GBRMC

Laboratory Building Systems

Student Guide

2013

GLOBAL BIORISK MANAGEMENT CURRICULUM

Note to printer

The majority of this document is intended for printing double sided on 8 ½” x 11” or A4 paper however there are drawings at the end which should be printed at 11”x 17” single sided.

Also note that the 11”x17” portion includes both vertical and horizontal layouts.


Laboratory Building Systems
GLOBAL BIORISK MANAGEMENT
CURRICULUM
GBRMC


GBRMC
Introductions
• Instructors
• Students
– Your name?
– Where are you from?
Slide 2

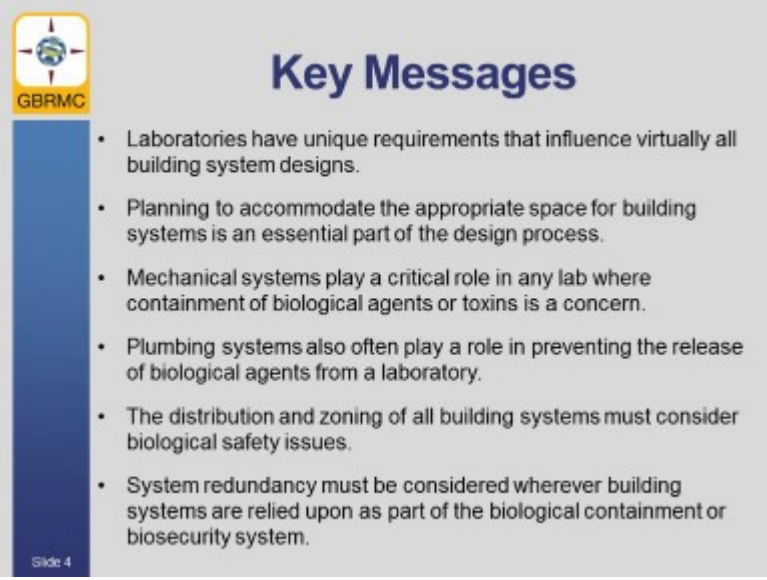
Action Plan

By the end of this lesson, I would like to:					
KNOW		FEEL		BE ABLE TO DO	

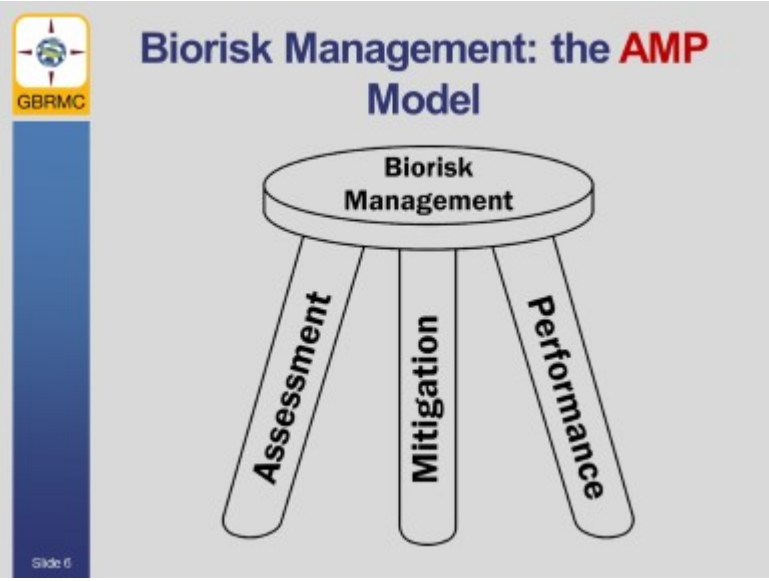
Your learning doesn't stop with this lesson. Use this space to think about what else you need to do or learn to put the information from this lesson into practice.

What more do I need to know or do?	How will I acquire the knowledge or skills?	How will I know that I've succeeded?	How will I use this new learning in my job?

3


GBRMC
Key Messages
• Laboratories have unique requirements that influence virtually all building system designs.
• Planning to accommodate the appropriate space for building systems is an essential part of the design process.
• Mechanical systems play a critical role in any lab where containment of biological agents or toxins is a concern.
• Plumbing systems also often play a role in preventing the release of biological agents from a laboratory.
• The distribution and zoning of all building systems must consider biological safety issues.
• System redundancy must be considered wherever building systems are relied upon as part of the biological containment or biosecurity system.
Slide 4

Notes:


GBRMC
Biorisk Management: the AMP Model
Biorisk Management
Assessment
Mitigation
Performance
Slide 6

Notes:

GBRMC

Key Components of Biorisk Management

- Biorisk **Assessment**
  - Process of identifying the hazards and evaluating the risks associated with biological agents and toxins, taking into account the adequacy of any existing controls, and deciding whether or not the risks are acceptable

Slide 6

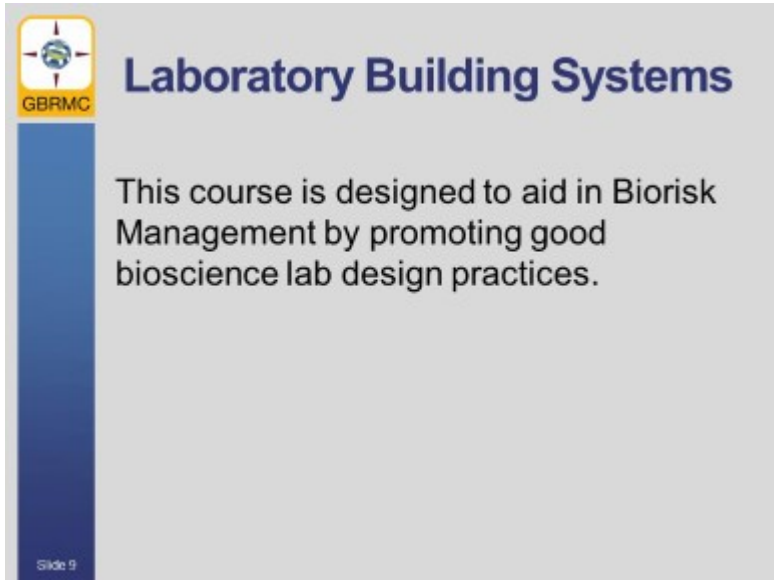
GBRMC

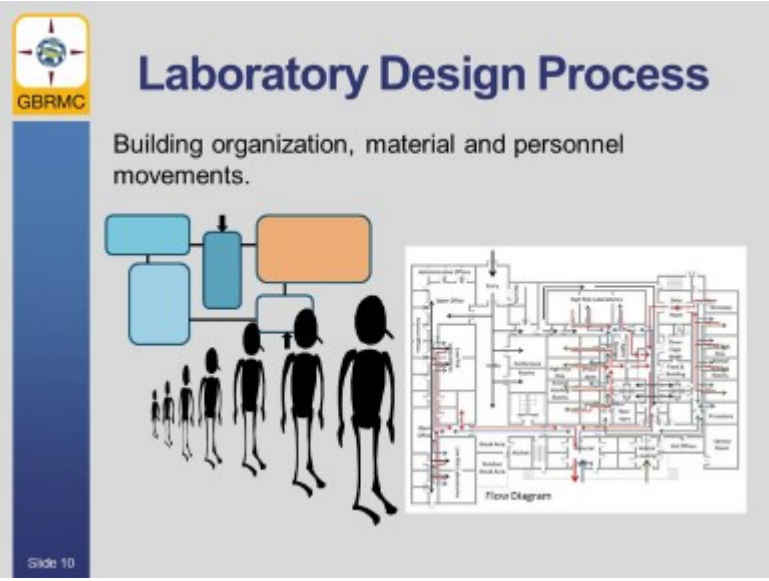
Key Components of Biorisk Management

- Biorisk **Mitigation**
  - Actions and control measures that are put into place to reduce or eliminate the risks associated with biological agents and toxins

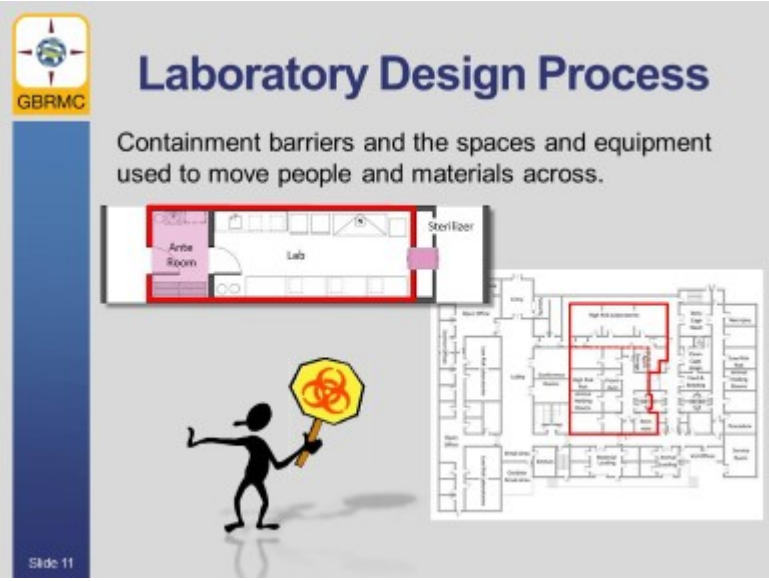
Slide 7


GBRMC
Key Components of Biorisk Management
• Biorisk **Performance**
– Improving biorisk management by recording, measuring, and evaluating organizational actions and outcomes to reduce biorisk.

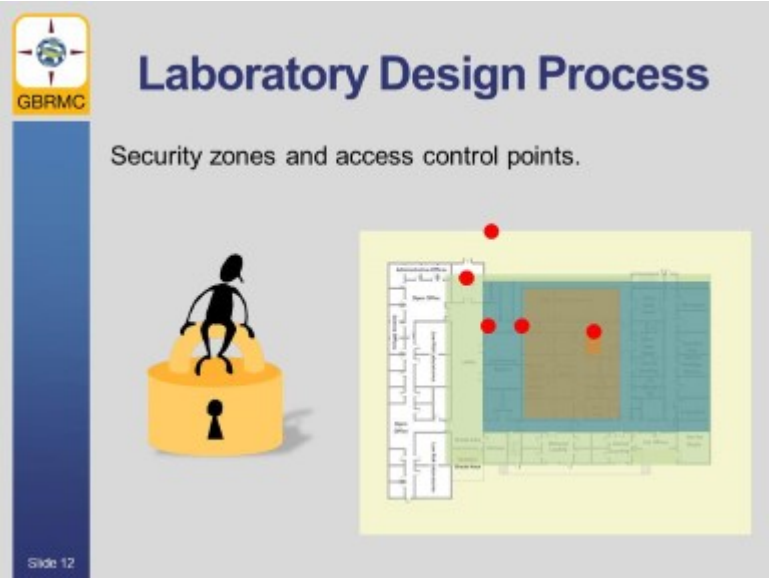

GBRMC
Laboratory Building Systems
This course is designed to aid in Biorisk Management by promoting good bioscience lab design practices.
Slide 9


GBRMC
Laboratory Design Process
Building organization, material and personnel movements.
Flow Diagram
Slide 10

Notes:


GBRMC
Laboratory Design Process
Containment barriers and the spaces and equipment used to move people and materials across.
Ante Room
Lab
Sterilizer
Slide 11

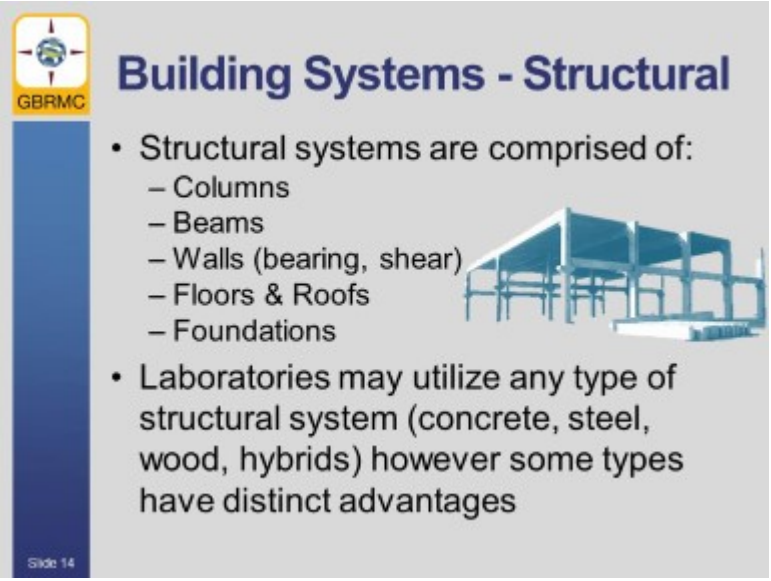
Notes:


GBRMC
Laboratory Design Process
Security zones and access control points.
Slide 12

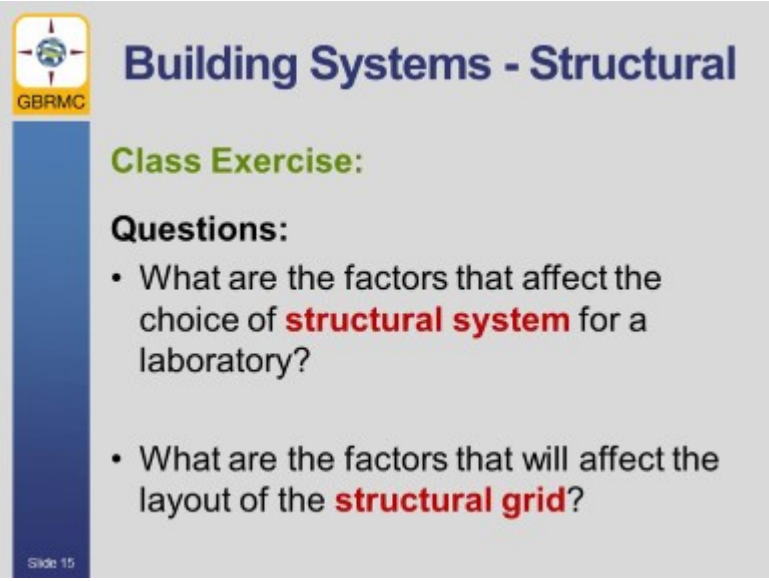
Notes:


GBRMC
Laboratory Building Systems
Today we will briefly discuss:
– Structural Systems for Laboratories
– Architectural Systems for Laboratories
– Mechanical Systems for Laboratories
– Plumbing Systems for Laboratories
– Electrical Systems for Laboratories
Slide 13

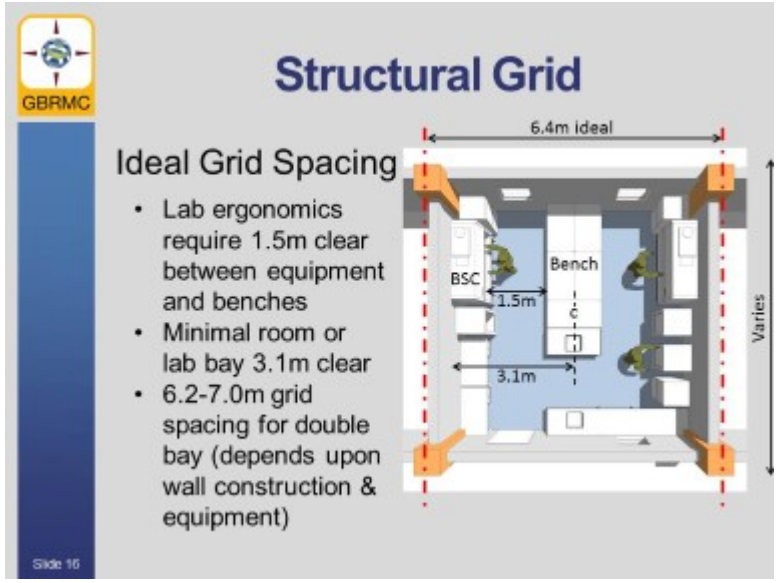
Notes:

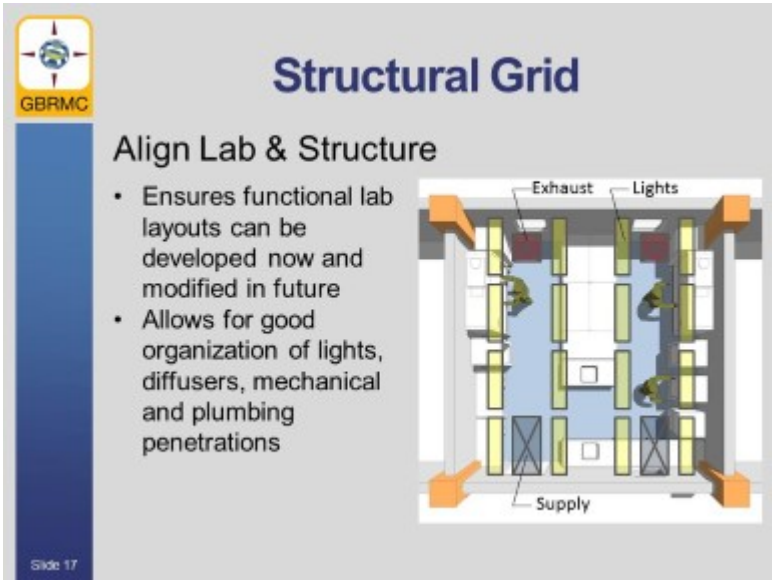

GBRMC
Building Systems - Structural
• Structural systems are comprised of:
– Columns
– Beams
– Walls (bearing, shear)
– Floors & Roofs
– Foundations
• Laboratories may utilize any type of structural system (concrete, steel, wood, hybrids) however some types have distinct advantages
Slide 14

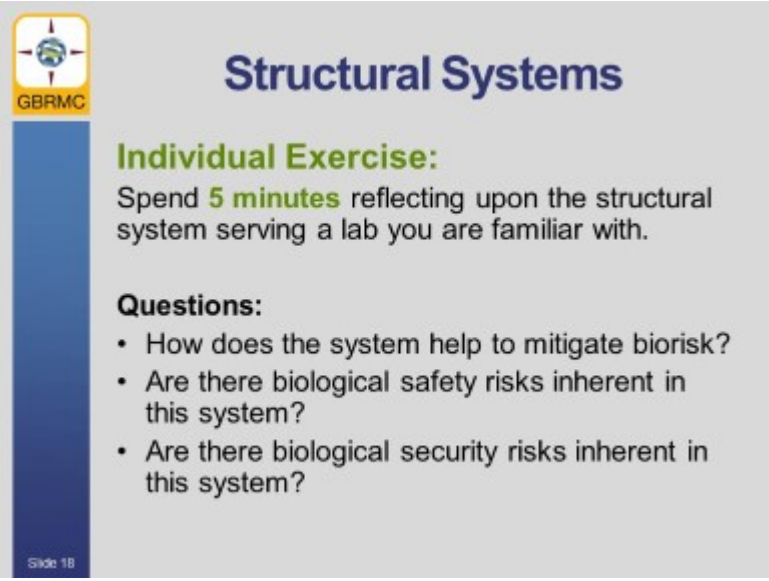
Notes:


GBRMC
Building Systems - Structural
Class Exercise:
Questions:
• What are the factors that affect the choice of structural system for a laboratory?
• What are the factors that will affect the layout of the structural grid?
Slide 15

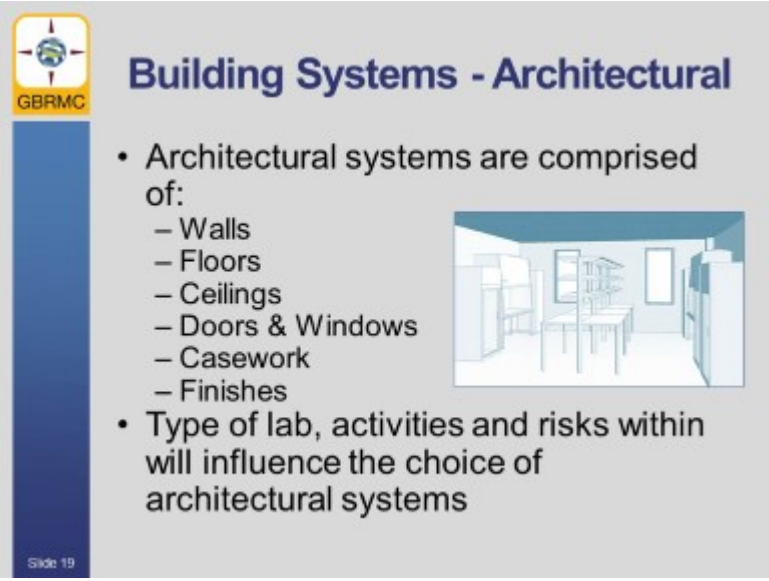
Notes:


GBRMC
Structural Grid
Ideal Grid Spacing
• Lab ergonomics require 1.5m clear between equipment and benches
• Minimal room or lab bay 3.1m clear
• 6.2-7.0m grid spacing for double bay (depends upon wall construction & equipment)
6.4m ideal
BSC
1.5m
Bench
3.1m
Varies
Slide 16

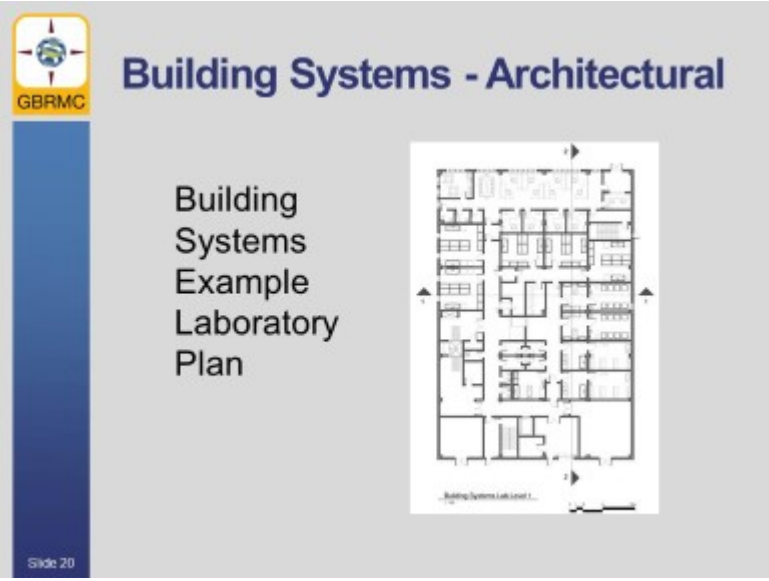

GBRMC
Structural Grid
Align Lab & Structure
• Ensures functional lab layouts can be developed now and modified in future
• Allows for good organization of lights, diffusers, mechanical and plumbing penetrations
Exhaust
Lights
Supply
Slide 17


GBRMC
Structural Systems
Individual Exercise:
Spend 5 minutes reflecting upon the structural system serving a lab you are familiar with.
Questions:
• How does the system help to mitigate biorisk?
• Are there biological safety risks inherent in this system?
• Are there biological security risks inherent in this system?
Slide 18

Notes:


GBRMC
Building Systems - Architectural
• Architectural systems are comprised of:
– Walls
– Floors
– Ceilings
– Doors & Windows
– Casework
– Finishes
• Type of lab, activities and risks within will influence the choice of architectural systems
Slide 19

Notes:


GBRMC
Building Systems - Architectural
Building Systems Example Laboratory Plan
Slide 20

Notes:


GBRMC
Building Systems - Architectural
Class Exercise:
• Which spaces in the facility will be exposed to some type of biological risk?
• How can the architectural materials in these spaces help to mitigate risks?
Slide 21

GBRMC

Building Systems - Architectural

Guidance on the appropriate finish and construction materials can be found in:

- **Biosafety guidelines**
- **Institutional standards**
- **Precedents,** similar labs in a similar environment

Slide 22

GBRMC

Guidelines

Often guidelines prescribe the **performance criteria** of finishes, services and construction for different lab types without specifying an exact material or system.

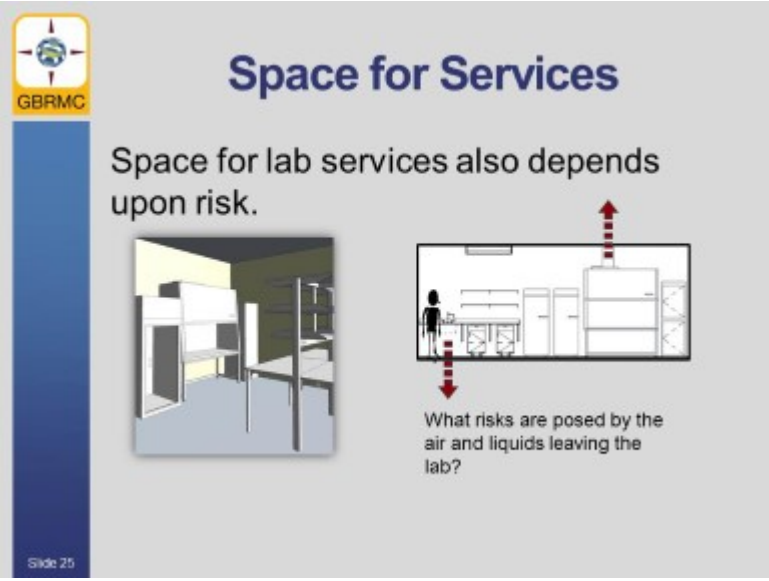
"Walls, ceilings and floors should be smooth, easy to clean, impermeable to liquids and resistant to the chemicals and disinfectants normally used in the laboratory. Floors should be slip-resistant.."

"Bench tops should be impervious to water and resistant to disinfectants, acids,
alkalis, organic solvents and moderate heat."

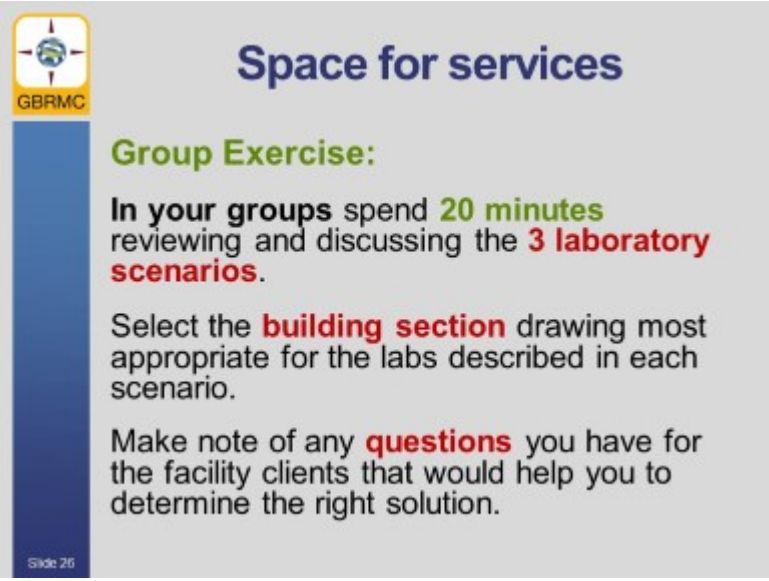
Slide 23

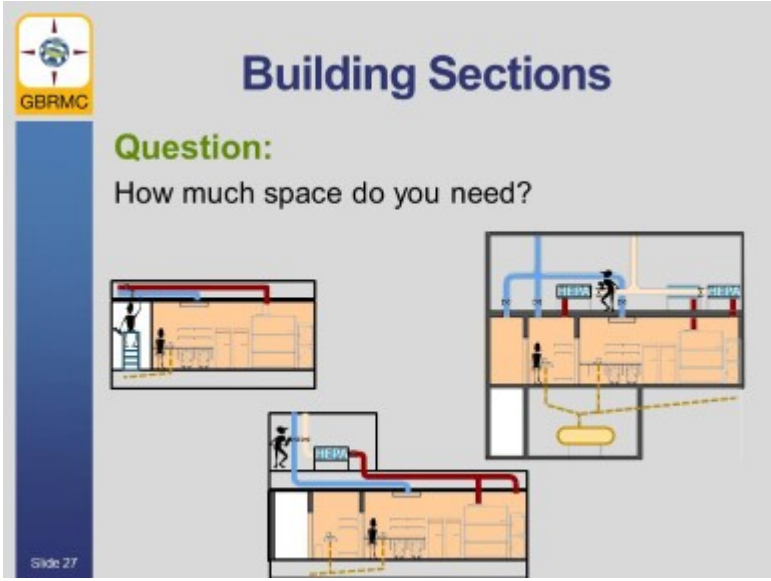

GBRMC
Building Systems - Architectural
• Basic principles
– Don't support growth of biological agents
– Don't absorb toxins
– Allow for easy cleaning (material and form)
– Stand up to disinfectants
– Withstand wear and tear of intended function
• Criteria more stringent with increased risk
– Stand up to gaseous decontamination
– Form an appropriately tight containment barrier
Slide 24

Notes:


GBRMC
Space for Services
Space for lab services also depends upon risk.
What risks are posed by the air and liquids leaving the lab?
Slide 25

Notes:


GBRMC
Space for services
Group Exercise:
In your groups spend 20 minutes reviewing and discussing the 3 laboratory scenarios.
Select the building section drawing most appropriate for the labs described in each scenario.
Make note of any questions you have for the facility clients that would help you to determine the right solution.
Slide 26


GBRMC
Building Sections
Question:
How much space do you need?
HEPA
HEPA
HEPA
Slide 27

Laboratory scenarios

Laboratory A is an animal disease diagnostics facility. This laboratory receives a variety of diagnostic samples which may range from fecal matter, blood, tissue and in some cases full carcasses of small animals. The laboratory tests these samples for a wide range of diseases and in many cases is working to determine the cause of illness or death of animals found in the wild. Many of the diseases this lab works with are dangerous to animals only, however some are zoonotic diseases, which pose a risk of serious disease in both animals and humans. Users in this laboratory change out of their street clothes and don lab greens in a general change area, then enter the lab via an ante room where they put on disposable coveralls, positive pressure respirators, gloves and shoes dedicated to the laboratory. Upon exiting the lab all personnel protective equipment is removed and disposed of except the respirator which is wiped down with disinfectant and stored in the ante room for re-use. All waste leaving this lab is removed via a pass through sterilizer connected directly to the laboratory.

Laboratory B is a diagnostics lab. The laboratory receives well packaged blood samples from a nearby hospital and tests these for a list of known diseases. Samples are examined inside biosafety cabinets. Lab users wear laboratory coats over their street clothes, disposable gloves and N-95 respiratory protection when working at the biosafety cabinets. Lab users remove their lab coats and disposable gloves at the laboratory exit and wash their hands prior to exiting. All waste from the labs is sterilized in a common use sterilizer outside of the laboratory prior to removal from the facility.

Laboratory C is a large animal vaccine testing laboratory. This lab houses large animals, usually cattle held in open air pens within the animal holding room. The animals have been vaccinated then exposed to a known disease and are held and tested to determine the efficacy of the vaccine. The disease in question poses no threat to humans but is of very high consequence to livestock. Users wear gloves, boots, re-usable coveralls and enter and leave the lab via a change room with shower. All waste removed from the room is taken out via a dirty corridor to a common use sterilizer.

