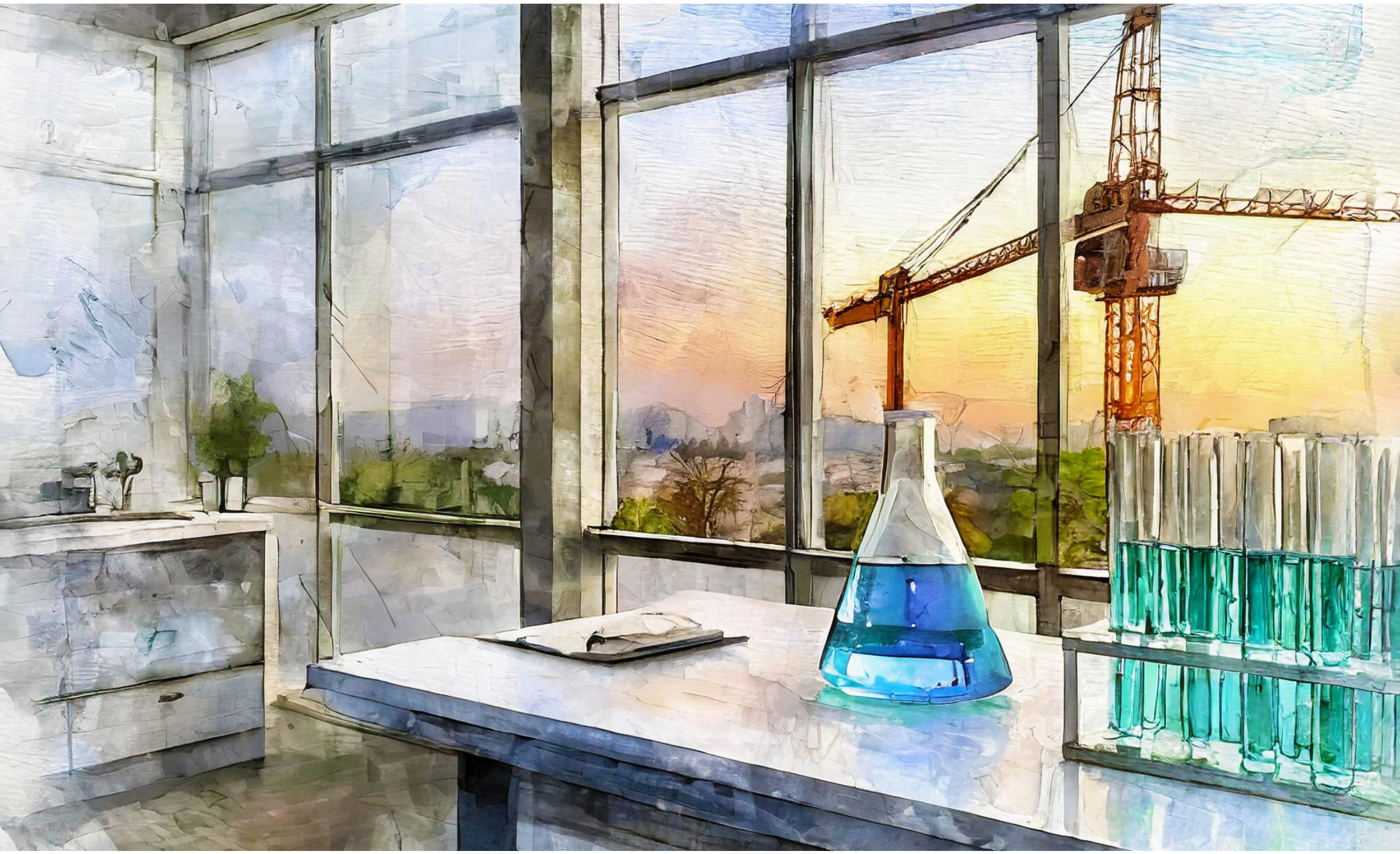
LABORATORIES
CANADA

SCIENCE BY DESIGN

LABORATORIES CANADA'S REPEATABLE LABORATORY DESIGN FRAMEWORK

2024



Public Services and Procurement Canada
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LABORATORIESCANADA

Science by design: Laboratories Canada's Repeatable Laboratory Design Framework | 2024

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Sponsor of the RLDF

Duncan Retson
Assistant Deputy Minister
Science and Parliamentary Infrastructure Branch

About Laboratories Canada

Laboratories Canada is delivering the long-term vision and strategy to strengthen federal science in Canada. Budget 2018 launched the first phase of this strategy, initiating a now $3.8B investment to support federal scientists with the important work they do for Canada.

The strategy signals a forward-looking approach to science planning by fostering innovation and collaboration in world-class environmentally sustainable and accessible facilities. The new facilities will house modern laboratories and collaborative spaces enabled with information technology and equipment tailored to meet the needs of federal scientists.

The strategy will increase the government's ability to attract a diverse range of talented scientists and researchers to work alongside federal leaders, while ensuring the government remains at the forefront of regulatory enforcement. It will also spark innovative ways of doing research, drive collaboration and economic growth, and deliver results for Canadians.

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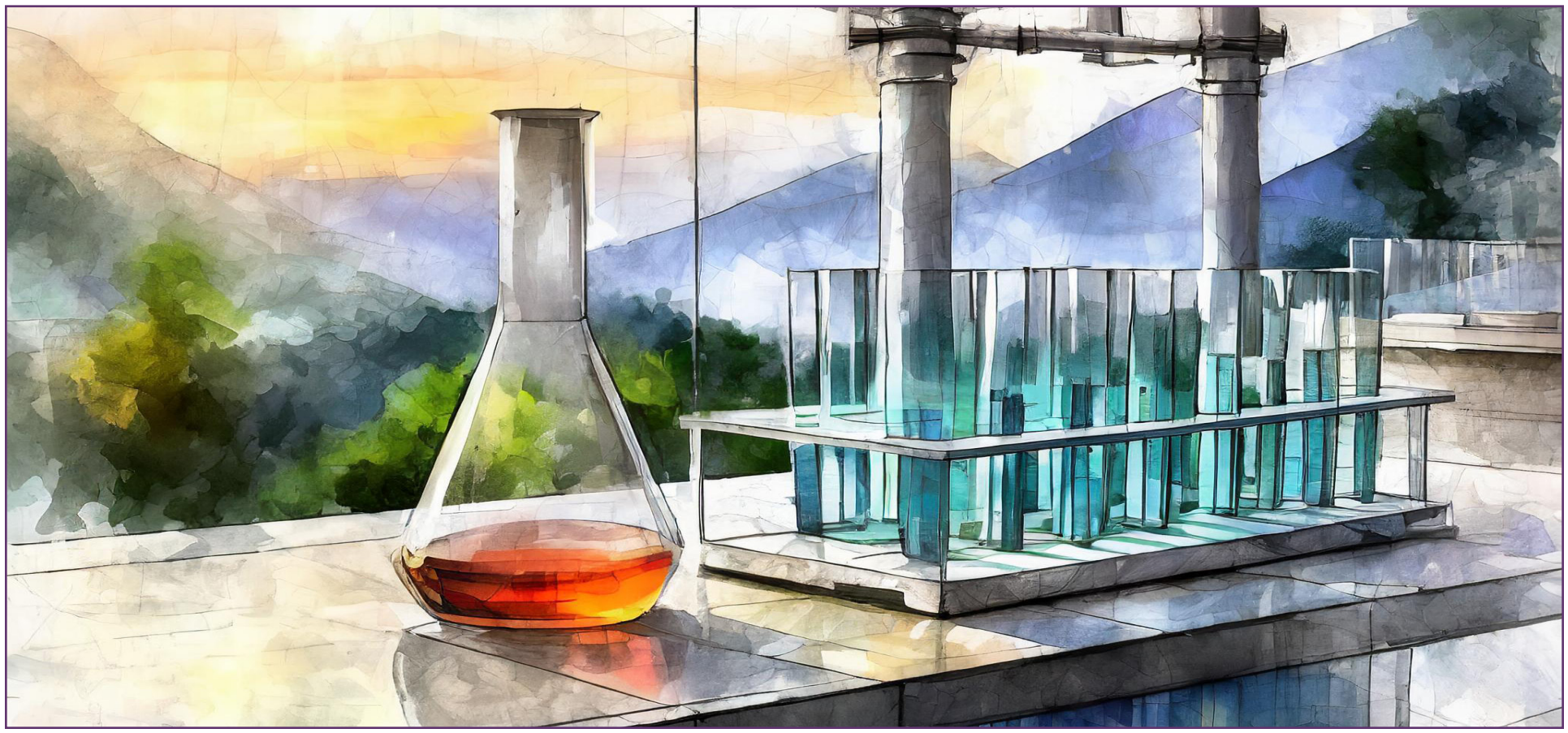


FOREWORD
BY THE ASSISTANT DEPUTY MINISTER

As sponsor, I am proud to introduce the Repeatable Laboratory Design Framework (RLDF), a key component in realizing the Long Term Vision and Plan (LTVP) for Canada's scientific infrastructure through Laboratories Canada. The goal of the LTVP is to create a cohesive network of federal laboratories that are innovative and support a collaborative approach to conducting science, to help solve our biggest societal challenges, and improve the lives of all Canadians. The RLDF is central to this vision, playing a pivotal role in modernizing, enhancing functionality, safety, and sustainability across our national laboratory facilities while aligning seamlessly with Laboratories Canada's commitment to enabling world-class evidence-based and multi-disciplinary scientific exploration. By integrating thorough planning with forward-thinking design, the RLDF ensures that each laboratory becomes a hub of innovation and functionality while embracing Laboratories Canada's core values of collaboration, agility, inclusivity and prudent public stewardship.

