State of Illinois
CAPITAL DEVELOPMENT BOARD

GREEN BUILDING MEASUREMENT AND VERIFICATION TOOL

Portions of these recommendations are adapted from the Pacific Northwest National Laboratory *Building Cost and Performance Metrics: Data Collection Protocol*.

Below are two metrics to be collected for both a LEED® sustainably designed building and baseline building model. Each of the offers a representative indication of building performance, however, because some data will not be available some metrics are optional.

The data from Table 1-Building and Site Characteristics can be used to normalize the monthly cost and performance data for comparison. The data in Table 2-Building Cost and Performance is collected monthly and aggregated annually for comparative analysis.

SUBMITTAL SUMMARY		
Project Phase	**Required Submittals**	**Submitted By**
Feasibility Study	1. LEED® Scorecard 2. *Table 1*-Building and Site Characteristics 3. *Table 2*-Building Costs and Performance, as applicable to current design phase **NOTE:** Information should be submitted for both baseline building model and LEED® building model.	A/E Team
Program Analysis	Same as Feasibility Study	A/E Team
Schematic Design	Same as Feasibility Study	A/E Team
Design Development	1. LEED® Scorecard 2. MEP and architectural Life-Cycle Cost Analysis Report 3. Energy Modeling Report including criteria and assumptions. Break out plug load from base building systems such as lighting, HVAC, plumbing and vertical transportation systems. 4. Basis of Design Report including building design criteria 5. *Table 1*-Building and Site Characteristics 6. *Table 2*-Building Costs and Performance, as applicable to current design phase **NOTE:** Information should be submitted for both baseline building model and LEED® building model.	A/E Team
50% Bid Documents	Same as Design Development	A/E Team
75% Bid Documents	Same as Design Development	A/E Team
95% Bid Documents	Same as Design Development	A/E Team
Construction Close Out	1. Final LEED® Scorecard 2. Pre-Final Commissioning Report (CX) including summary of cost savings/cost avoidance related and the commissioning process and O&M staff training documentation.	A/E Team Commissioning Team
Building Operation	1. *Table 1*-Building and Site Characteristics 2. *Table 2*-Building Costs and Performance **NOTE:** Compile data monthly. Submit to CDB annually.	Building Operation Staff

TABLE 1—BUILDING AND SITE CHARACTERISTICS		
METRIC	**DATA**	
	Required	**Optional**
All measurements are in square feet unless otherwise noted.		
Building Information	**Building Location** address city	**Gross Ground Floor Area**

	zip code county	
	Building Function office, classroom, storage, etc.	**Parking Area** pervious area impervious area
	Key Building Features landscaping, lighting, materials, energy model, etc.	**Undeveloped/Restored Site Area**
	Expected Building Life	**Maintained Exterior Area**
	Year Building First Occupied or **Year of Last Major Renovation**	**Gross Building Floor Area**
	Gross Interior Floor Area	**Conditioned Building Volume** (cubic feet)
	Gross Conditioned Floor Area	
	Gross Unconditioned Floor Area	
	Landscaped Area pervious area impervious area plant species	
	Total Site Area	
	Site Characteristics prime farmland, wetlands, undeveloped land lower than 5 ft. above 100-year flood, etc.	
Occupancy	**Hours of Operation** number of days typical day schedule hours per week occupant hours per year	
First Cost	**Total Project Cost** $ $/square foot describe what was included in total cost	**Unusual Cost Elements** $ $/ square foot
	Design Cost $ $/square foot	
	Life Cycle Cost Analysis Costs $ $/square foot	
	Construction Cost $ $/square foot	
	Commissioning Cost $ $/square foot	
	Energy Modeling Cost $ $/square foot	
	LEED® Registration and Certification Cost $ $/square foot	

