# Richmond School – Solar Wall Case Study

Prepared By: SUSTAINABLE PROJECTS GROUP

| | |
|---|---|
| Building Name/Address | McMath Secondary, 4251 Garry St, Richmond Columbia |
| Building Asset Class | Universal; K-12 School |
| Building Size | Approx. 105,344 $ft^2$ (whole school), 24,900 $ft^2$ (gymnasium & install location area) |
| Year Built | 1998 |
| Building Owner & Manager | Richmond School District (SD-38) |
| Engineering Consultant | Sustainable Projects Group, Conserval Engineering Inc. |

RICHMOND SCHOOL DISTRICT NO.38

SPG SUSTAINABLE PROJECTS GROUP

BOMA BRITISH COLUMBIA

SolarWall® by Conserval

## Contents

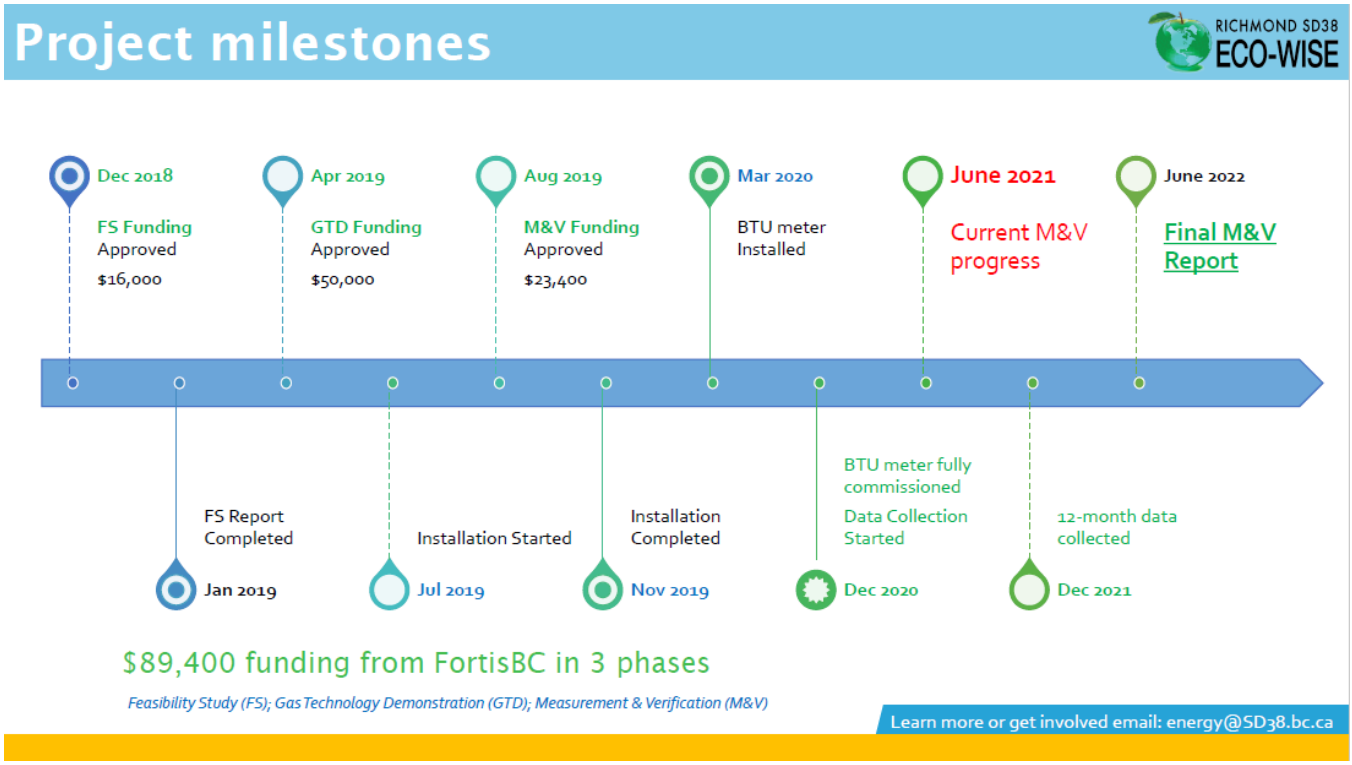


## PROJECT INTRODUCTION

SolarWall is an innovative solar technology that stands apart from conventional solar PV systems by seamlessly integrating solar modules with the building envelope. This cutting-edge design, merging solar technology with building facades, allows SolarWall to generate electricity while simultaneously heating or cooling the building, providing a dual benefit of renewable energy generation and enhanced energy efficiency. With its unique ability to optimize space and maximize energy savings, SolarWall presents an enticing proposition for sites seeking to harness sustainable power while reducing their carbon footprint.

