, and urinals.[230]

310 CMR 36.00: The Water Management Act Regulations establishes standards, criteria, and procedures to comprehensively manage water withdrawals. It also outlines the restrictions on nonessential outdoor water use, including irrigation of school recreation fields, under varying drought conditions.[231] Further guidance on nonessential outdoor water use was published to supplement the regulation.

Code of Federal Regulations (CFR) Title 10, Chapter II, Part 429 and 431—Energy Conservation Program: Energy Conservation Standards for Commercial Prerinse Spray Valves establishes maximum water use requirements for commercial prerinse spray valves, which are not covered in Massachusetts state regulations.[217]

CFR Title 10, Chapter II, Part 430—Energy Conservation Program for Consumer Products establishes maximum water use requirements for residential-style dishwashers and clothes washers that could be used in schools and are not covered in Massachusetts state regulations.[232]

CFR Title 10, Chapter II, Part 431—Energy Efficiency Program for Certain Commercial and Industrial Equipment establishes maximum water use requirements for commercial ice makers, which are not covered in Massachusetts state regulations.[233]

Relevant Standards

Massachusetts Appliance Energy and Water Efficiency Standards sets water efficiency standards for plumbing fittings, plumbing fixtures, commercial ovens, commercial dishwashers, commercial steam cookers, and spray sprinkler bodies.[234]

Massachusetts Drought Management Plan Preparedness & Response aims to minimize drought impacts to the Commonwealth by improving agency coordination; enhancing monitoring and early drought warning capabilities; and outlining preparedness, response, and recovery activities for state agencies, local communities, and other entities affected by drought.[46]

Massachusetts Water Conservation Standards (2018) set statewide goals for water conservation and water-use efficiency and provides guidance on effective conservation measures.[200]

ANSI/ASABE S626: Landscape Irrigation System Uniformity and Application Rate Testing provides methods for evaluating the application rate and/or uniformity of coverage of installed landscape irrigation systems and can be helpful when conducting irrigation systems audits.[220]

USGBC's LEED v4.1 Building Design + Construction guides and recognizes the design and construction of high-performance, environmentally sustainable buildings.[198] It emphasizes strategies that improve energy efficiency, reduce water consumption, promote indoor environmental quality, and incorporate sustainable materials and practices.

Table 47 summarizes the statutes, regulations, and performance standards related to optimizing water efficiency in schools.

Table 47. Statutory/Regulatory Framework and Notable Standards for Optimizing Water Efficiency in Schools

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Statutes			
Act of 2021 Chapter 8, Section 51: An Act Creating a Next-Generation Roadmap for Massachusetts Climate Policy	X		
M.G.L. c. 25B, §§ 3-10: Massachusetts Appliance Efficiency Standards Act	X		
M.G.L. c. 21 § 67: System Interruption Devices Requirement for New Irrigation Systems	X		
M.G.L. c. 21G: The Water Management Act	X		
Energy Policy Act of 2005, Public Law 109-58		X	
Regulations			
225 CMR 9.00: Appliance Energy-Efficiency Standards, Testing and Certification Program	X		
248 CMR 10.00: Uniform State Plumbing Code	X		
310 CMR 36.00: The Water Management Act Regulations	X		
CFR Title 10, Chapter II, Part 429 and 431—Energy Conservation Program: Energy Conservation Standards for Commercial Prerinse Spray Valves		X	
CFR Title 10, Chapter II, Part 430—Energy Conservation Program for Consumer Products		X	
CFR Title 10, Chapter II, Part 431—Energy Efficiency Program for Certain Commercial and Industrial Equipment		X	
Standards			
Massachusetts Appliance Energy and Water Efficiency Standards			X
Massachusetts Drought Management Plan Preparedness & Response			X
Massachusetts Water Conservation Standards (2018)			X
ANSI/ASABE S626: Landscape Irrigation System Uniformity and Application Rate Testing			X
USGBC's LEED v4.1 Building Design + Construction			X

Relevant Resources

Table 48 provides a summary of notable resources related to optimizing water efficiency in schools.

Table 48. Resources for Optimizing Water Efficiency in Schools

Resource	Author	URL
Massachusetts Water Conservation Standards web page	Massachusetts Water Resources Commission	https://www.mass.gov/massachusetts-water-conservation-standards
Massachusetts Water Conservation Toolkit	EEA, Water Resources Commission	https://www.mass.gov/conservemawater
School, Recreation and Facilities Managers web page	Massachusetts Water Resources Commission	https://www.mass.gov/guides/school-recreation-and-facilities-managers
ENERGY STAR Product Finder Tool	EPA	https://www.energystar.gov/productfinder/
FEMP Alternative Water Sources web page	FEMP	https://www.energy.gov/femp/alternative-water-sources
WaterSense Find a Pro Tool	EPA	https://www.epa.gov/watersense/find-pro
WaterSense Product Search Tool	EPA	https://www.epa.gov/watersense/product-search
WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities	EPA	https://www.epa.gov/watersense/best-management-practices

Objective 1c. Optimize Solid Waste Reduction and Diversion

Methods and Best Practices

This section offers a discussion of methods and best practices for optimizing solid waste reduction and diversion in schools across two categories. First, this section summarizes methods and best practices for reducing the generation of waste. These are important practices, as they ultimately reduce the total volume of waste that schools need to expend resources to properly manage. Next, this section summarizes methods and best practices for effectively managing the solid waste that schools generate through routine operations.

Reduce Solid Waste Generation

To reduce the generation of solid waste as part of routine operations, schools should consider strategies for reducing cafeteria waste, educating staff and students to transform habits, and implementing item exchange opportunities.

(1) Reduce cafeteria waste

Across the nation, K–12 school cafeteria waste amounts to approximately 530,000 tons, representing one of the largest waste streams coming out of K–12 schools.[235] The following practices can be adopted to minimize the amount of waste and money lost to food waste and disposables in the cafeteria.

(1a) Practice offer versus serve

The concept of Offer versus Serve (OVS) allows students to decline select food items offered by the National School Lunch Program and School Breakfast Program if they choose not to eat these items. OVS is a mandatory practice for Massachusetts high schools during lunch but is optional for elementary and middle schools in the Commonwealth.[236] Elementary schools that practice OVS waste significantly fewer calories, fruits, and vegetables than schools that practice the "serve-only" model.[237] While few studies have quantified the reduction of food waste in school cafeterias associated with OVS, it is a commonly accepted best practice for food waste reduction. According to the USDA, upwards of 81 percent of middle schools and elementary schools practice OVS during lunch.[238]

Elementary and middle schools interested in implementing OVS to reduce food waste in their cafeteria should see additional guidance from the USDA for implementing OVS for the National School Lunch Program and School Breakfast Program.[239]

(1b) Serve grab-and-go meals

Grab-and-go style meals can allow students more time and flexibility to eat their food.[240] This practice has increased in popularity under the School Breakfast Program in particular—in 2014, only 7 percent of schools served grab-and-go meals, while in 2019, this figure increased to 23 percent.[241] Pre-packaged, grab-and-go style meals are allowed to be served to all grade levels and ages.

(1c) Offer student-informed meal options

Students produce less food waste at school when they find the meals served more palatable. Taste tests offer an opportunity to receive student feedback on meal preferences and have been shown to reduce the amount of wasted food.[242] Schools should consider surveying and/or interviewing the student population to determine the cultural backgrounds and dietary preferences of their students.[243]

(1d) Extend the lunch period

Many studies have shown that extending the lunch period decreases the amount of food that students throw away.[244–246] Students require a minimum of 20 minutes of sitting time to eat and socialize. Students with longer lunch periods are more likely to consume at least 10 percent more of their food.[244] A minimum 30-minute lunch period is recommended to allow students enough time to grab food, eat, socialize with peers, and tidy up.

(1e) Schedule recess before lunch

Scheduling recess before lunch in elementary schools can reduce food waste generated by students.[242] Taking recess before lunch results in students consuming a greater variety of foods that they may not typically favor.[242]

(1f) Use reusable and washable trays and utensils

Schools can reduce waste by limiting their use of disposable trays and utensils.

New Bedford Public Schools Goes Green with Grant

In 2019, New Bedford Public Schools received a School Recycling Assistance Grant through MassDEP's Sustainable Materials Recovery Program to purchase and install 10 school dishwasher systems. The grant has enabled the school district to completely eliminate Styrofoam trays (the district purchased 1,627,980 Styrofoam trays in the 2018-2019 school year) and use paper trays when a disposable option is needed. Despite the initial capital costs of dishwashers and the additional labor needed to clean reusable trays, the recurring costs associated with disposable and recyclable trays exceed those of reusable trays and utensils.

Source: MassDEP [247]

If schools must use disposable trays and cutlery, compostable options are preferred to divert waste from the landfill. Where possible, schools should strive to procure cutlery that is not wrapped in plastic packets since these packets are typically not recyclable or compostable.

(1g) Install and use milk dispensers as an alternative to milk cartons

The installation and use of milk dispensers can reduce milk waste by as much as 40 percent, increase cost savings, and decrease vulnerability to supply chain instability.[248] Milk cartons are a major waste product from schools, with some waste audits estimating that milk cartons represent upwards of 17 percent of a school district's waste stream.[248] In 2023, schools around the nation faced milk shortages due to carton supply chain issues.[249,250] In King County, Washington, school districts that switched from milk cartons to milk dispensers realized (1) a reduction in milk waste, (2) increased cost savings resulting from reduced garbage and recycling collection costs, and (3) lower supply costs due to reduced milk waste and the phaseout of purchased milk cartons.[251] K–12 schools are widely adopting milk dispensers, and they are already widely implemented in college cafeterias.

(1h) Install and use water bottle fillers

Water bottle fillers are widely implemented across educational buildings to reduce plastic waste. Many students and staff carry and customize reusable water bottles. While studies at the K–12 level are limited, one mid-sized university reported that the implementation of water bottle fillers reduced their annual use of disposable single-use plastic water bottles by approximately 400,000.[252]

(1i) Establish and use food share tables

Based on federal guidance from USDA,[253] DESE encourages and outlines guidance for the use of food share tables in schools in its Massachusetts School Meal Programs Share Table Guidance. Students use share tables to exchange whole and uncontaminated food items (e.g., whole fruit, chip bags). Schools can elect to manage these tables in different ways: (1) food can be exchanged with no costs, (2) students can be reimbursed for later meals, or (3) food can be donated to local institutions.[253] Share tables must be in compliance with federal food safety regulations [7 CFR 210.13, 220.7, 226.20, and 225.16(a)] and the local School Food Authority's food safety plan. Schools should contact and obtain written approval from their respective local board of health prior to establishing and using share tables.

(2) Educate staff and students to transform habits

Waste education is essential to encourage the adoption of new waste-reducing infrastructure and practices and to increase awareness of the consequences of waste. Schools can educate their staff and students on why waste matters (e.g., circular economy, systems-thinking), how they can reduce the amount of waste they produce, and how to properly sort their waste. Education should take place both in and out of the classroom. Waste audits combined with field trips to waste processing facilities help schools better understand their waste stream and are effective hands-on learning experiences for students to learn the life cycle of waste. In Massachusetts, MassDEP's Green Team offers many waste lesson plans for teachers and awareness campaign materials for administrators.

Implementing sustainable infrastructure often requires participants to disrupt their current habits and adopt new ones. For example, a student may normally throw their entire lunch tray into one trash bin. That student may find it inconvenient to adopt a school's transition to sustainable practices, which could require them to scrape food off their reusable tray, recycle a fruit cup, and then place the tray in a designated location. Interventions can be used to discourage old habits, and actions that encourage repetition can reinforce the formation of new habits. Life changes make people more likely to break their old habits; as such, when a student starts a new grade or begins at a new school, they are especially able to accept new sustainable behaviors.[254] Penalties for bad behavior (e.g., throwing trash in recycling) can be effective in moderation but can often result in defensiveness and no behavioral changes.[255] New habits can be encouraged by making it easy to adopt them, using reminder prompts, providing feedback, and creating incentives.[254]

(3) Institute item exchange opportunities

Schools can use item exchange opportunities to recirculate items in good condition that are often discarded and replaced (e.g., backpacks, pencil boxes, and folders). Large events, such as school-sponsored yard sales or end-of-year exchanges, are effective at diverting large amounts of waste, but may require substantial effort to organize. Schools can supplement these large events with smaller, passive, easier-to-implement solutions, such as swap tables or “good-on-one-side” paper swap boxes. Schools may also choose to partner with faith-based organizations, thrift stores, food pantries, or donation centers to transfer school-community resources into the broader community. Item exchange opportunities have the co-benefit of supporting students from lower-resourced backgrounds in obtaining essential school items.

Effectively Manage Generated Solid Waste

To effectively manage generated solid waste, schools should consider establishing an effective electronic waste (“e-waste”) recycling program, designating staff and students to manage and implement the school’s waste program, maximizing the collection of divertible solid waste, optimizing collection bin location and labeling, processing organic waste onsite, composting or leaving lawn clippings in place, and using smart waste monitoring technology.

(4) Establish an electronic waste recycling plan for electronic learning tools

Prompted by the COVID-19 pandemic, many school districts have adopted electronic learning tools (e.g., laptops and tablets) to facilitate remote learning and enhance in-school instruction. According to some surveys, 90 percent of middle and high schools and 84 percent of elementary schools provide electronic devices to their students.[256] While this transition has contributed to a reduction of paper waste, the increased prevalence of electronic learning tools has resulted in greater quantities of e-waste. If not responsibly recycled (e.g., through a certified electronics recycling vendor), e-waste can end up in the landfill or shipped to another country for unregulated, informal e-waste recycling that often presents numerous human health risks, including increased lead exposure for children.[257] Typical K–12 laptops last an average of four years without repairs, and the cost of simple repairs can often be equivalent to approximately half the price of a new replacement laptop.[256] School districts providing personal devices to students should develop and routinely update an e-waste recycling plan that details the district’s protocols for repair and sustainable, responsible disposal to maximize diversion from landfills. In addition to reducing the amount of e-waste sent to landfills, the effective and responsible management of e-waste also reduces the harmful exposures that communities practicing informal e-waste recycling may face.[257]

(5) Designate staff members and students to implement and manage waste programs

Improving waste management programs often requires redistributing responsibilities across existing roles or hiring new staff to support the increased level of effort. In schools, these responsibilities are often voluntarily assumed by students rather than paid staff, leading to long-term staffing instability. To avoid this, schools can hold conversations proactively, and include important stakeholders such as the custodial union, cafeteria staff, and grounds workers.

It is likely that some students may be eager to participate in improving the school's waste management program. Student engagement should be encouraged. It is recommended that a school's largest waste streams (landfill, recycling, compost, and e-waste) be managed professionally, but smaller waste programs (e.g., TerraCycle®) can be run effectively by student volunteers.

Formalize Waste Program Responsibilities

To ensure school maintenance staff understand and meet expectations for their participation in the school waste management program, schools should formally document roles and responsibilities in all job duty descriptions.

(6) Collect divertible waste

The first step to diverting waste from the landfill is to collect it separately from waste intended for the landfill. Schools can collect recycling (paper, corrugated cardboard, glass, plastics, and metals), compost (organics), and e-waste to meet zero-waste facility and operations standards set by LEED v4.[258] This standard also outlines how divertible waste should also be collected during the construction of a new facility.[258] Schools registered as Green Team members through MassDEP can submit an application form to receive single-stream recycling and composting equipment to collect these items.

(7) Optimize bin location and labeling

The thoughtful location and consistent labeling of bins can influence how students and staff sort and dispose of various waste streams. To maximize the diversion of material from the landfill, schools should locate bins as close as possible to the point of waste generation. For example, schools implementing a compost collection program should place compost bins in close proximity to food preparation (i.e., the kitchen) and consumption (cafeteria). Where possible, the selection of bin color and labeling should intuitively reflect the waste stream being collected. To avoid confusion and reduce contamination, schools should implement a consistent approach to bin color and labeling across all bins to the maximum extent possible. Table 49 provides an example of effective bin color and labeling selections.

Table 49. Example of Effective Bin Color and Label Selection

Waste Stream	Bin Color	Label
Trash	Brown, Black, or Grey	"Landfill"
Recycling	Blue	"Recycling"
Organics	Green	"Compost" or "Organics"
E-Waste	Orange	"E-Waste"
Other	Depends on collected item	Depends on collected item

(8) Process organic waste on site

Some schools may be capable of processing organic waste on site. Onsite organics waste processing can decrease hauling costs by reducing pickup frequency or eliminating the need for organic waste haulers. Advanced technological options (e.g., dehydrators, pulpers, and anaerobic digestors) have high up-front capital costs and some ongoing operational costs. These machines suit facilities with sufficient outdoor area for composting or limited hauler access and would likely be inefficient for most schools; however, smaller-scale composting is appropriate in most schools. Schools with agricultural or environmental programs may especially benefit from composting on site with organic waste from the cafeteria, lawns or landscaping, livestock, agricultural plots, or classrooms. The remaining compost should be hauled off-site for processing. Schools that implement onsite composting must notify MassDEP.

(9) Leave lawn clippings in place or compost

Lawn clippings are often bagged and sent to the landfill, adding to a school's total waste stream. If it does not interfere with the purpose of the lawn, short clippings (~1 inch) should be left in place to decompose after mowing to reduce nitrogen fertilizer requirements (by as much as 75 percent) and increase soil organic matter content.[259,260] Longer clippings could smother the grass and instead should be collected and composted on-site or sent for off-site composting.

(10) Use smart waste monitoring technology

Smart waste monitoring technologies are used to provide real-time insights into waste generation, composition, and collection. They are relatively inexpensive and can be used to track a bin's location and, when it is nearing capacity, allow for optimized collection schedules that can reduce hauling fees. Schools can also leverage the data collected from bin sensors to better understand their waste stream.

Statutes, Regulations, and Standards

Statutes, regulations, and standards that include a focus on solid waste management are detailed below.

Summary of Relevant Statutes

Massachusetts Mercury Management Act (M.G.L. Chapter 21H, Sections 6A-6N) prohibits the disposal of any product that contains mercury as solid waste (e.g., flat-screen computer monitors, televisions, and other devices that have a back-lit screen containing fluorescent lamps).[261]

Summary of Relevant Regulations

310 CMR 19.000 provides guidelines for the storage, transfer, processing, treatment, disposal, use, and reuse of solid waste in Massachusetts.[262]

Federal Share Table Food Safety Regulations [7 CFR 210.13, 220.7, 226.20, and 225.16(a)] require that food served to children in schools, childcare centers, and summer programs meet nutritional standards and is safe for consumption.[253]

Summary of Relevant Standards

USDA Standard for the Use of Share Tables in Child Nutrition Programs points to guidelines and regulations that govern the implementation of share tables in schools.[263]

USGBC's LEED v4.1 Building Design + Construction promotes sustainable building practices, improves building performance, and contributes to a healthier environment by encouraging the adoption of green building strategies and technologies in new construction and major renovation projects worldwide.[198]

Table 50 summarizes the statutes, regulations, and performance standards related to the optimization of solid waste reduction and diversion in schools.

Table 50. Statutory/Regulatory Framework and Notable Standards for Optimizing Solid Waste Reduction and Diversion

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Statutes			
Massachusetts Mercury Management Act	X		
Regulations			
310 Code of Massachusetts Regulation (CMR) 19.000: Solid Waste Management	X		
Federal Share Table Food Safety Regulations (7 CFR 210.10, 220.8, 226.20, and 225.16)			X
Standards			
USDA Standard for the Use of Share Tables in Child Nutrition Programs			X
USGBC's LEED v4.1 Building Design + Construction			X

Relevant Resources

Table 51 provides a summary of resources related to optimizing solid waste reduction and diversion in schools.

Table 51. Resources for Optimizing Solid Waste Reduction and Diversion in Schools

Resource	Author	URL
For Teachers		
Food Waste Estimation Guide for Schools	RecyclingWorks Massachusetts	https://recyclingworksma.com/food-waste-estimation-guide/#ElementaryAndSecondarySchools
The Green Team	MassDEP	https://thegreenteam.org/
Waste Educational Resources	The Story of Stuff Project	https://www.storyofstuff.org/
Food Share Tables		
Food Sharing Tables Guidance	Vermont Agency of Education	https://cswd.net/wp-content/uploads/Sharing-Tables-Guidance-for-Schools-2016.pdf
Massachusetts' School Meal Programs Share Table Guidance	Massachusetts DESE	https://thegreenteam.org/wp-content/uploads/2014/04/Share-Table-Guidance.pdf
The Use of Share Tables in Child Nutrition Programs (SP 41-2016)	USDA	https://fns-prod.azureedge.us/sites/default/files/cn/SP41_CACFP13_SFSP15_2016os.pdf#page=4
Directories for Waste Processors and Haulers		
Advanced On-Site Systems for Managing Food Waste	RecyclingWorks Massachusetts	https://recyclingworksma.com/wp-content/uploads/2016/07/On-Site-Systems-for-Managing-Food-Waste-1.pdf
Find a Recycler	RecyclingWorks Massachusetts	https://recyclingworksma.com/
Options for Recycling Unique Waste Streams	TerraCycle	https://www.terracycle.com/en-US/
Sites Accepting Diverted Organic Material	MassDEP	https://www.mass.gov/doc/map-list-of-massachusetts-sites-accepting-diverted-food-material-february-2023/download
Small-Scale Organics-to-Energy Vendor Directory	Massachusetts Clean Energy Center	https://www.masscec.com/sites/default/files/documents/Small-ScaleOrganics-to-EnergyVendorDirectory.pdf
Grants		
Sustainable Materials Recovery Program Municipal Grant	MassDEP	https://www.mass.gov/how-to/apply-for-a-sustainable-materials-recovery-program-smrp-municipal-grant
Reduce, Reuse, Repair Micro-Grant	MassDEP	https://www.mass.gov/how-to/massdep-reduce-reuse-repair-micro-grant

Objective 1d. Electrify School Bus Fleets

Methods and Best Practices

This section offers a discussion of methods and best practices for electrifying school bus fleets related to planning, acquisition, and operations. Each of these methods and best practices are described in more detail below.

Planning Considerations

When planning the electrification of a fleet of school buses, schools should consider engaging with electric utility providers, utilizing microgrids for charging, and exploring V2G and/or V2L technology. These three best practices are discussed in more detail below.

(1) Engage electrical utility provider early and often

A school district's successful deployment of ESBs requires careful planning and coordination with the district's electrical utility provider. ESBs have a larger battery than light-duty electric vehicles. Therefore, the vehicles will draw larger amounts of electricity from the grid when charging. Consistent communication with the electric utility provider will assist with the timely completion of ESB projects by identifying and addressing potential issues (e.g., necessary infrastructure upgrades) early in the electrification process. Additionally, some electrical utilities may offer funding or technical assistance to fleets that are in the process of converting their vehicles to electric.

(2) Utilize microgrids for charging

A microgrid usually uses a local power generation unit and an energy storage system such as a battery to create an isolated electrical network. Microgrids can help simultaneously reduce charging costs and improve operational resiliency. Districts that operate their own fleets often choose to utilize on-site power generation units such as solar PV panels/canopies to charge their vehicles. This improves the environmental benefit of the vehicle by ensuring that it is powered (at least partially) by clean energy. Power from solar panels also offers a charging option for ESBs, even during periods of local electrical grid outages.

(3) Explore V2G and/or V2L technology

V2G and V2L are areas of growing interest for ESB owners. Districts that procure both V2G-/V2L-capable vehicles and chargers can essentially turn their ESBs into "batteries on wheels." This process involves a bus sending power back to either a load that requires power (e.g., a school building) or to the electrical grid through the vehicle's charger. Some utility providers will offer to buy electricity provided to the grid through V2G at times when electrical demand is high. This technology could also prove useful in emergencies such as a school blackout; V2G-/V2L-capable buses can be connected to buildings to provide power from their batteries. Some districts chose to incorporate microgrids into their V2G systems and store locally generated electricity (e.g., from onsite solar panels) in the vehicle battery and sell it back to the grid at times of peak demand. While this technology is still in its infancy, some districts have already managed to take advantage of V2G/V2L, such as Beverly Public Schools in Massachusetts (see text inset box) and the Cajon Valley School District in California.

ESBs are Powering the Grid in Massachusetts

Beverly Public Schools deployed its first V2G project in 2021. Partnering with their utility provider, the school agreed to use their buses to provide power back to the grid during summertime when the vehicles would otherwise be idle. The electric utility provider alerts the district when electrical demand is the highest and they need the ESBs. In turn, the district ensures the buses are charged and ready to send power back to the grid.

Electric School Bus Acquisition

When acquiring ESBs, schools should consider leveraging available funding, working with a local vehicle dealer, and purchasing vehicle warranties. These three best practices are discussed in more detail below.

(4) Leverage available funding programs

There are currently numerous federal-, local-, and utility-level funding programs available to school districts interested in purchasing ESBs. Historically, EPA programs such as the Clean School Bus (CSB) Program, the Diesel Emission Reduction Act (DERA), and the Clean Heavy Duty Vehicle (CHDV) Program have funded the replacement of ICE school buses with electric alternatives. Additionally, in 2022, the Inflation Reduction Act made tax-exempt entities eligible for certain tax credits. Of note, the Commercial Clean Vehicle Credit (Section 45W) provides up to $40,000 for certain eligible vehicles weighing over 14,000 lbs. At the state level, MassCEC has provided funding and technical assistance to districts through its ACT Program. The Commonwealth has also encouraged EV adoption through its MOR-EV Program, which provides rebates for a number of electric vehicles, including ESBs. Finally, it is also crucial to determine if the local electrical utility provides financial assistance. Common utility funding programs include time-of-use rates or make-ready programs. Time-of-use rates incentivize the charging of electric vehicles at times when electricity demand is low through decreased billing rates. Make-ready funding subsidizes or entirely covers the cost of preparing a charging site to handle the increased demand of school bus charging. The Alternative Fuels Data Center's Laws and Incentives Tool is a great way to determine what local programs are available to fund an ESB deployment.

(5) Work with a local vehicle dealer

Many districts have found it beneficial to work with a vehicle dealer who has a local presence, whether it be a dealership or service network. If a school district requires significant repairs for an ESB, working with a local dealer can help districts avoid incurring the cost and headache associated with shipping a bus out of state for repairs.

(6) Purchase vehicle warranties

While it is true that ESBs have comparatively fewer mechanical issues, in large part because of the fewer moving pieces, when an ESB component does break, it can be expensive to replace. This is partly due to the materials used to manufacture EV parts and the complexity of the parts.[264] Furthermore, the high-voltage systems in an EV can make repairs more complicated as personnel must be properly trained and equipped to work with high-voltage parts. For this reason, some districts chose to purchase an extended warranty or a service contract on their vehicle.

Electric School Bus Operations

To optimize and maximize the safety of ESB operations, schools should consider deploying telematics and implement operator training. Both of these best practices are discussed in more detail below.

(7) Deploy telematics

A great way to track the performance of electric school buses is to utilize telematics. While some manufacturers build telematics devices into their vehicles, there are also third-party telematics devices that can be easily installed in any vehicle. Usually, third-party telematics devices are connected to the vehicles through the onboard diagnostics-II port. This allows the device to collect a variety of data. Most devices can measure the speed of the vehicle, the time it takes to complete a route, the vehicle's idling time, internal temperatures, state of charge, and GPS location of the vehicle. The major benefits of telematics include monitoring the vehicle's battery life, aiding drivers and vehicle monitor timecards, and quickly locating vehicles that have been in an accident or have run out of battery. Many districts have also found telematics useful in quantifying the environmental and financial impact of their ESBs. Some funding programs, such as New Jersey's Electric School Bus Program, require that telematics be installed in ESBs purchased with awards.

(8) Implement operator training

Crucial to the success of an ESB deployment is ensuring that drivers are trained on the unique features of an electric vehicle. One of the most important skills for drivers to learn is how to effectively use regenerative braking. Regenerative braking occurs when an electric vehicle's motor reverses while decelerating. As the motor reverses, energy is captured and sent back to the battery, effectively extending the vehicle's range. These courses often also teach basic skills, such as how to plug a vehicle in and perform simple troubleshooting. Operator training is often offered by the vehicle's OEM or dealer. Alternatively, many third-party, non-profit, and for-profit organizations offer driver training courses and resources.

Statutes, Regulations, and Standards

Statutes, regulations, and standards that include a focus on school bus electrification are detailed below.

Relevant Statutes

M.G.L. c. 30B and c. 30, § 39M concerns the procurement of electric vehicles and their charging infrastructure in Massachusetts. Under current Commonwealth law, the procurement of school buses falls under the jurisdiction of M.G.L. c. 30B.[265] Conversely, the procurement of charging infrastructure is considered a construction project under M.G.L. c. 30, § 39M.[265] This means that districts looking to procure ESBs must have separate procurement processes for both the vehicles and the associated equipment. Massachusetts does offer a state contract, but this contract currently has only one bus vendor under contract.[265]

M.G.L. Part 1, Title XIV, c. 90, §7B determines the necessary features for a legal school bus in the Commonwealth of Massachusetts. The comprehensive list of requirements includes everything from the necessary physical features such as the word "School Bus" being painted on the vehicle to driver and operation requirements.[221]

Relevant Regulations

310-7.40 CMR adopts California's vehicle emissions standards and compliance requirements under the Massachusetts Low Emission Vehicle Standard. All new passenger cars, light-duty trucks, medium- and heavy-duty vehicles and engines sold and registered in Massachusetts must meet these requirements.[266] Additionally, by 2035 all new passenger vehicles sold in Massachusetts must be zero-emission vehicles.[266]

Relevant Standards and Other Requirements

Additional Funding for ADA-Compliant Buses: Some federal programs will provide additional funding to school districts that procure ESBs compliant with the Americans with Disabilities Act (ADA). For example, the CSB and CHDV funding programs each offer an additional $20,000 for ESBs that are ADA-compliant.

Leasing Exclusions for ESBs: The most popular school bus funding programs such as EPA's CSB Program, CHDV Program, DERA Program, and the Internal Revenue Service's (IRS's) Section 45W Tax Credit, do not allow applicants to lease electric school buses. All vehicles procured or reimbursed with funding from these programs must be purchased.

Qualified Manufacturers for Certain Funding Programs concerns the qualified vehicle manufacturers under Internal Revenue Code 30D(d)(1)(C). This is particularly relevant for those interested in receiving tax credits under IRS Section 45W. It is important to note that while this standard also applies to IRS Section 30D, school buses and school districts do not qualify for the 30D credit. The IRS provides an index of qualified manufacturers for clean vehicle credits.

Scrapping Requirement for ESB Programs: Most federal programs (including the CSB Program, the CHDV Program, and the DERA Program) and many local programs that fund the replacement of existing ICE school buses with ESBs include scrapping requirements. These requirements involve some variation of cutting the frame rails and drilling a hole in the engine block of the ICE vehicle to be replaced.

Table 52 summarizes the statutes, regulations, and performance standards related to electrifying school bus fleets at schools.

Table 52. Statutory/Regulatory Framework and Notable Standards for Electrifying School Bus Fleets

Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard/ Other Requirements
Statutes			
M.G.L. c. 30B and c. 30, § 39M	X		
M.G.L. Part 1, Title XIV, Chapter 90, Section 7B	X		
Regulations			
CMR 310-7.40	X		
Standards			
Additional Funding for ADA Compliant Buses			X
Leasing Exclusions for ESBs			X
Qualified Manufacturers for Certain Funding Programs			X
Scrapping Requirement for ESB Programs			X

Relevant Resources

Table 53 provides a summary of resources related to school bus electrification in schools.

Table 53. Resources for Electrifying School Bus Fleets

Resource	Author	URL
Step-by-Step Guide for School Bus Electrification	The Electric School Bus Initiative	https://electricschoolbusinitiative.org/step-step-guide-school-bus-electrification
Federal Laws and Incentives	The Alternative Fuels Data Center	https://afdc.energy.gov/laws
State Laws and Incentives	The Alternative Fuels Data Center	https://afdc.energy.gov/laws/state

Objective 1e. Provide Electric Vehicle Charging Stations for School Staff and Public Use

Methods and Best Practices

This section offers a discussion of methods and best practices for providing EV charging stations for school staff and public use related to planning, acquisition, and operations. Each of these methods and best practices are described in more detail below.

Planning Considerations

When planning the electrification of a fleet of school buses, schools should consider engaging with electric utility providers, confirming the onboard charger capacity of fleet vehicles, determining the charger rating needs of vehicles, exploring V2G and V2L technology, utilizing networked and managed charging, evaluating parking locations of EVs, and exploring potential liability concerns. These best practices are discussed in more detail below.

(1) Engage with the utility provider early and often

The electric utility provider is a key stakeholder in the EVSE installation process. It is best practice to reach out to a potential site's utility provider before beginning the installation of the EV chargers. Communication with the electrical utility throughout the project period can increase the likelihood that permitting, construction, and commissioning deadlines are met. The utility provider should also be able to provide information on necessary site upgrades and whether or not there are any incentive programs offered by the utility.

(2) Confirm the onboard charger capacity of fleet vehicles

If an EV charger is being purchased to serve a particular vehicle or fleet, be sure that the vehicle's onboard chargers can accept the energy output of the charger. If the output of the charger is greater than the capacity of the onboard charger, it is possible that the vehicle could encounter charging issues. The vehicle and charger OEMs may be able to confirm compatibility.

(3) Determine the charger rating needs of vehicles

After deciding what vehicles will be using the EVSE, determine how much charging time the vehicles will need. It is important to match the charger power rating to the vehicle battery and vehicle downtime. In other words, do not default to DC fast chargers because they are faster if level 2 or even level 1 chargers can meet the charging needs. This is because higher-level chargers, especially DC fast chargers, are more expensive to procure, operate, and maintain than lower-level chargers.

(4) Explore V2G and/or V2L technology

Consider whether your district will ever want to utilize V2G or V2L. V2G is the process of hooking up an electric vehicle's battery to the electrical grid, presumably in an emergency scenario or when the grid cannot meet its demand. Some utility providers may pay for energy dispensed to the grid. Similarly, V2L involves connecting an EV battery to a load, such as a district building, and sending energy from the battery to the load.

(5) Utilize networked and managed charging

Networked chargers are EVSE that can connect (wirelessly or through a wired connection) to the internet. Networked chargers usually provide several unique benefits, such as the ability to collect charger data, see when a charger is down and what the issue is, schedule charging sessions, and easily contact the manufacturer. Included in the benefits of a networked charger is managed charging, which allows operators to schedule stop and end times for charging sessions without staff having to be on site to plug in and unplug the vehicle. Many use this feature to schedule charging sessions when electricity is comparatively cheaper, usually at night or in the early morning. Networked chargers require the purchase of an additional subscription.

(6) Evaluate parking locations of EVs

Place the charger in a location accessible to different vehicles without interrupting the flow of traffic. If the main use of the EVSE is to charge EVs owned by school staff members and the general public, be sure that parking spots in which EVSE is installed can comfortably fit a variety of light-duty vehicles. If the charger will mainly serve ESBs, situate the charger in a location that buses can easily access. Make a note of where the charge port is on the vehicle and place the charger in a location where the charging cable can reach the port.

(7) Explore potential liability concerns

Some EV charger owners mandate that any vehicle using their equipment does so at their own risk and is liable for any issues that may arise from connecting to the charger.

This is particularly common with chargers that are made accessible at the workplace for staff members' personal vehicles. Districts should consider how to reduce their liability as charger owners.

EVSE Acquisition and Installation

When acquiring EVSE, schools should consider leveraging available funding, planning for long lead times, deploying charger retractors, and purchasing charger warranties. These best practices are discussed in more detail below.

(8) Leverage available funding programs

Take advantage of existing funding programs. Many funding opportunities for electric vehicles account for EVSE costs such as EPA's Clean School Bus Program and the Clean Heavy Duty Vehicle Program. Additionally, there are many EVSE-specific funding programs on the federal level such as the National Electric Vehicle Infrastructure (NEVI) Formula Program and the Charging and Fueling Infrastructure (CFI) Grant Program. Locally, Massachusetts offers several EVSE incentive programs through the Massachusetts Electric Vehicle Incentive Program (MassEVIP). Look into these programs early in the EVSE exploration process to verify that any district project can meet these program's requirements. Finally, many electrical utility providers offer EVSE financing programs such as reduced electricity rates for EV charging and make-ready funding (funding devoted to upgrading site equipment and getting it ready to handle EV charging).

(9) Plan for long lead times

Lead times for EV chargers and their associated equipment can be unpredictable. Some Massachusetts-based projects have seen lead times for crucial equipment take six months.[267] This is why it is important to reach out to manufacturers early in the process and prepare for components to take a while to be delivered.

(10) Deploy charger retractors

As previously mentioned, it is important to replace a charger cord at the end of the charging session. Failing to do so may lead to a vehicle unknowingly running over the charger's cord or head. This, in turn, can damage the charger and potentially put it out of service. To address this issue, many EVSE owners opt for cord retractors, which automatically pull the cord and head back to the charger body after it has been unplugged from a vehicle.

(11) Purchase charger warranties

EV chargers can be, at times, expensive or burdensome to repair. Warranties can help alleviate some of the cost. Districts should consider warranties with a high percentage uptime guarantee. An uptime guarantee is when the manufacturer guarantees that a charger will be operational a certain percentage of the time. While charger warranties vary by charger and warranty type, estimates suggest that an extended warranty for a

DC fast charger can be over $800 a year.[268] It is important that after a warranty is purchased, proper documentation is kept to confirm all warranty requirements are met so that the manufacturer honors the warranty.

