



# **Indoor Environment Quality + Workplace Environment Wallin Medical Biosciences Building (WMB) Report 2**

**February 2014, Minneapolis, MN  
Sustainable Post-Occupancy Evaluation Survey (SPOES)  
B3 Guidelines**

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## 1.0 Overview

The purpose of this report is to examine the connection between sustainable design criteria used in the design of the Wallin Medical Biosciences Building (WMBB) and employees' satisfaction with their work environments. The WMBB was designed using the B3 Guidelines (formerly known as the Minnesota Sustainability Guidelines or MSBG) and completed for occupancy in 2009. The B3 Guidelines tracks specific state-funded, B-3 buildings as a means of demonstrating real outcomes aimed at the conservation of energy resources, creation and maintenance of healthy environments, and occupants' satisfaction with their work environments. The Sustainable Post-Occupancy Evaluation Survey (SPOES) was developed to assess human outcomes in classroom and workplace settings in compliance with the project tracking requirements for the B3 Guidelines goals. This is a report of occupants' (hereafter called employees) responses at five years post-occupancy. The survey was conducted in February 2014 and serves as the second of two required POE events.

This SPOES report focuses on employees' satisfaction with the physical environment as related to 15 indoor environment quality (IEQ) criteria (hereafter called categories) such as lighting, thermal, and acoustic conditions in their primary workspaces, i.e., offices. Employees' satisfaction with the facility (site, building, and interior) and the effect of the facility's physical environment on their perceptions of their work performance and health are included. Finally, a brief look at employees' commuting and physical activities within the building are also reported. The report provides descriptive information about employees' perceptions of the IEQ of their work environments. In addition, this information serves the broader development of knowledge regarding the influence of IEQ on employees.

## 2.0 Method

SPOES consists of a self-administered, Internet-based, questionnaire submitted to and completed by employees. The SPOES questionnaire has been tested for **validity** (measures what it is intended to measure) and **reliability** (repeatability or replicability of findings) in studies involving similar facilities and employees. Employees rate their level of satisfaction on a **Likert-type scale** (measurement scale) from 1 (very dissatisfied) to 7 (very satisfied) with IEQ of the facility and their primary workspaces. They also rate the influence of their physical environment on their perception of their work performance and health on a scale from 1 (hinders) to 7 (enhances). There were no physical measurements taken of environmental conditions such as temperature or acoustic level. This study is limited to employees' perceptions.

The report provides a descriptive summary of the results stated as a **mean** (M = average of all responses), **standard deviations** (SD) (how different scores are from each other and the mean), and **number of responses** (N) for questions analyzed. The mean for a 7-point scale is 4.00. Lower or higher means reflect stronger tendencies towards dissatisfaction/satisfaction and hinders/enhances. Means that are close to the center of the scale (4) are considered to be neither dissatisfied/hinders or satisfied/enhances.

When interpreting **mean** responses, the following labels were used:

- 1-3.99      dissatisfied (hinders)
- 4-4.49      neither satisfied (enhances) or dissatisfied (hinders)
- 4.5-7        satisfied (enhances)

An IEQ Score is also calculated for employees' satisfaction with IEQ in their primary workspaces. This is a statistical combination of all IEQ scores, which results in a single IEQ score for all employees on all IEQ variables and is reported in an IEQ Scorecard.

## 2.1 Description of the Questionnaire

Employees first rate their level of satisfaction with the facility and the influence of their physical environment on their perception of their work performance and health. Then they respond to questions about their satisfaction with their primary workspace in relation to the IEQ categories. The questionnaire uses 15 IEQ categories from the B3-MSBG and relates each of them to employees' satisfaction with their physical environment.

Categories include (in alphabetical order):

1. Acoustic Conditions
2. Appearance
3. Cleaning and Maintenance
4. Daylighting Conditions
5. Electric Lighting Conditions
6. Function
7. Furnishings
8. Indoor Air Quality
9. Lighting Conditions
10. Personal Adjustability Conditions
11. Privacy
12. Technology
13. Thermal Conditions
14. Vibration and Movement
15. View Conditions

## 2.2 Limitations

Employee participation is voluntary, and responses are self-reported. As is true with all survey research, the responses indicate employees' perceptions. There were no physical measurements, e.g., temperature, humidity, or lighting levels, of the environment taken.