## BACKGROUND

Before install, the School District decided to initiate a study with Rocky Point Engineering to understand the technology's feasibility with their goals, receiving $16,000 of funding from FortisBC for the study. Upon completion of the study, they moved forward with the project and received further funding of $50,000 through FortisBC's Gas Technology Demonstration (GTD) program for reduction of natural gas.

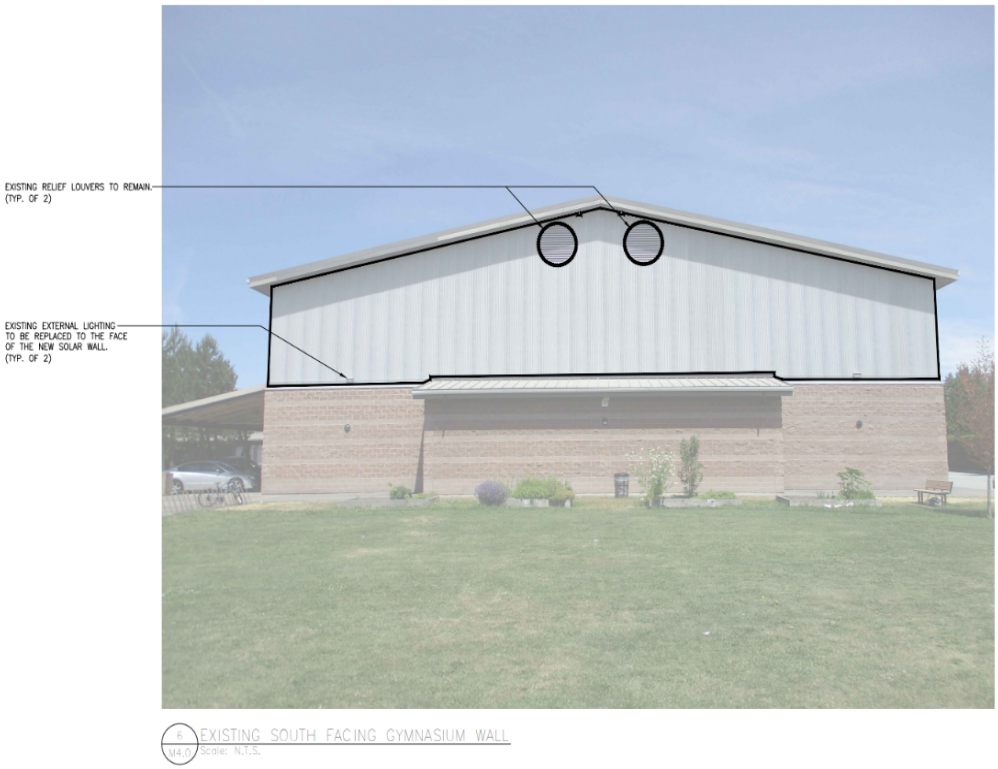



*Project timeline from Richmond School District No.38 project overview*

# PROJECT SUMMARY

## Existing Building Systems

*Mechanical drawing image from Rocky Point Engineering Ltd.*



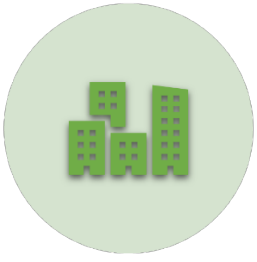

Ecole Robert A. McMath Secondary School is part of Richmond School District No. 39, located at 4251 Garry St. in Richmond, BC. The facility has approximately 1,200 students and is comprised of classrooms, administrative offices, and a dedicated gymnasium building that is roughly 24,800 $ft^2$. The SolarWall was installed on the south wall of the gymnasium building to maximize solar radiation potential. The installation began in May 2019 and was completed in November 2019.

