LEED for New Construction & Major Renovations

Guideline for Concrete Pipe and Boxes

Canadian Concrete Pipe Association
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Content

Introduction

The purpose of this guideline is to help applicants for a LEED certified project achieve LEED points with reinforced concrete pipe and boxes.

In the USA, buildings use one-third of the nation's total energy, two-thirds of its electricity, one-eighth of its water, and transform land that provides valuable ecological resources. Since the LEED Green Building Rating System for New Construction (LEED-NC version 2.0) was first published in 1999, it has been helping professionals to improve the quality of buildings and their impact on the environment.

LEED was launched to develop a "consensus-based, market-driven rating system to accelerate the development and implementation of green building practices." This Point Rating System is not rigidly structured; i.e., not every project must meet identical requirements. The flexibility in the rating system allows each project team to "select the green strategies that will best meet the project's goals".

As the green building sector grows exponentially, more building professionals, owners, and operators are seeing the benefits of green building and LEED certification. Green design not only makes a positive impact on public health and the environment, it also reduces operating costs, enhances building and organizational marketability, potentially increases occupant productivity, and helps create a sustainable community. LEED fits into this market by providing rating systems that are voluntary, consensus-based, market-driven, based on accepted energy and environmental principles, and they strike a balance between established practices and emerging concepts.

The LEED rating systems are developed by USGBC committees, in adherence with USGBC policies and procedures guiding the development and maintenance of rating systems.

Using concrete can facilitate the process of obtaining LEED Green Building certification. LEED is a point rating system to evaluate the environmental performance of a building. The system is credit based, allowing projects to earn points for environmentally friendly actions taken during the building process.

Concrete pipe and boxes are extremely durable and should be the products of choice for a sustainable drainage infrastructure. Reinforced concrete pipe (RCP) has a proven record of accomplishment for over a century of providing a strong and durable structure for sewers and culverts, and is produced from one of the most versatile green building materials (concrete) available today.

A "sustainable" or "green" building is defined as a structure that is developed, designed, built, renovated, operated, reused or redeveloped in a resource efficient manner. LEED is the effort to create and provide a national standard for what constitutes a green building and sustainable building practices. It is important to note that the LEED system does not certify products to be used in LEED projects; rather the system sets forth a design and construction process in which a product can help the project achieve LEED points, if the product has specific qualities that are considered sustainable or green.

Project Checklist for Concrete Pipe – LEED NC

Due to the versatility of reinforced concrete pipe, it can be used in a multitude of applications in the LEED process (such as stormwater control), and as a building material to achieve the intent of the LEED credit. As a material, concrete will receive LEED credits in the Materials and Resources section of LEED for New Construction, but the RCP will be used as a building material in other LEED categories. In other words by using more RCP throughout the project, RCP can help the project gain LEED points under the Materials and Resource credit. While RCP and other materials can both be used in stormwater applications, RCP should be the sustainable choice due to its durability and reduced bedding requirements.

The purpose of the rating system is to accumulate enough project points to reach a level of certification set forth by the LEED program and thus provide a classification for rating the sustainability of the project. The LEED certification process provides third-party certification that a project meets the building and performance standards set forth by LEED. The project must submit an application and provide documentation throughout the project to receive credit for possible LEED credits. Some of the LEED categories have prerequisites that must be achieved to qualify for LEED certification. The points available for each LEED category vary and a project checklist is used to allocate points for specific design and building elements of a project, such as the types of construction materials used, or the efficiency achieved.

The most widely used LEED rating system is currently the New Construction and Major Renovation (LEED-NC). Even though each LEED Rating System is distinct, most of the topics covered by the rating system can be grouped into some of the same categories. This document focuses primarily on the LEED-NC system and how reinforced concrete pipe can help a project obtain LEED points. The LEED-NC rating system is a building/development credit accumulation system that attempts to rate how environmentally efficient a project was once it has been completed. The LEED-NC system is centered around six basic categories that include:

1. **Site Sustainability (SS)** **14 LEED-NC Points Available**
   Goals: Develop only appropriate sites; Reuse existing buildings and/or previously developed sites, including Brownfield sites; Protect and conserve natural and agricultural areas; Restore damage areas to provide wildlife habitat and promote biodiversity; Reduce need for automobile use; Limit disruption of natural water hydrology.

2. **Water Efficiency (WE)** **5 LEED-NC Points Available**
   Goals: Eliminate the use of potable water or other natural surface or subsurface water used for landscape irrigation; Reduce potable water supply and generation of wastewater by the building.

3. **Energy and Atmosphere (EA)** **17 LEED-NC Points Available**
   Goals: Establish and optimize energy efficient system performance; Support ozone protection protocols; Encourage renewable and alternative energy sources.

