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# Impacts of School Design to Ongoing Maintenance/Operations

LHB
Architecture Engineering Planning

Tuesday, October 31, 10:10 am – 11:00am
Room Africa 50

# Agenda

**Introductions**

**Why are We Here**

**Selecting A Design Standard**

**What is Value Engineering**

**Value Saving Considerations**

- **Building Reclassification**
- **Building Benchmarking**

**System Considerations**

- **Mechanical Systems**
- **Acoustics**
- **Lighting**

**Funding Options**

**Questions and Answers**

***We Don't Know What We Don't Know***

*Donald Rumsfeld*

*February 12, 2002*

# Why Improve Our Buildings?

**Reduce Building Maintenance Costs**

**Reduce Operating Costs/Energy Efficiencies**

**Modernize/Replace Obsolete Systems**

**Remove Hazardous Conditions/Materials**

**Address Complaints** (Staff and Visitors)

**Opportunities Provided by Added Funding**

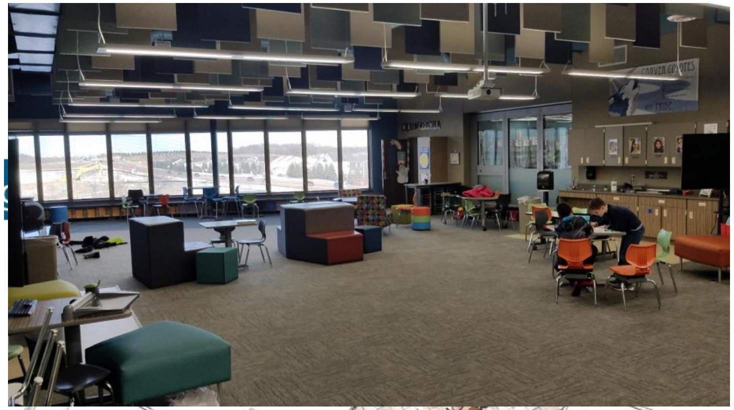
**IMPROVE/EXPAND WORKING ENVIROMENTS**

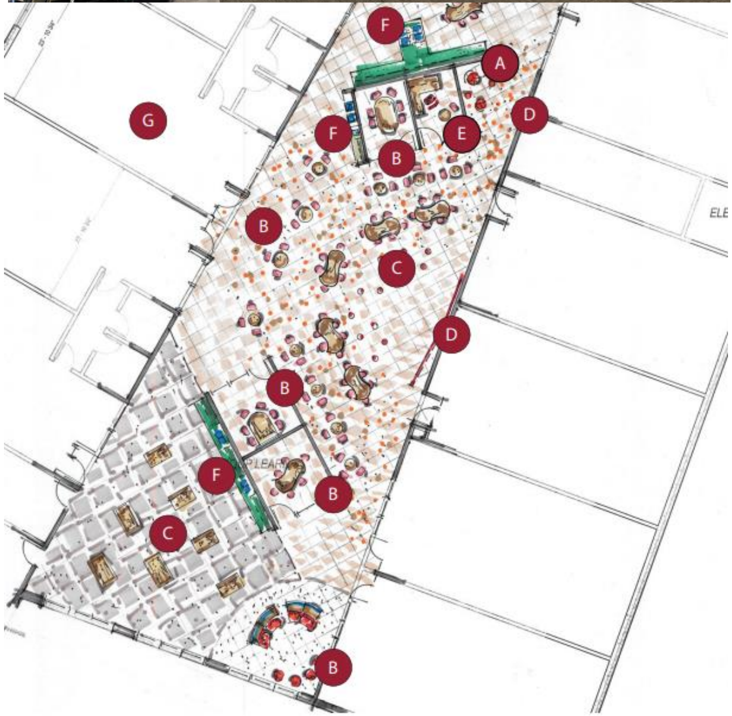
**So related to any of these projects,**
**What does VALUE ENGINEERING mean to you?**

**ARE YOU STARTING WITH PROJECT GOALS** ARE THEY PART OF YOUR CONTRACTS/AGREEMENTS

# Opportunities for Growth and Understand

- Keep the focus on students and their daily activities rather than “a Program/Room”
- Be aware of the challenges of our diverse society and the impacts on a school
- Visit other buildings which reflect your vision and goals
- Be open to new ideas and opportunities to evolve what is teaching and learning
- Use association groups, peers, and researchers as opportunities to grow your understanding of the opportunities





# Your Tools to Guide Decision Making

INTERNATIONAL WELL BUILDING INSTITUTE

**AIR**
- Quality
- Purification
- Humidity

**WATER**
- Quality
- Treatment
- Drinking Promotion

**LIGHT**
- Natural Access
- Color
- Dimming/Circadian Rhythms

**NOURISHMENT**
- Selection/Availability
- Serving Size
- Information

**FITNESS**
- Fitness Centers
- Stairs
- Bike Room
- Incentives Programs

**COMFORT**
- Ergonomics
- Sound Reduction
- Olfactory Comfort

**MIND**
- Collaboration
- Quiet Rooms
- On-site Child Care
- Health & Wellness Library

OPERATIONAL EFFECTIVENESS | PAGE 19

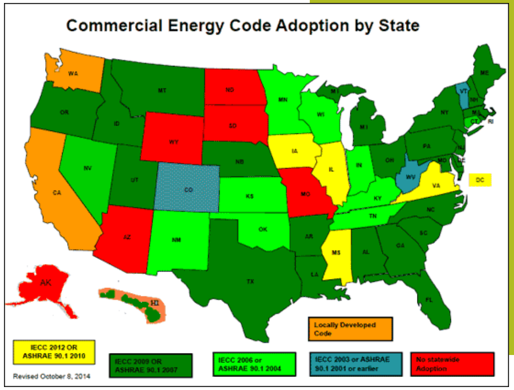
**THERE ARE MANY TOOLS AND OPTIONS** FIND ONE WHICH REFLECTS YOUR PROJECT EXPECTATIONS

# Changes to Building Codes

*Which code you apply will allow for different design strategies and project processes. There is no longer a one size fits all application for the buildings.*

**Building and Energy Code Changes** **(ASHRAE 90.1 vs IECC 2012)**

- Renovations/Additions to Existing Buildings
- Exemptions to Historic Structures
- Insulation Requirements
- Air Barrier, Water Barrier and Vapor Barrier
- Lighting and Plug Load Controls
- Building and Systems Commissioning
- R-Values, u-Values, Reflectivity, Shading Co-Efficient
- NRFC Ratings for Windows and Doors
- Limits to the Window Wall Ratios
- Mandates for Energy Recovery
- Re-Roofing Projects
- Vestibules Locations
- Lighting Control and Lighting Reduction


**AND THE SOCIAL CHALLENGES AND IMPACTS** GENDER EQUITY I ADA I SAFE SECURE I STORMWATER I ROOF LOADS

# What is Value Management

## Seemed Like a Good Idea

- Mechanical Retrofit and Reroofing Project
- Increases in wind and snow loading
- Point loads from the roof top units
- Roof draining off the north and east sides of building
- Walls are deteriorating due to water freezing and thawing
- Added railings puncture membranes

## Implementation of the International Building Code

- Redesigning of the roof structure
- Wall repairs and flooring repairs
- Repair the tunnels and grade around the building
- Replace the mechanical system
- Operations and maintenance impacts (comfort/utilities)

