## Mind the Gaps: Post-Occupancy Discoveries from Design to Operation

March 09, 2017 BuildingEnergy Boston

Patrick Murphy, PE, LEED AP BD+C Chuck Stellberger, PE, LEED AP BD+C



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#### Introduction

What is Post-Occupancy Evaluation?

- Value Proposition
- Process

**Case Studies** 

- Commercial: Parks & People
- Multifamily Residential: Radian
- Science & Technology: Shire Genetics Lab

Wrap-Up / Recap

## About the Speakers

#### Patrick Murphy, PE, LEED AP BD+C

- MEP Project Manager and Senior Mechanical Engineer
- 10 years' experience designing high-performing buildings, including more than 20 LEED projects, including three LEED NC Platinum projects and one net zero off-grid project.

#### Chuck Stellberger, PE, LEED AP BD+C

- Mechanical Engineer and Energy Modeler
- Energy modeling, energy audits, and sustainability consulting across commercial, laboratory, and healthcare projects, including more than 20 LEED projects.





## About the Company

Vanderweil Engineers is a full-service MEP/FP and technology design firm headquartered in Boston with over 400 employees committed to delivering high-performing, sustainable buildings.



## Learning Objectives

- 1. To understand the value proposition of post-occupancy review.
- 2. To learn the process by which owners and MEP engineers execute a post-occupancy program.
- 3. To learn about common findings in MEP-based postoccupancy reviews.
- 4. To understand how the findings from post-occupancy reviews can affect future designs.



Introduction

#### What is Post-Occupancy Evaluation?

- Value Proposition
- Process

**Case Studies** 

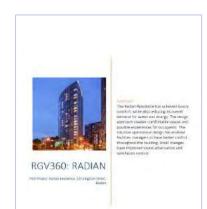
- Non-Profit: Parks & People
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Wrap-Up / Recap

# What is Post-Occupancy Evaluation (POE)?

- POE is a high-level evaluation of MEP system performance and overall occupant experience.
- The project team revisits the site 1-3 years after substantial occupancy.
- The project team issues a report summarizing findings and makes recommendations for improvement.





## Value Proposition: Client

- Engages the design team during/beyond the warranty period
- Enhances owner understanding of their building and design intent
- Provides recommendations for improved operations
- Outlines corrective actions for issues





## Value Proposition: Design Team

- Solicits candid feedback on building design, maintainability, and performance
- Analyzes real-life performance data to evaluate design decisions
- Follows up on commitments made by the project (EUI, IEQ metrics, etc.)





## Value Proposition: Design Team

- Incorporates lessons learned into future designs
- Deepens the client relationship
- Opportunities to conduct energy audits and retrocommissioning

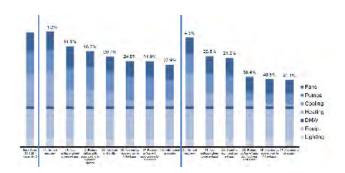




## How is POE Different From...

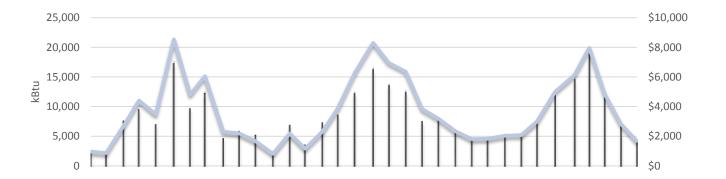
- ...M&V or an energy audit?
  - POE is not focused solely on energy consumption
  - POE does not include energy model calibration
- ...retro-commissioning?
  - POE occurs before retro-Cx
  - POE does not alter system operations

POE is a higher-level and shorter process than either of these activities.





- Follow up with the owner 1-3 years after occupancy
- Outline POE process and value proposition
  - Send questionnaire
  - Request utility data
  - Schedule site visit
- Evaluate utility data, compare to energy model



- Conduct site visit:
  - Interview owner and occupants
  - Interview facilities staff
  - Inspect the building systems





- Issue report with findings and corrective actions
- Follow up with owner to review findings and next steps

**Questionnaire and Interviews** 

- Building controllability and complexity
- Equipment maintenance and warranty issues
- Energy performance
- Physical installation
- Project closeout & training
- Occupant comfort
- Overall occupant experience

Assessment Area	Score (out of 5)	Notes
General System Performance:	****	
Building Controllability:	***	Controls issues stem from the user interface and the interaction between the master controls and the individual system control.
Energy Performance:	***	The Energy performance has not been calibrated with the model. However, the overall energy use is for the whole-building is tracking in line with the model.
Physical Installation:	****	There have been few issues with actual installation. However, the water heater was placed in a way that has made the access to instantaneous hot water slightly limited. The hot water takes a few minutes to occur in the showers that are across the building.
Project Closeout:	****	The building has been well maintained although the controls specialists have not been easy to be in contact with. A potential next step would be to work with BGE to determine whether lighting rebates are available.
Decopant Experience:	****	The occupants have been very satisfied with room-level thermal comfort, temperature control, and tayout. The light/glare has been an issue occasionally but the shades can be drawn and tend to allay the problem.