4. **Materials and Resources (MR)** **13 LEED-NC Points Available**
   Goals: Reduce the amount of materials needed; Use materials with less environmental impact; Reduce and manage waste; Promote the use of material with recycled content; Promote the use of regional materials.

5. **Indoor Environmental Quality (EQ)** **15 LEED-NC Points Available**
   Goals: Establish good indoor air quality; Manage, reduced and/or eliminate the sources of indoor air pollutants; Ensure thermal comfort and system controllability; Provide for occupant connection to the outdoor environment.

6. **Innovation in Design (ID)** **5 LEED-NC Points Available**
   Goals: Provide opportunity for projects to be awarded points for exceptional performance above the requirements set by the LEED system; Ability to award points for innovative performance in categories not specifically addressed by the LEED system; support and encourage the design integration required by LEED.

The LEED sustainability classification considers the entire project relating to the building structure, including the vertical and horizontal infrastructure, structures footprints, impervious surface area, resource conservation and energy conservation. There are currently four LEED-NC certification levels based on points accumulated.

Platinum LEED Certification	**52 to 69 points**
Gold LEED Certification	**39 to 51 points**
Silver LEED Certification	**33 to 38 points**
LEED Certification	**26 to 32 points**
Total Available Points	**69**

Durability **1 point**

LEED Canada's Materials and Resources Credit 8 Durable Building (LEED Canada-NC 1.0) requires building designers to develop a Building Durability Plan to ensure that the predicted service life of the building and its components exceeds the design service life. The credit draws from CSA S478 (R2001) Guideline on Durability in Buildings to establish requirements and minimum benchmarks to achieve the single point available for this credit.

In satisfying the requirements for this credit, the designer is asked to establish a Design Service Life from Table 2 in the Guideline. Except for temporary buildings and parking structures, Table 2 requires that all buildings be designed for a service life in the range of 50-99 years.

LEED –ND projects may reference this LEED system and in so doing may benefit from the documented durability of reinforced concrete pipe that has a record of accomplishment surpassing 100 years.

To obtain this point, it should be shown that it is possible to minimize materials use and construction waste over a building's life resulting from premature failure of the building and its constituent components and assemblies.

Concrete Solution

For concrete pipe, it is recognized that the service life is at least 100 years. Moreover, it is proven that concrete pipe gets stronger as it ages. There are several cases that have shown that that concrete pipe has grown stronger over time after compression testing. It is also possible to rehabilitate concrete pipe without excavating the pipeline. It is a fast technique for protecting the built structures over buried concrete pipelines.

The key to getting LEED points is to design for energy efficiency, minimize the project waste streams and use renewable materials all together to create a green project. One of the best green materials that can be used in numerous applications on a project to receive LEED points is reinforced concrete and one of the key products made with reinforced concrete is RCP. Although easily overlooked RCP can help a project secure valuable LEED points and RCP has a proven record of being a durable and sustainable construction material.

On any project, the use of reinforced concrete pipe and boxes should not be overlooked for their use in constructing infrastructure or components of buildings. Even though the structures built from precast concrete pipe and boxes may not contribute to LEED points, they should not detract from the rating system, if the owner is looking for infrastructure that is sustainable for the design life of the project.

The information presented in this document below is directed at gaining LEED points from the USGBC through the LEED for New Construction (NC) Version 2.2 program.

Possible Applications for RCP Under the LEED System

Due to the versatility of reinforced concrete pipe and boxes, it can be used in a multitude of applications. There are numerous applications where concrete pipe and boxes can be used in the LEED process (such as stormwater control), and as a building material to achieve the intent of the LEED credit. RCP will receive LEED credits in the Materials and Resources section because of its reinforced concrete component. In addition, reinforced concrete can be used as a building material in other LEED categories. In other words by using more RCP throughout the project, RCP can help the project gain LEED points under the Materials and Resource Credit. While reinforced concrete and other materials can both be used in stormwater applications, RCP should be the sustainable choice due to its durability and reduced bedding requirements. Additionally, RCP through its construction materials can directly help the project achieve LEED points through the Materials and Resources Credits.

The LEED Credits where RCP can be included as a building material include:

SS Credit 6.1: Stormwater Design, Quantity Control
Intent: Limit disruption natural water hydrology by reducing impervious cover, increasing on-site infiltration, reducing or eliminating pollution from stormwater runoff, and eliminating contaminants.

SS Credit 6.2: Stormwater Design, Quality Control
Intent: Limit disruption of natural water flows by managing stormwater runoff.