Operations and Maintenance

To optimize EV charging operations, schools should consider developing a maintenance plan and creating expectations for charger use etiquette. Both of these best practices are discussed in more detail below.

(12) Develop a maintenance plan

Before purchasing a charger, verify that the OEM or an associated entity can provide service to it locally. There are limits to what an OEM can do to troubleshoot a charger over the phone or over the internet. If the charger OEM cannot provide service, it is important to explore other maintenance options, such as local electricians who have been certified to work on EVSE. It is crucial to develop a maintenance plan since having access to an in-person technician can significantly reduce the downtime of a broken charger.

(13) Create expectations for charger use etiquette

If charger usage is granted to district staff and the public, it will be important to create expectations for its usage. This includes replacing the charger cord at the end of a charging session and not occupying the charger beyond the time it takes to charge a vehicle. Creating these expectations will help keep the charger cord from being damaged and allow for more people to access the charger. Additionally, many charger operators choose to limit charger availability to certain times of the day. This allows the district to avoid charger usage during times of high electrical demand.

Statutes, Regulations, and Standards

Statutes, regulations, and standards that include a focus on EVSE are detailed below.

Relevant Statutes

Act of 2021, Chapter 8, Section 49, 2021 requires that all EV charging stations meet certain energy efficiency requirements that are set by DOER.[225]

M.G.L. c. 25A, Section 16B-16E determines that the owners and operators of public EV charging stations that require payment must allow for publicly accessible payment options.[269] This means that the charger cannot require a subscription fee or a membership. Information on the charger (including the location, payment methods, hours of access, etc.) must be shared with the DOE's Alternative Fuels Data Center.

Build America Buy America (BABA) Act governs certain purchases made with federal funding. Enacted in 2021, the BABA Act requires that federally funded infrastructure projects use domestically produced iron, steel, manufactured products, and construction materials.[270] Previously, EPA had issued a waiver for EV chargers that were assembled in the United States.[119] On July 1, 2024, however, this waiver expired, and EV chargers are once again subject to BABA Act requirements.

Relevant Standards and Other Requirements

Data Collection Requirements: Some EVSE funding programs include requirements for the recipient to collect and report data. When applying to an EVSE funding program, schools should verify if the program requires the charger to collect and submit data. For example, the Department of Transportation's NEVI Formula Program lists the collection of data from a national network of chargers as a primary program objective.[271] Chargers will need to be networked to collect data. Districts should be informed of the additional costs and benefits of networked chargers.

The **EVITP** established a 20-hour training program provided exclusively to certified electricians.[272] This training program has become an industry standard with many federal and state funding programs. For example, the NEVI Formula Program requires that all electricians who work on program-funded projects be certified under EVITP.[273]

MassEVIP Availability Requirements: EVSE installed using funding from MassEVIP must be publicly available for at least 12 hours a day.[274] There are similar requirements for the federal CFI Grant Program, which mandates that all chargers must be publicly accessible. This is notable for districts who want to access EVSE funding but do not want to make charger use available to the general public.

Open Charge Point Protocol (OCPP): This protocol is growing in popularity and governs "networked" chargers. EV chargers that are considered networked can connect to the internet and other chargers on the same network. Typically, these chargers can share information that non-networked chargers cannot track, such as error codes and usage data. A networked charger will usually require a subscription to a charger network provider. OCPP-compliant chargers allow charger owners to easily change charging network providers without having to replace the equipment itself.[275] Prominent federal and state funding programs such as the NEVI Formula Program and CFI Grant Program require EVSE funded through their programs to be OCPP-compliant.[276,277]

Table 54 summarizes the statutes, regulations, and performance standards related to installing EV chargers at schools.

Table 54. Statutory/Regulatory Framework and Notable Standards for Providing Electric Vehicle Charging Stations for School Staff and Public Use

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standards/ Other Requirements
Statutes			
Act of 2021, Chapter 8, Section 49, 2021	X		
M.G.L. c. 25A, Section 16B-16E	X		
Build America Buy America Act		X	
Standards/Other Requirements			
Data Collection Requirements			X
EVITP			X
MassEVIP Availability Requirements			X
Open Charge Point Protocol (OCPP)			X

Relevant Resources

Table 55 provides a summary of resources related to installing EV chargers at schools.

Table 55. Resources for Providing Electric Vehicle Charging Stations for School Staff and Public Use

Resource	Author	URL
All About Working with Your Electrical Utility	World Resources Institute, Electric School Bus Initiative	https://electricschoolbusinitiative.org/all-about-working-your-electric-utility
Electric Vehicle Charging Stations	DOE Alternative Fuels Data Center	https://afdc.energy.gov/fuels/electricity-stations
Procurement and Installation for Electric Vehicle Charging Infrastructure	DOE Alternative Fuels Data Center	https://afdc.energy.gov/fuels/electricity-infrastructure-development

Objective 1f. Enhance Climate Resilience

Methods and Best Practices

School districts can build on state-level efforts presented in the ResilientMass Plan by conducting planning activities and implementing school-level resilience projects by implementing the methods and best practices described below.

(1) Conduct vulnerability assessments

Vulnerability assessments determine the exposure, vulnerability, and consequence of climate hazards to a school district's students, workforce, and assets, as well as the utilities, infrastructure, and services upon which the school district relies to successfully execute its mission. A school district should begin an assessment by organizing a team of key partners and establishing the assessment goals, timeframe, and scope of the hazards and school district operations it intends to analyze. After scoping the hazards analysis, the school district should perform community and stakeholder outreach to confirm that hazards appropriately reflect the concerns of the community. Once the scope is established, a school district should identify existing local hazard mitigation plans and data sources for the existing condition of assets, geospatial data, climate hazard data, health data (e.g., asthma and heat stress), school district capabilities and capacity, and any existing adaptation and risk reduction strategies. This data can be applied to the site and asset level using a combination of surveys of key site staff and site visits. There can be overlap with other assessment activities, such as FCAs, which are also concerned with asset existing conditions, maintenance and replacement schedules, past hazard events and associated damage, disruption, and loss.

The collected data is combined to score assets based on their hazard exposure, sensitivity, vulnerability, and consequence. The final step of the vulnerability assessment is to develop actions, adaptation, and hazard mitigation strategies to reduce vulnerabilities. Additional details on the planning process are offered by the MVP Program.

(2) Prepare a comprehensive climate action plan

A comprehensive climate action plan (CAP) uses the results of the vulnerability assessment to establish an integrated strategic plan for the implementation of identified strategies. At this stage, a district should:

- **Prioritize strategies** to address the most critical vulnerabilities to human health and infrastructure resulting from the earliest hazard exposures and those that have the highest consequence from a potential disruption.
- Summarize the high priority and high consequence assets for each school.
- **Revise strategies** to incorporate key issues such as equity and environmental justice, feasibility, and economic benefits.
- **Identify overlapping or integrated vulnerabilities and adaptation strategies** across schools. For example, multiple schools may be served by the same local electricity distribution network that has proven to be unreliable in past hazard events and would benefit from district coordination with the electric transmission and distribution utility. This is the stage at which strategies should be incorporated into existing capital planning processes.

- **Document** key progress indicators, status, progress made, roles and responsibilities for seeing it to completion, working timeline for completion, and potential funding sources for each strategy.
- **Develop and share** resources, technical support, curriculum, and other guidance to aid individual schools in implementation.

(3) Incorporate resilience into new construction and modernization projects

Districts should include resilience strategies and goals identified during the vulnerability assessment in project requirements and other relevant procurement documents. For projects that occur prior to a vulnerability assessment taking place, there are a number of building code requirements and best practices included in other standards used by schools that address resilient design. For example, the ResilientMass Climate Resilience Design Standards Tool allows users to input project information to generate recommended standards.[278] Additionally, NE-CHPS awards points to projects that conduct a vulnerability assessment, incorporate all feasible adaptation measures for top hazards and include passive survivability in the design.[183] For new construction, site selection offers a significant opportunity to mitigate vulnerabilities, whereas hardening of existing infrastructure may be necessary for modernization projects.

Many building decarbonization best practices also offer resilience benefits, including a well-insulated and airtight building envelope; HVAC systems that provide sufficient cooling, ventilation, and filtration; natural ventilation via operable windows; and daylighting. In particular, investing in a high-performance envelope can support passive survivability, where the building can maintain a habitable indoor environment without active systems during disruptions to utilities or HVAC systems.[279]

(4) Implement retrofit projects targeting resilience

Some discrete resilience strategies that apply to new construction and modernizations can be implemented as individual retrofits or a phased series of retrofits. Specific types of retrofits that address Massachusetts' highest consequence hazards (extreme temperatures, flooding, hurricanes, severe winter storms, and tsunamis) include installing central air conditioning and increased cooling capacity, wind-resistant roofs and windows, and green infrastructure for flood mitigation and shading. Districts should work with project teams to identify HVAC and envelope retrofits that achieve health co-benefits from improvements to indoor air quality.

Backup power generation to cover critical building services is one of the most commonly considered resilience projects. While backup power has traditionally been provided by diesel and natural gas generators, there are increasing options for non-GHG emitting backup power in the form of onsite solar PV, BESS, and even V2L-enabled electric school buses (see Objective 1a. Install and Use Onsite Renewable Energy Systems and Objective 1d. Electrify School Bus Fleets for additional details). It is important to note there are specific electrical infrastructure and permitting requirements to allow schools to safely "island" themselves from the electrical grid in the event of an outage.

BESS and other forms of energy storage also support Massachusetts' Energy Storage Initiative goas and targets.

(5) Perform resilient O&M

Knowledgeable O&M staff are critical to school operations and increasingly important in the event of a disruption. A strong preventive maintenance program can decrease the risk of system failures due to a hazard event. Emergency preparedness plans can establish procedures for response to hazard events and prepare staff to execute plans. This can range from O&M staff being knowledgeable about transferring from grid-supplied electricity to backup power systems to district staff expanding community support services at a school following a hazard event. Establishing mutual aid agreements with other government and community organizations can provide a framework for a coordinated response to hazard events.

Statutes, Regulations, and Standards

Statutes, regulations, and standards that include a focus on climate resilience are detailed below.

Relevant Regulations

Massachusetts State Building Code (MSBC) 780 CMR is a statewide mandated construction code that "includes most of the federal construction requirements listed in the U.S. Code of Federal Regulations Title 44, Section 60.3 for floodplains as defined by FEMA Flood Insurance Rate Maps."[95] Other hazards included in the MSBC include wind, snow, and earthquakes.

Relevant Standards

LEED v4.1: Resilient Design Pilot Credit awards up to five points for projects that perform a vulnerability assessment, implement mitigation strategies for two of the top three identified hazards, and incorporate passive survivability and backup power in the design.[279]

NE-CHPS: Design for Adaptation and Resilience awards points to projects that perform vulnerability assessments covering the lifespan of the asset, incorporate all feasible adaptation measures for top hazards, and include passive survivability in the design.[183]

Table 56 summarizes the statutes, regulations, and performance standards related to enhancing climate resilience in schools.

Table 56. Statutory/Regulatory Framework and Notable Standards for Enhancing Climate Resilience at Schools

Regulation/Standard	Local/State Statute/ Regulation	Other Statute/ Regulation	Performance Standard
Regulations			
MSBC 780 CMR	X		
Standards			
LEED v4.1: Resilient Design Pilot Credit			X
NE-CHPS: Design for Adaptation and Resilience			X

Relevant Resources

Table 57 provides a summary of resources related to enhancing climate resilience in schools.

Table 57. Resources for Enhancing Climate Resilience in Schools

Resource	Author	URL
Climate Enhanced Community Profiles	DPH	https://matracking.ehs.state.ma.us/Climate-Change/climate_and_health_profile.html
Climate Resilience Design Standards & Guidance	ResilientMass	https://resilient.mass.gov/rmat_home/designstandards/
Extreme Heat Resource Guide	DPH, BCEH	https://www.mass.gov/doc/extreme-heat-resource-guide-pdf/download
Local Hazard Mitigation Planning	MEMA	https://www.mass.gov/info-details/local-hazard-mitigation-planning
MVP Planning 2.0	MA EEA	https://www.mass.gov/info-details/mvp-20
ResilientMass Plan	MEMA and MA EEA	https://www.mass.gov/info-details/2023-resilientmass-plan
Climate Resilient Schools Coalition	Climate Resilient Schools Coalition	https://www.climateresilientschoolsma.org
School Decarbonization Strategy Spotlight: Resiliency	New Buildings Institute	https://newbuildings.org/wp-content/uploads/2024/03/School-Decarbonization-Spotlight_Resiliency_NBI-122923.pdf

Resource	Author	URL
Template Policy Language for Addressing Extreme Heat and Air Quality in Schools	MAPC	https://www.mapc.org/planning101/extreme-heat-air-quality-in-schools/
UndauntedK12 – Work in Massachusetts	UndauntedK12	https://www.undauntedk12.org/massachusetts

VII. Additional Details Related to Goal 2: Achieve Healthy Schools

This section presents the following content:

- A more detailed narrative description of the methods and best practices presented in Goal 2: Achieve Healthy Schools (Section III)
- A narrative and tabular summary of the relevant statutory/regulatory framework and notable standards
- A tabular summary of relevant resources that can help school districts across the Commonwealth achieve green schools

Content is provided across the following 10 objectives:

a. Improve air quality
b. Improve water quality
c. Maintain thermal comfort
d. Use integrated pest management
e. Procure and use green cleaning supplies/chemicals
f. Minimize exposure to hazardous substances
g. Safely procure, use, and dispose of crumb rubber
h. Create a safe environment for students with life-threatening food allergies
i. Create a productive learning environment for all students
j. Design the Built Environment to Foster a Peaceful School Community

Objective 2a. Improve Air Quality

2a(1) Reduce Airborne Transmission of Disease

Methods and Best Practices

The first category of recommendations are practices that schools can use in their daily operations to reduce the airborne transmission of disease. The second category is steps for when an individual is sick or when rates of disease are high in a school community.

In Everyday Operations

These recommendations are steps that schools can take in their everyday operations to reduce the airborne transmission of diseases. Schools may want to increase these practices during winter months when respiratory virus transmission is typically highest.

(1) Increase ventilation to bring more outdoor air to indoor spaces

Improving indoor air quality can reduce the concentration of pathogens and, therefore, reduce airborne transmission of diseases.[280,281] One major way to improve air quality for this purpose is to bring more outdoor air indoors, which dilutes the concentration of pathogens released by anyone who may be sick. HVAC systems should meet the minimum outdoor air ventilation requirements in accordance with design codes and consider enhancements to ventilation systems when remodeling or planning new construction.[280,281] HVAC systems that mix outdoor air with recirculated indoor air should be set to maximize outdoor air, within manufacturer's recommendations, during periods of high disease transmission.[281] Note that in conditions of high humidity when the HVAC system is providing chilled air, there are more opportunities for condensation and mold growth if the system and building are not designed to accommodate 100 percent fresh air. In these conditions, check for condensation more frequently to avoid mold growth.

Opening windows can help bring more outdoor air to indoor spaces without mechanical ventilation, such as rooms with low airflow, schools without ventilation systems, or school buses.[280,281] This is a short-term solution when mechanical ventilation systems are not available and is not an energy efficient solution to outdated building heating systems. Even cracking a few windows open is better than keeping all shut.[280] Using fans to draw in outdoor air can help increase the effectiveness of open windows.[280,281] However, opening windows may not always be possible on very hot summer days, very cold winter days, days when outdoor air pollution is high, or in areas with outdoor safety concerns.[281] Schools should keep windows closed during periods of elevated relative humidity (>60 percent) and when air conditioning is operating so as to prevent condensation and mold growth. See the Reduce Exposure to Mold and Moisture section for additional details about the use of sensor technology to monitor indoor relative humidity and other air quality parameters.

(2) Filter indoor air

For buildings with ventilation systems that recirculate air, schools should increase the level of their air filter to MERV 13 or higher, if appropriate for the system.[281] In addition, whoever manages the air filtration system should check that the filters are installed correctly and fit well, check that sufficient airflow is maintained across the filter, and maintain and change filters based on the manufacturer's recommendation.[281] For spaces with low ventilation or to supplement ventilation, schools can filter the air with portable air cleaners with high-efficiency particulate air (HEPA) filters.[280,281] When selecting a portable air cleaner with a HEPA filter, school staff should consider the size of the room, the clean air delivery rate of the unit, the airflow pattern of the room, the distribution of people in the room, and decibel or sound rating of the device.[281]

(3) Move large gatherings to outdoor spaces

Holding large gatherings of students and staff outdoors can greatly reduce the risk of airborne disease transmission.[280] This may include assemblies, lunch, certain classes (e.g., physical education, music, theater), and recess or social periods.[280,281] New construction can include shaded outdoor green space to accommodate outdoor gatherings in warmer weather in accordance with climate model projections indicating warmer temperatures and more frequent heat waves in Massachusetts throughout the 21st century in Massachusetts.[22]

(4) Teach and reinforce respiratory etiquette

Schools should teach and reinforce respiratory etiquette to reduce the amount of airborne pathogens expelled by individuals who may be sick.[280] CDC recommends covering the mouth and nose with a tissue when coughing or sneezing, throwing the used tissue in the trash, and then washing hands. If a tissue is not available, coughing or sneezing into the elbow is better than into the hands. Teachers should provide tissues in easily accessible areas around the classroom.[280] Encourage students and staff to wash hands frequently, especially after coughing, sneezing, or blowing their nose. Good hygiene practices, such as hand-washing, help to prevent the spread of illness as well as ingestion of contaminants like PCBs or lead that may end up on hands (see best practice (10) Teach and reinforce good hand-washing etiquette, particularly before eating and drinking in the Reduce Exposure to Polychlorinated Biphenyls [PCBs] section).

During Times of Illness

The last two recommendations here apply during times of illness, whether for a sick individual or for a school community at large.

(5) Encourage students and staff to stay home when sick

When students or staff members are sick, school administrators should encourage them to stay home while they are contagious.[281] 105 CMR 300.00 provides minimum periods of isolation, which includes staying home from school, for some illnesses transmissible through air, such as measles and pertussis.[282]

(6) Take additional steps to minimize transmission during times of elevated rates of illness

During periods of increased illness in a school, as indicated by high rates of absenteeism, or during an epidemic, pandemic, or public health emergency, the CDC or the DPH may recommend additional steps to reduce airborne transmission of disease in schools.[283] These could include wearing masks or respiratory protection, physically distancing students and staff within classrooms, and grouping students in cohorts to minimize the spread of disease throughout the community, monitoring for signs and symptoms of illness, testing if available, and creating spaces where sick students can isolate while waiting to leave school.[283] Other strategies to reduce airborne transmission of disease in schools may include staggering arrival/dismissal times, transition times, and lunch times; holding staff or parent-teacher meetings via videoconferencing; and providing additional protections for people at higher risk of severe disease.[281]

Statutes, Regulations, and Standards

Statutes, regulations, and standards that include a focus on airborne transmission of respiratory disease and illness are detailed below.

Relevant Regulations

105 CMR 300.00: Reportable Diseases, Surveillance, and Isolation and Quarantine Requirements describes isolation and quarantine requirements for certain infectious diseases, which would apply to schools. Any students or staff with diseases listed here with isolation or quarantine requirements would need to comply by staying home as required by this law. Infections transmitted through the air that have isolation and quarantine requirements include measles and pertussis.[282]

Table 58 summarizes the statutes, regulations, and standards related to reducing airborne transmission of respiratory disease/illness in schools outlined above.

Table 58. Statutory/Regulatory Framework and Notable Standards for Reducing Airborne Transmission of Respiratory Disease/Illness

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Regulations			
105 CMR 300.00: Reportable Diseases, Surveillance, and Isolation and Quarantine Requirements	X		

Relevant Resources

Table 59 provides a summary of resources related to reducing airborne transmission of respiratory disease/illness in schools.

Table 59. Resources for Reducing Airborne Transmission of Disease/Illness

Resource	Author	URL
Preventing Spread of Infections in K–12 Schools	CDC	https://www.cdc.gov/orr/school-preparedness/infection-prevention/index.html
Preventing the Spread of Respiratory Viruses in Public Indoor Spaces	US EPA	https://www.epa.gov/indoor-air-quality-iaq/preventing-spread-respiratory-viruses-public-indoor-spaces
Schools for Health (website and tools)	Harvard T.H. Chan School of Public Health	https://schools.forhealth.org/
Ventilation and Respiratory Viruses	US EPA	https://www.epa.gov/indoor-air-quality-iaq/ventilation-and-respiratory-viruses

2a(2) Prevent Exposure to Asbestos

Methods and Best Practices

This section summarizes methods and best practices for preventing exposure to asbestos across three areas: preparation; continual monitoring and exposure mitigation; and exposure mitigation during renovations or abatement.

Preparation (Education and Planning)

(1) Develop an Asbestos Management Plan (AMP) in accordance with the Asbestos Hazard Emergency Response Act and 454 CMR 28.00

As required by the Asbestos Hazard Emergency Response Act (AHERA) and 454 CMR 28.00, districts must have school buildings, porticos, and roof mounted ventilation components inspected for ACM, then prepare an AMP to prevent and reduce asbestos hazards in school buildings.[99,101,284,285] The MA Department of Labor Standards (DLS) uses EPA's model AMP for schools, which is available for schools to use on the DLS and EPA websites (see list of resources in Table 61).[286] In accordance with AHERA and 454 CMR 28.00, the AMP should specify a "designated person" to oversee asbestos-related activities in the school.[286] Table 30 includes Massachusetts resources that may be helpful for the designated person. Once developed, schools should store the AMP on site and keep it up to date. The plan should also include records of relevant events such as response actions, training, and inspections.[287]

(2) Provide easy access to and training for the effective implementation of the AMP

School leaders should confirm that all O&M staff thoroughly understand the AMP and how to minimize asbestos exposure. This may require training on the AMP, review, and frequently sharing the AMP. The AMP should be available to anyone who is interested without restricitons.[101,287]

Continual Monitoring and Exposure Mitigation

(3) Inspect schools for ACM every three years

Schools should be inspected for ACM by licensed asbestos inspectors in compliance with 454 CMR 28.00. A licensed inspector should re-inspect ACM at least every six months, as required by 454 CMR 28.00, to look for any changes in the condition of the materials and any suspected ACM not previously identified.[100,284,287]

(4) Label all ACM

All ACM should be prominently labeled.[287] They typically do not need to be removed unless severely damaged or disturbed, but should be identifiable.[101]

(5) Train staff to report any asbestos exposure risks to the building administrator

Train staff about common locations of and procedures for identifying ACM. Urge staff to report any concerns about damage or deterioration of ACM to the school building administrator.[101]

(6) Conduct asbestos response actions to reduce exposure risk in accordance with AHERA and 454 CMR 28.00

In accordance with 454 CMR 28.00, response actions must be consistent with the assessment.[288] Minimizing the risks of asbestos, as mandated by AHERA, is based on the principle of "in-place" management. The goal of this approach is to teach people to recognize and monitor ACM, then manage it as necessary without removing it. Removal is not usually necessary unless the ACM is severely damaged or disturbed, which may happen during a major renovation project or during an incident such as a burst pipe or flooding event.[101,284,285] Air clearance monitoring must be conducted after a response action.[288]

Exposure Mitigation During Renovations or Abatement

(7) Minimize disturbance of ACM during renovations or conduct appropriate abatement actions

Before undertaking renovations, school personnel should review the AMP and location of any ACM.[100,287] Schools should create barriers so that ACM is not touched during renovations or should take appropriate abatement actions. Abatement procedures should be included in the design of the renovation project.[100] All renovations must be completed in compliance with National Emission Standards for Hazardous Air Pollutants (NESHAP), which requires that schools notify the appropriate state agency before any demolition or renovation of buildings with a certain amount of ACM. In Massachusetts, schools should contact MassDEP and DLS at least 10 business days before conducting renovations that involve ACM or, in the case of an emergency project, within one working day after the project begins.[100,287]

(8) Schedule renovations or asbestos abatement activities when students and staff are not in the building

Renovations that involve ACM or asbestos abatement activities should not occur when students or staff are in the building. Schools should schedule renovations outside the school year or during school breaks, unless in emergency situations.[100,288]

(9) Confirm safe air quality sampling results prior to allowing students and staff to return to the building

After completing renovations involving ACM or asbestos abatement activities, schools must contract for asbestos clearance air monitoring in accordance with 454 CMR 28.00. Students and staff should only be allowed back into the building once the air has been cleared of asbestos.[289]

Statutes, Regulations, and Standards

Statutes, regulations, and standards that include a focus on exposure to asbestos are detailed below.

Relevant Regulations

310 CMR 7.15 U Asbestos applies to anyone engaged in or associated with asbestos abatement activities, including surveys, visual inspections, and record-keeping.[290] The regulation specifies how to conduct asbestos-related activities. Prior to renovations, facility operators are required to have an asbestos inspector identify any ACM that may be affected and prepare the findings in a written asbestos survey report, as described in 4) Survey Requirements.[290] The facility operators must remove or encapsulate ACM during demolition or renovation. Facility operators are required to notify MassDEP of ACM and obtain authorization before conducting any asbestos abatement activities unless any exceptions described in 6) Notification Requirements apply.[290] The regulation includes specific requirements for working with ACM found in certain types of materials such as asphaltic roofing, siding materials, window glaze or caulking, cement pipes, floor tiles, and gypsum wallboard. Requirements for worker safety, packaging of removed ACM, and labeling of ACM are also described.[290]

454 CMR 28.00: The Removal, Containment, Maintenance, or Encapsulation of Asbestos protects the health and safety of workers and the public from asbestos.[284] It establishes health and safety requirements for when dealing with ACM and standards for competency, certification, and licensure for those who work with ACM.[284] All schools subject to the Asbestos Hazard Emergency Response Act (AHERA) must comply with section 28.13, which describes how local education agencies must:

- Develop an asbestos management plan
- Ensure that any asbestos-related activities are carried out in compliance with these laws and regulations
- Designate a person to implement requirements
- Inspect each school building unless they have documentation of a recent inspection compliant with AHERA
- Implement appropriate response actions
- Adhere to the law for all operation and management of buildings with ACM
- Maintain records of ACM and asbestos-related activities[284]

Asbestos-Containing Materials in Schools Rule requires schools to develop an AMP, conduct inspections every three years to determine the presence of ACM, and take steps to prevent or reduce exposure to asbestos.[100,285]

Asbestos NESHAP specifies work practices and notification requirements for schools undergoing demolition or renovations of structures that meet a certain threshold level of asbestos or ACM.[100,285]

For additional information regarding the regulation of asbestos, see EPA's Asbestos Laws and Regulations page at https://www.epa.gov/asbestos/asbestos-laws-and-regulations#neshap.

Table 60 summarizes the statutes, regulations, and standards related to preventing asbestos exposure in schools outlined above.

Table 60. Statutory/Regulatory Framework and Notable Standards for Preventing Exposure to Asbestos

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Regulations			
310 CMR 7.15: U Asbestos	X		
454 CMR 28.00: The Removal, Containment, Maintenance, or Encapsulation of Asbestos	X		
Asbestos-Containing Materials in Schools Rule		X	
Asbestos National Emission Standards for Hazardous Air Pollutants (NESHAP)		X	

Relevant Resources

Table 61 provides a summary of resources related to preventing asbestos exposure in schools.

Table 61. Resources for Preventing Asbestos Exposure

Resource	Author	URL
Asbestos in Schools	DLS Lead and Asbestos Program	https://www.mass.gov/info-details/asbestos-in-schools
Department of Labor Standards – Lead and Asbestos Program	DLS	Hotline: (617) 626-6030 Email: DLSfeedback@MassMail.State.MA.US
MassDEP Asbestos, Construction & Demolition Notifications	MassDEP	https://www.mass.gov/guides/massdep-asbestos-construction-demolition-notifications

Resource	Author	URL
Tips on Organizing and Maintaining the AHERA Management Plan	DLS	https://www.mass.gov/doc/organizing-the-management-plan-2021/download
Model AHERA Asbestos Management Plan for Local Education Agencies	EPA	https://www.epa.gov/sites/default/files/2013-12/documents/modelamp_0.pdf
Sensible Guide for Healthier School Renovations	EPA	https://www.epa.gov/sites/default/files/2016-01/documents/schools_renov_brochure-8_5x11_final.pdf

2a(3) Reduce Exposure to Carbon Monoxide

Methods and Best Practices

This section summarizes the methods and best practices for reducing exposure to carbon monoxide in schools in two areas: planning and management; and technical interventions.

Planning and Management

The following recommendations involve planning measures and interventions to monitor carbon monoxide.

(1) Annually inventory and inspect all gas-burning appliances

Carbon monoxide is produced by appliances which use combustion to generate energy. Incomplete combustion results in more carbon monoxide. To prevent excess carbon monoxide from being released at schools, it is best practice to annually inspect all gas burning appliances, including stoves, furnaces, and water heaters, to confirm they are working properly and are ventilated to the outside.[101]

(2) Install carbon monoxide alarms near fossil fuel-fired appliances

Carbon monoxide alarms should be installed, at a minimum, near all appliances that burn natural gas, oil, wood, or gas.[101] Carbon monoxide alarms are devices that can warn of excess carbon monoxide and allow schools to mitigate the carbon monoxide before building occupants are exposed to high levels. Schools should consider carbon monoxide alarms that can detect and store carbon monoxide levels and integrate the warning equipment into the school's central monitoring system. Carbon monoxide alarms should be installed near sources of combustion, as these spaces have a greater risk of elevated carbon monoxide due to malfunctioning equipment or inadequate ventilation.[104] DPH also recommends installing sensor technology in classrooms that measure carbon monoxide as a best practice.

(3) Restrict school buses and other vehicles from idling directly outside of the school

Carbon monoxide is a byproduct of gas or diesel combustion in vehicles. Avoid vehicle idling directly outside of the school, particularly where products of combustion, including carbon monoxide, can be drawn into the school through air handling intakes, windows, or exit doors.[101,104] See the Reduce Exposure to Emissions from School Bus Idling section for additional details about best practices on this topic.

Technical Interventions

The following methods and best practices concern school equipment and equipment operations.

(4) Ensure negative pressure in rooms where carbon monoxide is likely to be generated

Rooms with certain equipment, like kitchens, science laboratories, and vocational classrooms, are more likely to contain equipment that can generate carbon monoxide. Ventilation in these rooms should be operated at negative pressure compared to surrounding rooms (i.e., the air is removed at a greater rate) so that carbon monoxide does not spread to other areas in the school. This can be done by adjusting components of the mechanical ventilation or by installing local exhaust ventilation. Ventilation in these rooms should be maintained such that it complies with other guidelines.[104]

(5) Remove or replace any unvented gas or kerosene space heaters

While uncommon in schools, removing any unvented gas or kerosene space heaters and restricting their use by contractors is essential. Incomplete combustion of these fuels will lead to the formation of carbon monoxide and lack of ventilation will allow carbon monoxide to accumulate. If the heaters are used as a primary heat source, replace them with electric or vented, code-compliant heating systems.[104]

Statutes, Regulations, and Standards

Statutes, regulations, and standards that include a focus on exposure to carbon monoxide are detailed below.

Relevant Regulations

105 CMR 675 establishes a corrective action air level of 30 parts per million (ppm) for carbon monoxide in indoor ice staking rinks with ice resurfacing machinery powered by combustible fuels. The same regulation establishes an evacuation air level of 125 ppm for carbon monoxide.[291]

NAAQS for carbon monoxide: EPA sets National Ambient Air Quality Standards (NAAQS) for six pollutants, including carbon monoxide, to protect public health and the environment. The current NAAQS for carbon monoxide are an eight-hour time-weighted average of 9 ppm and a one-hour time-weighted average of 35 ppm.[292]

Permissible Exposure Level: The Occupational Safety and Health Administration (OSHA) has established the permissible exposure level (PEL) for carbon monoxide as an eight-hour time-weighted average concentration of 50 ppm. This is established in CFR Title 29, Part 1910, Subpart Z.[293]

Relevant Standards

American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) recommends a TLV as an eight-hour time-weighted average concentration of 25 ppm.[294]

ASHRAE 62.1: ASHRAE uses EPA's one-hour NAAQS for carbon monoxide as a component in their guidelines for "Ventilation and Acceptable Indoor Air Quality."[295]

DPH IAQ Assessment Manual states that carbon monoxide should not be present in a typical indoor environment. If present, carbon monoxide levels should be less than or equal to outdoor levels.[296]

Recommended Exposure Limit: The National Institute for Occupational Safety and Health (NIOSH) established a recommended exposure limit (REL) for carbon monoxide as an eight-hour time-weighted average concentration of 35 ppm.[297]

Table 62 summarizes the statutes, regulations, and standards related to reducing carbon monoxide exposure in schools outlined above.

Table 62. Statutory/Regulatory Framework and Notable Standards for Reducing Exposure to Carbon Monoxide

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Regulations			
105 CMR 675	x		
NAAQS for carbon monoxide		x	
OSHA PEL for carbon monoxide		x	
Standards			
ACGIH TLV			x
ASHRAE 62.1: Ventilation and Acceptable Indoor Air Quality			x
DPH IAQ Assessment Manual			x
NIOSH REL			x

Relevant Resources

Table 63 provides a summary of resources related to reducing carbon monoxide exposure in schools.

Table 63. Resources for Reducing Carbon Monoxide Exposure in Schools

Resource	Author	URL
Energy Savings Plus Health: Indoor Air Quality Guidelines for School Building Upgrades	US EPA	https://www.epa.gov/sites/default/files/2014-10/documents/energy_savings_plus_health_guideline.pdf
Sensible Steps to Healthier School Environments	US EPA	https://www.epa.gov/sites/default/files/2014-05/documents/sensible_steps.pdf
The Massachusetts Anti-Idling Law – Frequently Asked Questions	MassDEP	https://www.mass.gov/doc/massdep-faq-the-massachusetts-anti-idling-law/download

2a(4) Reduce Exposure to Mold and Moisture

Methods and Best Practices

The following are methods and best practices related to reducing mold exposure during construction, O&M, remediation.

Construction

Measures can be taken during school construction and renovation projects to reduce moisture problems in buildings and prevent mold growth. The following methods and best practices can be implemented during construction and renovation projects.

Numerous Co-benefits of Optimized HVAC Systems and Building Envelope Improvements

Many of the methods and best practices in this section (especially those related to the optimized operation of HVAC systems and building envelope improvements) not only promote healthier learning environments, but also promote schools that are more energy efficient and resilient to the impacts of climate change. See Objective 1a. Decarbonize Buildings and Objective 1f. Enhance Climate Resilience for additional details on these co-benefits.

(1) Choose materials that will control moisture

During construction or renovation projects, review the types of materials chosen and select those that will control moisture in areas which may be prone to wetness or humidity (e.g., insulation, sealant, basement moisture barriers). For example, use nonporous or moisture-resistant materials in areas that are likely to become wet frequently, like around water fountains or bathrooms.[104] Use proper moisture barriers in roofing systems and repairs and in the foundation.[104] Also, below-grade space should not be converted to occupied space if it is subject to chronic dampness.[298]

(2) Seal unwanted openings and leaks in the building envelope

The building envelope plays a part in keeping water and moisture out of the building and ensuring that systems designed to maintain the ambient conditions and air quality inside the building are working efficiently. Seal unwanted openings and leaks in the building envelope to reduce infiltration using long-lasting sealants with low contents of volatile organic compounds (VOCs).[104]

(3) Keep building materials dry to prevent the growth of mold and bacteria

There is a greater likelihood of mold developing if building materials are installed moist or wet. Keep building materials dry to prevent the growth of mold and bacteria.[183] If materials become wet, dry them within 24 hours; if materials do not dry, they should be replaced.[183]

Indoor Air Monitoring

Sensor technology in classrooms can provide continuous monitoring of multiple parameters, including temperature, relative humidity, particulate matter, carbon monoxide, and carbon dioxide. As air quality sensor technology becomes more sophisticated and less expensive, schools can place sensors in classrooms to provide accurate, real-time information via an application or web-based dashboard, eliminating the need for personnel to take measurements with hand-held equipment.

Boston Public Schools (BPS) has implemented IAQ sensors in all classrooms in schools across the district and publishes real-time monitoring information on its web-based IAQ Sensor Dashboard. These sensors have allowed BPS to make timely temperature adjustments, immediately identify issues with ventilation systems, and rapidly respond to air quality events.

O&M

Routine O&M best practices can help to prevent mold growth by controlling moisture and catching and remediating leaks before they lead to mold problems. The following methods and best practices relate to routine maintenance of school buildings.

(4) Maintain interior relative humidity levels below 60 percent

High humidity encourages mold growth. Indoor relative humidity should be maintained at a level below 60 percent, but ideally between 30–50 percent.[100,101,104] Humidity levels can be maintained using an HVAC system or dehumidifiers. Schools can measure indoor relative humidity with hygrometers; these devices range from low-cost handheld instruments that can be carried from room-to-room, to devices integrated into building systems that can transmit readings to centralized building monitoring systems and create alerts when humidity is outside of the target range. Hygrometers are often paired with thermometers to measure temperature. Sensors should be re-calibrated quarterly or according to the manufacturer's specification.