## 3.0 Sample Description

### 3.1 Building Description

The Winston and Maxine Wallin Medical Bioscience Building (WMBB) is located at 2102 6<sup>th</sup> St. SE, Minneapolis, Minnesota. The building (see Figure 1) is comprised of 40 private and shared offices, 25 research laboratories, eight conference rooms, and animal holding facilities. These areas are distributed across five floors and 118,858 square feet. Departments at this site include the Center for Immunology and the Paul and Sheila Wellstone Muscular Dystrophy Center.



Figure 1. Wallin Medical Bioscience Building (Photo credit: <http://www1.umn.edu/twincities/maps/WMBB/>)

### 3.2 Description of Respondents

The WMBB has 426 employees, which can vary slightly over the year. The response rate was approximately 13%. Of those responding, 50% were male and 50% were female. Relating to hours worked in WMBB, 3% of the employees spend 40+ hours in their primary workspace; 19% spend 30-40 hours in their primary workspace; 8% spend 20-29 hours in their primary workspace; and 17% spend less than 20 hours in their primary workspace. The mean age of respondents was 37 years, with a range of 22 to 64 years.

WMBB is a research facility with offices and laboratories serving as primary workspaces. Results indicated 57% of the employees work in laboratories, 27% work in private offices, 8% share private offices, 4% work at a desk in an open area, and 4% worked in unassigned building spaces. Results also indicated that 64% of the primary workspaces were located within 15 feet of an exterior window, 25% of the employees were not within 15 feet, and 11% where uncertain of the distance to an exterior window.

WMBB has been occupied since December, 2009. Of those years, 42% of the respondents reported that they had worked at this location for more than 3 years, 15% had been there 2-3 years, 19% had been there for 1-2 years, and 25% spent less than 1 year at this site. (Note: all percentages reported may not add to 100% due to rounding.)

## 4.0 Findings and Discussion

### 4.1 WMBB Facility (site, building, and interior): Overall Satisfaction, Work Performance, and Health

Employees responded to questions concerning the WMBB facility (site, building, and interior) and their overall satisfaction with the facility, overall perceptions of their work performance in relation to the facility, and their overall perception of their health in relation to the facility. Table 1 and Figure 2 show a summary and interpretation of their responses.

Table 1. Overall satisfaction, work performance, and health related to the WMBB facility.

WMBB Facility (site, building, and interior)	Mean (1-7)	SD	N	Interpretation
Overall satisfaction	5.33	.95	51	Satisfied
Overall work performance	4.78	1.26	51	Enhances
Overall health	4.53	1.19	51	Enhances

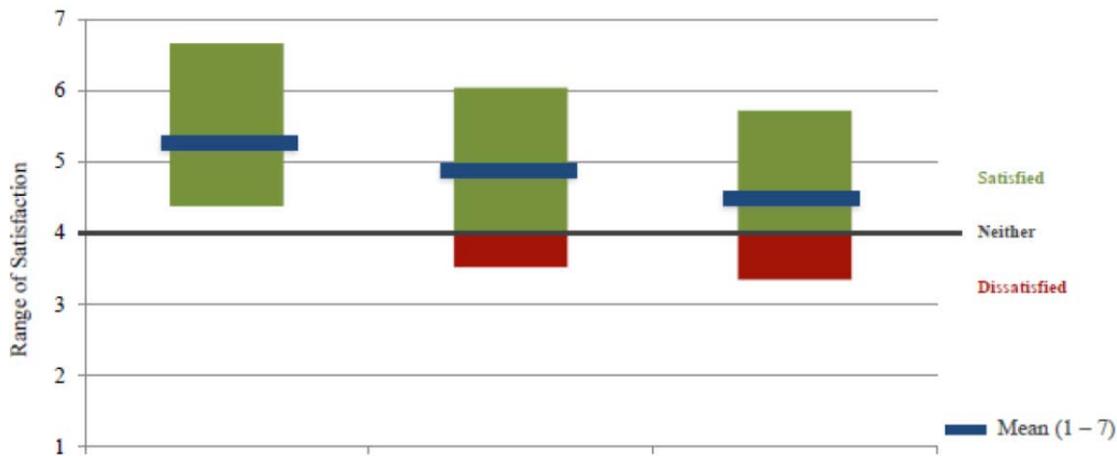


Figure 2. Overall satisfaction, work performance, and health related to the WMBB facility.