WE Credit 1.1: Water Efficient Landscaping: Reduce by 50%
Intent: Limit or eliminate the use of potable water, or other natural surface or subsurface water resources available on or near the project site, for landscape irrigation.

WE Credit 1.2: Water Efficient Landscaping: No Potable Use or No Irrigation
Intent: Eliminate the use of potable water, or other natural surface or subsurface water resources available on or near the project sire, for landscape irrigation.

WE Credit 2: Innovative Wastewater Technologies
Intent: Reduce generation of wastewater and potable water demand, while increasing the local aquifer recharge.

Available LEED Credits that RCP included as a Material Can Directly Contribute

The use of RCP on a LEED project would help a project achieve LEED-NC credits as a building material under the Material and Resource category. Under the Material and Resource (MR) category there are three credits where RCP use or reuse could help the project gain valuable LEED-NC points. Table 1 contains a brief description of the credits that are available to RCP and each is discussed in detail after the table.

Table 1 : Summary of LEED-NC v2.2 Credits - RCP Contribution as a material.

LEED-NC Category	Credit	Description	Requirements	Possible Credits
Materials and Resources	MR 2.1	Construction Waste Management	Recycle and/or salvage at least 50% of non-hazardous construction and demolition debris	1
Materials and Resources	MR 2.2	Construction Waste Management	Recycle and/or salvage at least 75% of non-hazardous construction and demolition debris	1 point in addition to the 1 point received for MR 2.1
Materials and Resources	MR 3.1	Materials Reuse 5%	Use 5% salvaged, refurbished or reused materials	1
Materials and Resources	MR 3.2	Materials Reuse 10%	Use 10% salvaged, refurbished or reused materials	1 point in addition to the 1 point received for MR 3.1
Materials and Resources	MR 4.1	Recycled Content 10%	Use 10% recycled content	1
Materials and Resources	MR 4.2	Recycled Content 20%	Use 20% recycled content	1 point in addition to the 1 point received for MR 3.1
Materials and Resources	MR 5.1	Regional Materials 10%	Use 10% Regionally	1
Materials and Resources	MR 5.2	Regional Materials 20%	Use 20% Regionally	1 point in addition to the 1 point received for MR 3.1
Innovation in Design	ID 1.1 – 1.4	Innovation in Design	Obtains points above the requirements set by LEED Green Building Rating System.	1-4
Innovation in Design	ID 2	LEED Accredited Professional	At least one principal participant of the project team shall be a LEED Accredited Professional.	1

MR Credit 2 – Construction Waste Management

MR Credit 2 is a Credit for Materials Reuse and the intent for the LEED-NC points is:

> "Divert construction and demolition debris from disposal in landfills and incinerators. Redirect recyclable recovered resources back to the manufacturing process. Redirect reusable materials to appropriate sites".

Under MR Credit 2 RCP that is removed from the site could be sent to salvage yards or to facilities that could recycle the old RCP. The Credit requirements for MR Credit 2 are:

- Recycle and/or salvage at least 50% (value 1 LEED-NC point) or 75% (value an additional LEED-NC point for a total of 2) of nonhazardous construction and demolition debris.
- A waste management plan should be in place that identifies materials that can be diverted from disposal and how the materials will be sorted. The calculations for this credit can be done by weight or volume as long as they are consistent throughout the project.
- Excavated soils or debris from land clearing cannot contribute to this credit.

MR Credit 3 – Material Reuse

MR Credit 3 is a Credit for Materials Reuse and the intent for the LEED-NC points is:

> "Reuse building materials and products in order to reduce demand for virgin materials and to reduce waste, thereby reducing impacts associated with the extraction and processing of virgin resources."

Under MR Credit 3 Materials Reuse salvaged or reused RCP could be reused on the project. The credit requirements for MR Credit 3 are:

- Use of salvaged, refurbished or reused materials such that the sum of these materials constitutes at least 5% (value 1 LEED-NC point) or 10% (value an additional LEED-NC point for a total of 2), based on cost, of the total value of materials on the project.[1]
- Mechanical, electrical and plumbing components and specialty items such as elevators and equipment shall not be included in this calculation. Only include materials permanently installed in the project. Furniture may be included, providing it is included consistently in MR Credits 3-7.

For RCP to help the project obtain LEED-NC points under this Credit the RCP used on the project must be salvaged or reused from another site. The cost of the reused material will be either the actual cost paid for the reused or salvaged material or the replacement value if the material came from on-site. Under this credit LEED allows that if the actual cost paid for the reused or salvaged material is below the cost of an equivalent new item, the higher value of the new material can be used in the calculations. Also if the cost to reclaim an item found on site is less than the cost of an equivalent new item, the higher cost of the new item should be used in the calculations. The salvaged material that is used from both on-site and off-site can be applied to Regional Materials Credit (MR Credit 5) if they comply with that credit's requirements.