(5) Maintain a properly balanced HVAC system

A balanced, properly sealed HVAC system will maintain the indoor climate at an appropriate temperature and humidity, thus reducing mold and moisture issues.[298] Positive pressure can help reduce moisture intrusion into the building envelope.[104]

(6) Clean any wet or damp areas within 48 hours and promptly repair all observed leaks

When wet or damp areas are discovered, dry and clean the area within 48 hours.[100,299,300] Investigate the cause of the wet or damp spots and fix any leaks or problems that led to the water buildup.[101] This will help to prevent the growth of mold.[100]

(7) Perform regular checks for condensation, wet spots, and signs of mold

Routinely check the school for areas of condensation, wet spots, and signs of mold. Proactively searching can help to prevent mold or stop moldy areas from expanding.[101] Areas prone to moisture or leaks should be prioritized. BCEH recommends that schools inspect below-grade spaces in school buildings at least quarterly, as well as after heavy rainfall or snowmelt, for evidence of water penetration or water damage.

(8) Consider using dehumidifiers

When other ventilation systems are insufficient or for buildings without an HVAC system, use dehumidifiers to reduce humidity to 30–60 percent.[104,299] Dehumidifiers may be necessary when HVAC systems are undergoing maintenance, outdoor heat and humidity levels are unusually high, or after activities like carpet cleaning introduce extra moisture into the school building.[104] If sinks or drains are available, configure dehumidifiers to empty directly into the sinks/drains to reduce maintenance and prevent mold growth and associated odors.

Remediation

When mold has already grown in a school building, it must be properly cleaned to avoid exposing students and staff to the mold as much as possible and to prevent recurrence. Implement the following methods and best practices when mold is found at a school.

(9) Contain and do not disturb areas with significant mold until they can be remediated

Disturbing mold can cause spores to become airborne and increase the likelihood of exposure among building occupants. To prevent this, when significant amounts of mold are found, contain the area and do not disturb the mold until proper remediation is arranged.[104] Remediate mold and damaged materials as quickly as possible. In addition, if mold growth is severe, it should be removed outside of school hours to avoid student exposure.[100]

(10) Clean small areas of mold with proper cleaning supplies

Mold can be removed from hard surfaces by scrubbing with water and the appropriate cleaning supplies.[101,299] Where possible, use “green” cleaning products and dry the surface completely after cleaning. Note that some cleaning products, such as bleach, can trigger asthma attacks.[299] Do not paint or caulk over mold without cleaning or removing the mold and ensuring that the cause of the mold is addressed.[100]

(11) Repair or replace moldy ceiling tiles and carpet

Porous and slow-drying materials such as carpet or ceiling tiles with mold growth should be replaced or repaired.[299] These types of materials are difficult to rid of mold once it has started growing, and often the most foolproof and cost effective way to address mold in carpets or ceiling tiles is to replace them.

Statutes, Regulations, and Standards

There are currently no federal or state standards to determine a safe or unsafe amount of mold.

Relevant Resources

Table 64 provides a summary of resources related to reducing exposure to mold in schools.

Table 64. Resources for Reducing Exposure to Mold

Resource	Author	URL
Asthma and Your Environment	DPH	https://www.mass.gov/doc/asthma-and-your-environment-english/download
Clearing the Air: An Asthma Toolkit for Healthy Schools: Leaks & Moisture	DPH, Health Resources in Action, MAAP	https://www.maasthma.org/toolkit/leaks
Energy Savings Plus Health: Indoor Air Quality Guidelines for School Building Upgrades	EPA	https://www.epa.gov/sites/default/files/2014-10/documents/energy_savings_plus_health_guideline.pdf
Northeast CHPS Criteria for New Construction and Renovations, Version 4.0	NE-CHPS	https://neep.org/sites/default/files/media-files/NE%20CHPS%20v4.0%20Clean%20Final%20Draft%20May%202022.pdf
Remediation and prevention of mold growth and water damage in public schools and buildings to maintain air quality	DPH	https://www.mass.gov/info-details/remediation-and-prevention-of-mold-growth-and-water-damage-in-public-schools-and-buildings-to-maintain-air-quality
Sensible Steps to Healthier School Environments	EPA	https://www.epa.gov/sites/default/files/2014-05/documents/sensible_steps.pdf
Sensible Guide for Healthier School Renovations	EPA	https://www.epa.gov/sites/default/files/2016-01/documents/schools_renov_brochure-8_5x11_final.pdf

2a(5) Reduce Exposure to PCBs

Methods and Best Practices

The methods and best practices described here cover identifying and removing PCBs from schools, considerations during renovations and repairs, and simple steps to reduce exposure to PCBs found in air and dust.

Identify and Remove Sources of PCBs

This section describes how to identify and remove PCBs from schools, starting with an inventory of potential PCB-containing materials and continuing with best practices for removing, encapsulating, and disposing of PCBs.

(1) Conduct an inventory of possible locations of PCB-containing materials

The first step in determining whether students and staff at a school are at risk of PCB exposure is determining where PCBs ≥50 ppm may be present in building materials. There is no visual standard for determining whether or not PCBs are present in building materials, but inspecting schools for potential sources of PCBs is a good place to start.[301,302] EPA recommends developing an inventory of all materials in the building that may contain PCBs. Historical records can help identify materials, areas, or parts of the school that were constructed or renovated between 1950 and 1979 or shortly after, and, therefore may contain PCBs.[301,302]

PCBs have frequently been found in and around window and door frames, on surfaces, within expansion joints, and in areas subject to high heat or fires, such as boiler rooms.[301,302] Potential manufactured PCB products that may be present in schools include:

- Paint, varnishes, and lacquers
- Non-conducting materials in electrical cables (e.g., plastic and rubber)
- Rubber and felt gaskets
- Coal-tar enamel coatings (e.g., pipe coating) and rust inhibitor coatings
- Insulation materials (e.g., fiberglass, felt, foam, and cork)
- Adhesives and tapes
- Caulk, grout, and joint material (e.g., putty, silicon, and bitumen)
- Pipe hangers
- Plastic applications, including vinyl and polyvinyl chloride
- Galbestos siding
- Mastics
- Acoustic ceiling and floor tiles
- Asphalt roofing and tar paper
- Synthetic resins and floor varnish
- Sprayed-on fireproofing[301]
- Fluorescent light ballasts[101]

Fluorescent light ballasts (FLBs) manufactured before 1979 are another common source of PCBs in schools.[104,303] PCBs can be found in the FLB capacitors and interior potting material of old magnetic T12 lighting fixtures.[303] FLBs manufactured between 1978 and 1998 that do not contain PCBs were required to be labeled "No PCBs," and newer lighting tends to use electronic ballasts that do not contain PCBs and should be marked as electronic. FLBs that are not electronic or manufactured before 1998 and not labeled as "No PCBs" should be assumed to contain PCBs unless the manufacturer can confirm otherwise.[104,303]

Check FLBs for PCBs

EPA provides detailed recommendations on how to check FLBs for PCBs.

(2) Conduct PCB sampling to confirm presence of PCBs

If leaders suspect that PCBs are present in school building materials, then schools should test the air and surfaces around the potential sources of PCBs to determine whether PCB exposure is occurring.[106,301] If PCBs are present in an intact material, such as caulking that is not deteriorating, then no appreciable PCB exposure or health effects would be expected.[106] If caulking or other PCB-containing materials are deteriorating or damaged, then air and surface wipe testing near the source is recommended.[106] Similar testing should be conducted in an area without deteriorating caulking to use as a comparison.[106] The results of this testing can inform abatement activities, cleaning procedures, and the implementation of other measures to reduce exposure.[106,301]

Following the inventory of potential PCB-containing materials, the building operator may choose to assume that they contain PCBs ≥ 50 ppm or test the composition of the potential PCB-containing materials.[301] If a school chooses to test materials, EPA recommends developing a building material sampling plan that considers current and future building use as well as remediation goals.[301] When testing for PCBs present in building materials, it is also important to consider porous materials that surround the materials that contain PCBs.[301] The EPA Technical Guidance for Determining the Presence of Manufactured PCB Products in Buildings and Other Structures can be used as a guide for sampling site selection, collection, and analysis.[302] DPH does not recommend disturbing intact materials for testing, as available data suggest that no appreciable exposure is likely from intact materials containing PCBs.[106] Information about exposure can be determined through air and surface wipe testing as described above.[106] A consultant can be hired to conduct surface wipe testing or testing can be done by school personnel and sent to an analytical laboratory. EPA's regional office can help identify contractors or laboratories for testing (see Table 67 for relevant contact information for EPA Region 1, which encompasses Massachusetts).

(3) Remove building materials with PCBs ≥50 ppm

The most effective way to reduce PCB exposure or risk of future exposure is to remove materials that contain PCBs ≥ 50 ppm or that are assumed to contain the regulated level of PCBs.[109] Caulk and other building materials with PCBs should be removed by personnel wearing appropriate PPE, following procedures to minimize the spread of PCBs, and in compliance with the Toxic Substances Control Act (TSCA).[101,110,304] During any renovations involving PCBs or abatement activities, school building occupants should be notified, and the parts of the building undergoing PCB-related activities should be physically isolated and possibly negatively pressurized if staff and students are still in the building.[304] Disposal of building materials with PCBs ≥50 ppm must be performed in accordance with TSCA.[110]

> EPA provides steps for safe PCB abatement activities that helps building owners and contactors plan for abatement projects of caulking and other building materials potentially contaminated with PCBs.

(4) Replace and properly dispose of PCB-containing light ballasts

> EPA's PCB-Containing FLBs in School Buildings website provides information to school administrators and maintenance personnel on the hazards posed by PCBs in PCB-containing FLBs, how to properly handle and dispose of these items, and how to properly retrofit the lighting fixtures in schools to remove potential PCB hazards.

Although intact FLBs with PCBs are not an appreciable source of exposure when functioning properly, they can release PCBs into the air as they degrade or if they break or catch fire.[106,303] Consequently, the best way to avoid PCB exposure from FLBs is to remove all PCB-containing FLBs identified in the inventory.[106,303,304] FLBs must be removed and disposed of in compliance with TSCA.[110,304] Any oil and stains leaked from FLBs with PCBs must also be cleaned up or disposed of in accordance with TSCA.[104,110] Schools should select an experienced contractor or facilities staff person to remove PCB-containing FLBs and decontaminate the surrounding area.[303] In preparation for removal, the area should be isolated from the rest of the building and ventilated separately; workers should wear proper PPE, and furniture under the fixtures should be removed.[303]

(5) Consider encapsulation of PCBs to reduce exposure

Encapsulation is the practice of painting a contaminated surface with a barrier coating that prevents the release of PCBs from the painted material.[305] Encapsulation may be helpful to reduce PCB emissions from sources contaminated by PCB-containing materials once the PCB materials have been removed.[304] For example, materials that were touching PCB-contaminated caulking or paint could be possible sites for encapsulation.[304] Encapsulation is only suitable for building materials with low PCB contents. Properties of the coating, properties of the source building materials, environmental conditions, and mitigation goals must be considered when determining whether encapsulation is appropriate.[305] EPA recommends contacting your regional PCB coordinator because the applicability of encapsulation can vary on a case-by-case basis.[304] Post-encapsulation monitoring with either air or surface wipe sampling will show whether the encapsulation was effective.[305]

EPA researchers tested the efficacy of ten coatings used for PCB encapsulation and found that the three epoxy coatings performed better than the other coating materials.[305] Generally, coatings that have smaller material/air partition coefficients and smaller diffusion coefficients for PCBs are better at reducing PCB emissions.[305] However, no coatings are truly impenetrable to PCBs, so encapsulation may not meet the mitigation goals of every situation.[305]

Renovations and Repairs

Schools planning renovations and repairs should consider the best practices described here when planning for and carrying out the projects.

(6) Remove PCB-containing materials disturbed during renovations and repairs and minimize PCB exposure

When undertaking normal renovations or repairs, school leaders and those planning for renovations or repairs should consider whether caulk or other building materials that contain PCBs may be disturbed.[104,304] EPA recommends using planning renovations and repairs as opportunities to remove PCB-containing materials (see *Remove building materials with PCBs ≥50 ppm in compliance with TSCA*).[304] Even if not removed, renovations that affect PCB-containing materials require additional caution. If PCBs are present in building materials that will be disturbed during renovations, schools and contractors should take appropriate precautions to minimize exposure to PCBs during renovations.[104,304] This may include informing school occupants about the renovations, isolating the area undergoing renovations, regularly wet-mopping renovation areas, modifying the HVAC system to keep PCBs in the affected part of the building, and taking precautions to protect workers. Once materials containing PCBs ≥50 ppm are removed, they must be handled and discarded properly in accordance with TSCA waste disposal requirements.[104,110] Schools should maintain all documentation of PCB testing results (if tested), sampling locations, disposal measures, disposal companies used, and final destination of waste materials.[104]

> EPA's Steps to Safe Renovation and Repair Activities website highlights precautionary measures and best work practices for conducting repairs or renovations in older buildings that have PCB-containing building materials.

(7) Follow EPA recommended steps for cleanup and decontamination if a PCB-containing FLB leaks, smokes, or catches fire

If an FLB that contains PCBs leaks, smokes, or catches fire, then the school must properly remove and dispose of the fixture and clean up the surrounding area.[303] EPA recommends that only experienced contractors or facilities staff should remove, clean up, and decontaminate areas around FLBs that leak, smoke, or catch fire.[303] The process should begin with preparation of the space, including isolating the affected area from the central ventilation system, ventilating the area separately, moving furniture and other objects out from under the fixture and covering them with plastic sheets, and turning off light switches and fuses or breakers.[303] Workers should wear appropriate PPE.[303] EPA describes detailed steps for inspection of damaged FLBs, removal and disposal of FLBs and other materials contaminated with PCBs, and cleanup of PCBs spilled in the surrounding areas.

(8) Follow EPA recommended steps when performing a retrofit for non-leaking PCB-containing FLBs

Even when performing a retrofit of undamaged PCB-containing FLBs, schools should follow EPA-recommended steps.[303] This applies to retrofits as part of other renovations and repairs or in an effort to remove all PCB-containing FLBs. EPA recommends that only experienced contractors or facilities staff should perform the lighting retrofit.[303] EPA describes detailed steps for removing and disposing of PCB-containing FLBs.

Reduce PCB Exposure Through Air and Dust

Given that it may not always be possible to identify all PCB sources or remove PCBs immediately, it is important to take steps in ventilation and cleaning to reduce PCB exposure through air and dust.

(9) Regularly inspect and maintain ventilation systems for proper operations

While the strategies described above can be used to reduce or remove PCB hazards, not all schools may be ready to undertake full PCB removal, and removal may not mean all residual PCBs are gone from school buildings. As a result, it is important to consider strategies to reduce exposure to PCBs through air and dust.[109,304] One common route of PCB exposure is through inhalation into the lungs.[109] Increasing ventilation to remove indoor air containing PCBs and bring outdoor air into the building reduces inhalation exposure to PCBs.[109] Schools should confirm that ventilation systems are operating properly, regularly inspected, and maintained according to system manufacturer instructions and guidelines.[109,304] EPA recommends use of ANSI/ASHRAE/Air Conditioning Contractors of America (ACCA) Standard 180-2012—Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems.[304] If system cleaning is needed, EPA recommends following ANSI/ACCA Standard 6–Restoring the Cleanliness of HVAC Systems (2007).[304] In addition to creating a healthy learning environment, a well-operating HVAC system also contributes to energy efficiency and climate resilience (see Objective 1a. Decarbonize Buildings and Objective 1f. Enhance Climate Resilience for additional details about these co-benefits).

(10) Teach and reinforce good hand-washing etiquette, particularly before eating and drinking

Another common route of exposure is through ingestion of PCBs in dust found on surfaces and hands.[109] Students and staff should wash hands with soap and water frequently, particularly before eating and drinking.[101,109,304] In classrooms with younger children, staff should regularly wash toys and frequently touched objects with soap and water.[101,109,304] In addition to preventing the accidental ingestion of PCBs, good hygiene practices such as hand-washing can prevent the accidental ingestion of other contaminants, such as lead, that may end up on hands, as well as prevent the spread of illness (see best practice (4) Teach and reinforce respiratory etiquette under Reduce Airborne Transmission of Disease)

(11) Reduce dust while cleaning

During some cleaning practices dust containing PCBs can be resuspended into the air. In buildings with known or suspected PCBs, cleaning staff should help reduce PCB exposure by using vacuums with HEPA filters and cleaning surfaces, including floors, walls, and window sills regularly with wet microfiber mops and cloths.[101,109,304] Cleaning staff should not sweep with dry brooms or dust with dry dusters or cloths, as both can resuspend PCBs in dust into the air.[101,109,304]

Statutes, Regulations, and Standards

This section summarizes the regulation that governs PCB testing and removal as well as the standard oral reference dose (RfD) recommended for schools.

Relevant Regulations

40 CFR § 761: Toxic Substances Control Act (TSCA) – PCBs Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions prohibits PCB production and establishes requirements for the manufacture, processing, distribution, use, disposal, storage, and marking of items containing PCBs.[110] Several subparts may be relevant for schools managing, cleaning up, or disposing of PCBs:

40 CFR § 761.60: Disposal and **40 CFR § 761.62: Disposal of PCB Bulk Product Waste** describe appropriate ways to dispose of waste that contains PCBs. If schools are undertaking renovations to remove PCBs, they are responsible for properly disposing of PCBs whether in caulk, fluorescent light ballasts, or other sources in accordance with 40 CFR § 761.[106,110,303]

40 CFR § 761.65: Storage for Disposal describes how waste containing PCBs must be stored while awaiting disposal.[110,303]

40 CFR § 761.125: Requirements for PCB Spill Cleanup pertains to all spills of PCBs at concentrations of 50 ppm or greater.[110] If such a spill were to occur at a school, for example, from broken fluorescent light ballasts that contain PCBs, the school would have to report, clean up, and certify clean up from the spill in compliance with 40 CFR § 761.125.[110,303]

Relevant Standards

Exposure Levels for Evaluating PCBs in Indoor School Air and the Oral RfD: EPA has defined the oral RfD of PCBs as 20 ng PCB/kg body weight per day. The RfD is the estimated dose of daily exposure that is unlikely to have an appreciable risk of harmful health effects during a lifetime.[306] Considering all exposure pathways in school and non-school settings, EPA calculated indoor air concentrations of PCBs that would result in an estimated total PCB exposure equal to the RfD by age group, assuming other school and non-school exposures were average background levels.[306] Acceptable concentrations in indoor air may vary by school and other background exposures.[306] The exposure levels for evaluating PCBs in school indoor air are outlined in Table 65.

Table 65. Exposure Levels for Evaluating PCBs in School Indoor Air by Age

Age	Exposure Levels for Evaluating PCBs in School Indoor Air (ng/m^3)
1 to <2 yr	100
2 to < 3 yr	100
3 to <6 yr	200
6 to < 12 yr (elementary school)	300
12 to < 15 yr (middle school)	500
15 to <19 yr (high school)	600
19+ yr (adult)	500

EPA recommends that these indoor air concentrations be used as a guide for thoughtful evaluation of indoor air quality in schools, not strict criteria. PCBs in indoor air should be as low as reasonably achievable, and total exposure should remain below the RfD.[306]

Table 66 summarizes the statutes, regulations, and standards related to reducing exposure to PCBs in schools outlined above.

Table 66. Statutory/Regulatory Framework and Notable Standards for Reducing Exposure to PCBs

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Regulations			
40 CFR § 761: TSCA – PCBs Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions		X	
40 CFR § 761.60: Disposal		X	
40 CFR § 761.62: Disposal of PCB Bulk Product Waste		X	
40 CFR § 761.65: Storage for Disposal		X	
40 CFR § 761.125: Requirements for PCB Spill Cleanup		X	
Standards			
Exposure Levels for Evaluating PCBs in Indoor School Air and the Oral Reference Dose (RfD)			X

Relevant Resources

Table 67 provides a summary of resources related to reducing airborne transmission of respiratory disease/illness in schools.

Table 67. Resources for Reducing Exposure to PCBs

Resource	Author	URL
EPA Contacts: Region 1 PCB Coordinator Regional Hotline Regional 24 Hour Spill Hotline	EPA	https://www.epa.gov/pcbs/epa-region-1-polychlorinated-biphenyls https://www.epa.gov/pcbs/epa-regional-polychlorinated-biphenyl-pcb-programs - r1
Fact Sheet: PCBs in Building Materials: Determining the Presence of Manufactured PCB Products in Buildings or Other Structures	EPA	https://www.epa.gov/sites/default/files/2021-05/documents/final_pcb_buildings_fact_sheet_05-10-2021_to_upload.pdf
Fact Sheet: Practical Actions for Reducing Exposure to PCBs in Schools and Other Buildings	EPA	https://www.epa.gov/sites/default/files/2016-03/documents/practical_actions_for_reducing_exposure_to_pcbs_in_schools_and_other_buildings.pdf

Resource	Author	URL
PCBs in Building Materials Frequently Asked Questions (FAQs)	DPH	https://www.mass.gov/info-details/pcbs-polychlorinated-biphenyls-in-building-materials

2a(6) Reduce Exposure to Radon

Methods and Best Practices

This section covers methods and best practices for the overall radon planning, testing, and mitigation process. Some of these steps will be carried out by school staff, others by certified radon mitigation professionals, but all will be organized and managed by school or district personnel. The second section describes specific technical interventions, most of which will be performed by radon mitigation professionals, to reduce radon exposure in schools.

Planning and Management

This section includes a series of methods and best practices for planning for and managing radon testing and mitigation in schools in both new and existing buildings. The best practices are arranged somewhat chronologically, beginning with considerations for new school construction (when relevant), then moving on to testing for radon, developing a mitigation plan, taking mitigation action, communicating with the school community, retesting for radon, maintaining records, and ensuring continuity.

(1) Consider radon in the design and construction of new school buildings

Rather than having to mitigate radon retroactively, it is best to consider radon in the process of constructing new schools.[183] The design and construction of new schools should follow *Soil Gas Control Systems in New Construction of Multifamily, School, Commercial and Mixed-Use Buildings – Rev. 5/23 (ANSI/American Association of Radon Scientists and Technologists (AARST) CC-1000-2018-0523)* for incorporating radon controls into new construction.

(2) Have certified personnel test all schools for radon

EPA recommends testing all schools for radon.[307] Qualified professionals certified by either the National Radon Safety Board (NRSB) or AARST's National Radon Proficiency Program (NRPP) should perform radon tests.[183,308]

A school planning building upgrades or renovations, should test for radon before doing the renovations so that, if needed, a radon mitigation system can be installed as part of the overall building modifications.[104] Schools should be tested at least once every five years unless they have previously recorded high levels, in which case they should be tested every two years after mitigation.[183] Rooms within schools that have demand-controlled ventilation systems may require special attention during testing, as their ventilation rates vary with occupancy. Assume a minimum outdoor air ventilation rate based on the minimum expected occupancy when testing these spaces.[104]

Radon Assessment Unit

DPH has a Radon Assessment Unit (RAU) within BCEH that assists schools with radon questions. The RAU does not conduct radon testing of schools but provides technical assistance for hiring certified professionals to conduct radon testing and mitigation in schools. The RAU can be reached at 1-800-RADON-95 (1-800-723-6695 - Massachusetts only) or (413) 586-7525 x 3185.

(3) Develop and implement a radon reduction plan

Planning where, when, and how to test and mitigate radon is a critical step before a school takes action. If schools have a larger approach to improving indoor air quality or environmental health, a radon reduction plan should be incorporated into that.[307] Schools may want to consult with the DPH Radon Assessment Unit (RAU) on specific steps for their school. This planning phase can include identifying possible funding sources and planning short- and long-term steps for radon reduction.[307]

(4) Take action to mitigate radon if levels are above or approaching EPA action levels

EPA's action level for radon (described under *Relevant Standards*) is 4 piC/L. However, buildings should also consider mitigation if levels are between 2 and 4 piC/L.[309] The main action to mitigate radon levels is to install a radon mitigation system, which removes air from indoor spaces and reduces radon exposure.[101] Technical strategies to mitigate radon are described below in 9, 10, and 11.

(5) Educate and communicate information to parents, students, and staff

Schools should communicate with parents, students, and staff regarding radon in their building and the steps they take for mitigation.[100] Schools should explain the importance of testing and the link between radon and building operations; encourage parents to test their homes for radon; share their radon reduction plan (#2 above); include teachers in your testing process; and encourage teachers to incorporate radon-related science projects into the classroom.[307] It is also important to educate maintenance and facilities staff about radon and how to identify radon risks.[307]

(6) Periodically retest areas of the school after mitigation

Even after radon mitigation interventions, radon testing continues to be important, particularly if any renovations occur. NE-CHPS suggests that radon should be tested at least every two years after you implement mitigation interventions.[183] After any renovation, the flow of indoor air can change, and EPA recommends retesting for radon.[100,104] Changes to the building envelope or mechanical ventilation systems, in particular, can affect indoor radon levels.[104]

(7) Maintain records of ongoing radon testing and radon mitigation system

Schools should maintain records of radon testing before and after mitigation, as well as records related to their mitigation system.[100] Review records as needed. When doing renovations, keep radon reduction methods in mind while designing the renovation, or leave existing mitigation systems in place.[100]

(8) Maintain continuity of the school's radon mitigation plan

After mitigating radon, schools should evaluate the success of their radon mitigation plan and program and find ways to continually improve. Determine if the school needs additional testing or mitigation and follow up with the necessary steps. Schedule future retesting with a certified professional. Consider how ongoing HVAC maintenance or upgrades may affect radon in the building.[307]

Technical Interventions

This section covers technical interventions to mitigate radon exposure, some of which should be performed by a certified radon mitigation professional.

(9) Install a radon mitigation system

Schools should hire a certified radon mitigation contractor to install a radon mitigation system.[307] Confirm that the contractor is certified through the NRSB or NRPP.[183,308] A radon mitigation system should follow the standards of practice described above in *Relevant Standards*. In general, most mitigation systems use a fan to create suction under the building's slab, which is called sub-slab depressurization. The radon gas is then forced up through a pipe and released outside.[308]

(10) Seal cracks and joints in concrete floors

Sealing cracks and joints in concrete floors may be a key part of the radon mitigation system to prevent radon from entering from the ground below.[104,308]

(11) Provide ventilation using a properly balanced HVAC system

A building's HVAC system can be operated to help reduce indoor radon concentrations. A properly balanced HVAC system that maintains positive pressurization indoors can reduce the intrusion of underground contaminants such as radon into the building.[104]

HVAC systems should be maintained regularly and balanced upon beginning operations, when there is a problem, or when there is a change in operations (e.g., every five years).

Statutes, Regulations, and Standards

This section describes an EPA action level at which schools should take steps to mitigate radon as well as building standards pertaining to radon in schools.

Relevant Standards

EPA Action Level recommends that buildings with radon levels at or above this level take steps to mitigate radon. Because there is no known safe level of radon exposure, EPA also recommends that building owners consider radon mitigation when radon levels are between 2 pCi/L and 4 pCi/L.[309]

Protocol for Conducting Measurements of Radon and Radon Decay Products in Multifamily, School, Commercial and Mixed-Use Buildings (ANSI/AARST MA-MFLB-2023) specifies procedures and minimum requirements when measuring radon concentrations in structures such as schools to determine if radon mitigation is necessary. MA-MFLB 2023 consolidates ANSI/AARST MAMF (rev. 1/21) and ANSI/AARST MALB (rev. 1/21) into one publication. Compliance with this standard was effective December 1, 2023.[310]

Soil Gas Control Systems in New Construction of Multifamily, School, Commercial and Mixed-Use Buildings–Rev. 5/23 (ANSI/AARST CC-1000-2018-0523) provides prescriptive minimum requirements for new construction, including of schools, to reduce exposure to radon and other hazardous soil gases. First published in 2017, this standard of practice was updated in 2023 for clarity and improvements such as making inspections during construction required rather than optional; clarifying qualified professionals needed; clarifying products to use for creating an air barrier between soil and indoor air; and integrating vapor intrusion design features into relevant sections. This standard should be used in the planning and construction of new school buildings.[310]

Soil Gas Mitigation Standards for Existing Multifamily, School, Commercial and Mixed-Use Buildings (ANSI/AARST SGM-MFLB-2023) specifies minimum requirements for methods that mitigate risks posed by radon gas and other chemical vapors or gases in existing buildings, including schools. SGM-MFLB consolidates the radon mitigation ANSI/AARST RMS-MF (rev. 12/20) and ANSI/AARST RMS-LB (rev. 12/20) into a single publication and harmonized it with ANSI/AARST SGM-SF (Soil Gas Mitigation in Existing Homes) for interactive use.[310]

Table 68 summarizes the statutes, regulations, and standards related to reducing radon exposure in schools outlined above.

Table 68. Statutory/Regulatory Framework and Notable Standards for Reducing Exposure to Radon

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Standards			
EPA's Action Level			X
Protocol for Conducting Measurements of Radon and Radon Decay Products in Multifamily, School, Commercial and Mixed-Use Buildings (ANSI/AARST MA-MFLB-2023)			X
Soil Gas Control Systems in New Construction of Multifamily, School, Commercial and Mixed-Use Buildings–Rev. 5/23 (ANSI/AARST CC-1000-2018-0523)			X
Soil Gas Mitigation Standards for Existing Multifamily, School, Commercial and Mixed-Use Buildings (ANSI/AARST SGM-MFLB-2023)			X

Relevant Resources

Table 69 provides a summary of resources related to reducing radon exposure in schools.

Table 69. Resources for Reducing Radon Exposure in Schools

Resource	Author	URL
Radon Standards of Practice	ANSI/AARST	https://standards.aarst.org/
DPH Radon Assessment Unit (RAU)	DPH	1-800-RADON-95 (1-800-723-6695) or (413) 586-7525 x 3185
DPH Radon in Schools home page	DPH	https://www.mass.gov/info-details/radon-in-schools
Northeast CHPS Criteria for New Construction and Renovations Version 4.0: Assessment Tool	NE-CHPS	https://neep.org/sites/default/files/media-files/NE%20CHPS%20v4.0%20Clean%20Final%20Draft%20May%202022.pdf
Managing Air Quality for Schools (part of the Indoor Air Quality Tools for Schools Action Kit)	EPA	https://www.epa.gov/sites/default/files/2014-11/documents/managing_radon.pdf

Resource	Author	URL
Sensible Guide for Healthier School Renovations	EPA	https://www.epa.gov/sites/default/files/2016-01/documents/schools_renov_brochure-8_5x11_final.pdf

2a(7) Reduce Exposure to Outdoor Air Pollutants

Methods and Best Practices

This section summarizes methods and best practices to reduce exposure to outdoor air pollution across two areas: policy and education; and infrastructure.

Policy and Education

Policy and education interventions describe methods or best practices for reducing exposure to emissions, achieved through increasing awareness of the issue and creating a policy to reinforce behaviors that reduce exposure.

(1) Educate staff about how outdoor air quality impacts indoor air quality

Educate school staff about how outdoor air pollution can enter the school through open doorways and windows, and what causes air pollution levels to increase. Empower school staff and students to react to poor outdoor air pollution. One way to do this is to implement an air quality flag program to increase awareness of outdoor air quality among school communities. Schools participating in this type of program will fly a colored flag that corresponds to EPA's color-coded Air Quality Index each day. This program educates students and staff and allows schools to make informed decisions about exposure to poor outdoor air quality during activities such as recess or sports practice.[311] Schools can use this program to decide when to reduce the impact of poor outdoor air quality on indoor air by closing doors and windows and increasing air filtration through a building's HVAC system.

In addition, school bus operators should receive information about idling and pollution exposure.[183,312] Morning and afternoon traffic periods (i.e., rush hour) are times associated with higher pollution; schools should educate staff about not opening windows and doors during these times.[313]

(2) Enforce a vehicle anti-idling policy

Schools can adopt and enforce a written idling-reduction policy that applies to all vehicles, including but not limited to school buses, cars, and delivery vehicles.[101,314] The policy should be explained and shared with the school community. Policies should include limits on the number of minutes that vehicles can idle (i.e., no more than 3–5 minutes).[183,287,312]

(3) Create a wildfire smoke readiness plan

A wildfire smoke readiness plan will prepare schools to take action when wildfire smoke events occur. Plans should include routine evaluation of the HVAC systems and routine HVAC filter maintenance so the building systems can adequately filter polluted air. Plans should also include routine assessment of the building envelope to limit wildfire smoke intrusion.[315,316] In addition, plans should specify other ways that the school will prepare for wildfires, including methods to monitor outdoor air quality threats, purchasing of equipment to monitor indoor air quality (see the Indoor Air Monitoring text box for additional details), and a backup plan to supplement HVAC systems should they not be able to adequately clean the indoor air.[315,316]

Infrastructure

Infrastructure interventions include methods to reduce exposure to poor outdoor air quality that can be achieved through physical equipment and changes to the built environment.

(4) Replace or retrofit legacy school buses

Older school buses typically emit higher levels of PM and other pollutants. Electrifying school bus fleets will greatly reduce near-school vehicle emissions. See Objective 1d. Electrify School Bus Fleets for more details about electrifying school bus fleets. Alternatively, older school busses can be retrofitted with PM filters to reduce vehicle emissions or replaced with engines that are certified to use alternative, cleaner fuels.[101,101,117]

(5) Establish anti-idling zones

Post signage indicating where vehicles are prohibited from idling.[104,183,314] This can reinforce the school's vehicle anti-idling policy.

(6) Locate passenger pickup and drop-off areas away from air intakes and classroom windows

If necessary, redesign school bus parking zones to minimize the potential for diesel exhaust to enter inside the bus or the school. Bus parking areas, passenger pick-up and drop-off lanes, and any loading docks should be located away from the school building air intakes.[101,104,117,287] Consider other design features that can help minimize exhaust exposure, including diagonal school bus parking.[314]

(7) Maintain HVAC systems and filter indoor air

Ensure that HVAC systems are maintained and properly filter any air entering the school from outside.[117,287] Filter systems will clean outside air that may be impacted by air pollution, including vehicle exhaust, to minimize exposure within the school; air should be filtered to the highest level of high-efficiency filtration the HVAC system is designed to handle, and filters should be inspected and replaced quarterly. HVAC systems should be run continuously while the building is occupied. In addition, HVAC systems should be balanced before beginning operation and when there is a change in operations so as to keep positive pressure within the school; negative pressure can draw in outdoor contaminants through the building envelope.[104,117]

(8) Consider sources of outdoor air pollution when siting a new school

Significant air pollution comes from heavily trafficked roadways and can also come from industrial areas. When deciding where to locate a new school, consider these sources of air pollution. Air pollution is higher within 500 feet of a major roadway.[313] Municipalities and school districts should avoid siting schools immediately adjacent to highly-traveled roadways and other significant sources of air pollution to the maximum extent possible.

(9) Consider community- and building-level design elements that mitigate infiltration of outdoor air pollutants from roadways and industrial areas

Ideally, a school district planning to construct a new school will have the flexibility to select a site that is removed from heavily trafficked roadways and industrial sites. There are often circumstances when this is not possible, including school districts located in densely developed urban areas or instances when a school elects to undergo an in-place renovation and the existing building is located near a busy roadway and/or industrial site. If there are limitations that necessitate the siting of a new school in a location near heavily trafficked roadways or industrial areas, or when a school is undergoing an in-place renovation, school districts still have options at the community and building levels to mitigate indoor exposure to outdoor air pollutants from roadways and industrial areas, including the following:

- Install roadside vegetation barriers (either alone or in combination with solid noise barriers) to reduce near-road air pollution[317]
- Locate school building spaces often occupied by people (e.g., classrooms, playgrounds, athletic fields) further from busy roadways and industrial sites[313]

See the Mitigate Occurrences of Vapor Intrusion section for additional details about mitigation strategies for schools located near industrial sites.

Statutes, Regulations, and Standards

Statutes, regulations, and standards that include a focus on outdoor air quality around schools are detailed below.

Relevant Statutes

M.G.L., c. 90 §16A restricts the operation of motor vehicle engines while stopped in excess of five minutes.[318]

M.G.L., c. 90 §16B restricts the prolonged idling of a motor vehicle engine on school property specifically.[319]

Relevant Regulations

540 CMR 27.00, Regulation of Motor Vehicle Idling on School Grounds[320] restricts unnecessary idling time and governs the time during which a motor vehicle can idle on school grounds, in order to improve and protect school campus air quality. Vehicle operators are not permitted to idle motor vehicles within 100 feet of known and active school intake systems. All schools must install and maintain permanent "NO IDLING" signage in a conspicuous location and visible from a distance of 50 feet. All school bus companies operating within the Commonwealth must inform each of their respective school bus drivers of the regulation's requirements and consequences of non-compliance.

Relevant Standards

ASHRAE Planning Framework for Protecting Commercial Building Occupants from Smoke During Wildfire Events provides recommendations for HVAC and other building measures to minimize occupant exposures to smoke during wildfire smoke events, including components of a wildfire readiness plan.[316]

Table 70 summarizes the statutes, regulations, and standards related to reducing exposure to outdoor air pollution outlined above.

Table 70. Statutory/Regulatory Framework and Notable Standards for Reducing Exposure to Outdoor Air Pollutants

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Statutes			
M.G.L., c. 90 §16A	X		
M.G.L., c. 90 §16B	X		
Regulations			
540 CMR 27.00, Regulation of Motor Vehicle Idling on School Grounds	X		
Standards			
ASHRAE Planning Framework for Protecting Commercial Building Occupants from Smoke During Wildfire Events			X

Relevant Resources

Table 71 provides a summary of resources related to reducing exposure to outdoor air pollutants at schools.