Results indicated that employees were satisfied with the (**M = 5.33**) WMBB facility (building, site and interior) and reported that their overall work performance was enhanced (**M = 4.78**) by the facility. Employees reported that their overall health was enhanced (**M = 4.54**) by the facility. See Figure 2.

#### 4.2 Primary Workspace: Overall Satisfaction, Work Performance, and Health

Employees responded to questions concerning their overall satisfaction and overall perceptions of their work performance and health as related to their primary workspace (e.g., private office, workstation, or other primary workspace). Table 2 and Figure 3 show a summary and interpretation of their responses.

Table 2. Overall satisfaction, work performance and health related to primary workspace.

Primary Workspace	Mean (1-7)	SD	N	Interpretation
Overall satisfaction	4.98	1.4	47	Satisfied
Overall work performance	4.98	1.3	49	Enhances
Overall health	4.53	1.1	49	Enhances

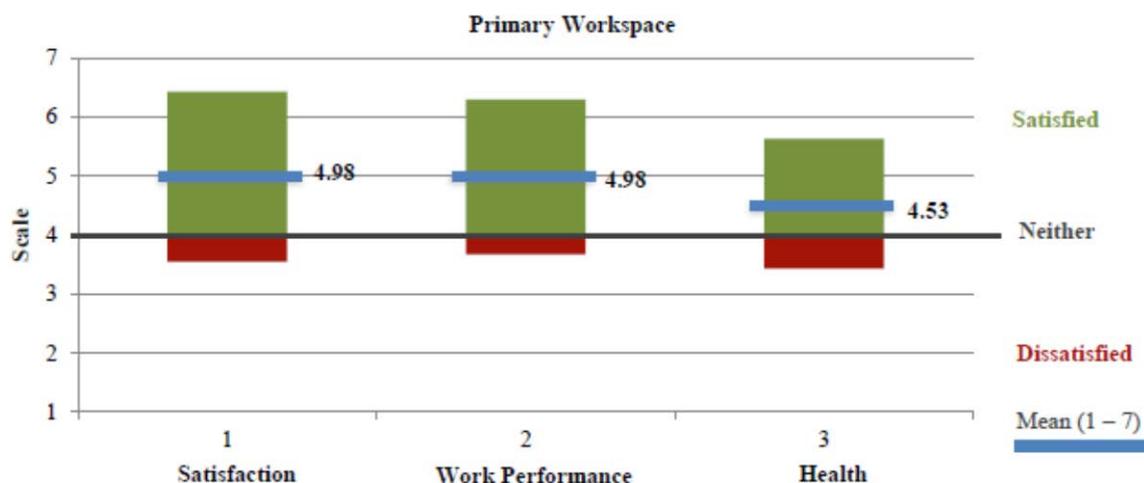


Figure 3. Overall satisfaction, work performance and health related to primary workspace.

Results indicated that employees were satisfied ( $M = 4.98$ ) with their primary workspace, their overall work performance was enhanced ( $M = 4.98$ ) by their primary workspace and their overall health was enhanced ( $M = 4.53$ ) by their primary workspace. See Figure 3.

### 4.3 Primary Workspace: Satisfaction with Indoor Environment Quality (IEQ)

Employees responded to questions concerning their satisfaction with IEQ categories (thermal conditions, indoor air quality, acoustic conditions, etc.) related to their primary workspace (e.g., private office, workstation, or other primary workspace). Table 3 and Figure 4 show a summary of the means, the standard deviations, and interpretation of their responses.

Table 3. Satisfaction with IEQ as related to primary workspace.

