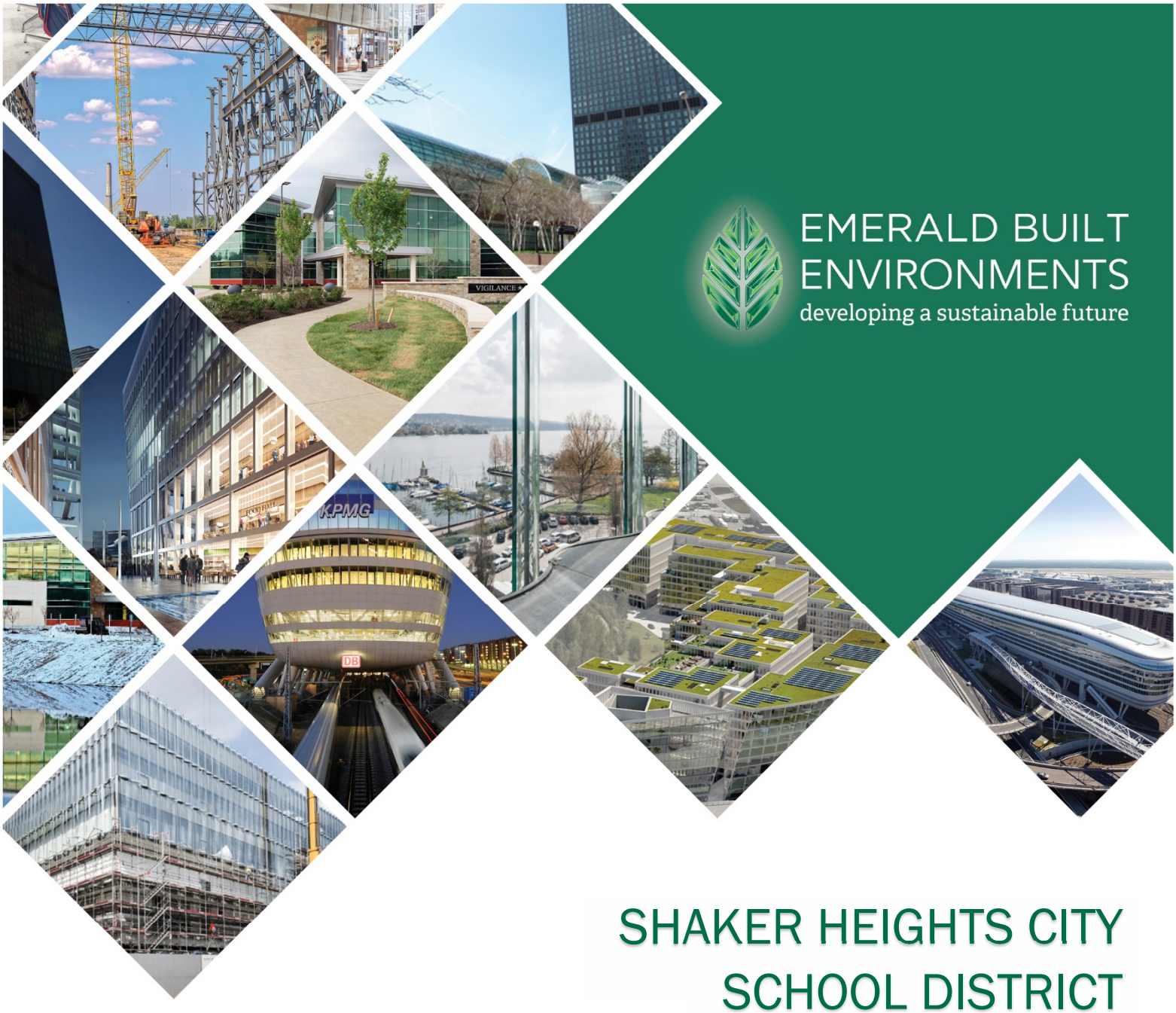

EMERALD BUILT ENVIRONMENTS
developing a sustainable future

SHAKER HEIGHTS CITY SCHOOL DISTRICT

DISTRICT SUSTAINABILITY PLAN

PRESENTED TO:

Shaker Heights City School District

November 25, 2025

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ACHIEVING SUSTAINABLE SUCCESS: THE EMERALD WAY

The Shaker Heights City School District Sustainability Plan engagement was designed in accordance with Emerald's proven four-step process, initially developed to help teams achieve high-performance buildings. The four-step process provides a benchmark for continuous benchmarking and improvement-planning for sustainability initiatives, including corporate strategies, product development, and facility design, operation, and maintenance. The quantitative and qualitative work that defined this engagement informs the recommendations of this report. Recommendations represent a first step at strategy development, and, ultimately, leadership will need a plan for implementation and a commitment to continued testing and measurement to ensure ongoing success.

INTRODUCTION:THE SHAKER HEIGHTS CITY SCHOOL DISTRICT

The Shaker Heights City School District (the District) includes the city of Shaker Heights and a small portion of Cleveland near Shaker Square, encompassing about 7.5 square miles. The District is situated within a 15-minute drive from Cleveland's University Circle, the home of world-class hospitals and museums, the Cleveland Orchestra, and Case Western Reserve University. Long known for the beauty of its neighborhoods and parklands, Shaker Heights is home to some 30,000 residents of diverse cultural backgrounds and is renowned for its commitment to educational excellence.

The District boasts more than 35,000 graduates worldwide, and more than 4,000 of them have returned to make their homes in Shaker Heights.

Per the Annual Comprehensive Financial Report (ACFR) for the fiscal year ended June 30, 2024, the District is the 72nd largest in student enrollment in Ohio, with an enrollment of 4,366 full time equivalent students for the 2023-2024 academic year.

The Mission

The District will nurture, educate, and graduate students who are civic-minded and prepared to make ethical decisions; who are confident, competent communicators, skillful in problem solving, capable of creative thinking; who have a career motivation and a knowledge of our global and multicultural society.

The Schools

Within the Shaker Heights City School District, there are currently eight school facilities:

- Shaker Heights Hight School: Grades 9-12
- Shaker Heights Middle School: Grades 6-8
- Boulevard Elementary School: Grades K-5
- Fernway Elementary School: Grades K-5
- Lomond Elementary School: Grades K-5
- Mercer Elementary School: Grades K-5
- Onaway Elementary School: Grades K-5
- Ludlow Early Learning Center: PreK (ages 3-5)

Long-Term Master Facilities Plan

The Shaker Heights City School District's Long-Term Master Facilities Plan is a comprehensive initiative aimed at modernizing and improving the district's aging school buildings to better support 21st century learning.

The **vision** for all Shaker Heights children is they engage in their learning and growth in facilities:

- that are welcoming, modern and safe;
- promote academic excellence in inclusive, diverse, and integrated learning environments; and
- are operated and maintained by a fiscally responsible District.

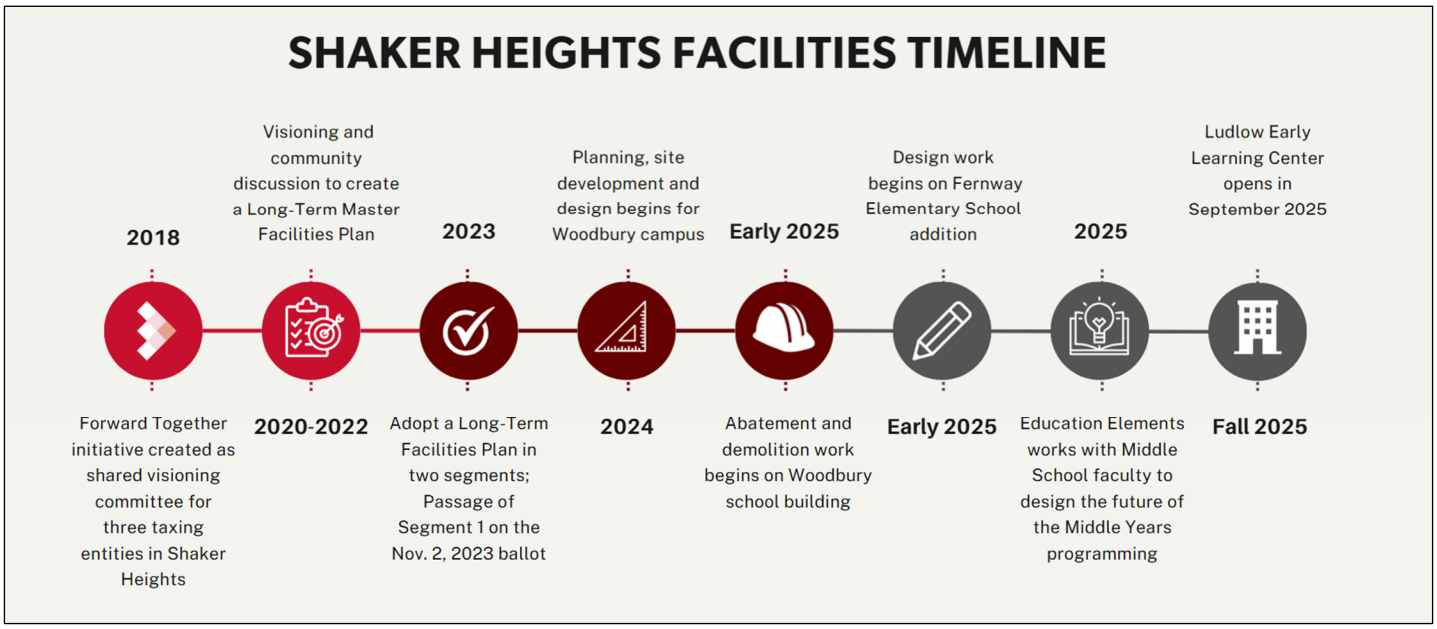
The District's Long-Term Master Facilities Plan has been a multi-year initiative with efforts commencing in 2018. Moving forward, the Long-Term Master Facilities Plan is divided into two primary segments:

Segment 1 - funded and underway

- Renovate Ludlow to accommodate expanded PreK program
- Renovate and expand Woodbury as a Middle Years Building (Grades 6-8)
- Renovate Boulevard, Lomond, Mercer and Onaway and convert elementary school buildings to include Grade 5
- Build addition to Fernway to accommodate Grade 5 (if needed)

Segment 2 – pending future funding

- Build new High School near current campus site



EXECUTIVE SUMMARY

As part of ongoing efforts to enhance its sustainability performance, the Shaker Heights City School District (District) engaged with Emerald Built Environments to develop a District Sustainability Plan (Plan) to guide its strategic efforts in the years to come. Over several months in 2025, the District and Emerald Built Environments collaborated on the following key actions:

- Completion of an energy analysis to inform upcoming K-5 renovations and broader district energy strategy
- Baselining the District's scope 1 and 2 greenhouse gas (GHG) emissions
- Facilitation of community partner engagement to uncover sustainability priorities
- Review of existing facility operations to align with sustainability best practices
- Development of a core strategy to achieve LEED Silver Certification or higher with a cost-effective certification strategy

The District Sustainability Plan was developed as the Shaker Heights City School District was implementing its previously initiated Long-Term Master Facilities Plan to modernize and improve the District's aging building portfolio. At every stage of the Plan's development, the Emerald team considered the efforts undertaken by the District in the years that preceded Emerald's engagement and how to most effectively integrate sustainability best practices into the Long-Term Master Facilities Plan already underway.