The RLDF integrates building codes, best practices, safety standards, and Laboratories Canada's design principles and is being regularly updated to keep pace with the dynamic nature of science. The holistic approach embodied in the RLDF is aimed at guaranteeing the safety and innovation of top-tier labs and their cost-effectiveness, quality consistency, and operational efficiency.

Laboratories Canada, within Public Services and Procurement Canada (PSPC), is committed to the government's broader objectives of transforming the management of science assets and delivering a modern portfolio that will position Canada for the 21st century and beyond. The RLDF exemplifies this commitment, setting each laboratory on a path to becoming a beacon of science excellence.

I encourage all our partners to be actively involved in and help shape this transformative process. I encourage others who are interested in potentially drawing upon and contributing to this evergreen framework to reach out to the Laboratories Canada team. We work together to shape a future where our labs are more than just functional, but are smart hubs of collaboration and innovation, facilitated by excellent design.

Duncan Retson
Assistant Deputy Minister
Science and Parliamentary Infrastructure Branch

LABORATORIES CANADA

Long Term Vision and Plan

Creating world-class national networks of science infrastructure, comprised of modern, multipurpose, federal science and technology laboratories to support collaborative, multidisciplinary research and innovation, and evidence-based decision making, including in regulatory responsibilities.

Exterior of the TerraCanada advanced materials research facility, Mississauga, ON

TerraCanada – NRCan CanmetENERGY facility, Ottawa, ON

INTRODUCTION

Science plays a critical role in fostering a vibrant society and thriving economy in Canada. The design of laboratory facilities and infrastructure is a primary driver in achieving important scientific advances, such as medical breakthroughs, insights that improve our environment and promote the health and well-being of Canadians.

Adopting a consistent and standardized approach in the planning and design process is essential to create laboratory facilities that support innovation and scientific advancement, while meeting sustainability and functional requirements. The Repeatable Laboratories Design Framework (RLDF) presented here is aimed at achieving this. The RLDF yields outcomes that align with the principles of effectively and efficiently operating and maintaining quality laboratory infrastructure that delivers a high standard of technical and operational performance, demonstrating Canada's commitment to science.

Laboratories Canada's vision is to establish a national network of modern, collaborative and accessible federal laboratories that foster science innovation and creativity in support of evidence-based decision making to advance departmental mandates and regulatory responsibilities. This vision involves Four Pillars to position Canada at the forefront of new discoveries, and enable federal scientists to continue their vital work for the benefit of Canadians:

Facilities: Build leading-edge, collaborative, accessible, and sustainable facilities

Equipment: Promote sharing and streamline procurement of major equipment

IM/IT: Modernize IM/IT systems to meet evolving science needs

Barriers: Address barriers to Science and Technology that inhibit collaboration

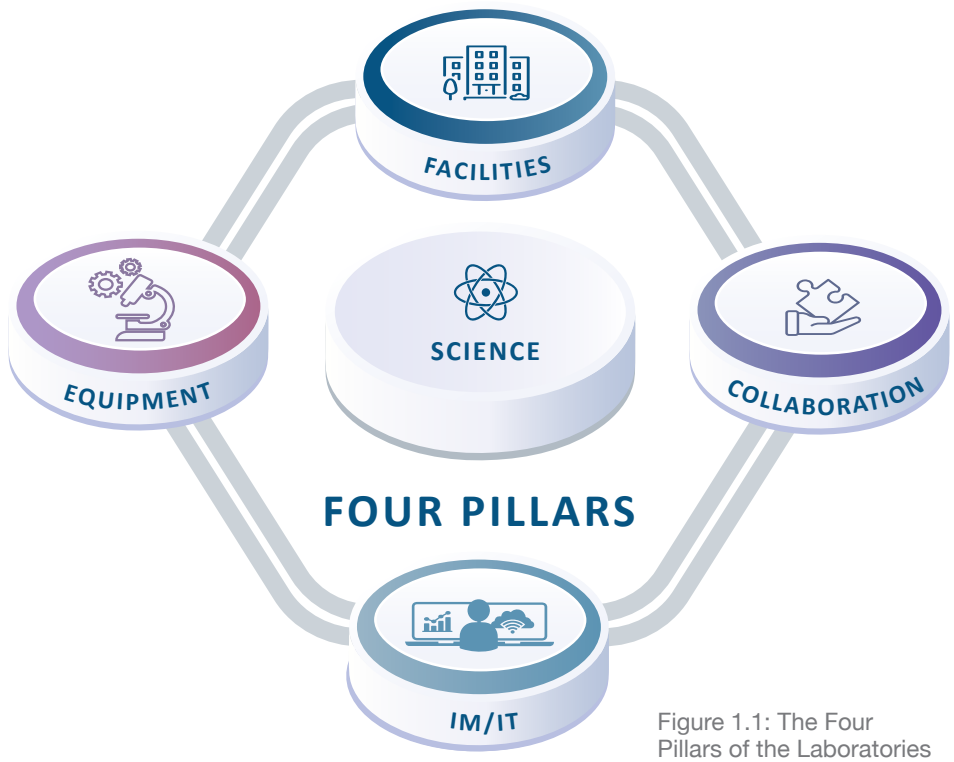


Figure 1.1: The Four Pillars of the Laboratories Canada Strategy

Laboratories Canada's Long Term Vision and Plan (LTVP) sets out the following Guiding Principles intricately linked to the Four Pillars, establishing the foundational values and priorities for the development and implementation of its strategy:

- Science Excellence
- Collaboration
- Diverse and Inclusive Talent Pool
- Agility and Responsiveness
- Environmental Responsibility
- Responsible Public Stewardship

Federal scientists already apply these Guiding Principles in how they work. By aligning with them, Laboratories Canada effectively integrates its vision, strategy, and priorities into every aspect of its program, ensuring that the needs of the science community are met.

TerraCanada advanced materials research facility, Mississauga, ON

LABORATORIES CANADA DESIGN QUALITY FRAMEWORK DEFINED

The RLDF serves as Laboratories Canada's design quality guideline and technical reference for laboratories. The RLDF is the result of rigorous research, review by industry subject matter experts, and discussions with a diverse range of stakeholders and specialized workgroups. This inclusive approach ensured consideration of a wide array of perspectives to address key challenges and provide valuable feedback, including practical live feedback from those engaged in designing and building the earliest of our projects, like the new Centre for Plant Health – our Pathfinder Project in Sidney, British Columbia.

A key benefit of the RLDF is its capability to accelerate the implementation of laboratory projects. It draws on industry best practices and provides design and technical recommendations, streamlining design and construction processes. It offers efficient, cost-effective, functional, and safe solutions that are consistent and replicable across multiple projects. This standardization ensures predictable and successful outcomes and ongoing incorporation of lessons learned, reducing project design and construction timelines.

In applying the RLDF, design and construction teams are able to ensure that laboratory buildings align with Laboratories Canada's benchmarks for performance, safety, and functionality. The RLDF encompasses building design requirements and performance objectives derived from building codes, best practices, safety regulations, and guidelines. Additionally, it aligns seamlessly with government policies and mandates, such as the Treasury Board Secretariat Greening Government Strategy, and those of Accessibility Standards Canada. Application of the RLDF will make a significant contribution to ensuring that Canada has quality, high-performance, functional, and climate-resilient laboratory portfolio to meet its science and technology needs.

PURPOSE AND OBJECTIVE OF THE RLDF

The RLDF is codified in an evergreen document that promotes the development of high-performance laboratory infrastructure, supporting broad Government of Canada priorities including prudent stewardship, Indigenous reconciliation and improved accessibility and sustainability. The RLDF is designed to fulfill a specific purpose:

> To achieve science excellence, sustainability, and agile high-performance laboratory facilities for Canada through leadership, collaboration, stewardship, and design processes that are consistently replicable across an entire portfolio.

The RLDF translates the LTVP Guiding Principles into a set of laboratory-specific Design Principles that serve as a foundation for design processes and technical design guidelines. These Design Principles provide guidance to the laboratory facilities design teams in developing designs that are functional and meet science needs.

APPLYING THE RLDF

The RLDF is tailored to provide guidance to a diverse range of professionals and stakeholders involved in laboratory facilities. Its purpose is to provide guidance and support in furthering excellence in laboratory design, sustainability, and innovation within the Laboratories Canada context. The two primary target audiences are:

(a) Architecture, engineering, and specialist lab design professionals:

These users are involved in laboratory design, operations, and maintenance and include designers, consultants, government officers, project managers, researchers, specialists from various disciplines such as planning, development, architecture, engineering, landscape architecture, cost consulting, lab specialist investment and finance practices, and building operators—individuals who collectively contribute to the effective management, utilization, and maintenance of laboratory facilities, ensuring their optimal performance and alignment with sustainability goals.

(b) Other science and technology stakeholders interested in laboratory facilities and projects, including building occupants:

This broader audience includes individuals interested in advancing science and technology, and wanting to see how their work may align with Laboratories Canada's vision and best practices. The RLDF can provide building occupants, including researchers and lab users, with valuable insights for enhancing the effectiveness and sustainability of their facilities. Their perspectives on usability, functionality, and safety contribute to the collaborative effort of achieving Laboratories Canada's vision of sustainable laboratory designs.