## Opportunity Costs Lost Due to Replacement Values

- Loss of quality interior and exterior finishes
- Environmental considerations: windows, lighting, IDAQ
- Repair of the existing structures and site

**CHANGING CODES AND REGULATIONS IMPACTS COSTS** OFTEN ARE NOT FULLY ADDRESSED PROJECT BY PROJECT

## How Many Decision Are Made Every Day with a Small Bit of Information?

## And How Many Decisions are Made Because That Is What We Always Do?

**If I had asked people what they wanted, they would have said faster horse**

*Henry Ford*

# Building and System Assessments

## Building Reclassification

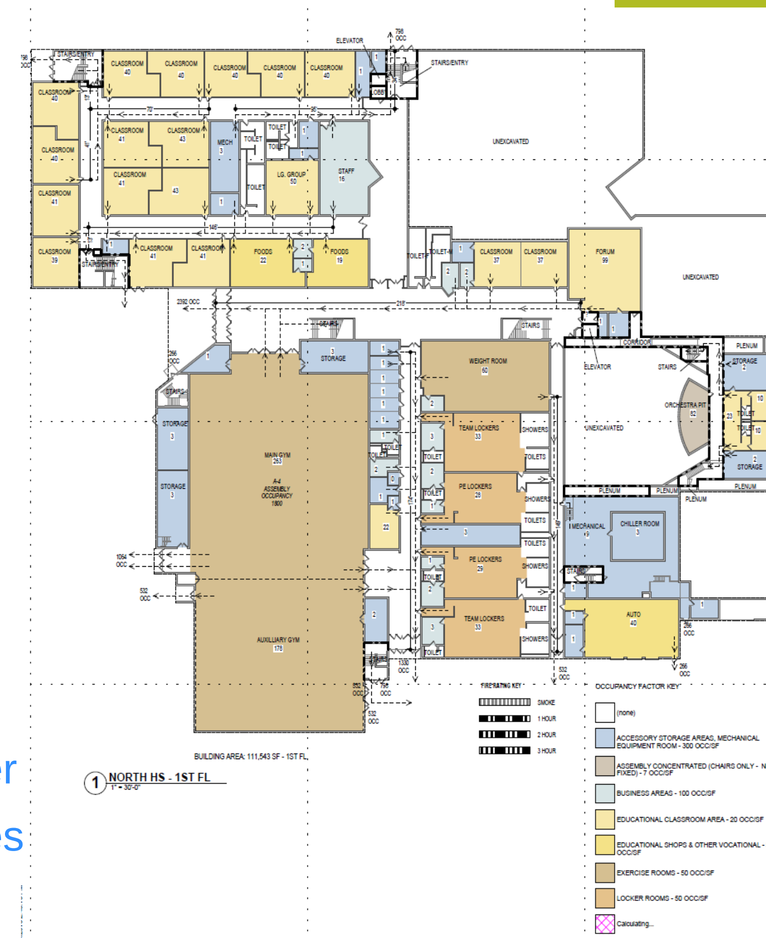
- May be able to eliminate rated walls
- Identifies future design strategies
- Impacts to ventilation rates

## Retro-Commissioning

- Functional testing and verification
- Depreciation and system age
- Controls and monitoring

## Construction Types

- Heat Sink Structures: 1990 and Older
- Insulated Structures:  1990 and Newer
- System Impacts and Design Strategies




**NOT UNDERSTANDING THE ENTIRE “BUILDING”** CAN DRAMATICALLY IMPACT ALL COSTS OF OPERATIONS AND MAINTENANCE

# Building Reclassification Benefits/Savings

## Doors and Hardware Modifications

- Fewer Doors with Fire/Smoke Gasketing
- Fewer Rated Doors, Frames and Hardware

## Mechanical and Life Safety Systems Modifications

- Elimination of Fire/Smoke Dampers
  Improved IDAQ, Efficiency, Maintenance, Operations
- Simplified Building Automation Systems
- Reduced Scope for Detection Systems

## Other Operational and Maintenance Savings

- Reduced Rated Penetrations Due to Fewer Rated Walls
- Fewer Inspections and Service Calls

**NOT UNDERSTANDING THE ENTIRE "BUILDING"** WILL DRAMATICALLY IMPACT ALL COSTS

# ISD 622 Savings Due to Building Reclassification

**Across the district the number of fire walls dropped from 23 to 7**

## Cost to the District

- Based on Building Size, Age and Complexity: $8,500 average
- 5 Buildings x $8,500 = $42,500 total costs

## Construction Savings

- Currently over $75,000 on just Five Buildings and Growing

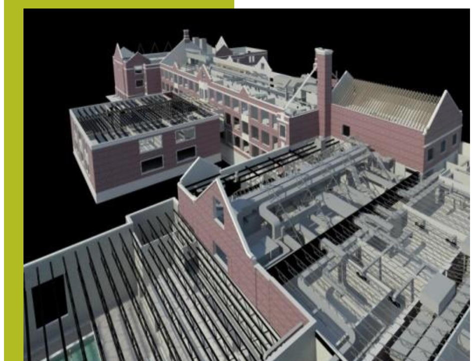
## Other Operational and Maintenance Savings

- Three Elementary Schools: $5,000 per year savings
- One Middle School: $8,250 per year savings
- One High School: $22,500 per year savings

**Total One Year Savings** (construction and operations): **$120,750**

**CONSTRUCTION COSTS ARE COMPONENT REPLACEMENT** OPERATIONS COSTS INCLUDE MAINTENANCE AND EFFICIENCIES

# Clients Use Multiple Strategies to Achieve Energy Reductions But Is There More?



- Requirements to include strategies to reduce consumption in a COMPREHENSIVE FACILITIES PLAN(S).
- Complete RETROCOMMISSIONING or RECOMMISSIONING to help with staff training and identifying potential building and system improvements/replacement.
- Make energy savings potential a factor in considering CAPITAL PROJECTS or changes in space function.
- Building project REPAIR AND REPLACEMENT is prioritized based on guaranteed energy savings and funds available, thereby freeing up money for other potential projects.
- Energy consumption was made a factor in more aggressively pursuing building/system RIGHTSIZING.
- Compile USER GROUP DATA. Use their comments to guide your goals and let them know how they impacted the process