The Need

Sustainability has been identified as a key priority for community members in the Shaker Heights City School District. As the District is implementing its Long-Term Master Facilities Plan, it is imperative that sustainability is embedded in the planning, design, construction, and operation of the facilities within the District's footprint, consisting of eight academic buildings and additional administrative/support facilities. For additional context, the following factors should be considered:

- The building portfolio primarily consists of older structures
- The District is in the early stages of a significant construction initiative including major renovation of six buildings, including the potential demolition and construction of a new high school
- The District operates in a LEED Gold Certified city
- The building program requires sustainable design, construction, and the achievement of LEED Certification
- Community members seek participation in sustainable strategy development
- Implementing sustainable operations across the District can (and must) begin now

Goals & Milestones

Although the Shaker Heights City School District currently lacks formal sustainability goals, there is a clear and growing desire to establish and communicate explicit goals in the years to come. This presents a valuable opportunity to align educational practices with environmental stewardship, fostering a culture of sustainability among students, staff, and the broader community. By developing explicit goals, the District can begin to systematically address energy efficiency, waste reduction, and sustainable transportation while also integrating environmental education into the curriculum.

Establishing these goals will not only demonstrate a commitment to responsible resource management but also empower students to become environmentally conscious citizens. The District's willingness to pursue sustainability initiatives is a promising step toward creating a more resilient and forward-thinking educational environment.

As the first sustainability plan for the District, this initiative is just the beginning. Production of this initial strategy report is a notable milestone, and success will be measured by the activities that follow and the refinement of the strategy to occur in subsequent years. In the short term, the District's goals will be focused on Reduction – utility consumption, GHG emissions, and cost – with the foundation developed and the efficiencies realized serving as a stepping stone to creating more quantifiable, measurable goals in the future.

Additionally, as a participant in the International Baccalaureate (IB) Programme, the District is deeply committed to leading by example, fostering responsible citizenship, and cultivating strong partnerships. These core values have been clearly present in the development of the District Sustainability Plan and will continue to guide this project in the years to come.

The collaborative efforts of the teams at the Shaker Heights City School District and Emerald Built Environments have produced this sustainability plan, a document that will provide a framework to help guide the evolution of the District's approach to sustainability moving forward. The components of this strategy and accompanying action plan will provide a snapshot of the District's status on sustainability and actionable, measurable, and clear next steps to be taken.

In short, the process has just begun. Congratulations to the Shaker team on taking this first step – developing its sustainability plan – as this is a significant milestone! Emerald is your team and will be with you in 2026 and beyond to support implementation of the initiatives described in this report.

Sustainability Defined

The World Commission on Environment and Development (WCED) in 1987 was the precursor to many business and government initiatives that seek to improve environmental health. Documented in the Brundtland Report, the WCED's work over thirty-five years ago is still referenced today by experts in sustainability. The most notable reference is to its succinct definition of sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Through its collaboration with the District to date, Emerald has crafted the proposed mission statement as it relates to sustainability:

The Shaker Heights City School District is dedicated to creating healthy, resilient, and environmentally responsible schools by integrating sustainable practices into design, construction, operations, and education. Through collaboration and continuous improvement, the District aims to reduce environmental impact, promote wellness, and engage the community in achieving shared sustainability goals.

We encourage District leaders to continue to work with community partners to refine this mission statement in the years to come.

Recommendations

Embedded throughout this document and the attached Action Plan Workbook are recommendations for moving forward. Having engaged with the team and the community over the course of 2025, Emerald recommends that District leaders consider the following recommendations that blend several concepts outlined in both this report and accompanying materials:

- **LEAD BY EXAMPLE:** Consistent with the District's core values, elevate key activities for sustainability thought leadership in 2026. Specifically, we recommend:
  - A partner engagement program should be defined and implemented, including both internal team members, such as faculty/staff, and external groups such as vendors. Of course, students and parents should be engaged at a foundational level. This engagement program may include workshops, surveys, or interviews.
  - Leverage the partner engagement program both to help implement elements of this Plan and to communicate success stories to the community more broadly.

- **CONTINUE TO EXPLORE AND REFINE THE DEFINITION OF SUSTAINABILITY:** The word "sustainability" means different things to different people, and each organization has its definition. What sustainability means to Shaker may change over time, shaping how resources are prioritized and allocated to achieve long-term goals. Establishing a clear and context-specific definition will be essential in guiding thoughtful and strategic decision-making. Engaging staff with questions such as, "How can your role or your team contribute to the District's sustainability objectives?" can spark innovative thinking and broaden perspectives. As competing priorities emerge in the years ahead, having a well-articulated and shared understanding of sustainability will help ensure that Shaker's approach remains comprehensive, balanced, and aligned with its values.

- **DEVELOP A SCORECARD AND TRACK REGULARLY:** In alignment with the aspirational goal to lead by example, when the District tracks its performance and reports results internally, it creates opportunities for people to find their place in helping achieve the goal. A scorecard with a few key metrics that affect employees and students, shared on the intranet or related communication system, will increase transparency and demonstrate what is important. Consider metrics such as:

  - Total GHG emissions saved and % compared to baseline
  - Total water consumed and % compared to baseline
  - Total waste diverted from landfills

Action Plan Workbook

This strategy document accompanies an MS Excel workbook with suggested action steps. The Action Plan is designed to be a working document that facilitates task assignment and progress monitoring. This template should be viewed as a starting point to help the District begin the implementation of this District Sustainability Plan and should evolve to best suit the needs of the team.

DISTRICT-WIDE ENERGY ANALYSIS

Introduction

Emerald Built Environments (Emerald) was requested by the Shaker Heights City School District to analyze energy needs for the District. The analysis included:

- A detailed evaluation of systems and the interconnection of efficiencies from envelope improvements to inform scope for K-5 buildings – Boulevard, Lomond, Mercer, and Onaway
- Recording analysis and recommendations in a clear Basis of Design (BoD) for the K-5 buildings
- A broader review of the district-wide energy profile based on the current energy use of the building portfolio
- A high-level review of potentials for on-site solar or other renewables

The analysis included energy audits, energy modeling, a review of utility consumption trends, and meetings with facilities personnel. The intent of this initiative was to gather baseline data on building conditions and performance to better understand where resources for improvement could be best directed to advance the goals of the District and the community.

Recommendation for HVAC Retrofit

Based on the buildings' age, historic character, and the District's sustainability goals, Emerald recommends pursuing variable refrigerant flow (VRF) systems as the primary HVAC retrofit strategy. VRF technology provides high energy efficiency, low operating costs, and zoning flexibility while minimizing disruption to historic features. Its ability to deliver heating and cooling simultaneously, operate quietly, and integrate into phased renovation schedules makes it particularly well-suited for the District. In addition to efficiency gains, VRF systems align with the District's climate commitments and provide long-term operational value.

We anticipate an overall energy cost reduction of 15-20% compared to a traditional VAV system, as well as a lower overall installation cost. Our assumptions are based on the amount of rework required to accommodate installation of ductwork and space for traditional heating/cooling plant equipment. A summary of the findings is listed below, along with further recommendations.

Energy Audit Findings

The following summarizes the findings of the site visits and is indicative of all buildings:

- Buildings have central ventilation systems, currently in disrepair at Onaway, Boulevard, and Lomond
    - The intent would be to correct deficiencies and utilize for future ventilation needs.
    - Add cooling/repair heating to create "DOAS" system – Dedicated Outdoor Air System
- Attic louvers and fans could be refurbished to allow for better heat removal from the attic.
- Controls systems could be improved.
    - All remaining pneumatic systems should be replaced with modern BAS connected thermostats and heating valves.
- Variable Frequency Drives (VFDs) on heating water pumps with updated outside air (OA) temperature reset controls strategy would save energy

- Steam boilers could benefit from economizers and other efficiency upgrades
- Heating water boilers could be replaced with modern high-efficiency boilers
- All fluorescent lamps should be replaced with LED as they fail

Overall Recommendations to Consider

Recommended HVAC Retrofit: Variable Refrigerant Flow (VRF) Systems:

As part of the planned energy and sustainability retrofit of the elementary schools, we recommend the installation of variable refrigerant flow (VRF) systems as the new HVAC solution. This approach provides an ideal balance between preserving the historic character of the school buildings and delivering modern, high-performance heating and cooling.

Preservation of Historic Architecture: VRF technology requires minimal ductwork and piping, which reduces the need for invasive alterations to walls, ceilings, and finishes. This approach helps maintain the historic integrity of the building while discreetly integrating modern comfort systems.

Energy Efficiency and Sustainability: VRF systems deliver exceptional energy efficiency through variable capacity operation and advanced heat recovery, reducing energy use and greenhouse gas emissions. These systems provide significant long-term operating cost savings while aligning with the District's sustainability goals.

Comfort and Learning Environment: The ability to control individual zones ensures that each classroom can be conditioned independently, providing optimal comfort for students and staff. Quiet operation reduces disruption, and precise temperature and humidity management support healthier indoor air quality.

Adaptability and Flexibility: VRF systems can be installed in phases and easily reconfigured as building spaces are repurposed, supporting long-term adaptability in a historic building setting.

Operational and Financial Value: VRF technology offers lower maintenance needs, extended equipment lifespan, and smart controls that allow facilities staff to monitor and optimize system performance remotely. The system may also qualify for rebates or incentives, improving total cost of ownership.

In summary, VRF technology offers a rare combination of historic preservation, sustainability, comfort, adaptability, and lifecycle value. By selecting this system, the District can preserve the heritage of the existing structures while advancing the District's modern energy performance goals.