TerraCanada advanced materials research facility, Mississauga, ON

BENEFITS OF THE RLDF

The RLDF is core to the Laboratories Canada program:

01 **Efficient and Effective Laboratory Design:**

In the ever-evolving arena of scientific research and innovation, the significance of efficient and effective laboratory design cannot be overstated. The RLDF emerges as a strategic response to address the challenges and complexities faced by laboratory projects, enabling laboratories to streamline their planning and design processes. This results in significant advantages that span various dimensions of a project.

02 **Maximizing Potential with Minimized Time and Cost Expenditures:**

A key goal of the RLDF is to maximize the potential of laboratory facilities while minimizing time and cost expenditures. Its systematic approach ensures compliance with all relevant codes, standards, and regulations right from the outset. By avoiding costly modifications and time-consuming revisions later in the project life cycle, the RLDF offers substantial savings in project cost and schedule.

03 **Fostering Sustainable and Environmentally Responsible Design**:

The RLDF embodies a holistic approach to design, emphasizing the integration of sustainable and environmentally responsible elements that contribute to high performance. By implementing energy-efficient solutions and sustainable practices, the RLDF ensures that laboratories not only meet the highest quality standards but also operate efficiently and are climate resilient.

04 **Attaining Exceptional Laboratory Performance:**

The RLDF integrates advanced design principles and leverages cutting-edge technologies, aiming to achieve exceptional laboratory performance. By pushing industry standards and promoting operational excellence, the framework enhances the overall efficiency and effectiveness of laboratory operations.

05 **Fostering User-Centric Design:**

Beyond the realm of technical and environmental considerations, the RLDF underscores the importance of user-centric design. By actively engaging stakeholders and end-users throughout the process, the technical guideline facilitates the creation of laboratories that are carefully tailored to fulfill specific needs. This promotes productivity, collaboration, and overall user satisfaction, ensuring that laboratory spaces are optimized for their intended purposes.

06 **Leading with an Innovative and Groundbreaking Approach:**

The RLDF is a transformative tool aimed at reshaping how laboratories are planned and designed. Its emphasis on adherence to regulations, environmental sustainability, and optimal performance makes it a thorough and progressive resource for laboratory development. The RLDF's benefits go well beyond the initial building phase, setting up Laboratories Canada projects for enduring success in the ever-evolving world of science.

TerraCanada advanced materials research facility, Mississauga, ON

ORGANIZATION OF THE RLDF

The RLDF is structured with five chapters, the first of which provides an overview. The remaining chapters address specific aspects of the design process.

In addition to these chapters, there is a separate section dedicated exclusively to appendices, ensuring detailed supplementary information is easily accessible and organized for reference.

ORGANIZATION OF THE RLDF

INTRODUCTION

This chapter provides an overview of the RLDF, explaining its purpose, intent, structure, and organization. It sets the stage for a cohesive and systematic approach to design quality over the project life cycle.

LABORATORIES CANADA DESIGN PRINCIPLES

This chapter establishes the fundamentals of Laboratories Canada Design Principles and their defining elements, highlighting key principles essential for creating high-performance laboratories.

LABORATORIES CANADA HOLISTIC DESIGN APPROACH

This chapter guides the implementation of Laboratories Canada Design Principles; outlines methodologies, targets, regulatory requirements, and design expectations aligned with Canadian industry standards.

TECHNICAL DESIGN GUIDELINES

This chapter specifies technical requirements for meeting the targets identified, including building system performance. It provides design guidance to ensure consistent quality and comparable outputs.

QUALITY MANAGEMENT AND CONFORMANCE

This chapter outlines Laboratories Canada's Third-Party Oversight, elaborating conformance measures employed to ensure excellence in design and construction.

APPENDICES

The Appendices provide additional data, technical specs, and insights, with in-depth exploration of the design principles included in the chapters to support the practical application of the RLDF.

DESIGN PRINCIPLES

LABORATORIES CANADA DESIGN PRINCIPLES: SHAPED BY THE LTVP GUIDING PRINCIPLES

The RLDF is shaped by the LTVP Guiding Principles, which inspired the formulation of the Design Principles. The LTVP Guiding Principles embody Canada's commitment to science excellence and innovation, while the Design Principles, developed through expert contributions, research, and stakeholder engagement, focus on creating high-performance labs benefiting Canada. Exploring the Guiding Principles is intended to promote a full appreciation of the Design Principles.

01

SCIENCE EXCELLENCE

Renewed federal laboratories will support top talent in delivering high-impact science that informs decision making and addresses the challenges of today and tomorrow.

02

COLLABORATION

Designed and equipped as collaborative hubs, renewed laboratories will bring together scientists and foster a culture of openness and engagement with partners and stakeholders.

03

DIVERSE AND INCLUSIVE TALENT POOL

Modern and collaborative spaces will help attract and retain high-calibre, diverse scientists, including early-career and international researchers.

04

AGILITY AND RESPONSIVENESS

Flexible, adaptable space will ensure that scientists can respond quickly to shifting priorities, new scientific discoveries, and stay at the cutting edge of their fields.

05

ENVIRONMENTAL RESPONSIBILITY

Environmentally sustainable facilities will be climate resilient and carbon neutral, supporting government commitments on climate change and green operations.

06

RESPONSIBLE PUBLIC STEWARDSHIP

Prudently managed science and technology assets will result in fit-for-purpose facilities that maximize space, reduce redundancy, and optimize investments.

THE LTVP GUIDING PRINCIPLES

SCIENCE EXCELLENCE

Laboratories Canada's high-performance laboratories are crucial for scientific excellence, robust evidence, solving challenges, engaging citizens, providing benefits to Canadians, and attracting and supporting top scientists.

COLLABORATION

Laboratories Canada's high-performance laboratories will foster collaboration and enable connectivity, promoting knowledge transfer, career development, and scientific innovation across government and beyond.

DIVERSE AND INCLUSIVE TALENT POOL

To achieve science excellence, Laboratories Canada's high-performance modern facilities and equipment must be coupled with talented and innovative individuals. Attracting and retaining diverse, inclusive, and international scientists will build Canada's reputation, and high-performance state-of-the-art facilities will help retain high talent.

AGILITY AND RESPONSIVENESS

It is important for federal science programs to adapt to changing global scientific contexts to produce impactful science for Canadians. Flexible facilities and adaptable spaces will enable quick pivoting in response to national issues and maintain a leadership role in the global science landscape.

ENVIRONMENTAL RESPONSIBILITY

Laboratories Canada's high-performance federal laboratories will showcase leadership in environmental sustainability by reducing facility footprints, designing new carbon-neutral and climate-resilient buildings, and supporting Canada's international commitments.

RESPONSIBLE PUBLIC STEWARDSHIP

Laboratories Canada aims to optimize science investments by reducing redundancy, maximizing laboratory space, and linking digital investments. Laboratories Canada's high-performance laboratories will be fit for purpose and respond to current and emerging science priorities while supporting asset recycling for sustainability.

Figure 2.1: The LTVP Guiding Principles

Conceptual design rendering of the Transportation Safety and Technology Science Decentralized Resource Centre, Ottawa, ON
Architects: A49 and B&H

DESIGN PRINCIPLES FOR CREATING HIGH-PERFORMANCE LABORATORIES

The Design Principles underpin Laboratories Canada's design process for achieving high-performance laboratories. Influenced by the LTVP, these Principles guide the integration of various design considerations and best practices to create transformative laboratory environments that foster science excellence. They ensure that designs are optimized for productivity, efficiency, safety, future-proofing, and sustainability, serving as the cornerstone of the RLDF.

The RLDF sets out seven Design Principles that Laboratories Canada has established as indicated in Figure 2.2. These are: Design Excellence, Collaboration, Flexibility, Functional Suitability and Expandability, Sustainability, Universal Accessibility, and Intelligent Building Infrastructure. Each principle addresses specific laboratory functions, establishing clear criteria that guide the solutions generated for various laboratory typologies, science office accommodations, and material and equipment selection to meet performance expectations.

The Design Principles provide a consistent, predictable, and replicable process for creating designs that effectively meet the needs of Canada's science community. These Principles align Laboratories Canada's vision and values with the practicalities of implementation, while promoting science excellence, efficiency, creativity, innovation, and sustainability.

The RLDF is grounded in these Design Principles, providing a foundation for measuring excellence and achieving high-performance laboratory facilities. The following sections elaborate each of the Design Principles.

Figure. 2.2: The Seven Laboratories Canada Design Principles

DESIGN EXCELLENCE

Design Excellence leads to high-performance laboratory projects. It emphasizes the importance of creating integrated and interconnected design solutions that meet or exceed performance expectations, while ensuring a holistic approach to design. This principle encompasses the high-performance expectations for laboratory environments, including functionality, sustainability, safety, comfort, durability, aesthetics, and user experience.

TerraCanada CanmetMATERIALS facility, Hamilton, ON

DEFINING ELEMENTS:

Integrated and interconnected design solutions: Results from an integrated design approach drawing on best practices in planning, architecture, engineering, procurement, maintenance, and operation methods to create laboratory environments that are interconnected, intuitive, efficient, and visibly promote scientific literacy.

