ABSTRACT
There are five different publications that establish guidelines for sustainable building development that are examined in this report: (1) Leadership in Energy and Environmental Design (“LEED”); (2) CalGreen; (3) the International Green Construction Code (“IGCC”); (4) ASHRAE Standard 189.1 (“Standard 189.1”); and (5) The San Francisco’s Green Building Ordinance (“SFGBO”).

Having multiple publications can cause confusion among building developers, architects, engineers, building consultants, or various jurisdictions on what publication to follow, use, or reference in building development projects.

This article will provide various parties involved in building development a thorough understanding of each publication and the similarities or differences between them, which will ultimately assist in identifying areas for all publications to improve.

Specifically, this article demonstrates that the Material and Energy sections for all the publications must advance beyond the current requirements. Also, the comparison validates that CalGreen’s Tier 2 is similar to LEED’s local ordinances, like the SFGBO. This may mean two things: (1) LEED will need to advance its gold or platinum certification requirements, or potentially become less relevant; or (2) local ordinances should reference or adopt CalGreen Tier 2 so that there is common language between local and state regulations. This article identifies that LEED has the most stringent guidelines under the Building Site section out of all the publications. Likewise, the IGCC and Standard 189.1 have provisions under the Water Use section, that goes beyond other publications. Additionally, similar language between LEED and Standard 189.1 was found, which was unsurprising as both publications are authored by the USGBC.

KEYWORDS
sustainable building development, local ordinances, jurisdictions, local and state regulations, voluntary & involuntary green building rating systems, LEED, CalGreen, IGCC, ASHRAE 189.1 and SFGBO
INTRODUCTION

There is an increasing number of guidelines for green building development (“publications”) that have been fashioned without much post-publication comparisons of the commonalities between each or consideration of common visions for sustainability. Often, the numerous publication options can cause confusion among building developers, architects, engineers, building consultants, or various jurisdictions on what publication to follow, use, or reference in building development projects. The purpose of this paper is to provide all parties involved in building development a more thorough understanding of each publication and the similarities or differences between them, which will assist in identifying areas for all publications to progress.

There are five key publications that are analyzed in this paper: (1) Leadership in Energy and Environmental Design (“LEED”); (2) CalGreen; (3) The International Green Construction Code (“IGCC”); (4) ASHRAE Standard 189.1 (“Standard 189.1”); and (5) San Francisco’s Green Building Ordinance (“SFGBO”). These five publications are a mix between voluntary and involuntary guidelines for green building development. Green buildings “offer one way to mitigate the current and growing environmental impacts from the built environment.”

LEED is a voluntary rating system created and maintained by the U.S. Green Building Council (“USGBC”) that evaluates a building’s environmental design and offers multiple levels of certification (Certified, Silver, Gold, or Platinum). LEED’s 2009 rating system for New Construction and Major Renovations is used for the purposes of this analysis.

LEED is “largely based on an assessment of the design intentions of the design team and attempts to ensure that much of this is translated into the built form.” While some jurisdictions across the United States have adopted LEED certification as a standard for any new construction, California has adopted the first ever statewide green building code, or involuntary rating system, CalGreen. CalGreen is a building code, and chapter 11 of California Code of Regulations Title 24. CalGreen went into effect January 1, 2011 and is the nation’s first mandatory statewide green building code.

The comparison between LEED and CalGreen is an important one, because since LEED was created in 1998 there have been over 5,000 LEED certified buildings constructed in California. It is still too early to determine if or how CalGreen will impact the rate at which LEED certification is awarded, but the greater the similarities between the two publications may mean that LEED will need to adapt beyond the standards listed in CalGreen or lose relevancy.

The IGCC is a standard put in place by the International Code Council in association with cooperating sponsors American Society for Testing and Materials International (ASTM) and the American Institute of Architects (AIA) as an alternative tool to voluntary rating system with mandatory language intended to be adopted by and administered by jurisdictions. The IGCC targets the market segment that is not likely to react to voluntary programs. The IGCC has a section dedicated to project electives, which allows the parties involved in the building process to advance the project beyond the IGCC’s minimum requirements.

Standard 189.1, Standard for High-Performance Green Buildings Except Low-Rise Residential Buildings, is an American National Standards Institute (ANSI) standard developed by the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
in association with the Illuminating Engineering Society (IES) and the USGBC for the design of high-performance green buildings. The IGCC accepts Standard 189.1 in lieu of following the standards prescribed by the IGCC.

The SFGBO is an ordinance that imposes green building requirements on newly constructed residential and commercial buildings, and renovations to existing buildings in San Francisco, California. The SFGBO often references LEED and in specific sections requires a higher threshold above that set by LEED.

The raw analysis of each publication is completed by first breaking each publication into common sections then comparing each section to determine where gaps and similarities currently exist in each publication. Whether each publication uses the same measures or metrics to determine a specific guideline for each section is also discussed.

**COMPARISON**

Within the five (5) publications: (1) LEED; (2) Standard 189.1; (3) IGCC; (4) CalGreen; and (5) the SFGBO there are six (6) sections that this paper compares. The sections were selected because each publication considers the topic. The sections are: (1) Sites; (2) Energy; (3) Water; (4) Materials; (5) Internal Air Quality (“IAQ”) / Environmental Air Quality; and (6) Commissioning. Under each section there may or may not be various subsections. The subsections were selected because each publication either considers or should consider the topic.

**Sites**

Standard 189.1 contains similar requirements as LEED in the Sustainable Sites Section, excluding requirements around bicycles and priority parking. Standard 189.1 utilizes the same metric for measuring light pollution as LEED.
The IGCC is unique in that it has a great deal of requirements regarding soil testing for subsurface greywater irrigation systems. It also has an extensive section aimed at protecting a building site’s natural resources, specifically soil and vegetation. Additionally, it forbids the use of potable water for irrigation. Lastly, when compared to LEED, the IGCC holds less stringent requirements regarding how close one can build to wetlands by twofold.

CalGreen’s section on Planning and Design contains few requirements including stormwater during and post construction, light pollution, priority parking and bicycle parking. CalGreen requires both long-term and short-term bike parking for 5% of the motorized vehicle parking capacity, yet does not require changing rooms like LEED and the IGCC.

The SFGBO has two requirements for sites, which both relate to stormwater: (1) stormwater management and design must follow guidelines of the San Francisco Public Utilities Commission; and (2) guidelines for stormwater quantity and quality that to meet or exceed LEED SS6.1 and SS6.2 guidelines.

Energy
Under the Energy section, there are ten (10) subsections within our comparison: (1) Energy Performance; (2) Energy Prescriptive; (3) Renewable Energy; (4) Energy Efficient Appliances; (5) Elevators, Escalators, etc.; (6) Thermal Bridging; (7) Metering; (8) Green Power; (9) Moisture Control; and (10) Demand Response.

(1) Energy Performance
Currently, LEED sets the standard for Energy Performance and is based off ASHRAE version 90.1-2007, which is the Energy Standard for Buildings except Low-Rise Residential Buildings, and goes up to a 48% energy cost savings. The new draft of LEED, which has not been released yet, has a few changes regarding how Energy Performance is calculated. Currently, Option 1 in LEED is Whole Building Energy Simulation and uses Energy Cost, but the new version of LEED “calls for a combination of energy cost and source Energy Use Intensity (“EUI”).” EUI “is a unit of measurement that describes a building’s energy use and it represents the energy consumed by a building relative to its size. A building’s EUI is calculated by taking the total energy consumed in one year (measured in kBTU) and dividing it by the total floorspace of the building.” The new version of LEED also references ASHRAE 90.1-2010 instead of ASHRAE 90.1-2007, the former of which is more stringent. The Optimize Energy Performance credit, under the expected new version of LEED, also has some changes with a more stringent baseline for receiving points and provisions for project teams “to establish an energy performance target during the schematic design phase, and for the simulation option, use the energy modeling process to inform their design.” Standard 189.1 has numerous requirements that supersede ASHRAE 90.1-2007, which LEED references for Energy Performance. On average, Standard 189.1 is 27% more energy efficient than ASHRAE 90.1-2007, and also moves to incorporate CO₂ and demand reduction measures into the Energy Performance of a building.