Regarding HVAC, there are multiple opportunities to explore for potential improvement:

- Continue to understand how to restore central ventilation system. This would include the ability to filter and temper outdoor air for both heating and cooling. It would also allow for better control of energy use during heating season
- Continue to work on attic louvers and attic exhaust retrofit
- Conversion to hot water heating system
    - This ECM will require substantial re-work of the existing steam heating system

  - The scope would include replacing existing boilers and local space radiators.
  - Hot water boilers can achieve efficiencies up to 97% vs steam boilers of 83%
- Investigate economizer for steam boilers
- Investigate more efficient condensing boilers for heating water system
- Ultrasonic leak detection for pneumatic systems
- Investigate improved HVAC monitoring and controls, including new control valves for heating and new BAS connected thermostats. This would also allow for nighttime setback.
- Replace fluorescent lamps with LED.
- Plan for replacement of domestic hot water heaters with newer, high efficiency gas units.

Energy Analysis

An energy model was constructed in Trane Trace™ 700 software, which is approved by LEED and the US Department of Energy, and ASHRAE 90.1 Appendix G for energy modeling, and was used to calculate the energy consumption of the building.

An energy model was also constructed to account for the change in HVAC system type as well as evaluate the current implemented ECM for reducing the fan run time near the beginning of the year. The building systems were assumed to operate

The following table summarizes the analysis results, comparing actual costs in 2024 against variable refrigerant flow (VRF) and traditional air handling unit (AHU) options. Please note the VRF and AHU costs increase in comparison to the 2024 actual costs – this result is expanded upon further below and can be attributed to the addition of central cooling and functioning ventilation systems:

	ACTUAL Cost (2024)	VRF HP Costs	AHU Costs
Boulevard			
Electric kWh	$ 21,616	$ 27,704	$ 28,549
Gas Therm	$ 8,294	$ 3,845	$ 4,178
	$ 29,910	**$ 31,549**	**$ 32,727**
Lomond			
Electric kWh	$ 27,088	$ 34,766	$ 36,736
Gas Therm	$ 9,704	$ 3,724	$ 3,673
	$ 36,792	**$ 38,490**	**$ 40,409**
Mercer			
Electric kWh	$ 21,220	$ 36,031	$ 41,271
Gas Therm	$ 7,360	$ 6,458	$ 6,236
	$ 28,580	**$ 42,489**	**$ 47,507**

	ACTUAL Cost (2024)	VRF HP Costs	AHU Costs
Onaway			
Electric kWh	$ 24,198	$ 22,906	$ 26,158
Gas Therm	$ 6,982	$ 5,504	$ 5,775
	$ 31,180	**$ 28,410**	**$ 31,933**

As shown above, the savings of a traditional AHU system would have comparable savings when compared to the VRF option, but with much more required renovation and infrastructure modifications.

Following preliminary conversations with District personnel, it is evident that VRF Systems, though cost effective and proven in the industry, may have some hurdles to overcome as it relates to OFCC funding. Additional system types, such as 4-pipe fancoils using chilled and hot water, offer similar benefits to VRF in that smaller zoned equipment is used in the spaces and leverages piping, instead of ductwork. These systems offer comparable energy savings, shown at Boulevard:

	ACTUAL Cost (2024)	VRF HP Costs	AHU Costs	4 Pipe Fancoil
Boulevard				
Electric kWh	$ 21,616	$ 27,704	$ 28,549	$27,820
Gas Therm	$ 8,294	$ 3,845	$ 4,178	$4,500
	$ 29,910	**$ 31,549**	**$ 32,727**	**$32,320**

With the models created, further analysis can be performed at either location with coordination from the design team once system options are further pursued. We recommend the following as next steps:

- Follow up with the OFCC on VRF system options and specific objections or clarifications to determine feasibility
- Include a preliminary energy modeling exercise for the next identified renovation
  - Early energy modeling can help target specific system options and assist with drafting a narrative for preliminary budget exercises
- Each property has its own unique features. Exploring multiple systems at each site may offer the best complete solution.

Energy Summary – Existing Buildings

The primary difficulties with performing energy comparisons with the existing buildings are as follows:

- As noted above, the existing buildings do not have central cooling – some sites have limited single zone split systems, but generally the buildings are not cooled.
- Ventilation – several buildings do not have a functioning ventilation system.

Adding cooling will increase energy use in the building; therefore, the existing conditions analysis is primarily attempting to validate the overall envelope and general utility use. Modeled results are within

10% overall from actual use. We can likely expect actual results to vary from predicted. The intent, however, is to ensure that modeled alternatives are using a valid base building and can be a reliable, relative comparison for energy use.

See accompanying Shaker Elementary Schools Assessment Summary document for individual building reports.

Renewables Assessment

The district-wide energy analysis addressed the potential for solar installations at the K-5 schools – Boulevard, Lomond, Mercer, and Onaway. This analysis is an estimate of solar potential and should be viewed as a preliminary assessment.

Of the four schools analyzed, three of the four have roofs that are currently suitable for solar installation. At Boulevard, the sloped slate roof is not conducive to panel installation, and the parapet offers minimal usable space. The only viable option for this site is covered parking, which is limited and represents the highest cost per watt for solar installation.

The remaining three school buildings have usable flat roof upon which solar panels could be installed. Our estimates are based on total free area and may be reduced for a more optimal configuration. Estimates are utilized to explore the opportunity and not intended to reflect actual solar design. Emerald's preliminary assessment of potential solar output is as follows:

	SF of Usable Flat Roof	Est. Output Capacity (KW)	Est. Output Capacity (kWh)*	2024 Electric Consumption (kWh)	% Offset by Solar
Lomond	9,450	175	212,076	210,316	100.84%
Onaway	5,000	100	125,088	234,642	53.31%
Mercer	10,000	200	237,783	178,974	132.86%

** Data generated using PVWatts® Calculator, National Renewable Energy Laboratory (NREL). Accessed November 25, 2025. Available at: https://pvwatts.nrel.gov.*

While, at first glance, it may sound attractive to be able to offset annual electricity consumption, when factoring in the current electricity spend and a conservative installation cost of $4/watt, the payback period may stretch beyond the District's goals:

	2024 Electric Cost (ACTUAL)	Est. Output Capacity (KW)	Installation Cost ($4/watt)	Payback Period (Current)
Lomond	$27,088	175	$525,000	25.8 years
Onaway	$24,198	100	$300,000	16.5 years
Mercer	$21,220	200	$600,000	37.7 years

Emerald is not a solar provider and cannot be quoted; however, based on industry averages, the above calculations show the general proportions solar could support and the estimated costs.

Unfortunately, when compared with projects across the country, those in the state of Ohio demonstrate a low IRR% (internal rate of return) on solar projects (7.8, with 13 or higher being a good target, 10 on

the low side), and Cleveland weather further reduces the benefit as typical conditions limit solar potential and extends the time it takes to recoup the initial investment – the payback period.

As such, without tax credits or other financial assistance, it is difficult to justify investment in on-site solar capabilities based *solely* on financial metrics. That said, there is a potential for offsetting a considerable amount of the electrical use at Lomond and Mercer. Solar installations could be considered for their environmental and resilience benefits, alignment with sustainability goals, and educational value.

The District should continue to evaluate the potential for on-site solar installations moving forward. Advancements in solar technology and evolving financial incentive frameworks may make solar a more cost-effective solution in the future. Ongoing assessment will help ensure the District remains positioned to take advantage of emerging opportunities in renewable energy.

GREENHOUSE GAS EMISSIONS BASELINE

Greenhouse Gas (GHG) Emissions - Introduction

The built environment plays a significant role in global greenhouse gas (GHG) emissions. Buildings account for nearly 40% of global energy-related CO_2 emissions, primarily through electricity use, heating, cooling, and material production. Every stage of a building's life cycle contributes to its carbon footprint: construction generates emissions from manufacturing and transporting materials, while ongoing operations consume energy for lighting, HVAC systems, and technology. In school districts, these impacts are amplified by large building footprints, extended operating hours, and aging infrastructure. High GHG emissions from buildings accelerate climate change, leading to extreme weather, resource scarcity, and health risks. Addressing emissions in the built environment is therefore critical—not only to meet climate targets but also to create healthier, more efficient spaces for learning.

Emerald Built Environments conducted a preliminary GHG emissions analysis for the purpose of developing a baseline that the Shaker Heights City School District can utilize as it further develops its sustainability initiatives over time. Having this established baseline will help the District demonstrate accountability, justify future capital expenditures, and guide continuous improvement in a science-based method.

Overview: Greenhouse Gas Protocol

Greenhouse Gas Protocol is one of the world's most widely used greenhouse gas accounting standards. Referred to as the GHG Protocol, this standard is referenced by many other reporting bodies and platforms. By using this protocol Emerald Built Environments can guide clients through the measurement of their GHG impacts, which is necessary to manage, offset, and set reduction goals.

GHG Scope by Category

The following table shows the full list of scopes and categories per the GHG Protocol. It is recommended that an organization begin GHG reporting with its highest impact scopes and continue to expand the reporting categories in future reports.

Scope 1 emissions are direct greenhouse gas emissions from sources that an organization owns or controls, such as on-site fuel combustion in boilers, furnaces, and fleet vehicles. **Scope 2 emissions** are indirect emissions from the generation of purchased electricity, steam, heating, or cooling consumed by the organization.

Scopes 1 and 2 for the Shaker Heights City School District will primarily consist of building portfolio energy emissions and fleet fuel emissions.

