VESTA
SUSTAINABLE CONSTRUCTION HANDBOOK
INDUSTRIAL PARKS

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Bioconstrucción y energía alternativa

VESTA Sustainable Construction Handbook

Industrial Parks

Complementary Technical Regulations to be implemented along VESTA's current construction practices and standards for the construction or renovation of Industrial Parks.

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TABLE OF CONTENTS

100 INTRODUCTION....1
110 Introduction to VESTA's Sustainable Construction Handbook: Industrial Parks....1
120 Background....1
130 Relevance of VESTA's Sustainable Construction Handbooks....1
140 Methodology....2
141 Base Case Analysis....3
142 Introduction to LEED ® Core & Shell Rating System....8
150 Case Studies....14
160 How to use this Handbook....21
200 GREEN BUILDING'S REQUIREMENTS....23
210 Owner's Project Requirements....23
300 GENERAL GUIDELINES FOR GREEN BUILDING'S DESIGN....25
310 Sustainable Sites....25
311 Site Selection....26
312 Development Density and Community Connectivity....27
313 Alternative Transportation – Public Transportation Access....28
314 Maximize Open Space....30
315 Stormwater Management....33
320 Indoor Environmental Quality....36
321 Environmental Tobacco Smoke (ETS) Control....36
322 Indoor Chemical and Pollutant Source Control....37
323 Daylight....38
324 Views....43
400 TECHNICAL STANDARDS....45
410 General Criteria....45
411 Materials and Resources....45
420 Preliminaries....60
421 Erosion and Sedimentation Control Plan....60
422 Habitat Protection Plan....64
423 Construction Indoor Air Quality Management Plan – During Construction....66

424 Construction Waste Management 69
430 Industrial Park 70
431 Facilities 70
432 Exterior vegetation and materials 88
440 Vesta Office Building 98
441 Structural Components 98
442 Finishes 105
443 Doors and Windows 108
444 Facilities 112
445 Public facilities 122
446 Exterior areas 123
450 Commissioning Plan 124
500 RETURN ON INVESTMENT ANALYSIS 126
510 Renewable Energy Systems 126
511 Industrial Park 126
512 Office Building 130
520 Efficient lighting 132
521 Industrial Park 132
522 Office Building 133
530 Efficient plumbing fixtures 135
531 Office Building 135
540 Efficient landscape design 137
541 Industrial Park 137
600 CONCLUSIONS 138
610 Sustainability Checklist: 140
700 Referenced Standards 142
800 Appendixes 143
810 Appendix 1: Owner's Project Requirement Outline 143
820 Appendix 2: Construction Indoor Air Quality Management Plan Outline 144
830 Appendix 3: Construction Waste Management Plan Outline 146
840 Appendix 4: Energy's Annual Measurement and Verification Report Outline 147

850 Appendix 5: Eco-technologies Technical Specification 151
860 Appendix 6: Materials and Finishes Technical Specifications 158
870 Appendix 7: Outline for a Commissioning Plan 205

TABLES

Table 1: LEED Core & Shell categories 8
Table 2: Sustainability targets per system 10
Table 3: Comparison between certification systems 11
Table 4: Adhesives and Sealants VOCs limits 51
Table 5: Aerosol Adhesives VOC limits 52
Table 6: Paints and coatings VOC limits 53
Table 7: Flooring systems requirements 53
Table 8: U-value calculations for different constructive elements 55
Table 9: ASHRAE 90.1-2007 Insulation requirements 59
Table 10: Effects of erosion and sedimentation 60
Table 11: Electric lighting power density for streets 73
Table 12: street lighting technologies comparative chart 74
Table 13: LED lighting savings when compared with other lighting systems 76
Table 14: LED lighting providers 76
Table 15: Hybrid lighting systmem provider 80
Table 16: Grid-connected photovoltaic system components 81
Table 17: Propose photovoltaic array for Vesta's Industrial Parks. 81
Table 18: Proposed PV panels 82
Table 19: Rainwater treatment techniques 84
Table 19: Average rainfall for Vesta's chosen locations 85
Table 21: Wastewater treatment systems providers 88
Table 22: Permeable paving providers in Mexico 92
Table 23: Native vegetation palette for Vesta's selected locations 95
Table 24: Comparison between conventional concrete and high volume fly ash concrete 99
Table 25: Providers of concrete with fly ash aggregates in Mexico 99
Table 26: ASHRAE wall insulation requirements for the proposed locations 100
Table 27: Hebel block thermal properties. 100
Table 28: ASHRAE roof insulation requirements for the proposed locations 101
Table 29: Proposed roof assemblies 102
Table 30: Roofing materials radiative properties 103

Table 31: Green roof providers in Mexico 104
Table 32: Environmentally friendly carpet providers 105
Table 33: Low VOC paintings 106
Table 34: Environmentally friendly Wood flooring 106
Table 35: Environmentally friendly flooring tiles 107
Table 36: Concrete floor finishes with low VOCs 107
Table 37: Environmentally friendly grid ceilings 107
Table 38: Ceiling providers with higher recycled content 108
Table 39: Windows requirements according to ASHRAE 108
Table 40: Pilkington glassing products 109
Table 41: Skylights requirements according to ASHRAE 110
Table 42: Solatube performance compared to traditional skylights 111
Table 43: Lighting power densities requirements 114
Table 44: Lighting consumption in Vesta's Office Building 114
Table 45: Plumbing fixtures selection criteria 115
Table 46: Suggested wáter saving fixtures 117
Table 47: Minimum ventilation rates for office buildings 118
Table 48: Air conditioning efficiency 119
Table 49: Propose photovoltaic array for Vesta's Industrial Parks. 120
Table 50: Proposed PV panels 121
Table 51: Commissioning Plan activities by phase 125
Table 52:Energy consumption for sodium vapor street lamps on VESTA's industrial park. 126
Table 53:Energy consumption for LED street lighting on VESTA's industrial park. 127
Table 54: Electricity cost by month 127
Table 55: Energy generation scenarios 128
Table 56: ROI Analysis 129
Table 57: ROI Analysis for LED lamps 129
Table 58:Energy consumption for decorative spots on VESTA's office building. 130
Table 59:Energy consumption if current lamps in office building are substituted by LEDs 130
Table 60: ROI analysis with current lighting fixtures 131
Table 61: ROI Analysis if current lighting fixtures are substituted by LEDs 132

Table 62: LED luminaries vs. sodium vapor lamps 132
Table 63: Life cycle analysis for LED luminaries 133
Table 64: ROI for LED luminaries 133
Table 65: Cost of current decorative spots vs. LED spots 133
Table 66: Life cycle analysis of current and proposed lighting fixtures 134
Table 67: Additional investment to replace current lighting in VESTA's office 134
Table 68: ROI for LED lighting in VESTA's office building 134
Table 69: Water fixtures considered for ROI analysis 135
Table 70: ROI considering one shower per employee per day 136
Table 71: LEED credits covered on this handbook 139

FIGURES

Figure 1: Toluca Vesta Park Aereal View 3
Figure 2: Toluca Vesta Park Zonning Diagram 4
Figure 3:Vesta Office Building in Toluca Vesta Park Zonning Diagrams 5
Figure 4: Vesta Office Building First Floor Plan 6
Figure 5: Vesta Office Building Second Floor Plan 6
Figure 6: Certification levels by system 11
Figure 7: Comparison between certification systems 12
Figure 8: Requirements by difficulty for the three certificaton systems 13
Figure 9: Amazon's North Plainfield Facility 14
Figure 10: Building 1 for Home Depot 16
Figure 11: Acces to Building 1 for Home Depot 17
Figure 12: G. Park Blue Planet, Chatterley Valley 18
Figure 13: G. Park Blue Planet, Chatterley Valley interior and exterior details 19
Figure 14: Characteristics to consider during site selection 26
Figure 15: Development density and community connectivity 27
Figure 16: Strategies to increase alternative transportation in the facilities 29
Figure 17: Strategies to reduce site disturbance 30
Figure 18: Heat Island Effect 31
Figure 19: Roofing materials that contibue to heat island effect reduction 32

Figure 20: Hardscape materials that contribute to heat island effect reduction 32
Figure 21: Commonly pervious materials for sidewalks and roads 34
Figure 22: Stormwater management - retention pound 34
Figure 23: Stormwater management - vegetated areas 35
Figure 24: Designate smoking areas for tobacco smoke control 36
Figure 25: Entryway track-off systems 37
Figure 26: Building orientation and daylight 38
Figure 27: Interior distribution and daylight 39
Figure 28: Overhangs 39
Figure 29: Daylight and building shape 39
Figure 30: Daylight in interior spaces 40
Figure 31: Daylighting strategies 40
Figure 32: Daylight strategy – Skylights 41
Figure 33: Daylight strategy – Saw-tooth apertures 41
Figure 34: Daylight strategy – Monitor aperture 41
Figure 35: Daylight strategy – atrium 42
Figure 36: Daylight strategy – light well 42
Figure 37: IncreasIncreased views accessibility 43
Figure 38: Distribution of selected Vesta's Industrial Properties 46
Figure 39: Regional material radius for El Potrero Vesta Park in Tijuana 47
Figure 40: Regional material radius for Bernardo Quintana Industrial Park in Queretaro 47
Figure 41: Regional material radius for Cancun, Cancún 48
Figure 42: Recycled content verification seal 49
Figure 43: Certified Wood Seal 50
Figure 44: U value diagram 54
Figure 45:Wall R value diagram 55
Figure 46: Erosion and sedimentation control – protect and maximize existing vegetation 61
Figure 47: Erosion and sedimentation control – use mulching and temporary seeding 62
Figure 48: Erosion and sedimentation control – use sediment fences 62
Figure 49: Erosion and sedimentation control - sedimentation basins 62
Figure 50: Erosion and sedimentation control – earth dikes 63

Figure 51: Erosion and sedimentation control – vehicle tracking.....63
Figure 52: Example of a Habitat Protection Plan 65
Figure 53:Air quality management plan – HVAC protection 66
Figure 54: Air quality management plan – Source control 67
Figure 55: Insolation of construction area from remainder of building 67
Figure 56: Materials kept off the floor to avoid damage and exposure to moisture 68
Figure 57: Construction waste management 69
Figure 58: Toluca Vesta Park Aereal View 70
Figure 59:Comparative images of High Presure Sodium Lighting and LEDs.....75
Figure 60: Photovoltaic lighting systems 78
Figure 61: Hybrid lighting system diagram 79
Figure 62: Grid-connected photovoltaic power system diagram 80
Figure 63: Water resources per capita in México through the years 82
Figure 64: Rainwater falling on roads should be conducted to green areas.....83
Figure 65: Main components of rainwater harvesting systems.....84
Figure 66: Methodology for estimating wastewater resources.....87
Figure 67: Typical diagram of a greywater treatment system 87
Figure 68: Strategies to reduce heat island on Vesta's Industrial Properties 90
Figure 69: Vesta Office Building in Toluca Vesta Park 98
Figure 70: Hebel bock's construction.....101
Figure 71: Building construction using Hebel Blocks and Panel Losa Hebel 102
Figure 72: Proposed Owens Corning's rigid insulation 102
Figure 73: Section of a typical green roof system 104
Figure 74: Solatube.....110
Figure 75: Solatube performance diagram.....111
Figure 76: All luminaries in the building should be Energystar or FIDE certified.....113
Figure 77: Lighting fixtures average energy consumption 113
Figure 78: Secure bicycle racks should be provided for employees. 122
Figure 79: Separate paper, cardboard, glass, plastic and metal containers. 122

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100 INTRODUCTION

110 Introduction to VESTA's Sustainable Construction Handbook: Industrial Parks

As designers and building owners learn that with a smart design, buildings can save energy, water, and reduce their environmental impact, sustainable design and construction is becoming increasingly important in the construction industry.

Building owners, designers and builders are being challenged to develop facilities that are secure, productive, and healthy, with low operation cost and minimum impact on the environment.

VESTA's Sustainable Construction Handbook has been developed as a tool to support the company's vision of social and environmental responsibility. Based on international standards and regulations VESTA's Sustainable Construction Handbooks provide a framework to incorporate sustainable construction best practices on VESTA's real estate properties.

120 Background

VESTA is an Industrial Real Estate Fund, with more than ten years of experience in the development of industrial infrastructure: Industrial Parks, "Build to Suit" and Spec building for lease. VESTA currently owns 103 properties distributed in 11 states of Mexico.

VESTA's Project's Manual establishes technical specifications for the construction of the company's industrial buildings. VESTA's Sustainable Construction Handbooks (Industrial Parks & Building Shells) aim to integrate current standards and practices used by the company with international standards and regulations for sustainable development.

130 Relevance of VESTA's Sustainable Construction Handbooks

Through the development of VESTA's Sustainable Construction Handbooks, Industrial Parks & Building Shells, VESTA wishes to move forward in the achievement of its vision of social and environmental responsibility. This Handbook includes sustainable best practices and strategies for the construction, operation and maintenance of VESTA's industrial real estate properties.

This handbook's sustainability strategies focus on the development of:

- *Best practices for the selection and development of the site.*
- *Best practices for the achievement of energy efficiency.*
- *Best management practices for materials and resources.*
- *Development of a commissioning plan to verify that the project's energy-related systems are installed calibrated and performs as designed.*
- *Return of investment analysis for implementing eco-technologies.*

VESTA's initiative of developing Sustainable Construction Handbooks to incorporate sustainability principles in its industrial parks and building shells reinforces the company's commitment with the environment and society, contributing to strengthen the company's image before investor, strategic partners and potential clients.

140 Methodology

VESTA's Sustainable Construction Handbooks were developed following world renowned sustainability standards. The Handbooks are based on the requirements for LEED™ Core & Shell 2009 Certification, as well as standards established by institutions mentioned in the LEED™ Reference Guide for Green Building Design and Construction, such as ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) or EPA (Environmental Protection Agency). VESTA's Sustainable Construction Handbooks also take into account the requirements of the IGCC 2.0 (International Green Construction Code).

VESTA's Sustainable Construction Handbooks take as reference current standards and practices used by VESTA in the development of its industrial properties, incorporating additional sustainability strategies and best practices, which can be divided into six main categories:

- *Sustainable Sites*
- *Water Efficiency*
- *Energy and Atmosphere*
- *Renewable Energy*
- *Materials and Resources*
- *Indoor Environmental Quality*

141 Base Case Analysis

An existing industrial park and office building representative of VESTA's developments were taken as a baseline for analysis purposes. Savings will be determined by contrasting energy and water consumption of baseline developments with projected resource consumption of industrial parks were sustainable strategies are to be implemented.

141.1 *Toluca Vesta Park*

Project Description: Toluca Vesta Park, located in Toluca, Mexico, has an approximated area of 120 hectares, mostly distributed along five warehouses. The leasable space in the park (warehouses, plus parking, plus some green areas) occupies nearly 87% of the plot. About two percent of the site's area is used for the administrative office building and the entrance gateways controlled by VESTA. The remaining area, also controlled by VESTA is used for sidewalks, roads, and infrastructure.

As shown in the following images, the majority of the site's area has been developed. Warehouses' footprints occupy the greatest amount of space, followed by the areas used for parking lots, roads and sidewalks.

The percentage of green spaces within the site is mostly distributed along the leasable area, and therefore is maintained by the tenants. Only the green spaces surrounding the administrative office building and entrance gateways are maintained by VESTA.

Figure 1: Toluca Vesta Park Aereal View

Figure 2: Toluca Vesta Park Zonning Diagram

Leasable Area
Administrative Office Building and Entrance Gateways Area
Warehouses' Footprint
Roads and Sidewalks
Green Areas

An analysis of the information provided by the client, followed by a visit to the site was used for a preliminary identification of opportunity areas for incorporating sustainable strategies and best practices on the industrial park. The identified areas of opportunity are:

- *Development of a commissioning plan to verify that equipment and systems perform according to design.*
- *Use of efficient public lighting and renewable energy systems to reduce energy consumption.*
- *Increase water catchment areas and pervious surfaces to minimize stormwater runoff.*
- *Use water efficient landscape to reduce water consumption for irrigation.*
- *Use finishes and hardscape materials with a high Solar Reflectance Index to reduce the heat island effect.*

141.2 *Vesta Office Building in Toluca VESTA Park*

Project Description: Vesta Office Building in Toluca VESTA Park, is an administrative building located at the entrance of the industrial park. The two story building has an approximate area of 174 square meters, and is regularly occupied by six persons.

Utilities, services and maintenance of VESTA Office Building and its exterior spaces (parking and green areas) are responsibility of VESTA. Most of the vegetation within the office building is turf grass, which is currently irrigated with non potable water treated within the industrial park.

In contrast with the VESTA's Warehouses, there is not a construction document regulating materials and finishes used in administrative office buildings, but there is a predilection of the company for modular design.

Figure 3:Vesta Office Building in Toluca Vesta Park Zonning Diagrams

Office Building
Roads and Sidewalks
Green Areas

The following images illustrate the interior space distribution within the office building. Typically the building has six users, four located on the first floor and two on the second floor.

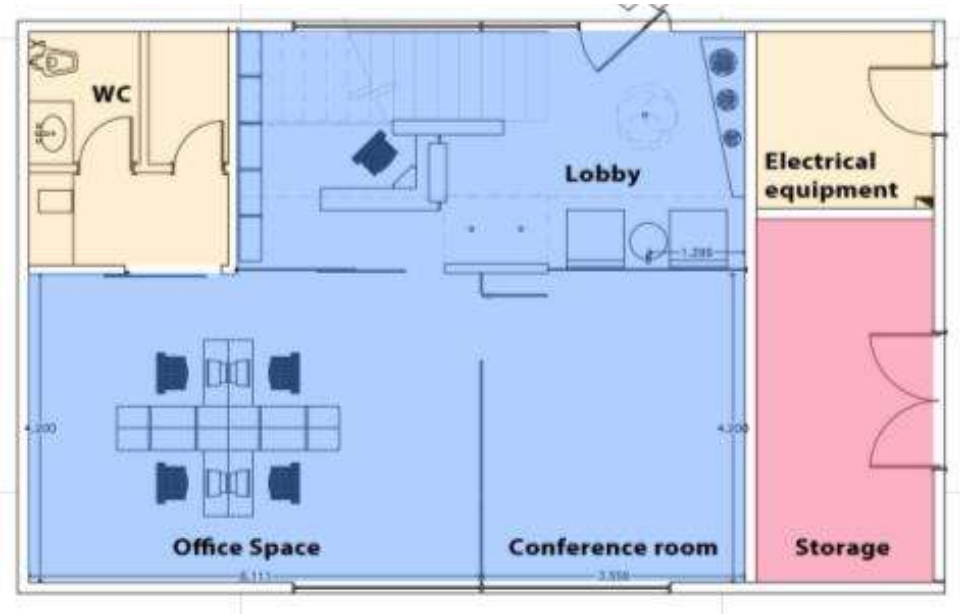

Figure 4: Vesta Office Building First Floor Plan

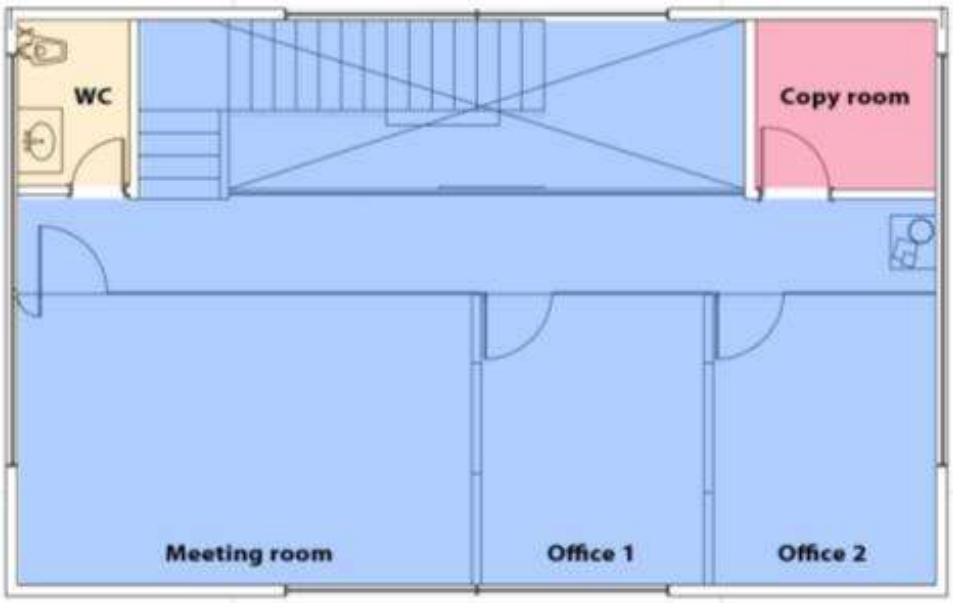

Figure 5: Vesta Office Building Second Floor Plan

Service areas
Office space
Storage

The identified areas of opportunity for the incorporation of sustainable strategies and best practices within Vesta Office Building are:

- *Use of appropriate insulation in the building envelope, to maximize thermal comfort while minimizing energy consumption.*
- *Adequate glazing and framing design to minimize energy consumption*
- *Use of materials with a high Solar Reflectance Index to reduce energy consumption and heat island effect.*
- *Development of strategies for the selection of materials and finishes based on LEED Core & Shell principles.*
- *Development of a commissioning plan to verify that equipment and systems perform according to design.*
- *Use of efficient lighting and renewable energy systems to reduce energy consumption.*
- *Use of water efficient fixtures to minimize water consumption.*
- *Increase water catchment areas and pervious surfaces to minimize stormwater runoff.*
- *Use water efficient landscape to reduce water consumption for irrigation.*
- *Development of a recycling plan to reduce waste stream.*
- *Provide bicycle racks and/or storage to reduce automobile use and air pollution.*
- *Development of a comprehensive transportation management plan to reduce personal automobile use.*

142 Introduction to LEED® Core & Shell Rating System

LEED (Leadership in Energy and Environmental Design) Green Building Rating System™ is a voluntary, internationally renowned certification program developed by the US Green Building Council (USGBC) to create concrete standards for measurement of what constitutes a green building design, construction, and operation.

LEED rating system is used in as many as 115 countries around the world, it has over 9,800 certified buildings and over 51,000 buildings pursuing certification, making it the most widely used sustainable rating system, globally.

Among LEED rating systems, LEED for Core & Shell was developed to serve the speculative development market, in which project teams do not control all scopes of a building's design and construction. Core and Shell construction covers base building elements, such as the structure, envelope and building level systems.

The certification process in LEED Core & Shell is based on a hundredth point scale with option to ten extra points (for Innovation in Design and Regional Priority). The certification works by awarding points for concrete measures taken into five environmental categories: Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials and Resources, and Indoor Environmental Quality.

Table 1: LEED Core & Shell categories

Category	Possible Points
Sustainable Sites	28
Water Efficiency	10
Energy and Atmosphere	37
Materials and Resources	13
Indoor Environmental Quality	12
Innovation in Design	6
Regional Priority	4
Total	**110**

The number of points the project earns determines the level of LEED Certification the project receives. LEED certification is available in four progressive levels according to the following scale:

- *Certified 40-49 points*
- *Silver 50-59 points*
- *Gold 60-79 points*
- *Platinum 80 points and above*

Sustainable Sites (SS): This category seeks to minimize buildings' impact on ecosystems and waterways, encourages regional landscape, and smart transportation choices. It seeks to reduce stormwater runoff, erosion, sedimentation, light pollution, heat island effect and construction related pollution.

Water Efficiency (WE): This category address issues related to building water usage. It encourages smart water use through water efficient fixtures, regional landscape, and innovative wastewater technologies.

Energy and Atmosphere (EA): Credits on this category address issues related to energy required during design, construction and operation of buildings. This category encourages commissioning of building energy equipment and systems, energy use monitoring, the use of efficient appliances, efficient lighting, and renewable and clean energy sources.

Materials and Resources (MR): This LEED category address issues related to materials selection, waste disposal, and waste stream reduction. It encourages the selection of sustainable grown, harvested, produced and transported products and materials. MR promotes the storage and collection of recyclables, material re-use, and source waste reduction.

Indoor Environmental Quality (IEQ): IEQ promotes strategies that improve indoor air quality, provide access to natural daylight and views. It address issues related to occupants' health, safety, and comfort; air change effectiveness; and air contaminant management.

Innovation in Design (ID): This category provides bonus points to projects that use constantly evolving processes, strategies, practices and technologies to improve a building's performance beyond LEED's credits requirements, or to account for green building considerations that are not specifically addressed elsewhere in LEED.

Regional Priority (RP): RP provides bonus points to those projects that address the most important local environmental concerns or priorities as determined by the USGBC regional chapters.