Holistic approach to design: Integrates technical mastery, science-centred, innovative design strategies, authenticity, and soundness to deliver high-performance laboratory environments that express civic significance, enhance the local context, and foster a sense of national pride.

Design integrity: Emphasizes the importance of craftsmanship to assure the quality and completeness of a design to meet all functional, safe, robust, and efficient requirements of the project, creating high-performance laboratory environments that are memorable and remain reliable over the entire life cycle of the facility.

Technical proficiency of team and solutions: Engages the services of the most qualified professionals and experts, utilizing good design principles and best practice standards, to design, deliver, maintain, and operate facilities with the highest level of technical proficiency and expertise.

Resilient, durable, and efficient: Involves application of sustainable design practices, considers life cycle requirements, and complies with building durability guidelines to create high-performance labs that will withstand changing climatic conditions and minimize resource consumption.

COLLABORATION

Collaboration is widely recognized as key to success in the scientific community. Laboratories Canada is committed to promoting and facilitating collaborative initiatives. High-performance, collaborative, laboratory environments encourage diverse perspectives and expertise, leading to novel insights and revolutionary solutions. Collaborative efforts foster cross-disciplinary research, resulting in breakthroughs and advanced technologies.

Laboratories Canada promotes and enables partnerships, community, and multidisciplinary interactions to stimulate creativity and innovation, which is fostered by encouraging the exchange of ideas in shared core facilities and integral and inviting huddle spaces. This in turn leads to cost reductions and improved research efficiency.

DEFINING ELEMENTS:

Prioritizing effective collaboration beyond physical space: Integrating collaborative technology, virtual capabilities, huddle and incubator spaces alongside physical spaces to facilitate interaction and communication among diverse teams, fostering knowledge sharing across scientific disciplines.

Facilitating multi-functional transdisciplinary spaces: Creating collaborative science environments with spaces that can be easily reconfigured to meet the needs of scientists from diverse backgrounds and expertise, fostering idea and knowledge sharing through a holistic design approach that integrates transdisciplinary approaches to comprehensively address complex problems.

Stimulating innovation and enhancing scientific impact: Optimizing collaboration through high-performance spaces, including shared core amenities and huddle spaces that foster brainstorming, idea exchange, and diverse perspectives, leading to breakthroughs in scientific understanding and technology development.

Supporting external partnerships with shared resources: Prioritizing partnerships by providing access to shared labs and maker spaces for collaboration with industry partners and external organizations, encouraging knowledge sharing and collaboration.

Providing a variety of collaborative space types and removing barriers: Creating open workspaces that encourage spontaneous interactions, removing barriers like walls and cubicles, while complying with Laboratories Canada's Science Office Accommodation and Labs Typology catalogues (described in RLDF Appendices A6.0 and A7.0 respectively). Offering common areas for socialization and idea exchange, including open and flexible spaces with visual connectivity and frictionless access to shared services and public areas for knowledge and technology sharing, enhancing scientific impact.

Conceptual design rendering of the Atlantic Science Enterprise Centre, Moncton, NB
Architect: Diamond Schmitt Architects

FLEXIBILITY

Flexibility emphasizes the importance of creating adaptable spaces that can be easily reconfigured to meet future changing needs. At its core, flexibility promotes a dynamic and responsive approach to design, recognizing that the needs of users are constantly evolving and that the design of a space should be able to accommodate these changes.

TerraCanada CanmetMATERIALS facility, Hamilton, ON

DEFINING ELEMENTS:

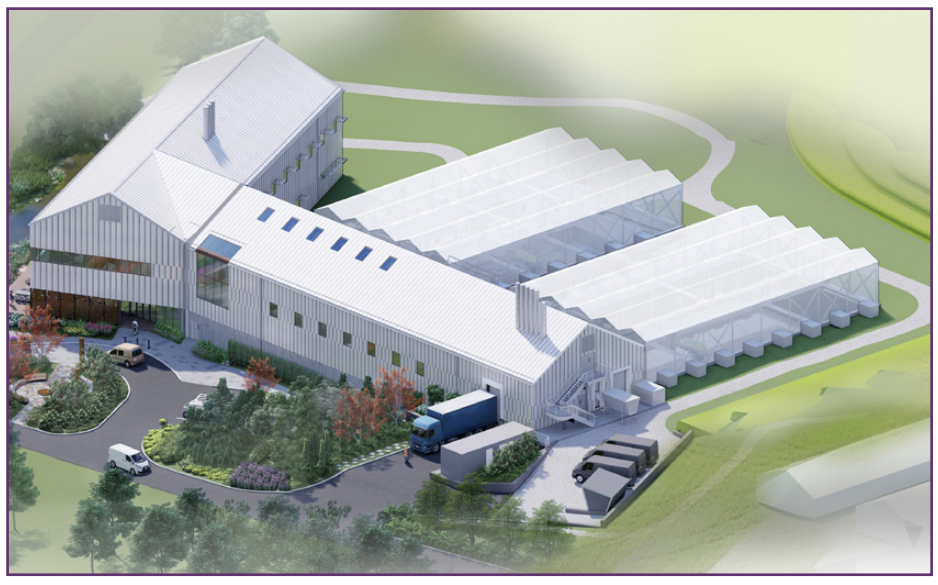
Adaptable spaces: Creation of spaces that can be easily modified to meet changing needs. This can include the use of modular furniture, movable partitions, and other flexible design elements.

Multi-functional modular design: Underscores the need for sound and practical modular laboratory planning strategies, creates multifunctional spaces that can serve multiple purposes, allowing spaces to be used in different ways at different times, making them more versatile and adaptable to changing needs.

Futureproofing: Flexible designs consider the future needs of a space and anticipate how it will be used in the years to come. This involves designing for flexibility and adaptability, ensuring that a space can evolve and change as needed.

User-centric design: Fosters a user-centric design approach that prioritizes the needs of the people who will be using a space. This involves engaging with Laboratories Canada users and stakeholders throughout the design process and creating spaces tailored to the needs of the science being conducted in the space.

Sustainability grounded in flexibility: Promotes sustainability by extending the lifespan of a space and reducing the need for costly renovations or new construction. By creating adaptable spaces that can evolve, flexibility can help to reduce waste and promote a more sustainable approach to design.



Conceptual design rendering of the Regulatory and Security Science Sidney Centre for Plant Health, North Saanich, Sidney, BC
Architect: Architecture 49

FUNCTIONAL SUITABILITY AND EXPANDABILITY

These are essential considerations in the design of high-performance laboratories because they determine the laboratory's ability to meet the needs of its users both now and in the future. This principle acknowledges that simply fulfilling the intended purpose of a laboratory is not enough. It is necessary for the design to enable facilities to adapt and grow alongside the evolving scientific practices they serve.

Aerial shot of the Regulatory and Security Science Sidney Centre for Plant Health, North Saanich, Sidney, BC

DEFINING ELEMENTS:

Purpose-driven design: Ensures facilities are fit for their intended use and meet user needs while providing several benefits, including improved efficiency, safety, cost-effectiveness, productivity, and high-performance design quality.

Scalability: Ensures facilities are designed with the potential for growth and expansion to accommodate evolving user requirements, while offering various advantages, including flexibility, cost-effectiveness, improved efficiency, increased capacity, and incorporation of innovations.

Flexibility factor: Integrates flexibility into the design, enabling modifications of design and operational requirements to suit the specific needs of users. This enhances the organization's research capabilities, promotes collaboration, and amplifies the impact of its research within the scientific community in Canada and beyond.

Modularity: Emphasizes the importance of effective and efficient modular laboratory planning strategies and components that can be easily replaced or upgraded, extending the functionality and life cycle of the facility.

Compatibility: Prioritizes the compatibility of facilities with other systems and devices to ensure seamless integration and interoperability, as well as ease of transformability to accommodate future changing needs.

SUSTAINABILITY

Much like a building's foundation is critical for its stability and longevity, sustainability is paramount for ensuring the long-term resilience and success of a facility. Sustainability is vital for efficient and effective operations while simultaneously reducing environmental impact and maximizing social and economic benefits.

The Treasury Board of Canada Secretariat Greening Government Strategy Directive establishes requirements for integrating sustainability principles in facility design, construction, operation, and maintenance. The Sustainability Design Principle recognizes this directive as a cornerstone of designing laboratory facilities that are safe, flexible, mission-driven, and resilient to climate change.

DEFINING ELEMENTS:

Safety, health, wellness, well-being and social equity: Ensures designs will protect personnel and promote wellness and sustainability. This involves limiting exposure to hazards and creating a comfortable and inclusive work environment that supports mental health, neurodiversity, and well-being. Accessibility and equal access are emphasized to ensure a fair and just work environment.

Science excellence and incorporations of innovation in designs: Supports innovative research in energy-efficient systems, renewable energy sources, sustainable materials, waste management, and green transportation so that facilities are energy-efficient and sustainable while optimizing resource utilization and promoting safety, health, and innovation.

Environmental stewardship and mission-specific mandate: Involves design of net-zero carbon laboratories to minimize environmental impact and maximize resource efficiency, aligned with energy efficiency, water conservation, waste reduction, carbon emissions reduction and other sustainability-related commitments.

Enhanced economic vitality and viability: Incorporates sustainable strategies to reduce operating costs and ensure long-term performance. Flexible designs attract talent and investments, contributing to the economic development of the community. Balancing costs and asset value, upfront investment in good design generates savings in maintenance and operation costs.