The IGCC has numerous requirements for Energy Performance documentation and Energy Performance verification. The measurement-based compliance under the IGCC is to be performed by an approved agency that documents the energy use of the building. Minimum performances are based on Total Annual Net Energy Use (“TANEU”), building peak energy demand, and reduced CO₂e emission calculations and reporting. Buildings are to
comply with the 2006 International Energy Conservation Code to have a TANEU score of 100. As previously mentioned, LEED is based off the ASHRAE 90.1-2007 for Energy Performance, which is the Energy Standard for Buildings Except Low-Rise Residential Buildings and ranges up to a 48% energy cost savings.

CalGreen references energy code Title 24, Part 6, of the California Code of Regulations for Energy Performance provisions. Under CalGreen, to achieve the optional Tier 1 and Tier 2 improvements Energy Performance improvement must go beyond Title 24, Part 6 by 15% or 30%. This is in terms of energy, not energy cost or CO₂e and exclusive of plug loads. As a result of plug load exclusion, an actual apple to apples comparison is likely with Tier 1 at 10% and Tier 2 at 20%.

The SFGBO provisions are for documentation by a Commissioning Agent that demonstrate fundamental commissioning of the building energy systems. This is LEED EA Pre-requisite 1 and is referenced by the SFGBO.

(2) Energy Prescriptive

Standard 189.1 has the same provisions for Energy Prescriptive as Energy Performance. The IGCC provides prescriptive-based compliance for the Energy Prescriptive section and shall be deemed to have a TANEU score of 70. LEED’s Energy Prescriptive section also references ASHRAE 90.1 while CalGreen references energy code Title 24, Part 6.

(3) Renewable Energy

Standard 189.1 has specific provisions for Renewable Energy requiring on-site renewable energy systems to provide an annual energy production of no less than 6.0 kBTU/ft². Exclusions exist under Standard 189.1 for projects that do not receive more than 4.0 kw/m²/day and for projects that purchase Green-e Energy of at least 7 kWh/ft² of conditioned space each year until the cumulative purchase is equal to 70 kWh/ft² of conditioned space. LEED provides points for a range of 1–13% of generated energy via on-site Renewable Energy sources. Possible points available under LEED for Renewable Energy range from one (1) point to seven (7) points and these Renewable Energy potential includes solar, wind, geothermal, low-impact hydro, biomass and bio-gas strategies.

The IGCC has provisions for building performance-based compliance and building prescriptive compliance for Renewable Energy system requirements. The provisions for Renewable Energy are for system performance monitors and metering. There are also provisions under the IGCC for solar photovoltaic systems, wind energy systems, and solar water heating equipment.

CalGreen does not have any mandatory requirements for Renewable Energy, however, per section A5.211.1, CalGreen suggests that the use of on-site renewable energy for at least one percent (1%) of the electrical service overcurrent protection device rating should be calculated in accordance with the 2007 California Electrical Code or 1KW, whichever is greater. In addition to the electrical demand required to meet one percent (1%) the natural gas and propane use is to be calculated in accordance with the 2007 California Plumbing Code. In section A5.211.4, CalGreen also references prewiring for future solar by requesting the installation of conduit from the building roof of eave to a location within the building identified as suitable for future installation of a charge controller and inverter.

The SFGBO provision is for solar electric systems under Renewable Energy. In this section there are installation provisions, compliance with third party verification, methodology of calculating the energy equivalent, and photovoltaic credit provisions.
(4) Energy Efficient Appliances

Standard 189.1 has prescriptive minimum equipment efficiency requirements under Energy Efficient Appliances. Specifically, Standard 189.1 has provisions for products to have a baseline efficiency addressed in the National Appliance Energy Conservation Act (“NAECA”), Energy Policy Act (“EPAct”), and the Energy Independence and Security Act (“EISA”). Standard 189.1 also has provisions for appliances to comply with the greater of the Energy Star requirements references in section 7.4.7.3. LEED does not directly address Energy Efficient Appliances in this section.

Provisions for efficiency of permanent and portable appliances exist under the IGCC for the Energy Efficiency Appliances section. Similar to Standard 189.1, the IGCC references Energy Star. The requirement under the IGCC are that the building owner or in tenant-occupied buildings, each tenant, is to maintain (on site) a list of the installed portable Energy Star eligible appliances and equipment. The IGCC also requires the aggregate rated power of all the Energy Star qualified portable appliances and equipment to be at least 50% of aggregate rated power of all portable appliances and equipment.

Under CalGreen there are no mandatory provisions required in Energy Efficient Appliances, but all equipment and appliances provided by the builder shall be Energy Star labeled if Energy Star is applicable to that equipment or appliance.

There are no provisions for this section under the SFGBO.

(5) Elevators, Escalators

Both Standard 189.1 and LEED do not directly address the energy requirements for Elevator, Escalator, Etc. The IGCC has provisions for power conversion systems for traction elevators, motors with Class IE2 efficiency rating, or alternative technologies that have equal or better efficiency. Provisions for elevator transmission efficiency and drive provisions for potential energy released during motion are to be recovered under IGCC. The IGCC also has specific requirements for escalators and their energy recovers, requiring down-running escalators with direct variable frequency drives to use regenerative drives and return recovered energy to the power grid. Standby mode provisions for buildings with multiple elevators serving the same floors are that one or more elevators is to be switched to sleep or low power mode during periods of low traffic. Similar standby mode provisions exist for escalators or moving walkways.

CalGreen, like Standard 189.1 and LEED, also has no mandatory provisions under this section but buildings with more than one elevator or two escalators should have controls provided to reduce the energy demand of elevators and reduce the speed of escalators under. CalGreen also requests documentation of the controls in the project specifications and commissioning plan. There are no provisions for this section under the SFGBO.

(6) Thermal Bridging

None of the publications directly address Thermal Bridging though LEED and Standard 189.1 note that potential and precedent exist for applicability through exceptional calculation. CalGreen also has no mandatory provisions but the design for steel framing be done to avoid thermal bridging.

(7) Metering

LEED has a provision to develop a Measurement and Verification Plan consistent with the International Performance Measurement & Verification Protocol (“IPMVP”) for implementation in the post occupancy phase. Standard 189.1, on the other hand, does not reference
the IPMVP, however, it does provide detailed guidance by source energy and sub-system thresholds.

The IGCC has a provision to determine energy use and peak demand. The IGCC permits utility energy meters to be used to collect whole building data. There are provisions under the IGCC for metering gaseous fuels, liquid fuels, solid fuels, electric power, district heating and cooling, combined heat and power, renewable and waste energy, and energy load type sub-metering. Along with those specific provisions there are also Measurement and Verification provisions for meters, sub-meters, and other approved devices.

There are no mandatory provisions in CalGreen for Metering, but there is an Energy Monitoring section that requests sub-metering or equivalent combinations of sensor measurements and thermodynamic calculations, if appropriate, to record energy use data for each major energy system in the building.

There are no provisions for this section under the SFGBO.

(8) Green Power

Standard 189.1 references the prescriptive Renewable Energy systems requirement exclusion for projects that purchase Green-e Energy of at least 7 kWh/ft2 of conditioned space each year, until the cumulative purchase is equal to 70 kWh/ft2 of conditioned space. LEED also references the purchase of Green-e certified Renewable Energy certificates for 35% of total energy demand.