MR Credit 4 – Recycled Content

MR Credit 4 is a Credit for Recycled Content and the intent for the LEED-NC points is:

> "Increase demand for building products that incorporate recycled content materials, thereby reducing impacts resulting from extraction and processing of virgin materials."

[1] It is possible for the project to receive an additional point under the Innovation Design section for exemplary performance when a project documents that the value of salvaged or reused materials used on the project is equal to at least 15% of the total materials costs.

Under MR Credit 4 Recycled Content, if the RCP used on the project contains more that 10% recycled content it will help the project obtain LEED-NC points under MR Credit 4. The credit requirements for MR Credit 4 are:

- Use of materials with recycled content such that the sum of post-consumer recycled content plus one-half of the pre-consumer content constitutes at least 10% (value 1 LEED-NC point) or 20% (value an additional LEED-NC point for a total of 2), based on cost, of the total value of the materials in the project.[2]
- The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.
- Mechanical, electrical and plumbing components and specialty items such as elevators shall not be included in this calculation. Only include materials permanently installed in the project. Furniture may be included, providing it is included consistently in MR Credits 3-7.
- Recycled content shall be defined in accordance with the International Organization of Standards document, ISO 14021 – Environmental labels and declarations – Self-declared environmental claims (Type II environmental labeling.)

Post-consumer material is defined by the USGBC as the waste material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose.

Pre-consumer material is defined by the USGBC as the material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it. **Note: USGBC has determined that fly ash should be considered a Pre-Consumer Recycled Content material.**

The recycled content value of the project uses the following two equations. Note that only half of the pre-consumer recycled material counts towards the recycled content value. The Recycled Content Value is calculated by taking the percentage of the post-consumer recycled content multiplied by the material cost plus half of the value of the pre-consumer recycled content multiplied by the material cost.

$$\text{Recycled Content Value (\$)} =$$

$$(\%\,\text{post-consumer recycled content} \times \text{material cost}) + \frac{(\%\,\text{pre-consumer recycled content} \times \text{material cost})}{2}$$

The percent recycled content is calculated by taking the total recycled content value and diving it by the total materials cost.

$$\text{Percent Recycled Content} = \frac{\text{Total Recycled Content Value (\$)}}{\text{Total Materials Cost (\$)}}$$

Supplementary Cementitious Materials

When considering supplementary cementitious materials (SCMs) MR Credit 4 allows the recycled content value of concrete to be calculated by the mass of the cementitious materials only, rather than on the entire concrete mix. For example, if the SCM used is fly ash and 150 pounds is used per cubic yard of concrete, the fly ash would only represent 5% of the material if

[2] It is possible for the project to receive an additional point under the Innovation Design section for exemplary performance when a project documents that the next incremental step is has been meet for recycled content and the total recycled content on the project has reached 30% or greater.

yard of concrete was 3,000 pounds. LEED allows the design team to calculate the recycled material based on the fraction of cementitious materials only. In order to calculate the value of the cementitious materials will be needed.

Below are two examples of reinforced concrete pipe design mixes and the calculations that would be completed to determine the recycled amounts applicable to obtain LEED credits under MR Credit 4.

Concrete Pipe Batch Design Cementitious Materials Examples:

Example 1: Small Diameter Dry Cast Pipe: Vibration System

Based on a cubic yard of concrete

- Type I/II Cement: 745 lbs (cost $113.21 / ton)
- Grand Blast Furnace Slag: 230 lbs (cost $96.60 / ton)
- Type F Fly Ash: 250 lbs (cost $16.00 / ton)

Example 2: Large Diameter Dry Cast Pipe: Packerhead System

Based on a cubic yard of concrete

- Type I/II Cement: 388 lbs (cost $113.21 / ton)
- Grand Blast Furnace Slag: 185 lbs (cost $96.60 / ton)
- Type F Fly Ash: 42 lbs (cost $16.00 / ton)

Example 3: 5000 PSI Wet Cast Pipe and Box Culverts

Based on a cubic yard of concrete

- Type I/II Cement: 394 lbs (cost $113.21 / ton)
- Grand Blast Furnace Slag: 170 lbs (cost $96.60 / ton)
- Type F Fly Ash: 0 lbs (cost $16.00 / ton)

Table of Example Results: Supplementary Cementitious Materials Calculation[3]