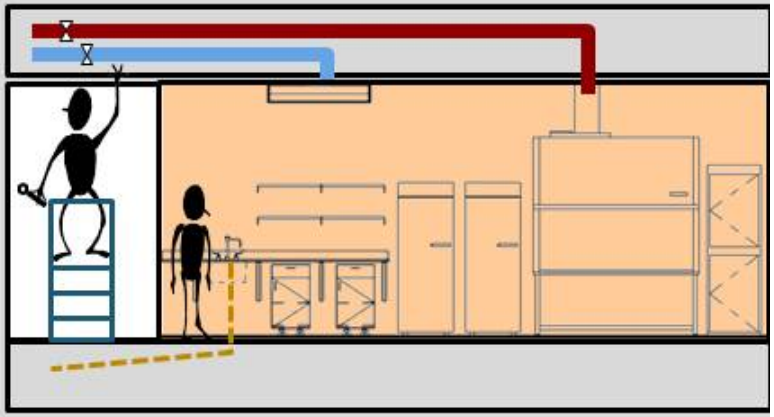
Space for Services

Concept Section 1 - Lab with ceiling plenum

Ductwork distributed in ceiling space

Valves accessible from adjacent corridor

Drainage piping buried or distributed in ceiling space of floor below



Slide 29

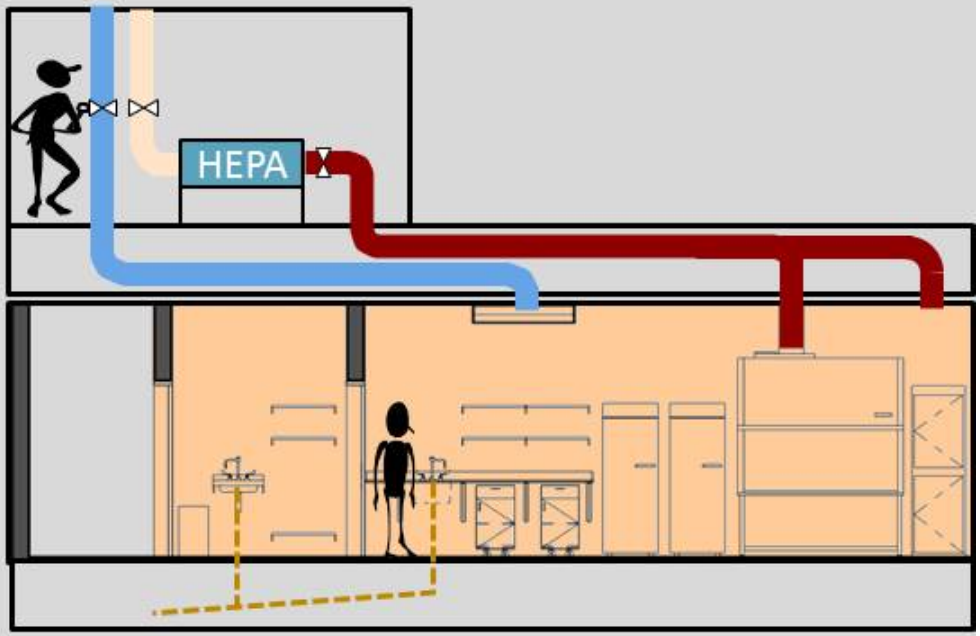
Space for Services

Concept Section 2 – Small mechanical space above

Space above or beside lab for HEPA filters and access to valves

Ductwork distributed in ceiling space

Drainage piping buried or distributed in ceiling space below



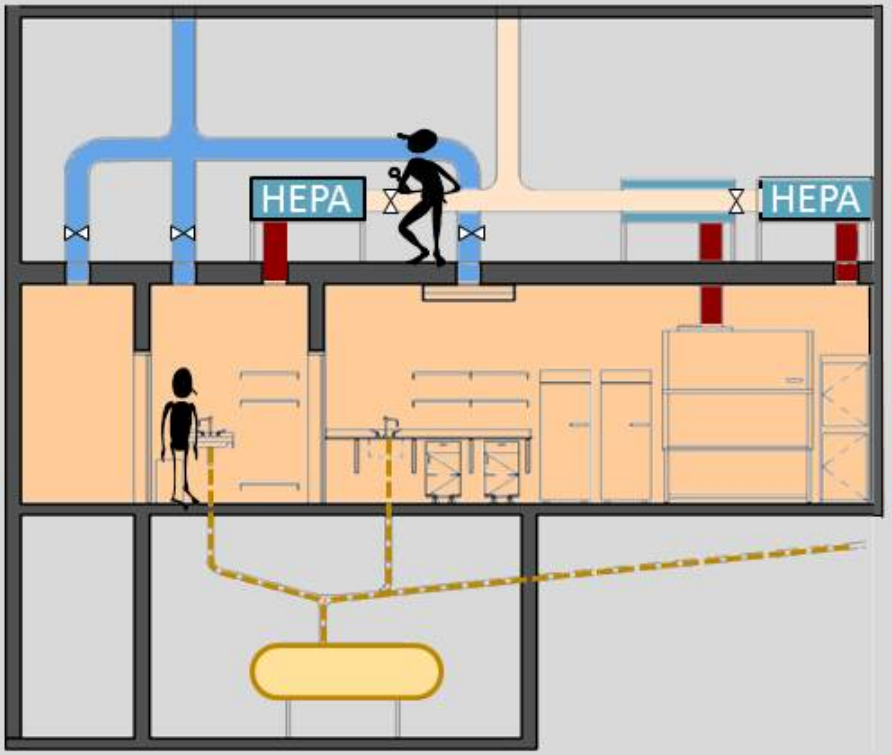
Slide 30

Space for Services

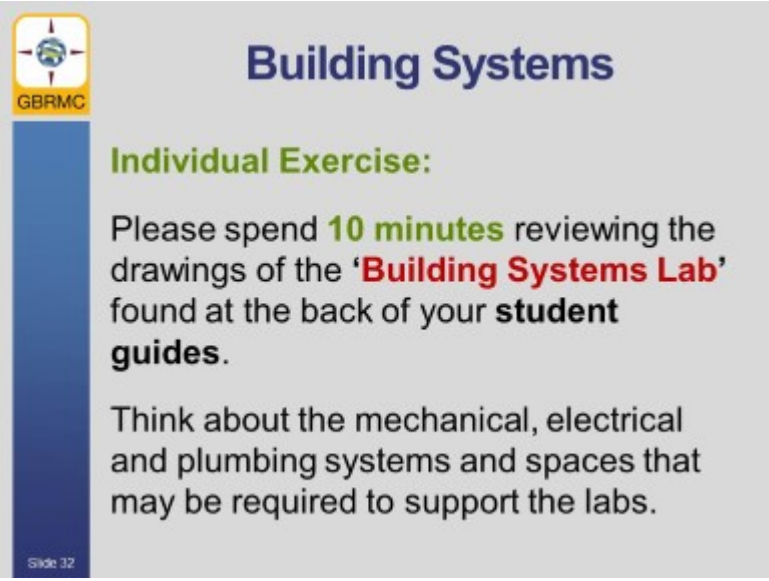
Concept Section 3- Service spaces above and below

Large dedicated space above the lab for HEPA filters and controls.

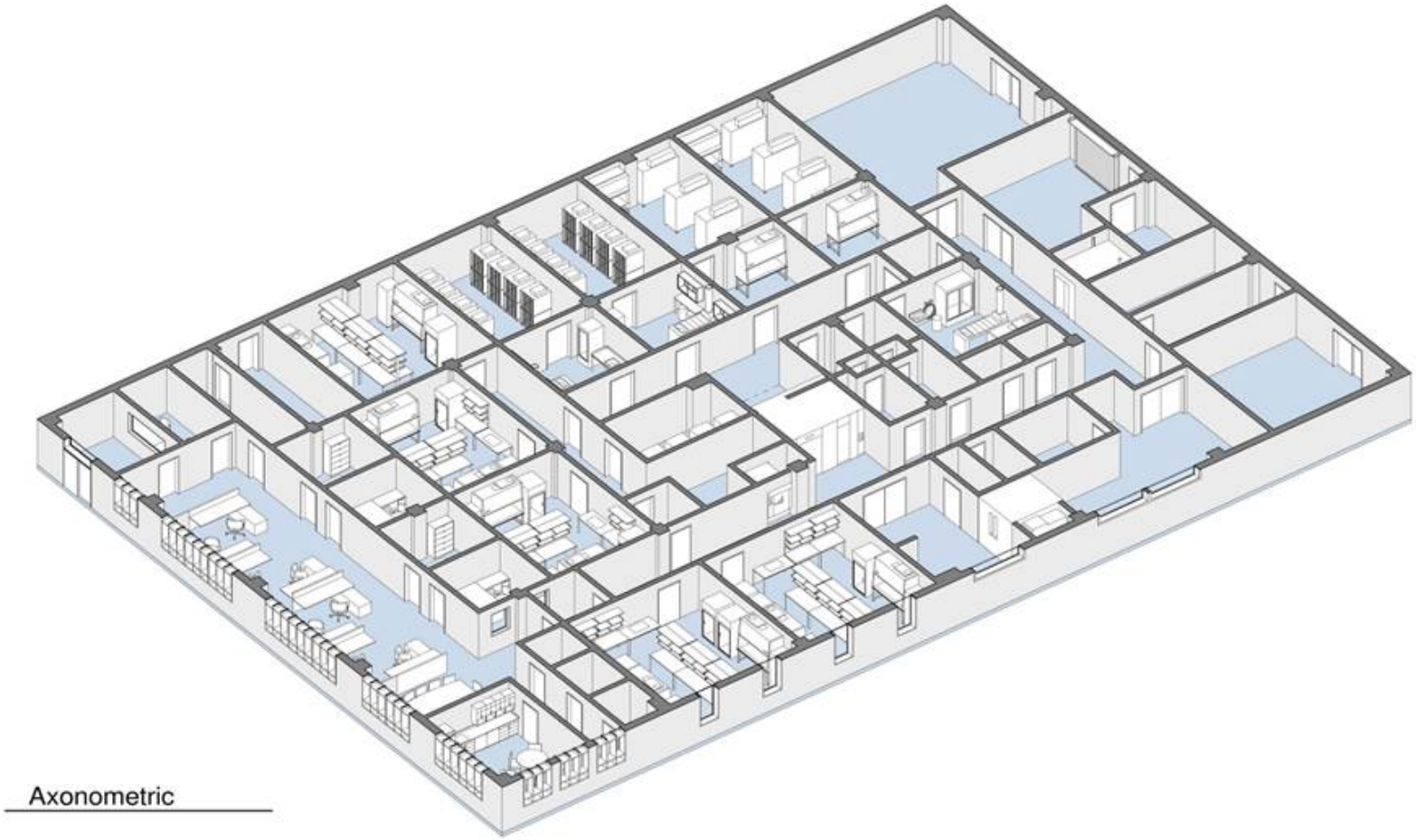
Effluent treatment system below with space for inspecting laboratory waste piping



Slide 31

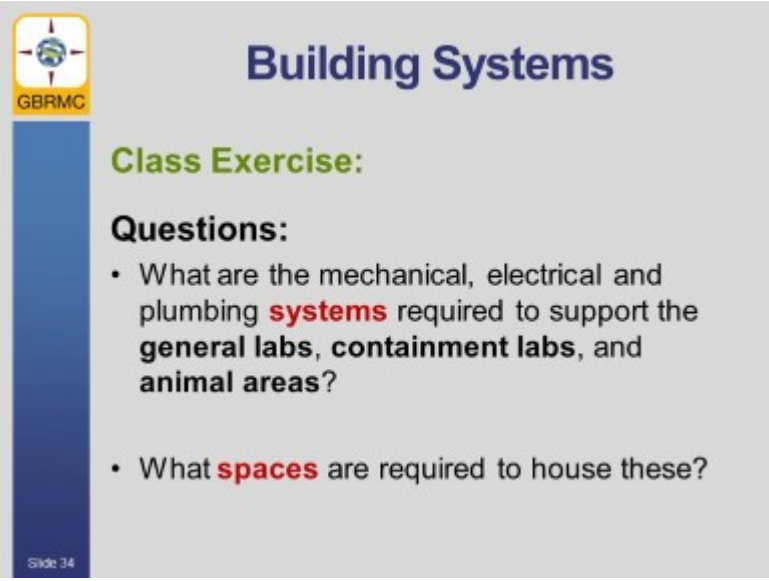

GBRMC
Building Systems
Individual Exercise:
Please spend 10 minutes reviewing the drawings of the 'Building Systems Lab' found at the back of your student guides.
Think about the mechanical, electrical and plumbing systems and spaces that may be required to support the labs.
Slide 32

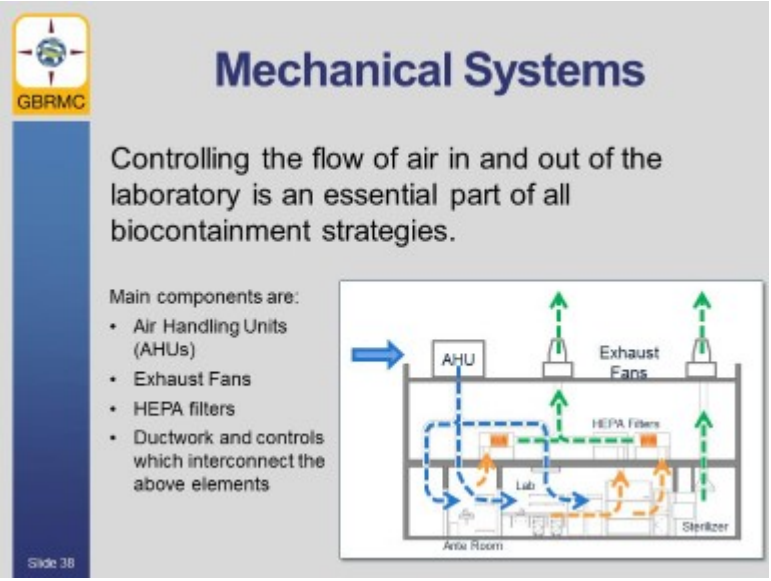
Building Systems



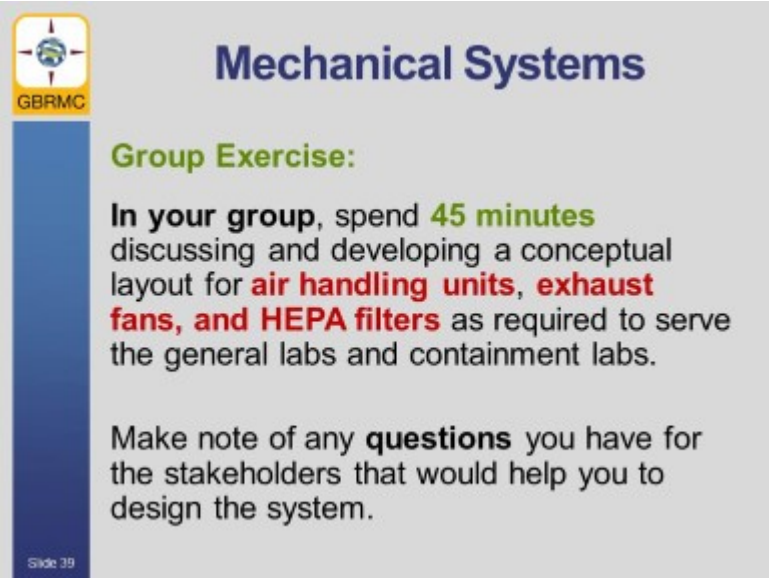
Axonometric

Slide 33


GBRMC
Building Systems
Class Exercise:
Questions:
• What are the mechanical, electrical and plumbing systems required to support the general labs, containment labs, and animal areas?
• What spaces are required to house these?
Slide 34


GBRMC
Mechanical Systems
Controlling the flow of air in and out of the laboratory is an essential part of all biocontainment strategies.
Main components are:
• Air Handling Units (AHUs)
• Exhaust Fans
• HEPA filters
• Ductwork and controls which interconnect the above elements
AHU
Exhaust Fans
HEPA Filters
Lab
Sterilizer
Ante Room
Slide 38

