Table of contents

- Foreword
- Acknowledgements
- Chapter 1 Introduction
- Core Principles
- Site Impacts
- Resources
- People
- Air Quality
- Occupant Comfort
- Access to Environment
- Metrics / Rating / Scorecards Why Use Them?
- BREEAM
- LEED
- Labs21
- ASHRAE Standard 189
- Focus on Energy and Carbon
- Laboratory Types
- Sustainability Categories
- Summary
- Key Concepts
- References
- Chapter 2 Integrated Design: Working Collaboratively to Achieve Sustainability
- Introduction to Integrated Design
- Sustainability Categories
- Planning and Integrated Design Process
- Assembling the Team
- Communicating Expectations
- Ongoing Interactions
- Traditional Sequential Design vs. Integrated Simultaneous Design
- Project Tasks in an Integrated Design Process
- Research / Evaluation
- Criteria / Loads
- Orientation and Massing
- Envelope Organization
- Glazed Areas
- External Solar Controls
- High Performance Glazing
- Double-Wall Facades
- Demand-Responsive Facades
- Dynamic Glazing
- Integral Loads
- Integrated Design and Building Information Modeling (BIM)
- Smithsonian Tropical Research Institute Research Station
- Site

- Energy Security
- Water and Waste
- Materials
- Design for Adaptability to Future Uses
- Indoor Environment
- Conclusion
- Key Concepts
- Chapter 3 Programming: Laying the Groundwork for a Sustainable Project
- Introduction
- Sustainability Categories
- Macro Programming
- The Program
- Laboratory Module and NSF/Scientist
- Building Organization
- Building and Floor Plate Efficiency
- Equipment Requirements
- Program Space for Sustainable Operations
- Reduce the Frequency and Scope of Renovations
- Micro Programming
- Temperature and Relative Humidity
- Air Changes
- Hours of Operation
- Redundancy
- Filtering
- Plumbing and Process Piping
- Power
- Lighting
- Exhaust Devices
- Code Classification
- Structural
- Equipment
- Conclusion
- Key Concepts
- References
- Chapter 4 Site Design: Connecting to Local and Regional Communities
- Introduction
- Sustainability Categories
- General Principals of Sustainable Site Design
- Choosing and Appropriate Site
- Site Assessment Study Part 1
- Site Assessment Study Part 2
- Designing a Project to Fit Sustainably on a Site
- Lab Specific Site Design Considerations
- Stormwater Management Techniques
- Below Grade Stormwater Storage Chambers
- Pervious Pavements in Action

- Landscaping Considerations
- Case Study: Boston University Medical Center, BioSquare III, Boston, MA
- Site Design Strategies
- Case Study: AstraZeneca, R&D Expansion, Waltham, MA
- Site Design Strategy
- Case Study: Arnold Arboretum at Harvard University, Weld Hill Research and Administration Building, Jamaica Plain, MA
- Geo-Thermal Well Field Design Challenges
- Conclusion
- Key Concepts
- References
- Chapter 5 Laboratory Performance: Simulation, Measurement and Operating Characteristics
- Sustainability Categories
- Energy Modeling
- Laboratory Energy Estimation Basics
- Energy Modeling Protocols
- Energy Analytics
- Life-Cycle Cost Analysis
- Metering for the Sustainable Laboratory Building
- Introduction to Metering
- What to Meter?
- Components of a Metering System
- Metering for the Multi-Tenant Laboratory Building
- Metering in Federal Government Laboratories
- Advancing Metering
- The Laboratory Building Dashboard
- Measurement and Verification
- Introduction to M&V
- The M&V Plan
- M&V Analysis Approach
- Metering to Support M&V
- Comparison of Measured and Forecasted Loads
- Dealing with Uncertainty in M&V
- Preparation of the M&V Report
- Laboratory Building Commissioning
- Retro-commissioning
- Conclusion
- Key concepts
- References
- Chapter 6 Engineering Systems: Reducing What Goes In and What Comes Out
- Introduction
- Sustainability Categories
- Mechanical and Electrical Demand Reduction
- Heating and Cooling Load Profiling
- Supply Airflow Required to Offset the Cooling Load

