

SFUSD PROJECT REQUIREMENTS

December 1, 2017

EXECUTIVE SUMMARY

Motivated by the California State Architect's **7x7x7: Design Energy Water Challenge**, SFUSD has completely transformed the process by which it designs, constructs, and modernizes its buildings in order to achieve a **carbon neutral district by 2040**. New buildings must be Zero Net Energy (ZNE) ready, modernized buildings are modeled so a pathway to ZNE can be incorporated into the design phase, and all facilities and deferred maintenance projects must adhere to a strict set of requirements to ensure alignment with **ZNE goals**.

Specifically, SFUSD is working to replace windows and add insulation, upgrade building controls, and replace aging gas boilers with electric heat pumps. The goal is to achieve a **50% reduction in natural gas usage** by 2030.

In addition, the District also seeks to reduce water usage by the same amount by specifying ultra-low-flow fixtures and implementing **rainwater catchment** for toilet flushing where feasible.

CONTENTS

Goals	2
-------	---

Strategy	3
----------	---

Process	
---------	--

New Buildings	4
---------------	---

Bond Modernizations	5
---------------------	---

Facilities Projects	7
---------------------	---

ZNE Guidelines	8
----------------	---

GOALS

The SFUSD School Board, via its *Carbon Neutral Schools* Resolution, is calling on the District to achieve the following targets as it seeks to phase out fossil fuel use by 2040:

Buildings

- New buildings will be designed wherever possible with the goal of using no more energy than they could generate on site.
- New and modernized buildings will be plumbed for rainwater collection where feasible.
- SFUSD will strive to reduce gas usage 30% by 2020, 50% by 2030, and 100% by 2040.
- SFUSD will strive to reduce its water usage 30% by 2020 and 50% by 2030.

Fleet

- All *new* SFUSD-owned vehicles shall be emissions-free.
- SFUSD will strive to fuel all diesel-powered buses with renewable diesel by 2020.
- All SFUSD-owned vehicles will be electric or powered by low-carbon fuels by 2030.

Renewables

- SFUSD will strive to generate all of its own power on site by 2050.
- SFUSD will strive to meet 50% of water demand via rainwater by 2050.

Background on the above targets, as well as District progress in meeting them, can be found in the District's *Carbon Reduction Plan (CRP)*.



What about electricity?

SFUSD receives its power and water from the SFPUC's Hetch Hetchy Power System, which generates 1.6 billion kilowatt hours of clean, hydroelectric energy each year. As a result, the District's electricity is already 100% greenhouse gas-free. To achieve carbon neutrality in its buildings, SFUSD is therefore focusing its efforts of switching its heating systems from natural gas to electricity.

STRATEGY

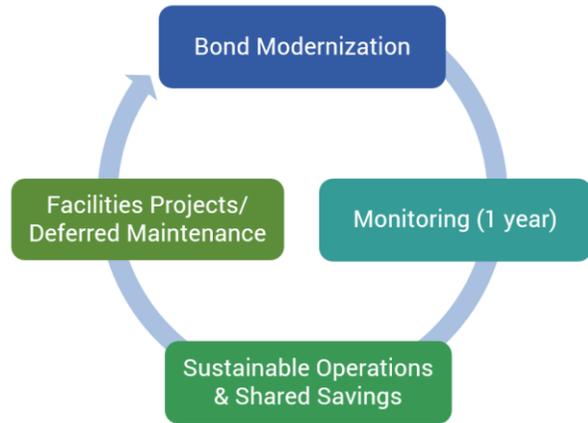
The District has many opportunities to improve the carbon footprint of its buildings:

BOND PROJECTS: voter-approved funding for new construction & major renovations provides the best opportunity for deep energy retrofits

MONITORING: post-occupancy commissioning and energy monitoring can identify opportunities to adjust operation to meet design intent

OPERATIONS & SHARED SAVINGS: preventative maintenance, energy and water monitoring, and engagement of users prevent rising energy and water usage as buildings age