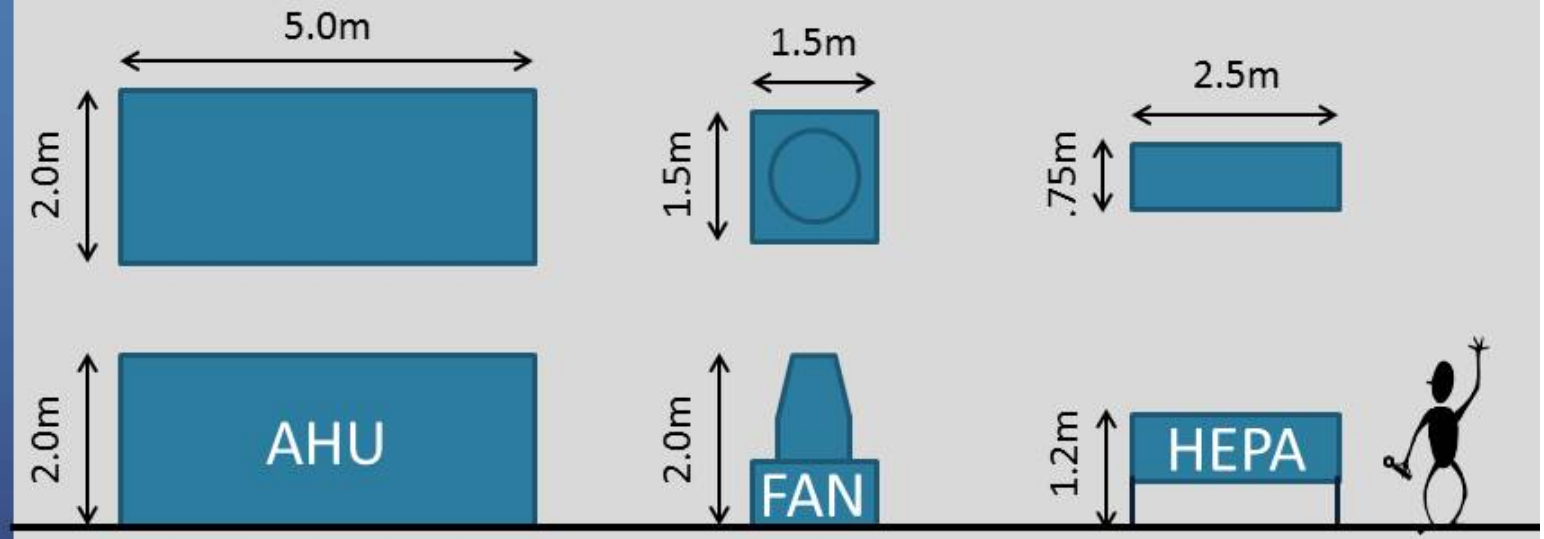
Notes:


GBRMC
Mechanical Systems
Group Exercise:
In your group, spend 45 minutes discussing and developing a conceptual layout for air handling units, exhaust fans, and HEPA filters as required to serve the general labs and containment labs.
Make note of any questions you have for the stakeholders that would help you to design the system.
Slide 39

Notes:

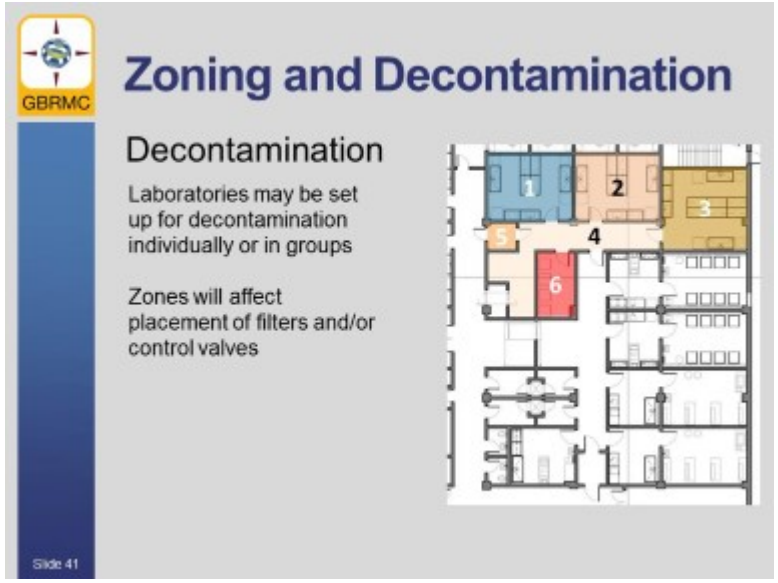
Mechanical Components

Component sizes

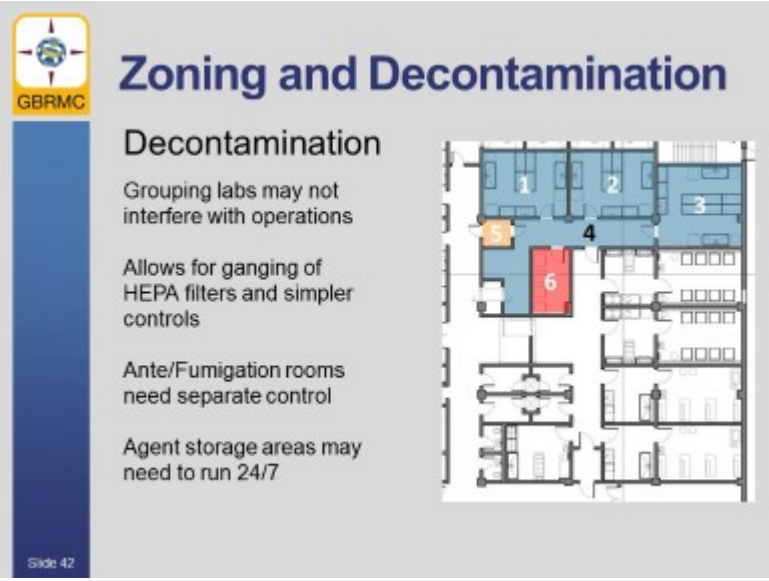


For concept design purposes assume these sizes

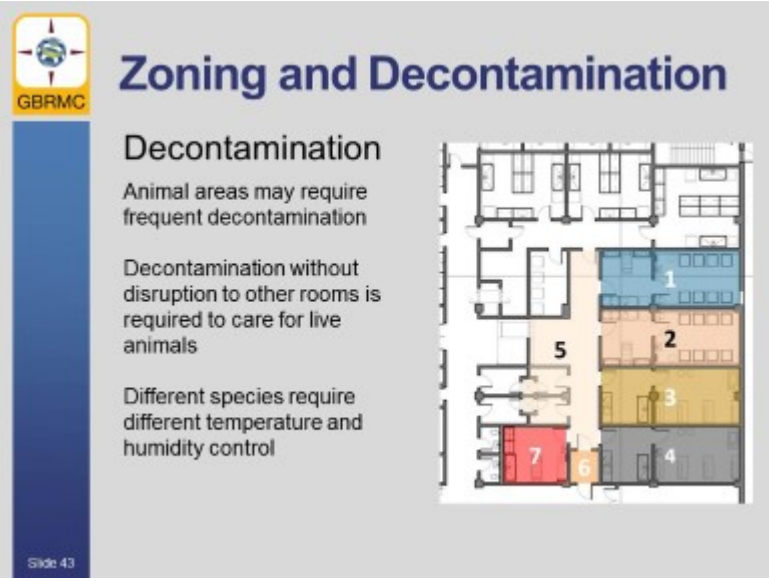
Slide 40


GBRMC
Zoning and Decontamination
Decontamination
Laboratories may be set up for decontamination individually or in groups
Zones will affect placement of filters and/or control valves
1
2
3
4
5
6
Slide 41

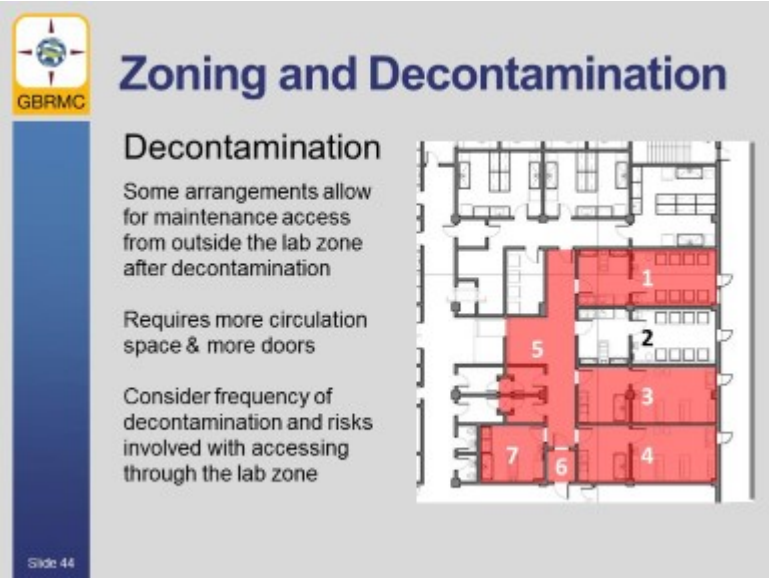
Notes:


GBRMC
Zoning and Decontamination
Decontamination
Grouping labs may not interfere with operations
Allows for ganging of HEPA filters and simpler controls
Ante/Fumigation rooms need separate control
Agent storage areas may need to run 24/7
1
2
3
4
5
6
Slide 42

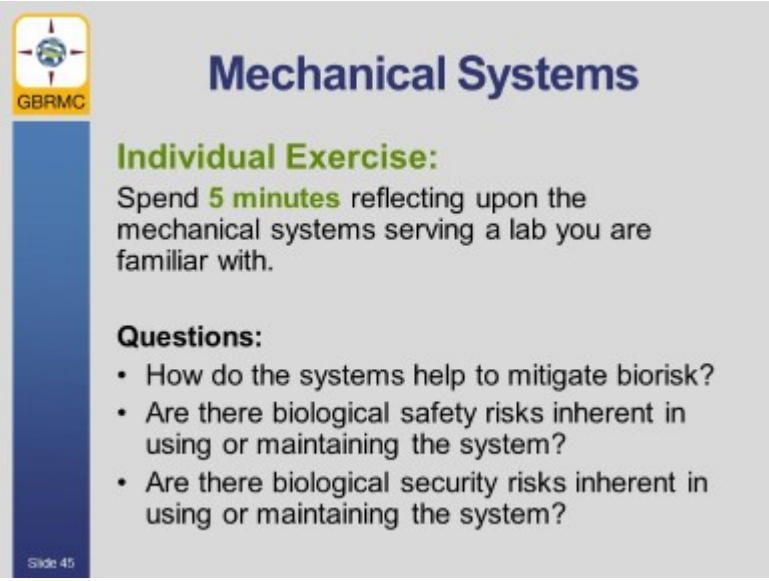
Notes:


GBRMC
Zoning and Decontamination
Decontamination
Animal areas may require frequent decontamination
Decontamination without disruption to other rooms is required to care for live animals
Different species require different temperature and humidity control
1
2
3
4
5
6
7
Slide 43

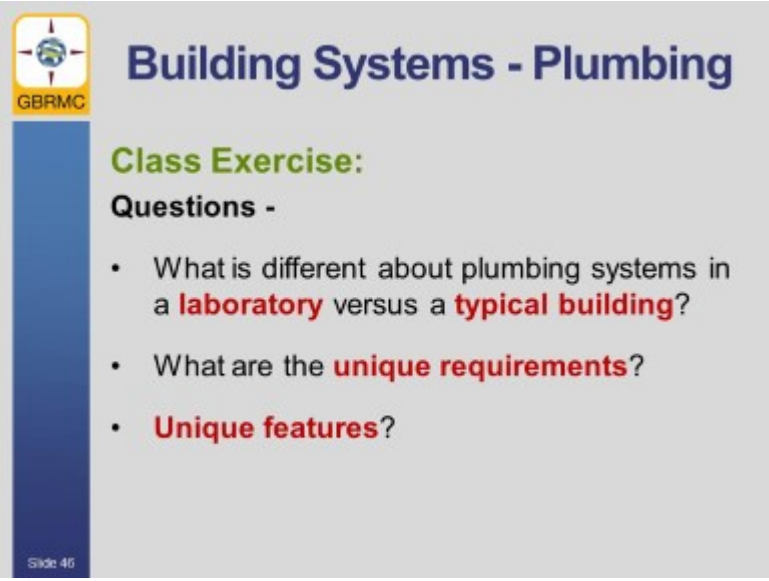
Notes:


GBRMC
Zoning and Decontamination
Decontamination
Some arrangements allow for maintenance access from outside the lab zone after decontamination
Requires more circulation space & more doors
Consider frequency of decontamination and risks involved with accessing through the lab zone
1
2
3
4
5
6
7
Slide 44

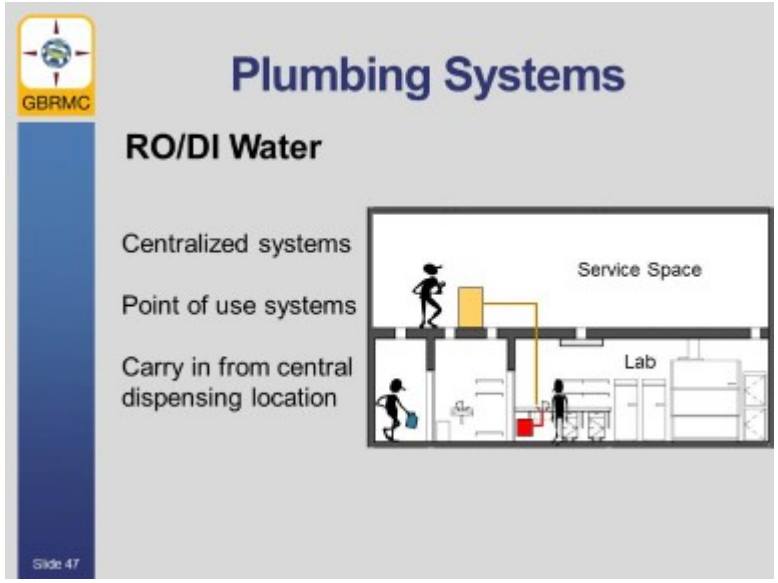
Notes:


GBRMC
Mechanical Systems
Individual Exercise:
Spend 5 minutes reflecting upon the mechanical systems serving a lab you are familiar with.
Questions:
• How do the systems help to mitigate biorisk?
• Are there biological safety risks inherent in using or maintaining the system?
• Are there biological security risks inherent in using or maintaining the system?
Slide 45

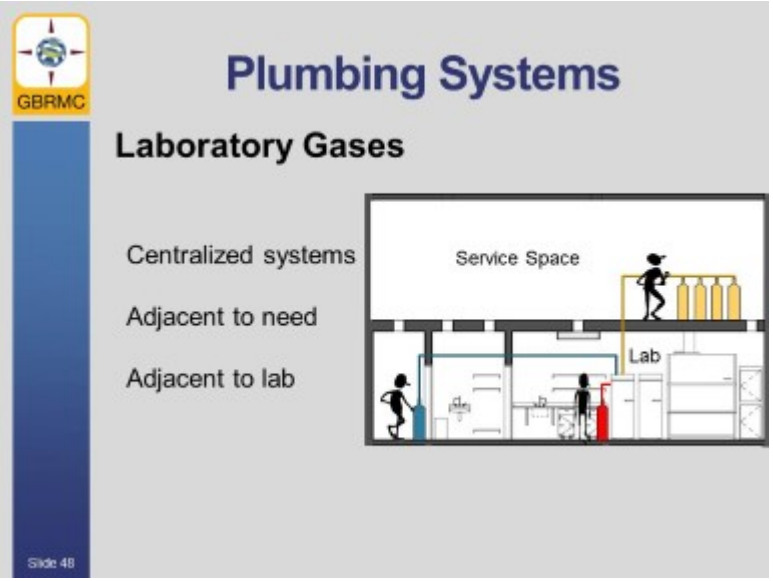
Notes:


GBRMC
Building Systems - Plumbing
Class Exercise:
Questions -
• What is different about plumbing systems in a laboratory versus a typical building?
• What are the unique requirements?
• Unique features?
Slide 46

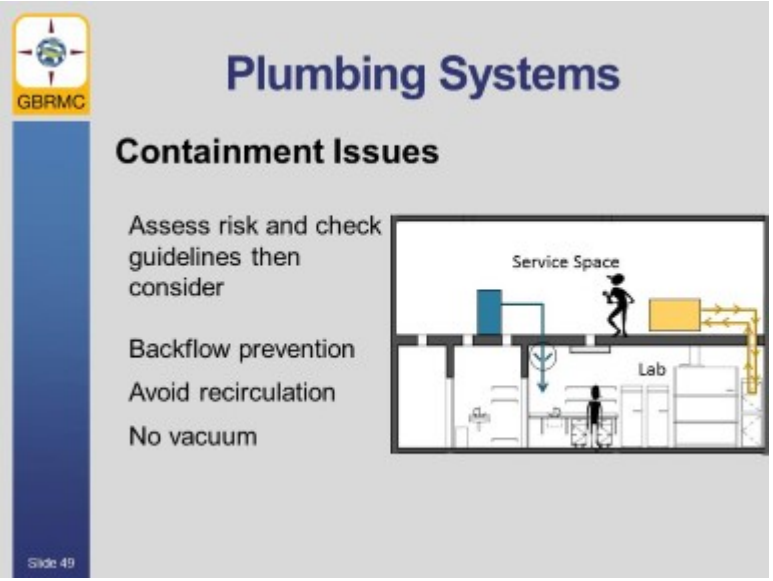
Notes:


GBRMC
Plumbing Systems
RO/DI Water
Centralized systems
Point of use systems
Carry in from central dispensing location
Service Space
Lab
Slide 47

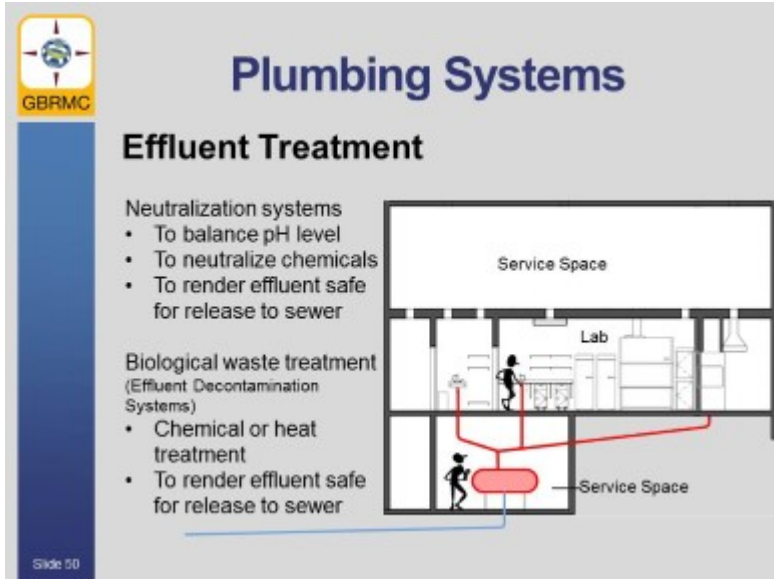
Notes:


GBRMC
Plumbing Systems
Laboratory Gases
Centralized systems
Adjacent to need
Adjacent to lab
Service Space
Lab
Slide 48

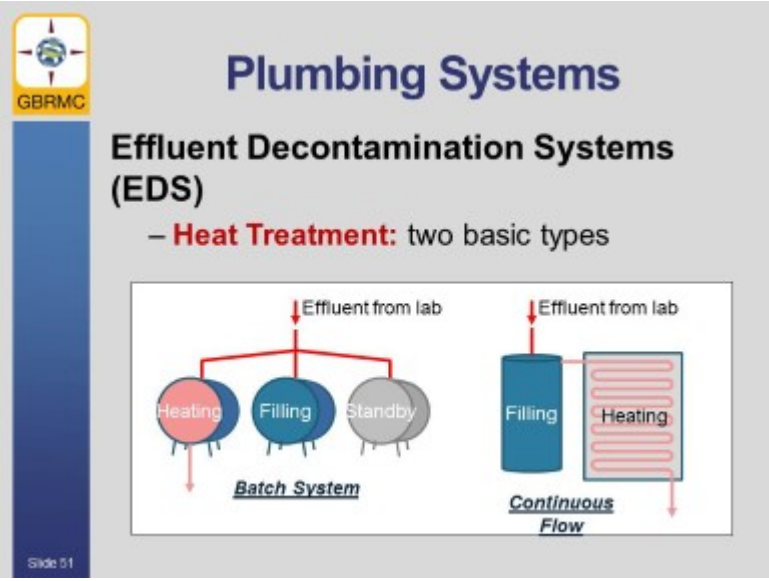
Notes:


GBRMC
Plumbing Systems
Containment Issues
Assess risk and check guidelines then consider
Backflow prevention
Avoid recirculation
No vacuum
Service Space
Lab
Slide 49

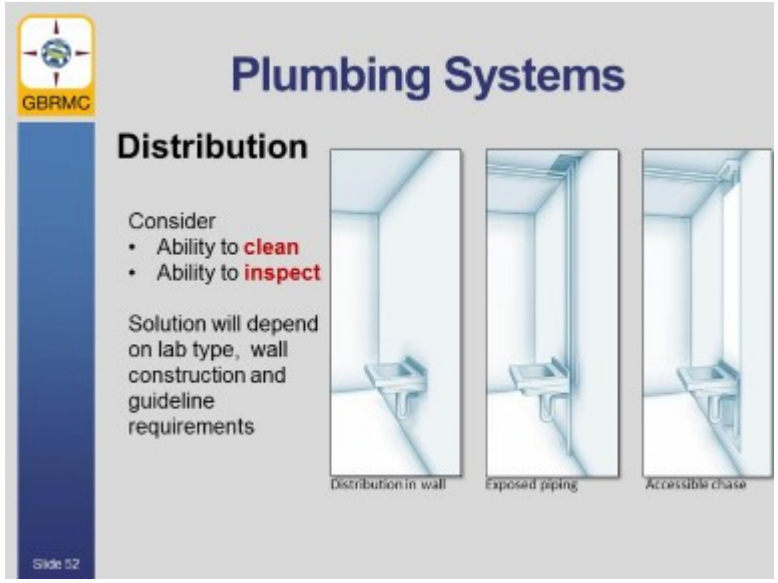
Notes:


GBRMC
Plumbing Systems
Effluent Treatment
Neutralization systems
• To balance pH level
• To neutralize chemicals
• To render effluent safe for release to sewer
Biological waste treatment
(Effluent Decontamination Systems)
• Chemical or heat treatment
• To render effluent safe for release to sewer
Service Space
Lab
Service Space
Slide 50

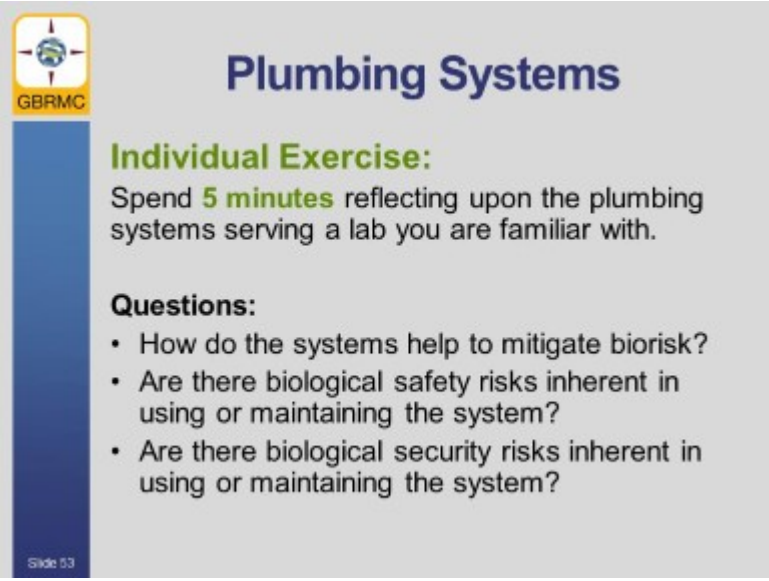
Notes:


GBRMC
Plumbing Systems
Effluent Decontamination Systems (EDS)
– Heat Treatment: two basic types
Effluent from lab
Heating
Filling
Standby
Batch System
Effluent from lab
Filling
Heating
Continuous Flow
Slide 51

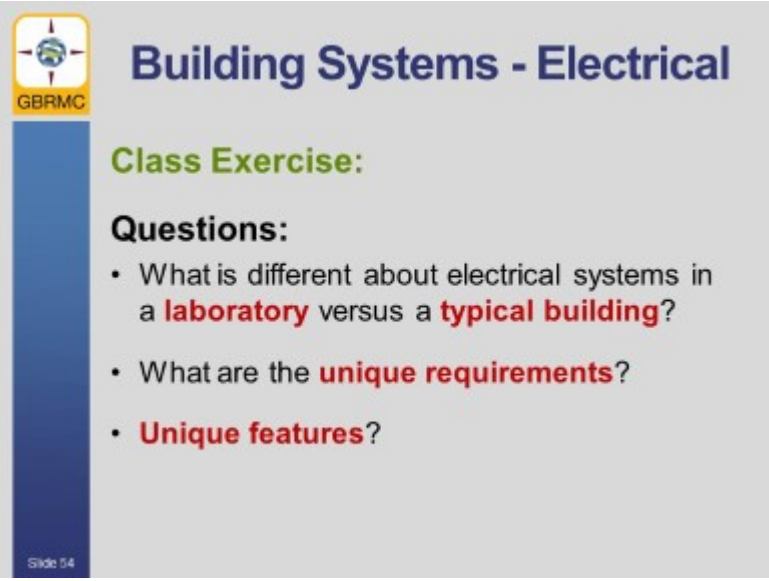
Notes:


GBRMC
Plumbing Systems
Distribution
Consider
• Ability to clean
• Ability to inspect
Solution will depend on lab type, wall construction and guideline requirements
Distribution in wall
Exposed piping
Accessible chase
Slide 52

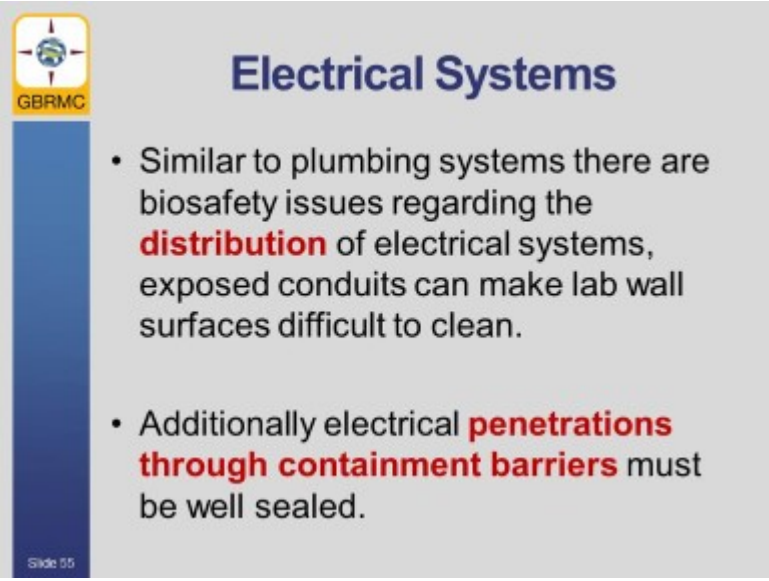
Notes:


GBRMC
Plumbing Systems
Individual Exercise:
Spend 5 minutes reflecting upon the plumbing systems serving a lab you are familiar with.
Questions:
• How do the systems help to mitigate biorisk?
• Are there biological safety risks inherent in using or maintaining the system?
• Are there biological security risks inherent in using or maintaining the system?
Slide 53

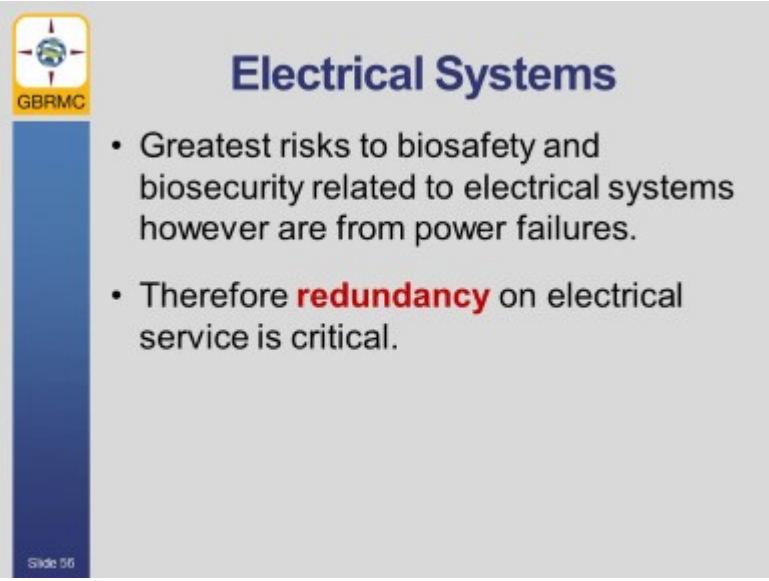
Notes:


GBRMC
Building Systems - Electrical
Class Exercise:
Questions:
• What is different about electrical systems in a laboratory versus a typical building?
• What are the unique requirements?
• Unique features?
Slide 54

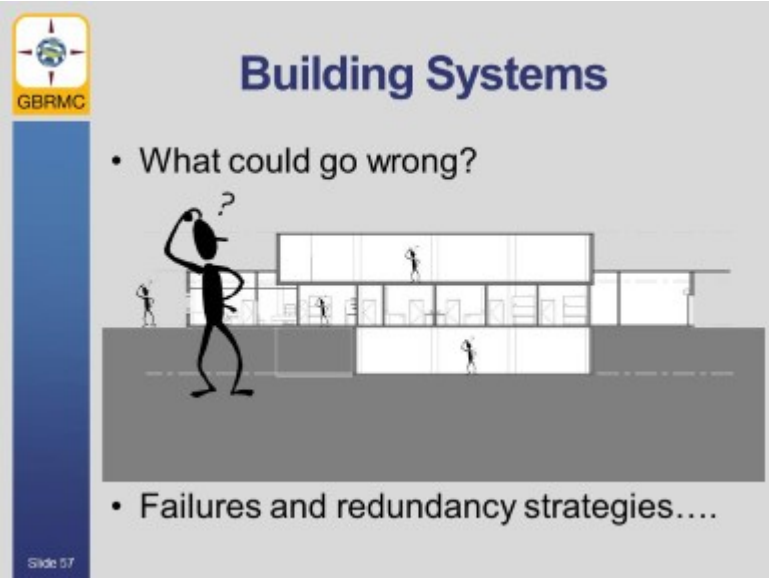
Notes:


GBRMC
Electrical Systems
• Similar to plumbing systems there are biosafety issues regarding the distribution of electrical systems, exposed conduits can make lab wall surfaces difficult to clean.
• Additionally electrical penetrations through containment barriers must be well sealed.
Slide 55