There is nothing explicitly stated about Green Power under the IGCC, however, measures exist on calculating annual energy use and electric power. Provisions also exist in the IGCC on solar electric power, wind power systems, and other renewable energy electric production systems.

CalGreen does not have any mandatory provisions for Green Power, but it has two voluntary tiers (Tier 1 and Tier 2) that require participation in the local utility’s renewable energy portfolio program that provides a minimum of 50% of the electrical power from renewable sources. CalGreen also requests the utility bills are saved to maintain documentation. There are no provisions for this section under the SFGBO.

(9) Moisture Control

Standard 189.1 and LEED do not directly address Moisture Control with the exception of moisture control during construction and adequate air ventilation rates. The IGCC also addresses Moisture Control during the construction phase. The IGCC also has provisions for a Moisture Control plan and Moisture Control during the construction phase. Unlike LEED and Standard 189.1, the IGCC has additional project elective provisions for inspections and compliance for foundation sub-soil drainage systems, foundation damp proofing and waterproofing, exterior wall coverings, and roof coverings. Unlike LEED and Standard 189.1, the IGCC does not directly address adequate air ventilation rates.

CalGreen references California Building and Energy Code requirements under this section. CalGreen also has a section termed “Water Resistance and Moisture Management,” which requires the project to provide a weather-resistant exterior wall and foundation envelope as required by California Building Code Section 1403.2 (Weather Protection) and California Energy Code Section 150, (Mandatory Features and Devices), manufacturer’s installation instructions or local ordinance, whichever is more stringent. There are no provisions for this section under the SFGBO.
(10) Demand Response

Under Demand Response, Standard 189.1 requires peak demand be reduced by 10% or more by containing automatic systems, like demand limiting or load shifting. Standard 189.1 does not allow standby power generation to be used to achieve the peak demand reduction. Demand Response is not directly referenced in LEED, but it will be a new credit under the new version of LEED providing two options to reduce the peak demand for utility power. The first option is to “participate in a demand-response program through a local utility.” The second option is to “implement electrical load-shifting measures, such as ice storage, that permanently transfer regulated electricity demand from daytime hours to off-peak hours.”

The IGCC has detailed provisions for an open and interoperable Automated Demand Response (“Auto-DR”) infrastructure. Provisions in the IGCC exist for Demand Response Automation Server (“DRAS”), heating, ventilating, and air-conditioning (“HVAC”) systems, rebound avoidance (to prevent rebound peak), lighting, and building component-specific strategies.

CalGreen does not have mandatory provisions for Demand Response, but options to have the HVAC systems include Direct Digital Control Systems and centralized lighting systems with preprogrammed demand response strategies that are automated with either a Demand Response Automation Internet Software Client or dry contact relays. CalGreen also has optional measures for the capacity to shed load by cooling temperature set point adjustment and total lighting loads by a minimum of 30% through dimming control or bi-level switching.

There are no provisions for this section under the SFGBO.

Water

Unlike LEED, Standard 189.1 does not specify a certain amount of potable water reduction. LEED requires a reduction in potable water consumption of at least 50%, however, Standard 189.1 does outline design requirements that lead to a reduction in potable water use. Standard 189.1 also specifies the need for smart controllers for irrigation systems and plumbing fixtures such as valve type flow volumes and rates that are acceptable. LEED has similar provisions but does not require the use of certain strategies to attain them. Standard 189.1 has more stringent requirements for the use of potable water in mechanical systems and equipment and requires water-efficient mechanical equipment. LEED does not address the water consumption of mechanical systems.

The IGCC has three options for the reduction of potable water irrigation that are comparable to LEED, though one IGCC option that denies the use of potable water for irrigation purposes, is more stringent. The IGCC has provisions for a 30%-40% reduction of potable water use in plumbing fixtures, while LEED has a slightly higher requirement of at least a 50% reduction. Though LEED does not have any provisions addressing the water consumption of mechanical systems, the IGCC is comparable to Standard 189.1 where it limits or prohibits the use of potable water in certain mechanical systems and equipment and requires water-efficient mechanical equipment.

CalGreen contains similar provisions to Standard 189.1 that require smart controllers for irrigation systems. Though CalGreen does not have specifications for a reduction in potable water consumption for irrigation, like LEED does, CalGreen does require a water budget conforming to the California Department of Water Resources Model Water Efficient Landscape Ordinance, if no local ordinance is applicable. CalGreen has provisions for the plumbing fixtures and fittings to be used, as well as the reduction of potable water and wastewater in plumbing fixtures by 20%. LEED has provision for a reduction of at least 50% reduction of
both potable water and wastewater. Similarly to LEED, CalGreen does not have any provisions that address the water consumption of mechanical systems.

SFGBBO references LEED for provisions on irrigation and plumbing fixtures. They both require at least 50% reduction in potable water use for landscaping. While SFGBBO requires a minimum of 30% reduction of potable water for plumbing fixtures, LEED specifies a 50% reduction. Like LEED (and CalGreen), the SFGBBO does not have provisions addressing the water consumption of mechanical systems.

**LEED Water Efficiency Notes and Expected Changes**

The new version of LEED, which is expected to be released mid-2011, has a few revisions to the Water Efficiency section and several new provisions. The revisions to the Water Efficiency section include that the Water Efficient Landscaping section is renamed to Landscape Water Use Reduction and is a prerequisite applying to all projects with over 1,000ft\(^2\) of exterior vegetated space. Under this section’s provisions, established by the WaterSense Water Budget Tool, exist to reduce water use by 30%.\(^{25}\) Another change to LEED is that the Innovative Wastewater Technologies credit under Water Efficiency is renamed to Sustainable Wastewater Management. This section provides three different “options” to fulfill the requirement. The first option, which is “to reduce water use for sewage conveyance by 50%, is simply reworded” in the new version of LEED.\(^{26}\) The second option changes from focusing on the treatment of wastewater onsite to focusing on reusing the wastewater. The third option is new, requiring “resource recovery and reuse from 25% of the baseline nitrogen or organic carbon loading from building occupants”.\(^{27}\)

New provisions under LEED include a new prerequisite for Appliance and Process Water Use Reduction, which sets performance requirements for appliances and processes (like heat rejection and cooling). Additional Appliance and Process Water Use Reduction allows projects to accumulate points for water efficiency and builds off the new prerequisite. Cooling Tower Makeup Water is a new credit that provides measures to “conserve water used for cooling tower makeup while controlling microbes, corrosion, and scale in the condenser water system”.\(^{28}\)

**Materials**

Under the Materials section there are twelve (12) subsections within the comparison: (1) Recyclable Collection; (2) Construction Waste; (3) Reused Materials; (4) Recycled Content; (5) Regional Materials; (6) Renewable Materials; (7) Recyclable Materials; (8) Certified Wood; (9) Life-Cycle Assessment; (10) Policy; (11) Service Life; (12) Architectural Efficiency.

(1) **Recyclable Collection**

LEED and Standard 189.1 both allocate areas that are dedicated to the storage of materials for recycling. Standard 189.1 has a specific section, 9.3.4.3, requiring proper storage and disposal measures for fluorescent, HID lamps, and ballasts. The storage and collection section under LEED is a pre-requisite, yet provides credit opportunities for maintaining the existing building structure, and building envelope. LEED also provides credit if at least 50% (by area) of the completed building used existing (pre-construction) interior nonstructural elements.