# Three Areas of Energy Management

## Energy-efficient operations

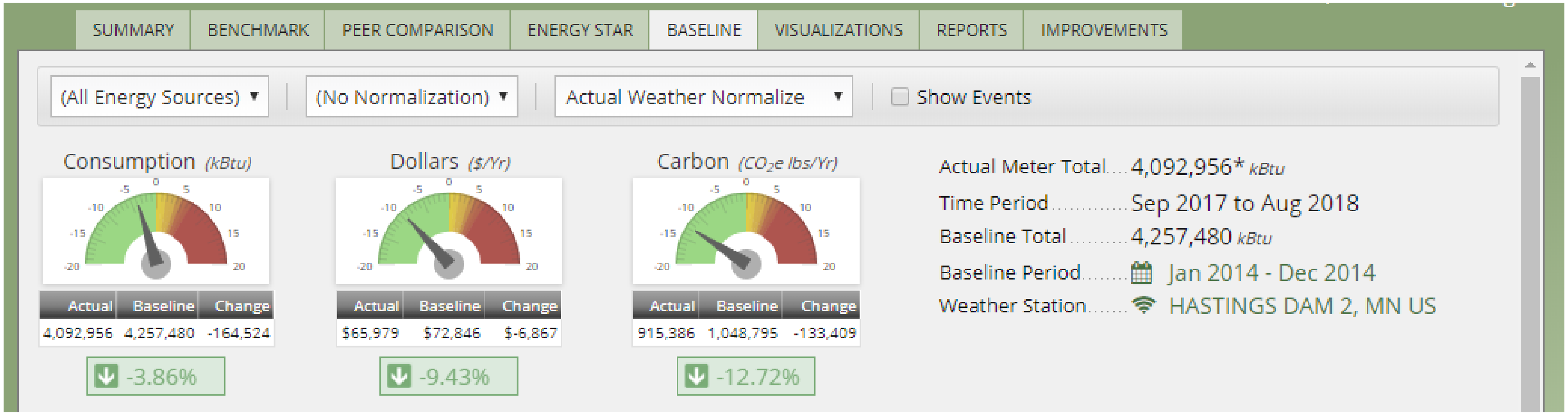
**Savings Potential: 7% to 17%**

## Building and systems improvements

**Savings Potential: 5% to 20%**

## Beyond the meter: understanding the rate structure

**Savings Potential: 1% to 3%**



# B3 Benchmarking: Consumption vs Dollars

## EUI: kBTU/sf/yr

| # | Name | EUI (kBTU/SF/yr) | Completed Sq Ft | Total Sq Ft |
|---|---|---|---|---|
| 136 | Mankato | 76.63 | 1,538,416 | 1,538,416 |
| 86 | Wayzata Public Schools | 63.80 | 992,240 | 1,613,919 |
| - | Hopkins | 0.00 | 81,526 | 1,621,933 |
| 132 | Edina Public Schools | 75.97 | 1,666,994 | 1,666,994 |
| 129 | Minnetonka | 75.26 | 1,689,112 | 1,689,112 |
| 107 | North St. Paul, Maplewood, Oakdale | 68.96 | 1,743,485 | 1,743,485 |
| 87 | White Bear Lake | 63.84 | 1,775,767 | 1,775,767 |
| 189 | Mounds View | 135.72 | 1,833,999 | 1,833,999 |
| 68 | Eden Prairie | 60.53 | 1,883,279 | 1,883,279 |
| 75 | Burnsville-Eagan-Savage | 61.84 | 1,900,504 | 1,900,504 |
| 109 | Eastern Carver County Schools | 69.69 | 1,912,060 | 1,912,060 |
| 77 | Lakeville | 62.23 | 1,918,474 | 1,918,474 |
| 122 | St. Cloud | 74.35 | 1,947,142 | 1,947,142 |

Ranking Among Districts of similar size (1.5 – 1.9 million sf)

1. Eden Prairie – 60.53 (68 /197)
2. Burnsville-Eagan-Savage – 61.84 (75/197)
3. Lakeville – 62.23 (77/197)
4. Wayzata Public Schools – 63.80 (86/197)
5. White Bear Lake – 63.84 (87 /197)
6. **North St. Paul, Maplewood, Oakdale – 68.96 (107/197)**
7. Easter Carver County Schools – 69.69 (109 /197)
8. St. Cloud – 74.33 (122 /197)
9. Minnetonka – 75.26 (130 /197)
10. Edina Public Schools – 75.97 (132 /197)
11. Mankato – 76.63 (174 /197)
12. Mounds View – 135.72 (189/197)

Target: 62.25
Data From 04/26/16

## Dollars: $/sf/yr

| # | Name | Dollars ($/SF/yr) | Completed Sq Ft | Total Sq Ft |
|---|---|---|---|---|
| 81 | Mankato | $0.90 | 1,538,416 | 1,538,416 |
| 130 | Wayzata Public Schools | $1.02 | 992,240 | 1,613,919 |
| - | Hopkins | | 81,526 | 1,621,933 |
| 125 | Edina Public Schools | $0.99 | 1,666,994 | 1,666,994 |
| 98 | Minnetonka | $0.94 | 1,689,112 | 1,689,112 |
| 143 | North St. Paul, Maplewood, Oakdale | $1.08 | 1,743,485 | 1,743,485 |
| 64 | White Bear Lake | $0.85 | 1,775,767 | 1,775,767 |
| 190 | Mounds View | $1.76 | 1,833,999 | 1,833,999 |
| 69 | Eden Prairie | $0.86 | 1,883,279 | 1,883,279 |
| 59 | Burnsville-Eagan-Savage | $0.83 | 1,900,504 | 1,900,504 |
| 174 | Eastern Carver County Schools | $1.28 | 1,912,060 | 1,912,060 |
| 87 | Lakeville | $0.91 | 1,918,474 | 1,918,474 |
| 132 | St. Cloud | $1.02 | 1,947,142 | 1,947,142 |

Ranking Among Districts of similar size (1.5 – 1.9 million sf)

1. Burnsville-Eagan-Savage – $0.83
2. White Bear Lake – $0.85
3. Eden Prairie – $0.86
4. Mankato – $0.90
5. Lakeville – $0.91
6. Minnetonka – $0.94
7. Edina Public Schools – $0.99
8. St. Cloud – $1.02
9. Wayzata Public Schools – $1.02
10. **North St. Paul, Maplewood, Oakdale – $1.08**
11. Easter Carver County Schools – $1.28
12. Mounds View – $1.76

Target: $0.78
Data From 04/26/16

# ISD 622 District Wide Energy Performance

| | |
|---|---|
| The average annual energy costs per square foot for IDS 622:<br>*Note: costs for the last 12 month period.* | $1.08 |
| The average annual energy costs per square foot for 15 districts: | $0.96 |
| The average annual EUI per square foot for NSP-M-O:<br>*Note: costs for the last 12 month period.* | 68.96 kBTU |
| The average annual EUI per square foot for 15 districts: | 68.41 kBTU |
| The difference between the energy costs average and ISD NSP-M-O: | $0.12 |

There are 1,743,485 square feet in the district so the potential operational savings to “average”

**$0.12 x 1,743,485 sf = $209,218 dollars annually.**

Some of the best performers include across the state:

Albert Lea ($0.67), Duluth ($0.75), Burnsville ($0.79),
Bloomington ($0.84), Eden Prairie ($0.82), Minnetonka ($0.87)

*Note: Building age has very little to do with the potential performance.*

*Data From 04/26/16*

*One Third of the utilities are provided by a small cooperative which charges more per kW*

*Due to the Extensive number of projects undertaken over the last 18 months, number have not been updated*

# Managing the Costs and Consumption

**Xcel Energy®**

| MAILING ADDRESS | ACCOUNT NUMBER | |
|---|---|---|
| ISD 277 SCHOOL DISTRICT<br>ATTN: BUSINESS SERVICES<br>5901 SUNNYFIELD RD E<br>MOUND MN 55364-8250 | 51-6795009-8 | |
| | STATEMENT NUMBER | STATEMENT DATE |
| | 530672653 | 01/10/2017 |