VESTA's Sustainable Handbooks (Industrial Parks & Building Shells) are based on the requirements for LEED™ Core & Shell 2009, as well as referenced standards mentioned in the LEED Reference Guide for Green Building Design and Construction, such as ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) or EPA (Environmental Protection Agency). The Sustainable Handbooks are based on LEED C&S to make sure the most up to date, internationally acknowledged sustainable principles and standards are being taken into consideration.

142.1 *Comparison between LEED, BREEAM and DGNB*

The DGNB (German Sustainable Building Certificate) was launched by the German Sustainable Building Council in cooperation with the German Federal Ministry of Transport, Building and Urban Development to evaluate sustainable buildings. This certification along with BREEAM (Building Research Establishment Environmental Assessment Method) developed in the United Kingdom, and LEED are the world most well-known sustainable buildings certification systems.

A comparison between these three certification systems was made to establish similarities, differences and set sustainability standards for the development of VESTA's Sustainable Construction Handbooks.

Main Sustainability Targets per Certification System (according to websites)		
LEED	BREEAM	DGNB
Lower operating cost and increase asset value of buildings Reduction of waste in the landfills Conservation of energy and water Design building which are safer and healthier for occupants Reduction of greenhouse effect Quality for tax discounts, zoning allowances, etc.	Decrease life cycle impacts of buildings. Recognition of environmental benefits of buildings. Provide credible environmental certification. Stimulate demand for sustainable buildings. Recognition of building with low environmental impact. Best practice in planning, design, construction and operation. Performance exceeding regulations requirements. Increase the market for innovative, cost effective solutions that minimize impact of building. Raise owners, occupants, designers and operators awareness. Progress towards corporate environmental objectives.	Nature conservation Retention of resources Lower impact on the climate Retention of economical capital Low maintenance and operational cost Human health concern Protection of social and cultural values.

Table 2: Sustainability targets per system

Figure 6: Certification levels by system Source: DGNB German sustainable Building Council

The following table establishes a comparison between the three sustainable certification systems, based on the weight that is given to different topics. As shown in the table LEED and BREEAM certifications are more ecologically and socially oriented, while DGNB certification also grants great weight to the economical sustainability of the project.

Buildings and uses	DGNB	LEED	BREEAM
Ecological aspects	22.5%	64.0%	58.5%
Economic aspects	22.5%	0.0%	0.0%
Social aspects	16.0%	14.5%	14.0%
Functional aspects	6.5%	0.5%	5.0%
Technical aspects	22.5%	0.0%	5.0%
Aspects in planning processes	5.0%	2.0%	1.0%
Aspects in construction processes	3.0%	8.0%	7.0%
Aspects in operational processes	2.0%	1.5%	4.0%
Aspects of the building site	Separately evaluated	9.5%	5.5%

Legend

Proportion of elements considered in category >31%
Proportion of elements considered in category 11% <31%
Proportion of elements considered in category <10%
Category not considered

Table 3: Comparison between certification systems Source: Institute of Concrete Structures, TU Darmstadt

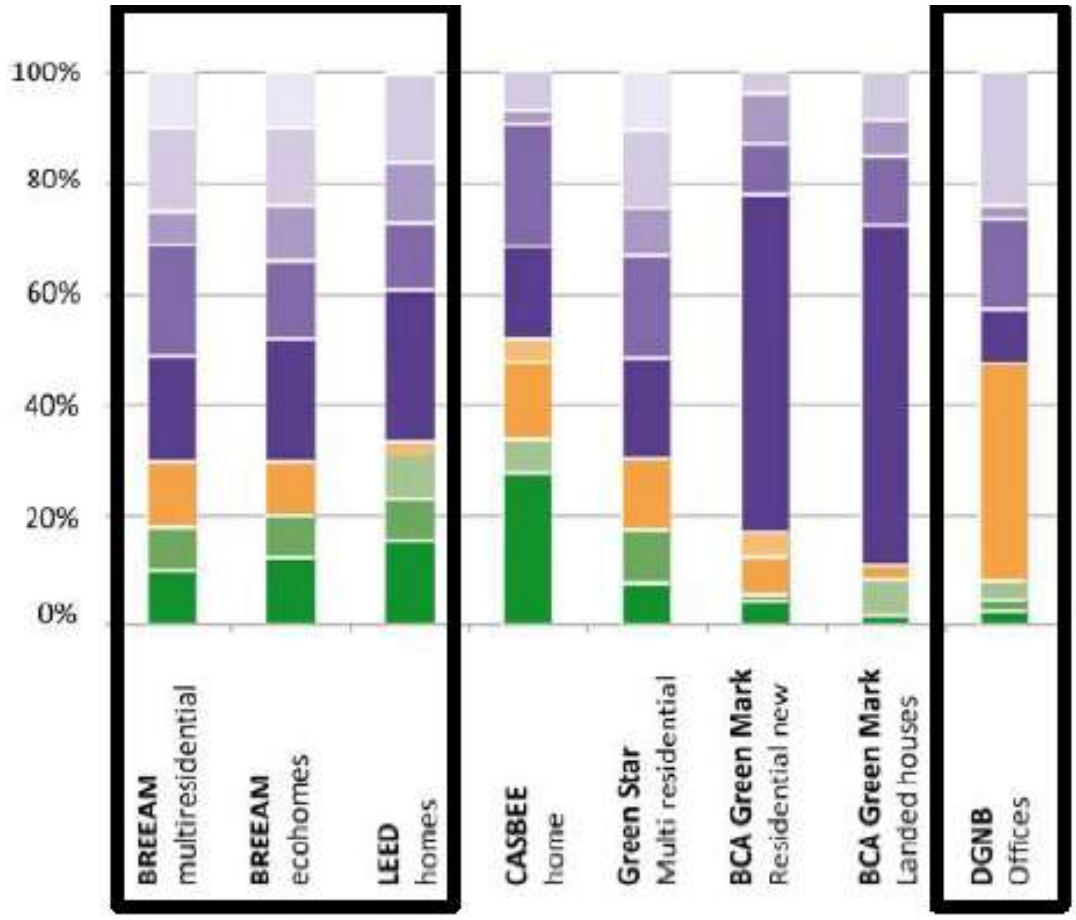

Figure 7: Comparison between certification systems

- Pollution, emissions
- Indoor environmental quality, wellbeing
- Water efficiency
- Materials & resources, waste & recycling
- Energy & atmosphere, renewable energy
- Awareness & education of user, function
- Maintenance & operation, economy
- Innovation & design, green features
- Location & linkages, transport
- Sustainable sites, land use & ecology

As can be seen on figure 8, according to a study developed by Drees & Sommer Advance Building Technologies for DGNB; DGNB and BREEAM have higher requirements than LEED, especially in topics related to economic sustainability of the project. DGNB emphasizes the importance of reducing maintenance and operation cost of the building, while the current version of LEED and BREEAM don't give too much weight to reducing life cycle cost of buildings. However, the operation cost of a project is directly related to its water and energy consumption, so it is indirectly addressed in the other certification systems.

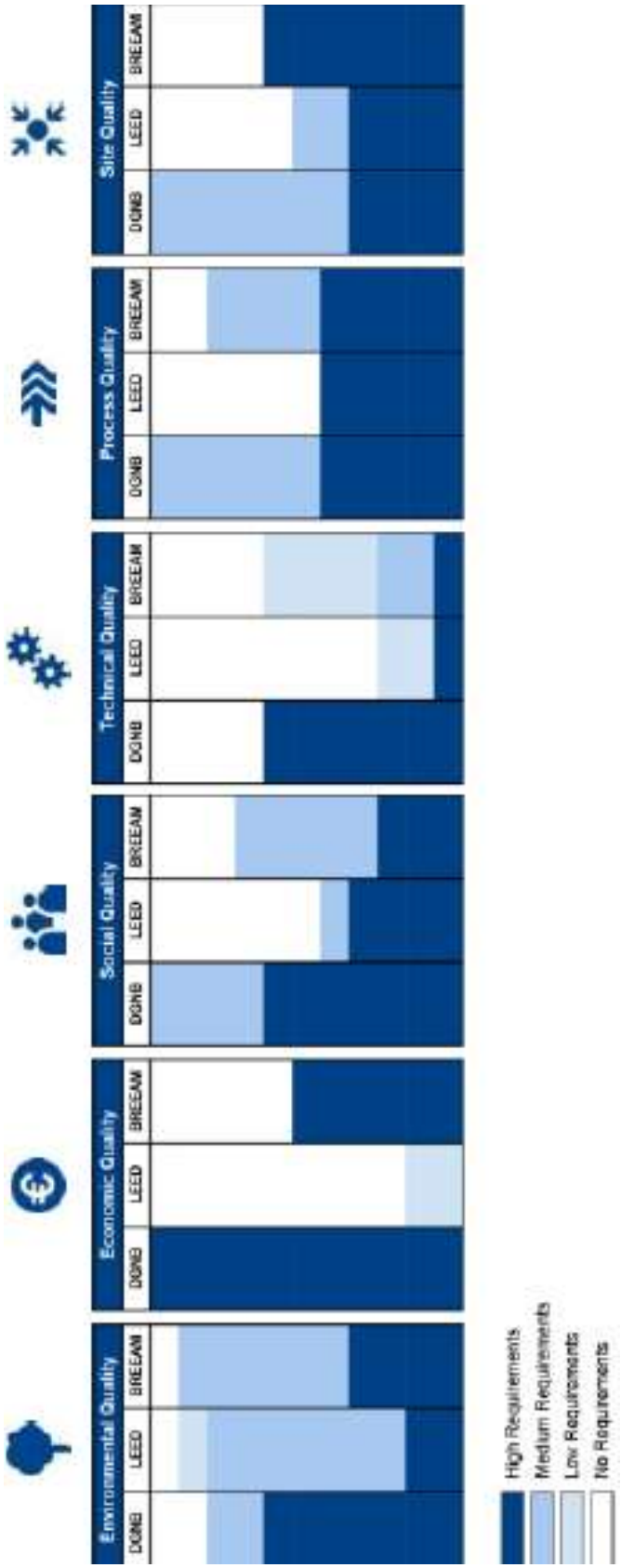

Figure 8: Requirements by difficulty for the three certificaton systems

150 Case Studies

There are a growing number of sustainable buildings in Mexico and around the world. Three representative sustainable industrial buildings were chosen for the analysis of their sustainability features, strategies and characteristics. The analysis of these buildings was used as a reference of what is being done on the sustainable field and as a tool to look for new technologies and strategies that can be implemented in VESTA's industrial properties.

Amazon's Industrial Building in North Plainfield
Indianapolis, Indiana USA
LEED-CI Silver certified 2009

Figure 9: Amazon's North Plainfield Facility

This large Midwest distribution center for Amazon has been awarded LEED®-CI Silver Certification by the U.S. Green Building Council (USGBC). The industrial facility it is located in Plainfield in a master planned industrial park close to the Indianapolis International Airport.

An extensive amount of sustainability features were incorporated on this project. The lighting dims or shuts off lights when adequate daylight is available, an energy management system maintains minimum indoor air quality by monitoring outside air temperature and interior CO_2 concentration, efficient plumbing fixtures were used for water efficiency.

Key sustainable features:

- *Energy-efficient T5 fluorescent light fixtures, photoelectric cells and motion sensors.*
- *Reduction in lighting power by 35% below the standard through lighting dimming systems that works in accordance with daylight.*
- *High-efficiency, zero CFC-based refrigerant HVAC equipment.*
- *Installation of bicycle racks and changing/shower facilities to promote alternative, non polluting transportation mechanisms.*
- *Reduction in water usage by 20% with the use of low flow plumbing devices.*
- *Energy Management System (EMS) to regulate indoor air quality.*
- *Use of Energy Star equipment and appliances throughout the facility to reduce energy consumption.*
- *Paints, carpets, sealants, adhesives and other materials rated low in Volatile Organic Compounds (VOCs).*
- *Extensive recycling of construction waste.*
- *Diversion of 90% of the construction waste material from landfills and incinerators back to the manufacturing process.*
- *Use of construction materials where at least 20% is processed and manufactured within 500 miles of the site.*
- *Use of certified wood base products, complying with the Forest Stewardship Council's Principles and Criteria.*

Building 1 for Home Depot
Monroe, Ohio USA
LEED-NC Gold certified 2009
Size: 61,309 square meters

Figure 10: Building 1 for Home Depot

This project was developed as a built to suit distribution facility for Home Depot. The customer wanted to improve service and increase efficiency in the building while meeting stringent requirements, including a tight construction schedule and precise building specifications.

The building was noted for exemplary performance in its use of regional materials. Regional materials are materials and products that are extracted and manufactured within the region, supporting the use of indigenous resources and reducing environmental impacts resulting from transportation.

Among the sustainability goals pursued for the development of Park Corridor 75 Building 1 were water and energy use reduction. The building is designed to achieve 42 percent reduced water usage and 30 percent reduced energy consumption when compared to a standard building.

Key sustainable fixtures:

- *Low-flow plumbing fixtures to achieve a reduction of 42% in water use over a standard building.*
- *Paints, carpets, sealants, adhesives and other materials rated low in Volatile Organic Compounds (VOCs).*
- *Energy-efficient T5 fluorescent light fixtures, photoelectric cells and motion sensors.*
- *Dark-sky exterior lighting to minimize lighting pollution.*
- *Use of white TPO roof membrane. TPO membranes are single-ply roof membranes constructed from ethylene propylene rubber. They have been tested as having excellent resistance to ozone and algae, while being environmentally friendly and safe to install.*
- *Exemplary performance in its use of regional materials.*
- *Use of rainwater harvesting strategies.*
- *Use of native vegetation to reduce irrigation requirements.*
- *Optimum skylight design to reduce lighting requirements.*
- *Use of solar water heaters.*
- *Use of materials with a high recycled content.*
- *Use of permeable paving to reduce water runoff.*
- *Energy renewable systems.*

Figure 11: Acces to Building 1 for Home Depot

G.Park Blue Planet, Chatterley Valley
Staffordshire, United Kingdom
The World's first BREEAM Outstanding rated logistic building

Figure 12: G. Park Blue Planet, Chatterley Valley

This project, unique on its kind, was developed by Gazeley, a leading developer of sustainable distribution space. Since 1987, Gazeley has built over 5.6 million square meters of built to suit warehouses and distribution parks globally. Among its various customers are P&G, Nestlé, Asda/Wal-Mart, Morrisons, Volkswagen, John Lewis and third party providers such as DHL, CEVA, Geodis, TNT, Zufall and Norbert Dentressangle. Gazeley is renowned for its commitment to develop sustainable warehouses, improving its environmental performance and energy efficiency.

G. Park Blue Planet features a variety of renewable and sustainable power sources with capacity to support the park and export power and heat to the neighboring residential development. The buildings are designed to maximize daylighting, solar power generation, energy efficient lighting and to eliminate night-time light pollution.

The main warehouse drains rainwater collected from the roof into ponds, streams, green areas, and a 20,000 liters tank that stores the rainwater for flushing WCs. The south wall of the warehouse is designed as a solar attractor, to absorb the warmth of the sun, which is then fed into a plenum and redistributed throughout the building as free heating. The design of the warehouse achieves lighting and power savings of 49%, heating energy savings of 68% and water savings of 60% when compared to a conventional distribution building.

Figure 13: G. Park Blue Planet, Chatterley Valley interior and exterior details

Key sustainable fixtures:

- *Photovoltaics were integrated into ETFE rooflights (a completely recyclable material).*
- *An energy panel was used in the southern elevation, allowing naturally heated air to be captured and used for internal heating.*
- *Kinetic energy plates in the access road produce power when driven over by vehicles entering or leaving the site.*
- *Underfloor heating fuelled by on site Biomass power station.*
- *Energy efficient lighting linked to movement detectors and daylight saving controls.*
- *Rainwater harvesting for irrigation and toilets' flushing*
- *Maximization of prefabricated materials and recycling. Building materials were chosen for their longevity and end of life recycling.*
- *Maximization of materials supplied from within 35 miles (40%)*
- *Biomass micro power station that provides power and heat to the development.*

Lessons learned

The case studies indicate that sustainability strategies and measures are being taken predominantly in the following areas:

- *Use of natural daylight strategies and energy efficient lighting fixture to reduce energy consumption.*
- *Use of regionally produced and distributed materials.*
- *Use of materials and products with high recycled content.*
- *Use of native vegetation to reduce irrigation requirements.*
- *Rainwater harvesting.*
- *Natural ventilation.*
- *Renewable energy systems.*
- *Alternative transportation strategies to minimize single vehicle ridership.*

160 How to use this Handbook

This Handbook is intended for the use of architects, engineers, developers and professionals related to the building industry, that have previous experience and/or training in topics related to sustainable development.

The purpose of this Handbook is to provide a framework to incorporate sustainable construction best practices in VESTA's real estate properties. This Handbook is based on international sustainability standards and codes which have proven to be successful on similar scenarios. However, it is acknowledged that strategies suggested in this document are not the only ones that can achieve sustainability in a building.

This Handbook is intended to work along with VESTA's existing standards and policies. In case of conflict between a project and the information provided in this manual, further analysis should be done, and individual decisions should be taken. In any case, **the information provided in this document does not substitute existing owner's requirements, building codes and/or design regulations**.

This Handbook should be periodically updated, to maintain its currency, providing up to date sustainable strategies and best practices.

Trained personnel should be in charge of applying strategies and technologies included in this document, to ensure task are being performed in a satisfactory way. Measures taken towards implementing sustainability strategies should take into account installation guides, manuals and/or other documentation provided by the supplier, engineers and/or professional personnel involved.

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200 GREEN BUILDING'S REQUIREMENTS

210 Owner's Project Requirements

It is fundamental that the owner documents the project's requirements through the *Owner's Project Requirements (OPR)* whenever a new construction or major renovation is being developed, to set the functional goals of the project in accordance to the owners needs. This document should be completed as early as possible, and should detail the functional requirements of the project and the expectations of the building's use and operation of systems (HVAC&R, lighting and daylight controls, domestic hot water systems and renewable energy systems if they are contemplated within the project).

The Owner's Project Requirements should document:

1. *Owner and User Requirements:* A description of the primary purpose, program, and use of the Project. It may also describe future expansion needs, flexibility, quality of materials, construction and operation cost goals.
2. *Environmental and Sustainability Goals:* A description of specific environmental or sustainability goals (like level of LEED certification desired).
3. *Energy Efficiency Goals:* A description of specific energy efficiency goals relative to local energy codes or internationally renowned standards. Desired energy efficiency measures that provide cost effective energy savings. Requirements for building orientation, landscaping, façade, fenestration, envelope and roof features that will affect energy use.
4. *Indoor Environmental Quality Requirements:* For each program/usage area it should include a description of: anticipated occupancy schedules, thermal comfort requirements, temperature and/or humidity requirements, desired user controllability of HVAC systems, ventilation and filtration requirements, accommodations for after hours use, acoustic environment requirements, indoor lighting requirements, occupant lighting control requirements, other owner's requirements like natural ventilation, operable windows, views.
5. *Equipment and Systems Expectations:* For each program/usage area it should include a description of: special HVAC equipment requirements such as type, quality, reliability, efficiency, preferred manufactures, maintenance requirements; special lighting requirements such as preferred lamp and ballast types; other systems requirements such as specific efficiency target, desired technologies, etc.
6. *Building Occupant and O&M Personnel Expectations:* A description of how the facility will be operated and by whom, including a description of the desired level of training and orientation required for the building occupants to understand and use the building systems.

Refer to Appendix 1 to see an outline of an Owner's Project Requirements document.

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300 GENERAL GUIDELINES FOR GREEN BUILDING'S DESIGN

This section aims to provide general guidelines for green building's design. The strategies and recommendations covered in this section have major implications in the development of sustainable industrial properties. It includes strategies like an adequate site selection, stormwater management, interior environmental quality, natural daylight strategies and strategies to procure thermal comfort for the building's users, which can greatly influence a building's environmental impact.

Because it is unknown the exact location and design requirements of VESTA's future industrial parks, it is not possible to provide specific recommendations about how to address the selected site. However, this section provides general criteria about how to select and develop a sustainable site, and it should be taken into consideration during those early phases of the project.

This Handbook does not pretend to substitute judgment and/or professional criteria of the people involved in the development of the project. It is a duty of the owner and/or developer to ensure that proper methods and strategies are being implemented in the project.

310 Sustainable Sites

"The selection and development of a building's site are fundamental components of sustainable practices. Environmental damage caused by construction may take years of work to remedy" (LEED Green Building Design and Construction, 2009).

It is fundamental to select a site that does not compromise existing habitats. A site that takes into account emissions associated with transportation of building's occupants. Moreover, the development of the chosen property must use sustainable practices to decrease soil erosion, sedimentation and pollution of the environment.

A properly developed site can reduce the heat island effect, can minimize stormwater runoff, can contribute to restore wildlife habitat and decrease pollution, while reducing energy, water consumption and maintenance cost of the building.

A sustainable site design requires holistic, ecologically based strategies to create and built projects that do not alter or impair, but instead help repair and restore existing site ecosystems, to promote sustainable development and well being of its occupants.

It is important to keep in mind sustainable sites strategies during the selection and development of the project. The architect, the owner and other team member involved should try to implement the strategies and recommendations covered in this section.

311 Site Selection

Sustainable buildings start with proper site selection. The location of a building will have effects on many factors like security, accessibility, energy consumption, energy consumed for transportation, ecosystems, the use/reuse of existing structures and infrastructures, etc. It is important to address site selection early in the project development process to ensure these factors are considered. Equally important is that the people involved in site selection understand sustainable site design and the impact a building's location can have on its performance.

Development of industrial properties should be avoided on sites that meet any of the following criteria:

- *Prime farmland*
- *Sites whose elevation is lower than 1.5meters above the elevation of the hundredth year flood*
- *Land identified as habitat for any species on federal or state threatened or endangered lists.*
- *Land within 30 meters of wetlands and 15 meters of a water body.*
- *Land that prior to acquisition for the project was public parkland.*

Figure 14: Characteristics to consider during site selection

Don't develop on land next to waterbodies

Brownfield redevelopment

Don't develop on farmland

Develop on dense sites

312 Development Density and Community Connectivity

During the site selection phase, the owner, architect and developer should give preference to sites within an existing urban fabric. Choosing a previously developed site contribute to take advantage of existing infrastructure while preserving natural habitat.

Development density and community connectivity promotes the use of public transportation in lieu of automobiles, increases community connectivity, decreases infrastructure needs, and provides access to amenities for populations dependent on public transportation.

This strategy addresses two basic issues: density of the surrounding neighborhood and occupant access to everyday services. During site selection priority should be given to:

- *Previously developed sites with a minimum density of 13,777square meters per hectare.*
- *Previously developed sites within .80 kilometers of a residential area with a minimum density of 25 units per hectare and accessibility to at least 10 basic services.*

  Basic services include but are not limited to: Banks, place of worship, convenience grocery, day care, cleaners, fire station, beauty, hardware, laundry, library, medical/dental center, senior care, park, pharmacy, post office, restaurants, schools, supermarket, theater, community center, fitness center, and museums.

Figure 15: Development density and community connectivity

Priority should be given to previously developed sites with a minimum density of 13,777 square meter per hectare

Priority should be given to sites with accesibility to services and existing infrastructure

313 Alternative Transportation – Public Transportation Access

Public transportation provides people with mobility and accessibility to employment, community resources, medical care, and recreational opportunities. The incorporation of public transportation options can help a community expand business opportunities, reduce sprawl, and create a sense of community. Moreover public transportation helps to reduce road congestion and travel times, air pollution, energy and oil consumption, benefiting both riders and non-riders.

Public Transportation Access

The project should aim to be located within 400 meters walking distance (measured from a main building entrance) of one or more stops for two or more public or private bus lines usable by building occupants. In case the industrial property does not comply with this condition, public transportation access should be procured to the nearest population center.

Alternative Transportation

Incentives should be granted to people using public and/or alternative transportation (low emitting vehicles, bicycles, carpooling, etc.) in order to encourage its use among building's occupants. An analysis of occupant's transportation necessities and preferences should be done to determine the most viable transportation options.

Some strategies to promote alternative transportation are:

- *Provide preferred parking for low emitting, fuel efficient, carpool and vanpool vehicles equal to 5% of the total vehicle parking capacity. Preferred parking is considered as those parking spaces closer to the building entrance and/or covered parking closer to the building entrance.*
- *Size parking capacity to meet but not exceed minimum local zoning requirements.*
- *For projects with an area of 27,870 square meters of less: provide secure bicycle racks within 180 meters of the building entrance for 3% or more of all building users.*
- *For projects larger than 27,870 square meters: provide secure bicycle racks within 180 meters of the building entrance for 3% of the occupants for up to 27,870 square feet, then an additional 0.5% for the occupants of the space over 27,870 square meters.*

Strategies to promote alternative transportation:

Figure 16: Strategies to increase alternative transportation in the facilities

314 Maximize Open Space

Open space provides habitat for vegetation and wildlife, contributes to reduce the urban heat island effect, increases stormwater infiltration, and provides the human population on the site with a connection to the outdoors.