FACILITIES PROJECTS: major repairs and deferred maintenance projects provide an opportunity to improve energy and water efficiency



These *SFUSD Project Requirements* were created to assist design teams in supporting the District's ambitious zero carbon goals. The following pages describe the process for incorporating ZNE-ready design into new buildings, bond modernizations, and facilities projects. In summary:

New Buildings will be designed to achieve an Energy Use Intensity (EUI) < 20 kBtu/sf/yr. SFUSD's preferred strategies for achieving such exemplary energy efficiency are outlined in the *ZNE Guidelines* at the end of this document. While the addition of renewable energy is generally outside the scope of new projects, solar readiness should be built into the building.

Bond Modernizations will focus on improvements to the lighting systems and building envelope as outlined in *ZNE Assessments* commissioned by the District for every project prior to the design phase. These assessments will also look for opportunities to improve end-of-life heating and ventilation systems, but these items will generally be tackled in future bonds.

Facilities Projects generally have limited scope and will support ZNE goals by upgrading building elements as they wear out. In each case, the *ZNE Guidelines* below and *District Design Standards + Guidelines* (DDSG) will inform the design and selection of materials and equipment.

Renewables & Storage will be incorporated into projects as budgets allow. In a few years, as solar prices sink further, it will be financially prudent for SFUSD to become its own utility by generating electricity at costs below market rates. If the SFPUC's electric rate shifts to a Time-of-Use structure, the District will begin to explore the possibility of installing batteries to absorb midday PV generation for later consumption.

PROCESS

New Buildings

Ensuring that the District's energy targets are faithfully met in new construction projects requires a rigorous design process, stellar construction techniques, and attention to quality control. To ensure the best possible outcome on each and every project, SFUSD requires architects to incorporate the following elements into the process of creating new buildings:

INTEGRATED DESIGN: All projects will commence with an architect-led design charrette specifically focused on identifying the strategies and systems necessary for meeting the EUI target. At a minimum, the Project Manager, Sustainability Office, Buildings & Grounds, Design Team, Commissioning Agent, and Electrical/Mechanical/Civil consultants will attend. Where feasible, a Design-Build procurement process will maximize the benefit of this approach.

ENERGY MODELING: Building form, massing, orientation, and roof layout (among other design parameters) have a significant impact on energy usage and solar energy production. Therefore, design decisions shall be evaluated against a constantly refined energy model from the earliest stages of a project. In this way, project architects will have many opportunities for course correction should site conditions or non-energy parameters make achievement of ZNE goals difficult. Modeling inputs should be clearly documented so deviations can be identified upon building occupancy.

COMMISSIONING: Commissioning agents hired by the District will be brought into the design process early on and follow each project through design, construction, and post-occupancy to ensure that design intent is achieved as outlined in this document and reflected in the Basis of Design (BOD). The *Commissioning Plan* will include design reviews, construction inspections, functional testing, development of a maintenance manual, and systems training (see Commissioning Procedures in the 2016 Bond Program *Procedures + Standards Binder*).

First ZNE Projects

SFUSD is in the process of designing its first new ZNE building at Claire Lilienthal School on Divisadero St. The building will house the middle school program of this K-8 school and replaced eight existing bungalows. The second ZNE project is a PG&E-supported modernization of Garfield Elementary on Telegraph Hill. The utility is particularly interested in identifying design solutions in the constrained urban environment.



TRAINING & STEWARDSHIP: In addition to the thorough training of Buildings & Grounds staff, it is critical that building occupants are properly engaged in order to operate a building efficiently and obtain feedback about building operation. The Sustainability Office will work with the Commissioning agent to conduct occupant training and post-occupancy commissioning and to instill a culture of stewardship that will benefit both the building and the environment.

VERIFICATION: The Sustainability Office will monitor building and end-use utility data before and after a project to see if performance specifications were truly met. Given the constrained nature of many school sites in San Francisco, attaining low energy usage is of paramount importance if future solar installations are to cover the entire energy demands of a site.