**METER READING INFORMATION**
**METER 17956112 - Multiplier x 300** Read Dates: 11/22/16 - 12/27/16 (35 Days)

| DESCRIPTION | CURRENT READING | PREVIOUS READING | MEASURED USAGE | BILLED USAGE |
|---|---|---|---|---|
| Firm Demand | Actual | | | 250 kW |
| Interrupt Demand | Actual | | | 157 kW |
| Demand | Actual | | | 407 kW |
| Billable Demand | | | | 407 kW |
| **Power Factor Demand** | 91.66% | | | |

**ELECTRICITY CHARGES** **RATE: Peak Controlled Service**

| DESCRIPTION | USAGE UNITS | RATE | CHARGE |
|---|---|---|---|
| Basic Service Chg | | | $55.00 |
| Energy Charge | 160617 kWh | $0.032010 | $5,141.35 |
| Fuel Cost Charge | 160617 kWh | $0.024360 | $3,912.59 |
| Firm Demand Winter | 250 kW | $9.960000 | $2,490.00 |
| Controllable Demnd | 157 kW | $8.210000 | $1,288.97 |
| Affordability Chrg | | | $2.79 |
| Resource Adjustment | | | $861.20 |
| Interim Rate Adj | | | $695.59 |
| **Total** | | | **$14,447.49** |

Predetermined Demand Level 250

| **Premises Total** | **$5,007.10** |
|---|---|

#9440.

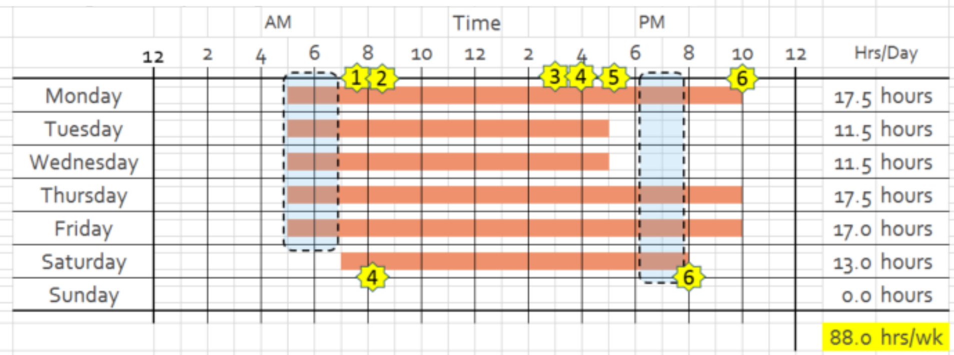
| DAILY AVERAGES | Last Year | This Year |
|---|---|---|
| Temperature | 32° F | 24° F |
| Electricity kWh | 4321.0 | 13492.6 |
| Electricity Cost | $1,589.53 | $1,327.52 |

**Xcel Energy Invoice**
Strategic Goal Review

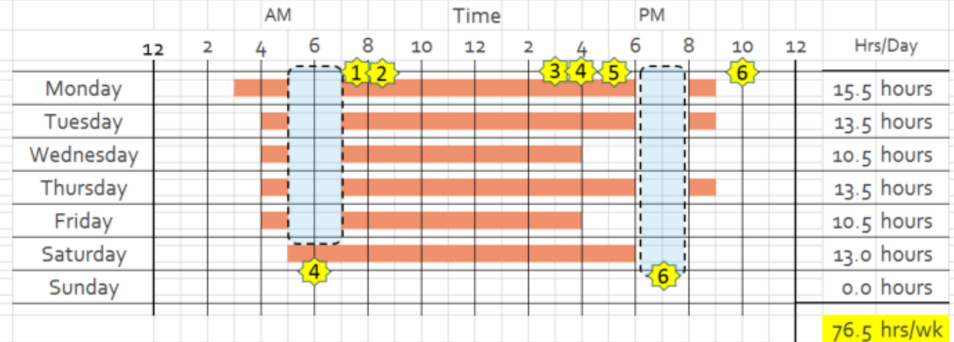
*Highlights of January 2017 Invoice:*

| Page | Building | Program | Demand Level | Last Year Daily Average | This Year Daily Average | Savings |
|---|---|---|---|---|---|---|
| 3 | Hilltop Elementary | Peak Controlled | 50 | 228.29 | 129.45 | 98.84 |
| 4 | Mound Westonka HS* | Peak Controlled | 250 | 1,589.53 | 1,327.52 | 262.01 |
| 11 | Grandview MS | Peak Controlled | 50 | 316.61 | 149.42 | 167.19 |
| 19 | Shirley Hill Elementary | Peak Controlled | 50 | 188.89 | 94.08 | 94.81 |

*Credit applied to MWHS invoice in the amount of $9,440.39.




**Proposed AHU2 Operating Schedule**




Symbol Key

- Peak Demand Charges
- AHU Operating
- 1 Staff and Students Arrive
- 2 Classes Begin
- 3 Classes End
- 4 Activities Begin
- 5 Classroom Staff Depart
- 6 Activities End

Considerations

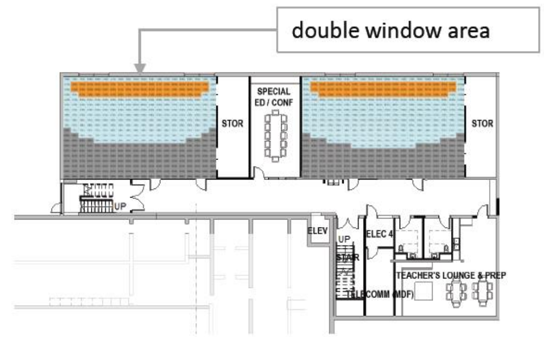
A. How long can we suspend system operation and maintain occupant comfort during occupied hours
B. Can schedules be adjusted to avoid peak demand charges (PDC)
C. Can avoiding PDC also reduce the hours of operation
D. Can temperatures be reduced during Activities (athletics) and still maintain occupant comfort
E. Is it cost effective to continue night set-back schedules
F. Are the AHUs zoned to reflect operational needs and schedules
G. Understand the costs ($) vs. consumption (kbtu) values

# Daylighting Analysis and Design Options


Level 1 – Current Design


Level 1 – Design Alternative


Basement – Current Design




Basement – Design Alternative

High contrast ratio may cause glare issues

Meets targeted daylight levels

Does not meet targeted daylight levels

May 15, 2018

# Lighting Systems

**LED Lighting** *(Light Emitting Diode)*

The technology first because utilized in 1968 and the first large scale lighting application in 2003.