Primary Workspace	Mean (1-7)	SD	N	Interpretation
1. Electric lighting conditions	5.43	1.7	47	Satisfied
2. Indoor air quality	5.40	1.3	48	Satisfied
3. Function	5.35	1.2	46	Satisfied
4. Cleaning and maintenance	5.19	1.5	48	Satisfied
5. Technology	5.15	1.1	48	Satisfied
6. Appearance (aesthetics)	5.06	1.3	47	Satisfied
7. Lighting conditions	5.06	1.8	48	Satisfied
8. Daylighting conditions	4.94	2.0	48	Satisfied
9. Furnishings	4.88	1.4	48	Satisfied
10. Vibrations and movements	4.83	1.5	48	Satisfied
11. View conditions	4.63	1.9	48	Satisfied
12. Acoustic conditions	4.44	1.5	48	Neither S/D
13. Thermal conditions	4.13	1.8	48	Neither S/D
14. Privacy conditions	4.00	1.5	48	Neither S/D
15. Personal adjustability	3.83	1.7	48	Dissatisfied

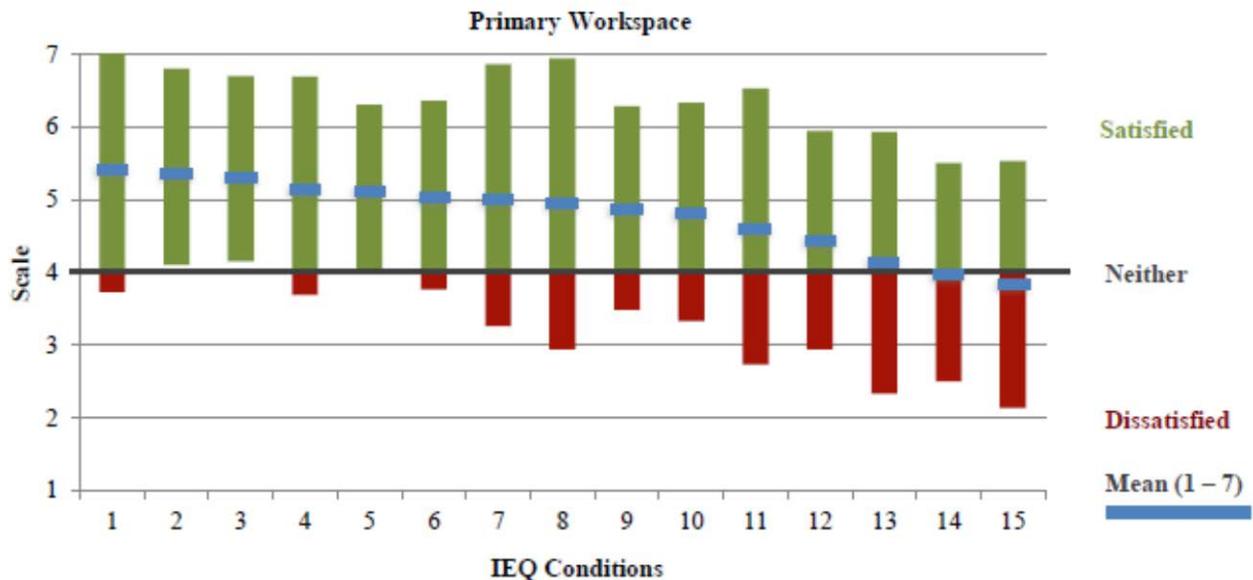


Figure 4. Satisfaction with IEQ as related to primary workspace (IEQ criteria are listed in Table 3 above)

Results indicate that employees were **satisfied** with the following IEQ conditions in their primary workspaces:

- Electric lighting conditions
- Indoor air quality

- Function
- Cleaning and maintenance
- Technology
- Appearance
- Lighting conditions
- Daylighting conditions
- Furnishings
- Vibrations and movements
- View conditions

Employees were **neither dissatisfied nor satisfied** with IEQ conditions for the following:

- Acoustic conditions
- Thermal conditions
- Privacy

Employees were **dissatisfied** with IEQ conditions for the following:

- Personal adjustability conditions

#### 4.4 IEQ Satisfaction Scorecard

The IEQ Satisfaction Score is determined by developing weighted factors of all categories, which is more representative of a fair overall IEQ score. For example, it might be more important for an employee to have satisfying thermal conditions than to have satisfying indoor air quality. Thus, if the employee gives a high thermal satisfaction score and a lower indoor air quality satisfaction score, the overall IEQ satisfaction will be scored much higher than one with the inverse statistics.

The weighted scoring system was developed by employing the following procedures:

1. **Factor analysis** (a multivariate statistical procedure) was conducted to determine the importance of various IEQ categories.
2. The factor loading of each IEQ category was regarded as the individual weight.
3. The weighted sum score was used to calculate the final mean score illustrating how well a particular building performed in terms of satisfying its occupants' IEQ needs. This becomes the IEQ Score.