Scope 3 emissions are indirect greenhouse gas emissions from activities in an organization's value chain, such as purchased goods, transportation, waste, and employee commuting. They often represent the largest share of total emissions, making them critical for a complete sustainability strategy. They are also more challenging to quantify. As such, the District has declined to pursue Scope 3 emissions reporting at this time, but it will become a long-term priority. To further illustrate, Scope 3 emissions may consist of the following:

Scope 3 Category	Description (from GHG Protocol)
1 – Purchased Goods & Services	Extraction, production, and transportation of goods and services purchased or acquired by the reporting company in the reporting year, not otherwise included in Categories 2 - 8
2 – Capital Goods	Extraction, production, and transportation of capital goods purchased/acquired by the reporting company in the reporting year
3 – Fuel and Energy Related Activities not included in Scope 1 & 2	Extraction, production, and transportation of fuels and energy purchased or acquired by the reporting company in the reporting year, not already accounted for in scope 1 or scope 2, including: **a.** Upstream emissions of purchased fuels (extraction, production, and transportation of fuels consumed by the reporting company) **b.** Upstream emissions of purchased electricity (extraction, production, and transportation of fuels consumed in the generation of electricity, steam, heating, and cooling consumed by the reporting company) **c.** Transmission and distribution (T&D) losses (generation of electricity, steam, heating and cooling that is consumed (i.e., lost) in a T&D system) – reported by end user **d.** Generation of purchased electricity that is sold to end users (generation of electricity, steam, heating, and cooling that is purchased by the reporting company and sold to end users) – reported by utility company or energy retailer only
4 – Upstream Transportation and Distribution	Transportation and distribution of products purchased by the reporting company in the reporting year between a company's tier 1 suppliers and its own operations (in vehicles and facilities not owned or controlled by the reporting company) Transportation and distribution services purchased by the reporting company in the reporting year, including inbound logistics, outbound logistics (e.g., of sold products), and transportation and distribution between a company's own facilities (in vehicles and facilities not owned or controlled by the reporting company)
5 – Waste Generated in Operations	Disposal and treatment of waste generated in the reporting company's operations in the reporting year (in facilities not owned or controlled by the reporting company)
6 – Business Travel	Transportation of employees for business-related activities during the reporting year (in vehicles not owned or operated by the reporting company)
7 – Employee Commuting	Transportation of employees between their homes and their worksites during the reporting year (in vehicles not owned or operated by the reporting company)
8 – Upstream Leased Assets	Operation of assets leased by the reporting company (lessee) in the reporting year and not included in scope 1 and scope 2 – reported by lessee

Scope 3 Category	Description (from GHG Protocol)
9 – Downstream Transportation and Distribution	Transportation and distribution of products sold by the reporting company in the reporting year between the reporting company's operations and the end consumer (if not paid for by the reporting company), including retail and storage (in vehicles and facilities not owned or controlled by the reporting company)
10 – Processing of Sold Products	Processing of intermediate products sold in the reporting year by downstream companies (e.g., manufacturers)
11 – Use of Sold Products	End use of goods and services sold by the reporting company in the reporting year
12 – End of Life Treatment of Sold Products	Waste disposal and treatment of products sold by the reporting company (in the reporting year) at the end of their life
13 – Downstream Leased Activities	Operation of assets owned by the reporting company (lessor) and leased to other entities in the reporting year, not included in scope 1 and scope 2 – reported by lessor
14 – Franchises	Operation of franchises in the reporting year, not included in scope 1 and scope 2 – reported by franchisor
15 - Investments	Operation of investments (including equity and debt investments and project finance) in the reporting year, not included in scope 1 or scope 2

GHG Data Findings – Buildings

To understand current emissions data, Emerald worked with the Shaker Heights City School District to collect building energy consumption from its building portfolio for both electricity and gas. If utility data was not available for a given building, Commercial Buildings Energy Consumption Survey (CBECS) data was utilized to approximate utility consumption by building size and type. From there, Emerald converted the annual electricity and natural gas consumption into Metric Tons of Carbon Dioxide Equivalent ($MTCO_2e$). This is the standard unit used to measure GHG emissions by converting different gases into the same scale based on their global warming potential (GWP).

The resulting findings represent a noteworthy first step taken by the District to begin to understand its current footprint. Having a GHG baseline will allow the District to track progress and hold itself accountable to its emissions reduction goals in a data-driven manner.

An estimate of the District's current emissions can be found in the following section:

Building	Square Ft.	Year	Electricity (kWh)	Annual Electricity $MTCO_2e$	Natural Gas (therms)	Annual Gas $MTCO_2e$	Annual Total $MTCO_2e$
Shaker Heights High School	324,956	2024	2,552,506	1,237	200,276	1,185	2,422
Shaker Heights Middle School	167,084	2024	1,431,198	693	51,928	307	1,000
Boulevard Elementary	48,276	2024	166,658	81	32,646	193	274
Fernway Elementary	42,746	2024	227,052	110	9,903	59	169
Lomond Elementary	62,356	2024	210,316	102	41,865	248	350
Onaway Elementary	59,639	2024	235,566	114	24,233	143	257
Mercer Elementary	81,225	2024	180,699	88	33,231	197	285
Ludlow Early Learning Center	38,462	2024	357,697	173	18,819	111	284
Woodbury Elementary	147,499	2024	731,273	354	93,565	554	908
Administration Building	13,912	2024	129,382	63	7,583	45	108
Service Center	5,296	2024	59,315	29	3,493	21	50
Library Media Office/Data Center	4,894	2024	54,813	27	1,090	6	33

GHG Data Findings – Fleet

The District also collected data to establish a baseline for fleet emissions for District-controlled vehicles. By establishing a baseline, the District will be able to evaluate efficiencies and impacts from route changes and better understand the emissions impact from different fuel-sourced fleets.

District-owned (or leased) fleet is included under Scope 1 direct emissions in accordance with the GHG Protocol. To begin tracking this emissions profile, the Shaker Heights City School District collected vehicle model data and total cost of fuel spent for the previous year (September 2024 – September 2025), which covered Garage (buses), Grounds, Services, and Maintenance. Some vehicle data miles traveled and/or miles per gallon of fuel, but the data set was inconsistent, with the only consistent source of data being the fuel cost.

Using a cost/emissions factor requires a standardization of the cost for fuel. The Shaker Heights City School District spent $107,128.22 on fuel during the period reviewed. Greenly, an emissions reporting platform and internationally recognized conversion tool (also compliant with the Greenhouse Gas Protocol), was utilized to establish ratio denominators. For 2023, the Greenly cost for both gasoline and diesel is $2.14/kg$CO_2e$. The conversion suggests the Shaker Heights City School District's fleet impact is **50.06 $MTCO_2e$** from September 2024 – September 2025.

It should be noted that calculating fleet emissions using a cost to emissions ratio is an effective, but somewhat limited, process for understanding a fleet's impact. As the Shaker Heights City School District continues to implement its sustainability initiatives, it is recommended that additional data, such as quantity of fuel consumed and distance driven, be included to continue to refine the District's emissions calculations moving forward.

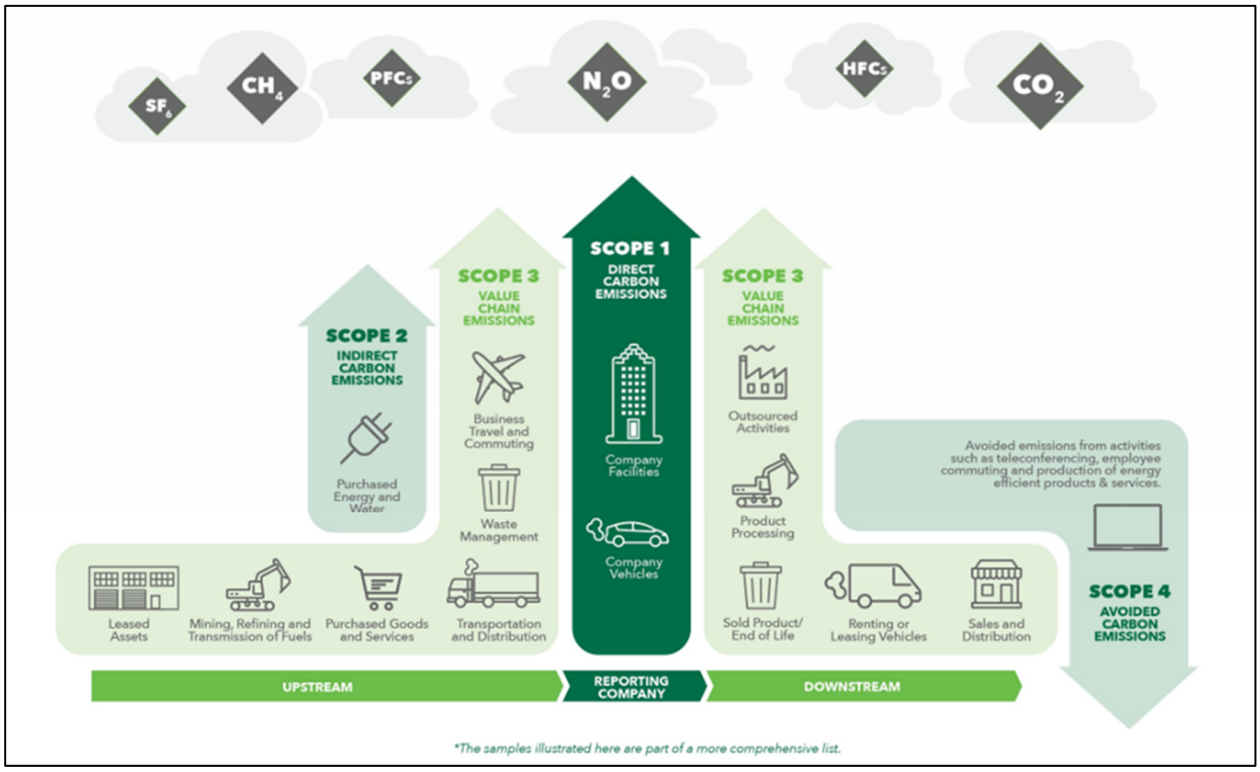


Illustration of the Greenhouse Gas scopes: Scope 1 covers direct emissions from company-owned facilities and vehicles; Scope 2 includes indirect emissions from purchased energy and water; Scope 3 accounts for value chain emissions from upstream and downstream activities such as business travel, transportation, and product lifecycle; Scope 4 represents avoided emissions through efficiency and sustainable practices.

COMMUNITY CONNECTIVITY

Throughout the course of the engagement, Emerald collaborated with the Shaker Heights City School District to lead a strategic community partner engagement process to support the development of this District Sustainability Plan. The effort focused on long-term sustainability, resilience, and student well-being, while also aiming to identify actionable strategies that could enhance the environmental performance of school facilities, enrich educational experiences, and promote community health.

The engagement process began with internal planning and coordination within the District, involving key administration and facilities personnel. These discussions centered on opportunities to integrate sustainability into school operations and learning environments, including infrastructure improvements, energy efficiency measures, and experiential learning tied to environmental stewardship.

To ensure broad community involvement, Emerald participated in various outreach efforts including presentations to the Board of Education, the City of Shaker Heights Sustainability Committee, the Facilities Advisory Committee (FAC), and Parent-Teacher Organizations (PTOs). These meetings provided a platform for local leaders, parents, and other partners to learn more about the initiative, share feedback and discuss priorities related to environmental stewardship, climate action, student health and well-being, and fiscal responsibility. The dialogue helped ensure that the District's planning was informed by broader community goals and positioned to contribute meaningfully to citywide sustainability strategies.