**Advantages**

- Operations: Installation, Pay-Back, Warranty, Security
- Efficiency: Size, Dimming, Focus, Maintenance
- 3.5 times Bulb/System Life: *42,500 hours vs 12,500 hours*
  - *LED vs Incandescent: 85% Reduction in Carbon*
  - *LED vs Fluorescent: 34% Reduction in Energy*
- Occupant Comfort: Color of Light, Flicker, Ballast Buzz
  - *Occupant Headaches and Impacts to Special Needs Students*
- Daylight Harvesting: Every Fixture can be Addressable
  - *Teaching Tools and Community Communication Tool*


**Disadvantages**

- Operations: Heat

# Getting The Full Benefit Of A System

**An LED Lighting Replacement Project**

**Project Budget**

- Construction
- Operations and Maintenance
- Benefit of Use

**Control Light Intensity (Dimming)**

- The Biggest Cause of Headaches
- Challenge for Students with Disabilities

We don’t know what we don’t know

**Color and Tuneability**

**Day Light Harvesting**

# Mechanical Systems Performance

Mechanical Systems are the most critical component regarding occupant comfort. Systems should consider:

- **System Types**
  - Unit Ventilators
  - Central VAV/Constant Volume
  - Displacement and Radiant
- **Consistent and Constant Temperature**
  - Space Heights and Floor Area
  - Heating vs Cooling
- **Limited Drafts and Uncomfortably Cold Surfaces**
  - Radiant Heat vs Forced Air
  - Heat Sinks vs Insulated Structures
- **Reduce Air and System Noises**
  - Background Noises Impact Learning (33db background)
- **Indoor Air Quality**
  - Stale Air vs Sick Air (human illnesses)
  - Molds and Other Unwanted Growths
  - Cleaning Practices are a Big Challenge

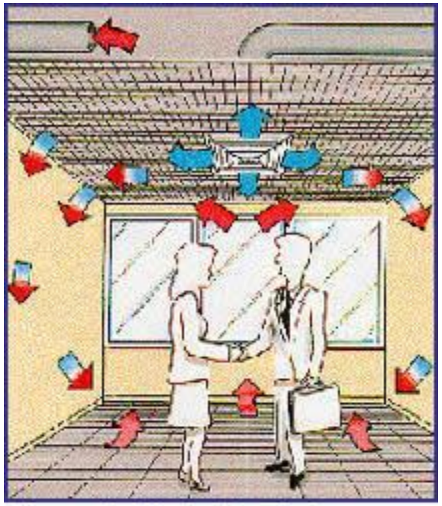


Figure 1 - Mixing Ventilation

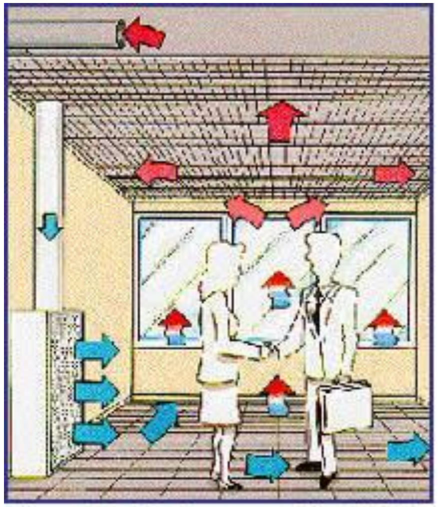
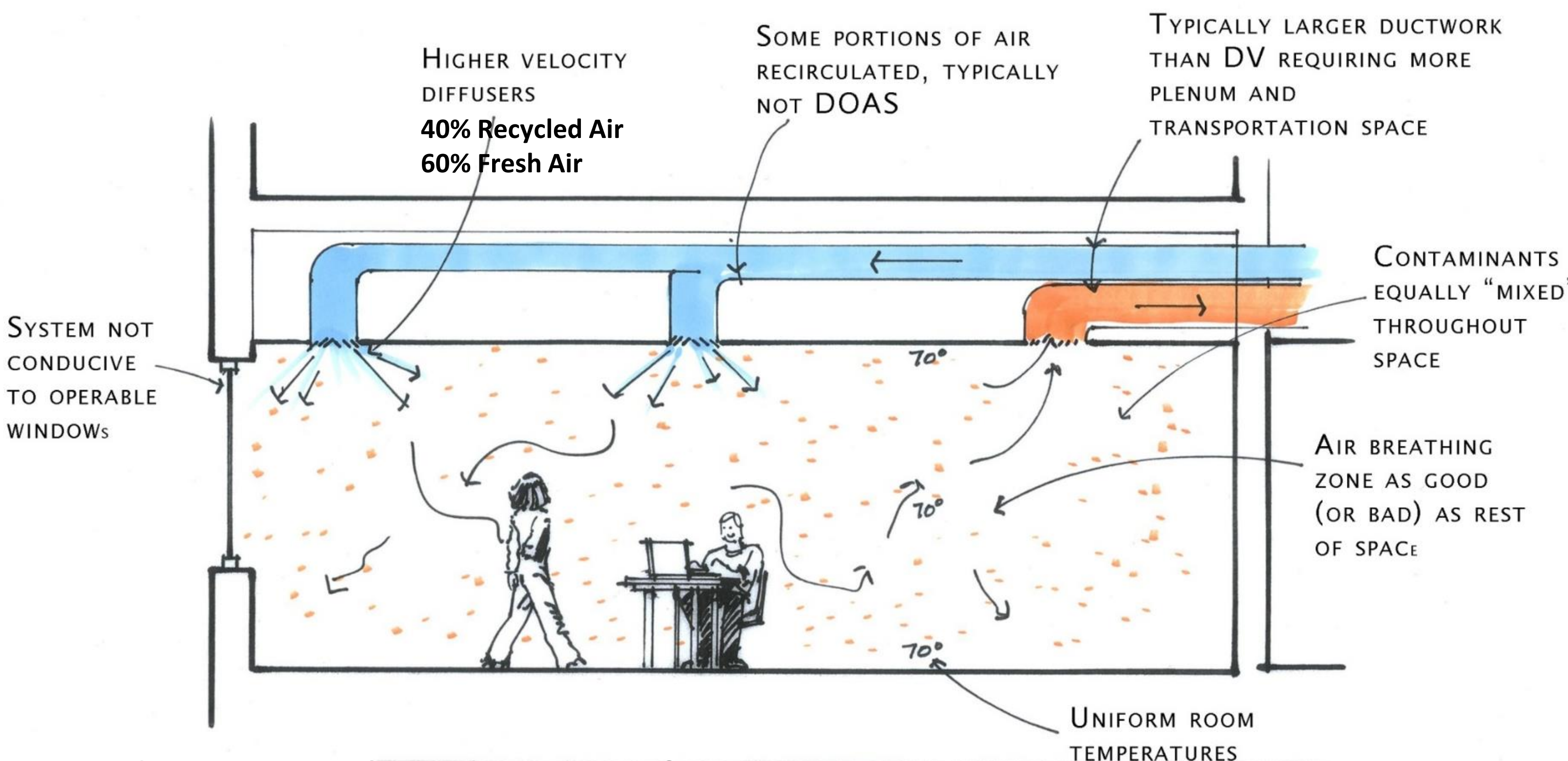