The design team should try to minimize the development footprint and/or provide vegetated open space within the project boundary such that the amount of open space exceeds local zoning requirements by 25%, or should provide vegetated open spaces equal to 20% of the project's site area.

Strategies like using open grid pavement and green roofs can count towards open space area.

Protect or Restore Habitat

An increase in open space area promotes biodiversity, by conserving existing natural areas, or by restoring areas within the site for vegetation and wildlife.

- *Previously developed sites should protect or restore a minimum of 50% of the site (excluding the building footprint) or 20% of the total site area, whichever is greater, with native or adapted vegetation.*
- *In case the previous strategy is not achievable, site disturbance should be limited to:*
    - *40 feet beyond the building perimeter.*
    - *10 feet beyond hardscape.*
    - *15 feet beyond primary roadway curbs and main utility branch trenches.*
    - *25 feet beyond constructed areas with permeable surfaces.*

Figure 17: Strategies to reduce site disturbance

Heat Island Effect

The heat island effect is a phenomenon in which built up urban areas are hotter than surrounding rural areas. The annual mean air temperature of a city with one million people or more can be up to 12°C warmer than its surrounding.

Natural surfaces are often composed of vegetation and moisture-trapping soils; they use a relatively large proportion of the absorbed radiation in the evapotranspiration process and release water vapor that contributes to cool the air in their vicinity. In contrast, built up surfaces are composed of a high percentage of non-reflective and water-resistant construction materials. As a consequence, they absorb a significant proportion of the incident radiation, which is released as heat.

Elevated temperature from urban heat islands can affect a community's environment and quality of life, increasing energy demand, air conditioning costs, air pollution, greenhouse gas emissions and water quality.

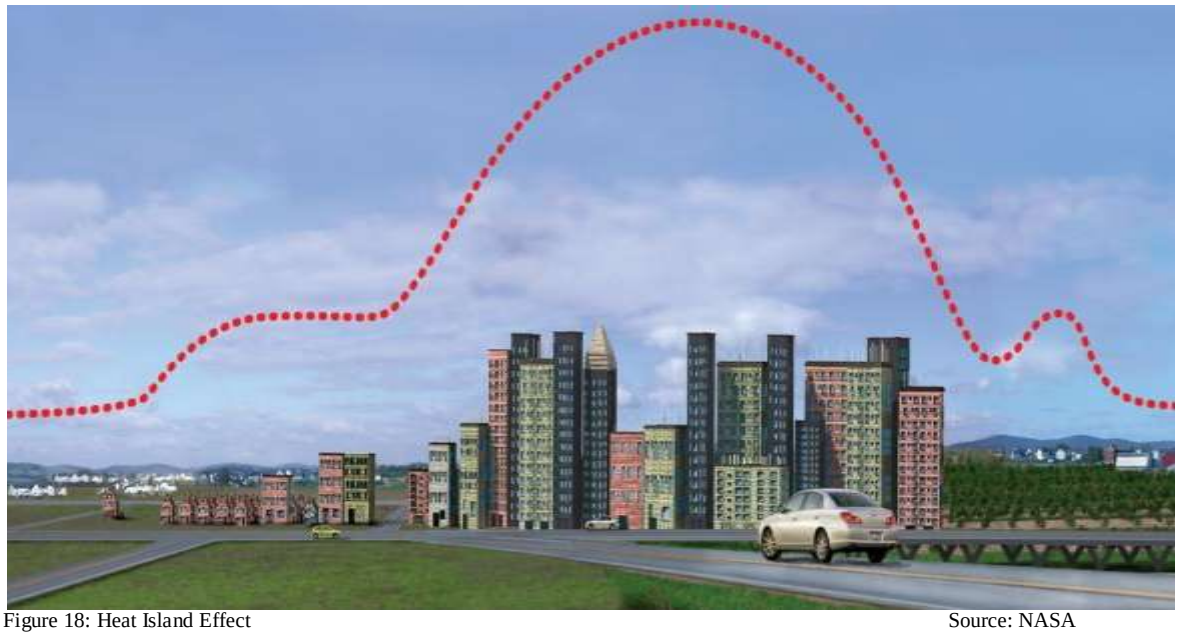

Figure 18: Heat Island Effect Source: NASA

The project should aim to reduce heat islands to minimize impacts on microclimates, human and wildlife habitats. To minimize heat islands roofing and hardscape materials should be carefully chosen.

Roofing Materials

Green roofs, photovoltaic panels, and/or materials with a high solar reflectance index should be used in at least 75% of the roof to minimize the heat island effect. See section 441.41 and 441.42for more details about roofing materials that contribute to reduce the heat island effect.

Figure 19: Roofing materials that contibue to heat island effect reduction

Hardscape Materials

Use trees, structures covered by solar panels, materials with a solar reflectance index of at least 29, and/or open grid pavement for at least 50% of the site hardscape to reduce heat island effect. See section 432.11 for more details about ways to reduce the heat island effect through the selection of proper hardscape materials.

Figure 20: Hardscape materials that contribute to heat island effect reduction

315 Stormwater Management

An effort to limit disruption of natural hydrology should be made. This can be achieved by reducing impervious cover and increase on-site infiltration. Applying these strategies will contribute to reduce or eliminate soil erosion, reduce potable water consumption, maintain the natural aquifer recharge cycle and restore depleted stream base flows. Strategies for both stormwater quantity and quality control should be implemented for better results.

Stormwater Quantity Control

One of the following requirements should be met:

- *Implement a stormwater management plan that prevents the postdevelopment peak discharge rate and quantity from exceeding the predevelopment peak discharge rate and quantity for the one and two year 24 hour design storms.*
- *Implement a stormwater management plan that results in a 25% decrease in the volume of stromwater runoff from the two year 24 hour design storm.*

Stormwater Quality Control

Pollution of natural water flows should be prevented, during construction and operation of the industrial facilities. Stormwater management practices should be implemented to treat polluted water before it leaves the site. It is advisable to treat or infiltrate 90% of the average annual rainfall.

Stormwater Management Plan

The first thing that should be taken into account for the development of a management plan, that contributes to maintain or improve stormwater quality and quantity control, is the prevailing condition of the site. The stormwater management plan should try to preserve existing water flow and natural soil conditions. On previously developed sites, the purpose of the stormwater management plan is to reduce existing water flow or restore natural site conditions. The following strategies are useful to reduce and treat water flow.

- *Reduce impermeable surfaces.* Pervious surfaces allow water to percolate into the soil to filter out pollutants and recharge the water table, reducing stromwater runoff. Impervious surfaces should be limited to vehicular roads.
- *Use pervious materials*. Preference should be given to pervious materials, open grid pavement, permeable pavers, etc. The selected material will depend on the specific requirements off each area.

Figure 21: Commonly pervious materials for sidewalks and roads

- *Design taking into account the topography of site*. The building and landscape areas should be design in accordance to the natural conditions of the site, to minimize erosion and site disturbance.

- *Use retention pounds to control water runoff*. Retention basins can be use to capture and infiltrate water coming from paved areas and impervious surfaces. It is advisable to direct water runoff towards retention basins to promote its infiltration before it leaves the site.

Figure 22: Stormwater management - retention pound (Source: Centro de aguas urbanas)

- *Use vegetated areas to control water runoff*. Vegetated areas can be placed between paved areas to reduce stormwater runoff and promote infiltration. Vegetated filter strips have a range of total suspended solids removal between 40%-90% depending on the slope, soil, and size.

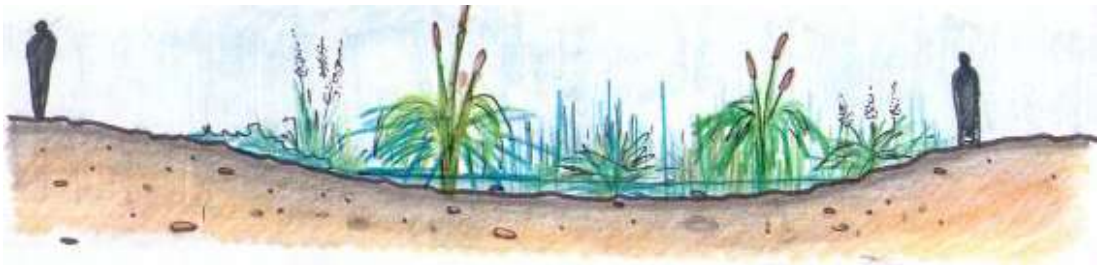

Figure 23: Stormwater management - vegetated areas (Source: Centro de aguas urbanas)

- *Green roofs*. Greening of rooftops, by incorporating plants into the design of roofing systems contribute to reduce the impacts of stormwater runoff. The benefits of green roofs for stormwater control include direct retention of a portion of the rainfall, and delaying and decreasing the peak rate of runoff from the site. Moreover, green roof have a range of total suspended solids removal between 75%-90%, depending on the system and vegetation used. Refer to section 441.42 for more details about green roof systems.

- *Cluster development to reduce paved surfaces such as roads and sidewalks.*

320 Indoor Environmental Quality

Indoor Environmental Quality (IEQ) refers to all environmental factors that affect the health and wellbeing of building occupants. IEQ encompasses factors such as indoor air quality, airborne contaminants, comfort, humidity, air exchange, acoustics, and lighting quality.

The main purpose of IEQ is to maintain and improve standards of health and comfort within indoor environments. By improving indoor air quality building related illnesses can be prevented, absenteeism can be reduced and employee productivity can be improved.

Providing acceptable indoor air quality for occupants and workers during and after construction requires significant planning and understanding of potential issues. The strategies to provide an adequate IEQ within buildings will vary depending on the specific design of warehouses and office buildings within VESTA's industrial parks. This chapter covers basic strategies and recommendations to achieve an adequate IEQ, and should be taken in consideration during the design phase.

321 Environmental Tobacco Smoke (ETS) Control

Smoking inside the building and within eight meters of entries, outdoor air intakes and operable windows should be prohibited, in order to prevent or minimize exposure of building occupants, indoor surfaces and ventilation air distribution systems to environmental tobacco smoke.

Figure 24: Designate smoking areas for tobacco smoke control

322 Indoor Chemical and Pollutant Source Control

The exposure of building occupants to potentially hazardous pollutants should be minimized by implementing these indoor chemical and pollutant control measures:

- *Install permanent entryway track-off systems*
- *Exhaust spaces with hazardous gases or chemical directly to the outdoors*
- *Provide containment drains to control hazardous liquids wherever they are used*
- *Install minimum MERV 13 rated filters on all mechanical ventilation systems*

Figure 25: Entryway track-off systems

323 Daylight

Daylight in buildings is important for its quality, spectral composition, and variability. It provides high luminance and permits excellent color rendering. Working long-term in electric lighting is believed to be detrimental to health, while working by daylight is believed to result in less stress and discomfort.

However, daylight can produce uncomfortable solar glare and very high luminance reflections on display screens, both of which interfere with good vision. Daylight can also increase energy consumption. Since glass is a poor insulator, a big amount of heat is loss and gain through windows and skylights. These factors need to be taken into consideration during the design phase of VESTA's office buildings. This section provides general recommendations for an adequate daylight design, which should address:

- *Building orientation and shape*
- *Heat loss and gain through glazing*
- *Solar glare*
- *Direct solar heat gain during summer months*
- *Daylight sensors with dimming to increase energy saving*

Building orientation and shape

Building shape and orientation should be considered since the beginning of the project. These factors should be acknowledged during the design phase to be able to provide daylight in an efficient way.

- *North and south façade exposure should be maximized for daylighting harvesting. Whenever possible openings to east and west should be avoided.*

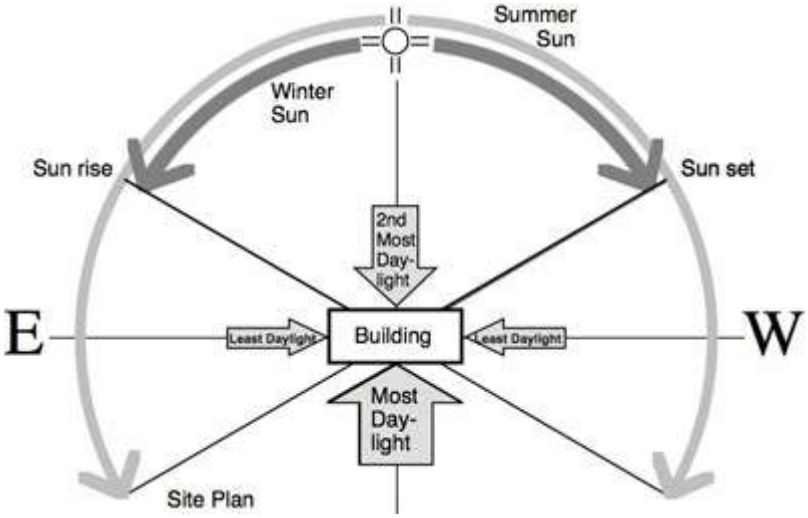

Figure 26: Building orientation and daylight (Source:WBDG)

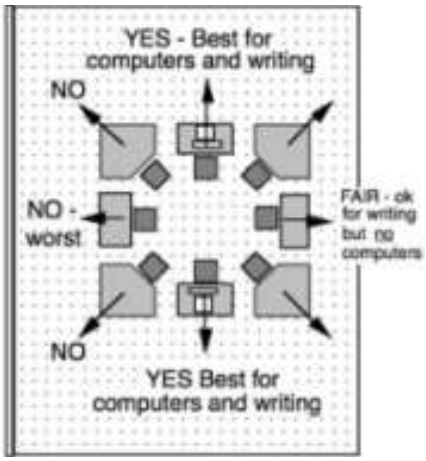

Figure 27: Interior distribution and daylight (Source: WBDG)

- *On the south façade overhangs and other solar shading devices should be proposed to reduce direct solar heat gain.*

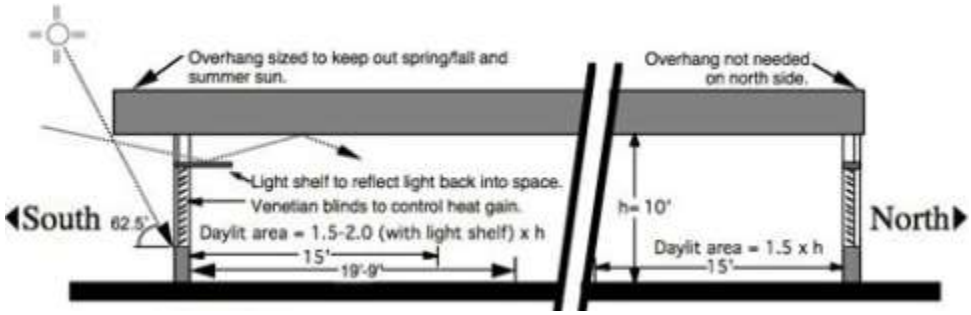

Figure 28: Overhangs (Source: WBDG)

- *Rectangular buildings with a greater north-south exposure are advisable since they allow natural daylight in all building's areas.*

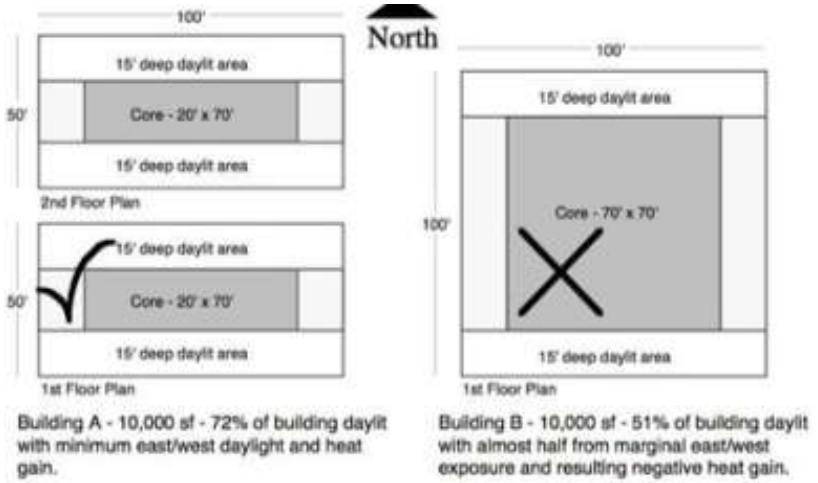

Figure 29: Daylight and building shape (Source: WBDG)

Strategies to improve natural daylighting in the building

Daylight can be achieved through the use of windows and/or skylights. The following information should be taken into consideration during the design phase to improve daylight quality.

As a general rule, daylighting will only reach a distance of 2.5 times the height of the top of the window above the work plane. In a standard office building with a window height of 2.5m, this means a maximum of about 5-7meters.

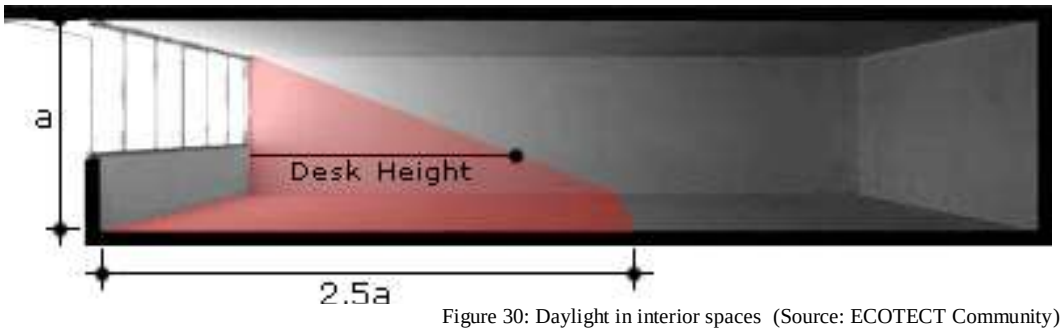

Figure 30: Daylight in interior spaces (Source: ECOTECT Community)

To improve daylighting within a building, windows can be added on multiple sides of the room, or a distribution system such as a lightshelf or prismatic glazing can be used to direct some of the light up onto the ceiling where it will diffuse deeper into the space.

Figure 31: Daylighting strategies (Source: ECOTECT Community)

Skylights are openings cut through the roof of a building, though they give excellent daylight levels it is difficult to control solar radiation coming from these elements. Angled louvers or some other form of seasonally adjustable shading must therefore be used, especially in hot climates.

Figure 32: Daylight strategy – Skylights (Source: ECOTECT Community)

Saw-tooth apertures are formed from a vertical glass element and a sloping roof. Saw-tooth glazing facing away from the equator provides diffuse daylight from the sky without direct sun penetration. Saw-tooth glazing facing East or West is very difficult to protect, so it should be avoided.

Figure 33: Daylight strategy – Saw-tooth apertures (Source: ECOTECT Community)

A monitor aperture has two opposing vertical glazed elements raised above the general roof line. Daylighting provided by these openings is similar to the one provided by saw-tooth apertures

Figure 34: Daylight strategy – Monitor aperture (Source: ECOTECT Community)

The atrium is a core lighting technique where the center of the building is opened up with a glazed element at the top. The outside perimeter is lit with windows while the interior spaces receive diffuse light from the atrium. The ratio of height to width of the light well should not be greater than 2:1.

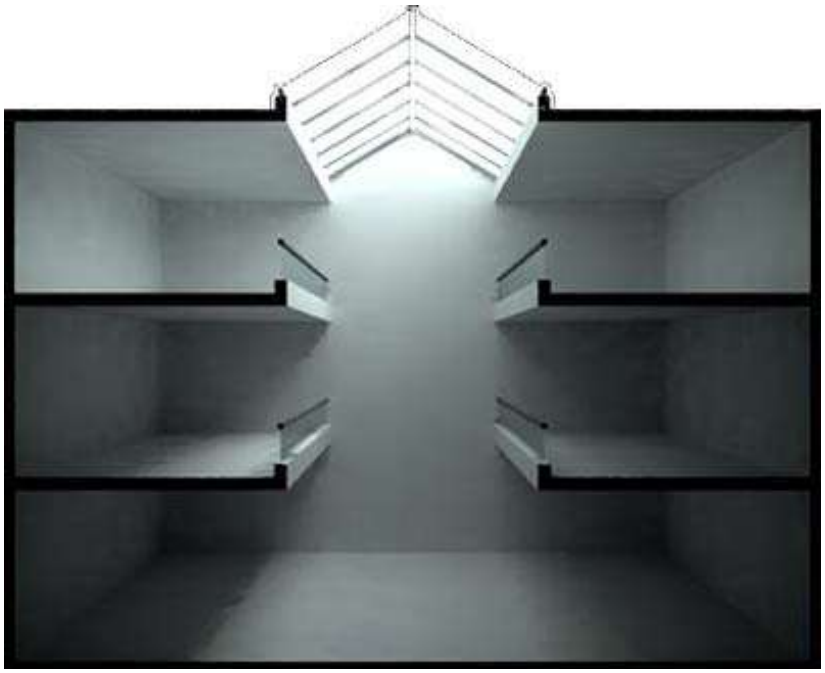

Figure 35: Daylight strategy – atrium (Source: ECOTECT Community)

Light wells down each side of an atrium can significantly increase the natural lighting, providing usually inaccessible spaces with a sense of connection with the outside.

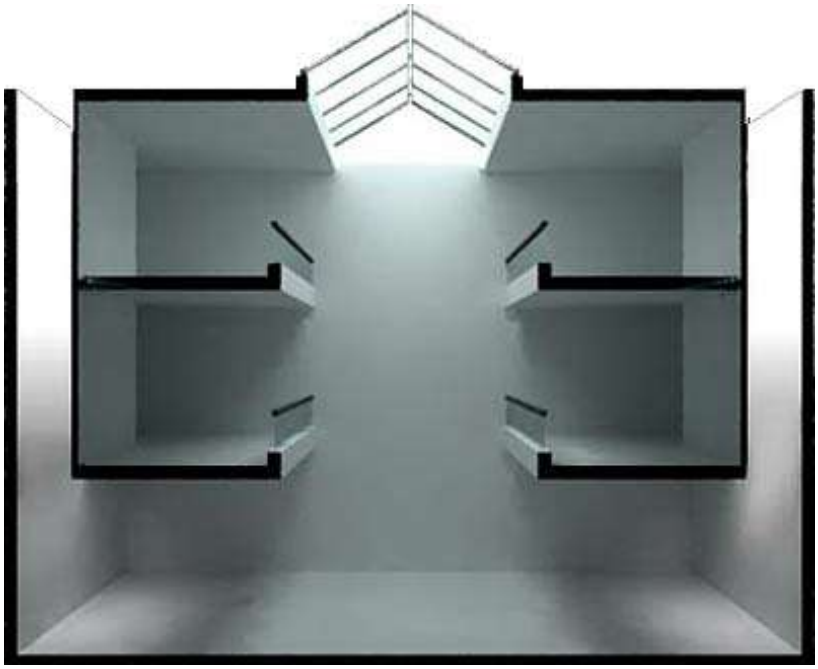

Figure 36: Daylight strategy – light well (Source: ECOTECT Community)

324 **Views**

Buildings that provide views to the outdoors have proven to enhance productivity, and overall occupant comfort and well-being. Recent studies have linked having access to views of nature in the workplace to the relief of boredom, anxiety, and stress.

Office buildings and other constructions within VESTA's industrial parks should try to provide a direct line of sight to the outdoors for occupants in 90% of all regularly occupied areas. Some strategies to increase views accessibility are:

- *Consider footprint shape and space layout early in design to maximize views to glazing.*
- *Design the building so that as many regularly occupied spaces as possible are located near the perimeter, with access to glazing. Open offices should be located at the perimeter with enclosed spaces and support areas near the building core.*
- *Glazing should be shaded appropriately to control solar heat gains.*
- *Include interior transom glazing to add views to enclosed spaces away from the perimeter of the building.*

Figure 37: IncreasIncreased views accessibility

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400 TECHNICAL STANDARDS

410 General Criteria

The following section provides general criteria for the selection of sustainable materials and finishes, and should be taken in consideration during the design and construction phase of the project. Specific details about constructive elements and environmentally friendly finishes for VESTA's roads and office buildings can be found in the sections of Industrial Park (432) and Office Building (441 and 442).

411 Materials and Resources

411.1 *Selection Criteria*

There are significant environmental impacts associated with materials used in a construction, like pollutants release, habitat destruction, and depletion of natural resources. The use of durable, healthy and environmentally responsible materials in a building contributes to preserve natural resources and wellbeing of its occupants.