Similarly to LEED and Standard 189.1, the IGCC also has area dedicated to the storage of materials for recycling. IGCC requires space to be provided in buildings for the storage of discarded lamps, batteries, electronics and other items that require special disposal practices in the jurisdiction.
Like LEED, Standard 189.1, and the IGCC, CalGreen also has provisions for allocated areas that are dedicated to the storage of materials for recycling, under this section. CalGreen references specific sections on how space allocation for recycling areas are to be dealt with and are to comply with Chapter 18, Part 3, Division 30 of the Public Resources Code. The storage and collection section under LEED is a pre-requisite, yet provides credit opportunities for maintaining the existing building structure, and building envelope.

The SFGBO has provisions for providing an area for Recyclable Collection and storage of materials for recycling.

(2) Construction Waste
LEED has recently made the construction and demolition waste management plan into a pre-requisite under the new version of LEED, set to be released to the public mid-2011, with no minimum threshold for implementation. \(^29\) Under Standard 189.1, a minimum of 50\% of nonhazardous construction and demolition waste material are to be diverted from disposal in landfills and incinerators by recycling/reuse. Also, new building projects on sites with less than 5\% existing buildings, structures or hardscape, total amount of construction waste generated on project are not to exceed 42 yd\(^3\) of the new building floor area. Standard 189.1 also provides information on extracting, harvesting, and/or manufacturing stating that all must be done in accordance to the laws and regulation of the country of origin.

The IGCC requires that at least 35\% of construction phase waste materials be diverted from landfills, and allows the jurisdiction to increase the materials required to be diverted and to increase material diversion from landfill by 20\%.

CalGreen allows either a construction waste management plan for the diverted materials or meet local construction and demolition waste management ordinance, whichever is more stringent. Recycling of construction waste is now directed in some municipalities in the U.S. \(^30\) Under CalGreen, specific guidelines are outlines where a local jurisdiction does not have a construction and demolition waste management ordinance, submit a construction waste management plan for approval by the enforcement authority that:

1. Identifies the materials to be diverted from disposal by efficient usage, recycling, reuse on the project, or salvage for future use or sale.
2. Determines if materials will be sorted on-site or mixed.
3. Identifies diversion facilities where material collected will be taken.
4. Specifies that the amount of materials diverted shall be calculated by weight or volume, but not by both.

CalGreen also provides specific information on the required documentation process; projects located in areas beyond the haul boundaries of the diversion facility, and excavated soil and land clearing debris.

SFGBO requires LEED points to be increased by 10\% if a building was demolished and was a historical resource. SFGBO also references LEED for this section with a provision for the diversion of at least 75\% of the project’s construction debris.

(3) Reused Materials
LEED provides an opportunity to receive points under Reused Materials if the project uses salvaged, refurbished or reused materials, the sum of which constitutes at least 5\% or 10\%, based on cost, of the total value of materials on the project. Standard 189.1 does not have
any provisions for this section. The IGCC at least 55% of the total materials in each building project must be reused materials and a whole building life cycle assessment is to be provided.

CalGreen has no specific requirements for this section.

The SFGBO references LEED, requiring one additional credit to be achieved under LEED MR3 (Reused Materials), MR4 (Recycled Content), MR5 (Regional Materials), MR6 (Renewable Materials), or MR7 (Certified Wood) through January 1, 2011. Effective January 1, 2012 two additional credits are to be achieved in accord with the above LEED section. The re-use or restoration of certain “character defining” features of historical features will be granted additional points or credits.

(4) Recycled Content
LEED provides three options to use materials with Recycled Content, which is the fourth subsection under this Materials section. The three LEED options are: (1) such that the sum of postconsumer; (2) recycled content plus 1/2 of the preconsumer; (3) content constitutes at least 10% or 20%, based on cost, of the total value of the materials in the project. Standard 189.1’s requirement looks similar to the third option above by requiring the sum of post-consumer recycled content plus one-half of the pre-consumer recycled content to constitute a minimum of 10% based on cost of the total materials in building project. The IGCC states recycled content materials must contain at least 25 percent combined post-consumer and pre-consumer recovered material, and must be recyclable.

CalGreen has no information on this section, but has voluntary provisions requiring the use of either pre-consumer or post-consumer material to contain 10% or 15% recycled content of the total material cost, which are voluntary tiers. See subsection (3) Reused Materials, above for SFGBO requirements.

(5) Regional Materials
LEED, Standard 189.1, and the IGCC have provisions to use building materials or products that have been extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site. The benefit of local material use is that there is the possibility of reducing carbon emissions associated with transportation. The difference between them is that LEED requires a range between a minimum of 10% or 20%, based on cost, of the total materials value, while Standard 189.1 requires a minimum of 15% of building materials or products used, based on cost, to be regionally extracted/harvested/recovered. The IGCC has special provisions for materials transported by water or rail, which is unique to this section.

CalGreen has no mandatory provisions in this section, though the voluntary provisions are similar to LEED, having 10% of the total materials value to be within 500 miles of the project site. See subsection (3) Reused Materials, above for SFGBO requirements.

(6) Renewable Materials
Renewable Materials is the next subsection. LEED uses rapidly renewable building materials and products for 2.5% of the total value of all building materials and products used in the project, based on cost. Standard 189.1 requires a minimum of 5% of building materials used, based on cost, to be biobased products. The IGCC does not measure renewable materials the same as LEED, instead the IGCC requires the bio-based materials have at least 50% bio-based content and recyclable materials have a minimum recovery rate of 30%. CalGreen has no mandatory provisions but the voluntary provisions are the same as LEED. See subsection (3) Reused Materials, above for SFGBO requirements.
(7) Recyclable Materials
LEED, Standard 189.1, CalGreen, and the SFGBO do not have any specific requirements for Recyclable Materials section. The IGCC requires that recyclable materials be with a minimum recovery rate of 30%.

(8) Certified Wood
The Certified Wood subsection is next. LEED requires a minimum of 50% (based on cost) use of wood-based materials and products that are certified in accordance with the Forest Stewardship Council’s principles and criteria, for wood building components. This includes, at a minimum, structural framing and general dimensional framing, flooring, sub-flooring, wood doors and finishes. Standard 189.1 require wood building component to not contain less than 60% certified wood content tracked through a chain of custody process. The IGCC does not have any specific requirements for Certified Wood

CalGreen also does not have any special requirements for Certified Wood, but voluntary measure indicated that the California Building Standards Commission (“CBSC”) would continue to develop a standard through the next code cycle.

See section (3) above for SFGBO requirements.

(9) Life-Cycle Assessment
Under the Life-Cycle Assessment (“LCA”) section, unlike Standard 189.1, LEED does not have a section covering the life-cycle assessment for materials. Standard 189.1 has three sections covered under life-cycle assessment: (1) life-cycle assessment performance—where a project is to have 5% improvement over the other building alternative assessed in the LCA in a minimum of two impact categories; (2) procedure—the life-cycle assessment is to include the following 3 steps (a) perform lifecycle inventory (LCI), (b) compare two building alternatives, and (c) conduct a critical review by an external expert independent of those performing the LCA; and (3) reporting—the following to be submitted to AHJ: (a) LCA report (b) documentation of critical peer review by third party.

IGCC requests a whole building LCA under the Materials, Reused Materials section. The SFGBO does not address LCA.

(10) Policy
There are no provisions for Policy under LEED, Standard 189.1, CalGreen or the SFGBO.