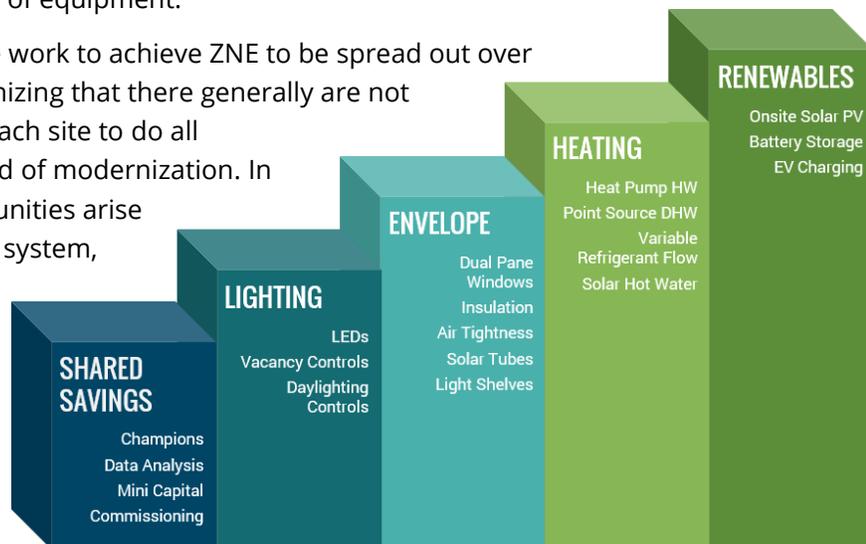
Bond Modernizations

While new buildings can be designed and built to meet ZNE-ready status relatively easily and with minimal additional cost, renovating existing buildings to reach similar levels of efficiency presents a much bigger hurdle. This is because many parts of the building cannot be cost-effectively upgraded. For example, improving envelope insulation levels cannot readily be done without removing an entire building façade. In addition to the enormous expense, upgrades of this kind do not lead to dramatic energy savings in the mild San Francisco climate zone.

For this reason, SFUSD has decided to hire energy modeling firms to conduct *ZNE Assessments* of all sites named in the 2016 bond in order to identify the importance of various energy efficiency measures in achieving an EUI of less than 20 kBtu/sf/yr. These firms will also calculate the area of solar generation required to offset predicted site energy usage. Thus, design teams will be able to combine this information with project cost estimates to select a package of efficiency improvements that most cost-effectively achieves the District’s EUI targets.

In deciding which recommendations from *ZNE Assessments* to include in the project scope, design teams will be guided by an implementation hierarchy that calls for lighting retrofits and envelope improvements to be adopted first, followed by heating upgrades, and finally renewable generation. In other words, the goal is to minimize heating load before implementing system upgrades, thereby avoiding possible oversizing of equipment.

This strategy also allows the work to achieve ZNE to be spread out over multiple bond cycles, recognizing that there generally are not enough funds assigned to each site to do all necessary work in one round of modernization. In cases where unique opportunities arise to replace an entire heating system, bond sustainability funds, Prop 39 funding, and/or support from the SF Public Utilities Commission (SFPUC) may allow a quicker approach.



The chart below summarizes which elements will be incorporated into each 2016 bond project and which will only be included on a case-by-case basis. Design teams will consider recommendations from the ZNE audit, synergies with other scope, available funding, and site-specific design parameters to determine which of the latter to include.