The selection of environmentally responsible materials requires the development of criteria to evaluate and properly choose building materials. The following is a recommended selection criterion for building's materials:

- *Use materials that are nontoxic or demonstrate to have reduced toxicity.*
- *Use products that have minimal chemical emissions, emit low or non volatile compounds (VOCs), and avoid the use of chlorofluorocarbons (CFCs).*
- *Use products with identifiable recycled content including pre-consumer and post-consumer.*
- *Use materials that are durable, reusable and/or recyclable.*
- *Use products manufactured with resource efficient processes including reduced energy consumption, minimal waste production, and reduced green house gases production.*
- *Use locally extracted, harvested and manufactured materials, to reduce energy consumption and resources required for transportation.*
- *Use rapidly renewable materials, harvested from sustainably managed sources, and preferably with independent certification.*

411.11 *Regional Materials*

The use of regional materials reduces fuel consumption and greenhouse gas emissions from the transportation of materials to the construction site. Regional materials require less protective packaging, and they are thereby associated with less waste.

Regional materials are easier to track down and determine if the extraction and processing were carried out in an environmentally responsible manner. The incorporation of regional materials has cultural and economic benefits at the local level; it can provide residents with a sense of identity, place and history, meanwhile supporting the local economy.

No less than 10 percent of products and materials used in the construction should be regionally extracted (within an 800 kilometers radius), harvested or recovered, and manufactured. The percentage is based on cost of the total materials value.

The following figures illustrate the regional material radius for three selected locations of VESTA's industrial parks. These locations were chosen because they are representative of the different climatic and zoning conditions of VESTA's real estate properties.

Figure 38: Distribution of selected Vesta's Industrial Properties (Source: vesta.com.mx)

Tijuana:

The 800 kilometers radius for Vesta Park in Tijuana (El Potrero Vesta Park) can be seen on figure 39; it includes part of the states of California, Nevada, Utah, Arizona, and a small part of New Mexico in the northern country of USA. In Mexico it includes the states of Baja California Norte, Baja California Sur, Sonora, and a small portion of Chihuahua.

Figure 39: Regional material radius for El Potrero Vesta Park in Tijuana

Querétaro:

The 800 kilometers radius considered for regional materials of Bernardo Quintana Industrial Park in Queretaro (Figure 40) includes a small part of Texas, the north east part of Mexico (Nuevo Leon, Tamaulipas, and Coahuila), all the central states of the country (Mexico City, San Luis Potosi, Guadalajara, etc.), and part of the southern states of Mexico (Guerrero, Oaxaca, part of Tabasco and Chiapas).

Figure 40: Regional material radius for Bernardo Quintana Industrial Park in Queretaro

Cancun:

The regional priority radius for Vesta Industrial Properties in Cancun (figure 41) includes part of Central America (Guatemala, Belize, Honduras, and a small part of San Salvador), the west part of Cuba, a reduced portion of Florida, and part of the south of Mexico (Quintana Roo, Yucatan, Campeche, Tabasco and Chiapas).

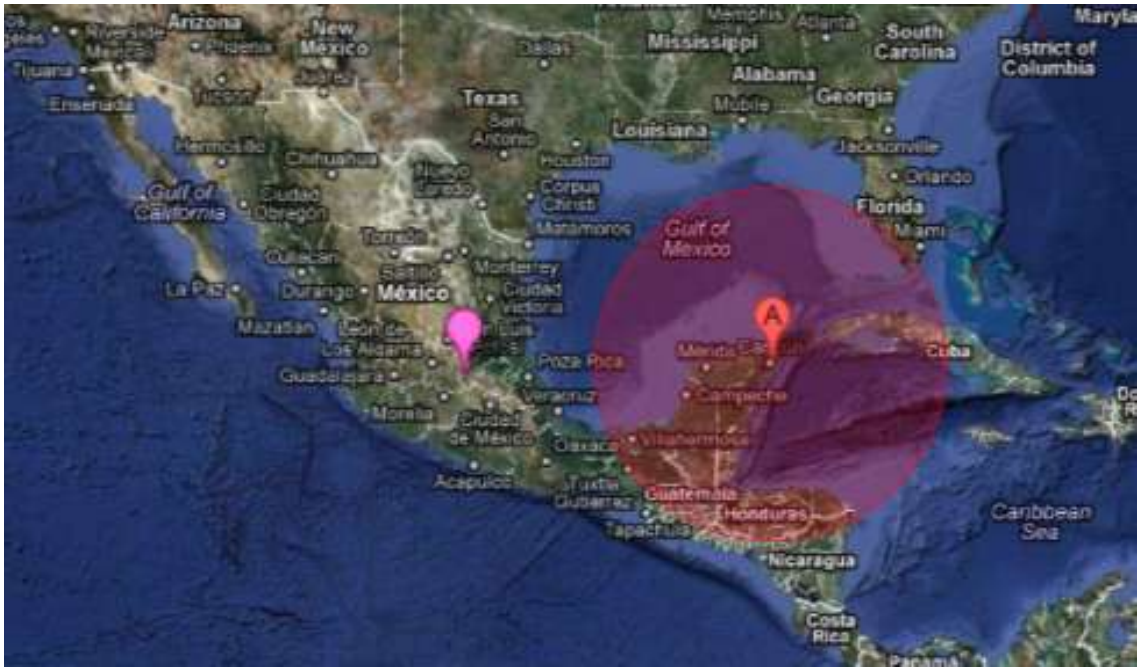


Figure 41: Regional material radius for Cancun, Cancún

411.12 ***Recycled Content***

A recycled content product is an item made with materials that were recycled, diverting them from conventional disposal methods such as landfills or incinerators.

Buying products with recycled content has many environmental benefits, among the benefits of using recycled products are:

- *Recycled products help to divert waste from landfills.*
- *They contribute to conserve natural resources, energy, and wildlife.*
- *The manufacturing process for recycled products creates far more jobs than disposing materials in landfills or incinerators.*
- *Recycled products from locally sourced materials/ waste reduce transportation requirements.*
- *Buying recycled products contribute to a more sustainable future by ensuring that the materials collected will be used again to manufacture new products or materials.*
- *Choosing recycled products increases environmental awareness.*

At least ten percent of materials and products used for construction should be recycled or should incorporate recycled content materials. The recycled content of a material is determined by weight. The recycled fraction of the assembly is then multiplied by the cost of the assembly to determine the recycled content value. Mechanical, electrical and plumbing components are not included in the calculations.

It is advisable to give preference to materials with post-consumer recycled content. Post consumer recycled materials are products that have completed its life cycle as a consumer item and would otherwise have been disposed of as solid waste. Pre-consumer or post-industrial recycled content refers to scrap that is generated during the manufacturing process and its recycled back into its raw material state.

Figure 42: Recycled content verification seal

411.13 *Certified Wood*

Certified wood comes from responsibly managed forest. The objective of certification is the improvement and documentation of forest management practices. It is usually associated with eco-labeling and chain of custody certification.

The basic requirements for forest certification programs usually include:

- *Protection of biodiversity, species at risk and wildlife habitats.*
- *Sustainable harvest levels.*
- *Protection of water quality.*
- *Third-party certification audits performed by accredited certification bodies.*
- *Publicly available certification audit summaries.*
- *Complaints and appeals processes.*

The Forest Stewardship Council (FSC) is the world's foremost and internationally recognized forest certification. The FSC certification is a voluntary tool that supports responsible forest management worldwide, ensuring that products certified under the FSC label are from responsibly harvested and verified sources.

Figure 43: Certified Wood Seal (Source: fsc.org)

At least 50 percent of wood-based materials and products used in a building should be certified in accordance with FSC's principles and criteria, including framing, flooring, doors and finishes. Only materials and products installed permanently in the project should be considered.

411.2 *Low-Emitting Materials*

Low-emitting materials are products that contain zero or low-volatile organic compounds (VOCs), reducing significantly the release of pollutants into the indoor environment.

VOCs are chemicals that are emitted by solids and liquids that evaporate into air at room temperature. Elevated levels of VOCs and interior pollutants have been linked to health concerns such as eye, nose and throat irritation, headaches, loss of coordination, nausea, and other health problems.

An increased awareness of possible health risks and air quality concerns has led to a demand for products lower in VOCs, which are now widely available. What is considered a low concentration of VOC emissions will vary according to the product type. The following sections provide further recommendations for the selection of low emitting materials of commonly used products.

411.21 ***Adhesives and Sealants***

All adhesives and sealants used on interiors shall comply with the VOC limits established on the table below.

Architectural Applications	**VOC Limit (g/L less water)**
Indoor Carpet Adhesives	50
Carpet Pad Adhesives	50
Wood Flooring Adhesives	100
Rubber Floor Adhesives	60
Subfloor Adhesives	50
Ceramic Tile Adhesives	65
VCT & Asphalt Adhesives	50
Drywall & Panel Adhesives	50
Cove Base Adhesives	50
Multipurpose Construction Adhesives	70
Structural Glazing Adhesives	100
Specialty Applications	**VOC Limit (g/L less water)**
PVC Welding	510
CPVC Welding	490
ABS Welding	325
Plastic Cement Welding	250
Adhesive Primer for Plastic	550
Contact Adhesive	80
Special Purpose Contact Adhesive	250
Structural Wood Member Adhesive	140
Sheet Applied Rubber Lining Operations	850
Top & Trim Adhesive	250
Substrate Specific Applications	**VOC Limit (g/L less water)**
Metal to Metal	30
Plastic Foams	50
Porous Material (except wood)	50
Wood	30
Fiberglass	80
Sealants	**VOC Limit (g/L less water)**
Architectural	250
No membrane Roof	300
Roadway	250
Single-Ply Roof Membrane	450
Other	420
Sealant Primers	**VOC Limit (g/L less water)**
Architectural Non Porous	250
Architectural Porous	775
Other	750

Table 4: Adhesives and Sealants VOCs limits (Source: LEED, 2009)

Aerosol Adhesives must comply with the VOC limits listed below.

Aerosol Adhesives	VOC Limit
General purpose mist spray	65% VOCs by weight
General purpose web spray	55% VOCs by weight
Special purpose aerosol adhesives (all types)	70% VOCs by weight

Table 5: Aerosol Adhesives VOC limits (Source: LEED, 2009)

411.22 ***Paints and Coatings***

Paints and coatings used on interiors shall comply with the VOC limits listed on table 6.

Coating	Ceiling Limit (g/L less water)	Current Limit (g/L less water)
Bond breakers	350	
Clear wood finishes	350	
- Varnish	350	
- Sanding	350	
Sealers	680	550
- Lacquer		
Clear brushing lacquer	680	
Concrete-curing compounds	350	
Concrete-curing compounds for roadways and bridges	350	
Dry-fog coatings	400	
Fire-proofing exterior coatings	450	350
Fire-retardant coatings		
- Clear	650	
- Pigmented	350	
Flats	250	100
Floor coatings	420	
Graphic arts (sign) coatings	500	
Industrial maintenance (im) coatings	420	
High temperature im coatings		
Zinc-rich im primers	420	
Japan/faux finishing coatings	700	350
Magnesite cement coatings	600	450
Mastic coatings	300	
Metallic Pigmented coatings	500	
Multicolor coatings	420	250
Nonflat coatings	250	150
Nonflat high gloss	250	
Pigmented lacquer	680	550
Pretreatment wash primers	780	
Primers, sealers, undercoaters	350	
Quick-dry enamels	400	
Quick-dry primers, sealers, undercoaters	350	

Recycled coatings	250	
Roof coatings	300	
Aluminum roof coatings	500	
Roof primers, bituminous	350	
Rust: preventive coatings	420	
Shellac		
- Clear	730	
- Pigmented	550	
Specialty primers	350	
Stains	350	
- Interior	250	
Swimming pool coatings		
- Repair	650	
- Other	340	
Traffic coatings	250	150
Waterproofing sealers	400	
Waterproofing concrete, masonry sealers	400	
Wood preservatives – Belowground	350	
Other	350	

Table 6: Paints and coatings VOC limits (Source: LEED, 2009)

411.23 ***Flooring Systems***

Flooring and floor coverings used on interiors should meet the requirements established on the following standards:

Option 1	
Carpet	Meet testing and product requirements of the Carpet and Rug Institute's Green Label Plus program.
Carpet cushion	Meet requirements of the Carpet and Rug Institute Green Label program.
Carpet adhesives	Meet VOC limit of 50 g/L
Hard surface flooring	Meet the testing and product requirements of FloorScore certification.
Floor finishes	Meet the requirements of South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings.
Tile setting adhesives and grout	Meet the South Coast Air Quality Management District (SCAQMD) Rule 1168
Tile, masonry, terrazzo, cut stone, and solid wood flooring without coatings or sealants	Does not require testing
Option 2	
All flooring elements installed in the building interior	Meet the testing and product requirements of the California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.

Table 7: Flooring systems requirements

411.24 *Composite Wood and Agrifiber Products*

Composite wood and agrifiber products used on the interior of the building shall contain no added urea-formaldehyde resins. Urea formaldehyde is commonly used in composite wood products such as hardwood plywood, particleboard, wheatboard, strawboard and medium density fiberboard (mdf). Adhesives and sealants described on section 411.21 should be considered instead of urea-formaldehyde resins.

411.3 *Thermal Properties of Building Materials*

Thermal insulation can be defined as the reduction of heat transfer between objects or surfaces. Heat transfer is an inevitable consequence of contact between objects of different temperature. Thermal insulation is used to keep buildings at a comfortable temperature by reducing the flow of heat through the exterior surfaces of the building. The choice of the insulating product and the amount of insulation required will depend on the climate, latitude and altitude of the building.

In building construction, insulating materials are assigned a quantitative measure of insulating capability called the R-value; R-values are expressed using the metric units in m2.K/W. The higher the R-value, the better the material is at resisting energy transfer.

The K-value measures the heat loss rate for a specific material, thickness, area, and temperature difference. The U value measures the ability of a substance to allow the transfer of heat. This means that the higher the U and K value the worse the thermal performance of the material or building envelope. Its units are expressed in W/m^2K.

The difference between U and K value is that K-value only measures the heat loss for a specific material, while the U value measures the heat transfer of a building element such as a wall, floor or roof.

The U value is the inverse sum of the resistances of each building material and surface. Because the interaction of the building element to the outside environments is measured in terms of surface resistance, the behavior of the built elements is also expressed in terms of resistances.

$$U = \frac{1}{R_{SI} + R_{SO} + R_A + R_1 + R_2 + R_4 + R_5}$$

R_{SI} - thermal resistance of internal surface
R_{SO} - thermal resistance of outside surface
R_A - thermal resistance of unvented air cavities
$R_{1 \text{ etc.}}$ - thermal resistances of building components

Units - W/m^2K

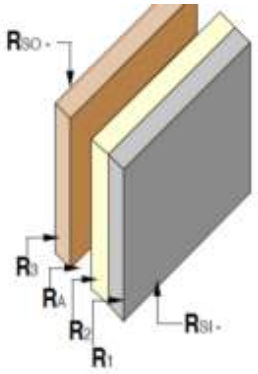


Figure 44: U value diagram (Source: architecture.com)

The following image illustrates a section of a wall composed by three elements; each element has a certain thickness "L", and a coefficient for thermal conductivity λ, resulting in three different R-values and one U-value for the complete building element.

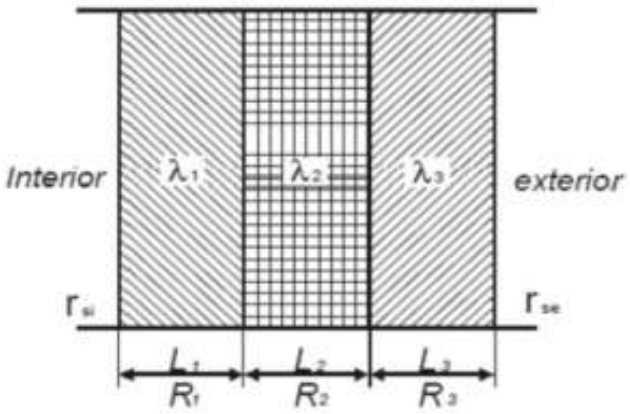


Figure 45:Wall R value diagram

The document "Taller para el Aislamiento térmico en una vivienda" found in the following link provides procedures and practical examples to perform U-value calculations for different elements:

http://www.cmic.org/comisiones/sectoriales/vivienda/2010/conavi/lo_nuevo/Taller_termico/TercerModulo.pdf

The following table illustrates U-value calculations for different wall and roof assemblies.

Description	U-value "U" (W/m^2K)
Wall Assembly Stucco (0.005 m) CMU (0.20 m) Rigid Extruded Polystyrene (0.02 m) Stucco (0.005)	$\frac{1}{\frac{1}{8.1}+\frac{0.005}{0.72}+\frac{0.20}{0.19}+\frac{0.02}{0.034}+\frac{0.005}{0.72}+\frac{1}{13}}$ =0.539
Roof Assembly Corrugated metal 22 ga. (0.0007 m) Polyisocyanurate foam (0.03 m) Concrete (0.10 m)	$\frac{1}{\frac{1}{6.6}+\frac{0.0007}{45}+\frac{0.03}{0.030}+\frac{0.10}{0.17}+\frac{1}{13}}$ =0.550
Green Roof Assembly Lightweight concrete slab (0.20 m) Polyisocyanurate foam (0.02) Green roof (0.40 m)	$\frac{1}{\frac{1}{6.6}+\frac{0.20}{0.17}+\frac{0.02}{0.030}+\frac{0.40}{0.032}+\frac{1}{13}}$ =0.068

Table 8: U-value calculations for different constructive elements

411.31 ***Building Envelope Requirements Based on ASHRAE 90.1-2007***

The standard ASHRAE 90.1-2007, mentioned on the LEED™ Reference Guide for Green Building Design and Construction, establishes minimum insulation values for the building envelope of energy efficient buildings. The values established on ASHRAE should be taken in consideration during the design and construction phase of VESTA's buildings to guarantee its adequate energy performance.

To establish building envelope requirements three different locations for VESTA's industrial properties were chosen. The site selection attempted to include the different weather conditions VESTA's properties could face. The selected locations and their climate zone according to ASHRAE 90.1-2007 are:

- *Tijuana: Climate zone 2B*
- *Queretaro: Climate zone 3A*
- *Cancún: Climate zone 1A*

The Building envelope requirements for this three climate zones are established in the following table.

Climate Zone 1A		
Opaque Elements	**Assembly** Maximum U-value W/m^2K ($BTU/Ft^2h°F$)	**Insulation** Minimum R-value M^2K/W ($Ft^2h°F/BTU$)
Roofs		
Insulation Entirely above Deck	0.358 (0.063)	2.64 (15.0 c.i.)
Metal Building	0.369 (0.065)	3.35 (19.0)
Attic and Other	0.193 (0.034)	5.28 (30.0)
Walls, Above-Grade		
Mass	3.293 (0.580)	NR
Metal Building	0.642 (0.113)	2.29 (13.0)
Steel-Framed	0.704 (0.124)	2.29 (13.0)
Wood-Framed and Other	0.505 (0.089)	2.29 (13.0)
Walls, Below-Grade		
Below-Grade Wall	6.473 (1.140)	NR
Floors		
Mass	1.828 (0.322)	NR
Steel-Joist	1.987 (0.350)	NR
Wood-Framed and Other	1.601 (0.282)	NR
Slab-On-Grade Floors		
Unheated	4.145 (0.730)	NR
Heated	5.792 (1.020)	1.32 (7.50)
Opaque Doors		
Swinging	3.975 (0.700)	
Nonswinging	8.233 (1.450)	

Fenestration	Assembly Maximum U-value W/m^2K ($BTU/Ft^2h°F$)	Assembly Maximum SHGC
Vertical Glazing, 0%-40% of Wall		
Nonmetal framing (all)[b]	6.814 (1.200)	0.25 all
Metal framing (curtainwall/ storefront)[c]	6.814 (1.200)	
Metal framing (entrance door)[c]	6.814 (1.200)	
Metal framing (all other)[c]	6.814 (1.200)	
Skylight with Curb, Glass, % of Roof		
0% - 2.0%	11.242 (1.980) all	0.36 all
2.1% - 5.0%	11.242 (1.980) all	0.19 all
Skylight with curb, Plastic, % of roof		
0% - 2.0%	10.788 (1.900) all	0.34 all
2.1% - 5.0%	10.788 (1.900) all	0.27 all
Skylight without Curb, All, % of Roof		
0% - 2.0%	7.722 (1.360) all	0.36 all
2.1% - 5.0%	7.722 (1.360) all	0.19 all

Climate Zone 2B		
Opaque Elements	**Assembly** Maximum U-value W/m^2K ($BTU/Ft^2h°F$)	**Insulation** Minimum R-value M^2K/W ($Ft^2h°F/BTU$)
Roofs		
Insulation Entirely above Deck	0.273 (0.048)	3.52 (20.0 c.i.)
Metal Building	0.369 (0.065)	3.35 (19.0)
Attic and Other	0.153 (0.027)	6.69 (38.0)
Walls, Above-Grade		
Mass	0.857 (0.151)[a]	1.00 (5.70 c.i.[a])
Metal Building	0.642 (0.113)	2.29 (13.0)
Steel-Framed	0.704 (0.124)	2.29 (13.0)
Wood-Framed and Other	0.505 (0.089)	2.29 (13.0)
Walls, Below-Grade		
Below-Grade Wall	6.473 (1.140)	NR
Floors		
Mass	0.608 (0.107)	1.11 (6.30 c.i.)
Steel-Joist	0.295 (0.052)	3.35 (19.0)
Wood-Framed and Other	0.290 (0.051)	3.35 (19.0)
Slab-On-Grade Floors		
Unheated	4.145 (0.730)	NR
Heated	5.792 (1.020)	1.32 (7.50)
Opaque Doors		
Swinging	3.975 (0.700)	
Nonswinging	8.233 (1.450)	

Fenestration	Assembly Maximum U-value W/m^2K ($BTU/Ft^2h°F$)	Assembly Maximum SHGC
Vertical Glazing, 0%-40% of Wall		
Nonmetal framing (all)[b]	4.259 (0.750)	0.25 all
Metal framing (curtainwall/ storefront)[c]	3.975 (0.700)	
Metal framing (entrance door)[c]	6.246 (1.100)	
Metal framing (all other)[c]	4.259 (0.750)	
Skylight with Curb, Glass, % of Roof		
0% - 2.0%	11.242 (1.980) all	0.36 all
2.1% - 5.0%	11.242 (1.980) all	0.19 all
Skylight with curb, Plastic, % of roof		
0% - 2.0%	10.788 (1.900) all	0.39 all
2.1% - 5.0%	10.788 (1.900) all	0.34 all
Skylight without Curb, All, % of Roof		
0% - 2.0%	7.722 (1.360) all	0.36 all
2.1% - 5.0%	7.722 (1.360) all	0.19 all

Climate Zone 3A		
Opaque Elements	**Assembly** Maximum U-value W/m^2K ($BTU/Ft^2h°F$)	**Insulation** Minimum R-value M^2K/W ($Ft^2h°F/BTU$)
Roofs		
Insulation Entirely above Deck	0.273 (0.048)	3.52 (20.0 c.i.)
Metal Building	0.369 (0.065)	3.35 (19.0)
Attic and Other	0.153 (0.027)	6.69 (38.0)
Walls, Above-Grade		
Mass	0.698 (0.123)	1.34 (7.60 c.i.)
Metal Building	0.642 (0.113)	2.29 (13.0)
Steel-Framed	0.477 (0.084)	2.29 (13.0)
Wood-Framed and Other	0.505 (0.089)	2.29 (13.0)
Walls, Below-Grade		
Below-Grade Wall	6.473 (1.140)	NR
Floors		
Mass	0.608 (0.107)	1.11 (6.30 c.i.)
Steel-Joist	0.295 (0.052)	3.35 (19.0)
Wood-Framed and Other	0.290 (0.051)	3.35 (19.0)
Slab-On-Grade Floors		
Unheated	4.145 (0.730)	NR
Heated	5.110 (0.900)	1.76 (10.0)
Opaque Doors		
Swinging	3.975 (0.700)	
Nonswinging	8.233 (1.450)	

Fenestration	Assembly Maximum U-value W/m^2K ($BTU/Ft^2h°F$)	Assembly Maximum SHGC
Vertical Glazing, 0%-40% of Wall		
Nonmetal framing (all)[b]	3.691 (0.650)	0.25 all
Metal framing (curtainwall/ storefront)[c]	3.407 (0.600)	
Metal framing (entrance door)[c]	5.110 (0.900)	
Metal framing (all other)[c]	3.691 (0.650)	
Skylight with Curb, Glass, % of Roof		
0% - 2.0%	6.643 (1.170) all	0.36 all
2.1% - 5.0%	6.643 (1.170) all	0.19 all
Skylight with curb, Plastic, % of roof		
0% - 2.0%	7.381 (1.300) all	0.65 all
2.1% - 5.0%	7.381 (1.300) all	0.34 all
Skylight without Curb, All, % of Roof		
0% - 2.0%	3.918 (0.690) all	0.39 all
2.1% - 5.0%	3.918 (0.690) all	0.19 all

Table 9: ASHRAE 90.1-2007 Insulation requirements

c.i. = continuous insulation
NR = no (insulation) requirement
a = Exception to Section A3.1.3.1 applies
b = Nonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding
c = Metal framing includes metal framing with or without thermal break. The “all other” subcategory includes operable windows, fixed windows, and non-entrance doors.