#### Report and Follow-Up

- Document questionnaire and interview findings
- Provide analysis of energy performance vs.
  - Modeled design
  - Similar buildings (i.e. Benchmarking)



#### **Report and Follow-Up**

- Suggest corrective actions
- Review lessons learned
- Celebrate what went right!

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Introduction

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#### **Case Studies**

- Non-Profit: Parks & People
- Science & Technology: Shire Genetics Lab
- Multifamily Residential: Radian

Wrap-Up / Recap

## Case Study # I

## The Sally & Butch Michel Center for Parks and People Baltimore, MD





Parks and People is a Baltimore non-profit which works to revitalize neighborhoods and communities through hands-on cleaning and greening of the natural environment.







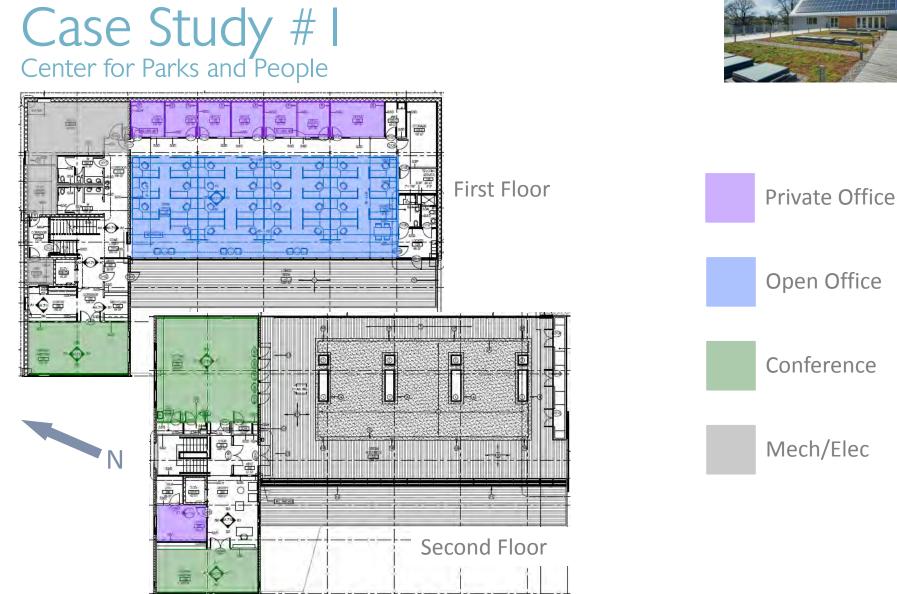
- Historic renovation of Park Superintendent House
- New construction of offices and community rooms



Headquarters building (10,000 SF)



Superintendent's building (4,700 SF)



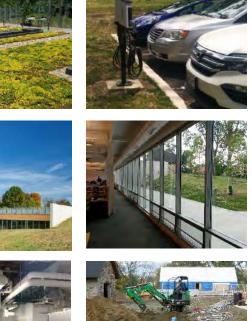


#### Intro

## Case Study # | Center for Parks and People

**Energy Conservation Measures:** 

- High-performance envelope ۲
- Green Roof
- Low Flow Plumbing Fixtures
- **Composting Toilets**
- Photovoltaic Array
- Electrical vehicle charging station
- Daylighting optimization
- Geothermal Variable Refrigerant Flow (VRF) System
- Natural ventilation
- Energy recovery ventilation
- Expanded thermal comfort conditions