The IGCC requires that at least 75 percent of the total materials in each project must comply with requirements for the following items: (1) for the country in which the project is located; (2) for the country in which the materials; or (3) products are harvested, extracted, processed and manufactured, whichever are more restrictive. IGCC also has policy for the following four sections:

a. Clean air: United States of America air Pollution Control Act (1955); Clean Air Act (1963); Air Quality Act (1967); Clean Air Act (1972); Clean Air Act Extension (1977); and Clean Air Act (1990).
b. Clean water: United States of America Federal Water Pollution Control Act (1948); Water Quality Act (1967); Federal water Pollution Control Act (1972); Clean Water Act Amendments (1977); and Clean Water Act Reauthorization (1987).
c. Resource conservation: United States of America Resource Conservation and Recovery act (RCRA) (1976) and RCRA Amendments (1984).
d. Noise control: United States of America Noise Control Act (1972).
(11) Service Life
There are no provisions for Service Life under LEED, Standard 189.1, CalGreen or the SFGBO. The IGCC requires that a Building Service Life Plan be included in the construction documents for the project and provides detailed requirements for the plan. The IGCC also requires an increase in building service life to 200 years or 100 years.

(12) Architectural Efficiency
There are no provisions for Architectural Efficiency under LEED, Standard 189.1, CalGreen or the SFGBO.

The IGCC has a section for multi story footprint which requires the floor area, excluding stairways and shafts, reduces footprint by a) 45% or b) 70%. The IGCC also has a section for building volume that requires a reduction in residential floor-to-floor & floor-ceiling average to 11 feet, others to 12.5 feet.

Internal Air Quality ("IAQ") / Environmental Air Quality
In this next section, there are twenty (20) subsections: (1) Outdoor Air; (2) Tobacco Smoke; (3) Outdoor Air Monitoring; (4) During Construction; (5) Before Occupation; (6) Adhesives / Sealants; (7) Paints / Coatings; (8) Flooring / Carpet; (9) Composite Wood; (10) Pollutant Isolation; (11) Controllability; (12) Thermal Comfort; (13) Daylight; (14) Views; (15) Acoustics; (16) Radon; (17) Fireplace; (18) Air Filtration; (19) Ozone / GHG; and (20) Moisture Control.

(1) Outdoor Air
Standard 189.1 and LEED both have Outdoor Air requirements per ASHRAE 62.1, which is the Ventilation for Acceptable Indoor Air Quality established by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). However, to achieve the credit under LEED either the mechanical ventilation needs to be increased by 30% or the naturally ventilated spaces need to show they meet the Chartered Institution of Building Services Engineers ("CIBSE") requirements.

IGCC has provisions for the building ventilation during construction and building flush out provisions after construction.

CalGreen has provisions for mechanically or naturally ventilated spaces in buildings to follow requirements of Section 121 of the California Energy Commission ("CEC"), California Code of Regulations ("CCR"), Title 24, Part 6 or the applicable local code, whichever is more stringent. CalGreen also requires Chapter 4 of the CCR, Title 8, to be met. CO₂ monitoring is required for demand control ventilation.

(2) Tobacco Smoke
For Tobacco Smoke Standard 189.1 and LEED are similar in that they both prohibit smoking 25 feet from the envelope openings of the building unless there are designated smoking areas. Signage is required in both Standard 189.1 and LEED, but Standard 189.1 specifies that signage needs to be posted within 10 feet of entryways. Under Standard 189.1 smoking is not allowed in any building.

The IGCC’s provisions are less stringent; stating that the design of building spaces and HVAC systems for jurisdictions that permit tobacco smoking by the occupants within buildings or tenant spaces is allowed.

CalGreen also has a no smoking provision within 25 feet from the building envelope, or to follow local regulation, whichever is more stringent. Under CalGreen when ordinances,
regulations, or policies are not in place, signage should be posted to inform building occupants of the prohibitions of Tobacco Smoke.

(3) Outdoor Air Monitoring
Standard 189.1 and LEED have similar provisions for Outdoor Air Monitoring, except under Standard 189.1 the monitoring system needs to be capable of measuring flow within an accuracy of ±15% of the minimum outdoor air flow rate. LEED is more stringent because the provisions for a permanently installed Outdoor Air Monitoring system that generates an alarm if outdoor air or CO$_2$ levels exceed a 10% deviation from design values.

The IGCC and CalGreen do not explicitly state the requirements for Outdoor Air Monitoring or the accuracy of measurement devices.

(4) During Construction
Both Standard 189.1 and LEED require an IAQ Management Plan in the During Construction section. LEED has provisions for the IAQ Management Plan to be for the construction and pre-occupancy phases of the project while Standard 189.1 includes moisture protection of absorptive materials, and restricted idling of construction vehicles. LEED has provisions to meet or exceed the Sheet Metal and Air Conditioning Contractors’ National Association (“SMACNA”) control measures, protect stored absorptive materials from moisture damage, and if permanently installed air handlers are used during construction that a filter of a least Minimum Efficiency Reporting Value (“MERV”) 8 need to be installed and then replaced prior to occupancy.

The IGCC has provisions for building ventilation during construction. LEED has provisions for the IAQ Management Plan to be for the construction and pre-occupancy phases of the project.

CalGreen has mandatory provisions for covering duct openings and protecting mechanical equipment During Construction. The voluntary measures CalGreen has are similar to LEED in stringency.

(5) Before Occupation
Under the Before Occupation section both LEED and Standard 189.1 are effectively equivalent and require a building flush-out or IAQ testing. Like LEED and Standard 189.1, the IGCC also has provisions to flush-out the building after construction though LEED and Standard 189.1 are more stringent than IGCC in the requirements.

There are no mandatory provisions under this section for CalGreen, but voluntary measures include a plan to flush-out the building after construction.

(6) Adhesives / Sealants
For the Adhesives/Sealants section LEED requires that all adhesives and sealants used in the interior of the building must comply, as applicable to the project scope, with South Coast Air Quality Management District (“SCAQMD”) for adhesives, sealants, and sealant primers. Standard 189.1 has provisions that all adhesives and sealants used on the interior of the building need to comply with the emissions requirements of California Section 01350$^{33}$, and Volatile Organic Compounds (“VOC”) contents should comply with SCAQMD Rule 1168$^{34}$ or Green Seal Standard GS-36.$^{35}$
The IGCC has provisions that a minimum of 85% by weight or volume, of applied Adhesives and Sealants, to comply with VOC content in accordance with the appropriate standard being either the U.S. EPA Method 24, SCAQMD Method 304, 316A, or 316B.

CalGreen requirements are that all adhesives, adhesive bonding primers, adhesive primers, sealants, sealant primers and caulks are to comply with local, or regional, air pollution control, or air quality management district rules, or with SCAQMD Rule 1168 Volatile Organic Compounds (“VOC”) limits.

Like LEED, the SFGBO has provisions that all Adhesives/Sealants used in the interior of the building must comply, as applicable to the project scope, with SCAQMD for adhesives, sealants, and sealant primers.

(7) Paints / Coatings
LEED, Standard 189.1, and the IGCC have provisions that limit the VOC content of Paints and Coatings. The IGCC has alternative emissions testing that is to be performed by a laboratory that has the CA/DHS/EHLB/R-174 test methodology in the scope of its ISO 17025 Accreditation.

Similarly to LEED, CalGreen and the SFGBO limit the VOC content of Paints and Coatings. CalGreen explicitly states the need to verify compliance through documentation.

(8) Flooring / Carpet
Standard 189.1 and LEED both have provisions covering Flooring and Carpet. Provisions under Standard 189.1 are that carpet and hard surface flooring in office spaces need to comply with California Section 01350. Provisions under LEED are for carpet to be tested and compliant to various standards. Under LEED all hard surface flooring needs to be compliant with FloorScore standards. The SFGBO references LEED in this section requiring the same provisions.

The IGCC has provisions for a minimum of 85% of the total area of flooring installed within the interior of the building to comply with listed product and for flooring with more than one distinct product the emissions from each layer to comply with specific requirements. There is also emissions testing required and is to be performed by a laboratory that has the CA/DHS/EHLB/R-174 test methodology in the scope of its ISO 17025 Accreditation.