SCOPE	MODERNIZATION		FUNDING			
	Mandatory	Case-by-case	Bond	Sustainability	Prop 39	Utility
Windows/shading if deteriorating or user discomfort/glare		✓	✓		✓	
Air sealing weather-stripping all doors/windows	✓		✓			
Insulation in attics or when reroofing/opening walls		✓	✓			
LED lighting indoor/outdoor with controls	✓		✓		✓	
Solar tubes/skylights in common areas w/reroof		✓		✓		
Metering smart, irrigation & submeter (w/switchgear)		✓	✓	✓		
Transformers outside & step-down w/fuel switch		✓	✓			
Dashboard touchscreen in lobby w/internet	✓			✓		
Kitchen equipment non-Energy Star	✓		✓			
EMS upgrades latest standard, connect all spaces	✓		✓			
Fuel switch replacing gas w/heat pump		✓	✓	✓	✓	✓
Heating system tcv, vfd, ecm, pipe insulation, steam traps, radiator bypass, thermostats, scheduling		✓	✓		✓	✓
Ventilation DOAS w/ERV		✓	✓		✓	
Solar readiness stanchions, obstructions & conduit		✓		✓		✓
DHW close to use, no recirculation, tank as needed	✓		✓	✓	✓	
Domestic H2O fixtures, aerators, valves & partitions	✓		✓			
Piping replace if past lead issues identified	✓		✓			
Irrigation backflow, hose bibbs & LTAP	✓		✓	✓		
Soil testing in existing landscaped areas	✓		✓			
Turf replacement where existing lawn		✓				✓
Stormwater control site disturbance, play matting		✓	✓	✓		
RWH pre-plumbing, roofing & external downspouts		✓	✓	✓		✓
Materials meet CalGreen & CA Section 01350	✓		✓			
Washing machine stub out & appliance	✓		✓			
Hand dryers new and remodeled restrooms		✓	✓			
Bottle fillers cafeteria & one per floor	✓		✓			
Trash sorting outdoor/indoor sorting areas	✓		✓			
Construction waste > 75% waste diversion	✓		✓			
Walk & bike infrastructure when restriping		✓	✓	✓		

Facilities Projects

Despite operating with a much smaller budget than the Bond Department, the Facilities Department is an integral part of the District's efforts to improve its building stock, tackle deferred maintenance, and occasionally even construct new buildings. Typical work includes window retrofits, roofing projects, installation of security or fire alarm systems, and replacement of boilers or other aging equipment. The Facilities Department is also implementing most of SFUSD's Prop 39 energy efficiency projects (lighting retrofits, control upgrades, etc.) and collaborating with the SFPUC to pilot the replacement of gas heating with heat pump/VRF systems.

In order to ensure that Facilities does not inadvertently work in opposition to the District's carbon neutrality goals, work will be aligned to the *ZNE Guidelines* below. Thus:

- Existing *ZNE Assessments* will be consulted to identify opportunities to improve energy efficiency.
- Specifications for new equipment will match those for new construction.
- New gas-fired equipment will not be installed.

The *District Design Standards + Guidelines* (DDSG) have recently been updated to ensure that proper guidance is given to architects of all magnitude of projects to ensure SFUSD's long-term achievement of energy goals.

ZNE GUIDELINES

Design teams working with SFUSD are asked to design buildings that are:

HEALTHY... maximizing daylight, views, air quality, thermal comfort, and acoustics.

BEAUTIFUL... encouraging pride and engagement among families and the community.

EFFICIENT... reducing energy use to a minimum to facilitate achievement of ZNE.

VALUABLE... minimizing lifecycle costs and reducing maintenance as much as possible.