Figure 2 - Displacement Ventilation

http://www.iklimnet.com

# **Mechanical System:** Traditional Mixed Air System

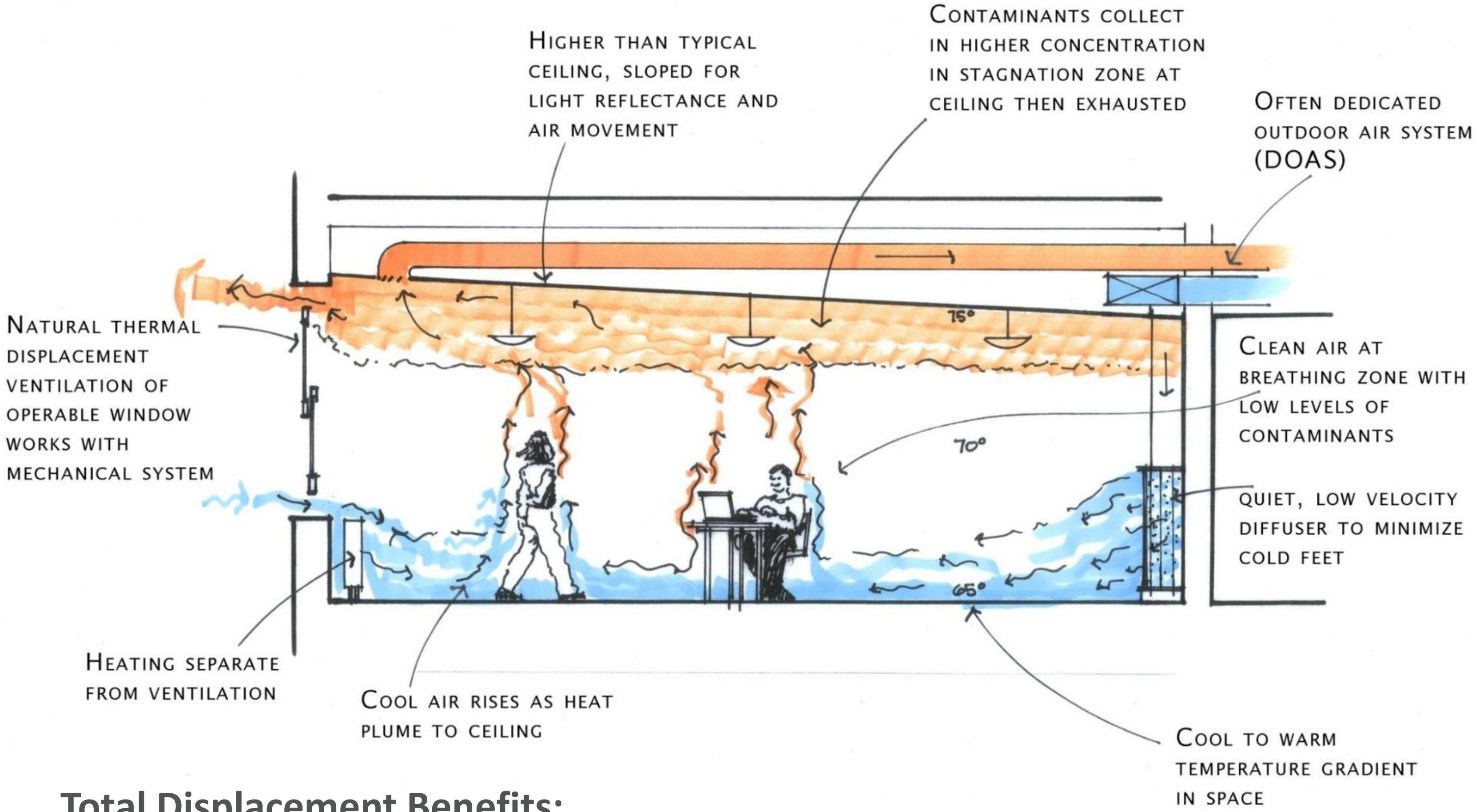



## Background Noise Levels and Mixing of Air:

The typical VAV system generates an average of 40 dB of background noise due primarily from fans pushing air from the ceiling to the floor. The Displacement and Conditioned Air Systems are generating and average of 30db (less than half) the background noise levels.

Mixed Air Systems will mix 30% to 55% of the return room air (recycled existing room air). Other systems can incorporate 100% outside air without mixing airborne germs/particulates.

# Mechanical System: Total Displacement Ventilation




## Total Displacement Benefits:

A hybrid displacement system is part of our healthy buildings research efforts. The system incorporates 100% outside air. This system has proven to reduce the number of sick days, improved learning/test scores, and improve overall occupant comfort.

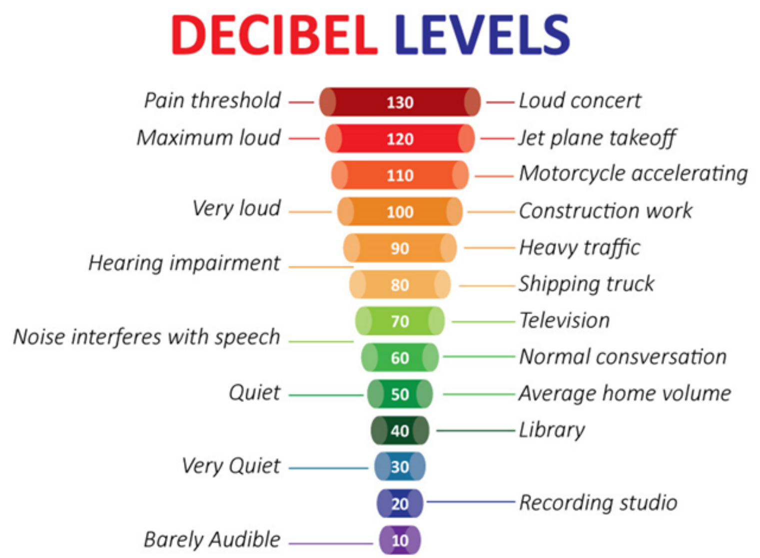
# Background Noise Levels

With the rise in studies regarding teaching and learning, one of the greatest challenges is the level in Background NOISE. Areas of greatest impact include:

- **Student Challenges**
  - Special Needs Students
  - English as Second Language
- **Hearing Development**
- **Teacher Variables**
  - Soft Spoken Individuals
  - Suffering from Illness
- **We Combat Noise with…..**

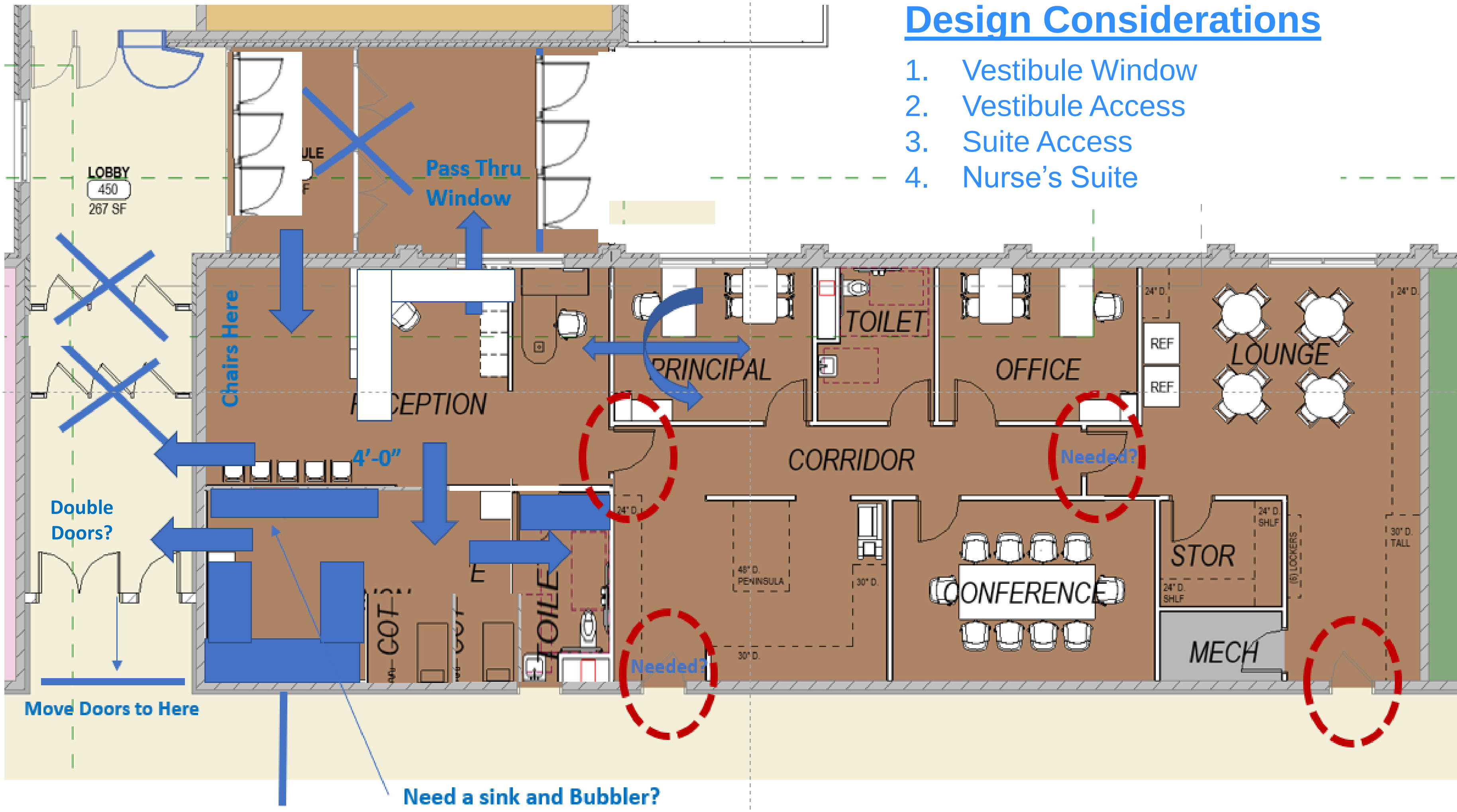
## MORE NOISE!!