CalGreen provisions for Flooring and Carpet include that at least 50% of carpet needs to be compliant with the Resilient Floor Covering Institute (“RFCI”) FloorScore program.

(9) Composite Wood
LEED had provisions for Composite Wood and agrifiber products used on the interior of the building cannot contain added urea-formaldehyde resins. LEED also requires laminating adhesives used to fabricate on-site and shop-applied composite wood and agrifiber assemblies cannot contain added urea-formaldehyde resins. Standard 189.1 also prohibits urea-formaldehyde resins. Under Standard 189.1, emissions need to comply with a third-party certification submission indicating compliance with California Air Resource Board’s (“CARB”) regulation and limit requirements for either office or classroom spaces regardless of space type.

The IGCC has provisions for Composite Wood by requiring interior particleboard, hardwood plywood, and medium density fiberboard used as sub-flooring and decorative wall coverings, and permanently installed millwork to be rated for exterior exposure in accordance
with DOC PS1\textsuperscript{38} or DOC PS 2,\textsuperscript{39} made using adhesives which do not contain urea-formaldehyde resins. The IGCC has provisions for compliance with the requirements of Section 93120 of Title 17, California Code of Regulations, which is Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products.

Under CalGreen, formaldehyde in Composite Wood needs to conform to limits specified by the California Environmental Protection Agency’s Air Resources Board (“ARB”) Air Toxics Control Measure for Composite Wood. Similarly to LEED, CalGreen also has provisions that the building interiors do not contain added urea-formaldehyde resins.

(10) Pollutant Isolation
Standard 189.1 requires all building entrances to employ an entry mat system that has a scraper surface, absorption surface, and a finish surface. The LEED credit for Pollutant Isolation requirements include an entryway system, similar to Standard 189.1, except LEED requires at least a 10 foot long system which is longer than Standard 189.1’s requirement. LEED also requires a sufficiently exhausting of spaces where hazardous gases or chemicals may be present or used is required. In mechanically ventilated buildings LEED requires air filters to be a minimum of MERV 13. Hazardous liquid waste containment is also required under LEED.

The IGCC has provisions for Pollutant Isolation that require enclosed rooms or spaces greater than 200 square feet in area, used as print or copy facility, janitorial room, repair garage or aircraft hangar, where chemical use occurs to have: (1) walls constructed to resist passage of airborne chemical pollutants; (2) doors to be automatic or self-closing; and (3) HVAC systems which provide separate exhaust airflow to outdoors at a rate of not less than 0.50 cfm\textsuperscript{40} per SF and maintains negative pressure of not less than 7 pa\textsuperscript{41} within the room, and prohibits recirculation of air from room to other portions of the building.

There are no mandatory provisions under the Pollutant Isolation section for CalGreen, but the voluntary measures specify a need for entryway systems, of 6 feet, that minimize and control pollutant entry.

(11) Controllability
For Controllability, Standard 189.1 specifies that thermal comfort needs to be met, but there are no provisions for controllability. The IGCC and LEED credits have provisions for Controllability of lighting and systems for thermal comfort.

No mandatory provisions exist under CalGreen for Controllability, but voluntary measures address the issue of controllability of lighting and systems for thermal comfort.

(12) Thermal Comfort
Standard 189.1 has provisions to design the building in compliance with ASHRAE Standard 55\textsuperscript{42} for Thermal Comfort. LEED also has provisions to meet Thermal Comfort criteria established by ASHRAE Standard 55, and, additionally, to verify Thermal Comfort through occupant survey.

The IGCC has vague language asking Thermal Comfort to be met “to the extent that is feasible” following criteria established by ASHRAE Standard 55 and 62.1\textsuperscript{43}

There are no provisions to design a building in order to meet a certain level of Thermal Comfort under CalGreen, but voluntary measures address controllability for the purposes of thermal comfort, as mentioned above.
(13) **Daylight**
While both Standard 189.1 and LEED have a Performance Option for Daylighting and both are to perform a simulation to show that at least 75% of Daylighting zones achieve daylight illuminance. Standard 189.1 requires the illuminance of at least 30fc (footcandles) at 3 feet above the floor, while LEED requires at least 25fc.

The IGCC contains a Performance and Prescriptive requirement. The Performance provision, under the IGCC, is that all points in the daylight area have daylight saturation of no less than 60%.

CalGreen has no mandatory provisions for Daylighting but voluntary provisions exist that reference the California Energy Code requirements for top lighting and side lighting.

(14) **Views**
Standard 189.1 does not have provisions for Views. LEED has provisions for line of sight for purposes of maximizing ones view. The IGCC has project elective provisions for line of sight for purposes of maximizing View.

There are no mandatory provisions for Views under CalGreen but the voluntary measures are the same as the LEED and the IGCC, which has provisions for line of sight for purposes of maximizing view.

(15) **Acoustics**
Standard 189.1 specifies Acoustical ratings of a building envelope and interior wall and floor-ceiling assemblies for different buildings and space types. LEED does not have any provisions for this section.

The IGCC has provisions for Acoustics that require specifications of the acoustical ratings of the building envelope and interior wall and floor-ceiling assemblies.

CalGreen has exterior sound provisions that are similar to Standard 189.1, which specifies acoustical ratings of the building envelope and interior wall and floor-ceiling assemblies for different building and space types. The only difference is CalGreen does not break down acoustical rating requirements by space type for interior sound.

(16) **Radon**
Standard 189.1 has provisions for Radon, specifying building projects that include construction or expansion of a ground-level foundation and which are located on brownfield sites or in “Zone 1” areas identified to have a significant probability of Radon concentrations higher than 4 picocuries/liter on the USEPA map of radon zones, shall have a soil gas retarding system installed between the newly constructed space and the soil. LEED and CalGreen do not have any provisions for this section.

Like Standard 189.1, the IGCC does have provisions for Radon mitigation where building projects are in high Radon Potential locations (Zone 1) and like Standard 189.1 references the USEPA map. See Figure 2 below for the EPA map of Radon Zones.

(17) **Fireplace**
Standard 189.1 and LEED have no provisions for the Fireplace section. The IGCC has provisions provided for fireplace installation, ventilation, gas fireplaces, and wood-burning fireplaces. CalGreen has provisions that limit the Fireplace type and indicates that the Fireplace must comply with local ordinances.


(18) Air Filtration
In the Air Filtration section, Standard 189.1 has provisions to provide filters of at least MERV 8. In sites that are designated, as “non-attainment”, filters should be provided of at least MERV 13. LEED has provisions, to achieve the pollutant source control credit, for mechanically ventilated buildings to have air filters that have a minimum of MERV 13. The IGCC, like LEED, has provisions for mechanically ventilated buildings to have air filters that have a minimum of a MERV 13 rating. The IGCC also requires filters for ducted space conditioning systems to have a minimum MERV rating of 6. CalGreen, similarly to Standard 189.1, has provisions to provide filters of at least MERV 8. There are voluntary provisions under CalGreen that require a MERV rating of 11.

(19) Ozone / GHG
Under the Ozone / GHG section LEED prohibits the use of chlorofluorocarbons ("CFC") based refrigerants in new building base HVAC&R systems. LEED includes two options for credits in this section: (1) not use refrigerants; or (2) use refrigerants that minimize, or eliminate, the emission of compounds that contribute to ozone depletion and climate change. Standard 189.1, like LEED, prohibits CFC-based refrigerants.