Community Feedback

The following items were identified as priority items as part of Emerald's engagement activities:

- **Composting:** There is a strong desire to continue to optimize district-wide composting initiative with Rust Belt Riders to reduce cafeteria and landscaping waste and promote responsible waste management.
- **Solar Energy:** The community supports the integration of renewable energy sources, especially solar panels, to reduce reliance on non-renewable energy and move toward a net zero future.
- **Elimination of Single-Use Plastics:** One of the most consistent requests, the community favors the elimination of single-use plastics in cafeterias, preferring reusable dishware and/or compostable tableware.
- **Native Plantings:** Advocacy for native plantings in landscaping to support local biodiversity, reduce maintenance needs, and minimize environmental impact.
- **Avoidance of Pesticides:** Community calls for minimizing or eliminating pesticide use on school grounds to protect student health and local ecosystems.
- **Recycling:** Emphasis on robust recycling programs for paper, plastics, and other materials, with education for students and staff on proper recycling practices.
- **Community Gardens:** Interest in establishing and maintaining community gardens to provide hands-on learning, promote healthy eating, and foster community engagement.
- **Light Pollution:** Requests to address light pollution through responsible outdoor lighting design and policies, supporting both environmental and student well-being.
- **Electric Vehicles (EVs):** Support for EV infrastructure, including charging stations and green vehicle credits, to encourage sustainable transportation options.

- **Anti-Idling Policies:** Desire for anti-idling policies for school buses and vehicles to reduce emissions and improve air quality around school campuses.
- **Healthy Foods:** Calls for healthier food options in cafeterias, including farm-to-school programs and sustainable food sourcing, to improve student health and support local agriculture.
- **Field Turf:** Desire to investigate the health impact of regular exposure to field turf for student athletes.

These points reflect the community's commitment to sustainability, health, and environmental stewardship, and align with the district's ongoing strategy discussions and operational priorities. It is Emerald's recommendation for the District to consider each priority item thoughtfully and make a plan to incorporate into existing or future budgeting and planning initiatives.

Collaboration Moving Forward

Robust and ongoing communication between a school district and its community is essential for achieving shared sustainability objectives. Through regular community partner engagement, collaborative workshops, and transparent updates, the District can foster a culture of teamwork and mutual accountability. Community partners shall be actively invited to participate in strategy sessions, provide feedback on initiatives and help shape operational policies. This open dialogue ensures that diverse perspectives are considered, builds trust, and empowers both the District and the community to work together toward creating healthier, more resilient, and environmentally responsible schools. The result is a dynamic partnership where collaboration drives meaningful progress on sustainability goals.

SUSTAINABLE OPERATIONS

For organizations seeking to improve sustainability performance, the LEED Operations and Maintenance (O+M) rating system offers a comprehensive and proven framework for transforming existing facilities into high-performing, environmentally responsible spaces. Designed specifically for buildings in use, LEED O+M emphasizes continuous improvement in energy efficiency, water conservation, indoor environmental quality, and sustainable purchasing and waste management practices. For a school district seeking to reduce its environmental footprint, improve student and staff health, and achieve long-term cost savings, LEED O+M provides measurable benchmarks, actionable strategies, and a pathway to certification that aligns with both educational and community values. By adopting this framework as a foundation, the Shaker Heights City School District can ensure that sustainability is not just a goal, but a core principle embedded in daily operations and decision-making.

The following Sustainable Operations Plan provides a comprehensive roadmap for integrating sustainable operations and maintenance practices across the District's existing buildings. By leveraging the LEED v4 O+M rating system, the District can aim to enhance building performance, reduce environmental impact, and promote healthier learning environments. In addition, the plan supports long-term cost savings, regulatory compliance, and alignment with community sustainability goals.

Many of the items contained in the Sustainable Operations Plan have been initiated, or at least discussed, as part of the development of the District Sustainability Plan.

Project Goals and Team Formation

- **Integrated Team Formation:** Establish a cross-functional sustainability team that includes facilities managers, custodial supervisors, district administrators, teachers, and external consultants. This team will oversee LEED implementation, monitor progress, and ensure accountability.
- **Goal Setting:** Define clear sustainability objectives such as reducing energy and water consumption by 20% over five years, achieving LEED certification for all eligible buildings, and improving indoor environmental quality for students and staff.
- **Baseline:** Conduct a district-wide audit of existing building systems, energy and water usage, waste generation, and maintenance practices. Use the data already gathered as part of the District Sustainability Plan along with additional information about factors such as waste generation to identify inefficiencies and prioritize improvements.

LEED Certification Strategy

- **Scope Definition:** Determine which buildings will be included in the certification process, if not all will be included.
- **LEED Scorecard Development:** Draft a LEED scorecard for each building. Ensure prerequisites can be met and identify achievable credits based on current performance, planned improvements, and budget constraints. Set realistic certification target (Certified, Silver, Gold, or Platinum).
- **Roles and Responsibilities:** Assign specific team members (champions) to lead each credit category (e.g., Energy, Water, IEQ). Designate a LEED project administrator (individual or

company) to manage documentation and communication with Green Building Certification, Inc. (GBCI).

Establishment and Performance Periods

- **Establishment Period Activities:** Develop and implement policies and procedures required for LEED prerequisites and credits, such as green cleaning protocols, purchasing policies, and waste diversion strategies.
- **Performance Period Execution:** Collect data over a defined performance period, minimum 3 months, maximum 24 months. Monitor and verify compliance with LEED standards.

Credit Categories and Possible Implementation Strategies

- **Energy and Atmosphere:** Conduct energy audits, benchmark energy performance using ENERGY STAR Portfolio Manager, implement building automation systems (BAS) to optimize HVAC operations, schedule preventative maintenance to ensure efficiency, and explore renewable energy options
- **Water Efficiency:** Retrofit restrooms with low-flow fixtures, install submeters to monitor water use in key areas, develop and implement leak detections and response protocol, replace high-water-use landscaping with drought-tolerant native species, use weather-based irrigation controllers to reduce outdoor water use
- **Indoor Environmental Quality (IEQ):** Upgrade air filters to MERV 13 or higher and maintain regular replacement schedules, implement a green cleaning program using certified products and practices, monitor CO_2 levels, temperature, and humidity to ensure occupant comfort, conduct regular IAQ assessments and address any issues promptly, provide daylighting and views where possible to enhance learning environments
- **Materials and Resources:** Track waste generation and diversion rates monthly, establish centralized recycling and composting stations in all buildings, adopt sustainable purchasing policies for office supplies, furniture, and custodial products, conduct staff training on proper waste sorting and reduction strategies, partner with vendors who offer take-back or recycling programs
- **Site Management:** Maintain permeable surfaces and bioswales to manage stormwater runoff, use non-toxic de-icing materials and integrated pest management practices, ensure safe pedestrian pathways and bike racks to promote alternative transportation, implement a no-idling policy for buses and delivery vehicles, conduct regular site inspections to ensure compliance with environmental standards

Documentation and Reporting

- **Manage Documentation:** Maintain organized records of utility bills, maintenance logs, and procurement receipts.
- **Submit for LEED Certification:** Prepare a comprehensive LEED submission package within 60 days of completing the performance period.

Recertification and Continuous Improvement

- **Plan:** Make preparation to recertify every five years
- **Establish Recurring Review:** Develop a continuous improvement cycle with regular reviews of sustainability metrics, update policies and procedures based on lessons learned and evolving best practices, and encourage innovation by piloting new strategies

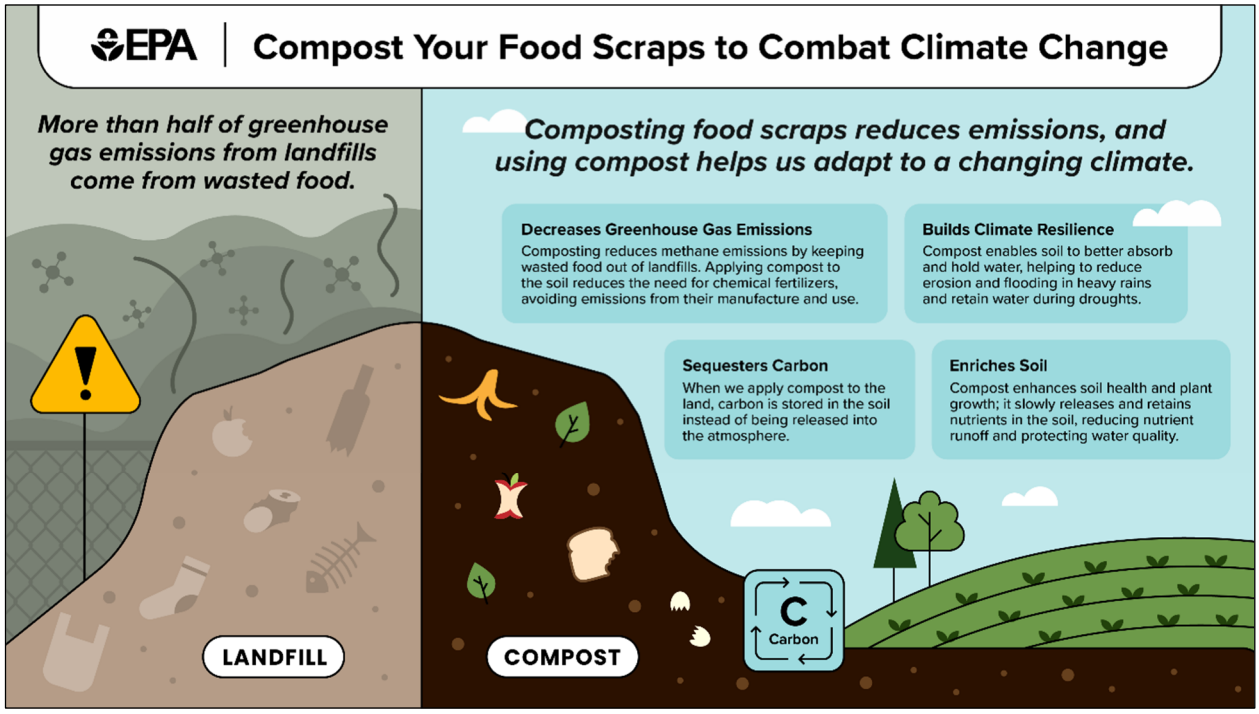
SUCCESS STORY – COMPOSTING WITH RUST BELT RIDERS

With all sustainability initiatives, it is important to celebrate wins whenever possible. These wins help build momentum and encourage continuous improvement while also recognizing the teams and individuals who made the success possible. To that end, the Shaker Heights City School District has partnered with Rust Belt Riders, a community composting service based in Cleveland, OH, on its mission of "feeding people, not landfills."