Mix	Mass of Portland cement (lbs)	Mass of recycled SCMs (lbs)	Mass of total cementitious materials (lbs)	SCMs as a percentage of total cementitious materials (%)	Dollar value of all cementitious materials	Recycled content value per yard [(SCM/2)x$ value]
Ex. 1	745 lbs	480 lbs	1225 lbs	39.2%	$55.28	$10.83
Ex. 2	388 lbs	227 lbs	615 lbs	36.9%	$30.68	$5.66
Ex. 3	394 lbs	170 lbs	564 lbs	30.1%	$30.00	$4.52

Once the value of the recycled cementitious content is calculated per cubic yard the amount of recycled content of the amount of reinforce concrete pipe can be calculated for the project. The reinforcement contained in the pipe should also be calculated as a recycled content value and listed as a line item for the reinforced concrete pipe on the project. The project data and calculations will be submitted by the project LEED coordinator and is required to document the process using a submittal template. The data that will be required to track recycled content must include a description of the material, the manufacturer of the material, the product cost, the pre-consumer and/or post-consumer recycled content percentage, and the source of the recycled content data.

[3] The recycled content value is calculated using the SCM percentage divided by two due to the fact that USGBC has determined that fly ash should be considered a Pre-Consumer Recycled Content material.

Another material used in reinforced concrete pipe is reinforcing steel. The steel can be made from more than 90% recycled scrap. Therefore, in the case of reinforced concrete pipe, the reinforcing steel should be included in the mix, and 90% of its evaluation cost should be included in the total value of the post consumption recycled material.

MR Credit 5 – Regional Materials

MR Credit 5 is a Credit for use of regional materials in the project and the intent for the LEED-NC points is:

> "Increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the use of indigenous resources and reducing the environmental impacts resulting from transportation".

Under MR Credit 5 Regional Materials, RCP that is produced with regional materials will help the project obtain LEED-NC points under MR Credit 5. The credit requirements for MR Credit 5 are:

- Use building materials or products that have been extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site for a minimum of 10% (value 1 LEED-NC point), based on cost of the total materials value.
- If only a fraction of a product or material has been extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) can contribute to the regional value.
- Includes only materials that are permanently installed in the project. Mechanical, electrical and plumbing components and specialty items (elevators and equipment) are not included in the calculation.

Regionally Manufactured Materials are defined by the USGBC as materials that are assembled as a finished product within a 500-mile radius of the project site. For MR Credit 5 assembly does not include on-site assembly, erection or installation of finished components, as in structural steel, miscellaneous iron or system furniture.

Regionally Extracted Materials are defined by the USGBC as materials having their source as a raw material from within a 500-mile radius of the project site.

To calculate the percent of local materials:

$$\text{Percent Local Materials} = \frac{\text{Total Cost of Local Materials (\$)}}{\text{Total Materials Cost (\$)}}$$

Innovation in Design LEED Credit

To create a system that can react to an ever changing and improving sustainability strategies the LEED system created the Innovation in Design Credit to allow projects to gain points and recognition for innovation building practices, design and features that contribute to sustainable building knowledge. This credit can be used to gain LEED points for building performance that greatly exceeds the LEED requirements as well as gaining LEED points for sustainable benefits not directly addressed by the LEED system. There are a total of 4 LEED points available through the Innovation in Design.

This last criterion makes it possible to provide design teams and projects to be awarded points for exceptional performance above the requirements set by the LEED Green Building Rating System and/or innovative performance in Green Building categories not specifically addressed by the LEED Green Building Rating System.

The current method to include innovative solutions is to make them pass in the category *Innovation and Design Process* with the intent to make of them criteria in the next version of LEED. The principal characteristics of concrete which cannot be considered in the current system are:

- *Life cycle costs analysis*: Analysis of costs associated with the life cycle of a structure are very important when considering long term performance because a design with low first costs can have very high costs at the end of its life cycle.
- *Fire resistance*: Fire resistance of materials is not regarded as a criterion for durability. If there were a fire and non fire-resistant materials were destroyed, their calculated life spans would have no meaning. The service life of materials resistant to fire, like concrete, would be preserved whether or not there is fire in the building.
- *Weak emissions*: Concrete is not considered by LEED in its section on materials emissions. However emissions of Volatile Organic compounds (VOC) Compounds is practically non-existent for the concrete and it does not require any coatings or finishings as to many other materials. The emissions criterion should be applied to all materials used in the construction industry.

Even though these characteristics of concrete pipe that make a better engineered building cannot be currently considered for LEED credits, reinforced concrete pipe used in a building design can be considered a building material to achieve the intent of the LEED credit.