420 Preliminaries

The following section provides information about how to develop an erosion and sedimentation plan, a habitat protection plan and a construction indoor air quality management plan, to guarantee a sustainable development of the site and healthy conditions for workers during construction.

421 Erosion and Sedimentation Control Plan

The consequences of soil erosion and sedimentation are significant. High suspended sediment concentrated in streams and lakes can increase the cost of water treatment, inhibit light penetration and photosynthesis. Sediment can lead to the development of sludge deposits and anaerobic conditions when untreated wastewater is discharged in the aquatic environment, causing destruction of aquatic ecosystems. Sediment also acts as a vehicle for transportation of other possibly damaging pollution, like PCB's and other industrial compounds, nutrients, insecticides and pesticides, and toxic metals as lead.

On-site and off-site effects of erosion and sedimentation:

On-site
Loss of topsoil
Undermining of roads and utilities
Traffic problems and road safety issues associated with mud on roads
Clogged drains and increased flooding
Loss of capacity in sediment basins
High cost for reconstruction and maintenance
Off-site
Sedimentation in reservoirs and storage structures, with loss of water storage capacity
Instability of stream channels caused by increased runoff and sedimentation loads
Sedimentation of rivers cause a reduction in channel capacity increasing frequency of floods
Smothering of aquatic and marine flora and fauna
Land degradation
Loss of navigable reaches of a river or watercourse
Decline or total loss of recreational and commercial fishing, as a result of increased turbidity
Reduced recreational and aesthetic value of riverbanks and waterways

Table 10: Effects of erosion and sedimentation (Source: Ooshaksaraie Leila et.al)

To reduce pollution from construction activities an erosion and sedimentation control plan should be created and implemented. Erosion prevention is the practice of protecting the soil surface and preventing the soil particles from being detached by rainfall or wind. Sediment control is the practice of trapping soil particles after they have been detached and moved by wind or water.

The erosion and sedimentation control plan must describe the measures implemented to accomplish the following objectives:

- *Prevent loss of soil during construction by stormwater runoff and/or wind erosion.*

- *Prevent sedimentation of storm sewers or receiving streams.*
- *Prevent pollution of the air with dust and particulate matter.*

It is highly advisable that the erosion and sedimentation plan complies with *the 2003 EPA Construction General Permit requirements,* more information can be found at: http://cfpub.epa.gov/npdes/stormwater/cgp.cfm

Implementation

During the design phase an *Erosion and Sedimentation Control Plan* should be developed by the civil engineer or landscape architect. The general contractor should work with the project team to implement the plan during construction and throughout the project completion. The plan should be included in construction documents outlining the team member's and subcontractors' responsibilities for installing, maintaining, using and documenting the specified erosion and sedimentation control best management practices.

As a minimum the Erosion and Sedimentation control Plan should include:

- *A natural resources map identifying soils, forest cover, and other resources protected under code.*
- *A construction sequence of the developed site, identifying the date on which clearing will begin, duration, areas of clearing, installation of temporary and permanent erosion and sediment control measures.*
- *Erosion and sediment control measures necessary to meet EPA's regulation throughout all phases of construction and after completion of site's development.*
- *Seeding mixtures and rates, types of sod, method of seedbed preparation, expected seeding dates, type and rate of lime and fertilizer application, kind and quantity of mulching for temporary and permanent vegetative control measures.*
- *Provision for maintenance of control facilities, including easements and estimates of maintenance cost.*

Strategies

Protect and maximize existing native vegetation and natural forest floor: natural vegetation can act as a natural buffer between construction and wetlands, streams, lakes, and water bodies.

Figure 46: Erosion and sedimentation control – protect and maximize existing vegetation

Use mulching and temporary seeding: use fast-growing grasses or place hay, woodchips, straw, or gravel to temporarily cover and hold the soils.

Figure 47: Erosion and sedimentation control – use mulching and temporary seeding

Sediment fences: use sediment fences to filter out soil from water and prevent erosion on development sites.

Figure 48: Erosion and sedimentation control – use sediment fences

Sedimentation basin: built temporary barriers or dams to intercept sediment runoff and remove the sediment.

Figure 49: Erosion and sedimentation control - sedimentation basins

Earth dike: construct a mound of stabilized soil to channel water to a desired location.

Figure 50: Erosion and sedimentation control – earth dikes

Vehicle tracking: use gravel beds on the entrance/exit of vehicles to avoid earth and pollutants dispersion. Instruct all vehicles to remove soil and loose material from their wheels and undercarriage when leaving the work area.

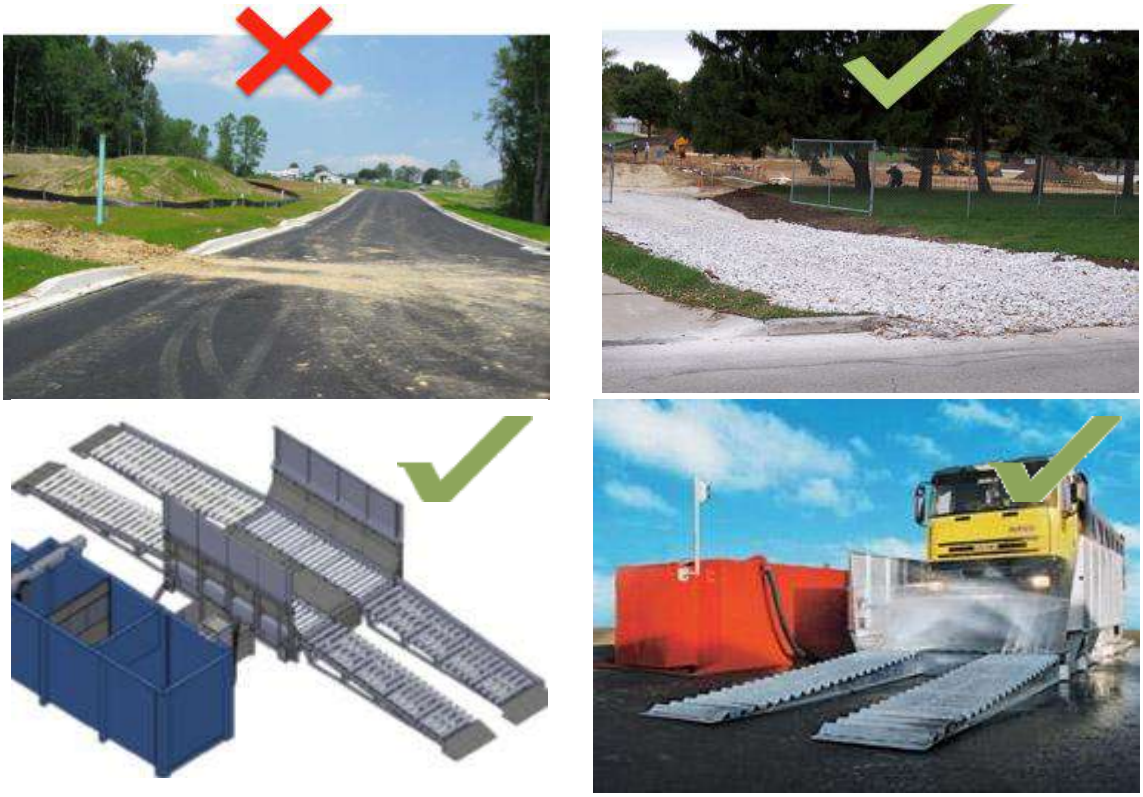


Figure 51: Erosion and sedimentation control – vehicle tracking (Source: aspent.com)

422 Habitat Protection Plan

A habitat protection plan seeks to conserve and protect habitat areas for wild plants and animals throughout preserving natural areas on a site, limiting disturbance during and after construction.

All site disturbances must be limited to the following parameters to conserve existing natural areas and protect existing habitat:

- *12 meters beyond the building perimeter.*
- *3 meters beyond surface walkways, patios and surface parking.*
- *5 meters beyond primary roadway curbs and main utility trenches.*
- *8 meters beyond constructed areas with permeable surfaces that requires additional staging areas to limit compaction in the constructed area.*

Implementation

During construction, clearly mark construction and disturbance boundaries and note the site protection requirements in construction documents. The contractor should specify lay-down, recycling, and disposal areas and use paved areas for staging activities. The cost and benefit of contractual penalties if protected areas outside the construction boundaries are destroyed should be considered.

The following figure illustrates a habitat protection plan.

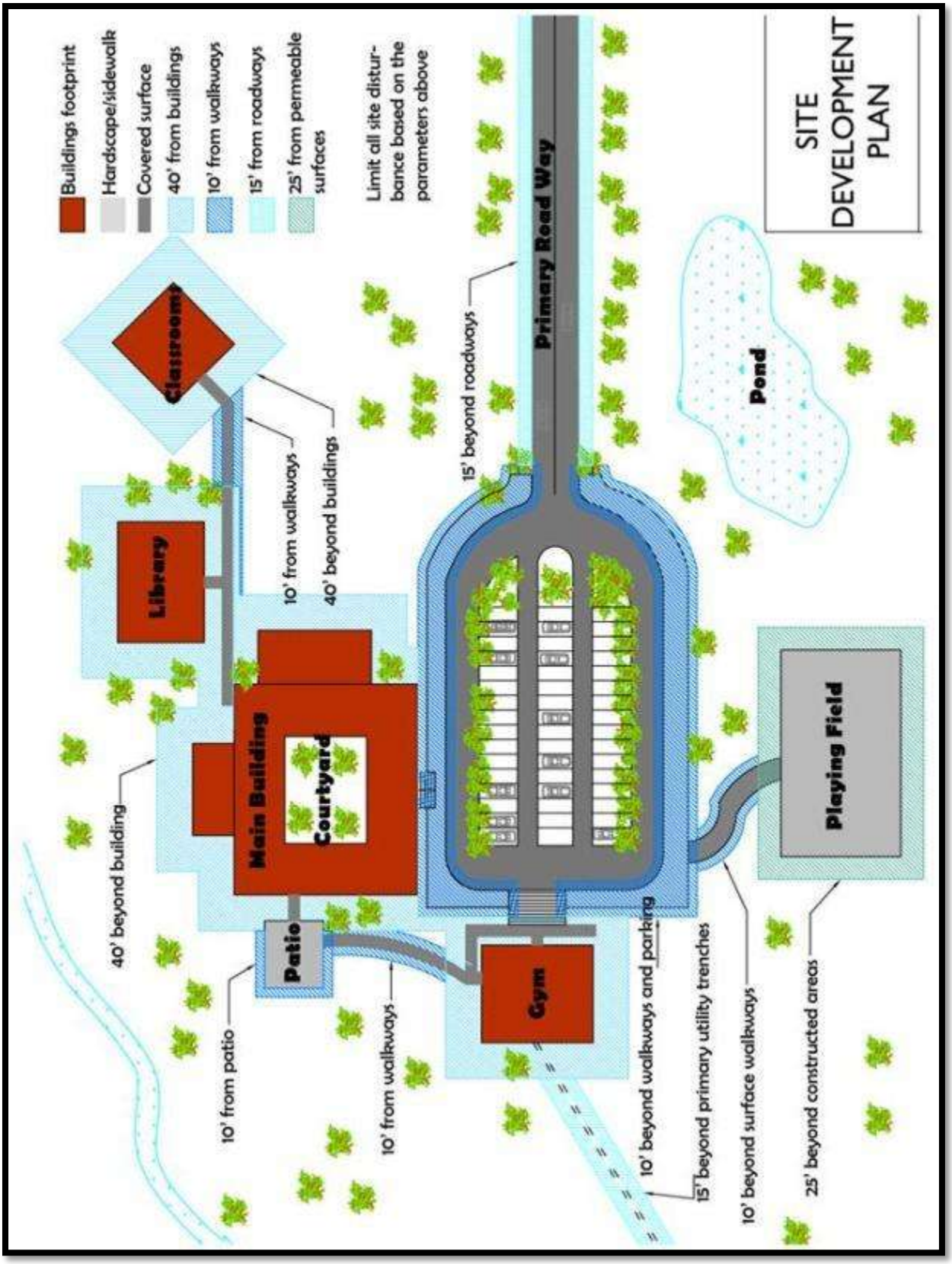


Figure 52: Example of a Habitat Protection Plan (Source: LEED User, 2011)

423 Construction Indoor Air Quality Management Plan – During Construction

Indoor air quality on the construction site may be poor due to improper ventilation, the presence of hazardous and volatile chemicals, dust, and moisture. Poor air quality can result in health implications for the individuals working on the construction. A construction Indoor Air Quality Management (IAQ) Plan – During construction, documents the construction methods that will be used to maintain indoor air quality during the construction process. The purpose of an IAQ plan is to protect the health of workers on the site, and prevent residual IAQ issues once the building is finished and sealed.

An IAQ management plan should be developed and implemented for the construction and preoccupancy of VESTA's buildings, such that it meets or exceeds the recommended control measures of the Sheet Metal and Air Conditioning National contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings Under Construction, 2nd Edition 2007, ANSI/SMACNA 008-2008 (chapter 3). For more information visit the website: www.smacna.org.

For an outline of a construction indoor air quality management plan go to appendix 2.

Implementation

The referenced SMACNA standard recommends control measures in the following five basic areas:

1. HVAC Protection: Avoid the use of HVAC systems during construction since the equipment can become contaminated and damaged. Protect all HVAC equipment from both dust and odors and seal all duct and equipment opening with plastic. If the HVAC system must be operated during construction, the contractor must install and maintain temporary filters over grilles and openings, the filtration medium must have a rating of MERV 8 or better. Once the construction is completed and previous to occupancy of the building the contractor should replace all filters. Consider using temporary ventilation units; it is a feasible, practical and generally not costly alternative.

Figure 53:Air quality management plan – HVAC protection (Source: mcaagreen.org)

2. Source Control: Specify finish materials (paints, carpets, composite wood, adhesives and sealants) that have low-toxicity levels or none at all. Recover, isolate, and ventilate containers housing toxic materials. Exhaust fumes from idling vehicles and gasoline and diesel fueled tools.

Figure 54: Air quality management plan – Source control (Source: njeja.org)

3. Pathway Interruption: During construction, the contractor must isolate areas of work to prevent contamination of clean or occupied spaces, and ventilate spaces during installation of Volatile Organic Compounds emitting materials.

Figure 55: Insolation of construction area from remainder of building (Source: Harvard Green Campus Initiative)

4. Housekeeping: The maintenance team should protect porous materials from exposure to moisture and store them in a clean area before installation. Cleaning activities should be instituted to control contaminants during construction and before occupancy.

Figure 56: Materials kept off the floor to avoid damage and exposure to moisture
(Source: Harvard Green Campus Initiative)

5. Scheduling: The design and construction team should coordinate construction activities to minimize the impact on indoor air quality, some construction activities might be conducted during off hours to allow time for new materials to air out. Flush out and indoor air quality test procedures should be scheduled before occupancy.

424 Construction Waste Management

The U.S. Environmental Protection Agency (EPA) estimated 136 million tons of building related waste generated during 1998, equivalent to 25% - 40% of the national waste stream. A 2003 update shows an increase to 164,000 million tons of yearly construction waste.

Responsibly managing waste on a construction jobsite is essential for sustainable constructions. The greatest benefit of construction waste management is reducing the total waste generated by the building industry. Recycling of construction and demolition debris reduces demand of virgin resources and environmental impacts associated with resource extraction, processing and transportation.

The recycling and/or salvaging of nonhazardous construction and demolition debris should be encouraged. A construction waste management plan should be developed and implemented during construction of VESTA's buildings, the plan must identify the materials to be diverted from disposal and whether the materials will be sorted on site or comingled.

Refer to appendix 3 for a sample outline of a Construction Waste Management Plan.

Figure 57: Construction waste management (Source: wrap.org.uk)

430 Industrial Park

The analysis of the industrial park established as the base case (Toluca Vesta Park), plus the analysis of current sustainable codes, standards (LEED C&S, ASHRAE, 90.1-2007, etc.), and case studies that incorporate sustainable strategies and best practices were used to identify opportunity areas for the incorporation of sustainable features in VESTA's properties. The identified areas of opportunity and the proposals made to increase sustainability of VESTA's industrial parks are further detail on this section.

Figure 58: Toluca Vesta Park Aereal View

431 Facilities

Among the areas of opportunity identified in Vesta's Industrial Parks is the development of a measurement and verification plan to ensure that systems are performing as designed, identifying if there are anomalies in equipment, operation procedures or user habits. Other area of opportunity is the incorporation of efficient public lighting and renewable energy systems to decrease energy consumption, and the integration of a water treatment plant for potable water reduction.

431.1 *Measurement and Verification*

Measurement and verification (M&V) is the process of using "measurements" to determine actual savings within an energy and water efficient project. The purpose of an M&V plan is to provide accountability of the building energy and water consumption, contrasting the results to projected savings, allowing for implementation of corrective actions if the desired savings are not being achieved.

Measurement and verification should be implemented on each project to obtain better results. The M&V plan should provide a level of accuracy consistent with the needs of the project, all participants involved should perform their designated tasks at an acceptable level, savings should be anticipated within reasonable margins, savings and payments should be properly credited and accounted for, and results should be used to identify, predict, and project problems that require correction.

431.11 *Measurement and Verification Plan*

The M&V plan is a document that defines a project specific procedures and methods for determining energy and water savings. The initial M&V plan should be developed during the project feasibility and definition stage, it is unadvisable to proceed with an energy saving project that does not have a way of measuring and verifying the savings outcomes. A final M&V plan should be prepared and submitted when details of the systems design are defined and installations are finalized.

The M&V plan must clearly define responsibilities, required abilities and training of the parties involved in the measurement and verification process, addressing at least the following issues:

- *Equipment procurement, installation and commissioning*
- *Equipment maintenance and calibration*
- *Warrantee responsibility and ownership*
- *Performance of calculations and reporting*
- *Auditing*
- *Record keeping*

The measurement and verification plan is responsibility of the maintenance manager, and should include the following information:

- *A general description of the facility*
- *People involved in measurement and verification activities:*
  - *Roles and responsibilities of the people involved*
  - *Training requirements of the people involved*
- *Description and accountability of systems to be measured*
- *Specification of metering points, periods, reading procedures, calibration processes and methods of dealing with missing or erroneous data.*
- *Monitoring and testing procedures for systems performance. This information should be automatically registered by automated systems within the facility (BAS and data loggers)*
  - *Automated systems log*
  - *Data loggers*
  - *Disposition of testing procedures*
  - *Reports outline*
- *Documentation of systems sensors*
- *Development of a plan for calibrating the equipment*

- *Expected accuracy of measurements, data capture and analysis*
- *Protocols for identifying existing systems issues and fixing procedures*
- *Annual verification reports*
  - *Summary of solved issues*
  - *Definition of the budget and resources required for measurement and verification procedures*
  - *Savings outcomes*

Appendix 4 includes a sample outline for an annual measurement and verification report. For more information about how to develop a measurement and verification plan go to http://mnv.lbl.gov/keyMnVDocs/femp.

431.2 ***Electrical Facilities***

Electrical facilities, particularly street lighting is an area of opportunity for the incorporation of green technologies in Vesta's Industrial Parks. Efficient street lighting design integrates efficient lamp technologies, optimum pole placement, efficient fixture photometrics (light distribution), and aesthetics while using the least amount of energy and complying with visibility and appropriate light levels requirements.

Among the benefits of efficient street lightings are:

- *Energy savings: efficient lighting fixture can reduce energy consumption.*
- *Capital cost savings: proper spacing and placement can reduce the number of fixtures needed.*
- *Maintenance cost savings: using lamps with longer lives and layouts with proper spacing and placement reduces cost for fixing burnouts and painting or replacing of damaged poles.*
- *Improved sense of security: efficient equipment and proper design can increase an area safety appearance, reducing crime rates.*
- *Evenly lit roads and sidewalks: a good lighting design can improve visibility on roads and walkways.*
- *Reduced glare and improved visibility: an adequate lighting design minimizes unwanted glare, improving visibility.*
- *Aesthetically pleasing: an adequate selection of lighting fixture can contribute to the overall appearance of the facility.*

431.21 *Lighting*

The selected street lighting within VESTA's Industrial Parks should comply with the Mexican norm NOM-013-ENER-1996 to ensure that an energy efficient product is being selected. The minimum required lamp efficacy should be 40 lm/W.

The maximum lighting power density for streets should be:

Luxes (lx)	Street width (m)			
	7.5	9.0	10.5	12.0
3	0.26	0.23	0.19	0.17
4	0.32	0.28	0.26	0.23
5	0.35	0.33	0.30	0.28
6	0.41	0.38	0.35	0.31
7	0.49	0.45	0.42	0.37
8	0.56	0.52	0.48	0.44
9	0.64	0.59	0.54	0.50
10	0.71	0.66	0.61	0.56
11	0.79	0.74	0.67	0.62
12	0.86	0.81	0.74	0.79
13	0.94	0.87	0.80	0.75
14	1.01	0.95	0.86	0.81
15	1.06	1.00	0.93	0.87
16	1.10	1.07	0.99	0.93
17	1.17	1.12	1.03	0.97

Table 11: Electric lighting power density for streets

Besides complying with the NOM-013-ENER-1996 it is highly advisable to incorporate High Power LED street lighting, since it will contribute to reduce energy consumption within the property. LED lighting has an efficiency of 80%, meaning that 80% of energy is converted to light, while the remaining 20% is lost as heat. A typical incandescent light bulb has an efficiency of 20%, losing 80% of energy as heat. Other benefits of LED lighting are:

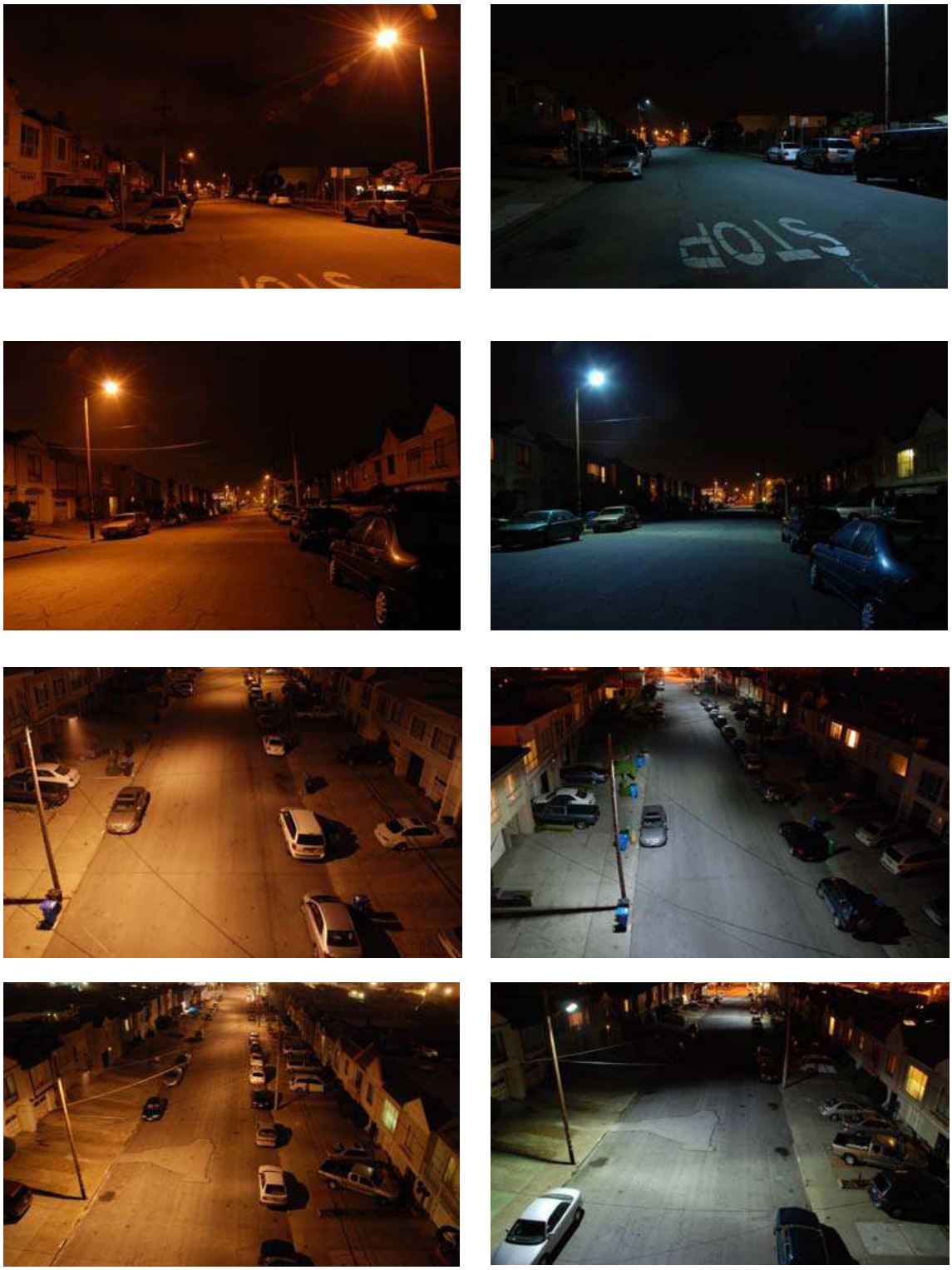
- *Increased longevity when compared to other systems.*
- *Decreased operative cost.*
- *It does not contain ultraviolet nor infrared rays.*
- *The Color Rendering Index is higher when compared to other luminaries, allowing clear lighting and true color reproduction.*
- *Minimum start up time.*
- *It does not include fragile components such as filaments, increasing its durability.*

The following chart compares LED lighting with other traditional lighting systems:

Lighting technology	Efficacy (lm/W)	Color Rendition Index	Lifetime (hours)	Characteristics
High-pressure Mercury	36-65 lm/w	Average	10,000-15,000	High energy consumption Reduced longevity
Metal halide	70-130 lm/w	Excellent	8,000-12,000	High efficiency Reduced longevity
High-pressure Sodium	50-150 lm/w	Average	15,000-24,000	Energy efficient Poor color rendering
Low-pressure Sodium	100-190 lm/w	Very poor	18,000-24,000	Energy efficient Poor color rendering
Low-pressure Mercury Fluorescent Tubular Lamp (T12 & T8)	30-90 lm/w	Good	5,000-10,000	Reduced longevity Medium energy efficiency Only available on low wattage
Efficient Fluorescent Tubular Lamp (T5)	100-120 lm/w	Very good	15,000-20,000	Energy efficient Increased longevity Only available on low wattage
LED	70-160 lm/w	Good	40,000-90,000	Increased energy efficiency Low maintenance required Increased longevity Does not use polluting components Increased cost Still a developing technology

Table 12: street lighting technologies comparative chart

Besides producing energy savings, LED lighting have a higher color rendering index than traditional high pressure sodium fixtures, as can be seen on the images below.