TABLE 2—BUILDING COST AND PERFORMANCE		
METRIC	**DATA**	
	Required	**Optional**
Water	**Total Building Potable Water**	**Indoor Potable Water**

	gallons/month $/month	gallons/month $/month
		Outdoor Potable Water gallons/month $/month
		Storm Sewer Discharge gallons/month $/month
		Graywater/Stormwater Reuse gallons/month $/month
Energy	***Predicted* Total Building Energy Use Per MONTH** predicted kWh/month predicted $/month predicted BTU/month	**Source Energy** source kWh/month source kg co_2/kWh
	***Predicted* Total Building Energy Use Per YEAR** predicted kWh/year predicted $/year predicted BTU/year	**Peak Electric Demand** kW actual
	Total Building Energy Use Per MONTH delivered kWh/month delivered $/month delivered BTU/month	
	Total Building Energy Use Per YEAR delivered kWh/year delivered $/year delivered BTU/year	
Maintenance and Operation	**Building Maintenance** $ hours number of requests by type number of preventive maintenance number of maintenance staff	**Grounds Maintenance** $ hours
		Recommissioning $ hours
Waste Generation	**Solid Sanitary Waste during *Construction*** cubic yards/month tons/month $/month	**Recycled Materials** cubic yards/month tons/month $/month
	Solid Sanitary Waste during *Operation* cubic yards/month tons/month $/month	
Occupant Health and Productivity	**Total Number of Regular Occupants**	
	Occupant Turnover Rate per Year	
	Absenteeism absentees/occupants/year	
	Building Occupant Satisfaction and Self-Rated Productivity	

Definitions

Gross Interior Floor Area

Measured from the *inside* surface of the exterior walls on a floor-by- floor basis and consist of all enclosed spaces.

Relevance

Resource use and cost values that are relevant to the building interior can be normalized according to gross interior floor area. Resource use quantities include materials purchasing, waste output, indoor water consumption, energy consumption, and maintenance costs. The performance and cost metrics can be normalized to occupant density (occupants/square feet).

Landscape Area

Non-parking developed area associated with the building. Parking areas that require landscaping maintenance such as permeable vegetated surfaces and vegetated islands are included. Other non-parking development including patios, walkways, decorative fountains, and water treatment pools are included. Green roofing is not included in landscaping area unless it can be considered a garden for occupant use. Undeveloped site areas including conserved or restored wetland, prairie, or other habitat are not included.

Relevance

Landscaping area can be used to normalize exterior water use and grounds maintenance costs. The intent is to determine how sustainable landscaping strategies affect material costs, time spent and water use.

Total Site Area

Includes areas for the building, landscaping, parking and undeveloped land primarily associated with that building *(Total Site Area = Building Footprint + Undeveloped Site Area + Landscaped Area).* For stand-alone facilities, the site area is equal to the lot area. For campus buildings, exterior areas are assigned by on-site personnel. Clear space divisions such as streets, streams, hedges, and fences can be used to apportion ground areas to the extent possible. Other considerations include what site area needs to be considered for collection of the other metrics, such as grounds maintenance, water use, and stormwater outflow.

Building exterior area includes all exterior landscaped area whose irrigation water use is considered part of the building. Inseparable stormwater outflow routes associated with the building can be included if stormwater is going to be measured. Parking areas serving more than one building are assigned proportionally according to building occupancy at peak time.

Relevance

Total site area can be used to provide overall site comparison for selected resource use metrics. It supports the analysis of the storm sewer metric for the calculation of site related runoff. Note that the storm sewer metric is optional.

Gross Ground Floor Area *(optional)*

The surface area covered by the building's enclosed spaces at grade level, measured from the *outside* face of exterior walls.

Relevance

Subdividing total building site area into components allows alternative normalization options for resource and cost measurements.

Gross Conditioned Floor Area

All of the conditioned spaces measured from the inside surface of the exterior walls. A conditioned space is an enclosed space within the building that is cooled, heated or indirectly conditioned. This area is equal to the gross interior floor area minus the floor area of unconditioned spaces and the exterior walls.