Table 71. Resources for Reducing Exposure to Outdoor Air Pollutants

Resource	Author	URL
Air Monitoring in Massachusetts	MassDEP	https://www.mass.gov/air-monitoring-in-massachusetts
Air Quality	MassDEP	https://www.mass.gov/topics/air-quality
Best Management Practices: Reducing Diesel Pollution at Schools	MassDEP	https://www.mass.gov/doc/massdep-best-management-practices-reducing-diesel-pollution-at-schools/download
Clearing the Air: An Asthma Toolkit for Healthy Schools	DPH, Health Resources in Action, MA Asthma Action Partnership	https://www.maasthma.org/toolkit/outdoorairpollution
Engine Idling Guidance for School Bus Drivers	MassDEP	https://www.mass.gov/doc/engine-idling-guidance-for-school-bus-drivers/download
MassAir Online	MassDEP	https://eeaonline.eea.state.ma.us/dep/massair/web/#/pollution/map/max
Air Quality Flag Program	AirNow	https://www.airnow.gov/air-quality-flag-program/schools/
Best Practices for Reducing Near-Road Pollution Exposure at Schools	US EPA	https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1013GDE.pdf
Healthy Air Network	Public Health Institute of Western Massachusetts	https://www.publichealthwm.org/healthy-air-network
NE-CHPS Criteria for New Construction and Renovations Assessment Tool	NE-CHPS	https://neep.org/sites/default/files/media-files/NE%20CHPS%20v4.0%20Clean%20Final%20Draft%20May%202022.pdf

Objective 2b. Improve Water Quality

2b(1) Reduce Exposure to Lead in Drinking Water

Methods and Best Practices

The following best practices aim to identify lead sources in drinking water, create communication, sampling, and testing plans, and remediate lead contamination drinking water in schools.

(1) Be familiar with the school's water source and condition of the school's plumbing system

An important first step when dealing with water quality concerns is identifying the school's drinking water source.[321] Additionally, it is essential to be aware of the condition of the plumbing system in schools since corroded systems can leach lead.[122] It is helpful to know how water enters and flows through schools and to have documented plumbing configurations for the building.[322] A water professional, such as a qualified plumber, may be able to assist schools in determining their plumbing configuration, ensure the system is functioning adequately, and identify lead-based or galvanized service lines and faucets.[287,322]

(2) Create a communication plan to notify stakeholders and build partnerships

The only way to know if lead is present in drinking water is to test, though before developing a sampling plan, it is essential that schools first create a communication plan.[121] The plan should be written for stakeholders such as staff, parents, students, public water system officials, and local elected officials. It should also detail how stakeholders will be notified regarding the health impacts of lead in drinking water, sources of lead in drinking water, sampling plans, and any results from testing. Further, schools should work to build partnerships with local community organizations or state drinking water programs to assist in communicating relevant and factual information.[121]

(3) Implement a water sampling plan in compliance with state guidance

It is important that all schools have a well-developed water sampling and testing plan to comply with state guidance. The first step of this plan should be to conduct a walk-through of the school to identify all sinks and fountains that provide water meant for consumption and to document the presence of aerators and filters.[121,323] Based on the information collected from the walk-through, determine which drinking water sources to sample. Multiple sources should be chosen, and they should be representative of all potential drinking water outlets, such as drinking fountains, kitchen sinks and kettles, classroom sinks, etc.[121]

Before sampling, schools should identify a Massachusetts-certified laboratory to analyze the water samples for lead.[121] Laboratories should provide details on sampling methodology, though MassDEP also provides the following information: 1) designate a school employee to lead the sampling plan or hire an experienced consultant, 2) create a diagram of where samples will be taken and assign an identification code to each location, and 3) record detailed notes during sampling such as the date and time of sampling and observations for each location (i.e., type of water source, whether an aerator or filter is present).[324,325] Some essential things to note are to always sample taps/outlets with aerators or filters attached if water is normally obtained using such measures and to never sample immediately after an extended closure or following a facility flush of the plumbing system.[121,322]

Note that MassDEP recommends that schools conduct testing once every three years, and that results come back under the detection limit of 1 ppb.[324] If results come back above this level, MassDEP recommends that schools notify the administrator and include the list of sampling locations with detectable levels and the remediation efforts the school will implement to address the contamination.[324] Regardless of the results, staff, parents, students, and other stakeholders should be notified of the testing as detailed in the school's communication plan.

(4) Remediate sources of contamination and establish routine practices to minimize future contamination

Long-term vs Short-term Solutions

Flushing the taps to reduce lead exposure is an example of a short-term solution. While it helps to lower lead exposure, it increases a school's water consumption and could further exacerbate water conservation concerns, especially during drought conditions. Ultimately, schools should work towards implementing long-term solutions that are sustainable and create a healthy learning environment.

If schools detect lead in drinking water, it is important to take immediate action to remediate the contamination. Depending on the level of lead detection, initial steps can range from flushing outlets, to posting signage indicating the outlet should not be used for drinking or cooking, to shutting off problem outlets.[121] Some short-term measures that could be implemented include installing filters, providing bottled water, or flushing the plumbing system.[121] Flushing involves opening taps and letting water flow to remove any stagnant water in the interior of the pipes, as stagnant water is more likely to have higher levels of lead.[122,321,322,326] Permanent control measures will require the complete replacement of problem outlets and any upstream plumbing components like piping, valves, and solder.[121] Another option would be to reconfigure the plumbing system to re-route water away from sections identified to contain lead-based materials.[323] Finally, the School Water Improvement Grants (SWIG) Program offers grants for the purchase and installation of filtered water-bottle filling stations in eligible schools and EECFs, while the Water-Smart Program offers filtered pitchers.

Other daily practices can be implemented to reduce lead in drinking water. For example, outlets should be flushed daily for at least 30 seconds, and complete system flushing should occur weekly, particularly after breaks.[326] Additionally, only cold water should be used for drinking and cooking, as hot water may have more dissolved lead.[122] Routine maintenance should also be performed, such as cleaning faucet aerators and installing certified low-lead materials.[122]

Statutes, Regulations, and Standards

The following statutes, regulations, and standards contain relevant information to lead and copper in drinking water, including the levels of contamination which should not be exceeded.

Relevant Statutes

Lead Contamination Control Act (LCCA) provides recommendations for identifying and addressing lead and copper at schools and childcare facilities.[324]

Reduction of Lead in Drinking Water Act prohibits the use or sale of lead pipes, solder, and flux, where 'lead-free' systems must demonstrate they contain less than 0.2 percent lead.[327]

Safe Drinking Water Act (SDWA) sets standards for drinking water including the control of contaminant levels, where lead and copper are regulated through the lead and copper rule.[328]

Relevant Regulations

MA Drinking Water Regulations, 310 CMR 22, control levels of various contaminants in drinking water and requires that levels remain under certain thresholds deemed health protective.[329] Such thresholds are set to the levels identified in the MA Maximum Contaminant Levels standard.

Lead and Copper Rule requires that drinking water is monitored for lead and copper and that levels remain below 15 ppb for lead and 1.3 ppm for copper.[330] Public water systems that exceed these action levels must undertake various control measures and inform stakeholders of how the contamination will be managed.

National Primary Drinking Water Regulations enforce primary standards and treatment techniques relevant to public water systems, where the maximum contaminant level for lead in copper are set to the federal action levels of 15 ppb and 1.3 ppm, respectively.[331]

Relevant Standards

MA Maximum Contaminant Levels sets levels for various contaminants in drinking water as required under MA 310 CMR 22, where levels for both lead and copper in public water systems are set to the federal action levels of 15 ppb and 1.3 ppm, respectively. These standards are for the entire system and not individual outlets such as those at schools if the school is part of a larger water system.[332]

National Sanitation Foundation (NSF)/ANSI/CAN 372 certifies low-lead plumbing products to have no more than 0.25 percent lead.[333]

Table 72 summarizes the statutes, regulations, and standards related to reducing exposure to lead in drinking water in schools outlined above.

Table 72. Statutory/Regulatory Framework and Notable Standards for Reducing Exposure to Lead in Drinking Water

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Statutes			
Lead Contamination Control Act (LCCA)		X	
Reduction of Lead in Drinking Water Act		X	
Safe Drinking Water Act (SDWA)		X	
Regulations			
Drinking Water Regulations, 310 CMR 22	X		
Lead and Copper Rule		X	
National Primary Drinking Water Regulations		X	
Standards			
MA Maximum Contaminant Levels			X
NSF/ANSI/CAN 372			X

Relevant Resources

Table 73 provides a summary of resources related to reducing exposure to lead in drinking water in schools.

Table 73. Resources for Reducing Exposure to Lead in Drinking Water

Resource	Author	URL
3Ts for Reducing Lead in Drinking Water	EPA	https://www.epa.gov/ground-water-and-drinking-water/3ts-reducing-lead-drinking-water
Drinking Water Quality	DPH	https://matracking.ehs.state.ma.us/Environmental-Data/Water-Quality/index.html
Drinking Water Quality Data	DPH	https://www.mass.gov/info-details/drinking-water-quality-data
Lead and Copper in School Drinking	MassDEP	https://www.mass.gov/info-details/lead-and-copper-in-school-drinking-water-sampling-results

Resource	Author	URL
Water Sampling Results		
Lead Contamination Control Act Program for Schools	MassDEP	https://leadandcoppercontrolact.donahue-institute.org/LCCA_Framework_4.26.18/story_html5.html
Lead in Drinking Water FAQ for Schools	DPH	https://www.mass.gov/info-details/lead-in-drinking-water-faq-for-school-and-childcare-facilities
Sampling for Lead and Copper at Schools	MassDEP	https://www.mass.gov/guides/sampling-for-lead-and-copper-at-schools-and-childcare-facilities
School and Child Care Lead Testing and Reduction Grant Program	US EPA	https://www.epa.gov/dwcapacity/wiin-grant-voluntary-school-and-child-care-lead-testing-and-reduction-grant-program
School Water Improvement Grants	MassDEP, Massachusetts Clean Water Trust	https://www.mass.gov/school-water-improvement-grants
Water-Smart Program	MassDEP	https://www.mass.gov/water-smart

2b(2) Reduce Exposure to PFAS in Drinking Water

Methods and Best Practices

The following best practices are aimed at identifying PFAS contamination in drinking water, remediating to reduce contamination, and eliminating sources of PFAS through green purchasing.

(1) Identify whether the school's drinking water source contains PFAS and conduct additional testing to determine the source of contamination whenever possible

An important first step in reducing exposure to PFAS in schools is to assess contamination in drinking water. All public water suppliers in Massachusetts are required to test for PFAS, whether the supplier is a community system or a school with its own well. If PFAS are detected, schools should contact MassDEP to identify appropriate next steps for addressing both long-term and short-term remediation strategies.

(2) Remediate sources of PFAS contamination and establish routine practices to minimize future contamination (long-term mitigation)

If the school is part of a larger public water system, the public water system is responsible for remediation actions to provide water to customers that complies with regulatory requirements. Long-term remediation by public water suppliers may include treatment to filter out PFAS or linking the water system to new sources of water that does not contain PFAS.[123] If the school is on well water, it is considered a public water system and, as such, is required to comply with the same state drinking water regulations (310 CMR 22). In such cases, schools can install activated carbon or reverse osmosis filters to treat water onsite.[124–126] The school should provide an alternative source of drinking water while installing a treatment system.

(3) Remediate sources of contamination and establish routine practices to minimize future contamination (short-term mitigation)

When PFAS contamination in local water sources cannot be immediately remediated, schools can switch to the use of bottled water as a temporary alternative.[124] DPH regulates bottled water in Massachusetts and—together with MassDEP—publishes a list of bottled water companies that have completed testing that demonstrates compliance with drinking water standards for PFAS.[126]

(4) Procure certified PFAS-free items as part of the school's green purchasing program

In addition to reducing PFAS in drinking water, efforts can be taken to reduce PFAS exposure in schools from everyday products. For example, New Hampshire has identified floor waxing and refinishing products as sources of PFAS in schools.[334] Schools should include PFAS as contaminants to monitor through their green purchasing program. This would entail procuring certified PFAS-free products for any food contact materials, cleaning products, classroom furnishings, flooring, paint, etc.[125] Note that Massachusetts has set goals to require reporting of PFAS in products by manufacturers and to phase out intentionally added PFAS in consumer products by 2030.[127]

Statutes, Regulations, and Standards

The following statutes, regulations, and standards control hazardous waste containing PFAS and set limits for these chemicals in drinking water and other matrices.

Relevant Statutes

MA Oil and Hazardous Material Release Prevention and Response Act, Ch. 21E regulates oil and hazardous waste contamination where cleanup standards set the limit to 20 ppt for the sum of perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorohexanesulfonic acid (PFHxS), hexafluoropropylene oxide dimer acid

(HFPO-DA), perfluorobutane sulfonate (PFBS), and perfluorononanoic acid (PFNA) in groundwater and 0.3-2 ppb in soil.[127]

Comprehensive Environmental Response, Compensation, and Liability Act designates PFOA, PFOS, and their salts and isomers as chemicals to be monitored for cleanup in the event of uncontrolled or abandoned hazardous waste.[335]

Relevant Standards and Regulations

PFAS National Primary Drinking Water Regulation sets a maximum contaminant level (MCL) standard in drinking water for five PFAS compounds where PFOA and PFOS are 4 ng/L and PFHxS, HFPO-DA, and PFNA are 10 ng/L.[336] Further, any given mixture of PFHxS, PFNA, HFPO-DA, and/or PFBS cannot exceed a hazard index of 1. This regulation also sets maximum contaminant level goals (MCLGs), which are non-enforceable health-based levels. The MCLGs were set to zero ng/L for PFOA and PFOS and 10 ng/L for PFHxS, HFPO-DA, and PFNA.

MA PFAS Drinking Water Standard (310 CMR 22.07: Per- and Polyfluoroalkyl Substances (PFAS) Monitoring and Analytical Requirements) has a current MCL of 20 ng/L for the sum of the concentrations of the following compounds: PFOA, PFOS, PFHxS, PFNA, PFHpA, and perfluorodecanoic acid.[337] MassDEP must adopt the national MCLs noted above and is considering additional information that could result in more stringent standards.

MA Drinking Water Standard (105 CMR 500.09: Standards for Bottled Water) requires laboratory results for source and finished water, including bottled water, to be under the MCL of 20 ng/L for the sum of the concentrations of the following compounds: PFOA, PFOS, PFHxS, PFNA, PFHpA, and perfluorodecanoic acid.[338] With regards to bottled water, manufacturers are to provide lab results annually showing that their finished water products meet these requirements.

Table 74 summarizes the statutes, regulations, and standards related to reducing exposure to PFAS in drinking water in schools outlined above.

Table 74. Statutory/Regulatory Framework and Notable Standards for Reducing Exposure to PFAS in Drinking Water

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Statutes			
MA Oil and Hazardous Material Release Prevention and Response Act, Ch. 21E	X		
Comprehensive Environmental Response, Compensation, and Liability Act.		X	
Standards and Regulations			
MA PFAS Drinking Water Standard (310 CMR 22.07)	X		X
MA Water Quality Standards (105 CMR 500.09)	X		
PFAS National Primary Drinking Water Regulation		X	X

Relevant Resources

Table 75 provides a summary of resources related to reducing exposure to PFAS in drinking water in schools.

Table 75. Resources for Reducing Exposure to PFAS in Drinking Water

Resource	Author	URL
Per- and Polyfluoroalkyl Substances (PFAS)	MassDEP	https://www.mass.gov/info-details/per-and-polyfluoroalkyl-substances-pfas
PFAS Free Buying Guider	MA Operational Services Division	https://www.mass.gov/news/pfas-free-buying-guide
PFAS in Drinking Water	DPH	https://www.mass.gov/info-details/per-and-polyfluoroalkyl-substances-pfas-in-drinking-water
Health Effects of PFAS	Agency for Toxic Substances and Disease Registry	https://www.atsdr.cdc.gov/pfas/health-effects/index.html
Key EPA Actions to Address PFAS	US EPA	https://www.epa.gov/pfas/key-epa-actions-address-pfas
Our Current Understanding of the Human Health and Environmental Risks of PFAS	US EPA	https://www.epa.gov/pfas/our-current-understanding-human-health-and-environmental-risks-pfas

Resource	Author	URL
PFAS Research: Extramural Funding Opportunities	US EPA	https://www.epa.gov/chemical-research/pfas-research-extramural-funding-opportunities
PFAS Resources, Data and Tools	US EPA	https://www.epa.gov/pfas/pfas-resources-data-and-tools

Objective 2c. Maintain Thermal Comfort

Methods and Best Practices

Methods and best practices for maintaining thermal comfort are described here, ranging from policy implementation, major changes to building HVAC systems, steps to consider for new construction, and steps that teachers can take within their classrooms.

(1) Establish and implement an extreme heat policy aligned with a completed climate vulnerability assessment

Climate change is contributing to more intense heat waves across Massachusetts and forcing schools to confront the challenge of managing an increased number of school days experiencing extreme heat.[339] Extended periods of hot weather can exacerbate underlying health conditions such as asthma and bronchitis, and prolonged exposure to high temperatures can impair cognitive function, learning, and academic performance. Using the results of a completed climate vulnerability assessment (see Objective 1f: Enhance Climate Resilience for additional details), schools should determine the need for, establish, and implement an extreme heat policy, where appropriate. An effective policy will outline a multi-pronged approach that considers relative humidity levels, appropriate air circulation, classroom temperature thresholds, appropriate hydration for students and staff, and necessary modifications to physical activities.[339]

(2) Keep classrooms at a comfortable temperature and humidity for learning

While no exact definition exists for “comfortable temperature,” what is typically thought of as a “comfortable temperature” will vary seasonally. Perceived heat and thermal comfort is also highly dependent on humidity, and as such, schools should strive to measure both temperature and humidity. There are several guidelines that schools can use to determine what a comfortable range of temperature and humidity is in their facilities. DPH recommends that classrooms be kept within the range of 70°F to 78°F and 40 to 60 percent relative humidity.[340] OSHA recommends that indoor workplace temperatures stay between 68°F and 76°F with humidity between 20 and 60 percent.[341] In addition, M.G.L., c. 149, § 113, which applies to workplace temperature, including schools, requires that workplaces be properly heated from October 15 to May 15.[342] During the heating season, DLS endorses keeping classrooms between 66°F and 68°F.[343] OSHA is currently developing a national standard for protecting workers during extreme heat, and recommendations for extreme heat in schools may change as the number of hot days increases.[344,345] Overall, schools should keep classroom temperature in the approximate range of 66°F to 78°F, as seasonally appropriate, and avoid extremely low and extremely high levels of humidity.

(3) Install air conditioning if temperatures regularly get above recommended levels (see best practice 1 above)

Some Massachusetts schools have begun installing air conditioning, which is the best way to reduce temperature and humidity in classrooms.[128,132] Schools have cited lack of air conditioning as driving the need for early dismissals and closures during hot conditions. Resources such as the National Best Practices Manual For Building High Performance Schools provide guidance for school design considering air conditioning requirements.[131,339,346]

(4) Maintain mechanical HVAC systems and balance systems as needed

For both heating and cooling systems, proper maintenance is essential. Schools should take steps to make sure their HVAC systems are operating properly, such as calibrating thermostats for accurate temperature control, balancing the system at least every five years using a third party specialist, and ensuring that air conditioning (AC) drip pans are properly draining and free of debris, all pipes are free of microbial growth, and window-mounted AC units are properly installed and maintained.[104,287]

(5) Proper heating and cooling in new construction

Given the increase in hot and humid days and the currently observed and anticipated future effects of climate change, schools should carefully consider projected heating and cooling needs, including air conditioning, when constructing a new building. School planners could consider passive heating and cooling systems, if thermal comfort can be maintained with these systems.[346] These systems aim to maximize heat from the sun in the winter and minimize this heat gain in the summer. Strategic window placement and shading play a large role in passive heating and cooling, prioritizing north-facing windows and shading those that face south.[346] Another way to improve the efficiency of heating or cooling systems in schools is to improve the building envelope (see Objective 1a. Decarbonize Buildings for additional details on building envelope improvements).

(5) Take simple steps to mitigate the effects of heat on health and learning

While established mechanical or passive cooling systems are most effective at reducing classroom temperature, school staff can take other interim steps to mitigate the negative effects of extreme heat on students and staff. Steps to mitigate heat include providing cool water for students and staff; reducing physical activity; improving air circulation (e.g., providing at least one fan per classroom); dimming or turning off lights; switching off unused electronics; opening windows (if cooler outdoors); closing shades to block solar radiation; and providing "cooling breaks" between instruction during which students can use misting fans, ice packs, or other cooling items.[131,339,347] Schools should develop a plan outlining which measures they will use to mitigate the effects of heat on health and learning during heat waves and extreme heat.

Statutes, Regulations, and Standards

Statutes, regulations, and standards that include a focus on improved thermal comfort are detailed below.

Relevant Statutes

M.G.L. c. 149, § 113 requires that workplaces, which includes schools, be properly heated from October 15 to May 15.[342]

Relevant Regulations

603 CMR 18.00 notes that room temperatures in rooms occupied by students should not be less than 68°F when it is 0°F outside and not more than the outdoor temperature when the outdoor temperature is above 80°F. This only applies to special education schools.[348]

Relevant Standards

ASHRAE Standard 55 outlines specifications for a combination of factors (temperature, thermal radiation, humidity, and air speed) that result in satisfactory thermal conditions for a majority of building occupants. The standard also provides criteria for evaluating comfort in existing buildings and calculation procedures for design compliance.[349]

Table 76 summarizes the statutes, regulations, and standards related to improving thermal comfort in schools outlined above.

Table 76. Statutory/Regulatory Framework and Notable Standards for Improving Thermal Comfort

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Statutes			
M.G.L. c. 149, § 113	X		
Regulations			
603 CMR 18.00	X		
Standards			
ASHRAE Standard 55			X

Relevant Resources

Table 77 provides a summary of resources related to improving thermal comfort in schools.

Table 77. Resources for Improving Thermal Comfort

Resource	Author	URL
Addressing Extreme Heat in Schools	MAPC	https://www.mapc.org/planning101/extreme-heat-air-quality-in-schools/
Extreme Heat Resource Guide	DPH, BCEH	https://www.mass.gov/doc/extreme-heat-resource-guide-pdf/download

Objective 2d. Use Integrated Pest Management

Methods and Best Practices

This section summarizes the methods and best practices for using integrated pest management in schools.

(1) Create an IPM plan

The Massachusetts Pesticide Control Act requires schools to:

- Adopt and implement an IPM plan
- File a copy of the IPM plan with the state
- Make a copy available to the public upon request
- Review the plan annually

The Massachusetts Department of Agricultural Resources (MDAR) has produced a model IPM plan that schools may adopt. School IPM plans must contain the following:

- Description of the school’s IPM communication and training programs for staff
- List of pesticides to be used
- List of non-pesticide control techniques and preventative methods to be used
- School location where the IPM plans and records are available for viewing

Schools are encouraged to further define routine service schedules and pest thresholds for which advanced action is taken.

(2) Perform routine and proactive pest service

A certified pest professional should proactively service all school spaces regularly. Schools may elect to hire an in-house technician or contract with a pest management company that practices IPM. At a minimum, the technician should:

- Report their pesticide applicator certification number
- Inspect for pest activity
- Inspect for structural, sanitation, or clutter concerns
- Place, remove, and replace traps, bait stations, and insect monitors; all should be dated
- Record the quantity, percent active ingredient, and trade name of any toxicant applied, and the weather conditions (if outdoors)
- Inquire with building occupants about any pest concerns
- Provide recommendations for resolving pest concerns

Any actions taken above should be recorded in a central data repository that is available to both the pest professional and administrative decision makers. It is critical that the **time** and **locations** for all observations are recorded so that problem areas can be identified at a later date. If a problem is identified during routine service, the technician should regularly service the space at an enhanced frequency until resolution. If the school has capacity, annual quality insurance inspections should be conducted to check the quality of the pest technician’s work.

The frequency of routine service should vary by space in accordance with the risks associated with each space. For instance, cafeterias should be serviced more frequently than administrative offices. Foodservice and childcare spaces are typically monitored at least weekly or biweekly, while office-like spaces are monitored quarterly or biannually. All spaces should be serviced by a technician at least twice a year.

(3) Field pest complaints from building occupants

Staff and students should be able to report any sighted pest activity to a central point of contact or reporting platform. A complete pest service request contains the reporter’s email, date and time of request, general type of pest or conducive condition observed, and a detailed location description. These details should be provided to the pest professional conducting routine pest service so that the technician can address the reported issue during their next scheduled visit, or if needed, during a sooner non-routine visit. The reporter should be notified that their complaint has been received and what action was taken to resolve their concern.

(4) Physically exclude pests

Preventing pests from entering facilities is the most effective way to reduce the need for chemical pesticide use in buildings. Physically exclude pests via the following methods:

- Seal utility entry points, cracks, and gaps in foundations, walls, and around windows. For larger openings, insert steel wool or mesh before sealing with caulk or foam.
- Check that windows and doors close completely.
- Install door sweeps on exterior doors. The housing and sweep should be cut on the "inside hinged" edge of the door and **not** the outer edge of the door.
- Install weep covers over window weep holes.
- Install screens in windows.
- Trim vegetation so that it does not touch building exteriors (vegetation should be 3 to 6 feet away from the building foundation).

While school maintenance teams may perform these exclusions, it is recommended that a trained pest professional performs pest exclusion.

(5) Perform pest sealing before final acceptance of new construction projects

Structural pests, such as rodents and certain insects, can migrate along utility and plumbing lines within building interiors. Before a new construction project is completed, a trained pest professional should perform pest sealing within building interiors to significantly reduce opportunities for pest mobility in buildings.

(6) Conduct pest-preventative repairs

Pest-preventative repairs should be implemented to address structural issues leading to pest proliferation. A trained pest professional may perform these repairs or in-house maintenance staff can be trained to do them. Below is guidance for common pest-preventative repairs:

- **Clean Drains:** Regularly clean drains to prevent the buildup of organic matter that can attract pests like flies and cockroaches. Inspect drains for the presence of standing water since drain water within otherwise "dry" areas (e.g., bathroom floor drains, mechanical room floor drains) may evaporate from the respective drain trap, creating an "open line" for sewer-dwelling pests such as American cockroaches, drain flies, phorid flies and other pests to emerge. If there is standing water present, and the drain sees a high volume of organic matter (such as shower drains in locker rooms or within food service areas), carefully remove drain covers, apply Biozyme enzymatic drain cleaner (or similar foaming drain cleaner) and scrub the inner walls of the drain to remove organic matter physically. Simply pouring hot water, bleach, or a foaming agent will not eliminate breeding sites. Mechanical organic matter removal is the only way to eliminate these breeding sites. Electric rotary brushes may also be used; stiff nylon bristles are preferred over steel bristles since the latter may damage older pipe walls.

- **Repair Water Leaks:** Fix leaks promptly to eliminate a water source that attracts pests and creates conducive conditions for mold. Standing water (even within the confines of a building) may invite mosquito breeding in as little as four days.
- **Manage Garbage Disposals:** Maintain and clean garbage disposals regularly to reduce odors and potential food sources for pests. In the event of a non-functioning or broken garbage disposal, it should be removed and replaced since organic matter collection will invite filth fly breeding. If a fly infestation occurs in a fully functioning disposal, the discharge line (from disposal to plumbing trap) as well as plumbing p-trap should be removed and brushed out to eliminate organic matter buildup and subsequent fly breeding sites. Biozyme enzymatic drain cleaner (or similar drain cleaner) may also be applied to make scrubbing easier.
- **Install Door Sweeps:** Properly install door sweeps to seal gaps at the bottom of doors, preventing entry for pests such as rodents and insects. Door sweeps should be bristled with aluminum housing and cut to allow for a 1/8" reveal on each side of the bristle sweep. Cut the housing and sweep on the "inside hinged" edge of the door and **not** the outer edge of the door. This practice will reduce cut hazards by mitigating sharp edges on the outermost edge of the door that may contact open-toed shoes of building occupants.

(7) Inspect buildings for conducive conditions

It is crucial to conduct annual, if not more frequent, building inspections for early detection and prevention of pest infestations. Additional inspections may be warranted throughout the year if significant changes to a building are expected to occur (e.g., façade renovation). Inspectors must keep detailed records of inspection findings, noting signs of pests, conducive conditions, or structural issues. Inspection may be conducted by a certified pest professional or facility manager. At a minimum, the inspection should include the elements outlined in Table 78:

Table 78. Recommended Elements of a Pest Inspection

Component	Recommended Action
Exterior Inspection	
Building perimeter	Check for cracks and gaps in the foundation, walls, and around windows and doors
Building perimeter	Ensure proper sealing of utility entry points
Landscaping	Check for overgrown vegetation touching the building
Landscaping	Check for proper grading and drainage to prevent water accumulation
Waste management	Inspect dumpsters and waste bins for cleanliness and confirm they have tight-fitting lids

Component	Recommended Action
Waste management	Assess whether waste is being removed at defined frequency
Entry points	Check doors and windows for proper sealing and functioning
Entry points	Inspect loading docks and entrances for signs of pests
Interior Inspection	
Structural integrity	Inspect walls, floors, and ceilings for cracks, holes, and other entry points
Structural integrity	Check for moisture issues, including leaks and condensation
Structural integrity	Check water fixtures for signs of pest activity, including drains, pipes and garbage disposals
Sanitation	Keep food storage and preparation areas clean and free of debris
Sanitation	Inspect restrooms and common areas for cleanliness
Sanitation	Inspect plants for pest presence
Waste Management	Verify that trash bins are emptied regularly and have tight-fitting lids
Waste Management	Check for proper disposal of waste, especially in food-related areas
Waste Management	Inspect recyclables for food waste materials
Storage Areas	Inspect storage areas for clutter
Storage Areas	Confirm food and beverages are stored in heavy duty metal or glass containers
Exclusion	Verify the condition of door sweeps, screens, and weather stripping
Pest Monitoring Devices	Check traps and monitoring and bait stations devices for pest activity
Pest Monitoring Devices	Confirm these devices are set correctly and have the date and location noted on the device
Pest Activity	
Rodents	Look for droppings, gnaw marks, and burrows
Rodents	Check for nesting materials
Insects	Check for live insects, dead insects, and insect droppings
Birds	Look for nests, droppings, and signs of roosting
Wildlife	Inspect for signs of raccoons, squirrels, and other wildlife intrusions
Findings and Recommendations	
Final summary	Summary of problem areas or practices identified during the building inspection to communicate with school administrators and other stakeholders

(8) Educate building occupants on best practices

Student and staff behaviors have a substantial impact on pest presence within schools. Therefore, they should be educated on how to report pest activity, what the school is doing to address pest concerns, and what they can do to prevent pest activity. Namely, students and staff can help by reducing food sources and clutter. The following instructions could be placed on flyers and distributed in classrooms and break rooms:

- Avoid eating and storing food in classrooms, offices, or cubbies.
- Wipe spilled food items off surfaces.
- Do not leave dirty dishes in classrooms, offices, and cubbies.
- Store food in sealed heavy plastic, metal, or glass containers.
- Rinse recyclables before placing them in recycling containers.
- Reduce clutter by removing or storing unused items.
- Check that the soil is free of pests before bringing a plant to the school.
- Dry out potted plants completely before watering.

Statutes, Regulations, and Standards

Relevant Statutes

M.G.L., c. 132B, §§ 2—6I regulates the distribution, sale, and use of pesticides within Massachusetts.[350]

Relevant Regulations

333 CMR 13.00 outlines conditions for the use of pesticides within Massachusetts.[351]

Table 79 summarizes the statutes, regulations, and performance standards related to IPM in schools.

Table 79. Statutory/Regulatory Framework and Notable Standards for Using Integrated Pest Management

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Statutes			
M.G.L., c. 132B, §§2—6I	X		
Regulations			
333 CMR 13.00	X		

Relevant Resources

Table 80 provides a summary of resources related to implementing IPM in schools.

Table 80. Resources for Using Integrated Pest Management

Resource	Author	URL
EPA Contacts: Region 1 IPM Coordinator	EPA	https://www.epa.gov/ipm/regional-ipm-contacts
Integrated Pest Management Programs	MDAR	https://www.mass.gov/info-details/integrated-pest-management-programs
Integrated Pest Management Six Step Approach	MDAR	https://www.mass.gov/info-details/integrated-pest-management-ipm-six-step-approach
Webinar: Pests of Public Health Importance and the Role of Integrated Pest Management in Schools	EPA	https://www.youtube.com/watch?v=mu8Q6XzGWpo

Objective 2e. Procure and Use Green Cleaning Supplies and Chemicals

Methods and Best Practices

The methods and best practices in this section focus on implementing a chemical management system and utilizing green chemicals to protect the health and safety of staff and students using chemicals in schools.

Chemical Management System

The following three best practices can assist in implementing a strong chemical management system within schools. Schools must use, store, and dispose of chemicals in a manner that minimizes the misuse of chemicals and ultimate exposure to hazardous substances by staff and students.

(1) Develop a school chemical management program

An important first step to minimize exposure to hazardous or mismanaged chemicals in schools is to develop a chemical management program, beginning with evaluating the current conditions of a school's use of chemicals and conducting an inventory of all chemicals present onsite.[133,352] A visual inspection should be performed to identify mismanaged chemicals, which are characterized by expired chemicals or those in poor condition (i.e., evident corrosion), unlabeled chemicals, mis-stored chemicals, and a lack of displayed safety information on the label.[101,133] A detailed chemical inventory should be noted, and any chemicals deemed unnecessary, expired, or posing a health, safety, or environmental risk should be appropriately disposed of.[99,101,133,287]

Additionally, attention should be paid to how chemicals are being physically stored and whether safety information is available.[99,101,133,287,353] Chemicals should be stored in an appropriate cabinet depending on their properties or chemical class, where acids and flammables are separated from other chemicals.[133,287,353] The storage cabinets should have shelving constructed to resist corrosion and include guardrails to prevent accidental slippage.[287,353] Designated chemical storage rooms should have dedicated exhaust ventilation systems to reduce the availability of chemical vapors.[133,353] Lastly, chemicals should always be easily identifiable via proper labeling mechanisms, and material safety data sheet (MSDS) information should be readily available.[99,101,287,353]

When disposing of hazardous chemicals, including electronics, follow guidance provided by MassDEP and local hazardous waste collection facilities that have been approved by MassDEP for collection. Massachusetts has a statewide contract (FAC110) in place to aid with hazardous waste disposal.

These practices should be put into place regularly for long-term adequate chemical use, storage, and disposal.

(2) Create an emergency and spill response plan

Another critical step in minimizing exposure to hazardous or mismanaged chemicals is to create an emergency and spill response plan. This should be a written plan describing what to do and who to contact in an emergency or spill.[99] The plan should include detailed information such as emergency response contact information, location of necessary supplies (e.g., spill kits), diagrams of facility grounds, evacuation and accountability plans, and communication plans or other means of alerting individuals.[99,133] Always call 911 in an emergency; however, the Massachusetts Emergency Response Line (1-888-304-1133) may also be a useful contact for answers to technical questions or assistance in determining if non-emergency situations warrant further action or reporting.[133,353]

(3) Form a chemical safety team and conduct adequate staff training

It is important to have a solid chemical safety team to oversee chemical management programs and emergency or spill response plans. The chemical safety team should coordinate and implement all strategic plans that minimize exposure to hazardous substances, promote chemical safety, and retain documents for long-term institutional memory.[133] The team should include diverse areas of expertise, where leadership and decision making roles are clearly defined.[352] Further, the team should conduct proper training for all staff and students who handle chemicals.[99,101] Training on emergency or spill response plans and MSDS and other chemical safety information should also be available.[99]

Green Cleaning Supplies/Chemicals

The following two best practices can help implement a green chemical purchasing policy and a plan effectively using such green chemicals. The goal of these practices is to decrease the amount of toxic chemicals used in schools and provide green alternatives.

(4) Implement a green chemical purchasing policy

A green chemical purchasing policy can help eliminate the purchase and use of unnecessary hazardous products and thus reduce overall risks to students and staff. An important first step may be to assess the current state of chemical purchasing to determine the chemicals currently being purchased and how they are being used.[99] Based on this information, the policy should be adapted to have defined quantities and types of chemicals approved for purchase.[99,133,287] Further, the policy should promote the use of less toxic or non-toxic chemicals and products.[99,133,134] Four top certifications to look for include Design for the Environment, Green Seal, Safer Choice, and UL ECOLOGO.[134] The approved chemical purchasing list should be created and maintained by the chemical safety and procurement teams and reviewed on a regular basis.

(5) Design a plan for green cleaning, sanitizing, disinfecting, and other daily practices plan

In addition to a green chemical purchasing policy, a plan that describes how these green chemicals can be used effectively in daily practices such as cleaning, sanitizing, and disinfecting will be helpful to schools. For example, some traditional cleaning agents are also hazardous substances that can irritate the respiratory tract and lead to unwanted side effects like triggering asthma symptoms.[134,299] However, ensuring that the alternative green cleaning agents are still effective in reducing the spread of infectious diseases is important and some sanitizing solutions, such as using only FDA-approved sanitizers on food preparation surfaces, may be required by regulation.[134] Thus, schools should develop a routine cleaning, sanitizing, and disinfecting schedule that details the green cleaning supplies and their respective procedures for use, as well as additional tools that can promote clean surfaces such as walk-off mats, microfiber cleaning cloths and mops, and HEPA or high-filtration vacuums.[134]

Statutes, Regulations, and Standards

The following statutes and regulations focus on the use, storage, and disposal of chemicals and provide information on chemical requirements that will be useful to schools.