RCP will receive LEED credits in the Materials and Resources section because of its reinforced concrete component. In addition, reinforced concrete can be used as a building material in other LEED categories. In other words by using more RCP throughout the project, RCP can help the project gain LEED points under the Materials and Resource Credit. RCP should be the sustainable choice due to its durability and reduced bedding requirements. Additionally, RCP through its construction materials can directly help the project achieve LEED points through the Materials and Resources Credits.

Reinforced concrete pipe can be made of several recycled materials that allow the project to claim LEED-NC certification points under the Materials and Resources section for materials with recycled content.

Backfill Requirements

Backfill requirements should also be considered when designing a project to achieve LEED credits. One advantage that RCP has over competitive products is that RCP can be installed with the native material used for backfill rather than requiring any additional backfill material which has to be considered under the LEED system. RCP can also be used

Summary of LEED-NC v2.2 Credits

LEED Category Prerequisite / Credit	Credit Description	Possible Points
Sustainable Sites (SS)		**14 (total)**
SS Prerequisite 1	Construction Activity - Pollution Prevention	Required
SS Credit 1	Site Selection	1
SS Credit 2	Development Density & Community Connectivity	1
SS Credit 3	Brownfield Redevelopment	1
SS Credit 4.1	Alternative Transportation – Public Transportation Access	1
SS Credit 4.2	Alternative Transportation – Bicycle Storage & Changing Rooms	1
SS Credit 4.3	Alternative Transportation – Low-Emitting & Fuel-Efficient Vehicles	1
SS Credit 4.4	Alternative Transportation – Parking Capacity	1
SS Credit 5.1	Site Development – Protect or Restore Habitat	1
SS Credit 5.2	Site Development – Maximize Open Space	1
SS Credit 6.1	Stormwater Management – Quantity Control	1
SS Credit 6.2	Stormwater Management – Quality Control	1
SS Credit 7.1	Heat Island Effect – Non-Roof	1
SS Credit 7.2	Heat Island Effect - Roof	1
SS Credit 8	Light Pollution Reduction	1
Water Efficiency (WE)		**5 (total)**
WE Credit 1.1	Water Efficient Landscaping – Reduce by 50%	1
WE Credit 1.2	Water Efficient Landscaping – No Potable Water Use / No Irrigation	1
WE Credit 2	Innovative Wastewater Technologies	1
WE Credit 3.1	Water Use Reduction – 20%	1
WE Credit 3.2	Water Use Reduction – 30%	1
Energy & Atmosphere (EA)		**17 (total)**
EA Prerequisite 1	Fundamental Commissioning of the Building Energy Systems	Required
EA Prerequisite 2	Minimum Energy Performance	Required
EA Prerequisite 3	Fundamental Refrigerant Management	Required
EA Credit 1	Optimize Energy Performance	10
EA Credit 2	On-Site Renewable Energy	3
EA Credit 3	Enhanced Commissioning	1
EA Credit 4	Enhanced Refrigerant Management	1
EA Credit 5	Measurement & Verification	1
EA Credit 6	Green Power	1
Materials & Resources (MR)		**13 (total)**
MR Prerequisite 1	Storage & Collection of Recyclables	Required
MR Credit 1.1	Building Reuse – Maintain 75% of Existing Walls, Floors & Roof	1
MR Credit 1.2	Building Reuse – Maintain 95% of Existing Walls, Floors & Roof	1
MR Credit 1.3	Building Reuse – Maintain 50% of Interior Non-Structural Elements	1
MR Credit 2.1	Construction Waste Management – Divert 50% from Disposal	1
MR Credit 2.2	Construction Waste Management – Divert 75% from Disposal	1
MR Credit 3.1	Materials Reuse – 5%	1
MR Credit 3.2	Materials Reuse – 10%	1
MR Credit 4.1	Recycled Content – 10% (post-consumer + ½ pre-consumer)	1
MR Credit 4.2	Recycled Content – 20% (post-consumer + ½ pre-consumer)	1