Under the Ozone / GHG section, the IGCC, like Standard 189.1 and LEED, prohibits the use of chlorofluorocarbons ("CFC") based refrigerants in new building. The IGCC also has provisions that prohibit Halons.
CalGreen, like Standard 189.1 and LEED, prohibits CFC-based refrigerants. CalGreen, like the IGCC, also prohibits Halons. The voluntary measures under CalGreen match the LEED provisions in stringency.

(20) Moisture Control

Both Standard 189.1 and LEED do not directly address Moisture Control with the exception of moisture control during construction and adequate air ventilation rates.

The IGCC, like LEED and Standard 189.1, has Moisture Control provisions during the construction phase. The IGCC also has project elective, or voluntary, provisions for moisture preventative measures and inspection procedures for five items: (1) foundation sub-soil drainage systems; (2) foundation damp-proofing and water-proofing; (3) flashing of windows, exterior doors, skylights, wall flashing and drainage systems; (4) exterior wall coverings; and (5) roof coverings, roof drainage, and flashing.

The CalGreen provisions for Moisture Control require that the provisions of California Building Code, CCR, Title 24, Part 2, Sections 1203 (Ventilation) and Chapter 14 (Exterior Walls) must be met. Additional mandatory measures under CalGreen provide moisture control by specifying design of sprinklers and various entries/openings.

Commissioning

LEED’s Commissioning requirements include one prerequisite and two credits. Credits include enhanced commissioning, and Measurement and Verification. All of these points are within Energy and Atmosphere. The intention of these credits is to ensure the design is implemented into reality to the energy related specifications of the design. LEED requisite requirements are very basic consisting of: (1) identify commissioning agent; (2) commissioning plan; and (3) commissioning report. Under the Measurement and Verification credit for LEED provisions exist for an energy conservation plan covering at least one-year post occupancy.

Unique to Standard 189.1 is that an acceptance representative leads the review of construction documents before a permit is obtained regarding sensors, devices and control sequences. The acceptance representative also performs testing and verifies the system manual, mechanical systems, lighting, renewable energy, water, and energy management before the building is occupied. The commissioning required under Standard 189.1 is very similar to LEED with requirements including commissioning for heating ventilation, A/C, IAQ, refrigeration systems, controls, thermal and moisture integrity of assemblies, pressurization, lighting controls and shading, irrigation, plumbing, domestic water, service water, renewable energy, water measurement devices, and energy measurement devices. The owner retains the System Manual, the Final Commissioning Report, and measurement and verification documentation under Standard 189.1. Like LEED, Standard 189.1 requires an erosion and sediment plan and requires air conveying devices covered during construction. Additionally, Standard 189.1 requires a high performance building plan of operation that consists of: (1) verifying vegetation is properly maintained when required for shading, tracking and assessing building water consumption and water storage devices for a minimum of three (3) years; (2) the collection and storage of energy data of each device, report, track, and assessment of energy use; and (3) the monitoring of outdoor airflows which consist of recording data on site or installing devices to react when outdoor airflow is 15% lower than the minimum outdoor airflow rate. Standard 189.1 also requires offer of incentives for the use of mass transit, non-motorized transit, carpools, support to reduce commuting of employees by 5%, or initiating rideshare.
IGCC has commissioning requirements similar to LEED, but unique to IGCC are requirements of roof coverings, exterior wall coverings, flashing, and foundation drainage system. Similar to LEED and Standard 189.1, the IGCC requires Measurement and Verification of energy use and energy efficiency. Unique requirements under IGCC include: vegetative roofs and terraces, shading, erosion/sediment control, and soil percolation. The IGCC also has commissioning of imported soils and site/land use.

CalGreen, like Standard 189.1 and LEED, has a CxA to make sure construction meets the owners project requirements. CalGreen has a unique level of detail of what will be in the Commissioning Plan, requiring commissioning goals, systems to be commissioned, an explanation of the design intent, describes testing procedure, schedules, and various responsibilities.

SFGBO has no unique requirements and shares LEED’s provisions for Measurement, Verification, and Operation as well as the documentation process and maintenance manual.

**GRAPHICAL ANALYSIS**

After considering the analysis of the different publications, it is useful to have two graphical analyses of the information discussed above.

The first graph, Figure 3 (attached hereto as Addendum A), is an analysis of the five publications at the minimal requirement to get certification under LEED, or the mandatory requirements under ASHRAE, the IGCC, CalGreen and the SFGBO.

The second graph, Figure 4 (attached hereto as Addendum B), is also an analysis of the publications, but at the “greenest level”; meaning the figure considers each allowable credit available under LEED, the project electives under the IGCC, and Tier 2 of CalGreen. The two graphical analyses are color coded to represent whether each publication discusses each line item under the specific section. The color-coding is ranges across four different shades of yellow to green. If there was little to no content discussed under that topic the cell is shaded in yellow. If, however, the publication showed leadership in the requirements in that topic it is shaded dark green. The two light green shades ranging between yellow and dark green represent a “good” and “very good” requisite within the topics.

Figure 5 (attached hereto as Addendum C), is a textual comparison of five different publications as shown in Figure 3 and 4. Like Figure 3 and 4, Figure 5 is color-coded to demonstrate various levels of stringency, however, when a cell has no shading that means that shading there is no to minimal content under that topic.

The coding scheme in Figure 3 provides a snapshot of how stringent the five publications are in terms of green building development:

- **Building Sites and Indoor Environmental Quality:** LEED shows the greatest leadership.
- **Water, Energy, and Materials:** the IGCC shows the greatest leadership.
- **Energy:** the IGCC leads in the Energy section in both Figures 3 and 4.
- **Building Site, Materials, or Indoor Environmental Quality:** CalGreen’s mandatory requirements are weaker than LEED’s minimal certification; however, as shown in Figure 4, Tier 2 of CalGreen shows comparable levels of leadership, or stringency, to LEED. Under the Materials section, the IGCC, however, is the only publication that discusses policy and building service life at any substantive depth.
- **Commissioning:** Standard 189.1 shows the greatest leadership
Figures 3 and 4 also show where gaps exist in each publication, even at the publication’s most stringent level. For example, under the Energy and Materials sections, none of the publications show leadership in thermal bridging, recycled content, regional materials, renewable materials, or architectural efficiency.

The figures also demonstrate that the SFGBO does not have unique requirements, nor does it contain language that raises the thresholds of any specific section.

CONCLUSION
The five publications analyzed in this article have been drafted without much post-publication comparison between each other. Now, after comparing the commonalities and differences between five publications, it is clear that there are important areas for each publication to improve.

The comparison between the various publications demonstrates that the Materials sections for all of the publications needs to advance, including the guidelines for life-cycle assessment measures, policy measures which are to be accounted for, and specific architectural efficiency measures development parties involved should take into consideration.

The comparison also demonstrates that there are areas under the Energy section that have room for improvement, in terms of environmental stringency. Specifically, under the section on Thermal Bridging, none of the publications directly address this topic.

More specifically, because CalGreen Tier 2 is so similar to LEED, local ordinances, like the SFGBO, should reference or adopt CalGreen Tier 2 so that there is common language between local and state regulations. Additionally, CalGreen Tier 2’s provisions are very similar to LEED’s. This may mean that LEED will need to advance its gold or platinum certification requirements, or potentially become less relevant. In general, however, CalGreen’s mandatory requirements are narrower than LEED, Standard 189.1, and the IGCC.

Also, the SFGBO, which mainly references building developments to meet or exceed LEED guidelines, needs to adopt Tier 2 CalGreen provisions. The SFGBO mentions local regulatory departments on specific sections, like the San Francisco Public Utilities Commission for guidelines regarding stormwater management and design. If SFGBO adopts Tier 2 CalGreen provisions, to be completed for new projects or major renovations, there will be greater consistency of language within the state. This will not only allow San Francisco to continue to show leadership on a local level, but also allow for improved synergy throughout what the state regulatory system requires.