Relevant Statutes

MA Hazardous Waste Management Act, Chapter 21C provides guidelines on how hazardous waste should be managed and requires the establishment of a hazardous waste advisory committee for the state of Massachusetts.[354] It also includes guidelines on hazardous waste collection, transportation, storage, treatment, and disposal.

MA Right-to-Know Act, Chapter 111F provides rights to public sector employees regarding information on toxic and hazardous substances.[355] Such rights include a labeling requirement that states that containers with toxic or hazardous substances must be labeled, a MSDS requirement that states public employers must maintain MSDS for all hazardous materials, required annual training for employees working with chemical products, and required Right-to-Know notices in the workplace.

MA Toxics Use Reduction Act, Chapter 21I promotes reducing the use of toxic chemicals to protect public health and the environment.[356] It includes requirements for reporting and planning and a fee structure for facilities that use large amounts of toxic chemicals. It also provides services such as education, training, grant programs, and technical assistance.

Relevant Regulations

Resource Conservation and Recovery Act (RCRA): This regulation gives EPA the authority to control hazardous waste including, generation, transportation, treatment, storage, and disposal.[357] Schools that generate hazardous waste are required to notify EPA where waste will be tracked throughout its lifecycle.

Table 81 summarizes the statutes, regulations, and standards related to procuring and using green cleaning supplies/chemicals in schools outlined above.

Table 81. Statutory/Regulatory Framework and Notable Standards for Procuring and Using Green Cleaning Supplies/Chemicals

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Statutes			
MA Hazardous Waste Management Act, Chapter 21C	X		
MA Right-to-Know Act, Chapter 111F	X		
MA Toxics Use Reduction Act, Chapter 21I	X		
Regulations			
RCRA		X	

Relevant Resources

Table 82 provides a summary of resources related to procuring and using green cleaning supplies/chemicals in schools.

Table 82. Resources for Procuring and Using Green Cleaning Supplies/Chemicals

Resource	Author	URL
About the Toxics Use Reduction Act Program	MA Executive Office of Energy and Environmental Affairs	https://www.mass.gov/guides/about-the-toxics-use-reduction-act-tura-program
Environmentally Preferable Products Procurement Program	MA Operational Services Division	https://www.mass.gov/environmentally-preferable-products-epp-procurement-program
Green Cleaning & Environmental Purchasing Programs	DPH, MAAP	https://www.maasthma.org/toolkit/green-cleaning
Massachusetts School Chemical Management Program	MassDEP	https://www.mass.gov/doc/massachusetts-school-chemical-management-program/download
Green Cleaning, Sanitizing, and Disinfecting Toolkit	Western States Pediatric Environmental Health Specialty Unit	https://wspehsu.ucsf.edu/main-resources/green-cleaning-sanitizing-and-disinfecting-a-toolkit-for-early-care-and-education/

Objective 2f. Reduce Exposure to Hazardous Substances

2f(1) Reduce Exposure to Lead in Paint and Soil

Methods and Best Practices

The following best practices focus on identifying sources of lead (outside of drinking water) in schools and implementing daily practices that can reduce student's exposure.

(1) Examine for lead paint and conduct renovations

In 1978, the Consumer Product Safety Commission banned the use of lead in paint; thus, if a school building was built prior to 1978, there is a chance that lead-based paint exists onsite.[99–101] The interior and exterior surfaces of the building, along with the surrounding soil, may be contaminated with flaking paint chips or dust containing lead particles.[99] Lead-based paint may also be present under newer layers of paint.[100] The only way to establish whether lead is present is to test. An accredited analytical laboratory or state-certified inspector should be used to test paint and soil for lead.[99,100]

If lead is detected, current or future renovation plans should take that into consideration. The Department of Labor Standards regulations require that (1) renovators provide a pre-renovation notification, (2) all individuals conducting the renovations must be trained and certified, and (3) lead-safe work practices must be followed and well documented if the school is considered a child occupied facility.[358] It is important to note that common renovation activities such as sanding, cutting, and demolition increase the spread of and subsequent exposure to lead particles.[100] Thus, vacating the building during renovations will likely be necessary.

(2) Implement a hand-washing routine after recess and before eating

Outside of inhaling contaminated dust, children are most likely to be exposed to lead via hand-to-mouth activity.[99] EPA has stated that washing hands with water and soap can effectively mitigate lead exposure.[359] Thus, it is essential to implement a hand-washing routine after playing outside and before eating to reduce the amount of accessible lead on children's hands.[101]

Statutes, Regulations, and Standards

The following regulations focus on setting requirements for removing lead paint and later renovations of buildings.

Relevant Regulations

105 CMR 460.000 establishes a statewide program for the prevention and control of lead poisoning. The regulation includes restrictions on the use of lead-based paints and glazes in school buildings.[360]

454 CMR 22.00 establishes regulations that require deleading and lead safe renovation requirements for residences and child-occupied facilities.[358]

TSCA Section 402 requires that activities related to preventing, detecting, and eliminating hazards associated with lead-based paint are performed by properly trained and certified individuals.[361]

TSCA Section 404 includes requirements on reporting and recordkeeping as it relates to any activities relevant to TSCA section 402.[361] Additionally, subsection G also provides guidance on grants that can be awarded to renovate buildings with lead-based paint.

TSCA Title 40, Chapter 1, Subchapter R, Part 745, Subpart E provides guidelines for renovations performed in residential and child-occupied facilities.[362] It also describes the requirements of pre-renovation education/notification, the certification details and responsibilities of renovators and sampling technicians, and work practice standards.

Table 83 summarizes the statutes, regulations, and standards related to reducing exposure to lead in paint and soil at schools outlined above.

Table 83. Statutory/Regulatory Framework and Notable Standards for Reducing Exposure to Lead in Paint and Soils

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Regulations			
105 CMR 460.000	X		
454 CMR 22.00	X		
TSCA Section 402		X	
TSCA Section 404		X	
TSCA Title 40, Chapter 1, Subchapter R, Part 745, Subpart E		X	

Relevant Resources

Table 84 provides a summary of resources related to reducing exposure to lead in paint and soil at schools.

Table 84. Resources for Reducing Exposure to Lead in Paint and Soil

Resource	Author	URL
Childhood Lead Poisoning Data	DPH	https://www.mass.gov/info-details/childhood-lead-poisoning-data

Resource	Author	URL
Childhood Lead Poisoning Prevention Program	DPH	https://www.mass.gov/orgs/childhood-lead-poisoning-prevention-program

2f(2) Reduce Exposure to Mercury

Methods and Best Practices

The following best practices focus on identifying mercury sources in schools and implementing safety plans in the event of a spill to reduce student exposure.

(1) Develop a mercury spill response plan

In schools where mercury-containing items are still in use, it is essential to minimize the chance that students and staff become exposed.[101] School administrators should create and distribute a mercury spill response plan and train appropriate staff to implement it in the event of a mercury spill.

Mercury is a toxic substance; if more than 2 tablespoons (approximately the size of an adult male thumb) of mercury has spilled, this is considered an environmental emergency.[363] Call 911 or MassDEP's 24/7 mercury spill hotline at 866-9MERCURY (866-963-7287).[136] Immediately, isolate the area of the spill to prevent foot traffic near the spill, turn off the HVAC system (or the appropriate zone in the HVAC system that serves the area of the spill), and evacuate the premises. Do not try to clean up the spill; wait for first responders to arrive.

Important Considerations for Mercury Spill Response and Cleanup

- It is critical to immediately isolate the area of the spill to prevent any further foot traffic through or near the affected area.
- Always apply PPE before attempting to clean the spill.
- Never attempt to clean a mercury spill with bare skin, vacuum cleaners, brooms, or mops.
- Never put mercury or mercury-contaminated items down the drain or in the trash.
- Always label contaminated items as containing mercury and treat them as hazardous waste.

If the spill is less than 2 tablespoons, it is not necessary to report it; the spill can be cleaned up following the appropriate procedures summarized below:[364]

1. Immediately isolate the area where the spill occurred to keep individuals away from the affected area.
2. Evacuate the premises and turn off the HVAC system.

3. Ventilate the area containing the spilled mercury by positioning a fan to blow air directly outdoors.
4. If the spill occurs on a hard, non-porous surface:
    a. Contain any visible mercury beads in a central location using a rigid material (e.g., squeegee, cardboard, thick paper).
    b. Collect the mercury beads into a plastic dustpan or using an eyedropper and transfer them to a wide-mouthed, plastic container with a screw-on lid.
    c. Once the visible mercury is removed, sprinkle sulfur powder on the impacted area. If the sulfur changes from yellow to brown, then mercury is still present.
    d. Once the area is determined to be mercury-free, clean the area with soap and water and discard all cleaning materials, clothing, PPE, or any other impacted materials.
5. If the spill occurs on hardwood, carpet, or any porous surface, the contaminated area should be removed and disposed of. If unsure of the most appropriate method for removing the impacted surface materials, schools should contact the MassDEP mercury hotline.
6. Following cleaning, ventilate the impacted area with the HVAC system shut off for at least 24 hours.

Rapid Surveillance and Contamination Tracing

As part of their mercury spill response plans, schools should include details for rapidly tracing all paths of potential contamination. This will help the school confirm all individuals that were in the vicinity of the spill event and take the necessary mitigation measure to prevent further contamination to other parts of the school or to students' homes. School staff should immediately isolate the area of the spill and identify all individuals (students and school staff) who were potentially exposed to mercury, including all people present at the spill and people who may have walked through the contaminated area before it was cleaned up. These individuals should be interviewed to determine the scope of possible exposure. Any contaminated clothing items and areas where they may have tracked mercury should be investigated for mercury contamination and cleaned up appropriately. This includes spaces within the school as well as outside of the school (e.g., hallways, cars, homes, washing machines). Where available, schools should utilize video camera footage to help identify the individuals in the vicinity of the spill.

(2) Maintain a mercury spill kit

Every school where mercury items are still in use should have a mercury spill kit available. Mercury spill kits typically include a mercury absorbent or amalgamation powder, clean-up tools, disposal bags, and appropriate PPE, such as thick nitrile gloves and goggles.

(3) Properly dispose of all mercury-containing items and replace with alternatives where possible

It is important to identify all mercury-containing items present in schools and to begin replacing them with alternatives wherever possible. An essential first step will be to conduct an inventory and locate all mercury-containing items.[101,365] These items may be located in science, art, home economics, HVAC and plumbing, automotive, or nursing and dental vocational classrooms.[366,367] Additionally, they may be used throughout the building or in medical/nurse's offices.[367]

Some of these mercury-containing items include thermometers/thermostats, barometers, hygrometers, hydrometers, manometers, vacuum gauges, spectral tubes, molecular motion devices, sling psychrometers, sphygmomanometers, elemental mercury, mercury-based compound solutions or powders, mercury gas law apparatuses, and float control switches, such as those used on sump pumps, vermillion paints, and fluorescent lamps.[366,367] Alternative products and practices can be introduced for each of these items. For example, digital, glass bulbs, spirit-filled, or tympanic thermometers are all effective alternatives to mercury-containing thermometers.[367]

As these products are replaced with alternatives, it is important to follow the appropriate safety steps. Mercury-containing items should always be placed in non-breakable, sealable containers and clearly labeled as hazardous before disposal.[365] It is important to use a licensed hazardous waste facility to recycle these items.[365] If needed, there are environmental service companies that can assist with removing mercury-containing items from schools. Contact the MassDEP's mercury hotline at 866-9MERCURY (866-963-7287) for assistance.[136]

Statutes, Regulations, and Standards

The following statutes and regulations set requirements for the use, storage, and disposal of mercury-containing items.

Relevant Statutes

M.G.L., c. 21H, § 6G restricts school from purchasing mercury-containing items to be used in the classroom.[368] Thermometers and measuring devices may be excluded if no adequate alternative exists.[368] Section 6G does not apply to the sale of mercury-containing lamps.[368]

M.G.L., c. 21H, § 6I restricts entities from knowingly disposing of mercury-containing items in a manner other than recycling, disposing as hazardous waste, or other state-approved methods.[369] Section 6I also calls for mandatory education on proper disposal of mercury-containing items for all citizens.[369]

Relevant Regulations

RCRA requires that EPA manage hazardous waste, including waste generated from the use, storage, and disposal of mercury-containing items.[370] Before these items can be disposed of, they must meet EPA's treatment and recycling standards. Current regulations require that low-mercury waste (<260 mg/kg total mercury) be treated to achieve 0.025 mg/L, as measured using the Toxicity Characteristic Leaching Procedure (TCLP).[371] Note that high-mercury waste (>260 mg/kg total mercury) must undergo retorting or roasting where the residuals produced after thermal processing must achieve 0.20 mg/L TCLP.[371]

Table 85 summarizes the statutes, regulations, and standards related to reducing exposure to mercury in schools outlined above.

Table 85. Statutory/Regulatory Framework and Notable Standards for Reducing Exposure to Mercury

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Statutes			
MA General Law, Chapter 21H, Section 6G	X		
MA General Law, Chapter 21H, Section 6I	X		
Regulations			
RCRA		X	

Relevant Resources

Table 86 provides a summary of resources related to reducing exposure to mercury in schools.

Table 86. Resources for Reducing Exposure to Mercury

Resource	Author	URL
24/7 Mercury Spill Hotline	MassDEP	866-9MERCURY (866-963-7287)
Mercury Spill Clean Up Procedure	DPH	https://www.mass.gov/info-details/mercury-spill-clean-up-procedure

Objective 2g. Safely Procure, Use, and Dispose of Crumb Rubber

Methods and Best Practices

This section summarizes the methods and best practices related to the procurement, use, and disposal of ATFs containing crumb rubber. The first section presents best practices for schools deciding whether to use an ATF and managing its use and disposal. The second section includes best practices for students, staff members, coaches, and families who play or attend events on ATFs.

Considerations and Practices for School Decision Makers and Field Maintenance Staff

This section discusses practices for schools deciding on whether or not to use ATFs and managing the use and disposal of an existing ATF.

(1) Consider the pros and cons of ATFs and natural grass when planning for field upgrades

When considering whether to install an ATF or natural grass playing field, school decision makers should consider the pros and cons of each. Materials in the resources section below may be helpful. School leaders should consider the following factors: installation and maintenance costs; individuals responsible for field maintenance; lifespan; disposal cost of an ATF; amount of space available; the direction and flow of runoff; whether small children will often be at this field; the typical temperatures during the sports season; the possibility of the urban heat island effect increasing temperature; the amount of use needed; and the availability of alternative fields if it rains. While some municipalities have banned ATFs, no statutes or regulations address ATFs at the state level; however, the Toxics Use Reduction Institute at UMass Lowell has identified organically managed natural grass as a safer alternative for sports surfaces.[138,372]

(2) Plan for and implement routine ATF maintenance

If a school has an ATF, it is essential to plan for and maintain it to keep it safe for students, staff members, and the environment. Maintenance may include disinfection; seam repairs; watering to lower temperatures on hot days; and fluffing, redistributing, shock testing, and replacing infill.[372] Over time, the shock absorbency of ATFs declines, meaning older turf can be less forgiving on joints and upon impact.[139,372] Regular maintenance and repair can help reduce the extent to which an ATF may contribute to injuries.

(3) Plan for and conduct proper disposal of ATFs at the end of their lifespan

Any school district that has an ATF or is planning to install one should plan for end-of-life disposal and the associated costs. Most municipalities have contractual arrangements with waste haulers, but those contracts may have restrictions on the types or volumes of waste. Disposal costs for ATFs will vary by waste contractor but may be substantial due to the size of an ATF. Improperly discarded ATF materials have been found in Massachusetts and have contaminated nearby streams with crumb rubber pellets and leached chemicals.[373]

Considerations and Practices for Students, Staff Members, and Families Playing on ATFs

Best practices discussed in this section apply to students, staff members, coaches, families, and school leaders when using ATFs for sporting events.

(4) Wear shoes on ATFs at all times

Wearing shoes eliminates dermal exposure to ATFs, which occurs when barefoot.[137] It also reduces the likelihood of getting crumb rubber stuck between the toes and tracking it into the home. This applies to students playing on the field, friends, family, and especially to any young children attending a sporting event.

(5) Do not swallow or allow small children to swallow crumb rubber

Students, staff members, and spectators should not swallow crumb rubber that accidentally enters the mouth.[137] If students playing on an ATF fall and get crumb rubber or plastic grass particles in their mouths, encourage them to spit it out. Monitor young children on ATFs to prevent them from swallowing or picking up crumb rubber particles.

(6) Increase ventilation at indoor ATF facilities

If an ATF is located indoors, increase ventilation if possible by opening windows and doors, turning on fans, and circulating air with outdoor air.[137] Indoor use of an ATF is generally thought to retain VOCs, SVOCs, or microplastic particles emitted by the ATF closer to the ground level where students play compared to outdoors where emissions are dissipated.

(7) Raise awareness of and protect against extreme heat exposure

In sunny, warm weather, the temperature of an ATF can be much hotter than the temperature of the air on natural grass fields, causing it to act as a heat island.[137,374] The hot temperature of an ATF can burn skin, damage equipment, and increase the risk of heat-related illness.[372] There are several methods to determine the temperature around ATFs. One heat metric, wet bulb globe temperature (WBGT), accounts for ambient air temperature, relative humidity, wind, and solar radiation, which can be helpful given that solar radiation heats ATFs. The Massachusetts Interscholastic Athletic Association 2019 heat policy is based on WBGT. However, WBGT does not capture the temperature of an ATF itself, so athletic staff may also want to measure the temperature of the ATF directly.[372]

Coaches and other staff should be educated about recognizing and preventing heat-related illnesses.[372] Prevention may mean providing additional water and shade breaks, monitoring for symptoms, changing practice times, and establishing a temperature and humidity threshold above which sporting activities on ATFs are canceled. Evidence shows that irrigating ATFs can reduce field temperatures for a short time, but temperatures rebound quickly in sunny conditions.[372,374] There is no standard approach to mitigating the intense heat that can be observed on ATFs, so each school should take appropriate steps to raise awareness of the ATF's heat, reduce ATF temperature, and prevent heat-related illness among students.

(8) Minimize passive recreation on ATFs

Minimize passive recreation on an ATF, such as laying and sitting.[137] Such activities put people physically closer to the ATF than playing sports and, unlike sporting practices and games, they are activities that do not have to happen on sports fields.

(9) Clean hands, clothing, equipment, and turf burns after playing on ATFs

School staff, athletic staff, and coaches should encourage students to clean up properly after playing on an ATF. Students should wash their hands after playing on an ATF and before eating, especially younger children who may have had more contact with the ground. When students arrive at home or go back to school, they should take off their shoes before going indoors to prevent tracking crumb rubber indoors. Students and parents should clean all clothes and equipment used on an ATF. If students have turf burns from falls on an ATF, they should be cleaned with soap and water.[137]

Statutes, Regulations, and Standards

No federal or state regulations or standards currently exist for ATFs.[4]

Relevant Resources

Table 87 provides a summary of resources related to procuring, using, and disposing of crumb rubber in schools.

Table 87. Resources Related to Procuring, Using, and Disposing of Crumb Rubber

Resource	Author	URL
Artificial Turf Fields (Fact sheet)	DPH	https://www.mass.gov/info-details/artificial-turf-fields
Athletic Playing Fields and Artificial Turf: Considerations for Municipalities and Institutions	TURI, UMass Lowell	https://www.turi.org/publications/artificial-turf/

[4] At the time of writing this report, House Bill 3948, "An Act Prohibiting State and Municipal Contracts for the Purchase and Installation of Artificial Turf Fields," was ordered for a third reading.

Resource	Author	URL
Athletic Playing Fields and Playgrounds	TURI, UMass Lowell	https://www.uml.edu/research/lowell-center/athletic-playing-fields/
Athletic Playing Fields: Choosing Safer Options for Health and the Environment	TURI, UMass Lowell	https://www.turi.org/publications/athletic-playing-fields-choosing-safer-options-for-health-and-the-environment/

Objective 2h. Create a Safe Environment for Students with Life-Threatening Food Allergies

Methods and Best Practices

This section presents methods and best practices for creating a safe environment for students with life-threatening food allergies related to developing written protocols, ensuring preparedness, and implementing prevention measures. Each of these methods and best practices are described in more detail below.

Develop Written Protocols

The following best practices concern creating plans for allergy planning and management.

(1) Develop an allergy management and prevention plan

School nurses should consider leading an interdisciplinary team to develop and implement an allergy management and prevention plan.[375] If schools are claiming exemption from other requirements of 105 CMR 590.011, schools must have written protocols and procedures for identifying, documenting, and accommodating students with food allergies. Allergy management and prevention plans should include cafeteria, classroom environmental, custodial, and emergency response protocols and guidelines. As necessary, allergen-free spaces should be designated in the cafeteria and in classrooms. Among other components, the plan should specify cleaning products and hand-washing protocols.[144]

(2) Develop and maintain individual health care plans

School nurses should maintain individual care plans for students with life-threatening allergies, which should include the actions to take if an allergic reaction occurs. Written 504 plans (plans to give kids with disabilities the support they need at school) personalized for each student with life-threatening allergies should also be written and implemented as appropriate.[376] As deemed necessary by school nurses, other school personnel supervising or providing services to the student in a high-risk setting (e.g., the cafeteria) should review and be aware of care plans.[144]

Facilitate Food Allergy Preparedness

The following best practices help schools prepare for severe allergic reactions.

(3) Conduct training on life-threatening allergies and emergency response

All staff who supervise students must receive basic training on life-threatening allergies and have education on the prevention and management of allergic conditions as it relates to their assigned duties.[144,375] The training must meet DESE and DPH requirements.

(4) Maintain a supply of epinephrine auto-injectors in a secure location

Each school should maintain an unexpired supply of epinephrine auto-injectors in a secure, unlocked location. All personnel approved to administer epinephrine to students should know of and have access to this location.[144] School bus drivers must receive training on the administration of epinephrine.[377]

Implement Prevention Measures

The following best practices can be implemented to reduce the likelihood that exposure to an allergen will cause an incident of anaphylactic shock at school.

(5) Prohibit eating food on school buses or in classrooms

To limit potential exposures, eating food on school buses should be prohibited, where possible. In addition, eating food in classrooms should be prohibited or limited to labeled approved foods. If food is allowed in classrooms, do not allow students to share food and encourage hand-washing before the consumption of food.[144,375]

(6) Prevent cross-contact in food

Cross-contact is the transfer of food allergens from one surface or food to another surface or food and can occur during food storage, preparation, or serving, as well as during dish cleaning or dining. Schools must create protocols to prevent cross-contact to protect people with food allergies. Measures to prevent cross-contact include storing allergen-free foods in a designated space; designating an allergen-free food preparation zone; fully cleaning and sanitizing containers, food preparation tools, and surfaces after each use with warm, soapy water; following strict hygiene procedures; discouraging students from sharing food; cleaning cafeteria tables after each use; and encouraging proper hand hygiene. In addition, allergen-free foods should be prepared before any allergen-containing foods.[144,375]

(7) Display a food allergen awareness poster

As required in M.G.L. c. 140, § 6B, schools must display an approved allergen awareness poster in food preparation areas to remind food preparation personnel of the importance of allergy-safe spaces and of common food allergens.[378]

Statutes, Regulations, and Standards

Statutes, regulations, and standards related to creating a safe environment for students with life-threatening food allergies are detailed below.

Relevant Statutes

M.G.L. c. 90, § 8A requires all licensed school bus drivers to complete a pre-service school bus driver training, including a basic first aid course including instruction on the administration of an epinephrine auto-injector.[377]

M.G.L. c. 71, § 55A limits the liability of public school employees who administer first aid in good faith as a result of their actions or omissions of first aid. M.G.L c. 90, § 8A specifically notes that this also applies to bus drivers providing first aid, including administration of an epinephrine auto-injector.[379]

M.G.L. c. 140, § 6B establishes food allergy awareness protocols for licensed food sellers. Requirements include the prominent display of a food allergy awareness poster, notice on all menus of the customer's obligation to inform the server about food allergies, and manager training on food allergies. Schools approved to participate in USDA Child Nutrition Programs may qualify for an exemption from parts of this law if schools can demonstrate the following:[380]

- There are written policies and procedures for identifying, documenting, and accommodating students with food allergies.
- There is documentation verifying participation in food allergen training that is recognized by DESE and DPH.

Americans with Disabilities Act (ADA), Title II prohibits discrimination against qualified individuals with disabilities participating in state and local government programs and services, including public schools. Life-threatening allergies are considered disabilities, and all public and charter schools are covered under this act.[155]

Rehabilitation Act of 1973, Section 504 enables individuals with a disability to fully participate in and receive the benefits of any program receiving federal financial assistance. Life-threatening allergies are considered disabilities, and most public schools will receive federal funding of some nature, including national school meal programs.[381]

Relevant Regulations

105 CMR 210.100 governs the administration of prescription medications in public and private schools in Massachusetts. Any properly trained school personnel may administer epinephrine in cases where the school nurse is not available, provided the school district registers with DPH.[382]

105 CMR 590.011 contains food allergy awareness requirements for all Massachusetts food establishments.[383] This regulation requires display of a food allergen poster, a notice requesting a customer to make the food establishment aware of an allergen, and mandatory training requirements. Public and private schools and educational institutions are exempt from these requirements if they are approved to participate in USDA Child Nutrition Programs. However, regardless of their participation in the USDA programs, schools must train employees in food allergy awareness and provide written policies and procedures for identifying and accommodating students with food allergies and documentation verifying participation in food allergen training satisfying DESE and DPH requirements.

CFR Title 10, Subtitle B, Chapter II, Subchapter A, Part 210 (National School Lunch Program) requires schools (as a condition for receiving federal reimbursement for school meals) to make substitutions for students whose disability restricts their diet and for students who cannot consume the regular lunch or afterschool snack because of medical or other special dietary needs. A physician or other recognized medical authority must provide a signed statement to make substitutions.[384]

Table 88 summarizes the statutes, regulations, and standards related to creating a safe environment for students with life-threatening food allergies in schools outlined above.

Table 88. Statutory/Regulatory Framework and Notable Standards Related to Creating a Safe Environment for Students with Life-Threatening Food Allergies

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Statutes			
M.G.L. c. 90, § 8A	X		
M.G.L. c. 71, § 55a	X		
M.G.L. c. 140, § 6B	X		
ADA, Title II		X	
Section 504, Rehabilitation Act of 1973		X	
Regulations			
105 CMR 210.000	X		
105 CMR 590.011	X		
CFR Title 10, Subtitle B, Chapter II, Subchapter A, Part 210 (National School Lunch Program)		X	

Relevant Resources

Table 89 provides a summary of resources related to creating a safe environment for students with life-threatening food allergies in schools.

Table 89. Resources Related to Creating a Safe Environment for Students with Life-Threatening Food Allergies

Resource	Author	URL
All About Allergies	Asthma and Allergy Network	https://allergyasthmanetwork.org/
Allergies and Anaphylaxis	National Association of School Nurses	https://www.nasn.org/nasn-resources/resources-by-topic/allergies-anaphylaxis
Back-to-School Headquarters	Food Allergy Research & Education	https://www.foodallergy.org/living-food-allergies/food-allergy-essentials/back-school-resource-hub
Food Allergen Awareness Training and Regulation (includes allergen awareness posters)	DPH	https://www.mass.gov/lists/food-allergen-awareness-training-and-regulation
Food Allergies & Intolerances Resources	John Stalker Institute	https://johnstalkerinstitute.org/resource/food-allergies-intolerances/
Food Allergies in Schools Toolkit	CDC	https://www.cdc.gov/healthyschools/foodallergies/toolkit.htm
Managing Life-Threatening Allergies in Schools	DESE	https://neusha.org/wp-content/uploads/2017/05/malta2016.pdf
Voluntary Guidelines for Managing Food Allergies in Schools and Early Care and Education Programs	CDC	https://www.cdc.gov/healthyschools/foodallergies/pdf/20_316712-A_FA_guide_508tag.pdf

Objective 2i. Create a Productive Learning Environment for All Students

2i(1) Optimize Lighting

Methods and Best Practices

The following best practices focus on enhancing natural and artificial lighting in schools to promote visual comfort in the classroom.

(1) Integrate both natural and artificial lighting throughout schools

High-quality lighting in the classroom should come from both natural and artificial sources because natural light can promote health benefits while artificial light can ensure appropriate illuminance.[145,385] The direction and amount of daylight that enters a space should be taken into account when designing the overall lighting system in the classroom.[145] Controls should be available to dim or turn off artificial lighting when sufficient daylight is available, and window shades should be available when daylight is excessive.[145]

(2) Consider illuminance, color temperature, and glare

In addition to natural and artificial lighting sources, it is important to consider factors such as illuminance, color temperature, and glare. An illuminance level of 350 lux is recommended for reading text in a normal-sized font with ease.[120] Research suggests, however, that 500-1,000 lux is more appropriate for the classroom.[385] Additionally, color temperature, measured as the thermal temperature of a light source, should be low to better mimic natural daylight.[120,385] Lastly, efforts should be taken to reduce or eliminate glare by considering how light enters the classroom and where it may hit reflective surfaces.[145] Further, using shades and blinds to control the amount of natural light that enters or modifying the brightness level of artificial light can be effective for minimizing glare.

Statutes, Regulations, and Standards

The following standard is focused on promoting high-quality lighting in educational facilities.

Relevant Standards

ANSI/IES RP-3-13 pertains to lighting in educational facilities and covers lighting design, quality, equipment, and energy controls.[386]

Table 90 summarizes the statutes, regulations, and standards related to optimizing lighting in schools outlined above.

Table 90. Statutory/Regulatory Framework and Notable Standards Related to Optimizing Lighting

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Standards			
ANSI/IES RP-3-13			X

Relevant Resources

Table 91 provides a summary of resources related to optimizing lighting in schools.

Table 91. Resources Related to Optimizing Lighting

Resource	Author	URL
K-12 Lighting Toolkit	DOE	https://betterbuildingssolutioncenter.energy.gov/k-12-lighting-toolkit

2i(2) Optimize Acoustic Performance

Methods and Best Practices

The following best practice focuses on creating optimal acoustic performance in the classroom by reducing reverberation time and background noise.

(1) Reduce Sound Reverberation Time and Minimize Background Noise in Classrooms

Schools should reduce sound reverberation times and eliminate background noise as much as possible for acoustic comfort in the classroom. Sound reverberation times can be reduced by increasing the number of sound-absorbing materials in the classroom.[387] For example, ceiling panels should have a minimum noise reduction coefficient of 0.70, meaning that 70 percent of the sound waves that strike the material is absorbed.[387]

Sound Reverberation Time

Sound consists of pressure waves that extend outward from the original source. Sound waves bounce off reflective surfaces such as the floor, walls, and ceiling, and gradually lose energy over time. “Reverberation” is defined as the collection of the reflected sounds. “Reverberation time” refers to the amount of time that it takes for the sound to fade away after the source of the sound has ceased.

Further, ceiling panels should have a high ceiling attenuation class value to reduce the noise traveling through walls.[387] Walls should also be constructed with sufficient insulation to reduce noise transmission.[388] Flooring can also assist in absorbing sound waves; for example, carpeting, in particular, can reduce overall background noise.[387] Lastly, HVAC units can be one of the primary sources of background noise in a classroom.[145,387] Centralized systems have reduced noise levels as compared to window units; thus, these systems should be employed where possible, and air handlers or any other equipment should be installed away from classrooms and near inherently noisy areas such as cafeterias and gymnasiums.[387]

Statutes, Regulations, and Standards

The following standard addresses classroom acoustics and sets limits for optimal speech intelligibility.

Relevant Standards

ANSI/ASA S12.60 addresses reverberation time and background noise limits in the classroom.[387]

Table 92 summarizes the statutes, regulations, and standards related to optimizing acoustic performance in schools outlined above.

Table 92. Statutory/Regulatory Framework and Notable Standards Related to Optimizing Acoustic Performance

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Standards			
ANSI/ASA S12.60			X

Objective 2j. Design the Built Environment to Foster a Peaceful School Community

Methods and Best Practices

Methods and best practices for designing the built environment to foster a peaceful school community are organized into three categories. The first focuses on reducing stressors resulting from the built environment, the second focuses on designing spaces in school buildings to support overall well-being, and the third focuses on designing spaces that facilitate positive social interactions at school.

Reduce Stressors

Reducing stressors from the built environment reduces tension experienced by students and school staff members, an important step to facilitate a peaceful atmosphere. Schools can reduce stressors associated with the built environment by reducing crowding and environmental stressors.

(1) Reduce crowding

Crowding in schools can increase stress and the likelihood of pushing/shoving, leading to further negative outcomes. [389–391] Schools should provide building spaces that are sufficiently wide enough to accommodate students and staff members to reduce crowding and resulting adverse outcomes. Areas to focus on include bathrooms, locker rooms, hallways, stairways, entrances and exits to buildings, classrooms, and other school spaces.

(2) Reduce environmental stressors

Environmental stressors such as noise, excessive lighting, poor air quality, and uncomfortable temperatures are, by definition, stressful to the human body. Optimizing environmental conditions reduces these stressors and improves well-being.[392–394] Best practices include using natural lighting through windows and skylights, acoustics to minimize stressful noises, maintaining thermal comfort, and ensuring air is free of pollutants or unpleasant odors. See Objective 2a. Improve Air Quality, Objective 2c. Maintain Thermal Comfort, and Objective 2i. Create a Productive Learning Environment for All Students for additional details and best practices for mitigating this collection of environmental stressors.

Design Spaces to Support Wellbeing

Designing spaces to support wellbeing promotes positive experiences within the school environment and enables students and staff members to be at their best, which, in turn, supports a peaceful school community. Schools can meet this objective by providing spaces to support neurocognitive balance, incorporating access to both indoor and outdoor nature, and using colors and textures that promote a peaceful environment.

(3) Provide spaces to support neurocognitive balance

Indoor and outdoor facility design can calm or activate people's neurological and cognitive systems in various ways—by promoting alertness, agitation, vigilance, distraction and calmness. For schools, the design goal is two-fold: to design facilities that support neurocognitive balance and, where possible, to provide specific spaces that are calming (when students' minds and nervous systems are over-activated) or activating (when students' minds and nervous systems are shut down).[392,393] In addition, some students benefit from indoor and outdoor spaces that satisfy their need for physical movement. See Objective 3b. Prioritize Universal Accessibility for additional discussion of the design of neuro-inclusive spaces.

(4) Incorporate access to both indoor and outdoor nature

Schools should provide students and staff with access to nature in diverse forms (e.g., visual, tactile). This can include nature-related art, windows with nature views, and live plantings—both indoors and outdoors. Access to nature has been shown to have important stress-relieving benefits and supports overall wellbeing,[389,393–395] which in turn contributes to a peaceful community.

(5) Use colors and textures that promote a peaceful environment

Color choices and textures facilitate calming environments supportive of learning and positive interactions.[392,395] Schools should incorporate textures and colors appropriate for each space, considering how these materials will impact students' experiences.

Design Spaces to Facilitate Positive Social Interactions

Designing spaces to facilitate positive social interactions supports the type of engagement that fosters a sense of community within the school. Schools can achieve these design goals by providing diverse communal spaces and designing spaces for students and staff members to move easily.

(6) Provide diverse communal spaces

Schools should provide diverse communal spaces to facilitate positive engagement among students and staff members. Spaces of different shapes, sizes, and purposes will allow students with different needs to engage with others in a safe space.

(7) Design spaces for easy movement

Feeling safe is a critical component of promoting positive social engagement. Schools should use care in the layout of school buildings to design spaces that facilitate easy movement of students and staff. Layouts that can trap students in a corner or nook can make them feel less safe, given the loss of freedom of movement. While designing space, consider traffic patterns in areas of congestion (e.g., hallways, stairwells).

Statutes, Regulations, and Standards

Statutes, regulations, and standards provide baseline requirements and expectations for topics relevant to fostering a peaceful school community. These include fire regulations, building code occupancy limits, and minimum standards regarding environmental conditions such as temperature, noise, air quality, and lighting. These frameworks are designed with a different objective than the primary objective of fostering a peaceful school community, which goes far beyond the minimum expectations of specific statutes and regulations. Therefore, these are not covered in detail in this section. See Objective 2a. Improve Air Quality; Objective 2c. Maintain Thermal Comfort; and Objective 2i. Create a Productive Learning Environment for All Students for additional details regarding relevant statutes, regulations, and standards.

Relevant Resources

Table 93 provides a summary of resources related to designing and using space to safely manage the flow of occupants in schools.