Climate resiliency: Incorporates climate resiliency in laboratory designs to minimize environmental impact and respond and adapt to climate change. Considers factors such as site selection, energy efficiency, renewable energy, water management, and emergency preparedness. Promotes flexible design and regular maintenance to ensure long-term sustainability and durability.

Conceptual design rendering of the Atlantic Science Enterprise Centre, Moncton, NB
Architect: Diamond Schmitt Architects

UNIVERSAL ACCESSIBILITY

Universal Accessibility underscores the need to incorporate universal design elements in laboratory designs to ensure that facilities are accessible and accommodating to individuals of all abilities and ages, and considers diverse factors such as gender, neurodiversity, cultural, social, and economic backgrounds. This principle is fundamental in promoting inclusivity and ensuring equal participation opportunities.

DEFINING ELEMENTS:

Equitable use: Ensures laboratories are accessible to all users, without impediments or putting anyone at a disadvantage. Incorporates features such as adjustable work surfaces, accessible shelving, and tactile indicators. Incorporating Gender-Based Analysis Plus tools during the functional programming process to support the design team in creating welcoming, accessible, and inclusive environments that lead to better outcomes.

Flexibility in use: Emphasizes the importance of flexibility in the design of Laboratories Canada laboratory facilities to accommodate the needs of all users. This can be achieved by providing workspaces that can be adjusted to meet the needs of different users, such as providing adjustable lighting, sound, and temperature controls.

Simple and intuitive use: Underscores the importance of designing laboratories so that they are easy to understand and use. This can be achieved by adopting clear innovative signage and wayfinding strategies, simple and intuitive controls, and tactile indicators.

Perceptible information: Fosters designs that provide laboratory information that is accessible to all users. This can be achieved by providing clear, intuitive, and legible signage, audible and visual alarms, and tactile indicators.

Tolerance for error: Fosters designs that minimize the risk of errors and accidents. This can be achieved by incorporating features such as non-slip flooring, accessible emergency exits, and clear pathways of travel.

Conceptual design rendering of the Atlantic Science Enterprise Centre, Moncton, NB
Architect: Diamond Schmitt Architects

INTELLIGENT BUILDING INFRASTRUCTURE

Intelligent Building Infrastructure (IBI) emphasizes the importance of establishing an integrated and digital optimization strategy and incorporating it into designs, based on science, health, comfort, safety, predictive operations, maintenance, service, and sustainability. Achieving this requires extensive integration of buildings systems beyond that involved in traditionally segregated communication networks.

Conceptual design rendering of the Atlantic Science Enterprise Centre, Moncton, NB
Architect: Diamond Schmitt Architects

DEFINING ELEMENTS:

Integration of building systems: Emphasizes the integration of all building systems, including heating, ventilation, air conditioning, lighting, security, and fire protection. Integrating these systems into a single, intelligent network increases their efficiency and reliability, and enables predictive maintenance.

Advanced analytics: Incorporates advanced analytics to analyze data from sensors and building systems to identify patterns, optimize energy use, and predict maintenance needs, leading to improved building performance, lower energy costs, and reduced environmental impact.

Autonomous building functions: Incorporates autonomous building functions to automate routine controls and tasks related to lighting, heating, and cooling, and adjust building systems in real-time based on occupancy and usage patterns, resulting in improved comfort, reduced energy consumption, and lower operating costs.

Secure and reliable IBI framework: Emphasizes the need for a secure and reliable IBI framework and recognition of its criticality in ensuring the safety of the building's occupants and protecting the integrity of the data transmitted through the IBI network, and complying with the latest standards for network requirements and physical security.

Futureproofing: Anticipates future requirements and plans for additional capacity and controls, ensuring that facility infrastructure is flexible and adaptable and capable of incorporating future technology advancements.

HOLISTIC DESIGN APPROACH

ENHANCING ENVIRONMENTAL SUSTAINABILITY AND EXCELLENCE IN OVERSIGHT AND GOVERNANCE

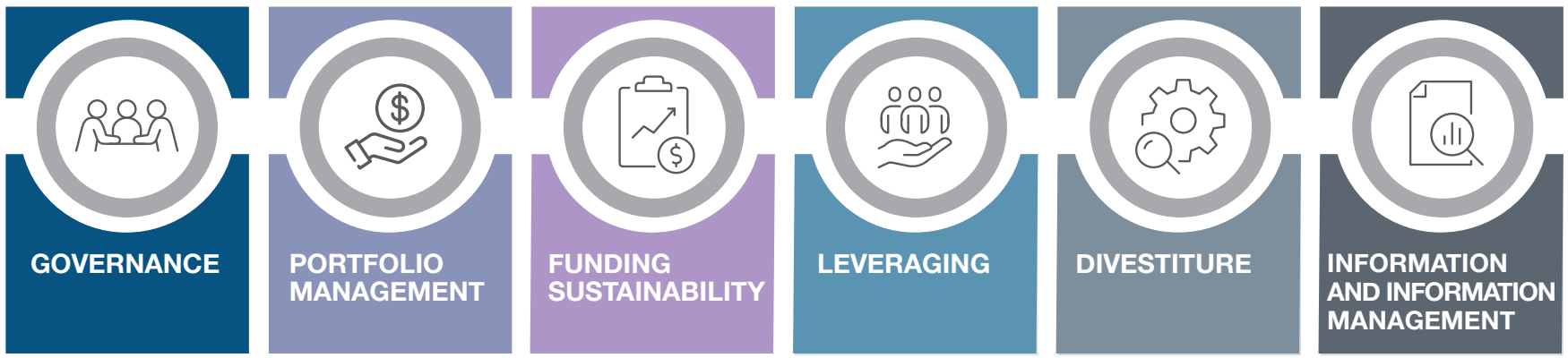
A holistic design approach considers the entire life cycle and the environmental, social, and economic impacts of laboratory facilities. It emphasizes a systems-thinking approach that considers the interconnectedness of design elements and the various interests of stakeholders involved in the design.

A holistic design process involves a series of stages, such as research, ideation, prototyping, testing, and iteration, carried out in an integrated manner to ensure that the design meets the needs of all stakeholders and considers the entire life cycle of the laboratory or system.

Laboratories are complex systems with interconnected parts working together to achieve optimal performance. A holistic design process accounts for the interrelationships among different elements and their broader impact on the system and its context. Creating sustainable and high-performance laboratories requires the application of whole life cycle thinking and application of circular economy and closed-loop systems principles.

The RLDF provides for consideration of sustainability across all aspects and stages of each project, addressing technical, environmental and social concerns leading to close alignment with Environmental, Social, and Governance (ESG) framework objectives. These frameworks evaluate how entities address environmental concerns, treat their employees and stakeholders, and uphold strong governance principles. ESG emphasizes the integration of sustainable practices, social responsibility, and ethical governance into decision-making processes. The holistic design approach and ESG frameworks share common objectives in seeking to create sustainable and responsible solutions. When harmonized, these two elements are mutually reinforcing and enabling Laboratories Canada to contribute effectively to fulfilling the recommendations of the Horizontal Fixed Asset Review, led by the President of the Treasury Board of Canada. These recommendations encompass considerations for sustainability, environmental impact, and responsible asset management, aiming to ensure that government assets are utilized efficiently, effectively, and in a manner that aligns with environmental and social objectives.

By embedding the principles of ESG and the recommendations from the Fixed Asset Review in the RLDF, Laboratories Canada is making meaningful contributions toward achieving the goals outlined in the recommendations of the Fixed Asset Review, as indicated in Figure 3.1.



GOVERNANCE	PORTFOLIO MANAGEMENT	FUNDING SUSTAINABILITY	LEVERAGING	DIVESTITURE	INFORMATION AND INFORMATION MANAGEMENT
Establish a robust governance and oversight structure for managing fixed assets. This includes enhancing professional capabilities and ensuring effective decision-making processes and accountability.	Implement a disciplined and systematic portfolio management regime for better management of fixed assets. This involves strategically assessing, prioritizing, and optimizing the portfolio to align with organizational objectives.	Develop a new approach to funding sustainability for fixed assets. This may involve exploring alternative funding models, optimizing resource allocation, and considering long-term financial sustainability in asset planning and management.	Recognize real property as a strategic enabler and create an environment that maximizes the value and benefits derived from fixed assets. This includes leveraging assets to support organizational goals, collaboration, and partnerships.	Adopt an innovative and streamlined approach to divestiture of fixed assets that are no longer required or aligned with organizational objectives. This may involve exploring new methods for disposal, such as public-private partnerships or asset repurposing.	Prioritize data and systems improvement to enhance information management related to fixed assets. This emphasizes the use of business intelligence and data analytics to drive evidence-based decision making and optimize real property management practices.
RLDF ALIGNMENT					
• Provides guidelines for establishing clear governance and oversight, including roles and responsibilities for design decision making and accountability. • Incorporates design review processes that involve stakeholders and subject matter experts, ensuring effective decision making and alignment with governance. • Establishes criteria for assessing the design quality and performance of individual assets, enabling prioritization and portfolio optimization based on strategic objectives.	• Includes a design and portfolio management framework that provides for consideration of factors such as project feasibility, alignment with organizational goals, and overall impact on portfolio performance.	• Integrates sustainability considerations into the design process, guiding decision making that promotes resource efficiency and long-term financial sustainability. • Encourages the exploration of sustainable design strategies, such as energy-efficient systems, renewable materials, and life cycle cost analysis to promote efficient, sustainable long-term operations, responding to the Fixed Asset Review recommendation to develop a new approach to funding sustainability.	• Emphasizes the importance of designing assets that can adapt to changing needs and support multiple functions, maximizing their value and benefits. • Encourages collaboration with stakeholders and partnerships with external entities to leverage shared resources and expertise, responding to the Fixed Asset Review recommendation to recognize real property as a strategic enabler.	• Establishes criteria for evaluating the ongoing relevance and alignment of assets with organizational objectives, facilitating informed decisions regarding divestiture. • Promotes alternative uses or repurposing of assets, considering their design quality and adaptability to minimize waste during divestiture. Aligns seamlessly with this objective through a holistic design approach and life cycle-based closed-loop circular economy focus.	• Promotes Intelligent Building Infrastructure and emphasizes the importance of data-driven decision making, promoting the collection, analysis, and utilization of integrated information throughout the design process. • Encourages the use of digital tools and technologies to manage and communicate design information effectively, a responding to the Fixed Asset Review recommendation to prioritize data and systems improvement.