Composting is great for the environment because it turns organic waste, such as food scraps and yard trimmings, into nutrient-rich soil instead of sending it to landfills. When organic waste is sent to a landfill and begins to decompose, it produces methane, a greenhouse gas that is far more potent than carbon dioxide in its ability to trap heat in the atmosphere. As the waste breaks down, it creates leachate, a liquid that can contaminate groundwater and nearby ecosystems. Finally, the nutrients contained within the organic waste that could otherwise have enriched the soil if the waste had been composted are, instead, lost.

The benefits, on the other hand, are numerous. As the below EPA exhibit illustrates, composting helps to combat climate change in various ways:

- Decreases Greenhouse Gas Emissions
- Sequesters Carbon
- Builds Climate Resilience
- Enriches Soil



Source: https://www.epa.gov/sustainable-management-food/composting

The Shaker Heights City School District began its collaboration with Rust Belt Riders in 2021 by adding composting to Fernway Elementrary School. In the years that followed, additional locations were added so that by the fall of 2023, composting was available at each of the 5 elementary schools:

School	Address	Compost Start	Total Waste Diverted*
Fernway	17420 Fernway Rd	May 14, 2021	19,870 lbs.
Onaway	3115 Woodbury Rd	September 30, 2022	15,120 lbs.
Lomond	17917 Lomond Blvd	May 19, 2023	14,877 lbs.
Mercer	23325 Wimbledon Rd	October 12, 2023	7,017 lbs.
Boulevard	14900 Drexmore Rd	October 20, 2023	14,725 lbs.

**Current as of November 2025*

Since the program began, the Shaker Heights City School District has diverted 71,609 pounds of organic waste from landfills. That is equivalent to:

71,035 miles offset!

Composting efforts are equivalent to not driving 71,035 miles.

9.9 tons of waste recycled, not landfilled!

The District has saved 9.9 tons from sitting in a landfill.

472 seedlings planted!

From a GHG equivalency standpoint, the District's composting efforts are equivalent to 472 urban tree seedlings grown for 10 years.

3,222 gallons of gas!

The number of gallons of gasoline offset by diverting food scraps from the landfill.

These statistics are commendable and should be celebrated on their own merit; however, it should also be mentioned that the introduction of composting in the elementary schools carries additional educational benefits through increased environmental awareness, opportunities for hands-on science learning, and the encouragement of sustainable habits for the students. In totality, the addition of composting to the Shaker Heights City School District has been a great success and will act as a foundation for the District's future sustainability initiatives.

SUSTAINABLE FLEET RECOMMENDATIONS

As part of the Shaker Heights City School District's commitment to environmental stewardship and operational efficiency, district leaders have started the process of integrating electric vehicles (EVs) into the District's fleet. A comprehensive fleet strategy will encourage District leaders to consider the adoption of additional electric vehicles (EVs), hybrid models, and other fuel-efficient alternatives. The following recommendations outline a phased and practical approach to achieving this goal:

Fleet Assessment and Planning

The first step is to conduct a comprehensive assessment of the current District fleet. This includes evaluating:

- Vehicle Age
- Fuel Consumption
- Maintenance Costs
- Route Characteristics

Identifying which routes are most suitable for electrification, including factors such as mileage and terrain, will help the District prioritize capital investments and ensure optimal performance.

Phased Implementation

When it comes to implementation, a gradual transition is typically recommended, beginning with a pilot program that introduces a small number of electric or hybrid vehicles. This approach will allow the District to evaluate performance, gather data, and refine its strategy before scaling up. Over time, older, less efficient vehicles should be replaced with cleaner alternatives as part of a long-term fleet renewal plan. The Shaker Heights City School District has already initiated this phased implementation process through the integration of a small number of EVs into its fleet – it is recommended that the District continue to monitor performance and gather data as it evaluates the program moving forward.

Charging Infrastructure

Transitioning to EVs requires thoughtful planning for charging infrastructure. It will be imperative for the District to collaborate with the local utility provider to assess grid capacity and determine optimal locations for charging stations. A mix of Level 2 chargers for overnight use and DC fast chargers for rapid turnaround should be considered based on the fleet needs determined during the Fleet Assessment and Planning phase.

Training and Capacity Building

Staff training will be critical to the success of the transition. Drivers, mechanics, and transportation coordinators must receive instruction on EV operation, safety protocols, and maintenance procedures. This training will ensure smooth integration and long-term reliability of the fleet.

Performance Monitoring

Ongoing evaluation is necessary to measure the impact of fleet changes. Key metrics will include fuel savings, maintenance costs, emissions reductions, and vehicle reliability. Data collected during the pilot phase should inform future procurement and route optimization decisions.

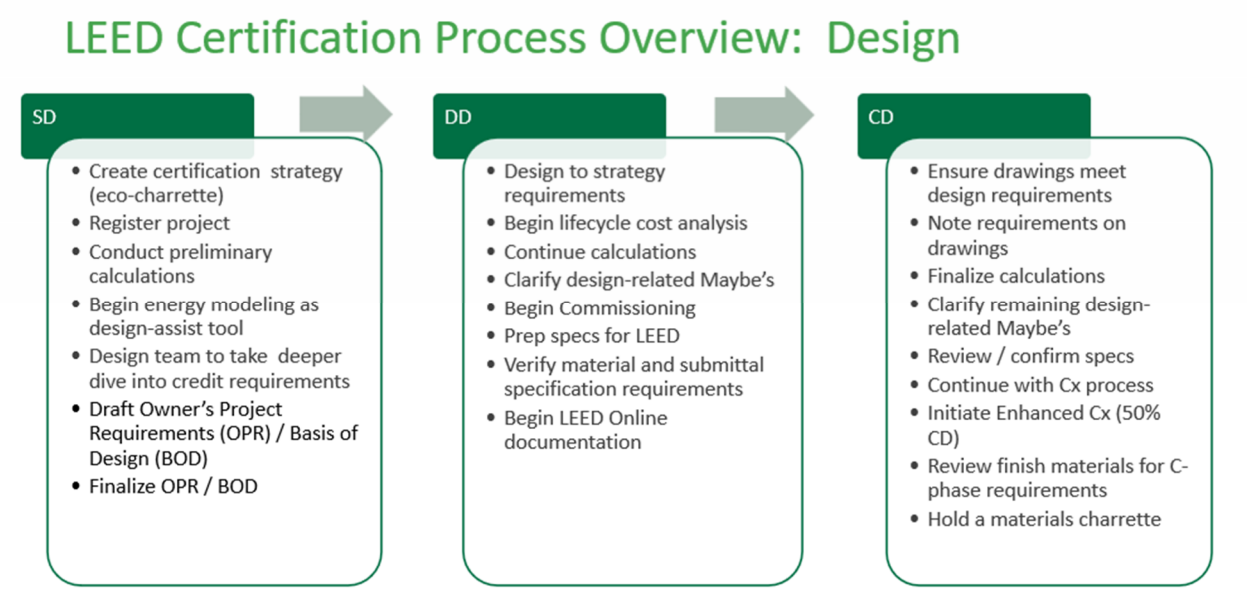
DEVELOPMENT OF CORE LEED STRATEGY

A core element of the comprehensive sustainability plan for the Shaker Heights City School District is the establishment of a core LEED strategy to inform new construction and renovation projects within the building portfolio. The approach began with a district-wide energy analysis to establish minimum performance targets for all buildings and identify opportunities to integrate renewable energy sources. Collaborators have been engaged to set sustainable performance targets for ongoing operations and renovations, with specific key performance indicators guiding progress.

Initially, it was Emerald's intent to conduct an integrative process charrette with appropriate District leaders and project team members to develop a core LEED strategy to guide the K-5 renovation projects. After deliberation with District leaders, it was determined that this charrette will occur at a later date, closer to the kickoff of renovations to the K-5 buildings. What follows is a high-level description of the LEED process and Emerald's strategic approach to LEED certification management.

LEED Certification Process

The Design Phase is structured into three key phases: Schematic Design (SD), Design Development (DD), and Construction Documents (CD). The major LEED activities and milestones associated with each phase are depicted below:



Similarly, the Construction Phase is grouped by distinct phases: Construction, Substantial Completion, and Occupancy. The major LEED activities and milestones associated with each phase are depicted below:

LEED Certification Process Overview: Construction

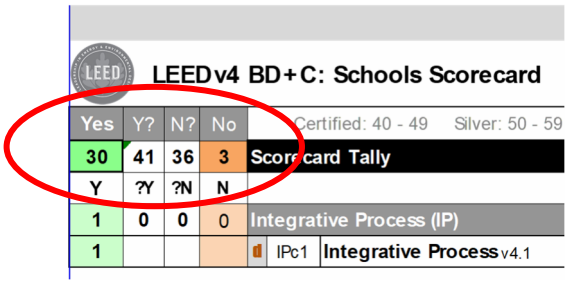
Construction
- Submit for LEED Design Phase Review
- Continue Commissioning process
- SWPP Plan / Implementation
- CWM Plan / Implementation
- IAQ Plan / Implementation
- Material tracking/LEED submittal process

Substantial Completion
- Commissioning – Functional testing
- Envelope testing
- Air testing / Flush-out
- Finalize material tracking

Occupancy
- Submit for Cphase review
- Enhanced Commissioning – 1 year
- EnergyStar Portfolio Manager
- LEED O+M Policy Implementation
- Post-Occupancy Evaluation

LEED Scorecard

The LEED scorecard is a one-page snapshot of the LEED strategy for a project. It is updated consistently throughout a project – typically monthly – and identifies credits by phase and if they are included in a project's intended compliance strategy.