MR Credit 5.1	Regional Materials – 10% Extracted, Processed & Manufactured Regionally	1
MR Credit 5.2	Regional Materials – 20% Extracted, Processed & Manufactured Regionally	1
MR Credit 6	Rapidly Renewable Materials	1
MR Credit 7	Certified Wood	1
Indoor Environmental Quality (EQ)		**15 (total)**
EQ Prerequisite 1	Minimum IAQ Performance	Required
EQ Prerequisite 2	Environmental Tobacco Smoke (ETS) Control	Required
EQ Credit 1	Outdoor Air Delivery Monitoring	1
EQ Credit 2	Increased Ventilation	1
EQ Credit 3.1	Construction IAQ Management Plan – During Construction	1
EQ Credit 3.2	Construction IAQ Management Plan – Before Occupancy	1
EQ Credit 4.1	Low-Emitting Materials – Adhesives & Sealants	1
EQ Credit 4.2	Low-Emitting Materials – Carpet Systems	1
EQ Credit 4.3	Low-Emitting Materials – Composite Wood & Agrifiber	1
EQ Credit 4.4	Low-Emitting Materials – Composite Wood & Agrifiber	1
EQ Credit 5	Indoor Chemical & pollutant Source Control	1
EQ Credit 6.1	Controllability of Systems – Lighting	1
EQ Credit 6.2	Controllability of Systems – Thermal Comfort	1
EQ Credit 7.1	Thermal Comfort - Design	1
EQ Credit 7.2	Thermal Comfort - Verification	1
EQ Credit 8.1	Daylight & Views – Daylight 75% of Spaces	1
EQ Credit 8.2	Daylight & Views – Views for 90% of Spaces	1
Innovation & Design Process (ID)		**5 (total)**
ID Credit 1	Innovation in Design	1-4
ID Credit 2	LEED Accredited Professional	1

Sustainable Sites (SS) 14 Possible Points

SS Credit 3: Brownfield Redevelopment (1 point) RCP/Boxes

Intent

Rehabilitate damaged sites where development is complicated by environmental contamination, reducing pressure on undeveloped land.

Concrete Solution

Reinforced concrete pipe and boxes have been used successfully in brownfield development in deep buries or in an environment of contaminated soils. Concrete mixes and service life of precast concrete products ensure low maintenance of a sewer and minimal disturbance of soils for the design life of a project. Concrete pipe installations located within brownfields has been tested for continued performance and left in the installed condition for the redevelopment of the site. Reinforced concrete pipe and boxes are a compatible infrastructure material for the redevelopment of brownfield sites.

SS Credit 6.1: Stormwater Design, Quantity Control (1 point) RCP/Boxes

Intent: Limit disruption natural water hydrology by reducing impervious cover, increasing on-site infiltration, reducing or eliminating pollution from stormwater runoff, and eliminating contaminants.

Concrete Solution

Precast concrete pipe and boxes are commonly used for underground storage of runoff that can be used for irrigation or part of a retention system of treated storm water and snow melt connected to oil sediment separators using precast concrete pipe, manhole and box components. Concrete detention and retention systems are used to reduce pollutant loadings in surface water bodies and to help restore local hydraulic regimes to pre urban development. Specially designed concrete pipe and boxes with internal baffles can reduce the energy of stormwater flow for discharge into streams, rivers and lakes with reduced or no erosion near the outfall. Concrete pipe producers have manufactured perforated concrete pipe and three-sided boxes to help recharge aquifers with stormwater channeled from urban areas with impervious streetscapes and parking areas.

SS Credit 6.2: Stormwater Design, Quality Control (1 point) RCP/Boxes

Intent: Limit disruption of natural water flows by managing stormwater runoff.

Concrete Solution

Concrete pipe and boxes have been used successfully to conserve habitat, wetlands and water bodies with the casting of internal baffles or dissipaters to reduce the energy of flowing water before it discharges into receiving lakes and streams. Such systems have been used for storm sewers, intermittent streams and creeks enclosed in culverts for road crossings. Precast concrete culverts can be three sided leaving the natural ecosystems of the stream intact and accommodating aquifer recharge, or cast with artificial bases to facilitate the movement of aquatic life through the culverts so that migration and spawning characteristics of an ecosystem can be maintained. Speedy installation of precast concrete pipe and box sewers and culverts reduces the impact on habitat during construction and ensures long service life with little maintenance to disturb habitat, wetlands and water bodies for periods of 100 years and more. Precast boxes have been used successfully for constructing aquatic habitat in harbors while providing structures for piers and groynes to manage currents.

Water Efficiency (WE) 5 Possible Points

WE Credit 1.1: Water Efficient Landscaping: Reduce by 50% (1 point) RCP/Boxes

Intent: Limit or eliminate the use of potable water, or other natural surface or subsurface water resources available on or near the project site, for landscape irrigation.

Concrete Solution

From the moment when a precast concrete pipe or box retention system is built, a pump can be used to pump water into the irrigation network. Irrigation can be supplied entirely from the stored rainwater and snow melt. Storm sewers are usually only conducting water during rain fall or snow melt and remain empty until the next event. It is possible to connect the storm drains to a detention system made of pipe or boxes to hold water for use during dry weather.