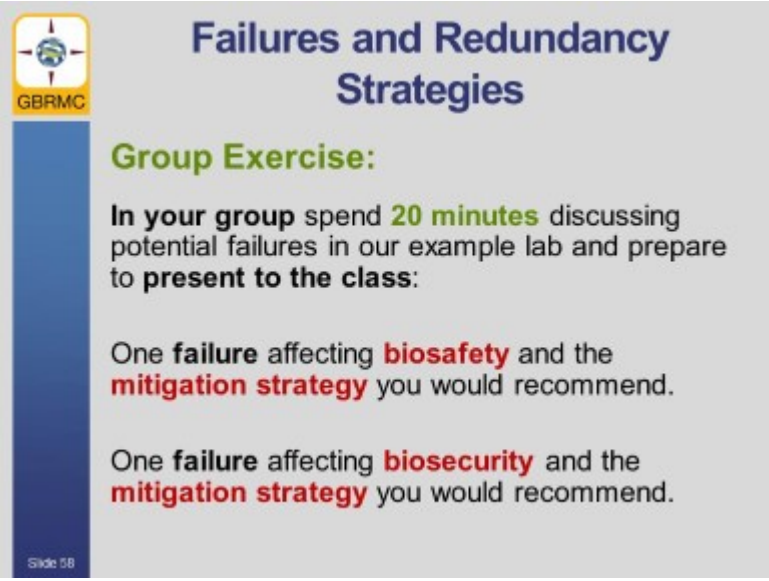
Notes:


GBRMC
Electrical Systems
• Greatest risks to biosafety and biosecurity related to electrical systems however are from power failures.
• Therefore redundancy on electrical service is critical.
Slide 56

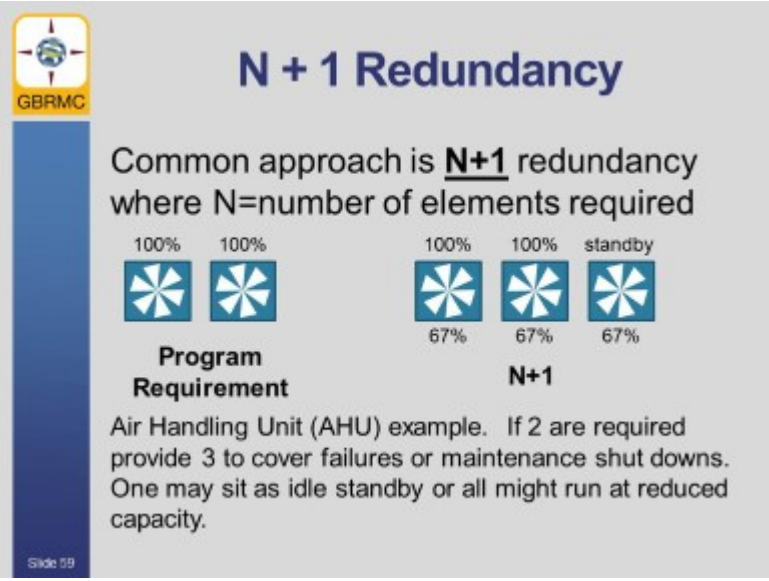
Notes:


GBRMC
Building Systems
• What could go wrong?
• Failures and redundancy strategies….
Slide 57

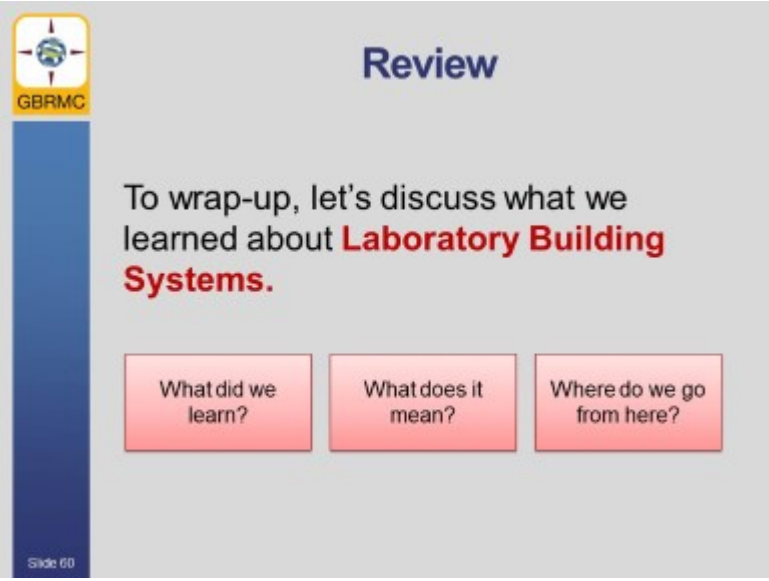
Notes:


GBRMC
Failures and Redundancy Strategies
Group Exercise:
In your group spend 20 minutes discussing potential failures in our example lab and prepare to present to the class:
One failure affecting biosafety and the mitigation strategy you would recommend.
One failure affecting biosecurity and the mitigation strategy you would recommend.
Slide 58

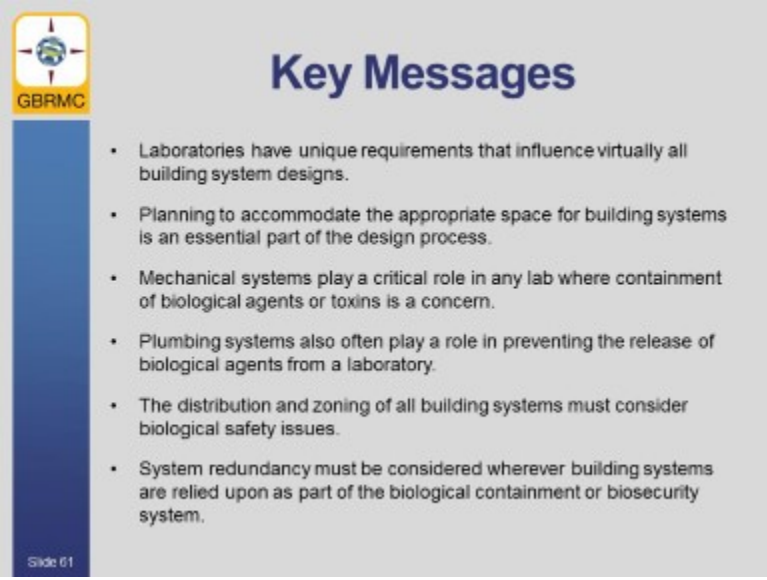
Notes:


GBRMC
N + 1 Redundancy
Common approach is N+1 redundancy where N=number of elements required
100%
100%
Program Requirement
100%
100%
standby
67%
67%
67%
N+1
Air Handling Unit (AHU) example. If 2 are required provide 3 to cover failures or maintenance shut downs. One may sit as idle standby or all might run at reduced capacity.
Slide 59

Notes:


GBRMC
Review
To wrap-up, let's discuss what we learned about Laboratory Building Systems.
What did we learn?
What does it mean?
Where do we go from here?
Slide 60

Notes:



- Laboratories have unique requirements that influence virtually all building system designs.
- Planning to accommodate the appropriate space for building systems is an essential part of the design process.
- Mechanical systems play a critical role in any lab where containment of biological agents or toxins is a concern.
- Plumbing systems also often play a role in preventing the release of biological agents from a laboratory.
- The distribution and zoning of all building systems must consider biological safety issues.
- System redundancy must be considered wherever building systems are relied upon as part of the biological containment or biosecurity system.

Remember your action plan!

Action Plan

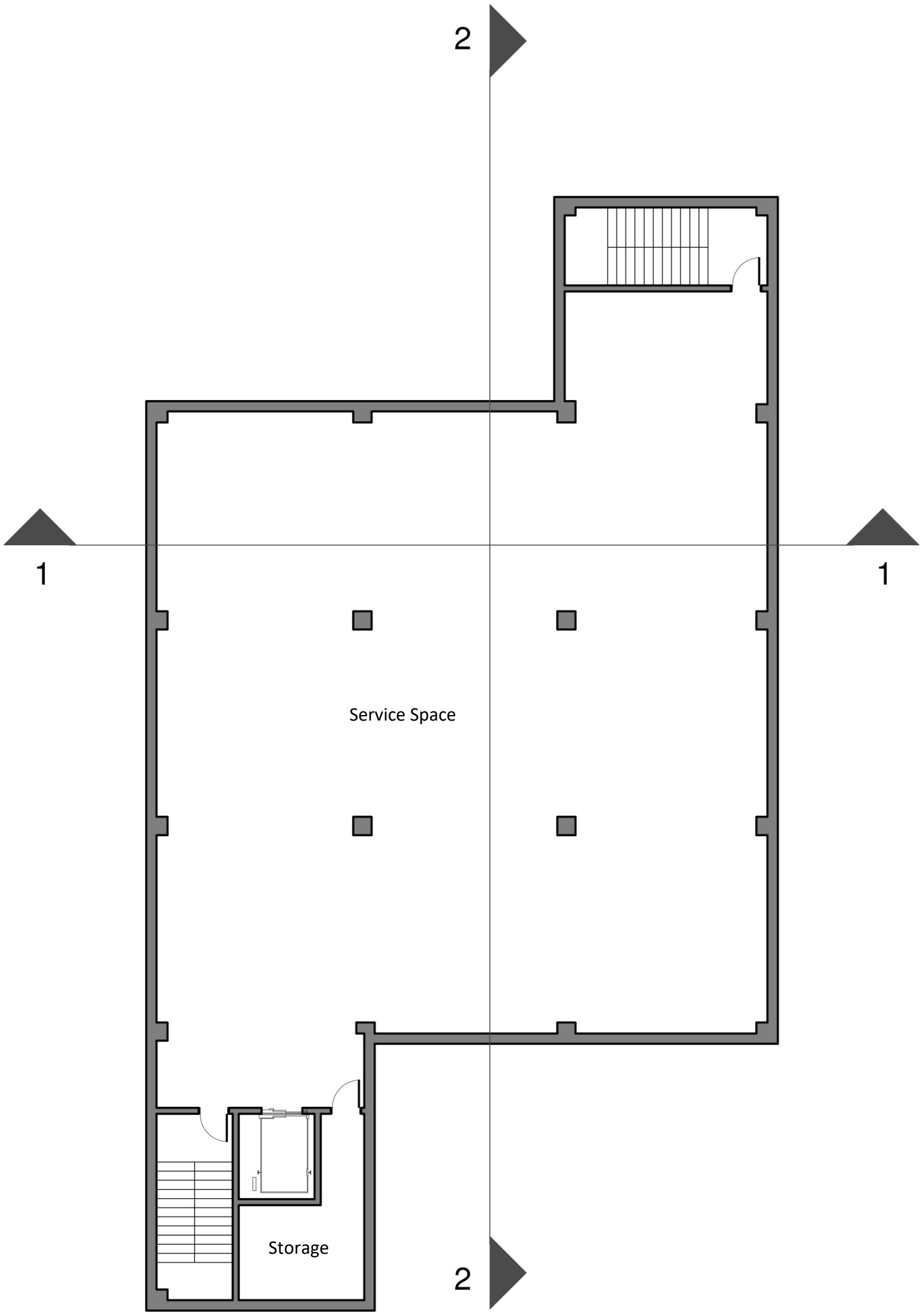
By the end of this lesson, I would like to:					
KNOW		FEEL		BE ABLE TO DO	

Your learning doesn't stop with this lesson. Use this space to think about what else you need to do or learn to put the information from this lesson into practice.

What more do I need to know or do?	How will I acquire the knowledge or skills?	How will I know that I've succeeded?	How will I use this new learning in my job?

Use space on back, if needed

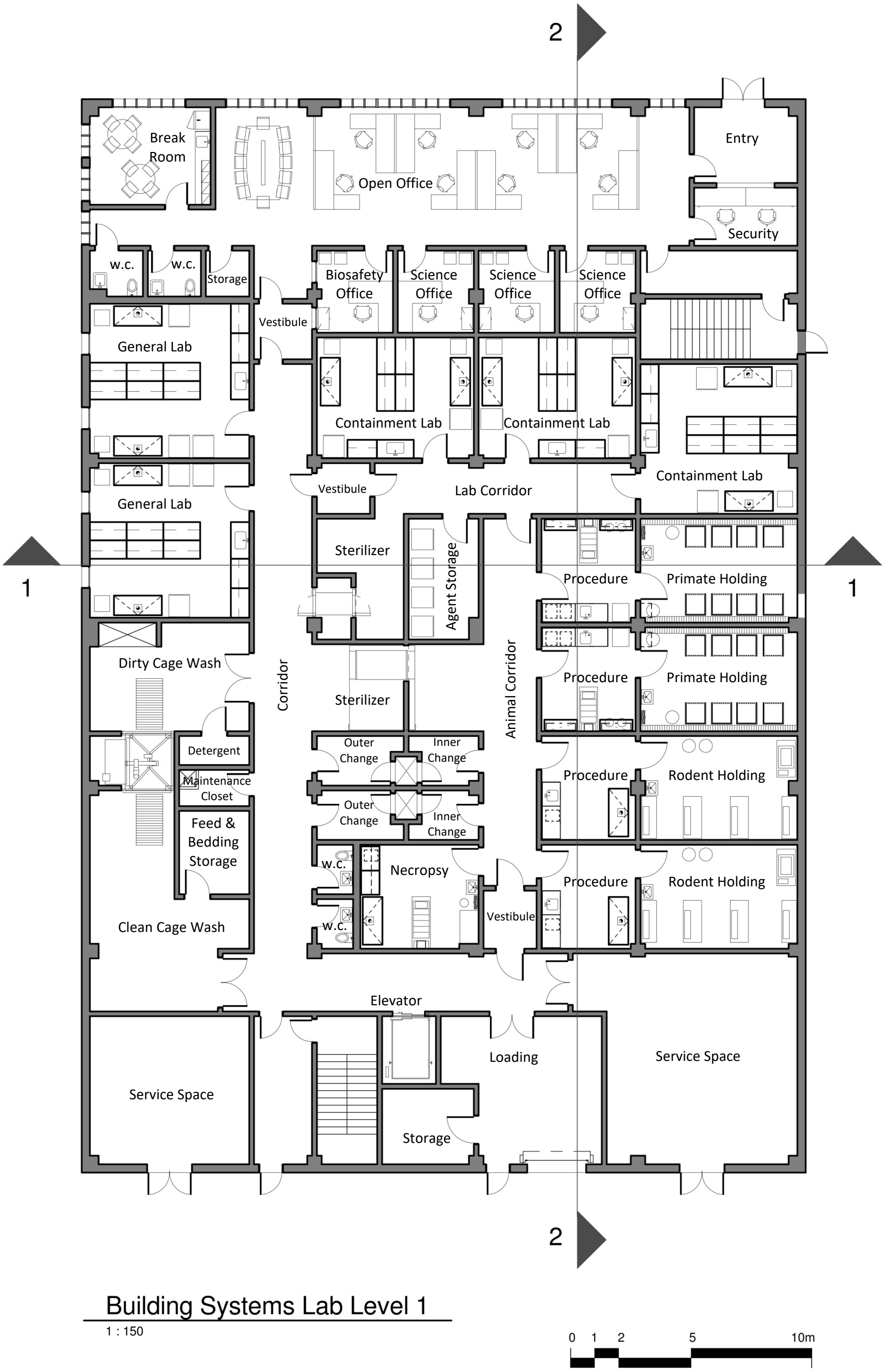

Thank You!
Don't forget to complete your evaluation!
GBRMC
GLOBAL BIORISK MANAGEMENT
CURRICULUM