LEED v4 BD+C: Schools Scorecard

Yes	Y?	N?	No	Certified: 40 - 49 Silver: 50 - 59
30	41	36	3	Scorecard Tally
Y	?Y	?N	N	
1	0	0	0	Integrative Process (IP)
1				IPc1 Integrative Process v4.1

Generally, LEED credits are organized by Yes, Maybe, or No; however, Emerald recommends managing Maybe credits with a Y? ("Maybe Yes) and N? ("Maybe No") for several reasons:

- **Enhanced Clarity** – More nuanced approach reduces ambiguity
  - Yes - reserved for 100% certainty based on existing project information
  - Y? – quite likely, but still needs to be shown in project documentation – i.e. work is not done
  - N? – additional information is needed to determine if possible
  - N – reserved for 100% not happening

  *Emerald will only put credits into the Yes when there is **no doubt** it will be achieved and can be documented
- **Improved Resource Allocation** – Prioritizes attention and effort

- **Enhanced Risk Management** – Supports proactively identifying and mitigating potential risks
- **Better Communication** – Facilitates better understanding of project status and progress, allowing for better tracking
- **Strategic Decision-Making** – More detailed approach allows teams to make more informed choices where to invest time and resources to optimize the LEED score for the resources available

Owner-Focus LEED Credits

All credits require owner direction; however, several cannot be solved without the District's clear direction. These credits are often captured in the OPR and are important for several reasons:

- **SYNERGIES** – Many of these credits are intertwined, and optimization requires an integrated, holistic approach.
- **COST SAVINGS** – Investing in energy efficiency, water conservation, and sustainable materials can generate notable cost savings over time. Coordination at the district level can leverage economies of scale and redirect savings to educational programs and resources that benefit the students.
- **REGULATORY COMPLIANCE & INCENTIVES** – OFCC, IRA, school improvement, and other energy efficiency grants offer financial benefits that are in several cases linked to the "focus credits" listed.
- **HEALTH & WELLNESS** – Improving indoor environmental quality directly impacts the health of students and staff. Balancing better air quality, natural lighting, and comfortable temperatures with energy efficiency affects absenteeism and overall well-being, creating a more conducive learning environment and budget.
- **FUTURE-Proofing Shaker Heights Schools** – Increasing uncertainty related to environmental changes requires key themes be addressed to mitigate potential risks associated with extreme weather events. These credits support preparing a more resilient built environment.
- **ACHIEVING LEED GOAL** - These key strategic elements of the LEED system offer multifaceted benefits. By focusing on these areas, the district will create healthier, more sustainable, and cost-effective learning environments ultimately benefiting students and staff while maximizing opportunities to earn points in the rating system.

Understanding the Cost of LEED

The Cost of LEED is not the total cost of the credit, it's what was done "beyond" the District's goals to achieve the credit. Examples include:

- The Green Vehicles credit may be the difference between the number of spaces the district would have wanted and what is required for LEED.
- An acoustician was engaged to achieve the Acoustics Performance credit specifically for the project, and additional sound masking measures were installed to achieve it.

Emerald will provide a tool for the District to use to understand potential added costs for each credit and confirm added cost to achieve each level of certification. The tool guides value engineering and decision-making in alignment with District goals.

BASIS OF DESIGN – INTRODUCTION

As the Shaker Heights City School District pursues upgrades to its existing K-5 building portfolio, the following Basis of Design (BoD) can be utilized as a foundational document that outlines the design intent, performance criteria, and technical approach for the building systems and components. Having a clearly defined BoD from the outset is critical for several reasons:

- **Clarifies Design Intent:** The BoD describes the owner's project requirements (OPR) and how the design team plans to meet them. It also ensures alignment between collaborators – school administrators, architects, engineers, contractors, and others.
- **Supports LEED or other Green Building Certification:** For LEED projects, the BoD is a required document that helps demonstrate compliance with sustainability goals. It outlines strategies for energy efficiency, indoor air quality, lighting, and more.
- **Facilitates Decision-Making:** The BoD provides a clear rationale for system selections (e.g., HVAC, lighting, plumbing) and helps justify choices based on performance, cost, and long-term maintenance.
- **Improves Coordination:** Having a BoD act as a reference for all disciplines involved reduces miscommunication and helps avoid scope creep or downstream design changes.
- **Guides Commissioning:** The BoD is used during the commissioning process to verify that systems are installed and operate as expected.
- **Documents Constraints and Assumptions:** Documenting items such as site limitations, budget constraints, code requirements, and existing conditions, the BoD helps future teams understand the context of design decisions.

The following BoD was developed for the elementary schools audited as part of the district-wide energy analysis Emerald conducted for the Shaker Heights City School District:

BASIS OF DESIGN – ELEMENTARY SCHOOL HVAC UPGRADES

Project: Shaker Heights City School District – [School(s)]
Location: Shaker Heights, Ohio
Date: [Insert Date]
Prepared by: [Engineer / Firm]
Discipline: Mechanical (HVAC)

1. Owner's Project Requirements (OPR) – Summary

- Provide reliable, efficient cooling and heating to historic elementary school buildings with minimal impact to historic fabric.
- Basis of Design (BoD) system: Variable Refrigerant Flow (VRF) with heat recovery.
- Alternates: (A1) Four-pipe fan coil system; (A2 – value option) Two pipe fan coil system (seasonal changeover).
- Reuse/rehabilitate existing central ventilation infrastructure to deliver code-compliant outdoor air with modern filtration and controls:
- Achieve minimum:
    - OFCC Ohio Facilities Construction Commission design guidelines (as minimum criteria).
    - LEED for Schools (target LEED Silver) prerequisites and applicable credits.
    - Ohio Building Code and referenced standards (confirm current adopted editions at time of permit).
- Maintain good classroom acoustics, thermal comfort, and maintainability

2. Existing Conditions

- Buildings are steam-heated only with scattered, small split systems and isolated cooling; no campus-wide central cooling.
- Existing central ventilation systems present but largely in disrepair, to be assessed, selectively rehabilitated, and integrated as outdoor air (OA) delivery for classrooms/interior spaces in conjunction with new HVAC systems.
- Historic interiors and limited shafts/ceilings constrain new ductwork and major penetrations.

3. Codes, Standards, and References

Minimum compliance (verify editions during design & permitting):

- Ohio Building Code (OBC) – current adopted edition & referenced ICC/ASHRAE standards. [Insert edition/year when confirmed.]
- Mechanical & Energy Codes: OMC, OEC (as adopted by Ohio).
- ASHRAE 62.1 (Ventilations for Acceptable IAQ) – for classrooms and other occupancies.
- ASHRAE 55 (Thermal Comfort).
- ASHRAE 90.1 (Energy Standard) – as referenced by OBC/LEED and OFCC.
- OFCC: Ohio Facilities Design Guidelines – schools (minimum design requirement).
- LEED for Schools (v4/v4.1) – target Silver; confirm pathway and reference version with Owner.
- Acoustics: ANSI S12.60 for classrooms (target background noise ≤ 35 dBA/NC-35).
- Other: NFPA, OSHA, ADA impacts to controls placement.

4. Design Intent & Rationale

- Why VRF: Minimizes invasive distribution work in historic buildings, reduces structural/architectural impact, provides zone-level control, and supports simultaneous heating/cooling via heat-recovery branch controllers.
- Perimeter Heat: Provide hot-water perimeter radiation to supplement VRF low-ambient heating limitations, support morning warm-up, and replace existing steam radiators to reduce risk and maintenance burden while preserving perimeter heating concept.
- Ventilation Strategy: Utilize/rehabilitate existing central OA system or provide dedicated outdoor air system (DOAS)/ERV modules as needed to deliver required OA with energy recovery and modern filtration; decouple sensible loads from OA delivery.

5. Basis Systems

5.1 VRF Heat-Recovery System (Basis of Design)

- Outdoor Units: Air-cooled VRF condensing units, roof or grade mounted (final siting to minimize noise/visual impact on historic facades); low-ambient kit as needed.
- Indoor Units (IDUs):
  - Primary: Concealed ducted IDUs (short duct runs) where ceiling space allows to preserve aesthetics and reduce classroom clutter
  - Secondary (as needed): Wall-mounted or ceiling cassette units in spaces with limited ceiling cavities; coordinate location to avoid interference with teaching walls and shelving.
- Branch Controllers: Heat-recover branch boxes enabling simultaneous heating and cooling; locate in accessible ceiling/service closets.
- Perimeter Hydronic Heat:
  - Convert existing steam to closed-loop hot water served by condensing boilers.
  - Supply temperature with reset: ~140°F design; outdoor-air reset down to ~80–100°F (final via load calcs/energy model).
  - Terminal types: fin-tube radiation or compact panel radiators with thermostatic/DDC control.
- Ventilation/OA Integration:
  - Rehabilitated central AHUs or new DOAS units with total energy recovery.
  - Filtration: Minimum MERV-13 final filters (higher if pressure/energy impacts acceptable).
  - Ventilation control: Constant volume to classrooms, demand-controlled ventilation (DCV) with CO_2 sensors in high-density spaces (cafeteria, gym, auditorium, media center).
- Distribution/Ductwork: Avoid new large main ducts; use short, concealed runs. Protect historic finishes; use minimally visible grilles and diffusers.
- Condensate: Trapped and drained to code; coordinate routing to avoid visible interior runs.

5.2 Alternate A1 – Four-Pipe Fan Coil System

- Central Plant: Air-cooled chiller (N+0) and condensing boilers (N+1 preferred); primary-variable pumping with 2-way valves at coils.

- Fan Coils: Concealed or closet-mounted where feasible; perimeter convectors acceptable if protected from blockage.
- Ventilation: Same OA/DOAS approach as VRF (decoupled ventilation).
- Controls: Full DDC integration; chilled- and hot-water reset schedules; occupied/unoccupied modes; coil condensation monitoring
- Pros/Cons: Robust performance vs. familiar maintenance; more piping risers/shafts and mechanical space impact vs. VRF.

5.3 Alternate A2 – Two-Pipe Fan Coil (Value Option)

- Seasonal changeover (cooling ↔ heating) with defined changeover criteria (see §9 Sequences).
- Risk: Thermal comfort gaps during shoulder days with diurnal swings; consider supplemental perimeter heat or limited DX in select rooms.
- Use only with Owner's approval acknowledging operational constraints.

6. Space Types & Zoning

- Classrooms: Individual or small-group zoning (≤ 2 rooms per zone when using ducted IDUs): avoid wall units directly behind student seating.
- Administrative/Offices: Smaller zones; after-hours scheduling.
- High-load Spaces (gym, cafeteria, kitchen, IT): Dedicated systems/zones; kitchen with Type I/II hoods and makeup air; server/IDF with 24/7 cooling and redundancy.
- Nurses/Isolation: Enhanced ventilation and pressure relationships per health guidance (coordinate with Owner).

7. Thermal Setpoints & Comfort

- Occupied Cooling Setpoint: 75°F (24°C)
- Occupied Heating Setpoint: 70°F (21°C)
- Unoccupied Setbacks: Cooling 80-82°F; Heating 60-62°F (programmable by schedule/holiday).
- Relative Humidity Targets: 30-60% annual band; prefer ≤ 55% in cooling season to limit mold risk.
- Deadband: ≥ 3°F between heating and cooling.
- Acoustics: Target NC-35 (≤ 35 dBA) in classrooms; select low-sone IDUs, line ductwork where needed, and place branch boxes/DOAS to meet target.