Table 93. Resources Related to Designing the Built Environment to Foster a Peaceful School Community

Resource	Author	URL
Schools That Heal, Design with Mental Health in Mind	Claire Latane	https://islandpress.org/books/schools-heal#desc

VIII. Additional Details Related to Goal 3: Achieve Equitable Outcomes for All Students

This section presents the following content:

- A more detailed narrative description of the methods and best practices presented in Goal 3: Achieve Equitable Outcomes for All Students (Section IV)
- A narrative and tabular summary of the relevant statutory/regulatory framework and notable standards
- A tabular summary of relevant resources that can help school districts across the Commonwealth achieve green schools

Content is provided across the following three objectives:

a. Optimize space to equitably meet special education needs
b. Prioritize universal accessibility
c. Use available data to identify and equitably prioritize schools of greatest need and advocate for additional funding opportunities

Objective 3a. Optimize Space to Equitably Meet Special Education Needs

Methods and Best Practices

This section summarizes the methods and best practices for optimizing space to meet special education needs equitably in schools.

(1) Design inclusive classrooms

Inclusion classrooms contain students with and without disabilities, incorporating supports for students in need of special education services. Students who receive special education in a full inclusion setting spend 80 to 100 percent of their day in a general education setting, while students with partial inclusion spend 40 to 80 percent of their day in general education.[396] Inclusion classrooms are often, but not always, the least restrictive learning environment for students receiving special education. In Massachusetts, 18 percent of students are eligible for special education services; of those students, approximately 60 percent are placed in an inclusion classroom.[397]

Inclusion classrooms benefit students both with and without disabilities. A review of special education in Massachusetts found that students with disabilities placed in inclusion settings were five times more likely to graduate high school in five years or fewer compared to their peers placed in substantially separate settings.[149] A study completed in 2021 found that students without disabilities also benefit from inclusion classrooms.[398] Maximizing the impact of inclusive classrooms requires designing classrooms with diverse learning needs in mind.

Student placement should always be based on individual needs rather than available space.[153] Existing schools are somewhat limited by existing classroom space; however, schools undergoing renovations or being newly constructed should prioritize designing inclusive classrooms. Inclusion classrooms should be large enough to accommodate push-in services, like small breakout groups.[396] When pull-out services are required, resource rooms, which can be smaller, should be in the vicinity of general classrooms.[396]

In some cases, substantially separate classrooms are the most appropriate learning environment to meet student needs. Inclusion practices for substantially separate classrooms involve locating these classrooms within general education neighborhoods, ensuring rooms are the same size as general education classrooms, and placing students of similar ages and grade levels together.[396] Additionally, gymnasiums, auditoriums, art rooms, and any other room that might supplement general education should be accessible to students in substantially separate settings to maximize inclusion opportunities when appropriate.

(2) Avoid clustering special education spaces

Massachusetts state regulations require that all eligible students have access to the school facilities necessary for implementing a student's IEP.[399] State regulation also requires that steps are taken to minimize the stigmatization of students receiving special education.[399] Classrooms designed to serve students with disabilities, like resource rooms or substantially separate classrooms, should never be clustered away from the age-appropriate general education neighborhood.[396,399] To meet the LRE mandate, schools must ensure every student, regardless of disability, has access to the general education curriculum and environment whenever possible. Special education classrooms should not be identifiable by signs or other means that differentiate them from classrooms that serve non-disabled students.[399]

Existing schools should evaluate how classrooms are dispersed throughout the school to determine if special education classrooms are clustered or located outside of age-appropriate classroom neighborhoods. This evaluation should also ensure that special education classrooms are not identified by signs or other means that stigmatize students.

Schools undergoing renovation and new schools should plan classroom neighborhoods to maximize the inclusion of special education services. These schools should consult with UD experts (see best practice 3) to develop plans that optimize the school layout so every student can access the general education environment, where appropriate. Gymnasiums, auditoriums, and other elective classrooms and extracurricular spaces should be accessible to every student in the school community, including students in substantially separate classrooms.

(3) Prioritize principles of universal design

UD challenges the typical design approach for the "average user" and focuses on developing designs with accessibility at the forefront.[400] This is accomplished by creating designs and products that are usable, accessible, and inclusive.[400] Universal design in learning (UDL) is an instructional approach aimed at creating a more inclusive learning environment by providing adequate accommodations and eliminating unnecessary barriers to the learning process.[401,402] Together, UD and UDL improve accessibility by guiding the development of buildings as well as the development of computers, computer software, curriculum, instruction, and a host of other products and services. Schools that incorporate principles of UD and UDL are better equipped to serve students, staff members, and visitors with and without disabilities.[400,403]

Existing schools are limited by their physical structure and layout; however, there are still ways to incorporate UD and UDL without renovations, especially in classroom settings.[404,405] Classrooms can be equipped with more physically accessible furniture and furniture layouts. This can include upgrading to larger desks and ensuring desks and chairs are not connected. Some resources for removing existing barriers and incorporating elements of UD are included in Table 95.

Schools undergoing extensive renovations and newly constructed schools should incorporate UD from the planning stage. The construction of Danahey Park in Cambridge, MA, is an example of a project that incorporated UD from the planning stage—ensuring the park is physically accessible while also accommodating the sensory, cognitive, and emotional needs of users.[406]

(4) Collaborate within and across districts

With adequate planning, larger school districts in urban and suburban areas can ensure that most students receive placements in the LRE within their district. Only some schools will be able to serve students with the highest needs; with proper planning, however, school districts can coordinate the placement of special education services throughout the district. These services should be dispersed across the district to ease accessibility for all.

In some cases, districts may only be able to meet the needs of some students. This is more common in smaller and rural districts with limited resources; however, this can also be challenging for larger districts. Collaboration across districts can help maximize efficiencies when serving students with the highest needs. Massachusetts has 24 Education Collaboratives across the Commonwealth designed to increase regional capacity and resources.[407] Similar coordination should occur across collaboratives to meet every student's needs. When out-of-district placements are determined to be the best option for servicing a student's IEP and transportation is a requirement on the student's IEP, the student is entitled to receive transportation.[151]

Statutes, Regulations, and Standards

Relevant Statutes

M.G.L., c.71B: Children with Special Needs guarantees all school-aged children (ages 3 to 21) in Massachusetts a "free and appropriate public education in the least restrictive environment" regardless of disability.[152] This statute is formerly known as M.G.L. c.766, which pre-dated federal special education legislation.[152]

20 U.S.C §§ 1400-1482 Individuals with Disabilities in Education Act guarantees free and appropriate public education to all eligible children with disabilities throughout the nation. This statute protects the rights of children with disabilities and assists states, localities, and other entities with providing those services.[150]

29 U.S.C. § 794 Section 504 of the Rehabilitation Act of 1973 protects the rights of individuals with disabilities to access any program or activity that receives federal funding, including schools.[381,408]

Relevant Regulations

603 CMR 28.00: Special Education guides the implementation set forth in state statute (M.G.L. c.71B), federal statute (20 U.S.C. § 1400 *et seq.*), and federal regulations (34

CFR Part 300 *et seq*) in Massachusetts schools so students receive services designed to develop their individual potential in the least restrictive environment.[151,399]

34 CFR Part 300: Assistance to States for the Education of Children requires that children with disabilities receive educational and other services in the least restrictive environment. Removal of a student from an inclusion setting only happens if inclusion cannot be achieved with supplementary aids and services due to the nature or severity of the disability.[409]

Relevant Standards

Continuum of alternative services and placements: School districts must provide or arrange for the placement of each student in an educational setting appropriate for their learning needs from the time they are three to 21 years old.[410]

Equal opportunity to participate in educational, nonacademic, extracurricular, and ancillary programs, as well as participation in regular education: Students receiving special education in both inclusion and substantially separate settings must have equal opportunity to participate in additional programs, classes, and extra-curricular activities offered to students in a general education setting.[410]

Least restrictive program selected: Students must be placed in programming with the least restrictive environment. If a student is removed from the general education classroom, there must be a clear explanation for why the less restrictive environment is appropriate for the student's needs.[410]

MA Local Education Agency (LEA) Special Education Determinations: DESE determines the needs for assistance or intervention in special education for every Local Education Agency (LEA). LEAs are scored based on performance and compliance data from multiple sources and given one of the following determinations: Meets Requirements, Needs Assistance, Needs Intervention, or Needs Substantial Intervention.[411]

Special education facilities and classrooms. School districts must provide facilities and classrooms that maximize the inclusion of special education students in the school community. These facilities and classrooms must provide appropriate accessibility for the implementation of each student's IEP and must be equal in all physical respects to the average general education setting.[410]

Table 94 summarizes the statutes, regulations, and standards related to optimizing space to equitably meet special education needs in schools.

Table 94. Statutory/Regulatory Framework and Notable Standards for Optimizing Space to Equitably Meet Special Education Needs

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Statutes			
M.G.L. c.71B: Children with Special Needs	x		
20 U.S.C §§ 1400-1482		x	
29 U.S.C. § 794 Section 504 of the Rehabilitation Act of 1973		x	
Regulations			
603 CMR 28.00 Special Education	x		
34 CFR Part 300 Assistance to States for the Education of Children		x	
Standards			
Continuum of Alternative Services and Placements			x
Equal Opportunity to Participate in Educational, Nonacademic, Extracurricular, and Ancillary Programs, as well as Participation in Regular Education			x
Least Restrictive Program Selected			x
MA LEA Special Education Determinations			x
Special Education Facilities and Classrooms			x

Relevant Resources

Table 95 provides a summary of resources related to optimizing space to meet special education needs equitably.

Table 95. Resources for Optimizing Space to Equitably Meet Special Education Needs

Resource	Author	URL
Special Education continuum of services and design considerations – rules of thumb	MSBA	https://www.massschoolbuildings.org/sites/default/files/edit-contentfiles/About_Us/Roundtables/Designer/Handouts.pdf

Objective 3b. Prioritize Universal Accessibility

Methods and Best Practices

This section describes the methods and best practices for prioritizing universal accessibility in schools. Prioritizing universal accessibility is addressed in three sections:

- Physical Disabilities: Design Physically Accessible Spaces
- Transgender, Non-Binary, and Intersex Experience: Design Gender-Inclusive Spaces
- Neurodivergence: Design Neuro-Inclusive Spaces

Physical Disabilities: Design Physically Accessible Spaces

This section describes the methods and best practices for creating accessible and safe spaces for students with physical disabilities.

(1) Evaluate barriers to physical access

Ensuring physical accessibility in schools is necessary to meet legal requirements and to guarantee students full access to the school community. By minimizing barriers to physical access, school districts across Massachusetts can better serve their students. Minimizing barriers to physical access requires understanding the barriers that exist. Not all physical barriers are legal violations since the ADA includes certain exemptions; however, ensuring all students have equal access to a free education in a least restrictive environment requires school districts to minimize as many physical barriers to learning as possible. Whether a school is planning to undergo renovations or not, school districts, administrators, educators, and other staff members should be aware of existing barriers to physical access and develop plans to mitigate or eliminate those barriers.[404] It's important to note that not every solution will work for every school or classroom; however, all schools should strive to improve physical accessibility whenever feasible.

There are formal and informal methods to evaluate the physical accessibility of the school. Formal audits of school accessibility can be costly. However, schools or school districts can perform evaluations using in-house staff and resources. The "ADA Checklist for Existing Facilities" (see Table 97) is a helpful checklist that summarizes the accessibility requirements in the Department of Justice's ADA Title II regulations, 28CFR Part 35.150.[412] This checklist includes information on how to use the checklist and conduct the survey, as well as post-survey activities. Since the survey was developed for use in multiple places of public accommodation, not every section of the survey is relevant to school facilities. Moreover, the survey does not cover classroom-specific features, such as ensuring accessible paths through desks and lab spaces, which schools should also consider.

(2) Prioritize universal access to school buildings

No two schools will have the same results following an accessibility evaluation. The ADA Checklist covers many of the barriers to physical access that schools need to address. A study from the U.S. Government Accountability Office on the accessibility of school facilities found that two-thirds of school districts identified barriers that can limit access to people with disabilities in a quarter or more of their school facilities.[413] The top five barriers found across school facilities are listed below.[413]

- Lack of accessible signs
- Playground barriers (e.g., mulch or other ground surface barriers)
- Door hardware that requires tight grasping, pinching, or twisting of wrist
- Assembly stages requiring steps
- Restroom barriers (e.g., lack of bathroom grab bars or exposed sink pipes)

The following are best practices schools should consider to provide universal access.

(2a) Update signage

ADA Standards call for accessible signs to identify spaces and accessibility elements in public areas.[414] Schools should update or add visual and tactile signs to identify permanent rooms and spaces, provide directional information, indicate accessibility, and highlight means of egress in compliance with ADA Sign Standards.

(2b) Update door handles

ADA Standards require door handles to be operable with one hand, not require tight grasping, pinching, or twisting of the wrist, operate with five pounds of maximum force, and be located 34-48 inches off the ground.[415] Schools with non-compliant door handles should invest in upgrades.

(2c) Update doors (i.e., remove heavy doors, add automatic door openers, etc.)

Doors and gates that provide accessible routes for user passage are required to comply with ADA Standards. Compliance guidelines for doors and entryways cover requirements for maneuvering clearance, thresholds, surface texture, hardware, viewing, opening force, and closing speed.[415]

(2d) Add ramps and chair lifts

Ramps and chair lifts can help make entryways more accessible when modifying the building or adding an elevator is not possible. ADA Standards define the necessary safety elements, slope, and landing requirements for ramps,[416] as well as the requirements for lifts.[417]

(2e) Update bathroom infrastructure (i.e., sinks, stalls, etc.)

Bathrooms that do not meet ADA Standards should be altered for compliance. Existing facilities have multiple avenues for ensuring adequate access to ADA-compliant bathrooms.[418] Bathroom updates for accessibility can also incorporate design elements to increase gender-inclusive access to maximize the benefits of updates.

Transgender, Non-Binary, and Intersex Experience: Design Gender-Inclusive Spaces

This section describes the methods and best practices for creating safe and inclusive school environments for transgender, non-binary, and intersex students.

(3) Evaluate gender-based rules, policies, and practices

Students in Massachusetts are protected from discrimination based on gender identity and sexual orientation.[156,419] Schools and school districts should review their policies and procedures to eliminate rules that perpetuate gender-based discrimination. This includes examining policies around student records, bathroom and changing facility access, dress codes, and any other gender-based policies.

(4) Provide access to gender-inclusive restrooms, locker rooms, and changing facilities

All students should have access to a restroom, locker room, and changing facility that aligns with their gender identity. If students do not feel safe accessing a facility, an appropriate alternative should be made available. For existing facilities, this can include changing a staff restroom to an all-gender restroom or providing access to the restroom in the nurse's office.

Newly constructed and renovated schools should strive to incorporate UD principles from the planning stage forward. Restrooms, locker rooms, and changing facilities designed around gender inclusion benefit everyone because they increase privacy, physical accessibility, and safety.[420]

Neurodivergence: Design Neuro-Inclusive Spaces

This section describes the methods and best practices for creating safe and inclusive school environments for neurodivergent students.

(5) Evaluate the school's sensory landscape

Students spend much of their day at school. The sensory environment of a school impacts all students; however, for some neurodivergent students, the sensory environment has a larger impact.[421,422] The sensory environment includes the school building's visual, auditory, and tactile stimuli. Currently, there are no readily available sensory evaluation guides, but there is information on how to create sensory-friendly environments that can inform how to design for the sensory experience (see Table 97).

(6) Design with sensory experiences in mind

Designing spaces to accommodate the sensory needs of neurodiverse students benefits all students. Existing schools will be limited when addressing specific sensory needs since the physical environment is somewhat set. Existing schools can prioritize minimizing excessive visual, auditory, and tactile stimuli where possible. This can involve replacing harsh light fixtures, installing sound-dampening materials, and changing other elements of the environment (see Objective 2i. Create a Productive Learning Environment for All Students for additional details about optimized lighting and acoustics). In addition to making these changes, existing schools can create sensory spaces designed to support the needs of neurodivergent students best.[423]

Newly constructed and renovated schools should consult experts on creating sensory-friendly spaces throughout the school. From hallways to cafeterias and classrooms, every student deserves to be in an environment designed to meet their needs. Thoughtfully designing with neuro-inclusion can help decrease changes necessitated by overstimulation and increase the time students spend with their peers focusing on the task at hand, whether that is eating lunch, playing at recess, or learning in the classroom.[424]

Statutes, Regulations, and Standards

Relevant Statutes

M.G.L. c.71 § 37D Public Schools: Racial Imbalance defines the condition of racial imbalance in Massachusetts public schools as the condition in which more than 50 percent of students attending a school are non-white. This law also defines racial balance, racial isolation, and exempt school. It describes the rights of non-white students attending racially imbalanced schools.[152]

M.G.L. c.76 § 5 Place of Attendance; Violations; Discrimination states that every person has the right to attend public schools in their town of residence and prevents exclusionary or discriminatory admissions practices based on race, color, sex, gender identity, religion, national origin, or sexual orientation.[152]

Massachusetts Act of 2011, c. 199 Section 1, An Act Relative to Gender Identity amends Section 7 of chapter of the M.G.L. to define gender identity and provide guidance on how gender-related identity can be shown with evidence including, but not limited to, medical history, care or treatment of gender-related identity, or consistent and uniform assertion of the gender identity.[425]

20 U.S.C. §1681-§1688. Title IX of the Education Amendment Act of 1972. Programs or activities that receive federal financial assistance cannot exclude from participation, deny benefits, or discriminate on the basis of sex. This also protects people from discrimination based on their gender identity and sexual orientation.[150]

42 U.S.C.c.126 § 12101 et seq., Americans with Disabilities Act of 1990 provides a national mandate that prohibits discrimination of individuals with disabilities, clearly lays out enforceable standards, and establishes a central role for the government in enforcing those standards.[155]

Relevant Regulations

521 CMR 12.00, Architectural Access Board: Educational Facilities regulates accessibility of public and private schools and other educational facilities across the Commonwealth. All administrative and instructional spaces shall comply with the regulations as well as any areas open to students or the general public.[426]

603 CMR 26.00, Access to Equal Educational Opportunity requires that students at public schools of the Commonwealth have equal rights of access and opportunities during their course of study at public schools and that public schools do not discriminate based on race, color, sex, gender identity, religion, national origin, or sexual orientation. This law takes precedence over any local law or rule or organization's regulation that discriminates on the aforementioned basis.[419]

28 CFR Part 35, Title II Regulations, Nondiscrimination on the Basis of Disability in State and Local Government guarantees the rights of people with disabilities to fully participate in all aspects of civic life by requiring all state and local governments to follow ADA regulations regardless of municipality's size.[412]

28 CFR Part 36, Title III Regulations, Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities guarantees the rights of people with disabilities to participate fully in all aspects of life by requiring most businesses to follow ADA regulations regardless of the size of their business or the age of the building.[427]

34 CFR Part 106, Title IX Regulations, requires the adoption of grievance procedures to ensure complaints of sexual discrimination receive fair, prompt, and equitable resolutions. Expands the meaning and clarifies the definition of sex discrimination to include discrimination based on sex stereotypes, sex characteristics, pregnancy or related conditions, sexual orientation, and gender identity.[428]

Relevant Standards

2010 ADA Standards for Accessible Design describes the requirements that must be met when constructing new buildings and facilities or altering existing buildings and facilities. Defines architectural barriers and explains how to remove them without difficulty or expense to an existing building.[429]

Table 96 summarizes the statutes, regulations, and standards related to prioritizing universal accessibility.

Table 96. Statutory/Regulatory Framework and Notable Standards for Prioritizing Universal Accessibility

Statute/Regulation/Standard	State Statute/ Regulation	Other Statute/ Regulation	Standard
Statutes			
Massachusetts Act of 2011, c. 199 Section 1, An Act Relative to Gender Identity	X		
M.G.L., c.71 § 37D, Public Schools: Racial Imbalance	X		
M.G.L., c.76 § 5, Place of Attendance; Violations; Discrimination	X		
20 U.S.C. §1681-§1688, Title IX of the Education Amendment Act of 1972		X	
42 U.S.C.c.126 § 12101 et seq., Americans with Disabilities Act of 1990		X	
Regulations			
521 CMR 12.00, Architectural Access Board, Educational Facilities	X		
603 CMR 26.00, Access to Equal Educational Opportunity	X		
28 CFR Part 35, Title II Regulations, Nondiscrimination on the Basis of Disability in State and Local Government		X	
28 CFR Part 36, Title III Regulations, Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities		X	
34 CFR Part 106, Title IX Regulations		X	
Standards			
2010 ADA Standards for Accessible Design			X

Relevant Resources

Table 97 provides a summary of resources related to ensuring universal access in schools.

Table 97. Resources for Ensuring Universal Access

Resource	Author	URL
ADA Checklist for Existing Facilities	Institute for Human Centered Design	https://www.adachecklist.org/doc/fullchecklist/ada-checklist.pdf
Design Strategies for Restroom & Locker Room Facilities	Opsis Architecture	https://www.opsisarch.com/wp-content/uploads//2022/06/Opsis-

Resource	Author	URL
		Architecture-Gender-Inclusive-Facilities-Design-Strategies-Case-Study.pdf
Harmonizing the seen and unseen when designing for neurodiversity	Brenda Bush-Moline, Stantec	https://www.stantec.com/en/ideas/topic/buildings/harmonizing-the-seen-and-unseen-when-designing-for-neurodiversity
K-12 Education: School Districts Need Better Information to Help Improve Access for People with Disabilities	Government Accountability Office	https://www.gao.gov/assets/d20448.pdf
Universal Design in Education: Principles and Applications	Disabilities, Opportunities, Internetworking, and Technology	https://www.washington.edu/doit/universal-design-education-principles-and-applications

IX. Conclusion

Massachusetts led the nation with the creation of the oldest public school system in the United States. While that legacy is a testament to our commitment to the betterment of our citizens, this legacy also leads to Massachusetts having an antiquated school infrastructure that is dispersed across a range of geographic locations including urban, rural, and those close to industrial activity. As this report demonstrates, the complexity and the interdependency of the types of problems these schools and districts face, as well as the complexity and interdependencies of the short-term and long-term solutions to address these problems is highly variable and, in some instances, require significant resources. This document strives to provide both high-level and detailed explanations of strategies to help Massachusetts schools incorporate sustainable design, construction, and operations and provide a healthy environment for all staff and students.

Appendix A: References

1. Massachusetts Department of Public Health. (n.d.). *About the Department of Public Health*. Retrieved August 8, 2024, from https://www.mass.gov/info-details/about-the-department-of-public-health
2. Kreslová, M., Kirchnerová, O., Rajdl, D., Sudová, V., Blažek, J., Sýkorová, A., Jehlička, P., Trefil, L., Schwarz, J., Pomahačová, R., & Sýkora, J. (2022). Bronchial Asthma as a Cardiovascular Risk Factor: A Prospective Observational Study. *Biomedicines*, *10*(10), 2614. https://doi.org/10.3390/biomedicines10102614
3. Massachusetts Department of Public Health. (n.d.). *2022–2026 Strategic Plan for Asthma in Massachusetts*. Retrieved July 25, 2024, from https://www.mass.gov/doc/strategic-plan-for-asthma-in-massachusetts-2022-2026/download
4. Massachusetts Department of Public Health. (2023). *Massachusetts Health Data Tool*. https://healthdatatool.mass.gov/
5. National Geographic. (2023, October 19). *First Public School in America*. https://education.nationalgeographic.org/resource/first-public-school-america
6. Town of Dedham. (n.d.). *Dedham's History*. Retrieved June 25, 2024, from https://www.dedham-ma.gov/services/dedham-historical-society
7. Race Forward. (n.d.). *Historical Timeline of Public Education in the US*. Retrieved June 25, 2024, from https://give.raceforward.org/give/419664/#!/donation/checkout?eg=true&egp=do&egfa=true
8. the English High School Association. (2021, July 9). History of The English High School. *The English High School Association*. https://englishhighalumni.org/2021/07/09/history-of-the-english-high-school/
9. FutureEd. (2023, August 28). *Historical Milestones in American Education*. FutureEd. https://www.future-ed.org/u-s-education-timeline/
10. WorldAtlas. (2018, August 30). *Where is the Oldest High School in America?* https://www.worldatlas.com/articles/oldest-public-high-schools-in-the-united-states-still-in-use.html
11. Richard, B. (2024, March 22). *Massachusetts Home to 28 of 100 Oldest High Schools in America*. 1420 WBSM. https://wbsm.com/massachusetts-oldest-high-schools/
12. Massachusetts Department of Elementary and Secondary Education. (n.d.). *School and District Profiles*. Retrieved June 26, 2024, from https://profiles.doe.mass.edu/search/search.aspx?leftNavId=11238
13. Massachusetts Department of Elementary and Secondary Education. (n.d.). *School and District Profiles, General, 2023-24 Enrollment Data*. Retrieved July 29, 2024, from https://profiles.doe.mass.edu/general/generalstate.aspx?topNavID=1&leftNavId=100&orgcode=00000000&orgtypecode=0
14. National Geographic. (n.d.). *Urban Area*. Retrieved August 8, 2024, from https://education.nationalgeographic.org/resource/urban-area
15. MA State Office of Rural Health. (n.d.). *MA State Office of Rural Health Rural Definition*. https://www.mass.gov/doc/rural-definition-detail-0/download#:~:text=%2D%20Urbanized%20Areas%20(UAs)%20are,of%202%2C500%20to%2050%2C000%20people.
16. US EPA, O. (2014, February 28). *Heat Island Effect* [Collections and Lists]. https://www.epa.gov/heatislands
17. U.S. EPA, Region 3. (2020, August). *Lead in Soil*. https://www.epa.gov/sites/default/files/2020-10/documents/lead-in-soil-aug2020.pdf
18. Ratcliffe, M., Burd, C., Holder, K., & Fields, A. (2016, December). *Defining Rural at the U.S. Census Bureau*. U.S. Department of Commerce, Economics and Statistics

Administration, U.S. Census Bureau. https://www2.census.gov/geo/pdfs/reference/ua/Defining_Rural.pdf
19. Health Resources and Services Administration. (2024, January). *Defining Rural Population*. https://www.hrsa.gov/rural-health/about-us/what-is-rural
20. *USDA ERS - Rural Classifications*. (2024, March 26). https://www.ers.usda.gov/topics/rural-economy-population/rural-classifications/
21. Berkshire Regional Planning Commission. (n.d.). *Massachusetts Rural Policy Plan*. Berkshire Regional Planning Commission. Retrieved August 8, 2024, from https://berkshireplanning.org/initiatives/massachusetts-rural-policy-plan/
22. Executive Office of Energy and Environmental Affairs. (2022, December). *2022 Massachusetts Climate Change Assessment*. https://www.mass.gov/info-details/massachusetts-climate-change-assessment#read-the-report-
23. Rural Schools Advocacy in Massachusetts. (n.d.). *Rural Needs and Information Sources*. Rural Schools Advocacy in Massachusetts. Retrieved July 8, 2024, from https://www.ruralschoolsma.org/info
24. Grossman, E. (2016, November 10). 12,000 U.S. schools are within a mile of a hazardous chemical facility. What should we do about that? *Ensia*. https://ensia.com/features/schools-hazardous-chemical-facilities/
25. Meng, Y. (2020). Schools near Toxics Release Inventory Sites: An Environmental Justice Study for Schoolchildren in Boston, MA. *Cybergeo: European Journal of Geography*. https://doi.org/10.4000/cybergeo.34682
26. US EPA, O. (2015, September 23). *What is Vapor Intrusion?* [Overviews and Factsheets]. https://www.epa.gov/vaporintrusion/what-vapor-intrusion
27. Massachusetts School Building Authority. (2024). *About Us | Massachusetts School Building Authority*. https://www.massschoolbuildings.org/about
28. Massachusetts School Building Authority. (n.d.). *Needs Survey FAQs*. Retrieved June 26, 2024, from https://www.massschoolbuildings.org/programs/needs_survey/FAQs
29. Trial Court Law Libraries. (2024, May 10). *963 CMR 2.00: School building grant program*. https://www.mass.gov/regulations/963-CMR-200-school-building-grant-program
30. *Chapter 70B: School Building Assistance Program*. (n.d.). Retrieved June 17, 2024, from https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXII/Chapter70B
31. Massachusetts School Building Authority. (n.d.). *Reimbursement Rate Calculation*. Retrieved September 24, 2024, from https://www.massschoolbuildings.org/sites/default/files/edit-contentfiles/Guidelines_Forms/Pro-Pay/Reimbursement-Rate-Calculation-UPDATE%20with%20changes.pdf
32. The General Court of the Commonwealth of Massachusetts. (2022, August 11). *Session Law—Acts of 2022 Chapter 179*. https://malegislature.gov/Laws/SessionLaws/Acts/2022/Chapter179
33. Alliance. (n.d.). *Green & Healthy Schools Academy—Green Building Alliance*. Retrieved December 12, 2024, from https://www.gba.org/initiatives/green-healthy-schools-academy/
34. The White House. (2024, April 26). *Fact Sheet: Biden-Harris Administration Hosts First-Ever White House Summit for Sustainable and Healthy Schools*. The White House. https://www.whitehouse.gov/briefing-room/statements-releases/2024/04/26/fact-sheet-biden-harris-administration-hosts-first-ever-white-house-summit-for-sustainable-and-healthy-schools/
35. Baillie, T. (2024, May 30). *Webinar Recap: Making the Honor Role with K-12 Waste Reduction*. Busch Systems Blog. https://www.buschsystems.com/blog/webinars/webinar-recap-k-12-waste-reduction/

36. New Buildings Institute. (n.d.). *Decarbonizing School Buildings – the Building Electrification Technology Roadmap*. Retrieved July 24, 2024, from https://drive.google.com/file/d/1yPyI994sR9BLtcrYCtul5Q47Jlwygtb7/view
37. Massachusetts Clean Energy Center. (n.d.). *Green School Works*. Retrieved July 24, 2024, from https://www.masscec.com/program/green-school-works
38. *2023 Stretch Energy Code Update and Municipal Opt-in Specialized Code*. (2022, September 22).
39. *Massachusetts Climate Report Card—Buildings Decarbonization*. (n.d.). Retrieved June 17, 2024, from https://www.mass.gov/info-details/massachusetts-climate-report-card-buildings-decarbonization
40. *Massachusetts Clean Energy and Climate Plan for 2025 and 2030*. (2022, June 30). https://www.mass.gov/doc/clean-energy-and-climate-plan-for-2025-and-2030/download
41. *Executive Order No. 594: Leading By Example: Decarbonizing and Minimizing Environmental Impacts of State Government*. (n.d.). Retrieved June 13, 2024, from https://www.mass.gov/executive-orders/no-594-leading-by-example-decarbonizing-and-minimizing-environmental-impacts-of-state-government
42. Mills, R. (2024, May 22). *The Retrofit Playbook for Large Buildings*. RMI. https://rmi.org/the-retrofit-playbook-for-large-buildings/
43. Torcellini, P., Zaleski, S., & McIntyre, M. (2021). *Affordable Zero Energy K-12 Schools: The Cost Barrier Illusion* (No. NREL/TP-5500-80766, 1837979, MainId:77550; p. NREL/TP-5500-80766, 1837979, MainId:77550). https://doi.org/10.2172/1837979
44. US EPA. (2024, May 24). *About WaterSense*. https://www.epa.gov/watersense/about-watersense
45. U.S. Department of Agriculture, National Drought Mitigation Center at the University of Nebraska-Lincoln, & National Oceanic and Atmospheric Administration. (2024). *Time Series | U.S. Drought Monitor*. https://droughtmonitor.unl.edu/DmData/TimeSeries.aspx
46. Massachusetts Energy and Environmental Affairs and Massachusetts Emergency Management Agency. (2023). *Massachusetts Drought Management Plan Preparedness & Response*. https://www.mass.gov/doc/massachusetts-drought-management-plan/download
47. Runkle, J., K.E. Kunkel, R. Frankson, D.R. Easterling, A.T. DeGaetano, B.C. Stewart, W. Sweet, and J. Spaccio. (2022). *Massachusetts State Climate Summary 2022* (No. NOAA Technical Report NESDIS 150-MA). https://statesummaries.ncics.org/downloads/Massachusetts-StateClimateSummary2022.pdf
48. Alliance for Water Efficiency. (2022). *2022 State Policy Scorecard for Water Efficiency and Sustainability*. https://www.allianceforwaterefficiency.org/sites/default/files/assets/AWE%202022%20Scorecard%20Full%20Report.pdf
49. US EPA. (2023, November 22). *National Overview: Facts and Figures on Materials, Wastes and Recycling* [Overviews and Factsheets]. https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials
50. US EPA. (2024, April 25). *Basic Information about Landfill Gas* [Overviews and Factsheets]. https://www.epa.gov/lmop/basic-information-about-landfill-gas
51. US EPA. (2024, February 21). *Municipal Solid Waste Landfills* [Overviews and Factsheets]. https://www.epa.gov/landfills/municipal-solid-waste-landfills
52. Rosenberg, D., Singla, V., & Hoover, D. (2021, July 19). Burned: Why Waste Incineration Is Harmful. *Burned: Why Waste Incineration Is Harmful*. https://www.nrdc.org/bio/daniel-rosenberg/burned-why-waste-incineration-harmful

53. Massachusetts Department of Environmental Protection. (2023). *2022 Solid Waste Data Update November 2023*. https://www.mass.gov/doc/2022-solid-waste-data-update/download
54. Massachusetts Department of Environmental Protection. (2023). *Greenhouse Gas Baseline & Inventory, Appendix C: Massachusetts Annual Greenhouse Gas Emissions Inventory: 1990-2020, with Partial 2021 & 2022 Data* [Dataset]. https://www.mass.gov/lists/massdep-emissions-inventories#greenhouse-gas-baseline-&-inventory-
55. *Massachusetts 2030 Solid Waste Master Plan: Working Together Toward Zero Waste*. (2021). https://www.mass.gov/doc/2030-solid-waste-master-plan-working-together-toward-zero-waste/download
56. *National Household Travel Survey*. (n.d.). Federal Highway Administration. Retrieved July 22, 2024, from https://nhts.ornl.gov/
57. *The Longer Route To School*. (2021, January 12). Bureau of Transportation Statistics. https://www.bts.gov/topics/passenger-travel/back-school-2019
58. *Why We Need to Transition to Electric School Buses | Electric School Bus Initiative*. (2022, October 17). Electric School Bus Initiative. https://electricschoolbusinitiative.org/why-we-need-transition-electric-school-buses
59. North Shine, K. (2023, April 10). *Upgraded school buses linked to increased student attendance*. University of Michigan News. https://news.umich.edu/upgraded-school-buses-linked-to-increased-student-attendance/
60. Liu, N. M., & Grigg, J. (2018). Diesel, children and respiratory disease. *BMJ Pediatrics Open*, *2*(1). https://doi.org/10.1136/bmjpo-2017-000210
61. *EDF_School_bus_pollution_studies.pdf*. (n.d.).
62. *EDF: ELECTRIC SCHOOL BUSES: GOOD FOR THE ENVIRONMENT AND THE BOTTOM LINE*. (n.d.).
63. Curran, A. (2023, April 17). *All About Total Cost of Ownership (TCO) for Electric School Buses | Electric School Bus Initiative*. Electric School Bus Initiative. https://electricschoolbusinitiative.org/all-about-total-cost-ownership-tco-electric-school-buses
64. Boloor, M., Valderrama, P., Statler, A., & Garcia, S. (2019, July 31). *Electric Vehicle Basics*. NRDC. https://www.nrdc.org/bio/madhur-boloor/electric-vehicle-basics
65. Muller, J. (2022, December 19). *Electric school buses are practically free now*. Axios. https://www.axios.com/2022/12/19/electric-school-buses
66. *All About Range and Reliability | Electric School Bus Initiative*. (n.d.). Electric School Bus Initiative. Retrieved July 17, 2024, from https://electricschoolbusinitiative.org/all-about-range-and-reliability
67. Ashmore, R. (2023, October 18). School Bus Drivers Discuss Real-Life Experiences Driving Electric Buses. *School Transportation News*. https://stnonline.com/special-reports/school-bus-drivers-discuss-real-life-experiences-driving-electric-buses/
68. Freehafer, L., Lazer, L., & Zepka, B. (2024). *The State of Electric School Bus Adoption in the US*. https://www.wri.org/insights/where-electric-school-buses-us
69. *Electric School Buses*. (n.d.). NYSERDA. Retrieved July 17, 2024, from https://www.nyserda.ny.gov/All-Programs/Electric-School-Buses
70. *Tracking Electric School Bus State Legislation | Electric School Bus Initiative*. (2023, September 19). https://electricschoolbusinitiative.org/tracking-electric-school-bus-state-legislation
71. *70 Municipal Officials Sign Letter to the Governor in Support of School Bus Electrification | Sierra Club*. (n.d.). Retrieved July 17, 2024, from https://www.sierraclub.org/massachusetts/blog/2024/02/70-municipal-officials-sign-letter-governor-support-school-bus