As shown in Figure 5, the **IEQ satisfaction score for WMBB is 4.91.**

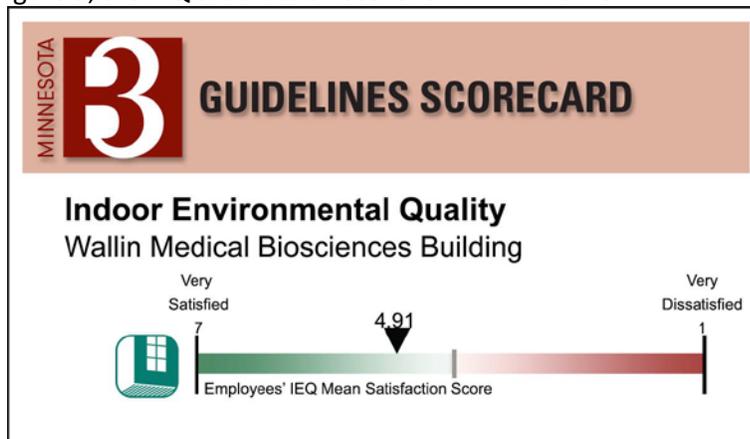


Figure 5. IEQ satisfaction score for WMBB

Overall, the occupants showed a **positive response** but low level of satisfaction, as indicated by the weighted mean score of **4.91**. Satisfaction with **Furnishings** of employees’ primary workspace was identified as the category that contributed most to the IEQ Satisfaction Score, followed by **Function** of the primary workspace. They determine IEQ satisfaction more strongly than other categories and differ slightly from the ranking of the means scores where **Electric lighting, IAQ, and Function** were the top satisfaction scores.

This score of 4.91 validates the overall satisfaction score in Table 2 (**4.98**). They are similar, but the IEQ Score is slightly lower because it may reflect some other factors beyond IEQ such as location or size of primary workspace. The IEQ Scorecard gives more refined knowledge.

## 5.0 Physical Activity Engagement and Commuting Practices

In the final section of the survey, employees responded to questions regarding their overall physical activity while at WMBB (site, building, and interior) and their commuting practices.

### 5.1 Physical Activity Engagement

Providing employees with opportunities for alternative paths of travel around the workplace, e.g., taking stairs as opposed to the elevator, provides opportunities to engage in additional types of physical activities. Engaging in physical travel throughout the work environment can be associated with healthier lifestyles.

Table 4. Overall physical activity (walking, stair use, etc.) affected by the WMBB facility.

WMBB facility (site, building, and interior)	Mean (1-7)	SD	N	Interpretation
Overall physical activity (walking, stair use, etc.)	4.94	1.14	49	Enhances

Results indicated that employees felt that WMBB enhanced (**M = 4.94**) their physical activities (walking, stair use, etc.). Further, of the 49 respondents to this set of questions: 59% said they were satisfied with the facility’s influence on their overall physical activity; 33% said they were neither dissatisfied nor satisfied, and 8% were dissatisfied.

### 5.2 Commuting Practices

WMBB is located on the northern side of the East Bank of the University of Minnesota. The east bank campus is located north of metropolitan hub providing bus and light rail transit service through the campus environment. The University provides several parking facilities, bike paths, and sidewalks throughout the campus and adjacent to the WMBB facility.

Table 5 provides results on employee commuting mileage, mode of transportation, commuting distances, and use of alternative modes of commuting. These results, although not related to IEQ, do offer the University insight into employees’ commuting behaviors and opinions. These data can provide important information about commuting practices that can reduce transportation energy consumption.

Table 5. Primary mode of transportation.

Commuting Mode	Drive alone (or with children ,< 16)	Carpool or vanpool	Public transit	Bicycle	Walk	Other
Primary mode of transportation	53.1 %	6.1%	14.3%	14.3%	8.2%	4.1%

The most frequent mode of transportation to WMBB was driving alone (or with children under 16) (53.1%), followed by public transit (14.3%), bicycle (14.3%), walking (8.25%), and carpool or vanpool (6.1%). Other mode of transportation (4.1%) included “50/50” combinations of driving and biking and ‘a combination of carpooling, biking and taking the bus.”