Figure. 3.1: Laboratories Canada's RLDF alignment and contributions towards achieving the goals outlined in the Fixed Asset Review recommendations

RLDF: SUPPORTING EFFECTIVE PERFORMANCE MANAGEMENT

Application of the RLDF provides the basis for effective and efficient measurement of laboratory design performance and the alignment of designs to meet broader Government of Canada objectives. As a result of the harmonization of the RLDF's holistic design approach with ESG objectives, the RLDF plays a crucial role in Laboratories Canada's efforts to adhere to key performance measures. These include objectives and results outlined in government policies such as the Treasury Board Policy on Management of Real Property, Treasury Board Secretariat of Canada's Fixed Asset Review recommendations and its Directive on Greening Government Strategy, among others.

The RLDF provides a technical design reference with a structured and systematic approach to evaluate and enhance the design of laboratories, ensuring that desired performance outcomes are met. By leveraging the RLDF and implementing its design strategies, Laboratories Canada directly addresses functionality, utilization, physical performance, financial performance, and sustainability. Regular, systematic performance measurement is a key requirement in the Treasury Board Directive on the Management of Real Property. By extension, the RLDF facilitates the measurement of performance, providing valuable insights on the degree to which established performance outcomes are met enabling performance to be tracked and monitored to identify required corrective actions or improvement opportunities. Adherence to the RLDF promotes accountability, facilitates continual improvement, ensures compliance, and enables benchmarking against industry standards.

The RLDF ensures functionality by optimizing the design of laboratory facilities, considering space planning, layout efficiency, integration of specialized equipment, and accommodation of scientific requirements. It promotes flexible and adaptable design principles to maximize space utilization and accommodate future changes in scientific activities and equipment needs.

Optimal physical performance is derived from robust construction, appropriate material selection, and effective maintenance planning, ensuring the durability, reliability, and maintainability of laboratory facilities. The RLDF provides design recommendations that contribute to the longevity of assets, and reduced downtimes caused by operations and maintenance problems.

Financial performance is optimized by the RLDF through cost-effective design solutions, efficient construction methods, and considerations for long-term operational efficiency. Life cycle costs, energy efficiency, and sustainable practices are taken into account to achieve financial savings and maximize the return on investment in laboratory facilities.

The RLDF's comprehensive design approach is aimed at producing high-performance facilities with superior environmental performance to meet government commitments to sustainability and environmental stewardship. The RLDF promotes and requires the application of sustainable and efficient real property management practices leading to reduced energy consumption and greenhouse gas emissions, and best practices in water conservation, waste management, and the selection and use of environmentally responsible materials.

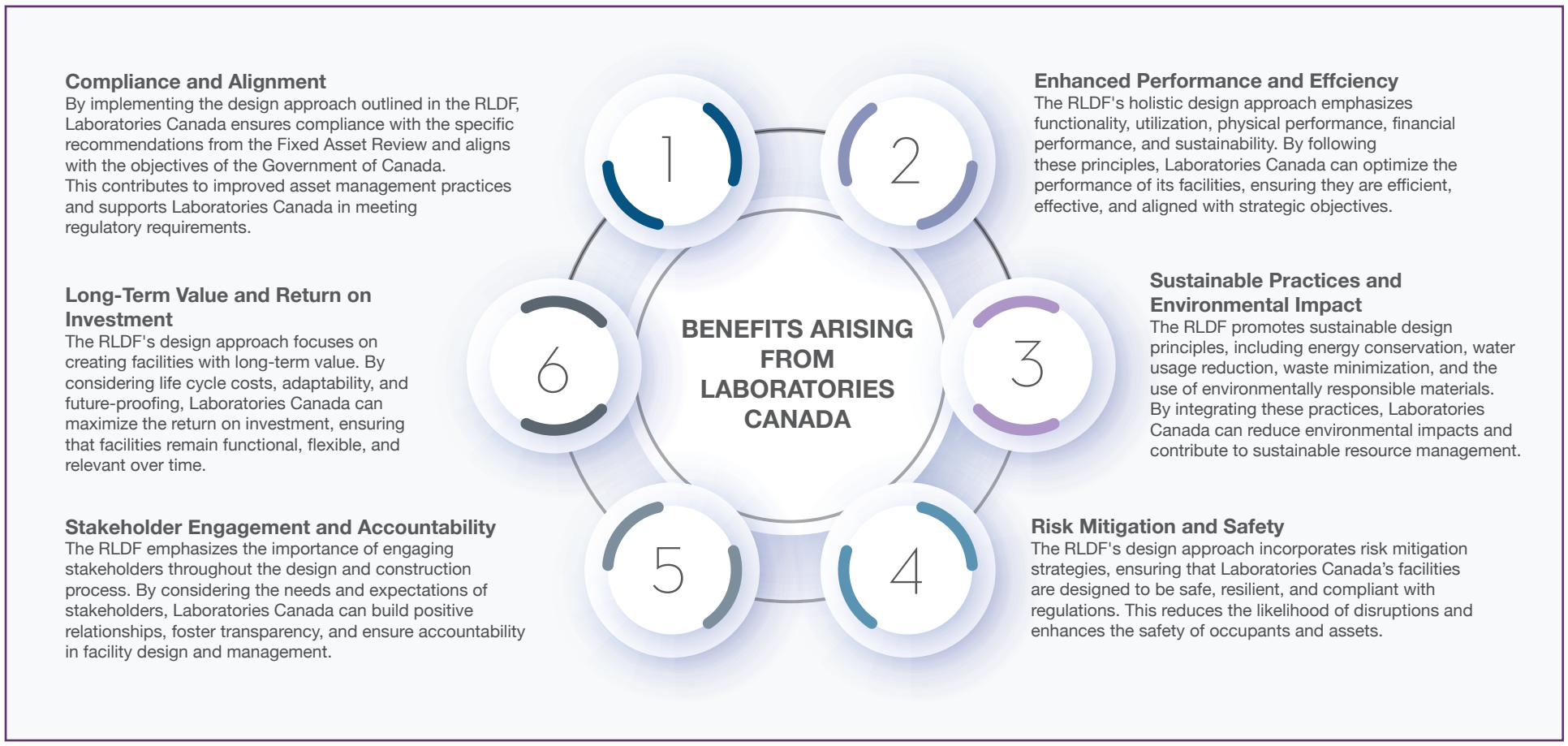


Figure. 3.2: Benefits Arising from the Application of Laboratories Canada's RLDF Holistic Design Approach to Meet Different Performance Measures

The RLDF highlights Laboratories Canada's commitment to considering the entire life cycle of assets, starting from their creation and their eventual disposal. This approach recognizes that assets have the potential to be re-purposed and continue to add value - even after their initial intended use, respecting the value of retaining embodied carbon. Laboratories Canada encourages the integration of design elements that promote adaptability, flexibility, and future reuse. This ensures that assets can serve multiple functions and contribute to sustainability efforts throughout their whole of life or whole building life cycle.

The RLDF is a valuable tool that empowers Laboratories Canada to assess, improve, and optimize the design of its facilities to meet the objectives and fulfill the specific recommendations of the Fixed Asset Review, resulting in several significant benefits, as illustrated in Figure 3.2 above.

DESIGN TASKS, ACTIVITIES AND PHASES

The integration of various design themes and elements is essential in implementing the RLDF to achieve high performance, sustainability, cost savings, and compliance with sustainability standards. This comprehensive approach revolutionizes Laboratories Canada's approach to planning, designing, and delivering science facilities, ensuring adaptability for multiple purposes, accommodating new workplace technologies, enhancing workplace health and safety, and reducing costs within the Laboratories Canada portfolio. The following examples of design elements and themes, while not exhaustive, illustrate the interconnectedness in Laboratories Canada's Holistic Building Design Approach (See Figure 3.3 below).

SITE SUSTAINABILITY
Implementing sustainable practices in site selection, such as considering the environmental impact, access to public transportation and availability of renewable energy sources.

SITE AND BUILDING RESILIENCY
Designing laboratories with robust infrastructure and backup systems to ensure continuous operations, even during power outages or other emergencies.

BUILDING ENVELOPE
Creating a well-insulated and airtight building envelope to minimize energy loss and maintain stable indoor environmental conditions.

MOISTURE CONTROL
Incorporating moisture-resistant materials and proper ventilation systems to prevent condensation and moisture-related issues that can affect laboratory operations and equipment.