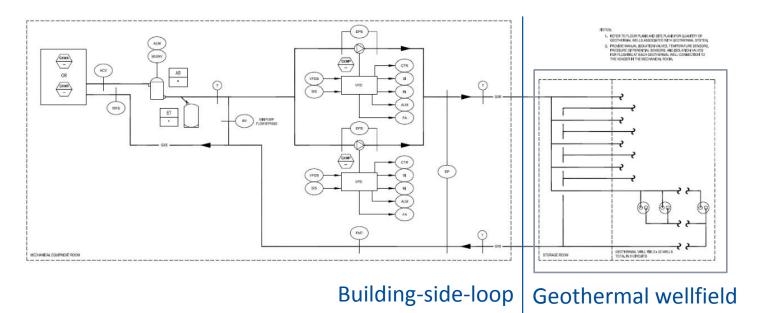
#### **Certified LEED Platinum!**

- 49.3% energy cost savings compared to ASHRAE 90.1-2004
- Energy Star score of 100
- Metered energy use of 43.1 kBtu/ft<sup>2</sup> (March 2015 through February 2016)





- Mechanical Highlights:
  - Geothermal VRF system
  - Natural ventilation backed up by mechanical energy recovery ventilation





- Electrical Highlights:
  - PV array
  - CFL lighting
  - Daylight optimization

THE SALLY & BUTCH MICHEL CENTER FOR PARKS & PEOPLE

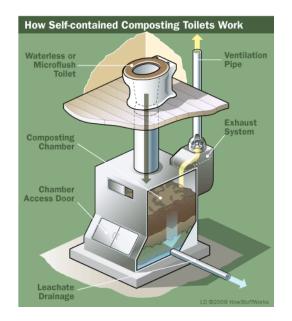








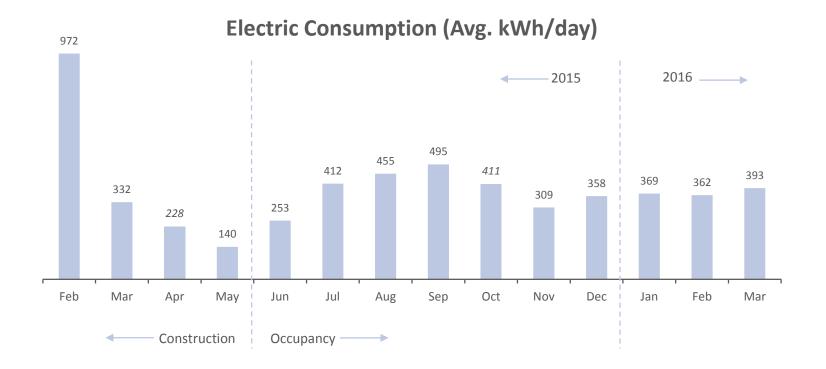
- Plumbing Highlights:
  - Low-flow fixtures
  - Composting toilets in the Superintendent's building







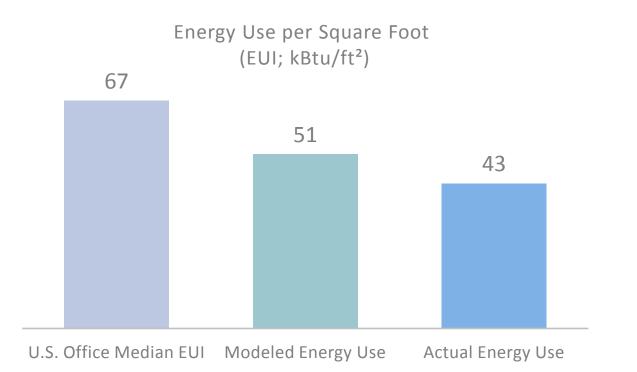
Utility Data Analysis:







Utility Data Analysis:







#### POE Highlights:

- The organization is thrilled overall with their new building
- Thermal comfort in open office, conference, and corridor spaces
- Daylight and views
- Headquarters building energy use

Issues raised:

- Occupant comfort in private offices
- Superintendent's house A/C use
- Ceiling fan control
- Groundwater pump shut-off
- Composting toilets









#### Lessons Learned:

- Thermal comfort
- Contractor availability and training
- Composting toilets: design vs. actual frequency of use
- Occupants moving into a new building are generally satisfied, but there is always room for improvement.