The two-stage system was tied into the intake ducting of the gymnasium building's two air handling units (8,500 L/s and 9,225 L/s respectively) to preheat the incoming air supplied to the building's two gymnasiums. The install was then retrofit to the existing HVAC system and clad to the existing wall. The install also required changes in the air intake for the AHUs to integrate them with the new system. Minimal changes to the exterior lights were also required to accommodate the SolarWall installation.

## Recommended Installation Conditions:

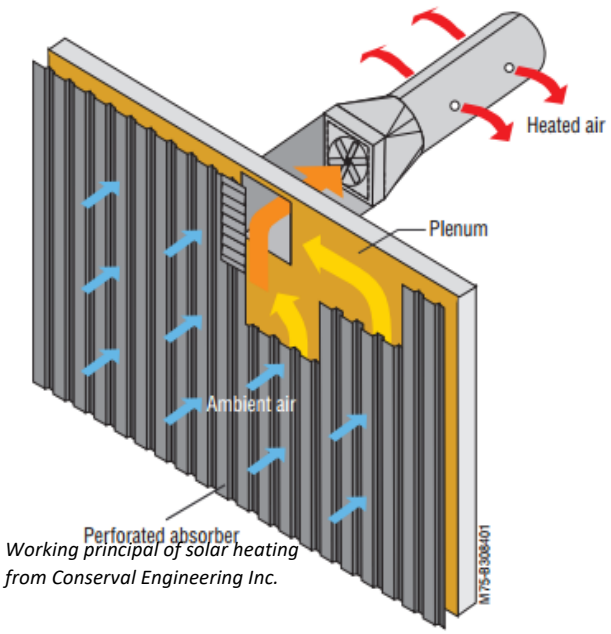
STANDARD CONSTRUCTION CONDITIONS

NO OCCUPANCY (SEASONAL UNOCCUPANCY OR EVENING WORK)



POTENTIAL MODIFICATION OF BUILDING FACADE

# TECHNOLOGY

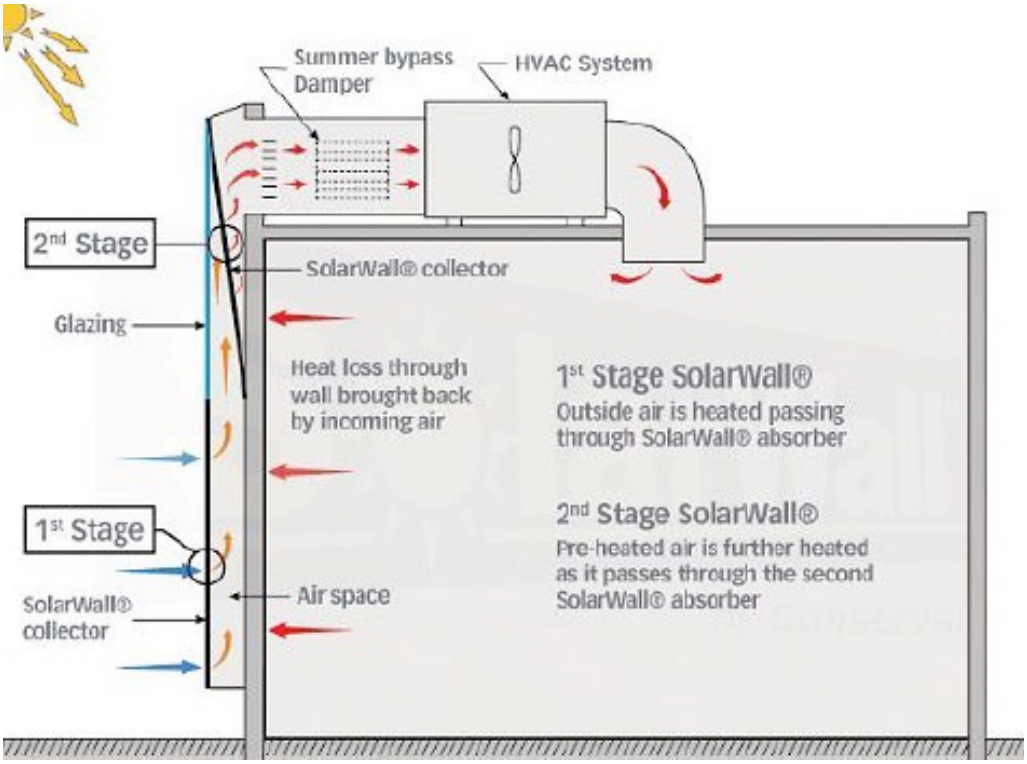



*Working principal of solar heating from Conserval Engineering Inc.*

A typical solar air heating system consists of collectors installed over the building's south facing wall. These collectors are dark perforated metal plates that heat on exposure to solar radiation. This heats the air in the cavity between the old wall and collectors. The heated air is drawn into the building using fans for space ventilation or to pre-heat air passing through heat recovery ventilators or warm the air coil of air source heat pumps. (Energy, 2023)