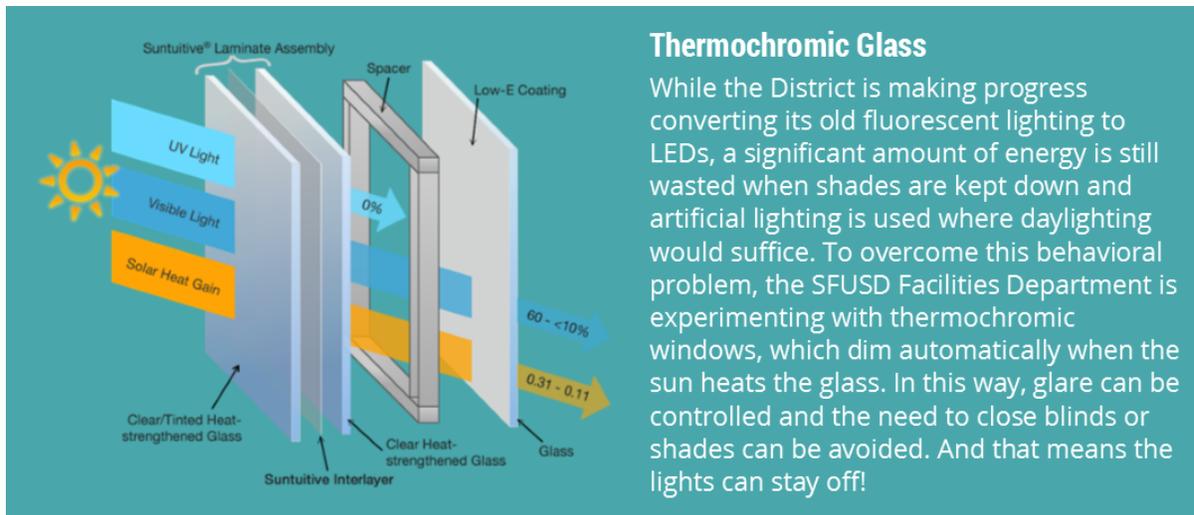
In order to achieve adequate levels of efficiency in San Francisco, design teams should consult the Department of Energy's (DOE) **Advanced Energy Design Guide for K-12 School Buildings: Achieving a Zero Energy Building (AEDG)** and follow the *ZNE Guidelines* below. While these guidelines are most easily implemented in new construction, they should also be utilized where applicable in bond modernization and facilities projects.

ENERGY: New buildings should be designed to achieve a modeled **Energy Use Intensity (EUI) below 20 kBTU/sf/yr**, a value that allows rooftop solar to offset yearly energy usage for a typical 2-3 story San Francisco school. Building systems should be **"designed for off"**, meaning that they will shut down without user intervention. **Solar analysis** during **Schematic Design (SD)** should confirm that rooftop solar potential will be adequate to cover modeled energy usage.

FORM & SITING: Buildings should be simple and compact, oriented and sited for maximum solar access, integrated into the landscape, and with a depth & layout that allows **daylight harvesting, natural ventilation, outside views**, and the use of **thermal mass**. Consider **exterior circulation** to minimize the need for conditioned common areas and **stacking functions** to promote construction and energy efficiencies.

MAINTENANCE: Every effort should be made to **facilitate maintenance access** to building systems (without ladders/lifts and without disturbing classes), materials should be chosen that are **easy to clean** and **inexpensive to maintain**, and design teams are encouraged to **expose the functional elements** of the building for students to see.

ENVELOPE: In order to minimize the heating load, roof, wall, slab edge, and door **insulation** should be **continuous** and **optimized** via building modeling to comply with the EUI target above. In general, **R30 roof** and **R20 wall** insulation should be specified. **Exterior insulation** should be specified **over cavity insulation** and **fiberglass batts** are **never allowed** due to poor thermal performance in the field. **Double swinging doors** without a center post or **rolling**



overhead doors without insulated panels are **discouraged** due to poor air sealing properties. Moisture and air **control layers** should also be continuous and reside on the **warm side of exterior insulation**, and architects should specify **airtight construction** practices (.25 CFM/SF @ 75 Pa). **Thermoplastic polyolefin (TPO)** is the preferred roofing material and **rain screens** are encouraged where feasible. Consult the *AEDG* for proper detailing of **envelope penetrations**.

WINDOWS: Windows size and specifications should be tuned based on building **orientation**, with north and shaded, south-facing glass being larger and/or having higher **Solar Heat Gain Coefficients (SHGC)** than east or west-facing glass. Assembly **U-values** should be **less than 0.30** on all sides (including roof) and **thermally-broken frames** are required. Avoid **spandrel glazing** and **insulated panels**. Glare and heat control (especially on E/W elevations) should be provided via optional **thermochromic glass** and/or **exterior shading** as well as mandatory **interior shades**.