DAYLIGHTING
Maximizing natural light penetration into laboratories through well-placed windows and skylights to reduce the reliance on artificial lighting and create a more pleasant working environment.

ACOUSTICS
Implementing sound-absorbing materials and proper insulation to control noise levels within laboratories, ensuring a quiet and work-focused environment.

VENTILATION
Designing efficient ventilation systems with a high standard of air filtration to maintain good indoor air quality and remove potentially hazardous fumes or contaminants.

WATER MANAGEMENT
Implementing water-saving fixtures and systems, such as low-flow faucets and water-efficient laboratory equipment, to minimize water consumption and promote sustainable water management sources.

ENERGY MODELLING
Utilizing advanced energy modelling techniques to optimize energy performance and identify opportunities for energy efficiency improvements in laboratory systems, including lighting, HVAC, and equipment.

SUSTAINABLE MATERIALS
Selecting environmentally friendly materials, such as recycled content, low-emission products, and materials with a reduced carbon footprint, for laboratory construction and fit-out.

INTEGRATED BUILDING MANAGEMENT SOLUTIONS
Incorporating advanced laboratory automation systems and integrated building management systems to enhance laboratory operations, control energy usage, and optimize safety and security protocols.

COMMISSIONING DESIGN CRITERIA
Establishing criteria for commissioning lab systems including thorough testing, verification, and documentation, to ensure that they meet the required performance standards and safety regulations.

Figure. 3.3: Examples of Interconnected Design Elements and Themes in Laboratories Canada's Holistic Building Design Approach

Laboratories Canada's holistic design process encompasses various activities at different phases to achieve project goals. By successfully completing these tasks and incorporating best practices, Laboratories Canada ensures optimal performance, safety, security, and sustainability of its facilities.

Pre-design phase

The pre-design phase of Laboratories Canada projects focuses on establishing a strong foundation for world-class facilities through a holistic design process. This involves integrating design elements across all project phases and incorporating proven strategies, methodologies, and design principles. By prioritizing best practices from the outset, Laboratories Canada optimizes efficiency and performance, ensuring all design disciplines and elements contribute effectively to the design. Key tasks and activities in the pre-design phase include Master Planning, Functional Programming, Site Selection, and Feasibility Studies.

Master Planning is an essential step in Laboratories Canada projects located in a campus-style setting with multiple buildings, serving as a prerequisite for detailed design. The Master Plan establishes a long-term vision for achieving project objectives by optimizing resources, infrastructure, and land. This includes defining planning elements, site analysis, space programming, conceptual design, site access, parking, and cost analysis. Laboratories Canada applies a master planning process that incorporates industry best practices that prioritizes stakeholder engagement, as well as Laboratories Canada's Design Principles.

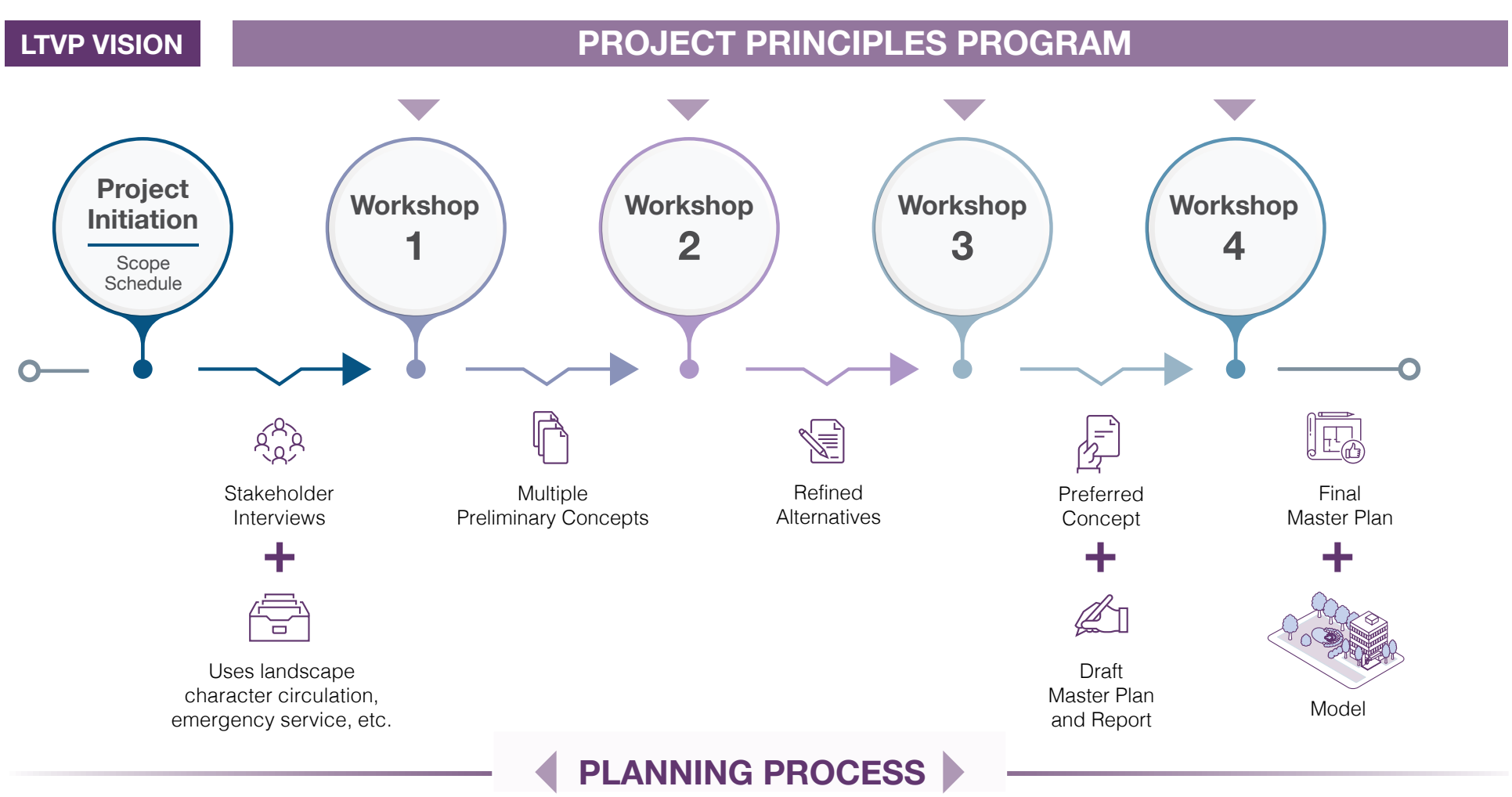


Figure 3.4: An illustrative representation capturing the key tasks, activities and deliverables of Laboratories Canada Master Planning Process

LABORATORY MODULARITY

Lab modularity is pivotal in laboratory design as it involves creating flexible and modular spaces that can be easily reconfigured or adapted to meet changing needs. This flexibility allows for greater efficiency in laboratory operations and enables the accommodation of new technologies or research areas. Modular lab designs reduce construction costs and minimize disruptions during renovations or upgrades.

The Laboratories Canada recommended standardized laboratory module size is 3.6 metres by 3.6 metres (3.6m x 3.6m). This size offers a high degree of flexibility in laboratory operations and can easily adapt to accommodate new technologies or research areas while minimizing disruptions.

If a design team proposes module sizes different than the recommended standardized module such as 3.4m x 3.4m, 3.4m x 3.6m, or any other size, they are required to prepare a detailed design analysis to demonstrate how the proposed module meets functional, safety, code, accessibility, and Laboratories Canada Design Principles requirements.

The RLDF includes a range of laboratory typologies to assist in the development of functional requirements for different laboratory types. The RLDF includes a Typology Catalogue (Appendix A7.0) that provides an overview of various laboratory typologies, such as wet laboratories, dry laboratories, animal laboratories, instrument laboratories, and shared science support spaces. These typologies are intended to accelerate the design process, helping designers understand and meet specific Laboratories Canada requirements and promoting consistency, flexibility and cost predictability across federal laboratories.

The RLDF emphasizes the need for laboratory equipment planning, which includes creating a comprehensive equipment list, to ensure the design can accommodate current and future equipment needs as well as facilitate accurate cost estimation and budgeting. Considerations related to laboratory equipment require proper coordination among various disciplines (structural, architectural, mechanical, electrical, and other specialists) with an emphasis on incorporating laboratory operational procedures into the design process. It stresses the need to consider biosafety requirements, emergency response plans, decontamination approaches, and incident response strategies to ensure the design meets operational needs and safety standards.

TerraCanada CanmetMATERIALS facility, Hamilton, ON

SCIENCE OFFICE ACCOMMODATION

The RLDF includes a Science Office Accommodation (SOA) planning guideline (Appendix A6.0) for designing science office spaces. It considers factors such as functional requirements, collaboration, staff wellness, individual work preferences, and new learning approaches. The SOA encompasses the key objectives depicted in Figure 3.6 below.

The planning process spans pre-design, design, and construction phases. Context, methodology, and survey data are analyzed during the pre-design phase to develop recommendations. In the design phase, the interpretation of survey results is validated, and schematic design plans are created. The design development phase focuses on gathering specific technical requirements and creating design development packages. A SOA Toolkit is also available on-demand, providing tools for determining work point quantity, size, and type. Application of the toolkit is intended to ensure that a comprehensive and informed planning process is followed, and that the needs of Laboratories Canada and laboratory occupants will be met.