There are different solar heating installations available depending on occupant requirements and building types. For all systems, the collector panels are made from metal with installation, architectural, and operational flexibility. The panels also come in a variety of colours to integrate with different sections of the building envelope regardless of the existing façade. (Conserval, 2023). The system chosen for McMath Secondary school was a two-stage Solar Wall Facade.

Single-stage and two-stage systems have Solar Wall facades on the building's exterior. The facade collectors accumulate fresh heated air through absorption of solar radiations. This air is further drawn into the cavity between the solar wall panels through the perforations in the panel. The HVAC system then uses this fresh air via ducting and distributes it further ahead. During cooling season, the bypass dampers become operational and the HVAC system reverts to its original setting. The two-stage system works in a similar manner to the single-stage one except there are extra elements involved in the technology. As a primary step, the outside air is heated when it encounters the heated panels' surface. This air is drawn through the panels' perforations by fans located inside the panel cavities. In the second stage, the solar radiation penetrates the polycarbonate glazing to heat the second layer of metal panels. The heated air in the cavity undergoes a second stage of heating, resulting in higher temperature air. This air is then drawn through the panel perforations further into the HVAC ventilation system.




*Two-stage SolarWall system from Conserval Engineering Inc.*

# MAINTENANCE & MEASUREMENTS

## 1) M&V MAINTENANCE

Minimal maintenance is required for SolarWall installations. The SolarWall helps with maintenance as the wall acts as a prefilter, and constricts the flow of large particles in the ventilation ducting system. Building management has noticed thin layers of ice buildup during peak winter season. This phenomenon may increase further depending on the location and corresponding weather of the install.

## 2) M&V RECOMMENDATIONS

Conserval Engineering does not recommend M&V study as a mandate. It is however recommended to perform measurement & verification (M&V) study to ensure that the savings calculated pre-install are being achieved or are within the acceptable range.

## 3) M&V FUNDING

Richmond School District was also awarded $23,400 for the M&V study. Honeywell Building Controls used to control the AHUs was modified with an addition of a BTU meter that included fresh air duct flow meter and a temperature sensor in March 2020.

## 4) M&V PROCESS

Several concerns with how the Solarwall was communicating with the DDC were determined. This affected initial savings and required said deficiencies to be addressed. According to building management, DDC issues are now resolved, and further M&V analysis is ongoing at the time of this publication.

Proposed Change:

**ONGOING MAINTENANCE:**

Minimal; system has acted as a pre-filter to constrict large particulates from entering the main ducting system

**WATCH FOR:**

Ice build-up during peak winter season (effects vary with location)

Existing building controls systems are calibrated appropriately as it may decrease savings

## TECHNICAL ANALYSIS

Following installation, a measurement & verification study was conducted utilizing meter level and whole facility measurements.

Electricity and natural gas consumption of the building were analyzed from December 2019 (the earliest available data) to March 2021. The overall building's electricity and natural gas consumption was 4,797,900 kWh and 21,906.3 GJ respectively. The gymnasium's utility consumption is not sub-metered, consequently specific consumption data for the gymnasiums is not available.

International Performance Measurement and verification Protocol (IPMVP) option A – Retrofit Isolation was chosen for primary verification. The retrofit installation for SolarWall and its associated savings and impacts were verified based upon the amount of heating energy saved. This system calculates measured hours of operation over the reporting period, changes in temperatures before and after the install and volumetric flow rates measured by the installed flow meter.