LIGHTING: Whenever possible, buildings should utilize **natural light** to meet lighting needs. Strategies include **sloped ceilings** (especially at the windows), **light shelves** on southern classrooms, **reflective interior** surfaces, **skylights** along **interior walls**, and avoidance of **direct sunlight** (see the *AEDG* for design guidance). **Interior** lighting shall be **100% LED**, with **manual on/auto off** (not occupancy) in classrooms and offices, **occupancy** sensors in **common areas**, and **daylighting controls per Title 24**. Classroom light levels of **35 foot-candles** are sufficient and overall Lighting Power Density (LPD) should be **0.4 w/sf max** (see the *AEDG* for specific **lighting levels** and **design guidance**). **Skylights, sun tubes, or light wells** should be included in sufficient quantity to allow zero artificial lighting in **common areas** during daytime hours. **Exterior** lighting should incorporate **bi-level control** and astronomical **time clocks**.

HEATING: Space conditioning should be limited to **permanently occupied areas**; no conditioning is needed in foyers, hallways, restrooms, or closets. Heating shall be provided by

HFC-free (when available), corrosion-resistant **Variable Refrigerant Flow** (VRF) systems with **heat recovery** as specified on a project-by-project basis. **NO FOSSIL FUEL-BASED HEATING (NATURAL GAS) IS ALLOWED.** Space heating should be controlled **separately for each zone**, with set points of **66-72 °F** in **occupied** spaces. Occupied hours should be aggressive (**M-F: 7am-6pm**); the system should be off after hours and on weekends (w/the possibility of limited duration and zone-specific overrides).

COOLING/VENTILATION: **Occupied spaces** should rely on **natural ventilation** unless schools are located in close proximity to a major pollutant source (e.g. freeway, major arterial). If mechanical ventilation is required, schools should incorporate **dedicated outside air systems (DOAS)** designed to **ASHRAE 62.1** or **CEC T24** requirements with **occupancy and/or CO2-based controls**, a **15-minute delay**, and **MERV 13** final filters throughout. **Fresh air** should originate from a **shaded/cool** part of the building exterior and be **delivered low** in each space. **Ceiling fans** should be used to expand the comfort range **only if** all other options (e.g. **window film**) have been exhausted. **Data closets** should have a **set point** of **75 °F**. Ventilation in cooking kitchens should incorporate **heat recovery** and exhaust rates aligned with **best practices** identified by the **Food Service Technology Center**.

HOT WATER: Design teams shall specify **point-of-use** water heaters for **staff restrooms**, **small electric tank** water heaters in **staff lounges** and **custodial closets**, and (until heat pump options come to market) **condensing gas** water heaters **in/near the kitchen**. **Recirculation** systems should be **avoided/removed** and **pipes** rigorously **insulated**.

METERING: All completed projects shall contain **smart electric, gas, and water meters** as well as a **networked touchscreen**. Where **irrigation** is served by a dedicated line, **meters** shall also be installed. Plug loads (controlled and uncontrolled), lighting, heating, ventilation, kitchen equipment, and DHW will be **separately sub-metered** where feasible. New **transformers** shall meet high-efficiency "**NEMA premium**" specs and right-sized for the electrical load.

Heat Pumps

For many decades, natural gas heating systems have been viewed as more efficient than electric ones. That's because from extraction to consumption, gas is about 70% efficient; electric (baseboard) resistance heaters are only 33% efficient. Recently, however, heat pumps have emerged on the market that move heat from outside air into a building, rather than generating it from the electricity itself. Overall efficiency has thus improved to the point where it matches or exceeds that of gas heating systems. Because the electricity powering a heat pump can be derived from renewable energy, however, the climate footprint of a heat pump can effectively be zero.