## 6.0 Conclusions

### 6.1 Summary

A post-occupancy evaluation was conducted of employees of WMBB at approximately three years after it was first occupied. Approximately 12% of the employees responded to the survey.

The survey included questions related to employees’ overall satisfaction with the facility (site, building, and interior) and influence of the facility on their overall work performance and health. Employees were satisfied with the facility (**M = 5.33**); they found the facility enhances their overall work performance (**M = 4.78**) and enhances their overall health (**M = 4.53**). In addition, similar results were reported when employees were asked these same questions about their primary workspaces (private office, shared office, laboratory, etc.). They reported overall satisfaction (**M = 4.98**) with their primary workspaces, and that their overall work performance (**M = 4.98**) and their overall health was enhanced (**M = 4.53**) by their primary workspace. However, as the range of scores was from 1-7, this is a low level of satisfaction, although still positive.

Most of the survey questions related to employees’ satisfaction with the IEQ categories in their primary workspaces (private office, laboratory, etc.). Employees were satisfied with 11 of the IEQ categories. The mean satisfaction scores ranged from **4.63** (View conditions) to **5.43** (Electric lighting conditions). Again, this shows a positive but moderate level of satisfaction. Four of the categories received neither dissatisfied nor satisfied scores from **4.00** (Privacy conditions) to **4.44** (Acoustic conditions). Lastly employees were dissatisfied with Personal adjustability, which received a dissatisfied score of **3.83**.

From the employees’ responses, an IEQ Scorecard was developed and shows respondents’ satisfaction with all categories and the contribution of each category to that satisfaction score. For WMBB, the IEQ Satisfaction Score was **4.91**, with satisfaction with Furnishings and Function of their workspaces as the two categories that influenced their satisfaction level most. This score reflects the moderate satisfaction level of the other categories. Finally, employees reported that WMBB enhances their physical activity, which is one of the sustainable design criteria that influences occupant behavior.

### 6.2 Recommendations

The satisfaction scores are certainly in the positive direction, however, improvement may be possible. For IEQ categories that have physical measurement possible, e.g., thermal, acoustic, and lighting, it is recommended that these measurements be taken in both overall workspaces and primary, individual workspaces. Recommendations follow:

#### Thermal Conditions

- Determine special thermal comfort requirements or problems that may be encountered in the building due to work activities or sitting or design considerations.
- Determine if any task areas differ now from original intent.
- Review conditions that affect thermal comfort using ASHRAE Standard 55-2004 or Human Factors Design Handbook.

- Measure performance variables on site.
- Log complaints related to thermal conditions.

#### **Lighting Conditions**

- Identify performance criteria that are to be met to achieve goals.
- Determine if any task areas differ now from original intent.
- Develop additional quality lighting criteria as needed for special facility issues such as employees' ages, duration of task, influence of daylight quality or quantity.
- Conduct onsite measurements using Illuminating Engineering Society standards for employees' tasks.
- Log complaints related to lighting conditions.

#### **Acoustic Conditions**

- Identify acoustic criteria for overall requirements.
- Determine if any task areas differ now from original intent.
- Develop any additional special acoustical performance requirements to support functional programming of building. (E.g. sources of recurrent noise that needs to be controlled, special user populations which may have distinct auditory performance limitations, multiple uses of building spaces which may have different acoustic criteria. Investigate and choose appropriate acoustics modeling software for the project.
- Measure acoustic performance onsite with full systems running.
- Log noise and other sonic environment complaints.

#### **Privacy Conditions**

- Identify employees' privacy concerns via focus groups or log complaints.
- Determine if any task areas or responsibilities differ from ordinal intent.
- Consider adding noise masking equipment and/or visual screening depending on nature of complaints.
- Compare acoustic privacy problem areas with acoustic measurements to pinpoint specific problem areas.

#### **Personal Adjustability**

- Determine if adjustability issues arise with temperature, lighting, or furnishings via focus group.
- Identify personal, individual problem areas and relate to other IEQ issues via log of complaints.
- Provide education to employees about adjustability of any applicable adjustment options, e.g., furnishings, air diffusers, lighting, temperature control, etc.