72. *Accelerating Clean Transportation (ACT) School Bus: Overview | MassCEC*. (n.d.). Massachusetts Clean Energy Center. Retrieved July 17, 2024, from https://www.masscec.com/accelerating-clean-transportation-act-school-bus-overview
73. *About*. (n.d.). MOR-EV.Org. Retrieved July 23, 2024, from https://mor-ev.org/about
74. *Eligible Trucks*. (n.d.). MOR-EV.Org. Retrieved July 23, 2024, from https://mor-ev.org/eligible-vehicles-trucks
75. *All About Operating Electric School Buses in Cold Weather | Electric School Bus Initiative*. (2024, February 27). Electric School Bus Initiative. https://electricschoolbusinitiative.org/all-about-operating-electric-school-buses-cold-weather
76. *Cold Weather Impacts on Electric School Buses*. (n.d.). Joint Office of Energy and Transportation.
77. Ellis, T. (2021, November 16). Alaska's first electric-powered school bus is performing well – even at 40 below. *Alaska Public Media*. https://alaskapublic.org/2021/11/16/alaskas-first-electric-powered-school-bus-is-performing-well-even-at-40-below/
78. Dumont, A., & Burgoyne-Allen, P. (2023, August 25). *The Electric School Bus Series: Successfully Operating in Cold Weather in Three Rivers, Michigan | Electric School Bus Initiative*. https://electricschoolbusinitiative.org/electric-school-bus-series-successfully-operating-cold-weather-three-rivers-michigan-0
79. *Hot Weather Impacts on Battery-Electric Transit Buses*. (n.d.). Joint Office of Energy and Transportation.
80. Eisenstein, P. (2019, February 7). *AAA confirms what Tesla, BMW, Nissan EV owners suspected of cold weather*. CNBC. https://www.cnbc.com/2019/02/06/aaa-confirms-what-tesla-bmw-nissan-ev-owners-suspected-of-cold-weather.html
81. Nelson, G. (2024, April 30). *Michigan schools receive $24 million to buy electric buses*. Bridge Michigan. https://www.bridgemi.com/michigan-environment-watch/michigan-schools-receive-24-million-buy-electric-buses
82. Matthews, K. (2021, March 6). *Total Cost of Ownership: Determining if Electric Buses are Right for Your District*. First Student, Inc. https://firststudentinc.com/resources/electric/total-cost-of-ownership-determining-if-electric-buses-are-right-for-your-district/
83. Burget, S. (2022, September 2). EV eligible funding in IIJA and IRA represents nearly 30 times the total EV funding awarded by U.S. government to date. *Atlas EV Hub*. https://www.atlasevhub.com/data_story/3-billion-in-federal-funding-for-evs-to-date/
84. Slowik, P., & Isenstadt, A. (2024, January 26). U.S. electric vehicle sales soar into '24. *International Council on Clean Transportation*. https://theicct.org/us-ev-sales-soar-into-24-jan24/
85. Pierce, L., & Slowik, P. (2024, March 13). Assessment of U.S. electric vehicle charging needs and announced deployment through 2032. *International Council on Clean Transportation*. https://theicct.org/publication/assessment-of-us-ev-charging-needs-and-announced-deployment-through-2032-mar24/
86. *Charger Types and Speeds | US Department of Transportation*. (2023, June 22). US Department of Transportation. https://www.transportation.gov/rural/ev/toolkit/ev-basics/charging-speeds
87. *Electric School Bus Guidebook—Guide 3: Charger Purchasing*. (n.d.). NYSERDA. https://www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Programs/Electric-School-Bus/Electric-School-Bus-Charger-Purchasing.pdf
88. *Frequently Asked Questions (FAQs) | Electric School Bus Initiative*. (n.d.). Electric School Bus Initiative. Retrieved July 17, 2024, from https://electricschoolbusinitiative.org/frequently-asked-questions-faqs

89. *Research on Health Effects, Exposure, & Risk from Mobile Source Pollution | US EPA*. (2024, May 7). EPA. https://www.epa.gov/mobile-source-pollution/research-health-effects-exposure-risk-mobile-source-pollution
90. Dellinger, A. (n.d.). *Peak and Off-Peak Energy Explainer: Here's the Cheapest Time to Use Electricity*. CNET. Retrieved July 17, 2024, from https://www.cnet.com/home/energy-and-utilities/peak-and-off-peak-energy-explainer-heres-the-cheapest-time-to-use-electricity/
91. Lee, J. (n.d.). *Thieves target electric vehicle charging stations, likely for copper in cables: Officials*. Fox29. Retrieved July 17, 2024, from https://www.fox29.com/news/thieves-target-electric-vehicle-charging-stations
92. Pape, P. (2024, April). *Protect Your EV Charging Station from Vandals*. NACS - Magazine. https://www.nacsmagazine.com/Issues/April-2024/Protect-Your-EV-Charging-Station-from-Vandals
93. Massachusetts Executive Office of Energy and Environmental Affairs. (2023). *ResilientMass Plan—Chapter 1 Introduction*. https://www.mass.gov/doc/resilientmass-plan-chapter-1-introduction/download
94. *Extreme Weather, School Closures, and Lost Learning Time*. (n.d.). UndauntedK12. Retrieved July 17, 2024, from https://www.undauntedk12.org/lostlearningtime
95. Massachusetts Executive Office of Energy and Environmental Affairs. (2023). *ResilientMass Plan*. https://www.mass.gov/doc/resilientmass-plan-2023/download
96. *Water, Water, Everywhere: The Increasing Threat of Stormwater Flooding in Greater Boston*. (n.d.).
97. *MEPHT | Asthma Overview*. (n.d.). Retrieved September 23, 2024, from https://matracking.ehs.state.ma.us/Health-Data/Asthma/index.html
98. CDC. (2024, May 17). *Preventing Spread of Infections in K-12 Schools*. CDC.Gov. https://www.cdc.gov/orr/school-preparedness/infection-prevention/index.html
99. US EPA. (2006). *Chemical Management Resource Guide for School Administrators*. https://www.epa.gov/sites/default/files/2017-01/documents/chemical_management_resource_guide_school_administrators_508.pdf
100. US EPA. (2016). *Sensible Guide for Healthier School Renovations: Key Environmental Health Considerations When Renovating Schools* (No. EPA-909-R-15-002). Environmental Protection Agency. https://www.epa.gov/sites/default/files/2016-01/documents/schools_renov_brochure-8_5x11_final.pdf
101. US EPA. (2012). *Sensible Steps to Healthier School Environments* (No. EPA-908-R-12-0001). https://www.epa.gov/sites/default/files/2014-05/documents/sensible_steps.pdf
102. Ernst, R. (2023, October 2). *Asbestos in Schools Across United States*. Mesothelioma Hub. https://www.mesotheliomahub.com/blog/asbestos-in-schools/
103. MA Department of Fire Services. (n.d.). *Carbon Monoxide (CO) Safety*. Mass.Gov. Retrieved June 19, 2024, from https://www.mass.gov/info-details/carbon-monoxide-co-safety
104. US EPA. (2014). *Energy Savings Plus Health: Indoor Air Quality Guidelines for School Building Upgrades*. Environmental Protection Agency. https://www.epa.gov/sites/default/files/2014-10/documents/energy_savings_plus_health_guideline.pdf
105. US EPA. (2024, June 17). *Learn about Polychlorinated Biphenyls* [Other Policies and Guidance]. https://www.epa.gov/pcbs/learn-about-polychlorinated-biphenyls
106. MDPH. (n.d.). *PCBs (Polychlorinated Biphenyls) in building materials*. Mass.Gov. Retrieved June 20, 2024, from https://www.mass.gov/info-details/pcbs-polychlorinated-biphenyls-in-building-materials

107. US EPA. (2023, September 11). *Polychlorinated Biphenyls (PCBs) in Building Materials* [Other Policies and Guidance]. https://www.epa.gov/pcbs/polychlorinated-biphenyls-pcbs-building-materials
108. *PCBs in Schools | Department of Environmental Conservation*. (n.d.). Retrieved September 23, 2024, from https://dec.vermont.gov/waste-management/contaminated-sites/PCBsinSchools
109. Western States PEHSU. (2017). *Managing PCBs in Schools*. Western States Pediatric Environmental Health Specialty Unit. https://wspehsu.ucsf.edu/wp-content/uploads/2017/10/the-final_managing-pcbs-in-schools-poster_2017.pdf
110. Toxic Substances Control Act, 40 CFR 761 - Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions, Pub. L. No. 94–469, 40 CFR 761 Code of Federal Regulations (1976). https://www.ecfr.gov/current/title-40/part-761
111. Lieberman, M. (2022, October 27). What to Know About PCBs in Schools: A Visual Primer. *Education Week*. https://www.edweek.org/leadership/what-to-know-about-pcbs-in-schools-a-visual-primer/2022/10
112. Christensen, K. (2022, March). Exposure to airborne PCBs an ongoing challenge, expert says. *Environmental Factor*. https://factor.niehs.nih.gov/2022/3/feature/2-feature-pcb-exposure
113. MDPH. (2024, April 3). *MEPHT | Radon*. Massachusetts Environmental Public Health Tracking. https://matracking.ehs.state.ma.us/Environmental-Data/radon/index.html
114. MDPH. (2023, November). *Radon—Get the Facts*. Mass.Gov. https://www.mass.gov/info-details/radon-get-the-facts
115. *What is Vapor Intrusion? | US EPA*. (n.d.). Retrieved September 23, 2024, from https://www.epa.gov/vaporintrusion/what-vapor-intrusion
116. MassDEP. (2016). *Vapor Intrusion Guidance: Site assessment, mitigation and closure*.
117. US EPA. (2021). *Best Practices for Reducing Near-Road Pollution Exposure at Schools* (No. EPA-420-R-21-022). https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1013GDE.pdf
118. OSHA. (n.d.). *Diesel Exhaust—Partial List of Chemicals Associated with Diesel Exhaust*. Retrieved July 22, 2024, from https://www.osha.gov/diesel-exhaust/chemical
119. *Wildfire Smoke Safety Tips | Mass.gov*. (n.d.). Retrieved July 22, 2024, from https://www.mass.gov/info-details/wildfire-smoke-safety-tips
120. Harvard T.H. Chan School of Public Health, Healthy Buildings program. (n.d.). *Foundations for Student Success: How School Buildings Influence Student Health, Thinking and Performance*.
121. US EPA. (2018). *3Ts for Reducing Lead in Drinking Water in Schools and Child Care Facilities*.
122. CT DPH. (n.d.). *Best Management Practices: Reducing and Monitoring Lead in Schools and Childcare Facilities*.
123. Clean Water Fund, & Community Action Works. (n.d.). *Massachusetts and PFAS*.
124. MA DEP, & Finn, M. (2019, March). *Current Issues in Drinking Water: PFAS Lead in Schools*.
125. Center for Green Schools. (n.d.). *PFAS in Schools*.
126. MassDEP. (n.d.). *Per- and Polyfluoroalkyl Substances (PFAS)*. https://www.mass.gov/info-details/per-and-polyfluoroalkyl-substances-pfas#pfas-detected-in-drinking-water-supplies-in-massachusetts-
127. MA Interagency Taskforce on PFAS. (2022, April). *PFAS in the Commonwealth of Massachusetts*.
128. Center for Climate Integrity. (2021). *Massachusetts* (Hotter Days, Higher Costs: The Cooling Crisis in America’s Classrooms). https://coolingcrisis.org/uploads/media/CCI-StateReport-Massachusetts.pdf

129. MDPH. (2024). *Extreme Heat and Poor Air Quality*. https://www.mass.gov/info-details/extreme-heat-and-poor-air-quality
130. Shyduroff, S. (2022, June 29). Heatwaves: How Extreme Heat Impacts Students and Educators. *MAPC*. https://www.mapc.org/planning101/how-extreme-heat-impacts-students-educators/
131. Jung, C. (2023, September 6). *Some Western Mass. School districts opt to end classes early during heat wave*. https://www.wbur.org/news/2023/09/06/western-mass-school-districts-heat-wave-september
132. Jung, C. (2023, September 5). *More Boston Public School buildings will start the year with air conditioning*. https://www.wbur.org/news/2023/09/05/boston-schools-air-conditioning-installation-heat
133. MassDEP. (2006, November). *Massachusetts School Chemical Management Program*.
134. Flattery, J., Jordan, D., Kunitz, J., Lipman, J., Messenger, B., Rose, B., Schaffner, A., & Weinberg, J. (n.d.). *Green Cleaning, Sanitizing, and Disinfecting: A Curriculum for Early Care and Education*.
135. Wilcox, M., & Colella, R. (n.d.). *Getting Mercury Out of Schools*.
136. MassDEP. (n.d.). *MassDEP Mercury Information*. https://www.mass.gov/guides/massdep-mercury-information
137. Massachusetts Department of Public Health. (2020, June). *Artificial turf fields*. Mass.Gov. https://www.mass.gov/info-details/artificial-turf-fields
138. Toxic Use Reduction Institute (TURI). (2019). *Athletic Playing Fields: Choosing Safer Options for Health and the Environment*. University of Massachusetts Lowell. https://easternresearchgroup.sharepoint.com/sites/FacilitiesTeam2/Shared%20Documents/General/Projects/MA%20DPH_BCEH_Green%20&%20Healthy%20Schools/01_Task%201%20(Review%20MSBA%20Assessment%20&%20Research)/Other%20Research/Env%20Health/Crumb%20Rubber/TURI+Report+2018-002+June+2019.+Athletic+Playing+Fields.pdf?CT=1721939336940&OR=ItemsView
139. Lazar, K. (2022, September 24). Aging artificial turf fields may carry risk of head injuries. *The Boston Globe*. https://www.bostonglobe.com/2022/09/24/metro/aging-artificial-turf-fields-may-carry-risk-head-injuries/?p1=Article_Inline_Text_Link
140. Perkins, T. (2022, September 30). Boston bans artificial turf in parks due to toxic ‘forever chemicals.’ *The Guardian*. https://www.theguardian.com/environment/2022/sep/30/boston-bans-artificial-turf-toxic-forever-chemicals-pfas
141. US EPA. (2024, April 17). *Federal Research on Recycled Tire Crumb Used on Playing Fields and Playgrounds* [Overviews and Factsheets]. https://www.epa.gov/chemical-research/federal-research-recycled-tire-crumb-used-playing-fields-and-playgrounds
142. *Food Allergies | Healthy Schools | CDC*. (2022, August 24). https://www.cdc.gov/healthyschools/foodallergies/index.htm
143. MA DPH. (2017). *Life-Threatening Allergies, Anaphylactic Events and the Administration of Epinephrine in School*. https://www.mass.gov/lists/life-threatening-allergies-and-anaphylactic-events-in-schools
144. Carter, S., Cavanaugh, J., Gapinski, M. A., Hall, M., Leshin, R., Fischer, L., Sedlacko, I., Socolow, A., Sylvia, D., Hughes, K., Leibowitz, R., & McGrail, K. (n.d.). *Managing Life-Threatening Allergies in Schools*.
145. Nicklas, M., & Design, I. (n.d.). *National Best Practices Manual for Building High Performance Schools*.
146. Eitland, E., Klingensmith, L., MacNaughton, P., Laurent, J. C., Spengler, J., Bernstein, A., & Allen, J. (2020). *Foundations for Student Success: How School Buildings Influence Student Health, Thinking and Performance*. Harvard T.H. Chan School of Public Health,

Healthy Buildings program. https://schools.forhealth.org/wp-content/uploads/2020/02/Schools_ForHealth_UpdatedJan21.pdf
147. Chaaraoui, L. (2024, January 5). Massachusetts' Public Schools Have Been Grappling with Educational Inequity for Decades. Cambridge has a Solution. *Harvard Political Review*. https://harvardpolitics.com/controlled-choice-cambridge/
148. Scharfenberg, D. (2020, December 11). *Massachusetts' public schools are highly segregated. It's time we treated that like the crisis it is—The Boston Globe*. BostonGlobe.Com. https://www.bostonglobe.com/2020/12/11/opinion/massachusetts-public-schools-are-highly-segregated-its-time-we-treated-that-like-crisis-it-is/
149. Hehir, T., Schifter, L., Grindal, E., Ng, M., & Eidelman, H. (2014). *Review of Special Education in the Commonwealth of Massachusetts: A Synthesis Report*.
150. About IDEA. (n.d.). *Individuals with Disabilities Education Act*. Retrieved June 24, 2024, from https://sites.ed.gov/idea/about-idea/
151. *603 CMR 28.00: Special Education—Education Laws and Regulations*. (n.d.). Retrieved June 24, 2024, from https://www.doe.mass.edu/lawsregs/603cmr28.html?section=01
152. *Learn about education rights | Mass.gov*. (n.d.). Retrieved June 24, 2024, from https://www.mass.gov/info-details/learn-about-education-rights
153. Graham, E. (n.d.). *Maximizing Student Success with Least Restrictive Environments and Appropriate Models of Inclusion | NEA*. Retrieved June 24, 2024, from https://www.nea.org/nea-today/all-news-articles/maximizing-student-success-least-restrictive-environments-and-appropriate-models-inclusion
154. Vaznis, J., & Staff, C. H. G. (n.d.). *Massachusetts spends thousands more on school construction aid for white students than for students of color—The Boston Globe*. BostonGlobe.Com. Retrieved July 25, 2024, from https://www.bostonglobe.com/2023/05/27/metro/massachusetts-school-construction-aid/
155. *Americans with Disabilities Act of 1990, As Amended*. (n.d.). ADA.Gov. Retrieved July 3, 2024, from https://www.ada.gov/law-and-regs/ada/
156. *Session Law—Acts of 2011 Chapter 199*. (n.d.). Retrieved July 2, 2024, from https://malegislature.gov/Laws/SessionLaws/Acts/2011/Chapter199
157. University Of Massachusetts Amherst, School of Education. (2003). Education REFORM: Ten Years after the Massachusetts Education Reform Act of 1993. *Education Connection*. https://www.mass.gov/doc/public-infrastructure-in-western-massachusetts-a-critical-need-for-regional-investment-and-revitalization/download
158. Massachusetts DESE. (2020, December). *Local Contribution Study*. https://www.doe.mass.edu/research/reports/2020/12local-contribution-study.docx
159. MFT. (n.d.). *Local Aid & K-12 Education*. Retrieved July 2, 2024, from https://www.masstaxpayers.org/sites/default/files/publications/2024-03/MTF%20Closer%20Look%20-%20Local%20Aid%20%26%20K-12%20Education.pdf
160. Commonwealth of Massachusetts, Office of State Auditor. (2021). *Public Infrastructure in Western Massachusetts: A Critical Need for Regional Investment and Revitalization*. https://www.mass.gov/doc/public-infrastructure-in-western-massachusetts-a-critical-need-for-regional-investment-and-revitalization/download
161. Allen, B. (n.d.). *Overview of Chapter 70 Funding for Education*. https://www.mma.org/wp-content/uploads/2024/03/MMA-webinar-Ch70-Foundation-Budget-Presentation-3.20.24.pdf
162. Commission on the Fiscal Health of Rural School Districts. (2022). *A Sustainable Future for Rural Schools*. https://drive.google.com/file/d/1i8MgkvJNG_mJDOoFL9yPIX1fz2NgiLT7/view?usp=sharing&usp=embed_facebook

163. *FY2024 Rural School Aid—Chapter 70 Program—School Finance*. (n.d.). Retrieved July 15, 2024, from https://www.doe.mass.edu/finance/chapter70/foundation/fy2024-rural-school-aid.html
164. MassCEC. (2024, July 12). *Green School Works_Draft Program Concept_FINAL_updated 240712.pdf*. https://www.masscec.com/sites/default/files/documents/Green%20School%20Works_Draft%20Program%20Concept_FINAL_updated%20240712.pdf
165. *School Water Improvement Grants | Mass.gov*. (n.d.). Retrieved July 15, 2024, from https://www.mass.gov/school-water-improvement-grants
166. MA Department of Revenue, Division of Local Services. (2020, January). *Understanding Municipal Debt*. https://www.mass.gov/doc/understanding-municipal-debt/download
167. None, N. (2021). *A Primer on Organizational Use of Energy Management and Information Systems (EMIS)* (No. DOE/EE--2195, 1755532, 8496; p. DOE/EE--2195, 1755532, 8496). https://doi.org/10.2172/1755532
168. Massachusetts Department of Energy Resources. (n.d.). *Large Building Energy Disclosure | Mass.gov*. Retrieved July 26, 2024, from https://www.mass.gov/large-building-energy-disclosure
169. *ENERGY STAR Score for K-12 Schools | ENERGY STAR*. (n.d.). Retrieved June 17, 2024, from https://www.energystar.gov/buildings/tools-and-resources/energy-star-score-k-12-schools
170. Kramer, H., Abram, T., Hart, N., & Granderson, J. (2023). *Framework for Greenhouse Gas Emissions Reduction Planning: Building Portfolios* (No. DOE/EE--2688, 1971619, 8954; p. DOE/EE--2688, 1971619, 8954). https://doi.org/10.2172/1971619
171. *For net-zero cities, we need to retrofit our older buildings. Here's what's needed*. (2022, November 8). World Economic Forum. https://www.weforum.org/agenda/2022/11/net-zero-cities-retrofit-older-buildings-cop27/
172. NEEP. (2020, May 1). *Zero Energy Schools Toolkit*. https://neep.org/sites/default/files/resources/Zero%20Energy%20Schools%20Toolkit%20FINAL.pdf
173. Torcellini, P. A., Trenbath, T.-K. L., Allen, N., & McIntyre, M. (2019). *A Guide to Zero Energy and Zero Energy Ready K-12 Schools* (No. NREL/TP--5500-72847, 1557416; p. NREL/TP--5500-72847, 1557416). https://doi.org/10.2172/1557416
174. *MassSave New Construction or Major Renovation Path 1*. (2022). https://www.masssave.com/-/media/Files/PDFs/Business/2022-MS-NC-Summary-Path-1-1222-Final.pdf
175. None, N. (2021). *Decarbonizing HVAC and Water Heating in Commercial Buildings* (No. DOE/EE-2525, 1832100, 8805; p. DOE/EE-2525, 1832100, 8805). https://doi.org/10.2172/1832100
176. *Building Envelope Campaign | Better Buildings Initiative*. (n.d.). Retrieved June 14, 2024, from https://betterbuildingssolutioncenter.energy.gov/alliance/technology-campaigns/building-envelope-campaign
177. *K-12 Lighting Toolkit | Better Buildings Initiative*. (n.d.). Retrieved June 19, 2024, from https://betterbuildingssolutioncenter.energy.gov/k-12-lighting-toolkit
178. Hines, E., Ross, S., Klein, J., Lu, A., Seals, B. A., Taylor, E., & Unger, R. (2023). *HVAC Choices for Student Health and Learning*.
179. *Town of Arlington Electrification & Air Quality Master Plan*. (2023, January). https://www.arlingtonma.gov/home/showpublisheddocument/65935/638233929669870000
180. *Calculators—California Energy Wise*. (n.d.). Retrieved June 17, 2024, from https://caenergywise.com/calculators/

181. *Anne Arundel County Public Schools: Optimizing Energy Use through Central Monitoring and Control | Better Buildings Initiative*. (n.d.). Retrieved June 20, 2024, from https://betterbuildingssolutioncenter.energy.gov/solutions-at-a-glance/anne-arundel-county-public-schools-optimizing-energy-use-through-central
182. *Clean Energy and Climate Plan for 2050*. (n.d.).
183. NEEP, & NE-CHPS. (2022). *Northeast CHPS Criteria for New Construction and Renovations Version 4.0: Assessment Tool*. Northeast Energy Efficiency Partnerships and Northeast Collaborative for High Performance Schools. https://neep.org/sites/default/files/media-files/NE%20CHPS%20v4.0%20Clean%20Final%20Draft%20May%202022.pdf
184. *Solar Massachusetts Renewable Target Program Guideline*. (2018, September 13). https://www.mass.gov/doc/ess-guideline-october-2020/download
185. *Session Law—Acts of 2021 Chapter 8*. (n.d.). Retrieved June 13, 2024, from https://malegislature.gov/Laws/SessionLaws/Acts/2021/Chapter8
186. *General Law—Part I, Title II, Chapter 25A, Section 11F*. (n.d.). Retrieved June 13, 2024, from https://malegislature.gov/Laws/GeneralLaws/PartI/TitleII/Chapter25A/Section11F
187. MA DOER. (n.d.). *Energy Management Services (EMS) Contracts RFP Process*. https://www.mass.gov/media/5806/download
188. Energy Management Services (EMS) Contracts Requests for Qualifications Process, 225 CMR 19.00. https://www.mass.gov/regulations/225-CMR-1900-energy-management-services-ems-contracts-requests-for-qualification-process
189. Commercial (and All Other) Construction Stretch Energy Code, 225 CMR 23. https://www.mass.gov/doc/commercial-and-other-stretch-energy-code-and-specialized-opt-in-code-language/download
190. Clean Energy Standard, 310 CMR 7.75. https://www.mass.gov/guides/clean-energy-standard-310-cmr-775
191. *Massachusetts State Building Code—780 CMR*. (n.d.). Mass.Gov. Retrieved July 26, 2024, from https://www.mass.gov/massachusetts-state-building-code-780-cmr
192. School Building Grant Program, 963 CMR 2.00. https://www.mass.gov/regulations/963-CMR-200-school-building-grant-program
193. Massachusetts Appliance Energy and Water Efficiency Standards. https://www.mass.gov/info-details/appliance-energy-and-water-efficiency-standards
194. *Northeast Collaborative for High Performance Schools Criteria (NE-CHPS) Version 3.2 | Northeast Energy Efficiency Partnerships*. (n.d.). Retrieved December 4, 2024, from https://neep.org/northeast-collaborative-high-performance-schools-criteria
195. DOE. (n.d.). *Appliance and Equipment Standards Program*. Energy.Gov. Retrieved December 4, 2024, from https://www.energy.gov/eere/buildings/appliance-and-equipment-standards-program
196. ANSI/ASHRAE/ACCA. (n.d.). *Standard for Commercial Building Energy Audits 211-2018*. https://www.ashrae.org/File%20Library/Technical%20Resources/Bookstore/previews_2016437_pre.pdf
197. ASTM. (n.d.). *Standard Guide for Property Condition Assessments: Baseline Property Condition Assessment Process*. Retrieved December 4, 2024, from https://www.astm.org/e2018-15.html
198. USGBC. (2024). *LEED v4.1 Building Design + Construction*. https://build.usgbc.org/bd+c_guide
199. US EPA. (2024, March 7). *WaterSense Best Management Practices*. https://www.epa.gov/watersense/best-management-practices
200. The Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs and Water Resources Commission. (2018). *Massachusetts Water Conservation*

Standards. https://www.mass.gov/doc/massachusetts-water-conservation-standards-2/download
201. Massachusetts Water Resources Commission. (2024). *School, Recreation and Facilities Managers*. https://www.mass.gov/guides/school-recreation-and-facilities-managers
202. US EPA. (n.d.). *ENERGY STAR Portfolio Manager*. Retrieved July 14, 2024, from https://portfoliomanager.energystar.gov/pm/login
203. US EPA. (2023). *WaterSense at Work Section 2.2: Leak Detection and Repair*. https://www.epa.gov/system/files/documents/2023-11/ws-commercial-bmp-watersenseatwork_section2.2_leakdetectionandrepair.pdf
204. US EPA. (2022). *Improving Water Management Using Advanced Metering Infrastructure Data: A Guide for Facility Managers*. https://www.epa.gov/system/files/documents/2022-09/ws-commercial-ami-guide-facility-managers.pdf
205. US EPA. (2023). *WaterSense at Work Section 2.1: Metering and Submetering*. https://www.epa.gov/system/files/documents/2023-11/ws-commercial-bmp-watersenseatwork_section2.1_meteringandsubmetering.pdf
206. US EPA. (2024). *WaterSense at Work Section 2.3: Benchmarking*. https://www.epa.gov/system/files/documents/2024-03/ws-commercial-bmp-watersenseatwork_section2.3_benchmarking.pdf
207. US EPA. (2023). *ENERGY STAR Portfolio Manager U.S. Water Use Intensity by Property Type*. https://www.energystar.gov/sites/default/files/tools/National%20WUI%20Technical%20Reference%202023_0719b.pdf
208. City of Boston. (2021, September). *City of Boston Code, Ordinances, Chapter VII, Sections 7-2.1 and 7-2.2, Building Energy Reporting and Disclosure*.
209. Town of Lexington, MA. (2024, March 11). *Town of Lexington, MA, Bylaws*. https://ecode360.com/41461386
210. US EPA. (2023). *WaterSense at Work Section 1.2: Water Management Planning*. https://www.epa.gov/system/files/documents/2023-05/ws-commercial-watersense-at-work_Section_1.2_Planning.pdf
211. US EPA. (2024, June 26). *WaterSense Webinars*. https://www.epa.gov/watersense/webinars
212. US EPA. (2024, February 2). *WaterSense Tools for CI Facilities*. https://www.epa.gov/watersense/tools-ci-facilities
213. Board of State Examiners of Plumbers and Gas Fitters. (2023, December 8). *248 CMR 10.00: Uniform State Plumbing Code*. https://www.mass.gov/regulations/248-CMR-1000-uniform-state-plumbing-code
214. US EPA. (n.d.). *WaterSense Product Search*. Retrieved July 15, 2024, from https://www.epa.gov/watersense/product-search
215. Massachusetts Department of Energy Resources. (2021, December 24). *225 CMR 9.00: Appliance energy-efficiency standards, testing and certification program*. https://www.mass.gov/regulations/225-CMR-900-appliance-energy-efficiency-standards-testing-and-certification-program
216. *ENERGY STAR Product Finder*. (n.d.). Retrieved July 15, 2024, from https://www.energystar.gov/productfinder/
217. U.S. Department of Energy. (2016, January 27). *CRF Title 10, Chapter II, Parts 429 and 431—Energy Conservation Program: Energy Conservation Standards for Commercial Prerinse Spray Valves*. https://www.regulations.gov/document/EERE-2014-BT-STD-0027-0050
218. US EPA. (2023). *WaterSense at Work Section 5.2: Irrigation*. https://www.epa.gov/system/files/documents/2023-11/ws-commercial-bmp-watersenseatwork_section5.2_irrigation.pdf

219. US EPA. (n.d.). *WaterSense Find a Pro*. Retrieved July 19, 2024, from https://www.epa.gov/watersense/find-pro
220. American Society of Agricultural and Biological Engineers. (2016, September). *ANSI/ASABE Standard S626: Landscape Irrigation System Uniformity and Application Rate Testing*. https://doi.org/http://dx.doi.org/10.13031/s2000.2013
221. The 193rd Court of the Commonwealth of Massachusetts. (n.d.). *General Law—Part I, Title II, Chapter 21, Section 67*. Retrieved June 25, 2024, from https://malegislature.gov/Laws/GeneralLaws/PartI/TitleII/Chapter21/Section67
222. Massachusetts Department of Environmental Protection. (2023, January 20). *Guidance on Nonessential Outdoor Water Use, Amended Water Resources Management Program Regulations 310 CMR 36.00*. https://www.mass.gov/doc/guidance-on-nonessential-outdoor-water-use-for-wma-registrants/download
223. International Institute for Sustainable Laboratories and US EPA. (2022). *Best Practices Guide: Water Efficiency in Laboratories*. https://www.i2sl.org/_files/ugd/59662e_464c82ed60d94cca9003e531101f08af.pdf
224. Federal Energy Management Program. (n.d.). *Federal Energy Management Program Alternative Water Sources*. Retrieved July 21, 2024, from https://www.energy.gov/femp/alternative-water-sources
225. Acts of 2021, Chapter 8: An Act Creating a Next-Generation Roadmap for Massachusetts Climate Policy (2021). https://malegislature.gov/Laws/SessionLaws/Acts/2021/Chapter8
226. Massachusetts Appliance Efficiency Standards Act, M.G.L. c. 25B §§ 3-10. https://malegislature.gov/Laws/GeneralLaws/PartI/TitleII/Chapter25B
227. System Interruption Devices Requirement for New Irrigation Systems, M.G.L. c. 21 § 67. https://malegislature.gov/Laws/GeneralLaws/PartI/TitleII/Chapter21/Section67
228. The Water Management Act, M.G.L. c. 21G. https://malegislature.gov/Laws/GeneralLaws/PartI/TitleII/Chapter21G
229. Energy Policy Act of 2005, Pub. L. No. 109–58 (2005). https://www.congress.gov/109/plaws/publ58/PLAW-109publ58.pdf
230. Uniform State Plumbing Code, 248 CMR 10.00. https://www.mass.gov/regulations/248-CMR-1000-uniform-state-plumbing-code
231. Massachusetts Department of Environmental Protection. (2023, January 20). *310 CMR 36.00: The Water Management Act Regulations*. https://www.mass.gov/doc/310-cmr-3600-the-water-management-act-regulations
232. U.S. Department of Energy. (2011). *CFR Title 10, Chapter II, Part 430—Energy Conservation Program for Consumer Products*. https://www.gpo.gov/fdsys/pkg/CFR-2011-title10-vol3/pdf/CFR-2011-title10-vol3-part430.pdf
233. U.S. Department of Energy. (2016). *CFR Title 10, Chapter II, Part 431—Energy Efficiency Program for Certain Commercial and Industrial Equipment*. https://www.gpo.gov/fdsys/pkg/CFR-2016-title10-vol3/pdf/CFR-2016-title10-vol3-part431.pdf
234. *Massachusetts Appliance Energy and Water Efficiency Standards*. (n.d.). Retrieved December 4, 2024, from https://www.mass.gov/info-details/appliance-energy-and-water-efficiency-standards
235. World Wildlife Fund. (n.d.). *Food waste warriors: A deep dive into food waste in US schools*. World Wildlife Fund. Retrieved June 21, 2024, from https://www.worldwildlife.org/stories/food-waste-warriors
236. MA DESE. (n.d.). *School Meal Programs Questions and Answers*.
237. Center for Science in the Public Interest. (2023). *Cut Waste, Not Nutrition, in School Meals*.
238. USDA. (2015). *Reducing Food Waste at K-12 Schools*. https://www.usda.gov/foodlossandwaste/schools