- Supply Air Required for Lab Dilution
- Supply Air Needed to Makeup Air to Exhaust Elements
- Lab Driver Characterization
- Perimeter Lab Calculation Example (Interior and Envelope Loads)
- Interior Lab Calculation Example (Internal Heat Gains Only)
- Reducing Airflow Demand in Load-Driven Labs
- Reducing Demand with Envelope Improvement
- Reducing Demand Caused by Equipment Heat Gain
- Reducing Demand in Hood-Driven Labs
- Reducing Demand in Air Change-Driven Labs
- Energy-Efficient Systems to Meet the Demand
- Variable Air Volume Operation
- Laboratory Air System Control Technology
- Air Distribution Efficiency
- Underfloor Air Distribution (UFAD)
- Chilled Beams
- Glycol Runaround Exhaust Air Energy Recovery
- Heat Pipe Exhaust Air Energy Recovery
- Exhaust Air Energy Recovery by Energy Wheels
- Comparison of Energy Recovery Technologies
- Low Pressure-Drop Air Distribution
- Demand-Controlled Ventilation
- Increase Return Air from Labs
- Passive-Evaporative Downdraft Cooling
- Biowall
- Radiant Heating Systems
- Internal Ventilation Requirements and Design Considerations
- Air Exhaust and Intake Design Considerations
- Exhaust Stack Design
- Exhaust Treatment and Emission Reduction
- Low-Energy Cooling and Heating
- Heat Pump Systems
- Chilled Water Distribution
- Ice Storage and Non-Electric Cooling Technologies
- Optimum Chiller Configuration
- Lake Source Cooling Water
- High Efficiency Condensing Boilers
- Heat Recovery from Boilers
- Active Solar Heating and Cooling
- Refrigerant Selection
- Power Generation and Renewable Energy
- Photovoltaic Arrays
- Wind Turbines
- Biomass-Fueled Power Generation
- Landfill-Derived Methane Fueled Generation
- Fuel Cells

- Cogeneration
- Carbon Neutral Laboratory Buildings
- Carbon Footprint Reduction
- Corporate Carbon Emission Initiatives
- Laboratory Water Conservation
- Laboratory Water Demand and Consumption
- Sustainable Water Systems
- Water Supply Concepts
- Waste System Concepts
- System Cleaning and Testing
- Conclusion
- Key Concepts
- References
- Chapter 7 Indoor Environment: The Health and Happiness of Building Occupants
- Introduction
- Learning from Corporate Workplace Trends
- Costs and Returns
- Indoor Air Quality
- Contaminants During Construction
- Contaminants from Material Offgassing
- Contaminants from Occupancy
- Chemical Safety / Chemical Dispensing
- Separation / Compartmentalization
- Limited Quantity Usage Dispensing / Centralized Storage
- Thermal Comfort / Occupant Control
- Access to Exterior Environment / Daylight
- Daylighting in Buildings
- Shaping the Building For Daylighting Conclusions
- Lighting Design for Laboratories
- Luminaire and System Component Selection
- Integrated Approach to Lighting Design
- Lighting Levels
- Lamp Efficiency and Related Selection Considerations
- Lighting Design Strategies
- Design Impacts on Lighting
- Task Lighting
- Daylighting and Daylight Harvesting
- Laboratory Lighting Controls
- Connections Between Acoustical Considerations and Sustainable Design for Laboratories
- Noise Control
- Outdoor Noise
- Indoor Noise
- Silencer Applications
- Architectural Acoustics Design
- Acoustical Materials for Laboratories

- Conclusion
- Key Concepts
- References
- Chapter 8 Materials: What is the Sustainable Lab Made Of
- Introduction What Makes Materials Sustainable?
- Sustainability Categories
- Material Reuse / Refurbishment / Downcycling
- Recycled Content and Recyclability of Materials
- Harvesting Practices and Transportation
- Healthy Materials VOCs, Low?Toxicity
- Sustainable Material Sources
- Certifications
- What is Different About Laboratory Materials?
- Casework
- Worksurfaces
- Material Selection Metrics
- Athena Institute
- Cradle to Cradle
- Living Building Challenge
- BRE Green Guide to Specifications
- ASHRAE 189
- Material Classification
- Flooring
- Wall Finishes
- FRP and PVC Panels
- Reinforced Epoxy Wall Coatings
- High Performance Coatings
- Wall Paint
- Casework
- Ceilings
- Conclusions
- Key Concepts
- References
- Chapter 9 Renovation and Leasing: Alternative Approaches to New Construction
- Introduction
- Sustainability Categories
- Converting Existing Buildings to Laboratory Use
- Benefits of Converting an Existing Building to Laboratory Use Compared to New Construction
- Conserving Embodied Energy and Reducing Waste
- Adaptive Reuse and LEED
- Characteristics of a Suitable Existing Building for Conversion to Laboratory Use
- Evaluation of an Existing Building for Conversion to Laboratory Use
- Case Study Examples
- NIBRI, Cambridge, MA
- University of DE Brown laboratory Newark, DE

- Gene Logic Gaithersburg, MD
- 640 Memorial Drive Cambridge, MD
- Leasing Laboratory Space in Multi-Tenant Buildings
- Sustainability Issues Unique to Multi-Tenant Buildings
- The Landlord's Motivation
- The Tenant's Motivation
- Identifying Grants and Rebates
- The LEED Green Building Rating System
- Case Study Examples
- 670 Albany Street at BioSquare, Boston, MA
- Renovating Previously Occupied Laboratory Space
- Conclusion
- Key Concepts
- Chapter 10 Conclusion