8. Ventilation & IAQ

- Outdoor Air Rates: Per ASHRAE 62.1 for each space category (e.g., classrooms, offices, assembly).
- Delivery: Central OA via rehabilitated AHUs or new DOAS/ERV; decoupled from space conditioning.
- Filtration: MERV-13 minimum; verify fan static and energy model impacts for higher MERV.
- CO_2 Monitoring: DCV in high-occupancy spaces
- Moisture Control: Maintain positive building pressure (≈ +0.02 to +0.05 in. w.c.) in classroom areas; dedicated dehumidification via DOAS coil where required.

- Flush-out/IAQ Plan: Provide pre-occupancy flush (LEED credit option) or IAQ testing pathway.

9. Controls & Sequences of Operation (SOO) – High Level

- DDC/BAS with web interface; all VRF/DOAS/Boiler/Chiller (if alt selected) integrated.
- Modes: Occupied, Unoccupied/Setback, Holiday, Warm-up, Cool-down.
- VRF Heat-Recovery:
  - Zone calls prioritize comfort; branch controller provides simultaneous heating/cooling.
  - Capacity balancing between modes; limit compressor short-cycling; low-ambient logic engages perimeter heat as needed.
- Perimeter Heat (HW):
  - Outdoor reset schedule; enable below [~55°F OAT, adjustable].
  - Morning warm-up: Preheat zones to occupied setpoint before school day.
- DOAS/ERV:
  - Maintain minimum OA by schedule; DCV in select spaces; economizer if available/beneficial.
  - Supply air temperature reset to control humidity and maintain neutral delivery to VRF zones.
- Two-Pipe Changeover (Alt A2):
  - Automatic changeover using rolling 48-72 hr. mean OAT with manual override; require admin notice.
  - Interlocks to prevent coil condensation during unexpected heat calls in cooling season.
- Fault Detection & Diagnostics (FDD): Basic trend logs, alarms for sensors, filters, condensate, and VRF error codes.
- Schedules: Align with school calendar; after-hours override via keypad/app with auto-timeout.

10. Energy & Sustainability (LEED/OFCC Alignment)

- LEED Target: Silver (v4/v4.1 Schools). Primary credit pathways anticipated:
  - EA Prereqs/Credits: Minimum Energy Performance (ASHRAE 90.1 as adopted), Fundamental/Enhanced Commissioning, Optimize Energy Performance (energy model), Advanced Energy Metering, Demand Response (if utility permits).
  - EQ: Enhanced IAQ, Increased Ventilation (if pursued), Low-Emitting Materials, Thermal Comfort (design & verification), Interior Lighting controls (coord.), Acoustic Performance.
  - WE/SS/MR: Coordinate with plumbing/site/specs.
- OFCC: Meet or exceed OFCC energy and system performance criteria for schools (document PIs: EUI target, ventilation compliance, acoustics, maintainability).
- Submetering: Whole-building electric and gas: end-use trending for DOAS fans, VRF compressors, boiler plant (and chiller if Alt A1).
- Envelope/Lighting Coordination: Support energy model with envelope assumptions and lighting power densities/controls (by others).

11. Equipment & Materials – Basis of Selection (Representative)

- VRF: Multi-port heat-recovery systems, inverter-driven; AHRI listed; low-ambient heating performance documentation.
- IDUs: Ducted concealed (preferred), ceiling cassette, wall-mounted (case-by-case).
- Boilers: High-efficiency condensing, ≥ 95% thermal efficiency, primary-variable pumping, N+1 where feasible.
- DOAS/ERV: Packaged with total energy wheels/plates; MERV-13 final filters; hydronic or DX reheat as needed.
- Fan Coils (Alt): 4-pipe (A1) or 2-pipe (A2) with ECM fans; drip pans with secondary drains; access for coil cleaning.
- Pumps/Valves: ECM/VFD pumps; 2-way control valves; DP reset.
- Controls: Open protocol (BACnet); trending, graphics, and alarm routing.

12. Distribution, Constructability & Historic Preservation

- Minimize penetrations of historic surfaces; route services in existing chases/attics/basements.
- Prefer concealed ducted IDUs to reduce visual impact; where wall units are used, coordinate mounts to avoid bookshelves and storage blockage and maintain clear intake/throw.
- Provide access panels for branch boxes and isolation valves.
- Noise/Vibration: Isolate outdoor units; consider enclosures/screens compatible with historic guidelines.

13. Water Treatment & Condensate

- Closed-loop water treatment for HW/CHW (if Alt A1/A2).
- Condensate neutralization where discharged to sanitary; heat-trace/insulate where exposed.

14. Commissioning (Cx) & Turnover

- LEED Fundamental & Enhanced Cx scope for HVAC&R, controls, and OA systems.
- Pre-functional checklists; functional performance tests for all modes (heating, cooling, heat recovery, warm-up, setbacks, DCV).
- Training: Minimum two sessions for facilities staff; O&M manuals and as-built controls graphics.
- Seasonal testing (shoulder seasons) for VRF + perimeter heat interoperability and, if applicable, two-pipe changeover.

15. Metering, Trending, and M&V

- Trend key points (zone temps, OA flows, RH, compressor speeds, boiler/chiller loads, valve positions, alarms) at 5-15 minute intervals initially, then optimize.

16. Setpoints & Schedules (Summary Table)

- Classrooms: 75°F cool / 70°F heat; RH 30–60%; OA per 62.1; NC-35.

- Admin/Offices: 75/70°F; occupancy scheduling by school day.
- Gym/Cafeteria: Zonal control; DCV enabled; supply air reset for humidity.
- IT/IDF: 72–78°F, RH 30–55%, 24/7, N+1 recommended.
- After-Hours: Auto set back; timed overrides.

17. Performance & Acceptance Criteria

- Comfort per ASHRAE 55; ventilation per 62.1.
- Classroom sound levels meet NC-35.
- Documented heat-recovery operation (simultaneous heat/cool) during functional testing.
- Energy model demonstrates compliance with code/LEED pathway and meets Owner EUI target [Insert EUI].

18. Basis of Sizing & Modeling Assumptions

- Weather file: [Insert city, TMY/ASHRAE].
- Internal loads: per OFCC/LEED assumptions (students/staff counts, plug/lighting).
- Infiltration: per envelope testing/assumptions.
- Diversity factors for classrooms per schedule; kitchen/gym peak coincident assumptions documented.
- Safety factors: ≤ 10% unless justified by calc.

19. Schedules, Phasing, and Continuity of Operations

- Phase upgrades to maintain occupancy; provide temporary conditioning/ventilation where needed.
- Coordinate outages for steam/hot-water conversion during breaks/summer.

20. Submittals & Closeout

- Full equipment submittals with AHRI ratings, sound data, controls narratives, and sequence matrices.
- Controls submittals: points list, graphics, alarms, trend strategy, and test scripts.
- O&M manuals, training agendas, and spare parts list.
- Final commissioning report with deficiency log resolution.

21. Deviations & Clarifications

- Any deviations from OFCC, LEED intent, or OBC to be documented with rationale and Owner/AHJ approvals.
- Confirm exact code editions and LEED version at start of Design Development and update this BOD accordingly.

NEXT STEPS

The Shaker Heights City School District Sustainability Plan marks a significant milestone in the District's continued journey toward environmental stewardship and operational excellence. Developed in collaboration with Emerald Built Environments, the plan outlines a comprehensive strategy to modernize facilities, reduce energy consumption, and lower greenhouse gas emissions, while fostering community engagement and educational innovation.

By implementing the plan's key recommendations, such as advanced HVAC systems, expanding composting and recycling initiatives, and pursuing LEED certification for all eligible buildings, the District will continue to differentiate itself as a sustainability leader. The plan emphasizes the importance of continuous improvement, transparent performance tracking, and active participation from students, staff, and community partners. By setting clear goals and embracing sustainable practices, the District is poised to create healthier learning environments and inspire responsible citizenship. This foundational strategy provides a roadmap for ongoing progress, ensuring that sustainability remains central to the district's mission and future growth.

The Shaker Heights City School District has an incredible opportunity to continue to integrate sustainability into all aspects of the built environment and we look forward to continuing our collaboration to ensure the District has the support it needs to exceed any goals it sets out to achieve. Moving from planning to implementation marks a significant milestone and we at Emerald look forward to all the wonderful progress that is to come. We are your team!

Project Team:

A steering committee comprised of Shaker Heights City School District personnel worked collaboratively with the Emerald team throughout this engagement:

Steering Committee Members:

- David Glasner, Ph.D., Superintendent
- Jeffrey Grosse, Assistant Superintendent
- David Boyer, Director of Buildings and Grounds
- Sean Brown, Assistant Director of Buildings and Ground

Emerald Built Environments Project Team Members:

- Matthew Setzekorn, President, PE, BCxP, BEMP, BEAP, LEED AP, NGBS Verifier
- Michael Fodor, Project Manager, LEED AP BD+C
- Savannah Thornburgh, Sustainability Consultant, LEED AP BD+C
- Sophia Hestad, Project Manager-Engineer, EI, LEED AP O+M, Fitwel Ambassador, GRESB AP

COMPANY INFORMATION

Emerald Built Environments is a Delaware Limited Liability Company with an S-Corp designation with the IRS.

Stability of Firm Leadership

Emerald Built Environments was formed in 2008 under a different name and was incorporated as an Ohio LLC in 2012 with Laura Steinbrink as a founding member. Matt Setzekorn joined the firm as a principal in 2017. The firm leaders, CEO Laura Steinbrink (MBA, LEED AP BD+C, ND) and President Matthew Setzekorn (PE, LEED AP, CBCP, BEMP, ASHRAE BCxP) developed an innovative model for achieving sustainability and business success that provides an integrated solution to project owners' challenges.

Litigation

The firm has not been involved in any litigation.

Bankruptcy

The firm has not declared bankruptcy under its current name or any previous name.

Dismissal

The firm has not been dismissed from work on a project.

Certifications

Emerald is a Certified B Corporation, a for-benefit company that balances purpose and profit.

Emerald achieved Carbon Neutral by the Carbon Footprint Standard for the twelve-month period ending September 30, 2022.

Emerald Built Environments has touched over

1,826

sustainable environments covering

52

million square feet across the United States and internationally.

The team has many firsts, several award winners, and

9

LEED Platinum projects.