Precast concrete pipe and boxes are commonly used for underground storage of runoff that can be used for irrigation or part of a retention system of treated storm water and snow melt connected to oil sediment separators using precast concrete pipe, manhole and box components. Concrete detention and retention systems are used to reduce pollutant loadings in surface water bodies and to help restore local hydraulic regimes to pre urban development. Specially designed concrete pipe and boxes with internal baffles can reduce the energy of stormwater flow for discharge into streams, rivers and lakes

with reduced or no erosion near the outfall. Concrete pipe producers have manufactured perforated concrete pipe and three-sided boxes to help recharge aquifers with stormwater channeled from urban areas with impervious streetscapes and parking areas.

WE Credit 1.2: Water Efficient Landscaping: No Potable Use or No Irrigation (1 point) RCP/Boxes

Intent: Eliminate the use of potable water, or other natural surface or subsurface water resources available on or near the project sire, for landscape irrigation.

Concrete Solution

From the moment when a precast concrete pipe or box retention system is built, a pump can be used to pump water into the irrigation network. Irrigation can be supplied entirely from the stored rainwater and snow melt. Storm sewers are usually only conducting water during rain fall or snow melt and remain empty until the next event. It is possible to connect the storm drains to a detention system made of pipe or boxes to hold water for use during dry weather.

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WE Credit 2: Innovative Wastewater Technologies (1 point) RCP/Boxes

Intent: Reduce generation of wastewater and potable water demand, while increasing the local aquifer recharge.

Concrete Solution

Concrete pipe producers have manufactured perforated concrete pipe and three-sided boxes to help recharge aquifers with stormwater channeled from urban areas with impervious streetscapes and parking areas.

Energy and Atmosphere (EA) 17 Possible Points

EA Credit 1: Optimize Energy Performance (1–10 points)

Intent: Achieve increasing levels of energy performance above the baseline in the prerequisite standard to reduce environmental and economic impacts associated with excessive energy use.

Concrete Solution

It is possible to seek several points in this category by exploiting the principle of geothermics with concrete pipes. In winter, the temperature of the ground remains constant below the frost zone. It is possible to use the constant Earth's temperature to moderate air temperature to ventilate a building. The principle is simple. Concrete pipes are placed in the ground under the frost zone. The air intake is at a certain distance from the building and the air circulates in the pipes before arriving in ventilation system of the building. In summer, the air cools before arriving inside of the building, and the energy requirements for air conditioning are reduced. In winter, the cold air has time to be heated before entering to the building and the heat energy requirements are reduced. Since heating and air

conditioning are two significant energy uses in a building, reduction of energy use with concrete pipe earth tubes is an important method of energy conservation.

Example of a geothermal system
Nine 20 metre-long rows of concrete pipe were placed under the Earth Rangers Centre in Woodbridge, Ontario. The Centre, completed in 2004, was used for the treatment and the rehabilitation of wild animals. It was also used as an education centre for youth. In addition to the geothermal system, a system for heating and cooling the concrete floor by radiation was installed. This system consists of a concrete flagstone floor with integrated polyethylene tubes which store heated or cooled water that is circulated through the floor. These two systems, combined with an effective insulation, allowed substantial energy savings. According to calculations, the annual energy use was 63% lower than what was required by the MNECB, which corresponds to about 9.5/10 in LEED.

Earth tube technology is proven and in use for unique structures. Concrete pipe and box sewers can be used to service any housing type and can be designed with a service life to match the design life of the project with minimal maintenance. The least cost (life cycle cost) of a long-term concrete sewer will be far cheaper than systems made with corrugated metal and thermoplastic materials currently on the market.

Indoor Environmental Quality (EQ) 15 Possible Points

Precondition 1 - Minimum Indoor Air Quality (IAQ) Performance

Concrete pipe can be used for ventilation to meet the requirements of the standard. Concrete pipe does not release gases, chemical substances, organic compounds or moulds and presents an excellent option for ventilating buildings.

Conclusion

Each project has different needs and design requirements, but RCP can be used in numerous applications throughout a project to provide a sustainable material that is designed to last. By reviewing the points available for each project RCP can contribute to LEED points, so that the more RCP is used on a project the more RCP can contribute to LEED credits.

References

1. "Earth Center Rangers", *Canadian association of Cement,* http://www.cement.ca/cement.nsf/f/36F1CE5C8C4421AE85256F 4900540E58?OpenDocument.
2. Use of Fly Ash and Slag in Concrete : A Best Practice Guide », *Supplementary Cementing* Materials, http://scm.gc.ca/docs/bestpractices.pdf.
3. LEED® for New Construction & Major Renovations Version 2.2, For Public Use and Display, October 2005

ACTB

Canadian Concrete Pipe Association

American **Concrete Pipe** Association