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#### **Case Studies**

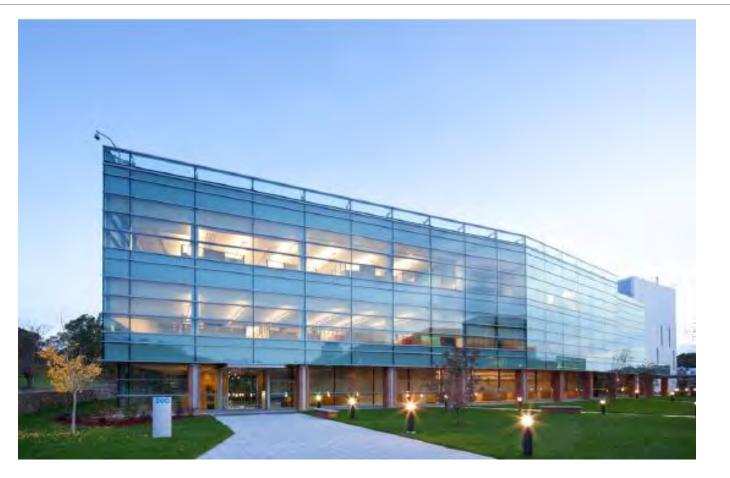
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Wrap-Up / Recap

## Case Study #2

#### Shire Pharmaceuticals: Genetics Laboratory

Lexington, MA





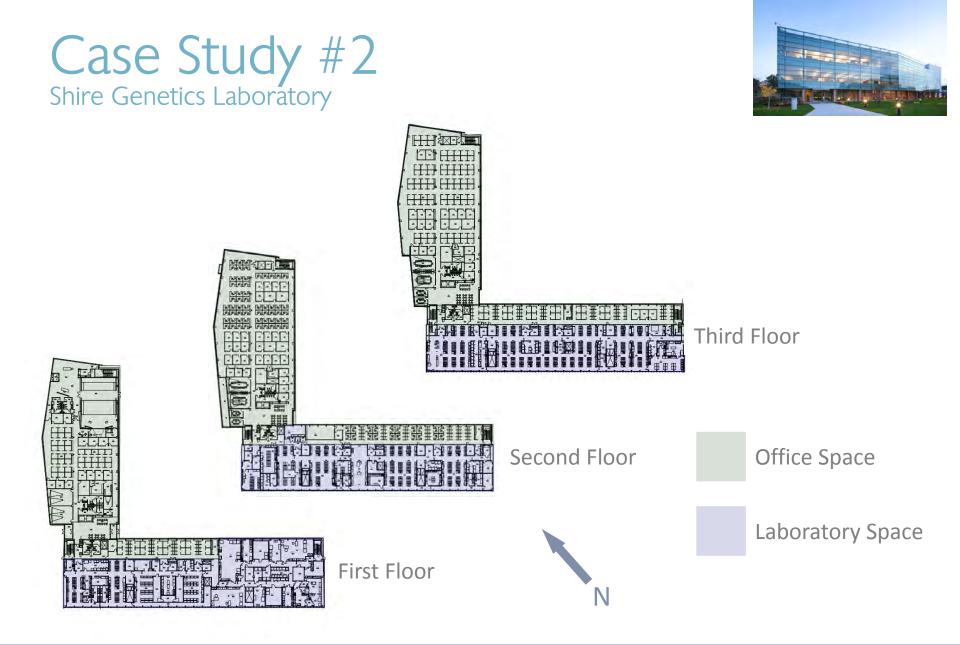
Recap



- Lexington, MA
- 190,000 ft<sup>2</sup> over four stories
- Completed in 2012







Case Study #2 Shire Genetics Laboratory

#### Mechanical Highlights:

- Heat-shift chiller
- Chilled beams in lab spaces
- Low-pressure air distribution
  design
- Laboratory exhaust energy recovery
- Condensing boiler plant









- Electrical Highlights:
  - Lighting power density reduction
  - Daylighting control
  - High process loads ranging from 5-60 W/ft<sup>2</sup> in each room
    For context, offices typically have loads of 2 W/ft<sup>2</sup>

RODI reject/reclaim system

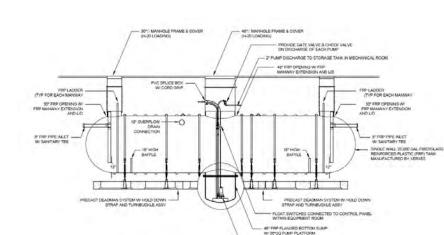
pH neutralization system 

Case Study #2

**Plumbing Highlights:** 

Shire Genetics Laboratory

flushing



OUPLEX SUMP PUM W RAL REMOVAL SYSTEM: PUMP OPERATION IS CONTROLLED BY LEVEL SWITCHES WITHIN INTERIOR STORAGE TANK

Rainwater collection for cooling tower makeup and toilet







#### **POE Highlights**

- Sound attenuation far exceeded owner's expectations
- Chilled beams functioning as intended
- Lighting levels in laboratories







Issues raised and lessons learned:

- Humidity control in laboratory spaces
- Snow entering the OA intake
- Energy recovery unit shifts into and out of economizer mode
- Importance of commissioning process



Introduction

What is Post-Occupancy Evaluation?