Relevance

Conditioned floor area allows for a more precise determination of energy use intensity in terms of functional conditioned space.

Parking Area *(optional)*

All usable capacity including underground lots and parking garages. This is measured on a floor-by-floor basis from the interior wall, excluding stairwells, elevators, and any other areas not usable for parking. Include information on permeable and impermeable parking areas, when appropriate.

Relevance
Parking area may be used for a maintenance cost per unit area or for a parking area per occupant. Impermeable surface area information along with measured stormwater runoff data will help evaluate the impact of surface area types and stormwater management efforts.

Undeveloped Site Area *(optional)*
Preserved or restored natural habitat including forest, prairie, or wetland that can be associated with the building.

Relevance
Subdividing total building site area into components allows alternative normalization options for resource and cost measurements. Site management costs can be determined both including and excluding undeveloped area stewardship and restoration costs. Stormwater outflow measurements can be normalized both including and excluding undeveloped site areas.

Maintained Exterior Area *(optional)*
Land area that requires labor and materials input, including parking, landscaping, and other hardscapes, but does not include undeveloped land or building footprint.

Relevance
Subdividing total building site area into components allows alternative normalization options for resource and cost measurements.

Gross Building Floor Area *(optional)*
The enclosed space measured from the *outside* face of exterior walls on a floor-by-floor basis and includes basements, mezzanines, penthouses, vertical penetration (such as elevator shafts and stairwells).

Relevance
Gross building floor area offers an alternative normalization from gross interior floor area for determining whether resource use metrics are accurately portraying building performance.

Building Conditioned Volume *(optional)*
The gross interior floor space and height with specific room dimensions as needed. The interior height is measured from floor surface to the bottom of the floor surface in multi-story buildings or inside the surface of the roof. It is calculated on a floor by floor basis with unique spaces, such as atriums, being calculated separately.

Relevance
This metric allows for the normalization of energy consumption by volume rather than area, offering additional detail for conditioned space with high ceilings (e.g., atrium, auditorium, gymnasium, etc.).

Gross Unconditioned Floor Area

All of the unconditioned spaces measured from the inside surface of the exterior walls. An unconditioned space is an enclosed space within the building that is NOT cooled, heated or indirectly conditioned. This area is equal to the gross interior floor area minus the floor area of conditioned spaces and the exterior walls.

Relevance
Unconditioned floor area allows for a more precise determination of energy use intensity in terms of functional unconditioned space.

Total Building Potable Water Use
All indoor and outdoor water use taken from a well or centralized water distribution. The potable water use

volume metric does not include captured stormwater or reused gray water. Potable water use cost can include costs assessed for sewage treatment as long as both baseline and sustainably designed buildings are measured the same way. Varying regional price structuring and metering may alter what data are readily available via utility bills. *Measurement and Verification Guidelines for Federal Energy Management Projects* offer detailed concepts in quantifying water consumption and cost.

Relevance
Water consumption allows for a building systems performance comparison; water use cost allows for an economic comparison. The total potable water use metric is likely not as instructive as values given when indoor and outdoor water use are separated, resulting in uncertainty regarding the reasons behind a more efficient water system. However, if separate metering is not available, this metric can be used, and individual uses may be calculated based on this total consumption.

Indoor Potable Water Use *(optional)*
Includes that portion of potable water use used in the building interior, including bathrooms, mechanical systems, laundries, and kitchens. Water used and discharged for cooling through once-through or cooling tower systems is included here. It does not include irrigation or other exterior water use that is routed through the interior building plumbing system.

Relevance
Building interior planning efficiency and fixture efficiency are represented by this metric. Comparisons of this indoor water use will likely be very meaningful because they can be evaluated among buildings with similar functions on both per unit and per occupant basis.

Outdoor Water Use *(optional)*
Potable and irrigation water use. Captured rainwater and reused gray water are not included in the volume metric, but estimated volumes should be included in the key building features metric.