It seems obvious that employees' satisfaction can be improved by addressing the categories that had the 'dissatisfied' or 'neither dissatisfied nor satisfied' scores. The above recommendations can help address change in these categories. The areas employees were dissatisfied with (Thermal conditions, Privacy conditions, and Personal adjustability) can all be addressed by the above recommendations. Exploring these areas in more detail and making adjustments may increase overall satisfaction at the primary workspace.

This study investigated employees' satisfaction with the facility and primary workspaces. IEQ satisfaction is individual, but the results of the survey show a central tendency of moderate satisfaction to satisfaction with the facility and most of the IEQ categories. The results can be used as a diagnostic tool to aid in improving IEQ conditions for employees and to set the benchmarks from which improvement can be measured in the future.

## Appendix A. Open-Ended Responses

Employees had the opportunity to raise specific concerns on the overall facility and their primary workspace. Important information can be gleaned from the open-ended responses given in four categories that employees found to be dissatisfied (personal adjustability) or neither dissatisfied or satisfied (acoustic, thermal, and privacy).

### Personal Adjustability

- Wish I had office furniture that would allow me to stand at my computer.
- In the winter mornings, the low bright sun makes it impossible to read my computer screen. The shades are nearly impossible to adjust up and down easily because they are so far inset from the lab floor.
- I would like to see more flexibility in the ability to add alternative storage shelves into the lab.
- There is a light above me that turns on and off randomly (it does this during the day and during the night) with no external control switch. This is especially annoying at night when the extra light would be very helpful, but the light randomly turns on and off.

### Acoustic Conditions

- I like the isolation of the louder heavy equipment (such as freezers and biosafety hoods) in the separate work areas. This makes the overall noise level in the main lab space fairly manageable.

### Thermal Conditions

- It is cold in the lab spaces. Have to wear sweater year-round.
- My lab is very, very warm. Please figure out a way to keep our lab a little bit cooler. It's hard on the machines, and it's hard on me. The warmth is not conducive to quality work.
- Love the window. Dislike that I can't control office temperature (often too cold).
- 5th floor lab space is always freezing! Summer and winter!
- It is very cold in my work area throughout the year.
- Temperature controls within the building are very unregulated. It is frequently too warm/too cold.  
It makes for uncomfortable working. This building is referred to also as the "Ikea building" due to poor quality furniture/interior/exterior/windows and frequent malfunctions in comparison to other buildings on campus.
- Every summer AC is set up too cold and thus you have to wear extra close just to stay warm. Increasing the AC temperature would save a lot of money and allow for comfortable work environment. And this is an opinion of all members of my lab!

### Privacy Conditions

- Little sound-protection against voices/noise coming from the adjacent office (sound "leaks" near the wall adjacent to windows).

## Appendix B. Glossary

### **Descriptive statistics**

Statistics used to summarize large sets of data (i.e., means, frequencies, medians). Descriptive statistics describe only the sample under consideration and are not intended to infer results to the larger population.

### **Factor analysis**

A multivariate statistical procedure that is used to identify and group together general dimensions or factors that underlie a large number of variables in a set of data. The procedure transforms the variables into new principal components or orthogonal factors. Variables within each factor are related to each other but have no relationship to variables in other factors.

### **Frequency**

A descriptive statistic that provides information about how many of a particular response or measurement are observed.

### **Likert-type scale**

A measurement technique, employed in questionnaires and interviews, that utilizes a range of standardized response categories such as strongly agree, agree, etc.

### **Mean**

The average score of a set of data calculated by adding all scores together, then dividing by the number of scores.

### **N**

The number of subjects or participants responding to the questions in the study

### **Reliability**

The repeatability or replicability of findings; the same results are produced each time. Instruments and procedures should produce the same results when applied to similar people in similar situations, or on a second occasion.

### **Standard deviation**

A statistic used to measure the variability of a group of scores (how different scores are from each other and the mean). For example, if the range of scores is 1-7 and the mean (average) is 5.0 with a standard deviation of 1.0, then the scores are closely clustered around the mean, i.e., there is one unit of variation among all scores. If the mean was 5.0 and the SD was 3.0, there is a broader range of variation among the scores...a smaller SD means the scores are similar and the mean score is likely to be more accurate and more useful (this is better!).

### **Validity**

The extent to which an instrument or procedure measures what it is intended to measure (internal validity). The generalizability of results to another population (external validity).