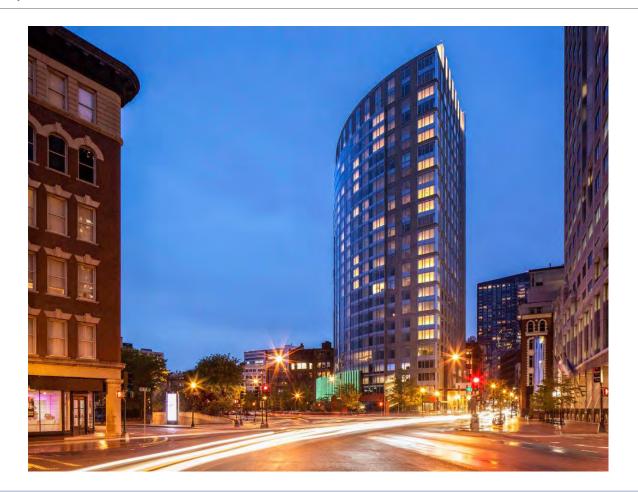
- Value Proposition
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Wrap-Up / Recap

### Case Study #3 The Residences at Radian Boston Boston, MA







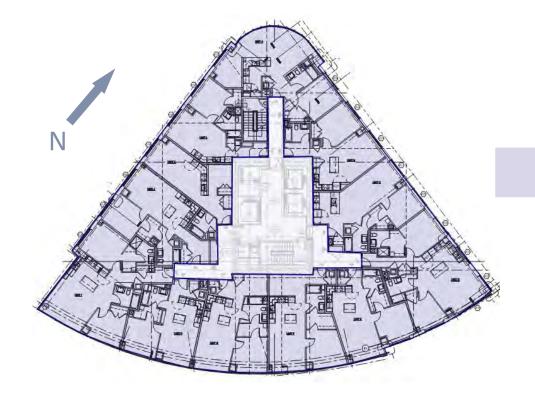
• 300,000 ft<sup>2</sup>, 26-story mixed-use residential high-rise



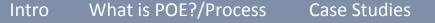




• 300,000 ft<sup>2</sup>, 26-story mixed-use residential high-rise



#### **Residential Space**



Certified LEED Gold

Radian Boston

Case Study #3

- 32.2% energy savings compared to ASHRAE 90.1-2004
- 25.8% energy cost savings compared to ASHRAE 90.1-2004



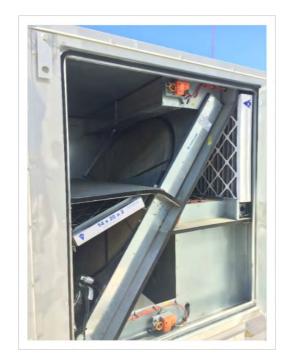


#### Intro What is POE?/Process Case Studies

#### Case Study #3 Radian Boston

Energy Conservation Measures:

- High-performance envelope
- Energy Star appliances
- High-efficiency air distribution
- Energy recovery ventilation
- Condensing boiler plant



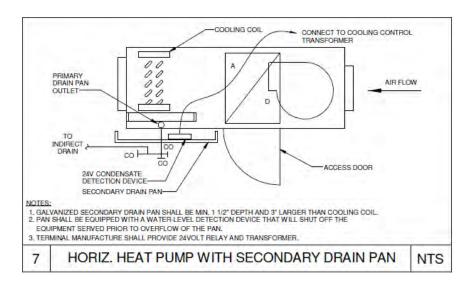


#### Case Study #3 Radian Boston



Mechanical Highlights:

- Ventilation provided via ERU in combination with operable windows in residences
- Local space conditioning via water-source heat pumps (WSHPs) supplemented by a condensing boiler plant and cooling tower





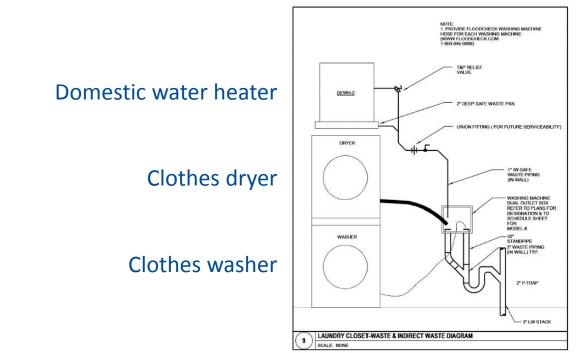


- Electrical Highlights:
  - Mixed CFL and LED lighting scheme beat code-maximum lighting power by 10%
  - Energy Star appliances specified in residences allowed credit against plug loads in Baseline energy model.