Relevance
Comparison of area-normalized outdoor water use will allow an evaluation of the relative cost and performance efficiency of sustainable landscaping strategies.

Total Storm Sewer Output *(optional)*
The volume of stormwater directed off the building site. Stormwater fees are generally assessed through taxes based on area, urban density, or impermeable surface area because outflow volumes are rarely metered.

Relevance

Total storm sewer output is an indicator of the effectiveness of site related stormwater management.

Greywater/Stormwater Reuse *(optional)*
Greywater is defined as the wastewater produced from baths and showers, clothes washers, and lavatories. The wastewater generated by toilets, kitchen sinks, and dishwashers is called blackwater.

Relevance
Comparison of area-normalized greywater reuse will allow an evaluation of the relative cost and performance efficiency of greywater reuse strategies.

Total Building Energy Use
All energy consumed in the building. Building energy consumption includes any exterior building illumination, but does not include parking garage or parking lot lighting.

Relevance
Building energy use allows for building systems performance, cost, and resource use comparisons.

Source Energy *(optional)*
The energy directly consumed at the building and the energy consumed at the source or production point used to deliver the quantity of energy to the building site. Source energy includes site consumed energy, transmission and distribution losses, and conversion inefficiencies. Combusted fossil, biomass, and refuse-derived fuel (RDF) source energy is equivalent to stored chemical energy; nuclear source energy is calculated as the thermal energy released in the fission reaction; hydroelectric source energy is the potential or kinetic energy contained within dammed water.

Source emissions can be calculated in terms of the mass of the seven primary pollutants as defined by the National Ambient Air Quality Standards of the Clean Air Act: ozone, particulate matter less than 10 μm in diameter, particulate matter less than 2.5 μm in diameter, carbon monoxide, sulfur dioxide, nitrogen oxides, and lead. They can also be reported in terms of mass carbon dioxide and rolled up into global warming potential as carbon dioxide equivalent, and acidification potential as sulfur dioxide equivalent. Where electricity is generated by a nuclear utility, the mass of radioactive waste (kg U) associated with site energy consumption can be collected. Other emissions data can be collected as determined available and relevant upon contacting the power utility.

Relevance
Source energy is a more detailed means of determining building resource use efficiency performance than site energy because it accounts for the imbedded inefficiencies of transmission, distribution, and conversion. Building designers and managers can change the impact of a building by installing on-site renewable energy and/or purchasing "green" energy from the utility. Source emissions offer an environmental impact indicator. Relative global warming, acidification, and radioactive waste impacts can be estimated from the collected values.

Peak Site Electricity Demand *(optional)*
The maximum power demand and the associated cost premium assessed over a period of one calendar month. Typically, peak demand is measured in 15-minute intervals. Only electricity drawn from the grid is included in this metric; electricity consumed from on-site generation is not included here.

Relevance
Peak electricity demand has associated economic and environmental impacts. Utilities generally charge additional fees based on monthly peak demand, sometimes including clauses that can affect an entire year's bills as a result of high electric consumption over one 15-minute period. Additionally, large demand variations force utilities to vary outputs, wasting energy because of startup and shutdown inefficiencies when making adjustments to match the required load. Utility and infrastructure capacity must keep pace with demand, and therefore, effective electricity load management can also reduce the need for additional construction.

Building Maintenance
All in-house and contracted resources expended for building monitoring, repair, preventative maintenance, training, and response to service requests. It does not include grounds work or major renovations. Costs do not include O&M staff overhead. The number of maintenance personnel can also be used as a reference point. The requests include service requests as well as complaints. They are the building occupant requests to building personnel that require some action. Examples include temperature complaints and repair requests.

Relevance
O&M expenditures are direct building costs that may also impact energy and water utility costs. Studies have shown that the quality and consistency of building operation, especially thermal comfort, impacts the productivity of the building occupants. Quality of service requests indicates how well the building is performing from an occupant's perspective as well as how much O&M personnel time is needed to maintain the building. Preventative maintenance regimes may decrease the number of service calls and increase the life of the equipment resulting in avoided life cycle costs. Training may increase as a result of managing more advanced building equipment.