PLUG LOADS: Expected plug loads should be discussed with the **IT department** and factored into modeling results. **Staff refrigerators** and **microwaves** should be provided so individual units are not purchased upon occupancy. Outlets wired for **receptacle control** (as per Title 24) shall be **clearly labeled**. **High-heat kitchen equipment** (e.g. griddle, fryers) should be **avoided** and only the most **efficient equipment (CEE Tier 2)** specified (see *Student Nutrition Standards in Procedures + Standards Binder*). The Food Service Technology Center provides design guidance and equipment recommendations for commercial kitchen appliances, walk-in refrigeration, and ventilation hoods. **Traction elevators** are preferred where new elevators are specified.

SOLAR: In general, the District plans to add solar only after having occupied a building for at least one year. However, design teams need to **estimate** the amount of **solar capacity** available so that EUI targets for the building can be modified to match expected power generation. *ZNE Assessments* will provide this guidance for modernization projects. Since these are only estimates, however, every effort will be made to **maximize roof area** available for solar and to orient it **toward the sun**. New construction and roofing projects shall include **stanchions** for future PV racking systems, **conduits** from the roof to the electric panel, and **space** for inverters and/or batteries **in the electrical room**.

LANDSCAPING: Separate **sub-meters** shall be installed for outdoor water use and only **drought-tolerant** plants should be planted outside of food gardens. **Drip** or **subsurface irrigation** should be used and tied to **rain sensors**.

(RAIN)WATER: **Urinals** shall use no more than **one pint per flush** and all other **fixtures** shall meet the latest **CalGreen** requirements. Bathrooms shall contain **shut-off valves** to aid in the identification and repair of plumbing leaks and be **pre-plumbed**, in new construction or where walls are opened, to receive **rainwater** for **toilet flushing** or **irrigation**. All **roofs** shall be **rainwater-harvesting friendly** (TPO, metal) and incorporate **external downspouts**. A **backflow device** is required at the **point of rainwater collection** and **at the street**.



Flushing with Rainwater

Starr King Elementary is the first SFUSD school that utilizes rainwater to flush toilets. As part of its modernization work, the new admin and library building was pre-plumbed to receive rainwater from its metal roof. The water is stored in a 5,000 gallon cistern and filtered and sterilized before entering the building. Should the cistern run dry, the system automatically switches over to city water until the next rain storm. All new buildings in the District will be outfitted with similar systems.

STORMWATER: The SFPUC requires all projects that disturb more than **5000 sf** of impermeable surface to submit a **Stormwater Control Plan (SCP)** to show how a project will reduce stormwater runoff and rate of flow by 25% (each). Beyond that, it shall be the goal of all new projects to **capture and retain all stormwater** runoff on site. **Playground matting** shall be **permeable** and schoolyards should be graded to allow **perimeter stormwater infiltration**.

MATERIALS: Finishes and other materials shall be **durable**, contain **recycled/bio-based** content, **lead** and **PVC-free, recyclable** at end-of-life, and meet low emissions criteria outlined in **CalGreen** and **CA Section 01350** where applicable (e.g. paints, coatings, adhesives, sealants, flooring/carpet, composite wood/panels, acoustical ceilings, insulation, and furniture).

WASTE REDUCTION: Hallways on each floor, as well as the cafeteria, shall be equipped with a **bottle filler**. Custodians shall be provided with a **high-efficiency washing machine** for washing microfiber mops used in SFUSD's green cleaning program. Student restrooms should be outfitted with **high-speed hand dryer** with a noise rating **below 70 db**.

WASTE DIVERSION: A **minimum of 75%** of construction waste shall be diverted from the landfill, with the contractor **providing proof** to the Sustainability Office. School designs shall include **adequate/accessible space** for **waste sorting** and **storage**.

COMMUTE: **Walking** and **biking routes** on the school campus shall be marked to improve safety and encourage active commutes. Design teams will provide **one bike rack** (4-loops) for schools on **hills** and **two bike racks** or enough to meet demand (whichever is greater) at all **other locations**. **Car parking** is not allowed on school sites.