IPMVP option C – Whole Facility Measurement was also applied to analyse performance, given the SolarWall would have impacted the overall school's performance. Since the gymnasium is not sub metered, savings post-SolarWall install affect the full facility consumption. A

*Table 1: SolarWall operations summary*

| | |
|---|---|
| **Reporting Period Start:** | 2020-12-17 |
| **Reporting Period End:** | 2022-03-17 |
| **Days of data:** | 455 |
| **Number of school days:** | 234 |
| **Solar Wall operation hours:** | 571 |
| **Average flow[1]:** | 72 L/s |
| **Peak flow:** | 359 L/s |

regression model was established to model natural gas consumption. The model was based upon daily natural gas consumption and heating degree days. Savings calculations were based upon the difference between modelled natural gas consumption and the reported values.

[1] Period of no flow excluded.

## SOLARWALL ENERGY SAVINGS & CHALLENGES

Based upon retrofit isolation, annual savings were determined to be 3.5 GJ. Occupancy changes due to COVID-19 restrictions and recommendations to increase ventilation significantly impacted the building's energy consumption as indicated by the savings using IPMVP option C. As a result, IPMVP option C was ruled out as a method of analysis, given the impact of the Solar Wall could not be interpreted from the overall building performance changes.

*Table 2: Energy Savings Summary*

| Method | Natural Gas Savings (GJ) |
|---|---|
| **IPMVP Option A – Retrofit Isolation:** | 3.5 |
| ***IPMVP Option C – Whole Facility Measurement:*** | *-418* |

### Factors That Affect Savings

Shortly after the install of SolarWall in 2019, the school underwent COVID lockdown and occupancy dropped drastically. The school began incorporating a reduced hybrid schedule during the measurement period and, after the initial savings were calculated, eventually moved back to full time occupancy in September 2022. Consequently, the savings reported are lower than expected in the M&V report. Additional concerns were identified in relation to how the system dampers interacted with the building's DDC system. Solar air dampers were observed open during non-daylight hours; as well, outdoor air dampers were observed open while the solar air dampers were actuating. Airflow readings were observed at zero while the solar wall damper was set to its minimum position at 10% open. Finally, the solar air damper was observed in its closed position despite occupancy being detected by the occupancy sensor. DDC issues have since been addressed and further M&V reporting is in place. Savings using the 2022/2023 school year will be reported at end of summer 2023 to determine savings during full occupancy and without control issues.

## POTENTIAL SAVINGS ANALYSIS

To determine SolarWalls future potential savings at McMath Secondary during full occupancy, a RETScreen model was developed based on building and equipment information. The assumptions and characteristics chosen to model the energy savings are presented below:

Table 5: Solar energy and heat delivered data from RETScreen

*Table 3: Load Characteristics from RETScreen*

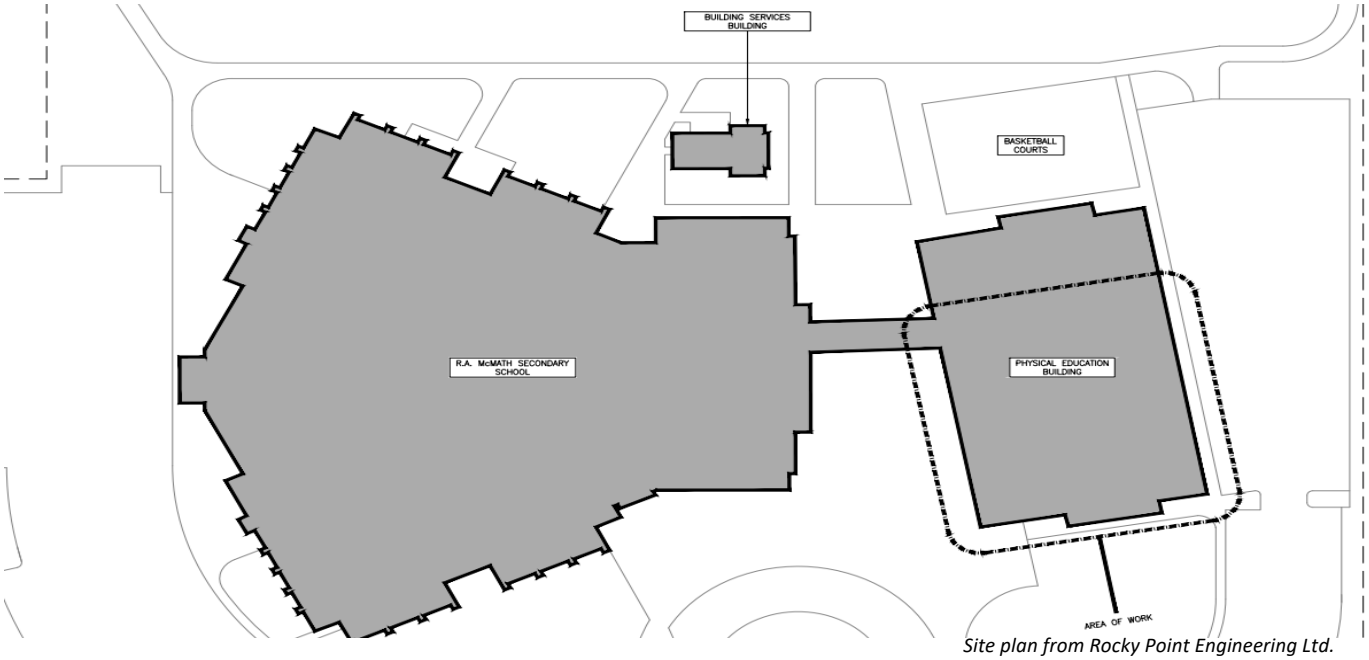
| | |
|---|---|
| **Facility Type:** | Institutional |
| **Indoor Temperature:** | 19°C |
| **Air Temperature – maximum:** | 18°C |
| **R-value-wall:** | 35 m2 - °C/W |
| **Design airflow rate** | 9,225 L/s |
| **Operating days/week – weekdays** | 5 |
| **Operating hours/day – weekdays** | 7 |
| **Operating days/week – weekends** | 0 |
| **Operating hours/day – weekends** | 0 |
| **Solar Tracking mode:** | Fixed |
| **Slope:** | 90 |
| **Azimuth:** | 0 |