Building Systems Lab Level 0

1 : 150

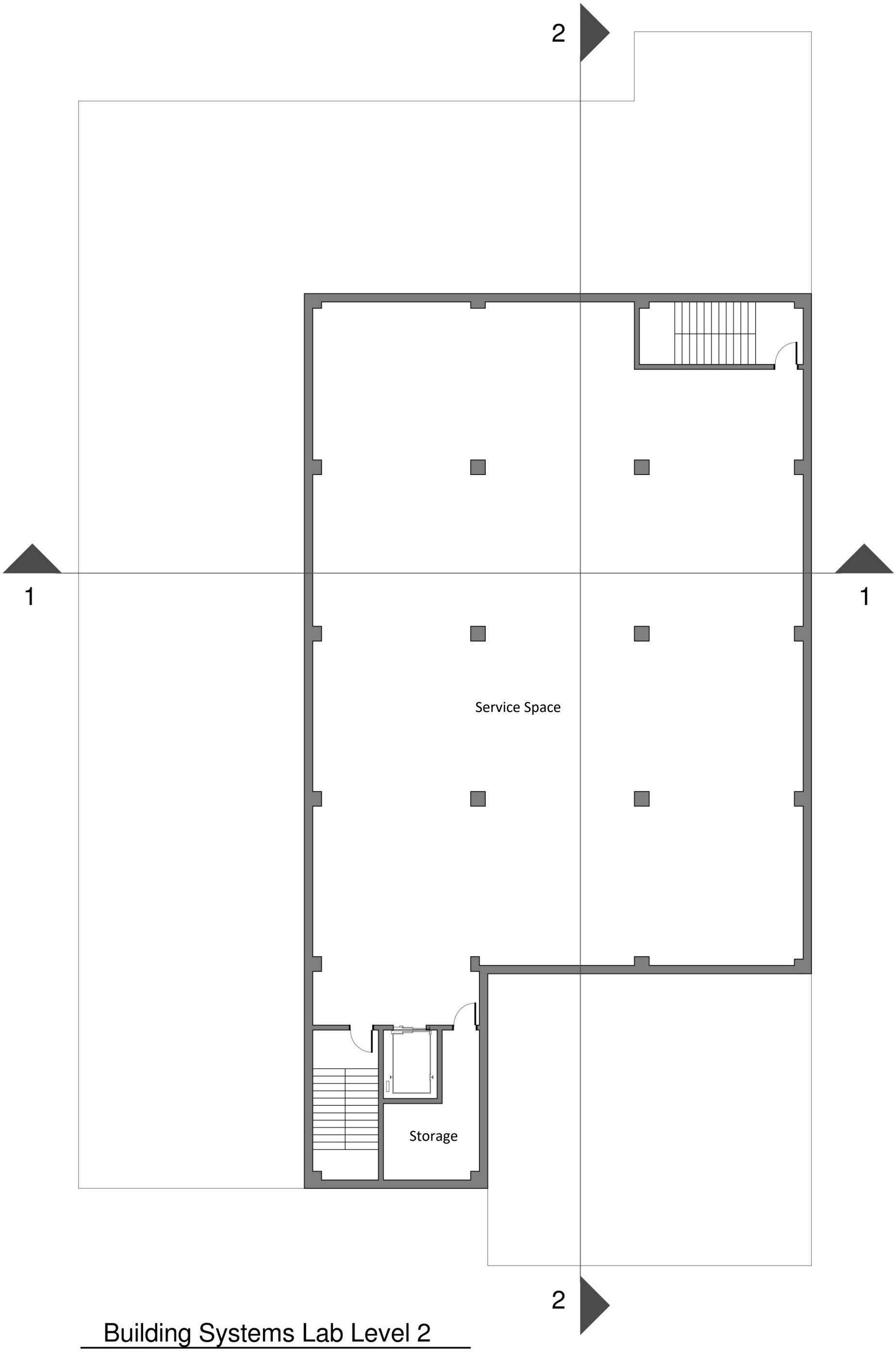
0 1 2 5 10m



Building Systems Lab Level 1

1 : 150

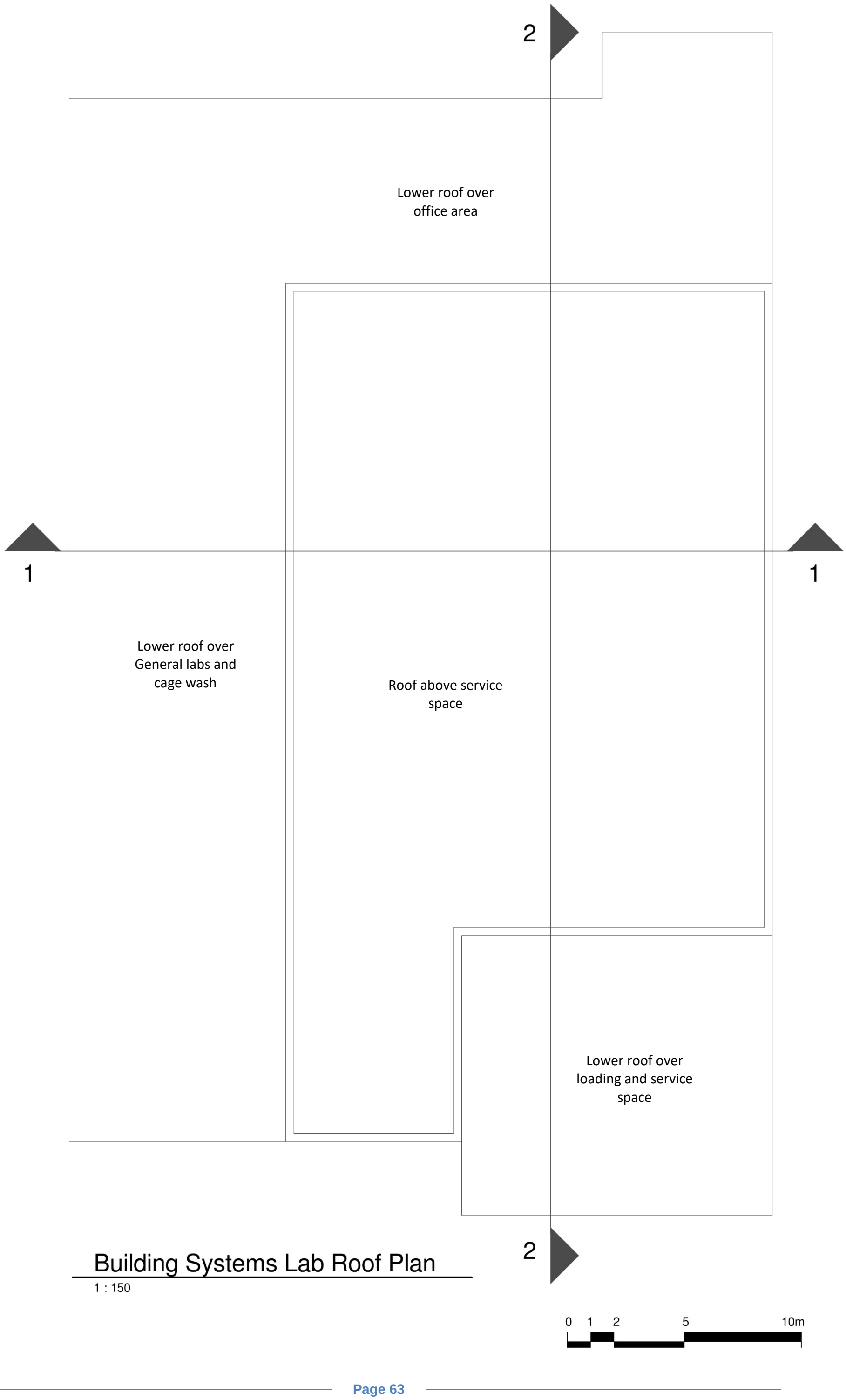
0 1 2 5 10m



Building Systems Lab Level 2

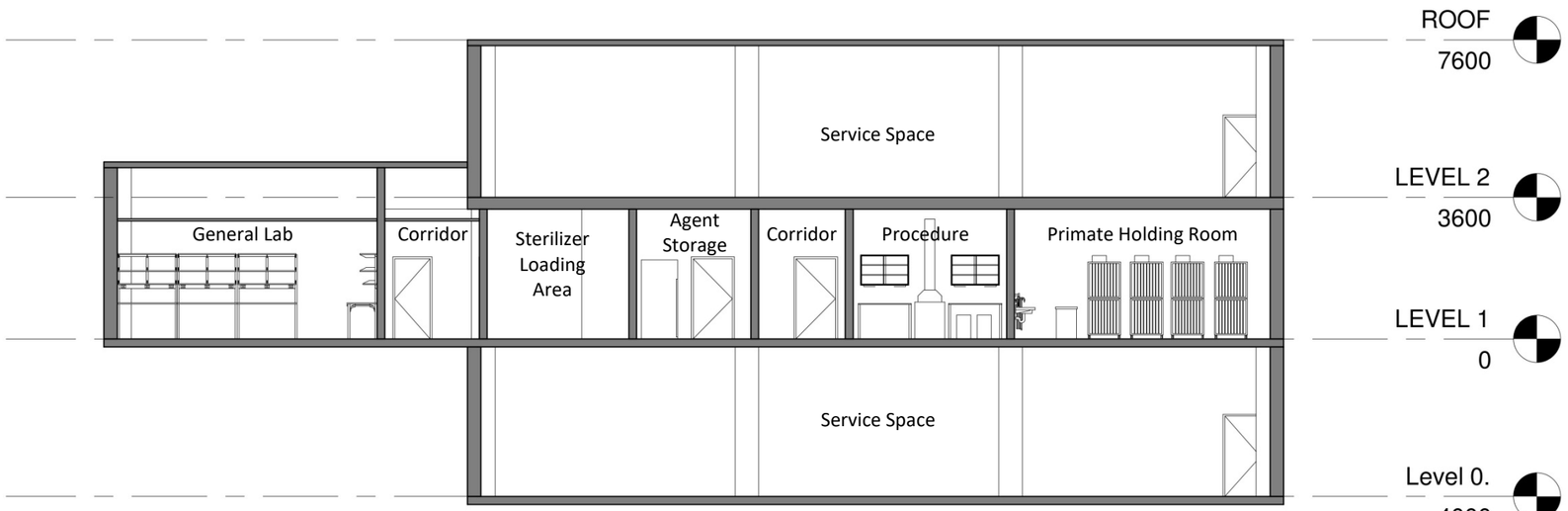
1 : 150

0 1 2 5 10m



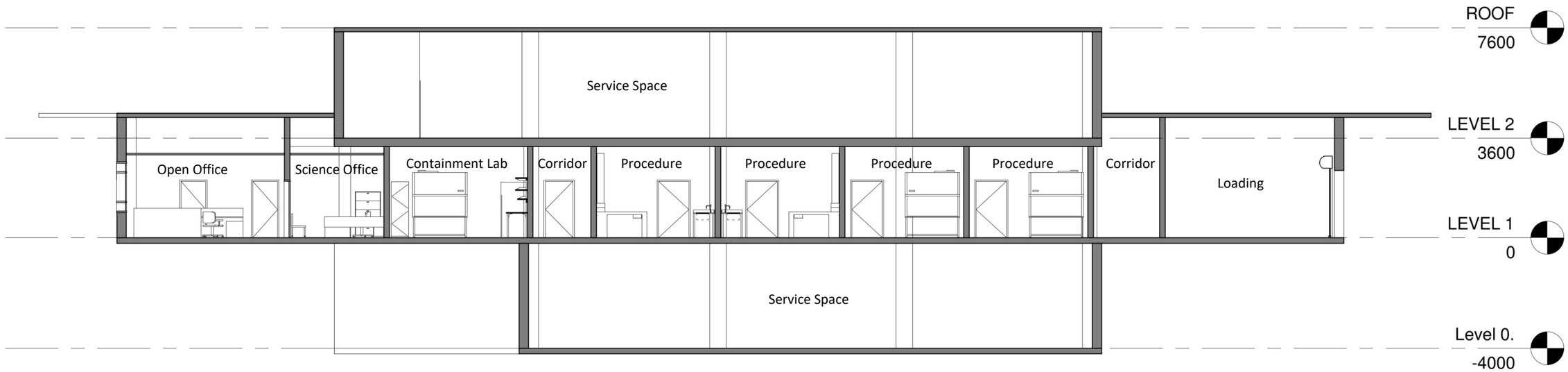
Building Systems Lab Roof Plan

1 : 150



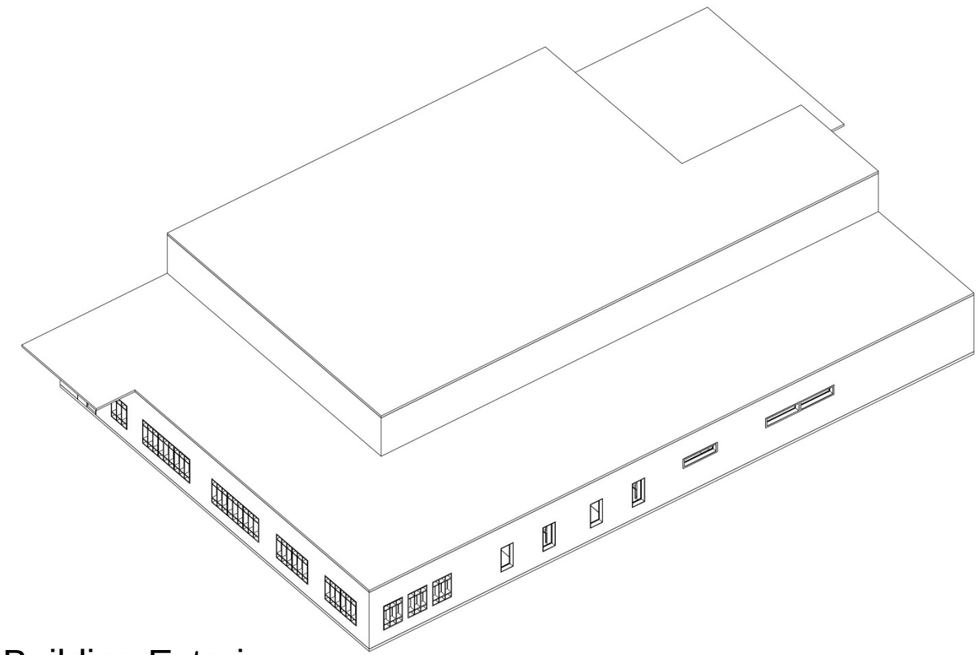
Section 1

1 : 150

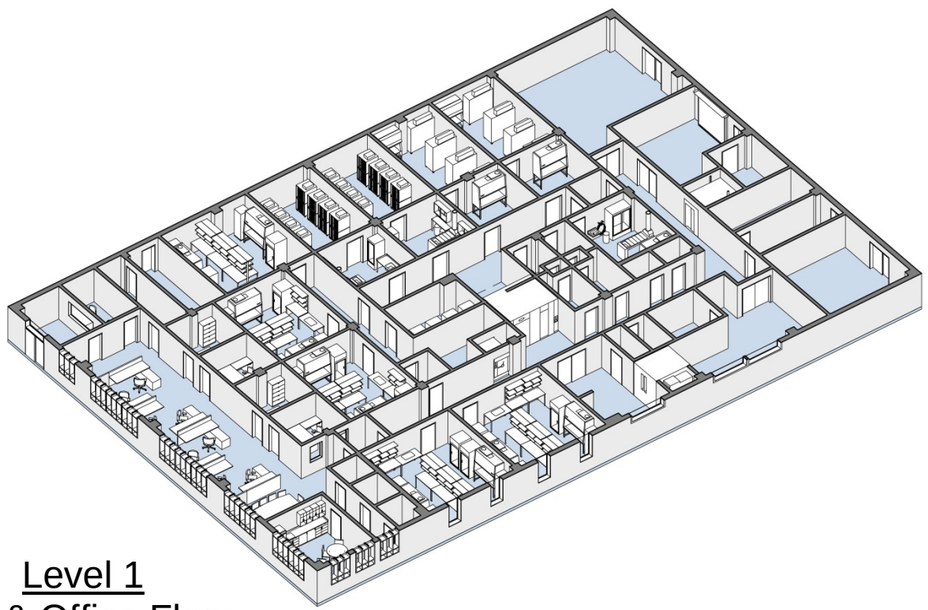


Section 2

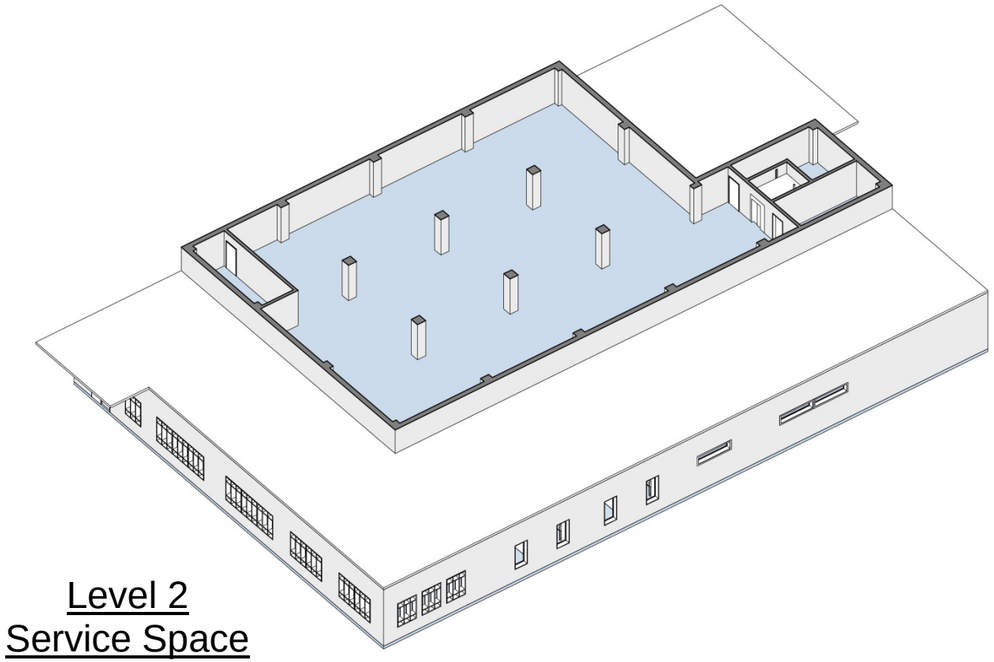
1 : 150