1 **Design Excellence**
Igniting creative and innovative office planning solutions that support the staff and empower the next generation of scientists.

2 **Collaboration**
Create dynamic office spaces that encourage serendipitous encounters and foster knowledge sharing to accelerate the pace of discovery.

3 **Flexibility**
Create adaptable office spaces that can expand and easily adapt to evolving science requirements.

4 **Functional Suitability and Expandability**
Designing innovative and technically compliant office spaces for science laboratory functions and operations.

5 **Sustainability**
Foster sustainability through the design of science office spaces thatprioritize the health and well-being of occupants.

6 **Universal Accessibility**
Design science office spaces that foster diversity, inclusion, and accessibility for all, ensuring barrier-free environments that accommodate a wide range of human abilities and promote inclusive accessibility.

7 **Intelligent Building Infrastructure**
Creating smart and responsive office spaces through integrated IT networks and building controls.

Figure. 3.6: The key objectives of the Science Office Accommodation

HOLISTIC APPROACH TO SUSTAINABLE LABORATORY DESIGN AND EVALUATION

The RLDF outlines a detailed and systematic approach for assessing the baseline performance of Laboratories Canada facilities, with a focus on integrated design and environmental responsibility. It incorporates a multidisciplinary team strategy, using the PSPC Project Greenhouse Gas (GHG) Options Analysis Methodology to assess laboratory designs for their GHG emission reduction potential. This methodology consists of iterative steps, involving stakeholder workshops and technical analyses to yield high-performance, economically efficient designs with a minimized environmental footprint. The RLDF stresses the importance of Life Cycle Assessment and Life Cycle Cost-Benefit Analysis to measure environmental impacts and overall ownership costs, endorsing designs that are sustainable and future-proof, in alignment with closed-loop life cycle principles.

Considering the unique and complex nature of laboratories and their substantial environmental impact, the RLDF adopts a broad assessment strategy of design themes and building energy modelling starting from the design phase. The RLDF supports the initial inclusion of energy modelling to refine both design and energy performance, in harmony with Laboratories Canada's objectives. This approach promotes the exploration of diverse design options that satisfy functional needs while curtailing environmental impacts, particularly in GHG emissions. Early integration of building energy modelling facilitates adjustments in design that diminish energy consumption and operational GHG outputs, aiding in the development of sustainable, high-performance laboratories.

The emphasis of the RLDF on integrating energy modelling from the initial design stages encourages designers to delve into a variety of options, refining both architectural and energy performance elements. During the pre-design phase, a minimum of four building design options must be assessed to ensure alignment with federal policies on sustainability and economic efficiency, and Laboratories Canada's mandate to deliver energy-efficient, low-GHG footprint laboratories that demonstrate design excellence. Each option is assessed for its capability to attain net-zero carbon performance. The approach ensures that designs resonate with Laboratories Canada's broader objectives and vision.

The four specific design options rooted in the PSPC Project GHG Options Analysis Methodology include:

1. NET-ZERO CARBON DESIGN: This is the baseline option to meet Treasury Board of Canada's Greening Government Strategy, and it serves as the comparative baseline against which other options are assessed. It requires the building design to achieve net-zero carbon and fulfill all minimum departmental design commitments. In this option, the design team is required to use a holistic integrated design process to optimize performance, sustainability, user experience, energy efficiency, and clean energy sources. This option dissuades on-site renewable energy generation, which needs to be evaluated on a case-by-case basis, considering a 40-year life cycle cost analysis. The baseline option emphasizes design capacity for net-zero carbon, discourages the use of renewable energy certificates or carbon offsets, and prohibits non-emergency fossil fuel combustion. It ensures a cost-effective and environmentally responsible design premise meeting energy performance targets.

2. NET-ZERO CARBON READY DESIGN: Prioritizes net-zero carbon readiness with the option to achieve net-zero carbon in the future while currently not operating as net-zero carbon but meeting all mandatory departmental commitments. The design team is expected to explore different design combinations, energy-efficient measures, and emission reduction strategies. Fossil fuel combustion systems may be used for emergency backup and peak load management to lower operating costs, but the proportion of peak load met by such systems should be assessed. The option prohibits purchasing renewable energy certificates or carbon offsets and utilizes a shadow carbon price for calculating life cycle costs over 40 years.

3. COST-EFFECTIVE NET-ZERO CARBON READY: Aims to achieve Net-Zero Carbon Readiness while reducing operating and life cycle costs and remaining cost-neutral within a specific timeframe. It utilizes more fossil fuel combustion equipment during building operation. The design team, in consultation with Laboratories Canada project and technical experts, proposes a financially prudent design that balances decarbonization, GHG emission reductions, and cost. This option fulfills all mandatory commitments, explores energy conservation measures, and assesses costs, energy savings, and GHG emissions. It prohibits the purchase of clean energy through certificates or offsets, uses a shadow carbon price for cost calculations, and allows for fossil fuel combustion for backup and peak load management.

4. DESIGN TO MEET MINIMUM DECARBONIZATION PRIORITY: Does not comply with the net-zero carbon requirement for new construction under the Greening Government Strategy. It lacks a carbon performance target and relies on cost-effective fossil fuel systems for heating, resulting in significant carbon emissions. While it fulfills the project's functional requirements, it serves as a cost comparison reference and is not pursued in Laboratories Canada projects due to misalignment with Laboratories Canada's LTVP and Design Principles. However, it can still provide incremental cost data for future capital investment planning and decision-making.

Conceptual design rendering of the Atlantic Science Enterprise Centre, Moncton, NB
Architect: Diamond Schmitt Architects

Conceptual design rendering of the Atlantic Science Enterprise Centre,Moncton, NB
Architect: Diamond Schmitt Architects

Conceptual design rendering of the Regulatory and Security Science Main, Ottawa, ON
Architect: Framework (Stantec, Dialog and Merrick in JV)

INCORPORATION OF INTELLIGENT BUILDING MANAGEMENT SYSTEMS

Incorporation of Intelligent Building Management Systems (IBMS) is essential to sustainable lab design, enabling high-performance building operations, monitoring, and control of various systems. The design team should consider building operations during the programmatic process to ensure sustainability throughout the building's life cycle. This includes incorporating features like recycling and composting locations. Specific facility management plans, such as maintenance, environmentally preferable purchasing, and energy-efficient operations, should be documented.

Metering is crucial for monitoring energy usage. Meters and submeters should be installed at both the building and individual device levels. These meters should be integrated into the IBMS and displayed on a building dashboard system. It is important to sub-meter all end uses that contribute to more than 10% of the facility's energy consumption. Separate energy metering should be provided for specific areas such as parking garages, kitchens, data centres, and data closets.

Commissioning is an integral process that ensures the proper installation and performance of building systems. The commissioning process must begin early in the design phase with milestone reviews of the building design, and continue over the course of construction with thorough inspections and testing to verify compliance with design criteria, industry standards, and applicable codes and regulations. The commissioning process includes reviewing the operation of laboratory spaces and defining science process requirements for certification and reliability.

Baseline commissioning requirements should be established, and the Functional Program should be reviewed to ensure appropriate equipment placement and space optimization strategies. Design quality assurance and quality control processes that affect energy reduction strategies should be identified. Additionally, continuous updating of the Whole Building Life Cycle Assessment and coordination with the Life Cycle Cost Analysis are necessary.

Taken together, the IBMS, metering, other design requirements, and the commissioning process are important contributors to achieving efficient building operations and effectively monitoring energy usage in Laboratories Canada facilities.

Climate Change Mitigation (Greenhouse Gas [GHG] Reduction)	Climate Change Adaptation (Resiliency)	Waste and Plastics, Water, Biodiversity, Materials, and Employee Well-being
Prioritize low-carbon options by considering the total cost of ownership in investment decisions	Climate Risk and Vulnerability Assessment completed (integrate into design, construction and building operations)	90% diversion of construction and demolition waste from landfills (strive to achieve 100% by 2030)
Net-zero carbon building unless a life cycle cost-benefit analysis indicates net-zero carbon-ready construction	Apply climate-resilient building guidance by National Research Council Canada	Reduce water consumption by using best-in-class water-use practices and designing all new buildings to effectively manage storm water
Use GHG Options Analysis Methodology to determine the optimal GHG savings		Low volatile organic compound materials
Achieve minimum performance target of National Energy Code of Canada for Buildings (NECB) 2020 Tier 2, that is 25% more energy efficient than NECB 2020 Tier 1 minimum performance		Conduct whole building (or asset) life cycle assessments (for structural materials) by 2025 at the latest
Requirement to disclose amount of embodied carbon in structural materials		Create sustainable workplaces, including employee mobilization and action
30% less embodied carbon in major construction materials (starting in 2025)		

Figure 3.6.1: Net-zero Carbon Design Options

The Repeatable Laboratory Design Framework (RLDF) provides platforms for Canada's federal scientists and their partners to make more and more nationally- and globally-significant contributions. The RLDF, through investment in infrastructure will enhance the research excellence of Canada, while enabling flexibility and responsiveness to support transformative research and innovation by our scientists.

It responds to the calls of the Fixed Asset Review to maximize the impact of real property investments so as to position Canada for success and cement its global reputation for excellence. The RLDF supports the Laboratories Canada strategy of a coherent, focused approach to advancing federal research success.

LABORATORIES

CANADA