For these reasons and others, many states (including Minnesota) are requiring background noise levels in learning spaces to be 35 dB or less.




http://tamco.com

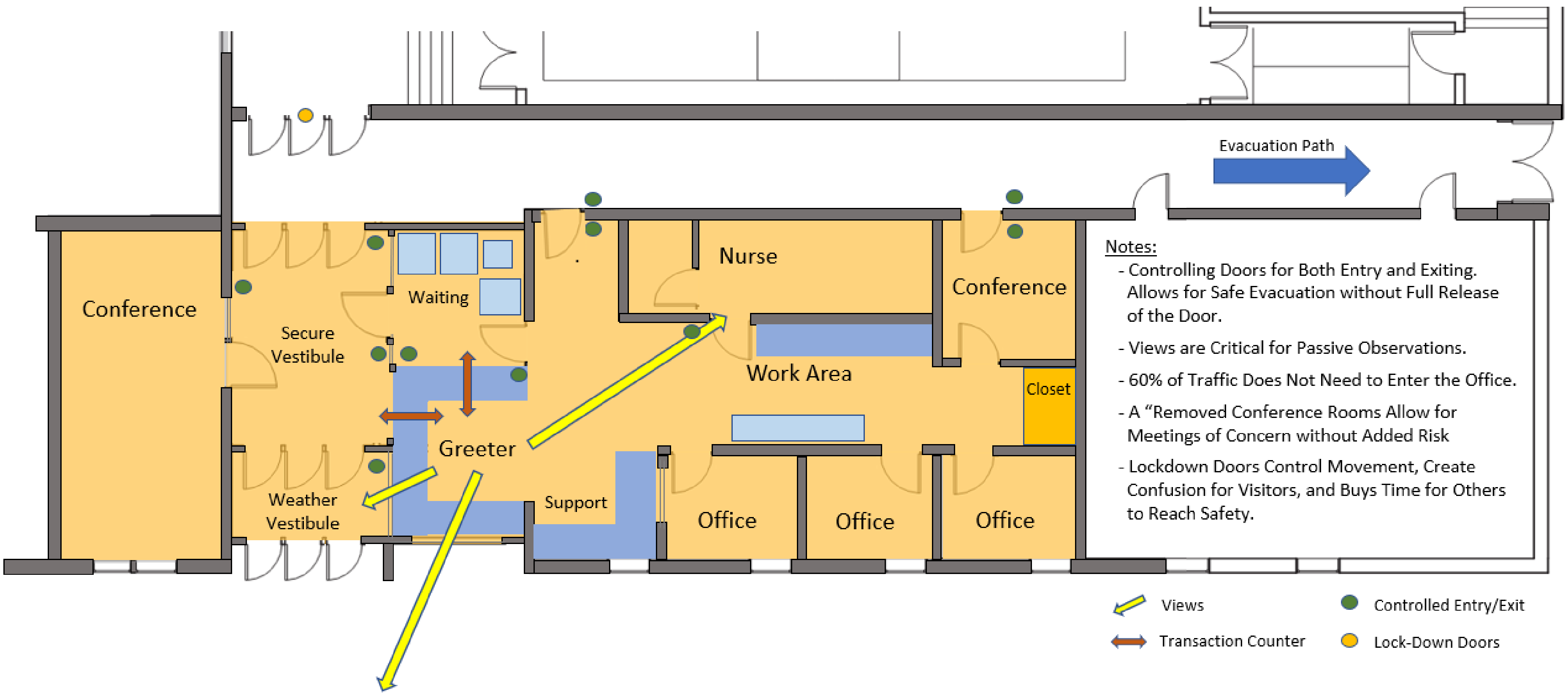
# Safe and Secure Strategies



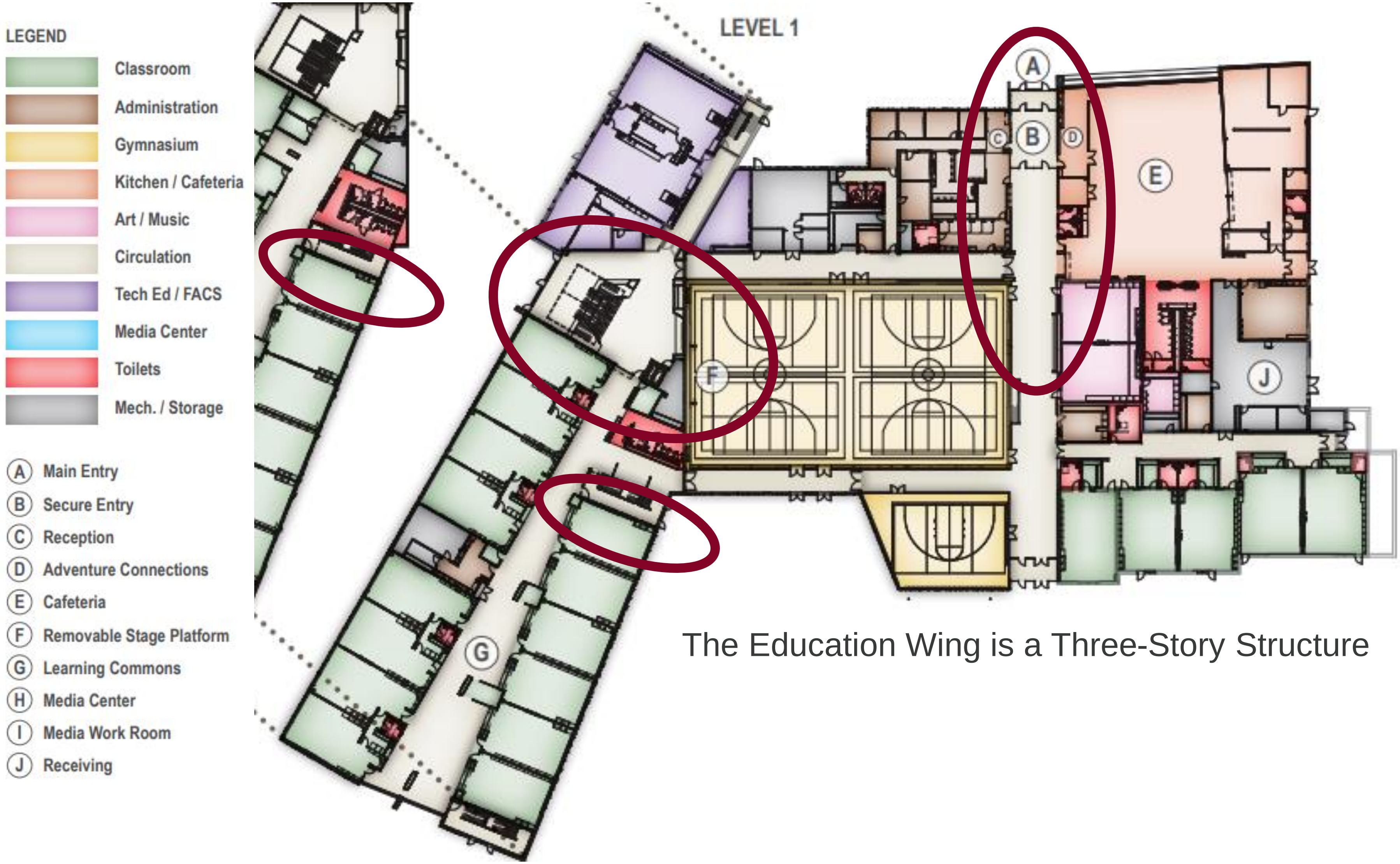

## Design Considerations

1. Vestibule Window
2. Vestibule Access
3. Suite Access
4. Nurse's Suite

# Safe and Secure
# Front Entry Design Discussions



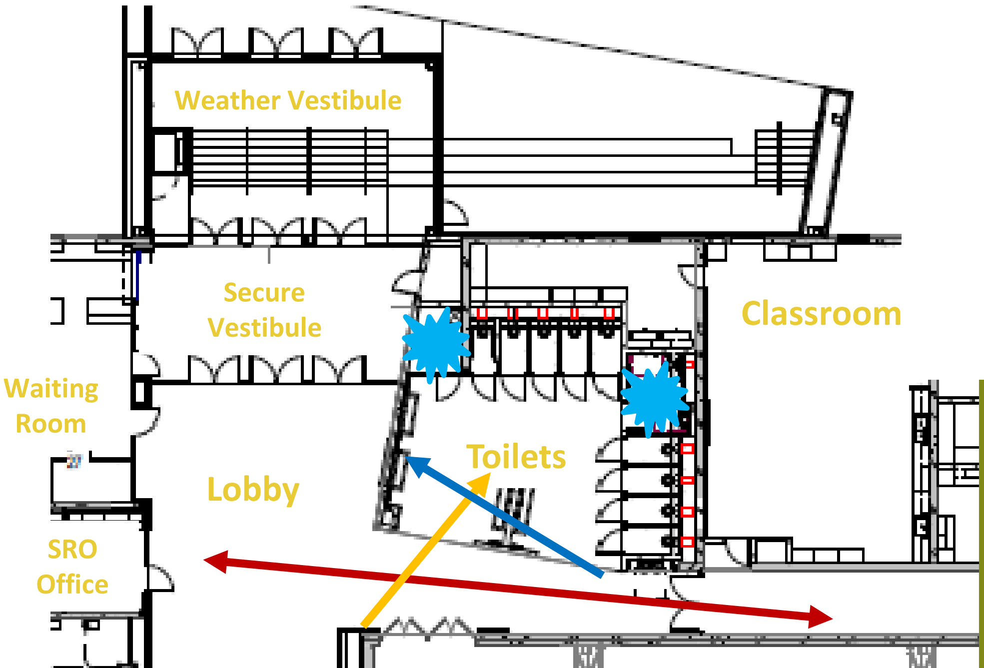