*Table 4: Solar air heater specifications from RETScreen*

| | |
|---|---|
| **Type:** | Transpired-plate |
| **Design Objective:** | Standard operation |
| **Manufacturer:** | Conserval |
| **Solar collector colour:** | SW6068 Black |
| **Solar collector absorptivity:** | 0.94 |
| **Performance factor:** | 1.0 |
| **Solar collector area:** | 181.29 $m^2$ |
| **Solar collector shading-season of use:** | 5% |
| **Heating delivered:** | 66.4 GJ |
| **Building heat loss captured:** | 0.21 GJ |
| **Heating energy saved:** | 14.2% |

| Month | % of month used | Daily solar radiation-horizontal kWh/$m^2$/day | Daily solar radiation-tilted kWh/$m^2$/day | Heating delivered GJ |
|---|---|---|---|---|
| January | 100% | 0.80 | 1.26 | 8.911 |
| February | 100% | 1.54 | 2.08 | 11.948 |
| March | 100% | 2.84 | 2.88 | 15.916 |
| April | 0% | 4.28 | 3.09 | 0.0 |
| May | 0% | 5.59 | 3.12 | 0.0 |
| June | 0% | 5.95 | 2.95 | 0.0 |
| July | 0% | 6.26 | 3.23 | 0.0 |
| August | 0% | 5.32 | 3.45 | 0.0 |
| September | 50% | 3.69 | 3.36 | 2.202 |
| October | 50% | 2.04 | 2.64 | 7.692 |
| November | 100% | 0.97 | 1.48 | 10.43 |
| December | 100% | 0.66 | 1.19 | 9.297 |
| Annual | 49.7% | 3.34 | 2.56 | 66.6 |

The model determined annual energy savings of 66.6 GJ and annual natural gas savings of 77 GJ, based on an 87% efficient boiler heating system. Using an average utility cost of $9.35/GJ natural gas annual savings equate to $722 CAD. Using current emission factors this results in an annual GHG reduction of 3.9 tonnes $CO_2e$.




*Site plan from Rocky Point Engineering Ltd.*

## REFERENCES

Conserval. (2023). SolarWall. Retrieved June 26, 2023 from https://www.solarwall. com/industries/commercial/

Energy, U. D. (2023). Active Solar Heating. Retrieved June 28, 2023 from https://www.energy. gov/energysaver/active-solar-heating

Richmond School District No.38. (2023). Ecole Secondaire R.A. McMath Secondary School. Retrieved June 26, 2023, from https://mcmath.sd38.bc.ca/our-school-story