Grounds Maintenance *(optional)*

All in-house and contracted labor and resources expended for landscaping, stormwater management, and parking lot/garage upkeep. Costs include labor, training, and materials. Hazardous materials used should be documented separately. If training costs can be separated from other O&M costs, it will allow for a more detail comparative analysis of O&M related costs.

Relevance
Sustainably designed grounds may incur fewer costs because of hardy native planting, reduced chemical application, and on-site rainwater infiltration. However, it may incur greater costs as a result of permeable surface maintenance or training needed to maintain new types of landscaping. The design differences can be noted in the key building features metric.

Commissioning
In new design and construction processes, commissioning begins at the beginning of the design process, to ensure the functions of the systems being designed meet the building performance requirements. Commissioning during construction ensures that the equipment installed during construction is the equipment specified and is installed appropriately. Commissioning at the completion of the construction ensures the systems operate as intended in the design, and that they meet the performance requirements of the building occupant.

Relevance
Commissioning is a pre-requisite requirement under the LEED® rating system.

Re-Commissioning *(optional)*
Re-Commissioning is the process through which buildings are commissioned again at some time after their initial completion, occupancy, and commissioning. Re-Commissioning is a check to ensure that building systems are still functioning as originally planned, constructed, and delivered, and to identify where periodic operating procedure changes or drifts in control calibrations have affected building system performance in a previously commissioned building.

Relevance
Sustainably designed buildings may incur fewer re-commissioning costs because of initial commissioning efforts.

Solid Sanitary Waste
Measures non-hazardous waste, also known as garbage, generated by building occupants and disposed of in a dumpster for pickup and delivery to a landfill or incinerator. Solid sanitary waste output can be reported in volume, mass, and dollars. Values can be normalized both on an occupant basis and on a gross building interior area basis.

Relevance
Low amounts of sanitary waste disposal may represent greater access to recycling containers, occupant values, or policies of reducing material use, reusing materials, or aggressive recycling within the building.

Recycled Materials *(optional)*
Items diverted from waste disposal for reuse, recovery or reclamation. A list of types of materials recycled at the building site should be included. These items may include aluminum, tin, glass, cardboard, paper, batteries, electronics, and chemicals. Recycled waste output can be reported in volume. Values can be normalized both on an occupant basis, and on a gross building interior area basis.

Relevance

Recycling can reduce sanitary and hazardous waste output, thus reducing the environmental impact and cost.

Occupant Turnover Rate
The number of building occupants that leave the organization over the course of a year. If possible, designate

whether the occupants left because of resignation, termination, or retirement and provide further detail on reasons for resignation. The ration of turnover to total numbers of occupants is a retention indicator that can be used as part of a comparative building analysis.

Relevance
Employee turnover cost time and money. Increased cost associated with training, recruitment, severance, and downtime are impacts of turnover. The occupant satisfaction survey, the turnover rate, and absenteeism can be used to indicate the cost and performance impact of IEQ.

Absenteeism
The number of days that an occupant is away from work for health reason.

Relevance
A healthy, satisfying, and productive work environment may be reflected in low absenteeism rates. Occupant absenteeism is an indicator of productivity. Absenteeism information along with occupant pay information can be used to determine a cost for work days lost.

Building Occupant Satisfaction
A relative measure of comfort, environment, and indoor air quality as determined with a survey. Ratings range from low to high satisfaction.

Relevance
A satisfying work environment has been correlated with staff retention and increased productivity.

Self-rated Productivity
A relative measure of an occupant's productivity. Ratings range from low to high productivity.

Relevance
Employee costs are the largest organizational cost over time. Occupant perception on how a building's IEQ affects productivity and the quality of work offers an indicator of potential building- related organizational costs.