High Pressure Sodium Lighting

LED Lighting

Figure 59:Comparative images of High Presure Sodium Lighting and LEDs (Source: PGEC, 2008)

A study conducted by the School of Swanson during 2010 compared the street lighting fixture most commonly used (High-pressure Sodium and High-pressure Mercury) with LED luminaries, resulting in life cycle savings of 53.5% compared to high-pressure sodium lamps and 74.8% compared to high-pressure mercury lamps.

New lighting fixture performance	High pressure Sodium	LED	High pressure Mercury	LED
Efficacy (lm/W)	120	72	65	72
Lamp efficiency	0.595	0.72	0.595	0.72
Average lighting efficiency (W/lm)	0.035	0.023	0.065	0.023
Energy savings	-	35.4%	-	65.0%
Life cycle performance	0.7	0.8	0.7	0.8
Maintenance factor	0.4	0.7	0.4	0.7
Luminance decay	3	10	3	10
Life cycle - years	0.7	0.85	0.7	0.85
Life cycle – average luminance decay	14.0	30.1	7.6	30.1
Life cycle – average lamp efficiency	0.071	0.033	0.132	0.033
Life cycle – energy savings	-	53.5%	-	74.8%

Table 13: LED lighting savings when compared with other lighting systems

In addition of using energy saving fixtures, the lighting design should comply with the following power densities:

Uncover parking areas	Parking lots and drives	0.15 W/ft^2
Loading areas for law enforcement, fire, ambulance, and other emergency service vehicles		0.50 W/ft^2

Table 14 provides contact information for some well acknowledged LED street lighting national providers.

Philips Mexicana S.A. de C.V.
Av. De la Palma No 6, Col. San Fernando La Herradura
52784. Huixquilucan, Edo. de México
http://www.lighting.philips.com.mx/connect/index.wpd

MetroLed
Av. Humberto Lobo No. 520, Local K-02
Plaza San Pedro 52.81.8378.3810
http://metroled.mx/catalogo/urbanas/

Kolben
Monterrey 52.81.8379.9941
01-800-900-8889
http://www.kolbentech.com/

Table 14: LED lighting providers

431.3 *Renewable Energy Systems*

Renewable energy systems derive their energy from existing flows of energy, from on-going natural processes such as sunshine, wind, flowing water, biological processes, and geothermal heat flow, as opposed to single-use fossil fuels such as coal or oil.

Fossil fuels pollute water and air, have negative impacts on plants and animal life, create toxic waste, and cause global warming. Nuclear fuels on the other side poses serious safety risk implications. Renewable energy avoids most of this environmental impacts and risks, and contributes to the conservation of fossil fuels for future generations.

The most common forms of alternative energy currently available are solar power, wind power and micro-hydro power. The use of one source over the others will depend on the natural resources available, and the specific weather conditions on the site.

In order to comply with international standards, such as LEED Core & Shell, it is highly advisable that Vesta's Industrial Parks use renewable energy sources to provide for at least 1% of its total energy consumption. Because street lighting consumes a high percentage of electricity in the Industrial Park, it is advisable to use renewable energy sources to decrease street lighting energy consumption.

431.31 *Photovoltaic systems*

Solar power is one of the most promising renewable energy sources in the world, it is non-polluting, requires little maintenance, PV panels have a light span of over 20 years and a relatively short return of investment. Therefore, it is advisable to install photovoltaic systems in VESTA's Industrial Parks to provide energy for exterior lighting.

There are different ways to integrate photovoltaics into street lighting systems, the most commonly used alternatives are:

- *Photovoltaic street lighting systems*
- *Grid-connected photovoltaic power systems.*

Photovoltaic street lighting systems

Photovoltaic or solar street lights are powered by photovoltaic panels that charge a rechargeable battery used to provide energy to the lamp. Most solar street lights include an outdoor sensor to turn on and off automatically depending on the natural lighting levels. Nowadays, solar street lighting systems can function without sunny conditions for a couple of days, but street light hybrid systems are becoming increasingly popular to guarantee an adequate performance of the luminary during the winter time or cloudy seasons.

Figure 60: Photovoltaic lighting systems

Hybrid street lighting systems are designed to be self sufficient but climate data such as average monthly sunshine and wind speed of the specific site location needs to be considered. In Mexico, there is an average of five peak monthly sunshine hours, but the wind speed changes widely depending on the specific site location and its topography. More information regarding wind speed can be found on the national meteorological service website http://smn.cna.gob.mx.

The usual startup wind speed of turbines used for hybrid street lighting is 2 meter per second, this need to be contrasted with the average wind speed of the site. The turbine and solar panel combined should provide enough energy for the battery backup of a 2 to 3 day - 10 to 12 hour cycle.

Street light powered by photovoltaic panels must be tilted 30º in the northern, 25º in central zones, and 20º in the southern part of the country. The panels array must always be facing south, and shadows must be avoided since it considerably decreases the panel efficiency. It is advisable that the solar street lighting provider conducts a shading study to guarantee an adequate performance of the system. Moreover, LED lamps should be use in solar street lighting to increase the efficiency of the system.

Figure 61 describe the components and functioning (electrical connection scheme) of the street lighting hybrid systems.

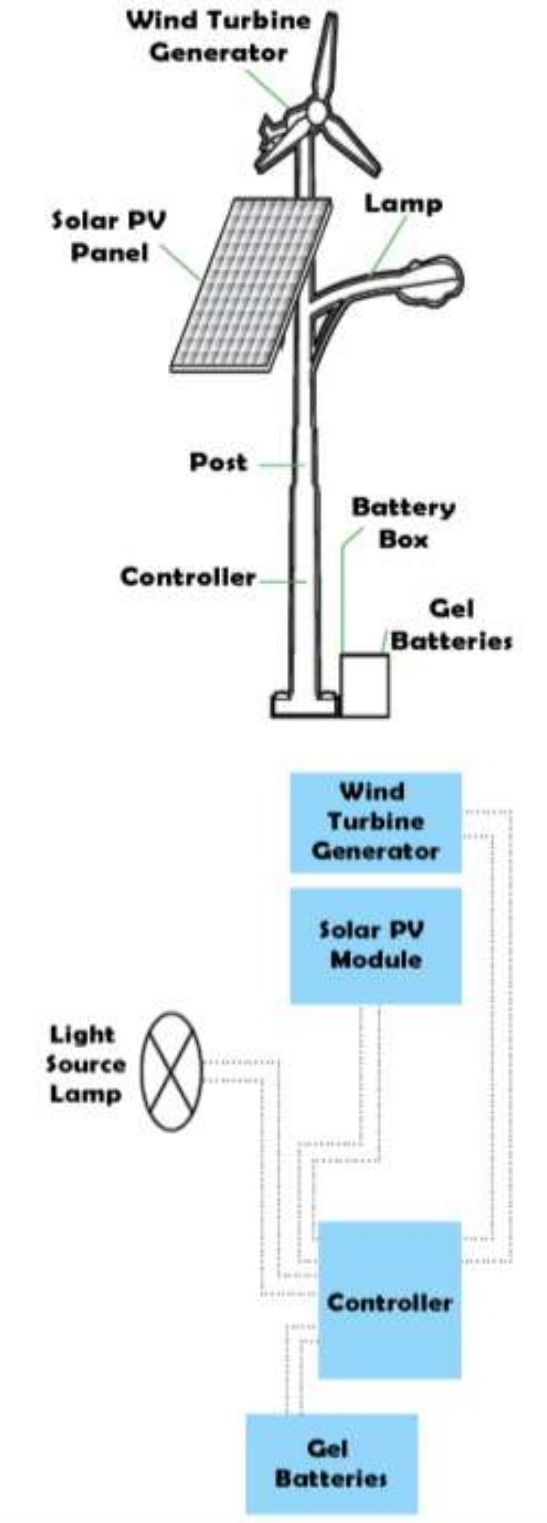


Figure 61: Hybrid lighting system diagram

Table 15 provides contact information for suppliers of photovoltaic and hybrid street lighting systems in Mexico. For further information about their products refer to appendix 5.

Photovoltaic Street Lighting Systems	
Grupo Ecos Chilpa #69 Col. Santa María Nonoalco Delegación Álvaro Obregón, México D.F. T. (5255) 5667 51 55 F. (5255) 5667 52 48 *info@eco-sistemas.com.mx* *www.grupoecos.com.mx*	
Hybrid Street Lighting Systems	
Bioconstrucción y Energía Alternativa Río Mississippi 347 Ote. Col. Del Valle, San Pedro Garza García, N.L. T. (5281) 8040 80 80 *ventas@bioconstrucción.com.mx* *carriaga@bioconstrucción.com.mx*	

Table 15: Hybrid lighting systmem provider

Grid-connected photovoltaic power systems

An alternative to photovoltaic and/or hybrid street lighting systems is the implementation of a grid-connected photovoltaic solar field to provide energy for exterior street lighting in the industrial park. These systems differ from standalone systems because they do not require batteries to store the energy produced. If in a particular moment more power is produced than required, the extra power will be sent (sell) to the grid, the feedback is done through a meter to monitor the amount of power transferred. The electricity send to the grid will produce savings for VESTA, since the cost of electricity generated by the PV panels will be deducted from the cost of electricity consumed.

It is necessary for the industrial park exterior lighting to have its own electric meter, to verify that the photovoltaic array is meeting the required lighting energy demand, and to differentiate the industrial park street lighting consumption from the warehouses and office building energy consumption, so that all energy produced by the photovoltaic array will be used for the exterior lighting of VESTA Industrial Park.

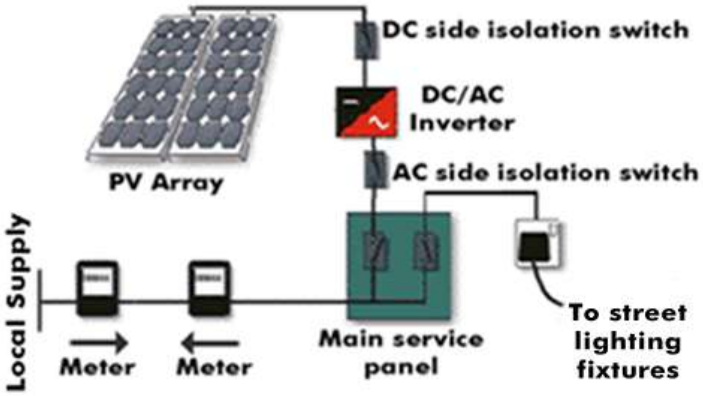


Figure 62: Grid-connected photovoltaic power system diagram

The typical grid-connected photovoltaic power system components are:

PV Array	Is made of PV modules, which are environmentally sealed collection of PV Cells (where conversion of sunlight to electricity takes place).
Balance of system equipment (BOS)	BOS includes mounting and wiring systems used to integrate the PV modules into the structural and electrical systems of the home. The wiring systems include disconnects for the dc and ac sides of the inverter, ground-fault protection, and overcurrent protection for the solar modules.
DC/AC Inverter	This device takes the DC power from the PV array and converts it into standard AC power used by the house appliances.
Metering	Used to provide indication of system performance. Some meters can indicate home energy usage.

Table 16: Grid-connected photovoltaic system components

An illumination level of 15 luxes and LED high output lamps were considered for the calculation of the number of photovoltaic panels needed to provide electricity for VESTA Industrial Park street lighting, considering the basecase scenario. The following table summarizes the analysis made to implement photovoltaic panels to provide energy for exterior lighting of common areas of the Industrial Park.

Industrial park photovoltaic system requirements	
Component	***Description***
Selected lamp	120 W HO LED (replace for 250 W Metal Halide)
Streetpole height	12 m
Separation between streetpoles	20 m
Street poles in the perimeter	46 pieces
Power required to satisfy all street lighting consumption considering existing lighting fixtures (sodium vapor lamps)	57 kW
Power required to satisfy all street lighting consumption considering LED lighting fixtures	
Module type	Policrystaline
Module Power Capacity	230 W
Number of modules required	247> if Sodium vapor lamps are used 113> if LED lamps are used
Minimum area requirements	485> if Sodium vapor lamps are used 222> if LED lamps are used
Total cost of the system installed	$256,000> if Sodium vapor lamps are used $117,000> if LED lamps are used

Table 17: Propose photovoltaic array for Vesta's Industrial Parks.

The photovoltaic panel considered for the solar field array at VESTA Industrial Parks can be seen on the following table. For further details about the panel go to appendix 5.

Proposed PV panel – electrical specifications	
	
Provider	Bioconstrucción y Energía Alternativa S.A. de C.V.
Product	Xtp60_60 photovoltaic panel
Features	High module conversion efficiency Positive tolerance Slender appearance Low PID rate Smart auto-recognition of weak light performance Steady resistance to strong hailstone, wind and snow loads Shinetime sorting standards Certified manufacturing facility

Table 18: Proposed PV panels

For further information about the initial investment cost of renewable energy system, and the payback period of such systems refer to section 500.

431.4 *Water Harvesting Systems*

Because water is usually mistaken as an unlimited resource, and it cost is highly subsidize by governmental institutions, not many efforts are put on reducing its consumption. However, it is fundamental to become environmentally conscious and implement sustainability strategies that contribute to reduce the impact on our natural resources.

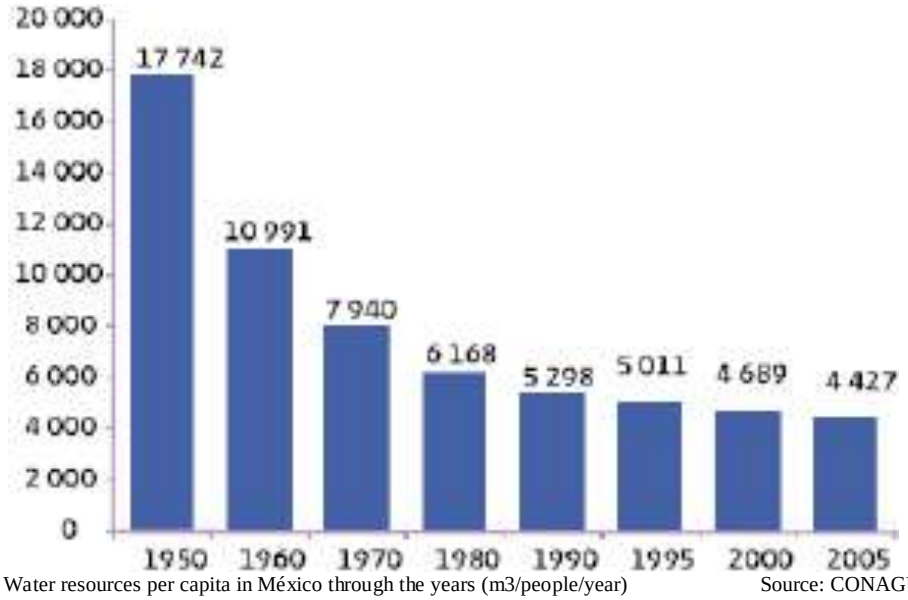


Figure 63: Water resources per capita in México through the years (m3/people/year) Source: CONAGUA

This section provides water harvesting strategies to reduce potable water consumption within VESTA's Industrial Parks.

431.41 *Rainwater harvesting systems*

"Rainwater harvesting is the capture, diversion, and storage of rainwater for a number of different purposes including landscape irrigation, drinking and domestic use, aquifer recharge, and stormwater abatement"(Texas Water Development Board, 2005).

VESTA Industrial Parks should incorporate strategies to capture and reuse rainwater to reduce potable water consumption. Reusing rainwater for irrigation adds minimum cost to the building, while it reduces infrastructure requirements (for channeling water to the drainage system) and maintenance cost. Figure 64 illustrates how rainwater harvesting can be implemented on VESTA's industrial properties.

Figure 64: Rainwater falling on roads should be conducted to green areas

As first step water falling on parking and roads should be channeled (through the use of slopes) to green areas, to allow natural percolation into soil. Overflows and retention basins should be considered to avoid flooding. Erosion control should also be considered during landscape design. Additionally rain falling on roofs should be captured and storage for landscape irrigation during drought periods. Minor filtering technologies must be employed to treat rainwater before it can be used for irrigation. Additional water treatment methods should be used if water is to be utilized for purposes other than irrigation. The following table summarizes rainwater treatment techniques according to water use.

Rainwater Treatment Techniques			
Use	***Method***	***Location***	***Result***
Non-potable	*Screening*		
	Leaf screen and strainers	Gutters and downspouts	Prevent leaves and other debris from entering tank
	Settling		
	Sedimentation	Within tank	Settles out particulate matter
	Activated charcoal	Before tap	Removes chlorine
	Filtering		
	Roof washer	Before tank	Eliminates suspended material
	In-line/ multi-cartridge	After pump	Sieves sediment
	Activated charcoal	After sediment filter	Removes chlorine, improves taste
	Slow sand	Separate tank	Traps particulate matter
Potable	*Microbiological treatment/ Disinfection*		
	Boiling/distilling	Before use	Kills microorganisms
	Chemical treatments (Chlorine or Iodine)	Within tank or at pump (liquid, tablet, granular)	Kills microorganisms
	Ultraviolet light	After activated charcoal filter, before tap	Kills microorganism
	Ozonation	After activated charcoal filter, before tap	Kills microorganism
	Nanofiltration	Before use, polymer membrane	Removes molecules
	Reverse osmosis	Before use, polymer membrane	Removes ions

Table 19: Rainwater treatment techniques Source: Texas Water Development Board, 1997

Figure 65 illustrates main components of a rainwater harvesting system, considering captured water will be used for non-potable purposes.

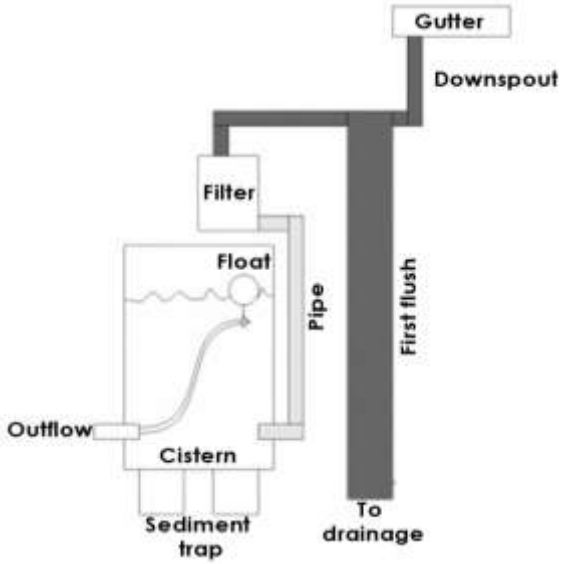


Figure 65: Main components of rainwater harvesting systems

Because VESTA Industrial Parks vary on size, location, rainfall, number of warehouses, design and characteristics of its buildings, rainwater resources will have to be estimated for each specific project. It is responsibility of the contractor to verify that rainwater cisterns are adequately sized for each project.

The following chart indicates average rainfall resources for VESTA's three chosen locations.

Average rainfall for VESTA's chosen locations (mm)												
Tijuana												
Jan	***Feb***	***Mar***	***Apr***	***May***	***Jun***	***Jul***	***Ags***	***Sep***	***Oct***	***Nov***	***Dec***	***Yearly***
43.8	36.5	42.7	17.6	4.4	0.7	0.7	0.9	5.0	7.8	33.8	37.0	230.9
Queretaro												
12.7	6.0	8.5	21.2	42.6	105.2	112.2	101.5	100.9	43.6	13.1	8.0	575.5
Cancun												
18.0	11.0	8.0	16.0	26.0	180	266	296	182	145	38.0	14.0	1200

Table 20: Average rainfall for Vesta's chosen locations Source: Wikipedia

It is advisable that a separate cistern is considered for each shell, that way each tenant will be directly benefited for water harvesting going on its site, while being responsible for the maintenance of the water harvesting cistern.

The cistern will be sized based on the site's rainfall, considering the volume of water of one precipitation event equivalent to 95% of all rain events during a 24 hours period. It is important that the system is sized to meet water demand through the dry season, meaning that the cistern should be large enough to hold water to satisfy daily water requirements throughout the dry season in VESTA industrial parks. If rainwater resources aren't sufficient to satisfy water requirements within the industrial property greywater harvesting can be implemented (see details on the following section).

431.42 *Greywater harvesting systems*

Greywater is wastewater that originates from showers, sinks and clothes washers. Wastewater from flushing toilets is called blackwater. Wastewater that originates in the kitchen (sinks and dishwashers) contains higher levels of organic solids and coliform bacteria than other greywater sources, so it is regularly considered blackwater as well. Greywater can be safely treated and recycled on site to reduce potable water irrigation requirements in VESTA's Industrial Parks. However, because of the amount and type of contaminants present on greywater, it is fundamental that it is adequately treated before it comes to contact with human beings.

The wastewater treatment system chosen for VESTA's industrial properties will have to be capable of treating wastewater flowing at a speed of 0.5 liters/second/hectare, according to the criteria established on the NMX-R-046-SCFI-2011. Meaning that it will

have to be capable of treating 12.5 liters of water per second, if we consider that typical VESTA industrial parks is around 25 hectares.

The NMX-R-046-SCFI-2011 also requires that at least 5% of the site is vegetated; meaning that at least 1.25 hectares of a typical VESTA park should be open green area. If wastewater is meant to be used for irrigation purposes, the cistern will have to be capable of holding enough water to satisfy the irrigation requirements of the 1.25 hectares of vegetated space. If we consider that around 50% of vegetation on the industrial park is native and the rest is turf grass, approximately 37.50 m3 of water will be needed for irrigation on a daily basis (considering that the 1.25 hectare is fully vegetated). The MEP engineer will have to evaluate wastewater resources on the site (greywater, rainwater, blackwater) to properly dimension the cistern. The formula to calculate the cistern volume is shown below:

C= (AXD) + 15%
C= Cistern volume (m3)
A= Daily water requirements
D= Number of storage days (this will depend on the site's water resources)
15%= Evaporation and other losses
1m3= 1000 liters

Because of the health implication risks usually associated with wastewater, it should be properly treated following the requirements established on the NOM-003-SEMARNAT-1997 and NOM-001-ECOL-1996. If treated water is going to be used for potable purposes it should be sample and tested to ensure that treated water is meeting with the standard NOM-127-SSA1-1994.

Table 21 includes a list of providers of greywater treatment systems in Mexico; they can provide further information about the most suitable technologies and equipment for a specific project. It is advisable to look for their assistance since early stages of the project.