# Carver Elementary School: Building Design

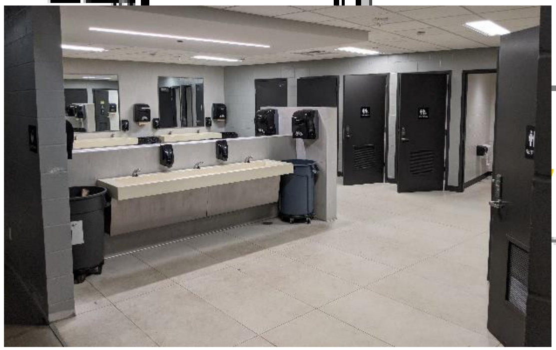


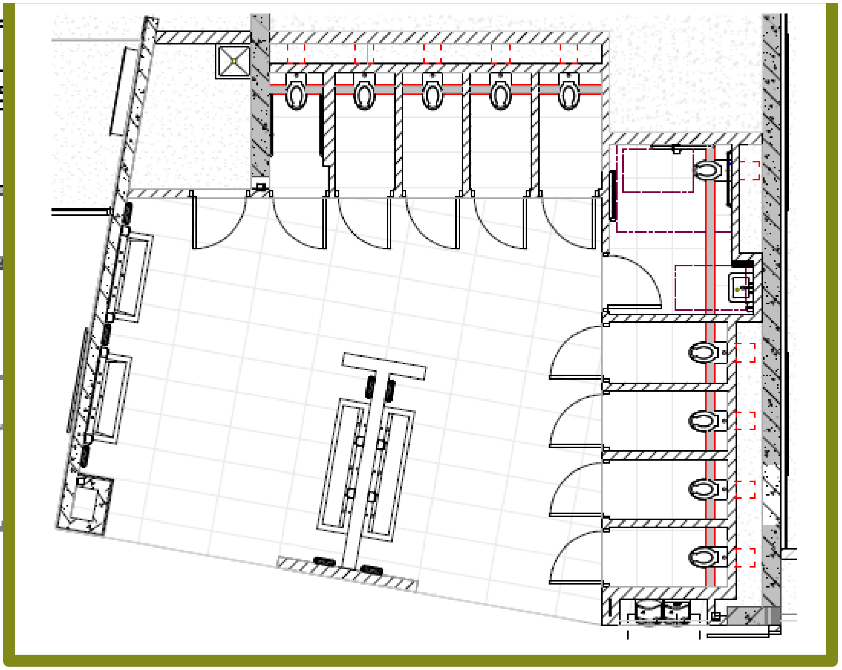

The Education Wing is a Three-Story Structure

# Safe and Secure: Restroom Design

- Staff Toilets, Janitor Closets, Special Spaces
- Camera Locations
- Location of Mirrors/Observation
- Near the Path of Travel/Classroom/Office
- Door Hardware/Security and Wall Heights
- **System Considerations:** Ventilation/Plumbing





# Questions and Answers

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