- Plumbing Highlights:
  - Electric water heaters local to each dwelling unit; space constraints within the residences required suspension over washer/dryer setups

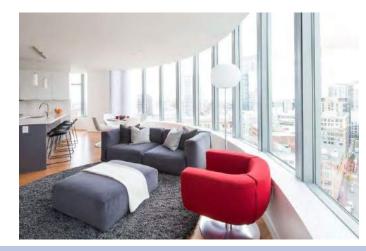






#### POE Highlights:

- Residence experience: overall thermal comfort, lighting, and layout.
- Maintenance clearance in mechanical penthouse
- Decentralized heating and cooling







Issues raised:

- Electric water heater serviceability
- Energy recovery unit controls
- Thermostat placement in studio apartments
- Sound and vibration traveling from mechanical penthouse
- Window frames

#### Case Study #3 Radian Boston

#### Lessons learned

- Importance of off-season commissioning
- Necessity of a thorough punchlist
- Impact of value engineering



Foam panel vibration isolation inside the Radian penthouse.





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#### Wrap-Up / Recap

Keeps the design team engaged beyond the warranty period.

• 3.5 years after the building was initially occupied, the design team remains engaged in helping the owner.



Better understanding of their building and why it was designed a certain way.

- Parks and People: DHW circulation pump Relatively small (and low-power) pump causes wait for HW in bathrooms but was necessary to achieve project's energy efficiency goals and limit the DHW loop's first cost.
- Radian: DHW heaters

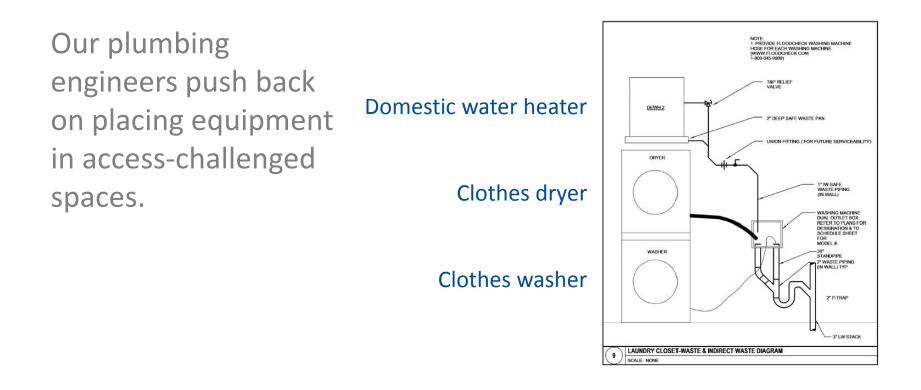
The need to maximize rentable square footage forced the DHW heaters into a tight space.

Provides recommendations and corrective actions

- Upgrade lighting from CFL to LED
- Install vibration isolation hangers

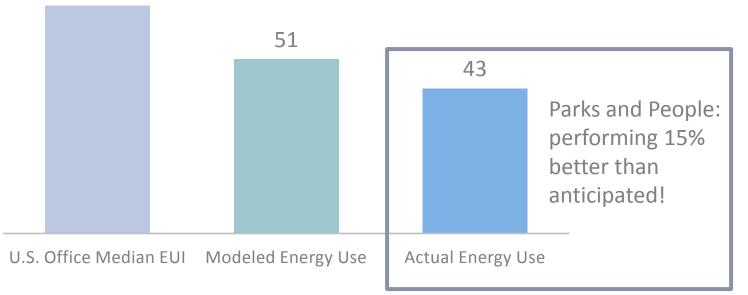


Incorporates lessons learned into future designs



- Analyzes real-life performance data to evaluate design decisions
- Follows up on commitments made by the project (EUI, IEQ metrics, etc.)





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Deepens client relationship

As part of our POE of Parks & People, we were able to engage the architect and the greater Baltimore sustainable design community in a celebration of the project's LEED Platinum achievement.

We continue to work with that client and receive referrals due to this work.



## Is POE Worth It?

- Yes! Assuming that:
  - The project team desires the data
  - The project team needs to follow up with and impress a good client
  - The project team believes there will be good lessons learned from the project



### Questions?



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