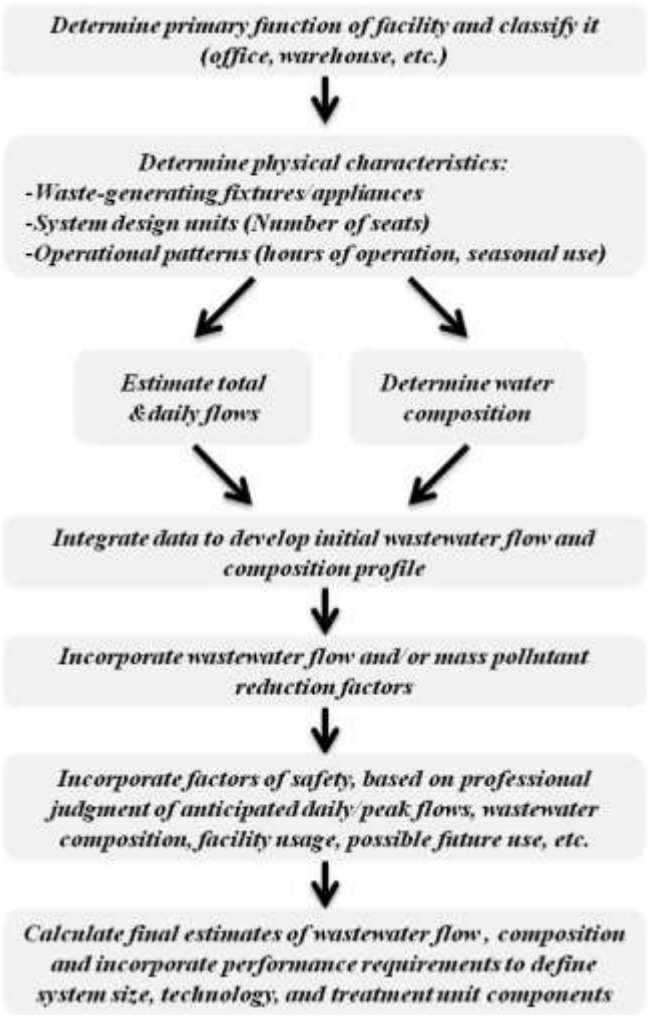
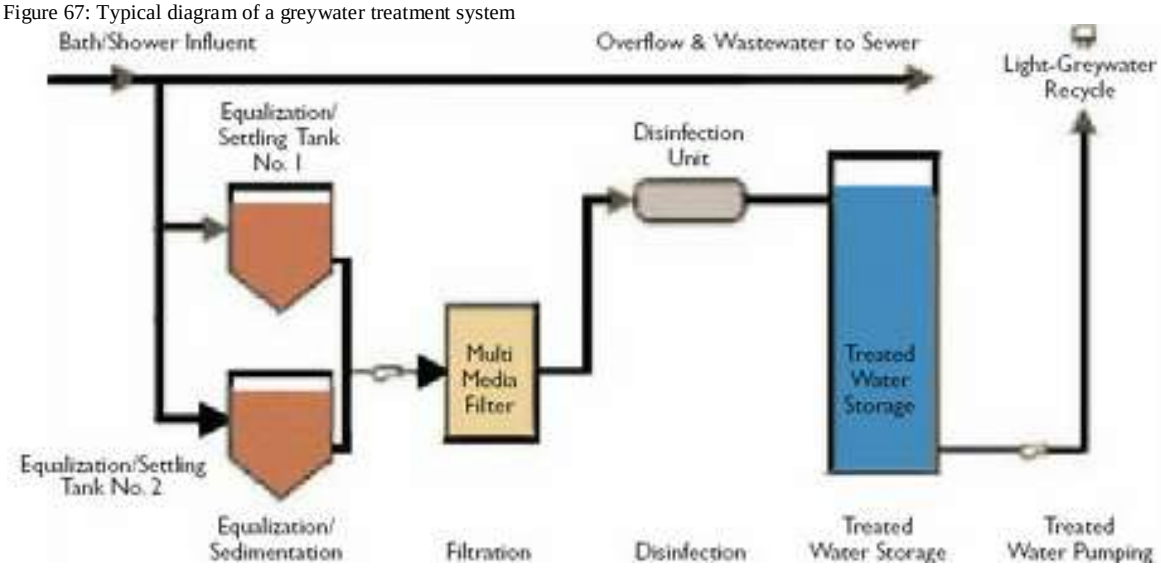


Figure 66: Methodology for estimating wastewater resources and proceed to an adequate selection of treatment systems

Figure 67: Typical diagram of a greywater treatment system



Wastewater Treatment Systems Providers	
Impulsora Hidráulica S.A. de C.V. C 59-A No. 312-D x 132 y 136 Av. Jacinto Canek, F. Yucalpetén Mérida, Yucatán, México Phone: (999) 945-54-59, 945-54-60, 945-54-21 *ventas@impulsorahidraulica.com.mx*	
Agua y Saneamiento Ambiental S.A. de C.V. Asa, Agua y Saneamiento Ambiental Guadalajara, Jalisco. Phone: +52 (33) 31-80-27-80 Fax: +52 (33) 31-80-00-56 *info@plantasdetratamiento.com.mx*	
Aguas Latinas México Asa, Agua y Saneamiento Ambiental Guadalajara, Jalisco. Phone: +52 (33) 31-80-27-80 Fax: +52 (33) 31-80-00-56 *ventas@aguaslatinas.com*	

Table 21: Wastewater treatment systems providers

432 Exterior vegetation and materials

It is important to make an adequate selection of exterior materials and vegetation for VESTA Industrial Parks, since it can contribute to decrease maintenance cost, minimize potable water requirements and reduce the heat island effect. A good landscape design and the use of permeable paving also promote rainwater infiltration and contribute to reduce water runoff, and pollution of nearby rivers, lakes and/or aquifers.

432.1 *Streets and hardscape areas*

432.11 *Heat Island Effect Reduction*

Paved areas like streets and sidewalks contribute to the heat island effect. The heat island effect increases the mean air temperature of urban zones in a range that goes from one to ten Celsius degrees, increasing summertime peak energy demand, air conditioning cost, air pollution and greenhouse gas emissions. Therefore, it becomes fundamental to choose adequate materials and techniques to minimize the heat island effect.

At least 50% of the exterior surfaces (streets and hardscaped areas) in VESTA's Industrial Parks should incorporate one or more of the following strategies:

- *Use exterior materials with a Solar Reflectance Index (SRI) of at least 29. The material provider should include a technical datasheet demonstrating a SRI of 29 or better.*
- *Use permeable paving (permeable paving should have a perviousness of 50% or more).*
- *Provide shade from existing tree canopies or within five years of landscape installation.*
- *Provide shade from structures covered by solar panels, the renewable energy should be used to decrease energy consumption of the industrial park.*
- *Use shading devices that have a SRI of at least 29.*

The following figure illustrates how these strategies can be applied into VESTA's Industrial Parks, the proposed strategies are intended to be illustrative rather than limitative, alternative strategies can be implemented to comply with the required percentage.

Figure 68: Strategies to reduce heat island on Vesta's Industrial Properties

To achieve the required percentage for Heat Island Effect Reduction the following permeable paving products can be utilized. Although in the previous plan permeable paving was not suggested for cargo areas, the technical data sheets for these products indicate that they can be used in such areas, for detail information on the products refer to appendix 6.

Permeable Paving Providers	
	**Company:** Ekeco **Product:** Concreto Permeable Ecológico **Description:** Resistance to compression 150 to 300 kg/cm2 Resistance to bending 25 to 55 kg/cm2 Weight 1,700 kg/m3 Permeability 100% **Applicability:** Pedestrian sidewalks, parking lots, low traffic roads, high traffic roads, cargo areas **Contact:** Sisteckocreto S. de RL. De CV. Plaza de la república 9, Col. Tabacalera, C.P. 06030, Mexico D.F. Phone 52-55-57030838 www.ekeco.org
	**Company:** Herko **Product:** Concreto Permeable Verdecreto **Description:** Resistance to compression 200 to 250 kg/cm2 Resistance to bending 30 to 50 kg/cm2 Weight 1,700 kg/m3 Permeability 100% **Applicability:** Pedestrian sidewalks, streets, high and light traffic roads, parking lots **Contact:** Cuahutemoc #1620 C-1 Col. Jardin C.P. 78260, San Luis Potosi, Mexico Phone 444-817-05-45 http://www.verdecreto.com.mx
	**Company:** Concreto Ecológico de México S.A. de C.V. **Product:** Hidrocreto **Description:** Resistance to compression 300 kg/cm2 Resistance to bending 40 kg/cm2 Weight 1,750 kg/m3 Permeability 100% **Applicability:** Pedestrian sidewalks, streets, high and light traffic roads, parking lots **Contact:** Monrovia No.1003 Int.5 Portales Sur CP.03300, Mexico DF Phone 55-5688-4332 www.concretopermeable.com

	**Company:**	CEMEX.
	Product:	Concreto sin finos
	Description:	Resistance to compression 100-250 kg/cm2 Resistance to bending 24-32 kg/cm2 Weight 1,900-2,100 kg/m3
	Applicability:	Parking lots, low traffic roads, sidewalks, patio, plazas.
	Contact:	www.cemexmexico.com

Table 22: Permeable paving providers in Mexico

432.2 *Green Areas*

Green areas within the project boundaries should incorporate water efficient landscape, such that irrigation will be no longer needed after the establishment period (within one year of installation).

Water-efficient landscape varies with the site and region; the vegetation palette used by the landscape architect should incorporate native or adaptive vegetation to guarantee that the proposed water use reduction will be achieved.

The following principles contribute to reduce irrigation and maintenance of green areas; they should be considered during the development of the landscape design:

- *Develop a site plan that considers topography, orientation, shading, sun and wind exposure of green areas.*
- *Cluster vegetation by water use (low, moderate or high water requirements).*
- *Reduce turf areas, since turf has high irrigation and maintenance requirements.*
- *Conduct a soil analysis to suggest adequate vegetation for the site's soil type.*
- *Include a diverse vegetation palette to discourage disease or insect infestations.*
- *Select plant species that need little to non fertilization.*
- *Regularly check irrigation systems to verify they are performing according to design.*
- *Use water efficient irrigation systems such as drip irrigation.*
- *Use mulching to conserve moisture and prevent water loss due to evaporation.*
- *Select native or adapted plants with minimum maintenance and irrigation requirements.*
- *Evergreen plants usually require less maintenance than perennial species.*

The following table suggests some native or adaptive vegetation that can be implemented into Vesta's Industrial Parks, considering the selected three site locations for Vesta's properties.

Tijuana

Scientific name:
Salvia mellifera

Common name:
Black sage
California black sage

Characteristics:
Openly branched
Evergreen shrub
0.90-1.80 meters tall
Low water requirements

Scientific name:
Eriogonum fasciculatum

Common name:
Flat top buckwheat

Characteristics:
Evergreen shrub
0.90 meters tall
1.20 diameter
Low water requirements

Scientific name:
Abronia maritima

Common name:
Red sand verbena

Characteristics:
0.90-1.80 meters tall
Beach adapted perennial plant
Moderate saline water requirements
Full sun exposure

Scientific name:
Simmondsia chinensis

Common name:
Jojoba

Characteristics:
1-2 meters tall
Evergreen
Drought resistant
Poisonous if ingested.

Scientific name:
Yucca shidigera

Common name:
Mojave yucca

Characteristics:
Perennial
4-11 meters tall
Fun sun exposure
Very low water requirements
With no summer water requirements

Scientific name:
Cercocarpus betuloides

Common name:
California Mountain Mahogany

Characteristics:
3-5 meters tall
Evergreen
Low water requirements
High drought tolerance
Slow growth rate

Scientific name:
Lyonothamnus floribundus

Common name:
Catalina Ironwood

Characteristics:
14 meters tall
Evergreen
Full sun to partial shade
Sand or Loam soil
Moist to dry soil
Drought tolerant

Queretaro

Scientific name:
Cardiospermum halicacabum

Common name:
Balloonvine
Love in a puff

Characteristics:
Climbing plant
With balloon like fruits
Can grow up to 3 meters in height
Moderate water requirements

Anisacanthus quadrifidus

Common name:
Flame honeysuckle
Hummingbird bush

Characteristics:
Full sun to partially shade exposure
1-2 meters tall
Low water use

Plumbago pulchella

Common name:
Flame honeysuckle
Hummingbird bush

Characteristics:
Up to 1 meter tall
Perennial

Scientific name:
Anisacanthus quadrifidus

Common name:
Cape leadwort
Skyflower

Characteristics:
.40-.80 meters tall
Average water needs
Drought tolerant
Evergreen perennial shrub

Scientific name:
Bursera cuneata

Common name:
Copal

Characteristics:
Small tree
Perennial
Low water requirements

	Scientific name: *Bursera fagaroides* Common name: *Copal*	Characteristics: *4 meters tall* *Low to moderate sun exposure* *Low water requirements* *Slow growth rate*
Cancun		
	Scientific name: *Drypetes lateriflora* Common name: *Guiana-plum*	Characteristics: *6-9 meters tall* *Slow to moderate growth* *Moderate water requirements* *Light shade requirements*
	Scientific name: *Thrinax radiata* Common name: *Florida tatch palm*	Characteristics: *5-10 meters tall* *.10-.15 meters diameter* *Slow growth rate* *Salt water resistant* *Drought resistant*
	Scientific name: *Coccothrinax readii* Common name: *Mexican silver palm*	Characteristics: *1-4 meters tall* *Moderate water requirements* *Full sun exposure* *Evergreen*
	Scientific name: *Astronium graveolens* Common name: *Glassywood* *Ronron*	Characteristics: *10-30 meters tall* *Flowering tree* *Perennial* *Moderate water needs*

Table 23: Native vegetation palette for Vesta's selected locations

Micro-irrigation should be used on vegetated areas (where irrigation is required) to promote potable water savings. Micro-irrigation refers to low-pressure irrigation systems that spray, mist, sprinkle or drip slowly to the roots of plants. These kinds of systems contribute to save around 30% of water if compared to traditional systems, by reducing evaporation and deep drainage. Micro-irrigation systems (mostly drip irrigation) are frequently used in combination with wastewater systems, because regulations typically do not permit spraying water through the air if it has not been fully treated to potable water standards.

Among the providers of micro-irrigation systems in Mexico are:

- *Weaks Martin México*
  Micro-sprinklers and drip irrigation providers
  ventas@weaksmartin.com.mx
  01 (836) 2730817

- *Sungarden*
  Micro-sprinklers providers
  contacto@sungarden.com.mx
  Independencia 19A, Nuevo Vallarta, Nayarit
  01 (322) 2975175

- *Siberline Mexico*
  Drip irrigation providers
  ventas@siberline.com.mx
  Av. Benito Juarez No.131, Santa Rosa Jauregui, Querétaro
  01 (442) 2409165

432.3 ***Exterior Finishes***

Besides complying with the requirements established on this chapter, it is important to consider the following points during the selection of exterior materials and finishes for VESTA's Industrial Parks to promote sustainable practices:

- *Give priority to regional materials, it will reduce pollution associated with transportation and it will contribute to the development of the local economy.*
- *Reuse building materials whenever possible, it contributes to energy consumption associated with transformation and manufacturing processes.*
- *Use materials with high recycle content especially those with high post-consumer recycle content, to preserve raw materials and natural resources.*
- *Consider the life span of the material. Give preference to durable finishes and materials to reduce maintenance requirements.*
- *Use materials with a SRI of at least 29, to contribute to the heat island effect reduction.*
- *Use porous pavement or permeable surfaces to promote water infiltration and reduce stormwater runoff.*
- *Utilize materials with low maintenance requirements.*
- *Give preference to rapidly renewable materials, it will help to preserve natural resources.*
- *Verify that all wood used on the project comes from responsibly managed forest.*
- *Give preference to materials with lower embodied energy. The embodied energy of a material refers to total non-renewable energy needed to produce the material (acquisition of raw materials, processing, manufacturing and transportation to the site).*

440 Vesta Office Building

The analysis of the VESTA's Office Building in Toluca Vesta Park, plus the analysis of current sustainable codes, standards (LEED C&S, ASHRAE, 90.1-2007, etc.), and case studies that incorporate sustainable strategies and best practices were used to identify opportunity areas for the incorporation of sustainable features in VESTA's properties. The identified areas of opportunity and the proposals made to increase sustainability on VESTA's office buildings are further detail on this section.

Figure 69: Vesta Office Building in Toluca Vesta Park

441 Structural Components

Adequate insulation should be used in the building envelope to reduce air conditioning requirements and its associated energy consumption. Materials and finishes should be environmentally friendly to promote sustainability and adequate indoor environmental quality. Roofing materials with high Solar Reflectance Index should be promoted, as a way to minimize the heat island effect.

441.1 *Structure*

Concrete

The technical specification for concrete structures will be determined by the competent authority on the project. However, he must seek to incorporate recycled materials and/or available materials on site to reduce environmental impact of VESTA's buildings.

- *Fly Ash is a noncombusted by product of coal fired power plants that generally ends up in landfills, but which can be incorporated on concrete structures (as pre-consumer recycled content), substituting between 15% and 30% of Portland cement. The following table offers a comparison between high volume fly ash concrete and conventional concrete.*

Conventional Concrete	High Volume Fly Ash Concrete
Energy intensive manufacture	Less energy intensive manufacture
Weaker ultimate strength	Higher ultimate strength
Less durable	More durable
Requires more water	Requires less water
Uses virgin materials only	Uses a waste by-product
Creates more global warming gases	Creates fewer global warming gases

Table 24: Comparison between conventional concrete and high volume fly ash concrete

- *Besides using materials with recycled content such as concrete with fly ash, the byproduct of excavation activities should be incorporated as a concrete aggregate when possible, to reduce use of raw materials.*

Among the providers of concrete that incorporates recycled content in their products are:

CEMEX	**Product:**	CEM2 & CEM3 blended cements
	Description:	CEM2 - Cementitious product that reuses Fly ash, and reduces carbon dioxide emissions by 25% for each ton produced. CEM3 – Cementitious product that reuses products from the iron or steel industries, reducing carbon dioxide levels by 49% for each tone produced.
Holcim	**Product:**	Envirocore (Cass C and Class F)
	Description:	Envirocore products utilize or incorporate recycled materials that may contribute to achieve LEED certification. Envirocore products are in accordance with international standards ASTM C 618 Standard and AASHTO M 295 Standard.

Table 25: Providers of concrete with fly ash aggregates in Mexico

Structural Steel

Structural steel has a high recycled content value. LEED takes into consideration 25 percent pre-consumer recycle content for structural steel by default. However, it is important to employ structural steel that is considered regional material, meaning that is extracted and processed within an 800 kilometer radius from the project.

441.2 *Walls*

Thermal comfort is a state of mind in which people expresses satisfaction with their surrounding thermal environment. This term is frequently used by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), since one of the most important goals of HVAC engineers is maintaining thermal comfort on buildings.

One way of reducing HVAC energy consumption while maintaining thermal comfort within the buildings is through the use of thermal insulation in the building envelope. Thermal insulation reduces the thermal load for residential, commercial and industrial buildings, reducing electric consumption by up to 40%.

The minimum thermal insulation requirements for walls in VESTA's office buildings to ensure thermal comfort for the three chosen locations are:

Cancun
The wall should have a maximum U-value of 3.293 W/m^2K (0.580 $BTU/Ft^2h°F$)
Tijuana
The wall should have a maximum U-value of 0.857 W/m^2K (0.151 $BTU/Ft^2h°F$) and a minimum continuous insulation value of 1.00 M^2K/W (5.70 $Ft^2h°F/BTU$)
Queretaro
The wall should have a maximum U-value of 0.698 W/m^2K (0.123 $BTU/Ft^2h°F$) and a minimum continuous insulation value of 1.34 M^2K/W (7.60 $Ft^2h°F/BTU$)

Table 26: ASHRAE wall insulation requirements for the proposed locations

The use of Hebel block in the building envelope is an efficient way to comply with the previous insulation requirements. Technical information regarding Hebel blocks thermal properties can be found on appendix 6. Table 20 summarizes wall's construction properties to comply with thermal insulation values required for Cancún, Tijuana and Querétaro.

Proposed location	Thickness cm	Weight Kg	U-value (W/m^2K)	Fire resistance Fº
Cancun	15.00	12.50	0.90	180
Tijuana	17.50	15.00	0.79	180
Queretaro	20.00	17.00	0.70	180

Table 27: Hebel block thermal properties.

It is important to consider that Hebel blocks require qualify installers to secure that no thermal bridging is occurring, and that the required thermal insulation is indeed being achieved. Cost related issues should also be considered; construction using Hebel blocks is around $450 MNX per m^2, while traditional CMU construction is around $200 MNX per m^2.


Figure 70: Hebel bock's construction

441.3 *Floor*

Select flooring materials that require low maintenance, that are durable and environmentally friendly. Concrete is the most frequently used material because of its durability and low maintenance. To increase sustainability the building contractor should seek that concrete flooring incorporates recycle content, as refer in section 441.1, refer to this section for further details about concrete providers that incorporate fly ashes in their production process. For information related to sustainable flooring finishes refer to section 442.

441.4 *Roof*

Provide adequate roof insulation to guarantee thermal comfort is being maintained within the building. The following table summarizes roof insulation requirements for an adequate thermal performance of VESTAS's office building in the three chosen locations.

Cancun
The roof should have a maximum U-value of 3.58 W/m^2K (0.063 $BTU/Ft^2h°F$) and a minimum continuous insulation value of 2.64 M^2K/W (15.0 $Ft^2h°F/BTU$)
Tijuana
The wall should have a maximum U-value of 0.273 W/m^2K (0.048 $BTU/Ft^2h°F$) and a minimum continuous insulation value of 3.52 M^2K/W (20.0 $Ft^2h°F/BTU$)
Queretaro
The wall should have a maximum U-value of 0.273 W/m^2K (0.048 $BTU/Ft^2h°F$) and a minimum continuous insulation value of 3.52 M^2K/W (20.0 $Ft^2h°F/BTU$)

Table 28: ASHRAE roof insulation requirements for the proposed locations

In order to comply with the previous roof insulation values, Panel Losa Hebel in addition to continuous rigid insulation is being proposed. As in the case of Hebel Blocks used for wall construction, Panel Losa Hebel has thermal properties that contribute to achieve the required insulation. However, additional rigid insulation will be needed to comply with the required values established on table 28. Owens Corning's Foamular^{TM}, Dow Building Solutions' Styrofoam^{TM} and Johns Manville's energy 3^{TM} are some well established rigid insulation products that can be utilized to achieve the required insulation values. The following table shows the proposed roof assemblies for the three proposed locations.

Material	*Thickness (cm)*	*W/m K*	*R-Value*
	Cancun		
Panel Losa Hebel	12.5	0.149	4.76
Owens Corning Foamular	2.54 (1”)	0.009	5.00
Lightweight mortar	10	2.000	0.28
Weathering	0.60	0.170	0.20
			15
	Tijuana and Queretaro		
Panel Losa Hebel	12.5	0.149	4.76
Owens Corning Foamular	7.62 (3”)	0.028	15.0
Lightweight mortar	10	2.000	0.28
Weathering	0.60	0.170	0.20
			20

Table 29: Proposed roof assemblies

Figure 71: Building construction using Hebel Blocks and Panel Losa Hebel

Figure 72: Proposed Owens Corning’s rigid insulation

For more information regarding technical details of Panel Losa Hebel and Owens Corning's rigid insulation refer to appendix 6.

If a different rigid insulation material (other than Owen's Corning Foamular) is going to be used in VESTA's offices, verify it complies with the R-value requirements established on table 29.

441.41 *Solar Reflectance Index (SRI)*

A substantial amount of solar radiation is absorbed by roofs and walls, increasing cooling requirements to keep occupants inside the building comfortable. The use of reflective materials reduces thermal loads and cooling energy use on buildings. Therefore, it is important that at least 75% of the roof surface area in office buildings have a finishing material with an SRI equal or greater than 78.

Commonly used roofing materials radiative properties			
	Solar Reflectance	Thermal Emittance	SRI
Metal (unpainted)	0.60 – 0.80	0.04 – 0.10	35 – 80
Metal (painted)	0.10 – 0.75	0.80	1 – 91
Asphalt shingles	0.05 – 0.25	0.90	0 – 25
Single ply membranes	0.70 – 0.80	0.85	85 - 99
Built up roofing	0.05 – 0.25	0.90	0 - 25
Concrete	0.20 – 0.70	0.90	19 - 86

Table 30: Roofing materials radiative properties Source: ORNL and LBNL

The SRI is a combination of the capacity of a material to reflect back radiation and heat into space. White coatings and light colored finishing materials are associated with high SRI values, so they should be procured for VESTA's offices, while dark colored waterproofing materials should be avoided. For further information about finishing materials refer to section 442.

441.42 *Green roofs*

Green roofs contribute to increase roof insulation reducing the amount of energy needed to maintain thermal comfort on interiors. Green roofs also decrease Urban Heat Island effect, through the use of vegetation that absorbs and transforms solar energy that otherwise would be release in the form of heat. If green roof are to be installed, native or adaptive vegetation should be used to minimize maintenance and water irrigation requirements. Refer to section 432.2 for information about native vegetation for the three proposed locations of VESTA's office buildings.