239. USDA. (2015, July 21). *Updated Offer vs Serve Guidance for the NSLP and SBP Beginning SY2015-16 | Food and Nutrition Service*. https://www.fns.usda.gov/cn/updated-offer-vs-serve-guidance-nslp-and-sbp-beginning-sy2015-16
240. USDA. (2016). *What You Can Do To Help Prevent Wasted Food*.
241. Calvert, H. G., Ohri-Vachaspati, P., McQuilkin, M., Boedeker, P., & Turner, L. (2021). Prevalence of Evidence-Based School Meal Practices and Associations with Reported Food Waste across a National Sample of U.S. Elementary Schools. *International Journal of Environmental Research and Public Health*, *18*(16), 8558. https://doi.org/10.3390/ijerph18168558
242. Cohen, J. F. W., Hecht, A. A., McLoughlin, G. M., Turner, L., & Schwartz, M. B. (2021). Universal School Meals and Associations with Student Participation, Attendance, Academic Performance, Diet Quality, Food Security, and Body Mass Index: A Systematic Review. *Nutrients*, *13*(3), 911. https://doi.org/10.3390/nu13030911
243. CDC. (2022, July 7). *Considering Cultural Food Preferences in Food Service*. Centers for Disease Control and Prevention. https://www.cdc.gov/nutrition/food-service-guidelines/strategize-and-act/cultural-food-preferences.html
244. Cohen, J. F. W., Jahn, J. L., Richardson, S., Cluggish, S. A., Parker, E., & Rimm, E. B. (2016). The Amount of Time to Eat Lunch is Associated with Children's Selection and Consumption of School Meal Entrée, Fruits, Vegetable, and Milk. *Journal of the Academy of Nutrition and Dietetics*, *116*(1), 123–128. https://doi.org/10.1016/j.jand.2015.07.019
245. Chapman, L. E., Cohen, J., Canterberry, M., & Carton, T. W. (2017). Factors Associated with School Lunch Consumption: Reverse Recess and School "Brunch." *Journal of the Academy of Nutrition and Dietetics*, *117*(9), 1413–1418. https://doi.org/10.1016/j.jand.2017.04.016
246. Price, J., & Just, D. R. (2015). Lunch, recess and nutrition: Responding to time incentives in the cafeteria. *Preventive Medicine*, *71*, 27–30. https://doi.org/10.1016/j.ypmed.2014.11.016
247. MassDEP. (n.d.). *Green SWoRD - School Waste Reduction and Diversion Working Group—Reusable Food Serviceware*. Retrieved June 17, 2024, from https://sites.google.com/view/ma-green-sword-k-12-schools/reusable-food-serviceware
248. King County. (2021). *Analysis of Milk Dispensers and Milk Cartons for Auburn School District*.
249. USDA. (2023). *Clarification of Allowable Flexibilities for Child Nutrition Programs Experiencing Milk Supply Shortages*.
250. Merod, A. (2023, November 8). *Milk carton shortage spills into schools*. Waste Dive. https://www.k12dive.com/news/milk-carton-shortage-schools/699137/
251. King County. (2024). *Reducing food waste in schools—King County, Washington*. https://www.kingcounty.gov/en/dept/dnrp/waste-services/garbage-recycling-compost/solid-waste-programs/green-schools/program-levels/level-one/food-waste
252. Duke University. (2015, October 27). *Campus Water Stations Save 400,000 Plastic Bottles | Duke Today*. https://today.duke.edu/2015/10/hydrationstations
253. USDA. (2016). *Share Table Guidelines*. https://fns-prod.azureedge.us/sites/default/files/cn/SP41_CACFP13_SFSP15_2016os.pdf
254. White, K., Habib, R., & Hardisty, D. J. (2019). How to SHIFT Consumer Behaviors to be More Sustainable: A Literature Review and Guiding Framework. *Journal of Marketing*, *83*(3), 22–49. https://doi.org/10.1177/0022242919825649
255. Geller, E. S. (n.d.). Encouraging Pro-Environmental Behaviour with Rewards and Penalties. *Environmental Psychology*. Retrieved June 18, 2024, from

https://www.academia.edu/69074765/Encouraging_Pro_Environmental_Behaviour_with_Rewards_and_Penalties
256. Gutterman, L. (2023, April 18). *“Chromebook Churn” report highlights problems of short-lived laptops in schools*. U.S. PIRG Education Fund. https://pirg.org/edfund/resources/chromebook-churn-report-highlights-problems-of-short-lived-laptops-in-schools/
257. Desye, B., Tesfaye, A. H., Berihun, G., Ademas, A., & Sewunet, B. (2023). A systematic review of the health effects of lead exposure from electronic waste in children. *Frontiers in Public Health*, *11*, 1113561. https://doi.org/10.3389/fpubh.2023.1113561
258. LEED v4. (n.d.). *LEED v4 Waste Management Credits—Zero Waste*. Retrieved June 21, 2024, from https://www.zerowastedesign.org/5-appendices/leed-v4-waste-management-credits/
259. Friell, J. (n.d.). *Benefits of Recycling Lawn Clippings: A Brief Summary | Turfgrass Science*. Retrieved June 21, 2024, from https://turf.umn.edu/news/benefits-recycling-lawn-clippings-brief-summary
260. University of Minnesota Extension. (2018). *What to do with lawn clippings*. https://extension.umn.edu/lawn-care/what-do-lawn-clippings
261. Massachusetts Department of Environmental Protection. (2024). *Mercury Management Act*. https://www.mass.gov/guides/massdep-mercury-information#-mercury-management-act-
262. Solid Waste Facility Regulations, 310 CMR 19.000. https://www.mass.gov/regulations/310-CMR-19000-solid-waste-facility-regulations
263. *Use of Share Tables in Child Nutrition Programs | Food and Nutrition Service*. (2016). https://www.fns.usda.gov/cn/use-share-tables-child-nutrition-programs
264. Henry. (2022, June 25). *Repairing An Electric Vehicle Could Cost More Than Gasoline Cars: A New Kind Of Sticker Shock*. Forbes. https://www.forbes.com/sites/jimhenry/2022/07/25/repairing-an-electric-vehicle-could-cost-more-than-gasoline-cars-a-new-kind-of-sticker-shock/
265. *OIG Letter to Committee on Transportation Re School Bus Procurement*. (n.d.).
266. *Massachusetts Laws and Incentives*. (n.d.). Department of Energy: Alternative Fuels Data Center. Retrieved July 23, 2024, from https://afdc.energy.gov/laws/all?state=MA
267. *ERG’s work with Massachusetts districts on ESB adoption*. (n.d.).
268. *Operation and Maintenance for Electric Vehicle Charging Infrastructure*. (n.d.). Department of Energy: Alternative Fuels Data Center. Retrieved July 24, 2024, from https://afdc.energy.gov/fuels/electricity-infrastructure-maintenance-and-operation
269. Public Electrical Vehicle Charging Stations, M.G.L. c. 25A §§ 16B-16E. https://malegislature.gov/Laws/GeneralLaws/PartI/TitleII/Chapter25A/Section16
270. *Build America, Buy America Act*. (2023, January 4). USDA Rural Development. https://www.rd.usda.gov/build-america-buy-america
271. *Bipartisan Infrastructure Law—National Electric Vehicle Infrastructure (NEVI) Formula Program Fact Sheet | Federal Highway Administration*. (2022, February 10). Federal Highway Administration. https://www.fhwa.dot.gov/bipartisan-infrastructure-law/nevi_formula_program.cfm
272. *Training | EVITP*. (n.d.). Electric Vehicle Infrastructure Training Program (EVITP). Retrieved July 17, 2024, from https://evitp.org/training/
273. *Alternative Fuels Data Center: National Electric Vehicle Infrastructure (NEVI) Formula Program*. (n.d.). U.S. Department of Energy. Retrieved July 17, 2024, from https://afdc.energy.gov/laws/12744
274. *Alternative Fuels Data Center: Public Access Electric Vehicle (EV) Charging Station Grants*. (n.d.). U.S. Department of Energy. Retrieved July 17, 2024, from https://afdc.energy.gov/laws/12159

275. *Open Charge Alliance—Connecting the EV charging industry*. (n.d.). Open Charge Alliance. Retrieved July 17, 2024, from https://openchargealliance.org/
276. *National Electric Vehicle Infrastructure Standards and Requirements*. (2023, February 28). Federal Register. https://www.federalregister.gov/documents/2023/02/28/2023-03500/national-electric-vehicle-infrastructure-standards-and-requirements
277. How to secure EV charger funding through the Charging and Fueling Infrastructure (CFI) Program. (2024, June 26). *SWTCH | Electric Vehicle (EV) Charging Solution*. https://swtchenergy.com/how-to-secure-ev-charger-funding-through-the-charging-and-fueling-infrastructure-cfi-program/
278. RESILIENT MASSACHUSETTS ACTION TEAM. (2022, July). *Climate Resilience Design Standards & Guidance*.
279. *LEED Resilient Design Pilot Credits*. (2019, January). USGBC. https://www.usgbc.org/sites/default/files/LEED-Resilient-Design-Pilot-Credits-Brief-FINAL.pdf
280. CDC. (2024, May 17). *Everyday Actions for Schools to Prevent and Control the Spread of Infections*. CDC.Gov. https://www.cdc.gov/orr/school-preparedness/infection-prevention/actions.html
281. Jones, E., Young, A., Clevenger, K., Salimifard, P., Wu, E., Luna, M. L., Lahvis, M., Lang, J., Bliss, M., Azimi, P., Cedeno-Laurent, J., Wilson, C., Segule, M. N., Keshavarz, Z., Chin, W., Dedesko, S., Parikh, S., Vallarino, J., & Allen, J. (2020). *Schools for Health: Risk Reduction Strategies for Reopening Schools*. Harvard T.H. Chan School of Public Health, Healthy Buildings program. https://schools.forhealth.org/wp-content/uploads/sites/19/2020/11/Harvard-Healthy-Buildings-Program-COVID19-Risk-Reduction-in-Schools-Nov-2020.pdf
282. 105 CMR 300.00: Reportable Diseases, Surveillance, and Isolation and Quarantine Requirements, 105 CMR 300.00 Code of Massachusetts Register (2022). https://www.mass.gov/regulations/105-CMR-30000-reportable-diseases-surveillance-and-isolation-and-quarantine-requirements
283. CDC. (2024, May 17). *Additional Strategies that May Be Used to Minimize Infectious Disease Transmission in Schools during Times of Elevated Illness Activity | CDC*. CDC.Gov. https://www.cdc.gov/orr/school-preparedness/infection-prevention/strategies.html
284. Massachusetts Department of Labor Standards. (2023). *454 CMR 28.00: The Removal, Containment, Maintenance, or Encapsulation of Asbestos*. https://www.mass.gov/doc/454-cmr-28-the-removal-containment-maintenance-or-encapsulation-of-asbestos/download
285. US EPA. (2013, March 12). *Asbestos Laws and Regulations* [Overviews and Factsheets]. https://www.epa.gov/asbestos/asbestos-laws-and-regulations
286. US EPA. (2023, September 1). *Model AHERA Asbestos Management Plan for Local Education Agencies* [Other Policies and Guidance]. https://www.epa.gov/asbestos/model-ahera-asbestos-management-plan-local-education-agencies
287. Healthy Schools Council. (2003). *Checklist Concerning Environmental Health & Safety in Schools*.
288. Massachusetts Department of Labor Standards. (2021). *AHERA Regulation Changes under 454 CMR 28.00* (No. Doc #2021-022). https://www.mass.gov/doc/faqs-about-ahera-regulation-changes-under-454-cmr-28/download
289. Commonwealth of Massachusetts, Executive Office of Labor and Workforce Development, Department of Labor Standards. (2014, May). *PCM Clearance Air Sampling Guidance for Asbestos Project Monitors*. https://www.mass.gov/doc/pcm-clearance-air-sampling-guidance-for-asbestos-project-monitors/download

290. MassDEP. (n.d.). *310 CMR 7.15: U Asbestos* (Air Pollution Control Regulation). Massachusetts Department of Environmental Protection. Retrieved June 26, 2024, from https://www.mass.gov/doc/310-cmr-700-air-pollution-control-regulation/download
291. Requirements to Maintain Air Quality in Indoor Skating Rinks, 105 CMR 675.000 State Sanitary Code, Chapter XI (2004). https://www.mass.gov/doc/105-cmr-675-state-sanitary-code-chapter-xi-requirements-to-maintain-air-quality-in-indoor-skating-rinks/download
292. US EPA. (2024, February 7). *NAAQS Table*. Criteria Air Pollutants. https://www.epa.gov/criteria-air-pollutants/naaqs-table
293. OSHA. (n.d.). *Limits for Air Contaminants* (No. 1910.1000 Subpart Z: Toxic and Hazardous Substances). Retrieved June 19, 2024, from https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1000TABLEZ1
294. ACGIH. (n.d.). *Carbon monoxide*. Retrieved June 19, 2024, from https://www.acgih.org/carbon-monoxide-3/
295. ANSI/ASHRAE. (2022). *Standard 62.1, Ventilation and Acceptable Indoor Air Quality*. https://ashrae.iwrapper.com/ASHRAE_PREVIEW_ONLY_STANDARDS/STD_62.1_2022
296. MA DPH Indoor Air Quality Program. (2015, September). *Chapter II: Indoor Air Quality Results Interpretation*. https://www.mass.gov/lists/indoor-air-quality-manual-and-appendices#indoor-air-quality-manual-
297. NIOSH. (2019, October 30). *Pocket Guide to Chemical Hazards—Carbon monoxide*. https://www.cdc.gov/niosh/npg/npgd0105.html
298. *Remediation and prevention of mold growth and water damage in public schools and buildings to maintain air quality | Mass.gov*. (n.d.). Retrieved July 24, 2024, from https://www.mass.gov/info-details/remediation-and-prevention-of-mold-growth-and-water-damage-in-public-schools-and-buildings-to-maintain-air-quality
299. MDPH. (2016). *Asthma and Your Environment*.
300. *Leaks & Moisture*. (n.d.). Asthma Prevention and Control. Retrieved July 24, 2024, from https://www.maasthma.org/toolkit/leaks
301. US EPA. (2021). *PCBs in Building Materials: Determining the Presence of Manufactured PCB Products in Buildings or Other Structures*. U.S. Environmental Protection Agency. https://www.epa.gov/sites/default/files/2021-05/documents/final_pcb_buildings_fact_sheet_05-10-2021_to_upload.pdf
302. US EPA. (2023). *Technical Guidance for Determining the Presence of Manufactured PCB Products in Buildings and Other Structures* (No. EPA-530-R-23-015). U.S. Environmental Protection Agency. https://www.epa.gov/system/files/documents/2023-09/Technical_Guidance_Determining_Presence_Manufactured_PCB_Products_Buildings_Structures.pdf
303. US EPA. (2023, November 4). *Polychlorinated Biphenyl (PCB)-Containing Fluorescent Light Ballasts (FLBs) in School Buildings* [Other Policies and Guidance]. https://www.epa.gov/pcbs/polychlorinated-biphenyl-pcb-containing-fluorescent-light-ballasts-flbs-school-buildings
304. US EPA. (2015). *Practical Actions for Reducing Exposure to PCBs in Schools and Other Buildings*. https://www.epa.gov/sites/default/files/2016-03/documents/practical_actions_for_reducing_exposure_to_pcbs_in_schools_and_other_buildings.pdf
305. US EPA. (2015). *Laboratory Study of Polychlorinated Biphenyl (PCB) Contamination in Buildings Evaluation of the Encapsulation Method* (Science in Action). U.S. Environmental Protection Agency. https://www.epa.gov/sites/default/files/2015-08/documents/pcb_encapsulation_fs.pdf

306. US EPA. (2023, October 25). *Exposure Levels for Evaluating Polychlorinated Biphenyls (PCBs) in Indoor School Air* [Other Policies and Guidance]. https://www.epa.gov/pcbs/exposure-levels-evaluating-polychlorinated-biphenyls-pcbs-indoor-school-air
307. US EPA. (2010). *Managing Radon in Schools* (The Indoor Air Quality Tools for Schools Approach). Environmental Protection Agency. https://www.epa.gov/sites/default/files/2014-11/documents/managing_radon.pdf
308. MDPH. (n.d.). *Fixing Radon In Your Home* [Fact Sheet]. Massachusetts Department of Public Health, Bureau of Climate and Environmental Health. https://www.mass.gov/doc/fixing-radon-in-your-home/download
309. US EPA. (2023, July 6). *What is EPA's Action Level for Radon and What Does it Mean?* [Overviews and Factsheets]. https://www.epa.gov/radon/what-epas-action-level-radon-and-what-does-it-mean
310. US EPA. (2024, January 30). *Radon in Schools* [Overviews and Factsheets]. https://www.epa.gov/radon/radon-schools
311. *Air Quality Flag Program Main Page | AirNow.gov*. (n.d.). Retrieved July 22, 2024, from https://www.airnow.gov/air-quality-flag-program/
312. MA DEP. (2020). *Engine Idling Guidance for School Bus Drivers*. https://www.mass.gov/doc/engine-idling-guidance-for-school-bus-drivers/download
313. MA Department of Public Health, & Massachusetts Asthma Action Partnership. (2024). *Clearing the Air: An Asthma Toolkit for Healthy Schools*. Asthma Prevention and Control. https://www.maasthma.org/toolkit/outdoorairpollution
314. MA DEP. (n.d.). *Best Management Practices: Reducing Diesel Pollution at Schools*. https://www.mass.gov/doc/massdep-best-management-practices-reducing-diesel-pollution-at-schools/download
315. EPA. (n.d.). *Recommendations for Reducing Wildfire Smoke Exposure in Commercial Buildings and Schools*. https://www.epa.gov/system/files/documents/2021-07/flyer-recommendations-for-reducing-wildfire-smoke-in-commercial-buildings-and-schools.pdf
316. ASHRAE. (2021). *Planning Framework for Protecting Commercial Building Occupants from Smoke During Wildfire Events*. https://www.ashrae.org/File%20Library/Technical%20Resources/COVID-19/Planning-Framework-for-Protecting-Commercial-Building-Occupants-from-Smoke-During-Wildfire-Events.pdf
317. U.S EPA, O. of R. and D. (2016, July). *Recommendations for Constructing Roadside Vegetation Barriers to Improve Near-Road Air Quality*. https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=NRMRL&dirEntryId=321772&subject=Air%20Research&showCriteria=0&searchAll=Air%20and%20%28roads%20or%20road%20or%20roadway%20or%20roadways%20or%20traffic%20or%20%7Bnear%20road%7D%29&actType=Product&TIMSType=PUBLISHED+REPORT&sortBy=revisionDate
318. Motor Vehicles and Aircraft | Stopped Motor Vehicles; Operation of Engine; Time Limit; Penalty, M.G.L., c. 90 § 16A. https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXIV/Chapter90/Section16a
319. Motor Vehicles and Aircraft | Idling of a Motor Vehicle Engine on School Property; Penalties; Adoption of Regulations, M.G.L., c. 90 § 16B. https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXIV/Chapter90/Section16B
320. Regulation of Motor Vehicle Idling on School Grounds, 27.00 MGL 90 § 16B 540. https://www.mass.gov/doc/540-cmr-27-regulation-of-motor-vehicle-idling-on-school-grounds/download
321. National Drinking Water Alliance. (n.d.). *Healthy Hydration: Ensuring Access to Safe Water in Schools*.

322. US EPA. (n.d.). *Ensuring Drinking Water Quality in Schools During and After Extended Closures*.
323. US EPA. (n.d.). *3Ts Checklist—Establishing a Lead Testing Program*.
324. MA DEP. (n.d.). *The Lead Contamination Control Act (LLCA)*. https://www.mass.gov/info-details/the-lead-contamination-control-act-lcca#:~:text=MassDEP's%20LCCA%20program%20recommends%20that,possible%20concentration%20of%20lead%20is
325. Tobiason, J. E., Ram, K., Hatte, M.-F., Larson, R., & Reckhow, D. A. (2018). *Massachusetts Assistance Program for Lead in School Drinking Water*.
326. MassDEP. (2019). *Flushing: A Short-Term Solution to Reduce Lead and Copper*.
327. US Congress. (n.d.). *S. 3874—Reduction of Lead in Drinking Water Act*. https://www.congress.gov/bill/111th-congress/senate-bill/3874
328. US EPA. (2024, February 14). *Overview of the Safe Drinking Water Act*. https://www.epa.gov/sdwa/overview-safe-drinking-water-act
329. MA DEP. (n.d.). *310 CMR 22: The Massachusetts Drinking Water Regulations*. https://www.mass.gov/regulations/310-CMR-22-the-massachusetts-drinking-water-regulations
330. US EPA. (2023, November 28). *Lead and Copper Rule*. https://www.epa.gov/dwreginfo/lead-and-copper-rule
331. US EPA. (2024, June 13). *National Primary Drinking Water Regulations*. https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations#Inorganics
332. MA DEP. (n.d.). *Drinking Water Standards and Guidelines*. https://www.mass.gov/guides/drinking-water-standards-and-guidelines
333. National Sanitation Foundation. (2018, June 8). *NSF/ANSI/CAN 372 Technical Requirements*. https://www.nsf.org/knowledge-library/nsf-ansi-can-372-technical-requirements
334. New Hampshire Department of Environmental Services. (2024). *Report on the Occurrence of Per- and Polyfluoroalkyl Substances (PFAS) in Floor Stripping and Refinishing Wastewater at Four Schools in New Hampshire*. https://www.pfas.des.nh.gov/sites/g/files/ehbemt341/files/documents/r-wd-24-04.pdf
335. US EPA. (2024, May 8). *Designation of Perfluorooctanoic Acid (PFOA) and Perfluorooctanesulfonic Acid (PFOS) as CERCLA Hazardous Substances*. https://www.federalregister.gov/documents/2024/05/08/2024-08547/designation-of-perfluorooctanoic-acid-pfoa-and-perfluorooctanesulfonic-acid-pfos-as-cercla-hazardous
336. US EPA. (2023, March 29). *PFAS National Primary Drinking Water Regulation Rulemaking*. https://www.federalregister.gov/documents/2023/03/29/2023-05471/pfas-national-primary-drinking-water-regulation-rulemaking#:~:text=In%20summary%2C%20the%20proposed%20MCLs,PFNA%2C%20and%2For%20PFBS.
337. MA DEP. (n.d.). *Massachusetts PFAS Drinking Water Standard (MCL)*. https://www.mass.gov/lists/massachusetts-pfas-drinking-water-standard-mcl
338. MDPH. (n.d.). *Water Quality Standards for Bottled Water in Massachusetts*. https://www.mass.gov/info-details/water-quality-standards-for-bottled-water-in-massachusetts
339. Ron, S. (2024, June 18). Addressing Extreme Heat and Air Quality in Schools. *MAPC*. https://www.mapc.org/planning101/extreme-heat-air-quality-in-schools/
340. MDPH. (n.d.). *Chapter II: Indoor Air Quality Results Interpretation*. Retrieved September 23, 2024, from https://www.mass.gov/doc/chapter-ii-indoor-air-quality-results-interpretation

341. *Reiteration of Existing OSHA Policy on Indoor Air Quality: Office Temperature/Humidity and Environmental Tobacco Smoke | Occupational Safety and Health Administration*. (n.d.). Retrieved September 23, 2024, from https://www.osha.gov/laws-regs/standardinterpretations/2003-02-24
342. Massachusetts Court System, & Trial Court Law Libraries. (2024, March 11). *Massachusetts law about winter heating*. Mass.Gov. https://www.mass.gov/info-details/massachusetts-law-about-winter-heating
343. *Minimum Workplace Heating Guidelines | Mass.gov*. (n.d.). Retrieved September 23, 2024, from https://www.mass.gov/doc/minimum-workplace-heating-guidelines
344. *A Comprehensive Strategy to Address Extreme Heat in Schools*. (n.d.). Retrieved September 23, 2024, from https://fas.org/publication/extreme-heat-schools/
345. OSHA. (2021, October 27). *Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings: Advance notice of proposed rulemaking*. Federal Register. https://www.federalregister.gov/documents/2021/10/27/2021-23250/heat-injury-and-illness-prevention-in-outdoor-and-indoor-work-settings
346. U.S. Department of Energy. (2007). *National Best Practices Manual for Building High Performance Schools*. https://www.energy.gov/eere/articles/national-best-practices-manual-building-high-performance-schools
347. Gorman, N. (2015, May 8). *Tips for Keeping Cool in the Classroom*. Education World. https://www.educationworld.com/tips-keeping-cool-classroom
348. 603 CMR 18.00: Program and Safety Standards for Approved Public or Private Day and Residential Special Education School Programs, 603 CMR 18.00 Code of Massachusetts Register (2016). https://www.mass.gov/regulations/603-CMR-1800-program-and-safety-standards-for-approved-public-or-private-day-and-residential-special-education-school-programs
349. ASHRAE. (n.d.). *Standard 55 – Thermal Environmental Conditions for Human Occupancy*. Retrieved August 6, 2024, from https://www.ashrae.org/technical-resources/bookstore/standard-55-thermal-environmental-conditions-for-human-occupancy
350. Massachusetts Pesticide Control Act, M.G.L., c. 132B § 2—6I. https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXIX/Chapter132b
351. Standards for Application, 333 CMR 13.00 (2017). https://www.mass.gov/regulations/333-CMR-1300-standards-for-application
352. US EPA. (2008, November). *Building Successful Programs to Address Chemical Risks in Schools*.
353. MDPH. (2016, May). *Guidance Concerning Proper Use and Storage of Chemicals in Schools to Protect Public Health*.
354. The General Court of the Commonwealth of Massachusetts. (n.d.). *Chapter 21C: Massachusetts Hazardous Waste Management*. https://malegislature.gov/Laws/GeneralLaws/PartI/TitleII/Chapter21C
355. The General Court of the Commonwealth of Massachusetts. (n.d.). *Chapter 111F: Hazardous Substances disclosure by Employers*. https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXVI/Chapter111F
356. The General Court of the Commonwealth of Massachusetts. (n.d.). *Chapter 21I: Massachusetts Toxics Use Reduction Act*. https://malegislature.gov/Laws/GeneralLaws/PartI/TitleII/Chapter21I
357. US EPA. (n.d.). *Resource Conservation and Recovery Act (RCRA) Overview*. https://www.epa.gov/rcra/resource-conservation-and-recovery-act-rcra-overview
358. Massachusetts Department of Labor Standards. (2017, January 13). *454 CMR 22.00: Deleading and Lead-Safe Renovation Regulations*. https://www.mass.gov/doc/454-cmr-22-deleading-and-lead-safe-renovation-regulations/download

359. US EPA. (2024, January 30). *Protect Your Family from Sources of Lead*. https://www.epa.gov/lead/protect-your-family-sources-lead
360. Lead Poisoning Prevention and Control, 105 CMR 460.000 (2017). https://www.mass.gov/regulations/105-CMR-46000-lead-poisoning-prevention-and-control
361. US EPA. (2000, February 23). *TSCA Sections 402/404 Training, Certification, Accreditation, and Standards for Lead-Based Paint Activities*. https://www.federalregister.gov/documents/2000/02/23/00-4240/tsca-sections-402404-training-certification-accreditation-and-standards-for-lead-based-paint
362. US EPA. (2008, December 8). *40 CFR Part 745 Subpart E: Residential Property Renovation: State, Territorial and Tribal Program Authorization Application Guidance*. https://19january2017snapshot.epa.gov/sites/production/files/documents/statetribalguidance.pdf
363. MDPH. (n.d.). *When Mercury-Added Products break, what do you do?*
364. MDPH. (n.d.). *Mercury Spill Clean Up Procedure*. https://www.mass.gov/info-details/mercury-spill-clean-up-procedure
365. MassDEP. (n.d.). *Getting Mercury Out of Schools: Guidance for Private and Parochial Schools in Massachusetts*.
366. Northeast Waste Management Officials' Association. (2007, October). *Mercury Use in School Classrooms: Summary and Assessment of Non-Mercury Alternatives*.
367. MassDEP. (n.d.). *Making Massachusetts Schools Mercury-Free*.
368. The General Court of the Commonwealth of Massachusetts. (n.d.). *Section 6G: Purchase of elemental mercury, mercury compounds and mercury-added equipment and materials by schools*. https://malegislature.gov/Laws/GeneralLaws/PartI/TitleII/Chapter21H/Section6G
369. The General Court of the Commonwealth of Massachusetts. (n.d.). *Section 6I: Disposal of mercury-added products; education program; discharge of mercury into water; scrap recycling of multi-component products containing mercury*. https://malegislature.gov/Laws/GeneralLaws/PartI/TitleII/Chapter21H/Section6I
370. US EPA. (2024, April 22). *Environmental Laws that Apply to Mercury*. https://www.epa.gov/mercury/environmental-laws-apply-mercury#:~:text=The%20Resource%20Conservation%20and%20Recovery,EPA's%20treatment%20and%20recycling%20standards.
371. US EPA. (2003, January 29). *Land Disposal Restrictions: Treatment Standards for Mercury-Bearing Hazardous Waste; Notice of Data Availability*. https://www.federalregister.gov/documents/2003/01/29/03-2035/land-disposal-restrictions-treatment-standards-for-mercury-bearing-hazardous-waste-notice-of-data#:~:text=Current%20regulations%20require%20that%20these,all%20other%20low%20mercury%20wastes.
372. Toxic Use Reduction Institute (TURI). (2020). *Athletic Playing Fields and Artificial Turf: Considerations for Municipalities and Institutions*. University of Massachusetts Lowell. https://www.turi.org/publications/artificial-turf/
373. Abel, D. (2019, October 19). Toxic chemicals are found in blades of artificial turf. *The Boston Globe*. https://www.bostonglobe.com/metro/2019/10/09/toxic-chemicals-found-blades-artificial-turf/1mlVxXjzCAqRahwgXtfy6K/story.html
374. Raza, S. (2023, August 3). Artificial turf replacement sparks PFAS concerns in Newton. *The Boston Globe*. https://www.bostonglobe.com/2023/08/03/science/artificial-turf/
375. *Voluntary Guidelines for Managing Food Allergies In Schools and Early Care and Education Programs*. (n.d.).

376. *Section 504 and Written Management Plans—FoodAllergy.org*. (n.d.). Retrieved September 23, 2024, from https://www.foodallergy.org/resources/section-504-and-written-management-plans
377. Section 8A: Operators of School Buses; Licensing; Training; Instructors, Part 1 Title XIV c90 MGL § 8A. Retrieved July 29, 2024, from https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXIV/Chapter90/Section8A
378. *Food Allergen Awareness training and regulation | Mass.gov*. (n.d.). Retrieved July 29, 2024, from https://www.mass.gov/lists/food-allergen-awareness-training-and-regulation
379. Section 55A: Sick, Injured or Incapacitated Pupils; Procedure for Handling; Emergency First Aid or Transportation; Exemption from Civil Liability, Part 1 Title XII c71 MGL § 55A. Retrieved July 29, 2024, from https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXII/Chapter71/Section55A
380. Section 6B: Food Allergy Awareness, Part 1, Title XX, c 140 MGL § 6B. Retrieved July 29, 2024, from https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXX/Chapter140/Section6B
381. Federal Rehabilitation Act of 1973. Retrieved June 24, 2024, from https://www.govinfo.gov/content/pkg/USCODE-2010-title29/pdf/USCODE-2010-title29-chap16-subchapV-sec794.pdf
382. THE ADMINISTRATION OF PRESCRIPTION MEDICATIONS IN PUBLIC AND PRIVATE SCHOOLS, 105 210.100 CMR. https://www.mass.gov/doc/105-cmr-210-the-administration-of-prescription-medications-in-public-and-private-schools/download
383. State Sanitary Code - Minimum Sanitation Standards for Food Establishments, 105 CMR 590.011. https://www.mass.gov/doc/105-cmr-590-state-sanitary-code-chapter-x-minimum-sanitation-standards-for-food-establishments/download
384. National School Lunch Program, Subtitle B c. II sc. A 210 7 CFR. Retrieved July 29, 2024, from https://www.ecfr.gov/current/title-7/part-210
385. MA Chapter of the American Institute of Architects. (n.d.). *Measuring Energy & Health in Existing Massachusetts Schools: Recommendations for Implementing Section 83 of Chapter 179 of the Acts of 2022*.
386. The Educational Facilities Committee of the Illuminating Engineering Society of North America. (2013). *American National Standard Practice on Lighting for Educational Facilities*.
387. Armstrong World Industries. (n.d.). *Meeting ANSI Standard S12.60 Requirements*.
388. Institute of Acoustics, & Acoustics & Noise Consultants. (2015). *Acoustics of Schools: A design guide*.
389. Ulrich, R. S., Bogren, L., Gardiner, S. K., & Lundin, S. (2018). Psychiatric ward design can reduce aggressive behavior. *Journal of Environmental Psychology*, *57*, 53–66. https://doi.org/10.1016/j.jenvp.2018.05.002
390. Walden University. (2024). *How Overcrowded Classrooms Affect Education*. Walden University. https://www.waldenu.edu/online-masters-programs/ms-in-education/resource/five-ways-that-overcrowded-classrooms-affect-education
391. Office of Justice Programs. (1994). *Violence in America's Public Schools: The Family Perspective*. https://www.ojp.gov/ncjrs/virtual-library/abstracts/violence-americas-public-schools-family-perspective
392. Stanford, L., & Baker, L. (2023, April 6). 5 Tips for Designing School Spaces That Support Students' Mental Health. *Education Week*. https://www.edweek.org/leadership/5-tips-for-designing-school-spaces-that-support-students-mental-health/2023/04
393. Latané, C. (2021). *Schools that heal: Design with mental health in mind* (Vol. 6). Island Press. https://doi.org/10.1080/23748834.2022.2136611
394. Steemers, K. (2021, May 7). *Architecture for Well-Being and Health*. https://www.daylightandarchitecture.com/architecture-for-well-being-and-health/

395. Karakas, T., & Yildiz, D. (2020). Exploring the influence of the built environment on human experience through a neuroscience approach: A systematic review. *Frontiers of Architectural Research*, *9*(1), 236–247. https://doi.org/10.1016/j.foar.2019.10.005
396. MSBA. (n.d.). *Special education continuum of services and design considerations—Rules of thumb*. https://www.massschoolbuildings.org/sites/default/files/edit-contentfiles/About_Us/Roundtables/Designer/Handouts.pdf
397. MA DESE. (n.d.). *Inclusive Practice*.
398. Molina Roldán, S., Marauri, J., Aubert, A., & Flecha, R. (2021). How Inclusive Interactive Learning Environments Benefit Students Without Special Needs. *Frontiers in Psychology*, *12*, 661427. https://doi.org/10.3389/fpsyg.2021.661427
399. 603 CMR 28. Retrieved June 21, 2024, from https://www.mass.gov/doc/603-cmr-28-special-education/download
400. *Universal Design in Education: Principles and Applications | DO-IT*. (n.d.). Retrieved June 24, 2024, from https://www.washington.edu/doit/universal-design-education-principles-and-applications
401. *Universal Design for Learning | Center for Teaching Innovation*. (n.d.). Retrieved June 24, 2024, from https://teaching.cornell.edu/teaching-resources/designing-your-course/universal-design-learning
402. *About Universal Design for Learning*. (n.d.). CAST. Retrieved July 23, 2024, from https://www.cast.org/impact/universal-design-for-learning-udl
403. Stone, J. (n.d.). When We Design for Autism, We Design for Everyone. *Metropolis*. Retrieved July 9, 2024, from https://metropolismag.com/viewpoints/when-we-design-for-autism-we-design-for-everyone/
404. Institute for Human Centered Design. (n.d.). *ADA Checklist for Existing Facilities*. Retrieved July 10, 2024, from https://www.adachecklist.org/doc/fullchecklist/ada-checklist.pdf
405. *Equal Access: Universal Design of Physical Spaces | DO-IT*. (n.d.). Retrieved June 24, 2024, from https://www.washington.edu/doit/equal-access-universal-design-physical-spaces
406. *Cambridge Playground Named Best Outdoor Play Space*. (2024, July 12). https://www.cambridgema.gov/en/news/2024/07/cambridgeplaygroundnamedbestoutdoorplayspace
407. *MOEC Collaboratives and Programs | MOEC Collaboratives and Programs*. (n.d.). Retrieved July 24, 2024, from https://moec-programs.org/
408. *Section 504—Special Education*. (n.d.). Retrieved June 24, 2024, from https://www.doe.mass.edu/sped/links/sec504.html
409. *34 CFR § 300.114—LRE requirements.* (n.d.). LII / Legal Information Institute. Retrieved June 24, 2024, from https://www.law.cornell.edu/cfr/text/34/300.114
410. DESE. (2016). *Special Education: Legal Standards, Compliance Ratings, and Comments*. https://campussuite-storage.s3.amazonaws.com/prod/11162/b2004386-1ca3-11e6-b537-22000bd8490f/1670790/165c4d40-dff5-11e7-a0f0-0a83b46fca6a/file/2Shrewsbury_02710000_CPR2016.pdf
411. *Special Education Policy Memo SY2023-2024—3: 2023-2024 Determinations of Need for Special Education Technical Assistance or Intervention—Special Education*. (n.d.). Retrieved June 24, 2024, from https://www.doe.mass.edu/sped/advisories/memo2023-3.html
412. *Americans with Disabilities Act Title II Regulations*. (2024, June 24). ADA.Gov. https://www.ada.gov/law-and-regs/regulations/title-ii-2010-regulations/
413. Government Accountability Office. (2020). *K-12 Education: School Districts Need Better Information to Help Improve Access for People with Disabilities* (No. GAO-20-448). https://www.gao.gov/assets/d20448.pdf

414. *U.S. Access Board - Chapter 7: Signs*. (n.d.). Retrieved July 24, 2024, from https://www.access-board.gov/ada/guides/chapter-7-signs/
415. *U.S. Access Board - Chapter 4: Entrances, Doors, and Gates*. (n.d.). Retrieved July 24, 2024, from https://www.access-board.gov/ada/guides/chapter-4-entrances-doors-and-gates/
416. *U.S. Access Board - Chapter 4: Ramps and Curb Ramps*. (n.d.). Retrieved July 24, 2024, from https://www.access-board.gov/ada/guides/chapter-4-ramps-and-curb-ramps/
417. *U.S. Access Board - Chapter 4: Elevators and Platform Lifts*. (n.d.). Retrieved July 24, 2024, from https://www.access-board.gov/ada/guides/chapter-4-elevators-and-platform-lifts/
418. *U.S. Access Board - Chapter 6: Toilet Rooms*. (n.d.). Retrieved July 24, 2024, from https://www.access-board.gov/ada/guides/chapter-6-toilet-rooms/
419. *603 CMR 26.00: Access To Equal Educational Opportunity—Education Laws and Regulations*. (n.d.). Retrieved July 2, 2024, from https://www.doe.mass.edu/lawsregs/603cmr26.html
420. Holser, A. (n.d.). *Design Strategies for Restroom & Locker Room Facilities*. https://www.opsisarch.com/wp-content/uploads//2022/06/Opsis-Architecture-Gender-Inclusive-Facilities-Design-Strategies-Case-Study.pdf
421. *Harmonizing the seen and unseen when designing for neurodiversity*. (n.d.). Retrieved July 5, 2024, from https://www.stantec.com/en/ideas/topic/buildings/harmonizing-the-seen-and-unseen-when-designing-for-neurodiversity
422. Maciver, D., Rutherford, M., Arakelyan, S., Kramer, J., Richmond, J., Todorova, L., Romero-Ayuso, D., Nakamura-Thomas, H., Veldenid, M., Finlaysonid, I., O’hare, A., & Forsyth, K. (2019). Participation of children with disabilities in school: A realist systematic review of psychosocial and environmental factors. *PLOS ONE*, *14*. https://doi.org/10.1371/journal.pone.0210511
423. NCSE. (2021). *Sensory Spaces in Schools*. https://ncse.ie/wp-content/uploads/2021/10/NCSE-Sensory-Spaces-in-Schools-2021.pdf
424. Cooke, S.-E. (2021, July 14). *How to Create a Sensory-Friendly Classroom*. Sensory Friendly Solutions. https://www.sensoryfriendly.net/how-to-create-a-sensory-friendly-classroom/
425. *Guidance for MA Public Schools Creating a Safe and Supportive School Environment—Student and Family Support*. (n.d.). Retrieved July 1, 2024, from https://www.doe.mass.edu/sfs/lgbtq/GenderIdentity.html
426. *521 CMR 12.00: Educational facilities | Mass.gov*. (n.d.). Retrieved July 2, 2024, from https://www.mass.gov/regulations/521-CMR-1200-educational-facilities
427. *Americans with Disabilities Act Title III Regulations*. (2012, March 8). ADA.Gov. https://www.ada.gov/law-and-regs/regulations/title-iii-regulations/
428. US EPA, O. (2015, February 28). *Title IX of the Education Amendments Act of 1972* [Other Policies and Guidance]. https://www.epa.gov/external-civil-rights/title-ix-education-amendments-act-1972
429. *2010 ADA Standards for Accessible Design*. (2010, September 15). ADA.Gov. https://www.ada.gov/law-and-regs/design-standards/2010-stds/