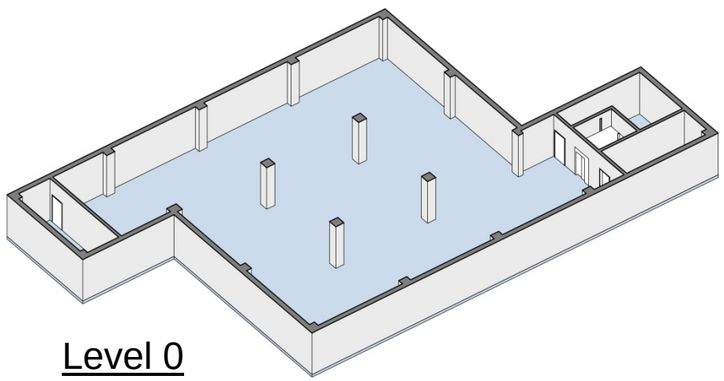
Building Exterior



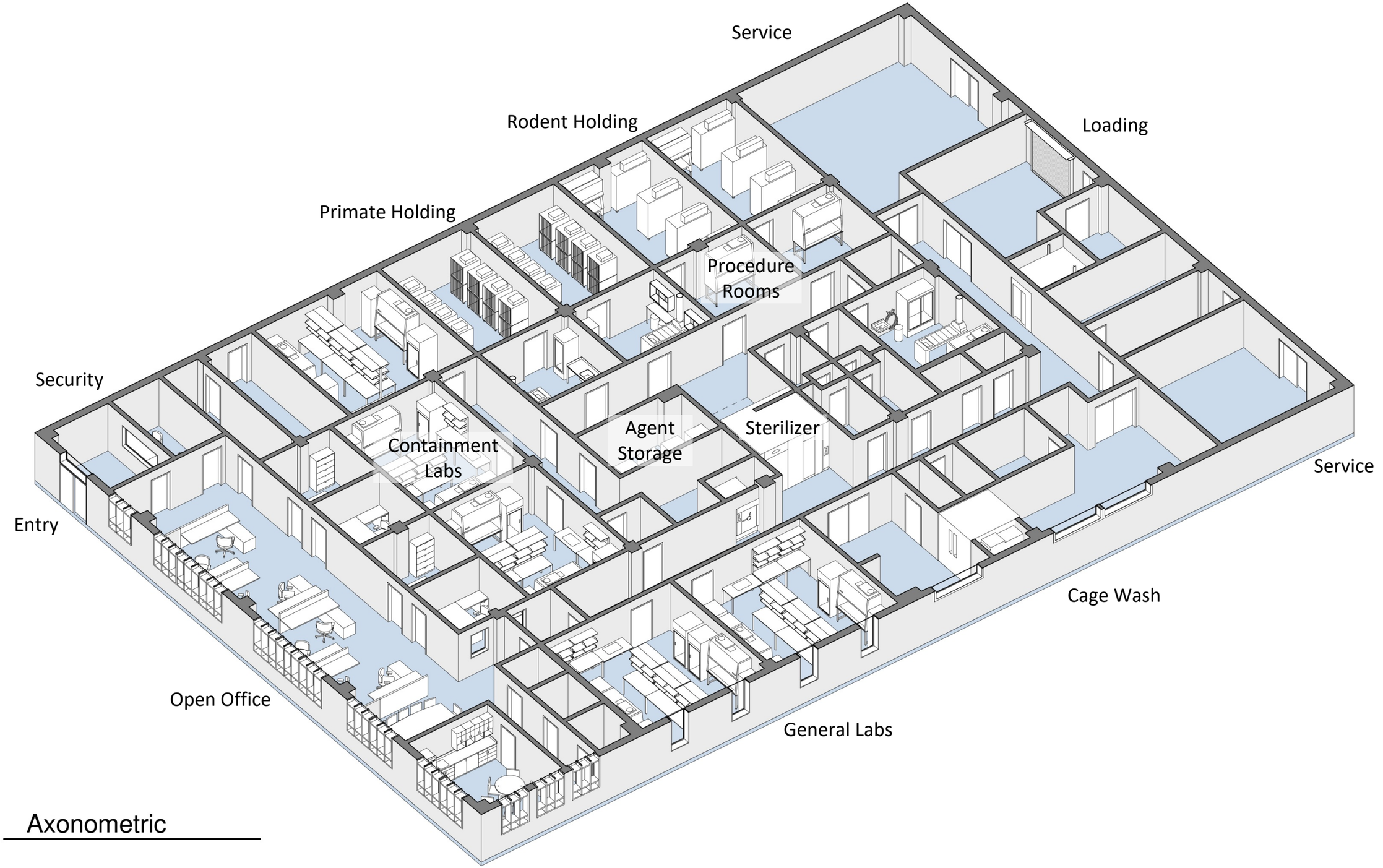
Level 1
Lab & Office Floor



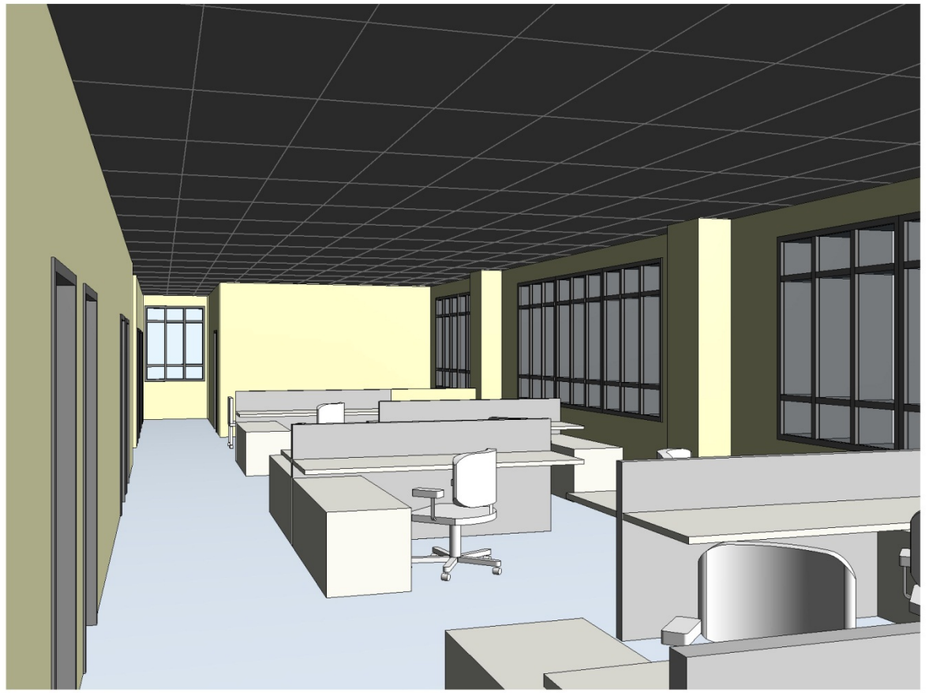
Level 2
Service Space



Level 0
Service Space



Axonometric



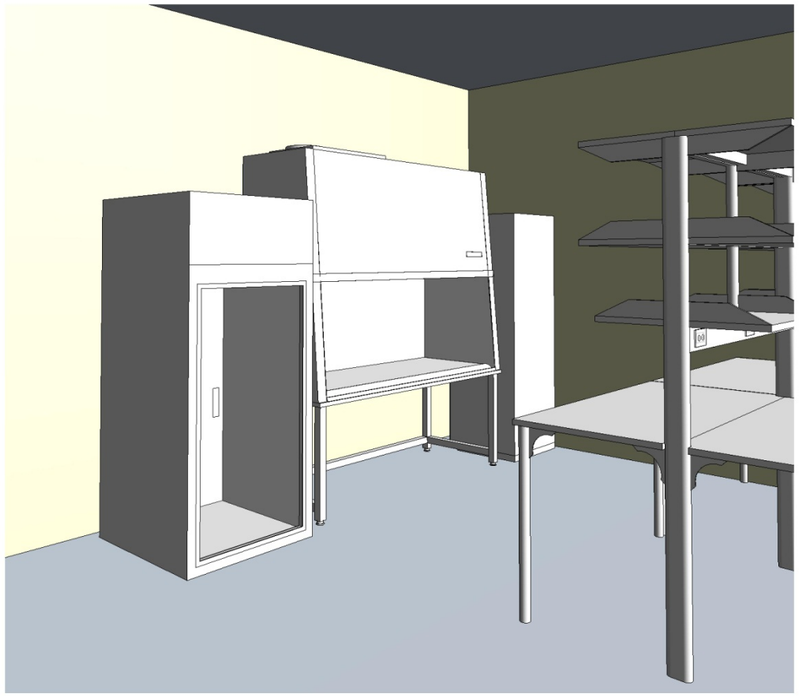
Open Office Area

Break Room

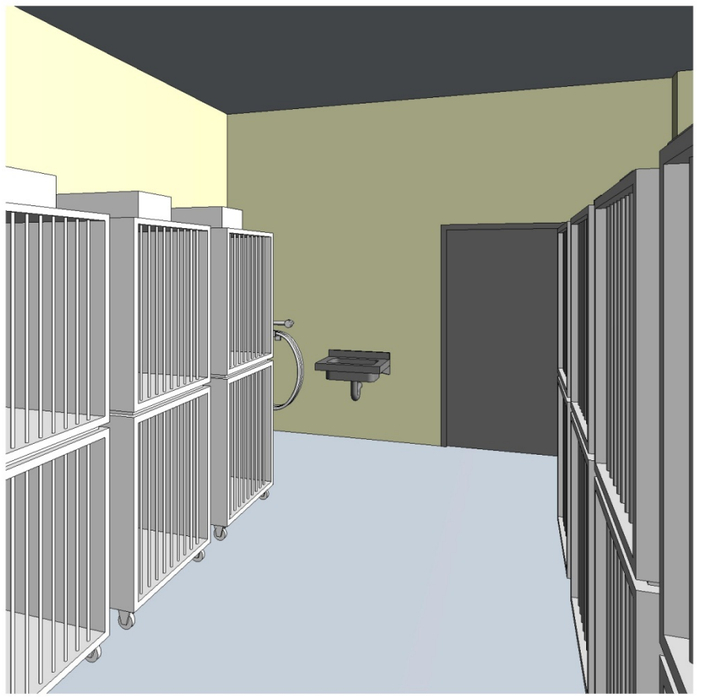
General Laboratory

Interior Views

Interior Views



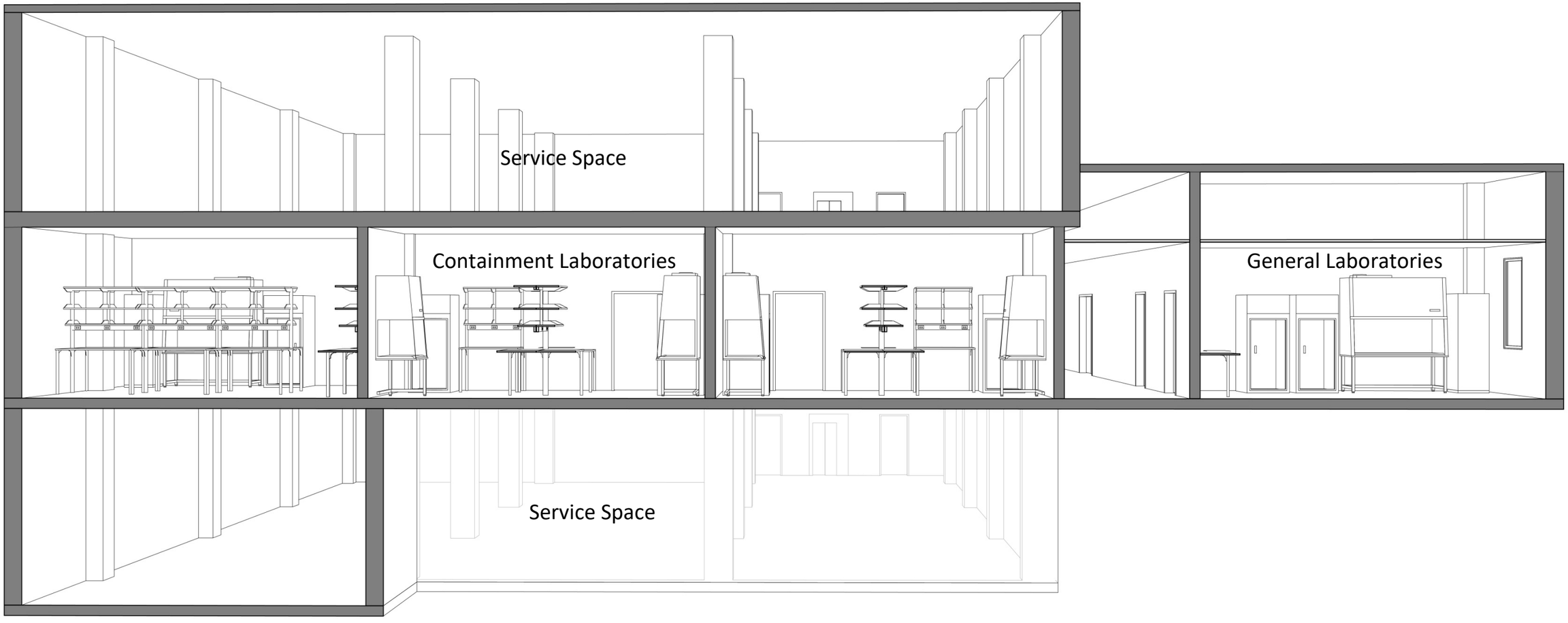
Containment Laboratory



Primate Holding Room

Rodent Holding Room

Cage Wash Area



Section View