Like LEED, Standard 189.1 was authored by the USGBC, which unsurprisingly results in similarities in the language between the two. LEED has the most stringent guidelines under the Building Site out of all the publications while Standard 189.1 and the IGCC have provisions under Water Use that expand beyond the other publications.

These are all areas for the publications to progress. Whether or not each publication makes changes, it is now clear where gaps exist, which will assist the parties involved in building development.

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32. MERV ratings are a way to judge the effectiveness of a filter. MERV was developed by ASHRAE and has values varying from 1 to 16. The higher the MERV value is, the more efficient the filter will be in trapping airborne particles.

33. Section 01350 consists of procedures to ensure good indoor air quality to protect human health established by the California Department of Public Health (“CDPH”).

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38. PS 1 is the U.S. Department of Commerce (DOC) Voluntary Product Standard for Construction and Industrial Plywood provides specifications on how plywood needs to be manufactured.

39. PS 2 is the U.S. Department of Commerce (DOC) Voluntary Performance Standard for Wood-Based Structural Use Panels provides specifications on how a panel product must perform in a designated application, rather than how it must be manufactured.

40. cfm = cubic foot per minute

41. pa = pascal pressure unit

42. ASHRAE Standard 55-2004: Thermal Environmental Conditions for Human Occupancy

43. ASHRAE Standard 62.1 is the Ventilation for Acceptable Indoor Air Quality established by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE).
### ADDENDUM A

**Legend**

- **Good** or minimum current
- **Very Good** leadership

#### Comparison Performance Matrix (Minimum)

| LEED 2009 | ASHRAE 189.1-2009 | IGCC | CAGreen 2010 | SF Green Building Ordinance |
|-----------|-------------------|-----|-------------|-----------------------------|
| **Building Site** | | | | |
| Construction Activity | | | | |
| Site Selection | | | | |
| Adj/Transit | | | | |
| Bracing | | | | |
| Alternative Fuel Vehicle Parking | | | | |
| Rooftop | | | | |
| Heat Island Effect | | | | |
| Light Pollution | | | | |
| LEED 2009 | ASHRAE 189.1-2009 | IGCC | CAGreen 2010 | SF Green Building Ordinance |
| Irrigation | | | | |
| Plumbing Fixtures | | | | |
| HVAC Systems | | | | |
| LEED 2009 | ASHRAE 189.1-2009 | IGCC | CAGreen 2010 | SF Green Building Ordinance |
| **Water Use** | | | | |
| **Energy Performance** | | | | |
| Energy Prescribed | | | | |
| Renewable Energy | | | | |
| Energy Offs. Appliances | | | | |
| Elevators, Escalator, etc. | | | | |
| Thermal Bridging | | | | |
| Materials | | | | |
| Green Power | | | | |
| Moisture Control | | | | |
| Demand Response | | | | |
| LEED 2009 | ASHRAE 189.1-2009 | IGCC | CAGreen 2010 | SF Green Building Ordinance |
| **Material and Resources** | | | | |
| Recyclable Collection | | | | |
| Construction Waste | | | | |
| Recycled Materials | | | | |
| Recycled Content | | | | |
| Renewable Materials | | | | |
| Recyclable Material | | | | |
| Certified Wood | | | | |
| Life-Cycle Assessment | | | | |
| Site Life | | | | |
| Architectural Efficiency | | | | |
| LEED 2009 | ASHRAE 189.1-2009 | IGCC | CAGreen 2010 | SF Green Building Ordinance |
| **Environmental Quality** | | | | |
| Outdoor Air | | | | |
| Tobacco Smoke | | | | |
| Outdoor Air Monitoring | | | | |
| During Construction | | | | |
| Before Occupancy | | | | |
| Adhesives / Sealants | | | | |
| Paints / Coatings | | | | |
| Insulation / Insulfelt | | | | |
| Composite Wood | | | | |
| Non-Volatile Dissipation | | | | |
| Controllability | | | | |
| Thermal Comfort | | | | |
| Acoustical | | | | |
| Visual | | | | |
| **Green Building Operations** | | | | |
| Owner’s Requirements | | | | |
| Acceptance | | | | |
| Commissioning System | | | | |
| MB & O Operations | | | | |
| Documentation | | | | |
| Maintenance Manual | | | | |

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### ADDENDUM B

#### Figure 4: Green Building Publication Comparison - Maximum

| BUILDING SITE | LEED 2009 | ASHRAE 189.1-2009 | IGCC | CALGreen 2010 (Tier 2) | SF Green Building Ordinance |
|--------------|-----------|-------------------|------|------------------------|----------------------------|
| Construction Activity | Site Selection | Good | Good | Good | Good |
| ASHRAE | Good | Good | Good | Good | Good |
| Ramps | Good | Good | Good | Good | Good |
| Accessibility | Good | Good | Good | Good | Good |
| Roof | Good | Good | Good | Good | Good |
| Heat Island Effect | Good | Good | Good | Good | Good |
| Light Pollution | Good | Good | Good | Good | Good |
| Irrigation | Good | Good | Good | Good | Good |
| Plumbing Fixtures | Good | Good | Good | Good | Good |
| HVAC System | Good | Good | Good | Good | Good |
| Energy Performance | Good | Good | Good | Good | Good |
| Energy Consumption | Good | Good | Good | Good | Good |
| Energy Off: Appliances | Good | Good | Good | Good | Good |
| Elevators, Escalators, etc. | Good | Good | Good | Good | Good |
| Thermal Bridging | Good | Good | Good | Good | Good |
| Lighting | Good | Good | Good | Good | Good |
| Green Power | Good | Good | Good | Good | Good |
| Moisture Control | Good | Good | Good | Good | Good |
| Demand Response | Good | Good | Good | Good | Good |
| Recyclable Collection | Good | Good | Good | Good | Good |
| Pre-Certified | Good | Good | Good | Good | Good |
| Regional Material | Good | Good | Good | Good | Good |
| Renewable Materials | Good | Good | Good | Good | Good |
| Recyclable Material | Good | Good | Good | Good | Good |
| Certified Wood | Good | Good | Good | Good | Good |
| Life-Cycle Assessment | Good | Good | Good | Good | Good |
| TCO | Good | Good | Good | Good | Good |
| Service Life | Good | Good | Good | Good | Good |
| Architectural Efficiency | Good | Good | Good | Good | Good |
| Outdoor Air | Good | Good | Good | Good | Good |
| Tobacco Smoke | Good | Good | Good | Good | Good |
| Outdoor Air Monitoring | Good | Good | Good | Good | Good |
| During Construction | Good | Good | Good | Good | Good |
| Before Occupancy | Good | Good | Good | Good | Good |
| Adhesives / Sealants | Good | Good | Good | Good | Good |
| Parties / Coatings | Good | Good | Good | Good | Good |
| Insulation / Paint | Good | Good | Good | Good | Good |
| Computer Usage | Good | Good | Good | Good | Good |
| Building Insulation | Good | Good | Good | Good | Good |
| Controllability | Good | Good | Good | Good | Good |
| Thermal Comfort | Good | Good | Good | Good | Good |
| Visual | Good | Good | Good | Good | Good |
| Acoustics | Good | Good | Good | Good | Good |
| Health | Good | Good | Good | Good | Good |
| Air Filtration | Good | Good | Good | Good | Good |
| Green / GRI | Good | Good | Good | Good | Good |
| Moisture Control | Good | Good | Good | Good | Good |

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#### Table: Comparative Performance Summary (Maximum)

- **Legend**:
  - No or minimal credit
  - Poor
  - Poor/mediocre
  - Fair
  - Good
  - Very Good
  - Leadership

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