Green roof can be extensive, if simple plants such as sedum are used, or intensive if it includes plants as shrubs and trees. It is advisable to select an extensive green roof system for VESTA's buildings because it requires less maintenance. Figure 72 shows a section of a green roof indicating its typical components.

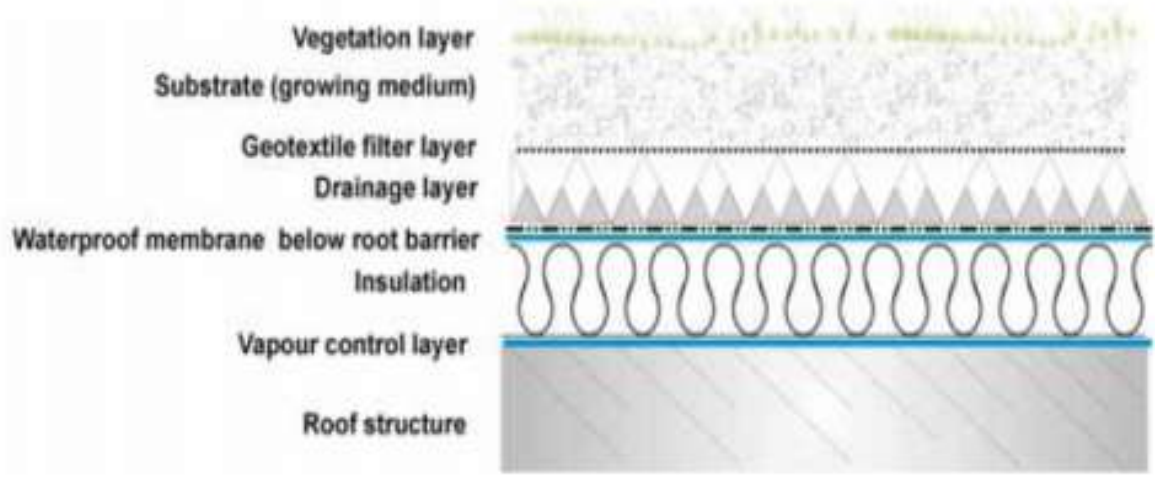


Figure 73: Section of a typical green roof system

Green roof dissipate heat absorbed through evapotranspiration and improve reflectivity of incident solar radiation. Studies about the thermal properties of green roofs have found that heat gain through an extensive green roof was reduced by an average of 70–90 % during the summer and heat loss by 10–30 % in winter.

For more information about Green Roof Systems, landscape design and Green Roof vegetation options refer to providers mentioned on the following table.

Green Roof Systems providers in Mexico	
	Bioconstrucción y Energía Alternativa S.A. de C.V. Río Mississippi 347-A Ote. Colonia del Valle San Pedro Garza Garcia, Nuevo Leon, Mexico 81-8040-8080 info@bioconstruccion.com.mx
	Biozotea Vicente Guerrero 142-A Col. Centro San Pedro Garza Garcia, Nuevo Leon, Mexico 81-8448-8350
	Green Roof Systems de Mexico Luis Spota No. 115-3, Col. San Simon Ticumac Benito Juarez, Mexico D.F. 55-1509-9237

Table 31: Green roof providers in Mexico

442 Finishes

During the selection process of interior and exterior finishes the following parameters should be taken into consideration:

- *Give preference to materials with higher recycled content*
- *All wood should be FSC certified*
- *Use products with low volatile organic compounds*
- *Give preference to rapidly renewable materials.*
- *Give preference to regional materials*

Some of the national available products and providers that comply partially or totally with the previous parameters can be seen on the following tables. For technical datasheets and additional information of the cited products see appendix 6.

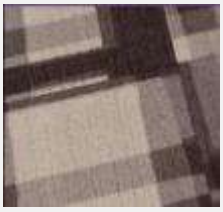
Environmentally friendly carpets providers		
	***Provider***	Intercorp Contract Resources
	Product	Milliken carpets
	Recycled content	35% recycled content (24% post industrial)
	Description	Certified by the carpet and Rug Institute's Green Label Plus. The only carpet manufacturer to achieve carbon negative status (capturing 10 times more CO2 than produced) All Milliken carpet can be renewed, reused or recycled, no carpet to landfill policy.
	***Provider***	Interfaceflor
	Product	Interface carpets
	Recycled content	Depending on the chosen product it contains up to 50% of recycled content. Convert™ products are made of type 6 or 6,6 nylon fiber and non-virgin PVC backing, featuring 64-73% total recycled content, including 32-35% post-consumer.
	Description	Low VOC emissions, complying with LEED's requirements.
	***Provider***	DuPont
	Product	DuPont Sorona Commercial carpet
	Renewable materials %	DuPont™ Sorona® contains 37% renewable sourced material derived from corn.
	Description	Sorona ® fiber contains 37% annually renewable plant based ingredients by weight (28% biobased carbon)

Table 32: Environmentally friendly carpet providers

Paint providers with low organic volatile compounds		
	***Provider***	PPG Architectural Coatings
	Product	Porter Paints : Silken Touch®, Hi-Hide® Pittsburgh Paints: Timeless®, Manor Hall Pure Performance®
	VOC content	Silken Touch, Hi-Hide Timeless and Manor Hall lines are low on VOCs, complying with LEED's requirements. Pure Performance line has Zero VOC content.
	***Provider***	Behr
	Product	Premium Plus Interior Paints & Primers Premium Plus Ultra Interior Paints
	VOC content	Low on vocs, complying with LEED's requirements.

Table 33: Low VOC paintings

Environmentally friendly wood flooring providers		
	***Provider***	Madex
	Product	FSC wood flooring Bamboo flooring
	Description	FSC certified wood flooring and FSC certified laminated wood flooring Laminated wood flooring of rapidly renewable materials
	***Provider***	Resysta
	Product	Resysta Aged Teak
	Description	Wood imitation flooring, made of rapidly renewable materials (60% rice husks, 22% common salt and 18% mineral oil)
	***Provider***	Recitec
	Product	Compuesto de fibra Plastica
	Description	Wood imitation flooring made of agricultural and plastic fibers.

Table 34: Environmentally friendly Wood flooring

Environmentally friendly ceramic tiles providers		
	Provider	Interceramic
	Product	Ceramic Flooring
	Description	Flooring tiles with recycled content, high SRI values, low VOC's, and locally manufactured. To verify the sustainable features of each product go to: http://www.interceramicgreen.com/MEX/green/productos.asp?OpcMenu=4
	Provider	Lamosa
	Product	Porcelanite Ceramic Tile
	Description	Durable ceramic tiles with incorporated recycled content. Verify the tile selection for specific recycled content.

Table 35: Environmentally friendly flooring tiles

Concrete floor finishes providers with low organic volatile compounds		
	***Provider***	CornerStone Flooring de Mexico
	Product	Polyurethane & Polymer Flooring
	VOC content	Corner*Stone* Flooring can provide low odor and low/zero VOC flooring systems with low to zero off-gassing.
	***Provider***	CureCrete
	Product	Ashford Formula
	VOC content	Contains no solvents or volatile organic compounds (VOCs). It is non-toxic, and produces no harmful fumes or vapors.

Table 36: Concrete floor finishes with low VOCs

Environmentally friendly grid ceilings		
	***Provider***	Armstrong
	Product	Tierra™
	Description	Grows from seed to harvest in just 100 days – 44% rapidly renewable material. The first Cradle to Cradle Certified℠ Silver ceiling tile Low VOC content Anti-Mold/Mildew & Bacteria
	***Provider***	USG
	Product	Mars™ Clima Plus™ Eclipse™ Clima Plus™
	Description	Available in Optimized Recycled Content formulations to help maximize LEED recycled content contribution Non-directional,monolithic visual reduces installation time and waste

Table 37: Environmentally friendly grid ceilings

Celings providers with higher recycled content			
Provider	***Product***	***Post-consumer recycled content***	***Pre-consumer recycled content***
USG-Mexico	Tablaroca	5%	36.5%
USG-USA	½" SheetRock	5%	94%
Georgia Pacific	ToughRock-USA	5%	0%
	ToughRock-CAN	5%	40%
	ToughRock-IN	6.2%	93%
American	Not Fire-Rated Plant: NM/OK/CO	6-7%	0-3%
Gypsum	Not Fire-Rated Plant: SC	6%	93%
	Fire Rated Plant:Nm/OK/CO	5%	0-3%
	1" Shaft Liner-Plant:NM/OK/CO	3%	0%
	1" Shaft Liner-Plant: SC	3%	95%
National	KS/TX/IA	5%	3%
Gypsum	NC/PA/FL	0%	95%
Temple-Inland	Regular and Waterproof	4%	93%
	Type X & C, and Fireproof	3%	90%

Table 38: Ceiling providers with higher recycled content

443 Doors and Windows

Wood

During the selection of doors and windows it should be kept in mind that all wood used or permanently installed in the project must be FSC certified, for additional information about certified wood refer to section 411.13.

Glass

To guarantee an adequate thermal performance of windows in VESTA's office buildings, glassing employed in the building should comply with the minimum requirements established on the following table.

Cancun
The window assembly (glass and frame) should have a maximum U-value of 6.814 W/m^{2}K (1.2 BTU/Ft^{2}h°F) and a maximum Solar Heat Gain Coefficient (SHGC) of 0.25.
Tijuana
The window assembly (glass and frame) should have a maximum U-value of 4.259 W/m^{2}K (0.75 BTU/Ft^{2}h°F) and a maximum Solar Heat Gain Coefficient (SHGC) of 0.25.
Queretaro
The window assembly (glass and frame) should have a maximum U-value of 3.691 W/m^{2}K (0.65 BTU/Ft^{2}h°F) and a maximum Solar Heat Gain Coefficient (SHGC) of 0.25.

Table 39: Windows requirements according to ASHRAE

Different providers can comply with the previous parameters; the contractor should verify that the chosen product complies with the desirable U-value and SHGC established on table 39. Among the providers that comply with the required parameters are Pilkington windows, the following table summarized the products that comply with both values.

Pilkington México
www.pilkington.com.mx
Calzada de la Naranja No. 154
Col. Industrial Alce Blanco
Municipio de Naucalpan de Juárez
T: 1800 561 6491

Visible light transmittance %	Solar direct transmittance %	U-value W/m^{2}K	SHGC
Exterior glassing Pilkington Solar-E™ Artic Blue Interior glassing Energy Advantage (based on 6mm glass thickness and 12,7mm air filled cavity)			
30	15	1.7	0.24
Exterior glassing Pilkington Solar-E™ Artic Blue Interior glassing Pilkington Optitherm™ (based on 6mm glass thickness and 12,7mm air filled cavity)			
32	15	1.5	0.23
Visible light transmittance %	**Solar direct transmittance %**	**U-value W/m^{2}K**	**SHGC**
Exterior glassing Pilkington Solar-E™ Grey Interior glassing Pilkington Optitherm™ (based on 6mm glass thickness and 12,7mm air filled cavity)			
26	16	1.5	0.24
Exterior glassing Pilkington Solar-E™ EverGreen Interior glassing Pilkington Energy Advantage™ (based on 6mm glass thickness and 12,7mm air filled cavity)			
37	16	1.7	0.25
Exterior glassing Pilkington Solar-E™ EverGreen Interior glassing Pilkington Optitherm™ (based on 6mm glass thickness and 12,7mm air filled cavity)			
40	16	1.5	0.24
Exterior glassing Pilkington Eclipse Advantage ™ EverGreen Interior glassing Pilkington Optitherm™ (based on 6mm glass thickness and 12,7mm air filled cavity)			
43	18	1.5	0.25
Exterior glassing Pilkington SuperGrey™ Interior glassing Pilkington Energy Advantage™ (based on 6mm glass thickness and 12,7mm air filled cavity)			
8	4	1.6	0.15
Exterior glassing Pilkington SuperGrey™ Interior glassing Pilkington Optitherm™ (based on 6mm glass thickness and 12,7mm air filled cavity)			
7	5	1.8	0.15

Table 40: Pilkington glassing products

If skylights are going to be used for natural illumination, make sure the following parameters are met.

Cancun
The skylight area should not exceed 5% of the total roof area.
Curbed skylights should have a maximum U-value of 10.788 W/m^{2}K (1.90 BTU/Ft^{2}h°F) and a maximum SHGC of .27.
Skylights without curb should have a maximum U-value of 7.722 W/m^{2}K (1.36 BTU/Ft^{2}h°F) and a maximum SHGC of .19.
Tijuana
The skylight area should not exceed 5% of the total roof area.
Curbed skylights should have a maximum U-value of 10.788 W/m^{2}K (1.90 BTU/Ft^{2}h°F) and a maximum SHGC of .34.
Skylights without curb should have a maximum U-value of 7.722 W/m^{2}K (1.36 BTU/Ft^{2}h°F) and a maximum SHGC of .19.
Queretaro
The skylight area should not exceed 5% of the total roof area.
Curbed skylights should have a maximum U-value of 7.381W/m^{2}K (1.30 BTU/Ft^{2}h°F) and a maximum SHGC of .34.
Skylights without curb should have a maximum U-value of 3.918W/m^{2}K (0.69 BTU/Ft^{2}h°F) and a maximum SHGC of .19.

Table 41: Skylights requirements according to ASHRAE

Solatube is an Energy Star certified product that contributes to increase daylight without considerable heat gain on interior spaces. It is advisable to use Solartube for interior illumination in case required lighting levels are not achieved through windows design.

Figure 74: Solatube

1. Solatube lens capture daylight, redirecting low-angle sunlight, and rejecting overpowering summer midday sunlight, while providing consistent lighting throughout the day.
2. Solatube reflector redirects low angle winter sunlight, increases light input for increased light output, and provides unsurpassed year-round performance.
3. Solatube reflective tubing provides 99.7% of spectral reflectivity, transferring sunlight at 15m/ 50ft
4. Solatube engineered light diffusion system blocks UV transmission, while its optical lenses deliver with a superior diffusion.

Figure 75: Solatube performance diagram

The following table compares the performance between a Solatube and a traditional skylight system.

	Solatube System	Traditional Skylight
Daylighting consistency Solatube technology gives consistent light throughout the day all year long, as opposed to the shifting pattern of light of traditional skylights.	☆☆☆☆	☆☆
Light output Solatube Effect Lenses can easily modify the color and strength of the daylight.	☆☆☆☆	☆☆
Energy efficiency Solatube offer maximum visible light transmittance with minimal solar heat gain	☆☆☆	☆☆
Operation Cost Solatube requires minimum maintenance as compared to traditional systems	☆☆☆☆	☆
Versatility Solatube reflective tubing directs sunlight into hard to reach areas, where traditional systems aren't an option	☆☆☆	☆☆

Table 42: Solatube performance compared to traditional skylights

For further information about Solatube products contact the official provider in Mexico:

Everlux S.A. de C.V.

Monterrey, México
Teléfono: +52 (81) 8192-0303
Fax: +52 8189 89 84 64
Sin Costo en México: 01800-614-1705

444 Facilities

Among the areas of opportunity identified in VESTA's Office Buildings is the development of a measurement and verification plan to ensure that systems are performing as designed, identifying if there are anomalies in equipment, operation procedures or user habits. Other areas of opportunity are the incorporation of efficient public lighting and renewable energy systems to decrease energy consumption, as well as water saving fixtures that contribute to reduce potable water consumption.

444.1 *Measurement and Verification*

Measurement and verification (M&V) is the process of using "measurements" to determine actual savings within an energy and water efficient project. The purpose of an M&V plan is to provide accountability of the building energy and water consumption, contrasting the results to projected savings, allowing for implementation of corrective actions if the desired savings are not being achieved.

Measurement and verification should be implemented on each project to obtain better results. The M&V plan should provide a level of accuracy consistent with the needs of the project, all participants involved should perform their designated tasks at an acceptable level, savings should be anticipated within reasonable margins, savings and payments should be properly credited and accounted for, and results should be used to identify, predict, and project problems that require correction.

444.11 *Measurement and Verification Plan*

Refer to section 431.11 for further information about how to develop an M&V plan for VESTA's Office Buildings. Refer to appendix 4 for a sample outline of an annual measurement and verification report.

444.2 *Electricity*

Among the identified areas of opportunity in VESTA's Office Buildings to reduce energy consumption are installing adequate insulation in the building envelope to reduce HVAC requirements, installing energy efficient fixtures and systems for illumination, heating and air conditioning, and implementing renewable energy systems. Adequate insulation for the three proposed location of VESTA's Industrial Parks was detailed on section 441. This section provides further details on efficient lighting and renewable energy systems.

444.21 *Efficient Lighting*

It is highly advisable to install LED lighting fixtures within the building. LEDs luminaries have an increased longevity when compared to other systems, require less energy, do not produce ultraviolet or infrared rays, have a high color rendering index, have a minimum start up time, and do not include fragile components such as filaments, increasing the product's durability. Preference should be given to LED luminaries that are Energystar or FIDE certified, because it guarantees an adequate performance of the fixtures. For further information about the characteristics and benefits of LED luminaries refer to section 431.21.

Figure 76: All luminaries in the building should be Energystar or FIDE certified

The following figure illustrates different lighting fixtures, indicating the average electrical consumption in watts of each kind of fixture. As it can be notice on the figure LED luminaries are among the most energy efficient luminaries.

Figure 77: Lighting fixtures average energy consumption

Besides installing efficient lighting it is important to make sure that acceptable lighting power densities (LPD) are being considered. The professionals involved on the lighting design of VESTA's office buildings should keep in mind the following lighting power density requirements (W/ft^2).

Lighting Power Density Requirements	
Space type	**LPD (W/ft2)**
Office - Enclosed	1.1
Office – Open plan	1.1
Conference/Meeting/Multipurpose	1.3
Atrium (first three floors)	0.6
Restrooms	0.9
Dressing/Locker/Fitting Room	0.6
Corridor/Transition	0.5
Active storage	0.8
Inactive storage	0.3
Electrical/Mechanical	1.5

Table 43: Lighting power densities requirements

The following table illustrates lighting requirements (kW) of the basecase office building, considering a regular office building occupation schedule (Monday to Friday from 8:00 am to 6:00 pm, and Saturdays from 8:00 am to 1:00 pm). The first scenario shows lighting energy consumption of the building as it is, without upgrading the luminaries. The second scenario shows energy consumption if all lighting fixtures are upgraded to LEDs.

Scenario A			
Equipment	**Quantity**	**Watts**	**Installed Power (kW)**
Spots 3'' w/ring	21	50	1.05
Spot 1 ½ ''	57	20	1.14
Spot 1 ½ '' rectangle	17	20	0.34
Total	-	-	2.53
Scenario B (LEDs)			
Equipment	**Quantity**	**Watts**	**Installed Power (kW)**
Substitute of spots 3'' w/ring	21	11	0.231
Substitute of spot 1 ½ ''	57	6	0.342
Substitute of spot 1 ½ '' rectangle	20	6	0.102
Total	-	-	0.675

Table 44: Lighting consumption in Vesta's Office Building

444.3 *Plumbing*

All plumbing fixtures within VESTA's office buildings should be water efficient. To verify that all equipment installed contributes to reduce potable water consumption it should comply with the requirements established on table 45. It is highly advisable to acquire only WaterSense certified products to guarantee and its adequate performance. WaterSense in water saving program associated to the U.S. Environmental Protection Agency, for more information about the program go to www.epa.gov/WaterSense/.

Fixture	Selection criteria
Lavatory faucets	0.5 gallons per minute
Toilets	1.6 gallons per flush
Kitchen faucets	2.2 gallons per minute
Showerheads	2.5 gallons per minute

Table 45: Plumbing fixtures selection criteria

Among the WaterSense products that comply with the selection criteria established on table 45 are:

Fixture	Provider	Product	
Toilettes			
	Caroma	Profile Smart 305 Sydney Smart Invisi Series II Somerton Smart Adelaide Cube	Bondi Caravelle Sydney Low Profile Walvit Wall Hung

American Standard	Compact Cadet 3 Flowise (México)	
	Townsquare Flowise	
	H2Option Dual Flush	
	Evolution 2	
	Boulevard Flowise RH	
	Tropic Flowise	
	Concealed Flowise	
TOTO (Watersense)	Aquia	Carlyle II
	Eco Promenade	Legato
	Drake II	Aimes
	Vespin II	Supreme
	Eco Drake	Carolina
	Eco Dartmouth	Eco Ultramax
	Eco Whitney	Eco Supreme
	Eco Clayton	Eco Lloyd
	Eco Nexus	Eco Soirée
	Ultramax II Toilet	Eco Guinevere
ROCA	W+W	
		
Kohler	Kelston	Cimarron
	Wellworth	Highline
	Saile	Karsten
	Strela	Reve
	Persuade Curv	

Showerheads			
	Caroma	Flow	
	American Standard	Flowise Traditional Flowise Square Flowise Transitional Flowise Modern Reliant Flowise Berwick Flowise	Portsmouth Flowise Serin Flowise Moments Foowise Studio Flowise
	TOTO	Trilogy 11” Rain Showerhead Trilogy HES Nexus HES Guinevere	10” Square Rain Showerhead Lloyd HES Soirée
	Kohler	Purist Forté	Mastershower
Faucets			
	American Standard (Watersense)	Reliant 3 Berwick Portsmouth Serin Moments Green Tea Studio Ceramix Cadet Neo	Copeland Tropic Princetown Townsquare Amarilis Dazzle Hampton Colony Soft Seva Simphony
	TOTO	Kiwami Renesse En Aimes Upton Ethos Lloyd Soirée EcoPower	Po Aquia Legato Mercer Clayton Nexus Guinevere
	Kohler	Margaux Stillness Purist Devonshire	Fairfax Forté Archer Coralais

Table 46: Suggested water saving fixtures

444.4 *Efficient HVAC*

Refrigerant selection

No CFC refrigerant should be used for the heating, ventilation, air conditioning and refrigeration equipments (HVAC&R). The system provider should guarantee that this requirement is being met. Preference should be given to refrigerants with low Ozone Depletion Potential (ODP) and low Global Warming Potential (GWP).

More information about refrigerants that do not damage the ozone layer can be found at ***http://www.epa.gov/ozone/snap***

Interior air quality requirements

The minimum requirements to guarantee an adequate interior air quality are established on the standard ASHRAE 62.1-2007 "Ventilation for Acceptable Indoor air Quality" section 4 to 7. It is important to have a commissioning authority that verifies that ASHRAE's requirements are being met.

Table 47 shows required minimum ventilation rates for VESTA's office buildings.

Occupancy Category	People Outdoor Air Rate Rp		Area Outdoor Air Rate Ra		Occupant Density	Combined Outdoor Air Rate	
	Cfm/person	L/s*person	Cfm/ft^2	L/s*m^2	#/1000 ft^2 or #/100m^2	Cfm/person	L/s*person
Office space	5	2.5	0.06	0.3	5	17	8.5

Table 47: Minimum ventilation rates for office buildings

For natural ventilated spaces ASHRAE's section 5.1 parameters should be considered, including the suggested strategies for sizing and location of openings. Mixed mode systems should comply with ASHRAE's 62.1-2007 section 6 requirements. The design team can use any methodology or acceptable calculation to document and support their design.

Filters

MERV 11 filters should be install to operate with the HVAC system, this value indicate that the filter should be able to capture between 65% and 79% of particles within 1 and 3 microns, and capture more than 85% of particles between 3 and 10 microns.

Energy efficiency of HVAC equipments

The Seasonal Energy Efficiency Ratio (SEER) and Energy Efficiency Ratio (EER) are the evaluation tools more utilized to measure the efficiency of air conditioning equipments. The following table provides information about the expected efficiency levels of air conditioning equipment.

It is advisable to install equipment that is Energystar certified, since Energystar products are internationally recognized for providing energy savings of about 30% when compared to traditional equipment. For further information about Energystar products go to. http://www.energystar.gov/index.cfm?c=products.pr_find_es_products.

	Central AC	Air Source Heat Pump	Ground Source Heat Pump
Market Range	13-21 SEER	13-17 SEER	8.7-20.4 EER
Availability	9-14 EER	9-13.5 EER	
ENERGY STAR	14 SEER	14 SEER	Open Loop
	11.5 EER	11.5 EER	16.2 EER
			Closed Loop
			14.1 EER
			DX
			15 EER

Table 48: Air conditioning efficiency

444.5 *Renewable Energy Systems*

Renewable energy systems derive their energy from existing flows of energy, from on-going natural processes such as sunshine, wind, flowing water, biological processes, and geothermal heat flow, as opposed to single-use fossil fuels such as coal or oil.

Fossil fuels pollute water and air, have negative impacts on plants and animal life, create toxic waste, and cause global warming. Nuclear fuels on the other side poses serious safety risk implications. Renewable energy avoids most of this environmental impacts and risks, and contributes to the conservation of fossil fuels for future generations.

The most common forms of alternative energy currently available are solar power, wind power and micro-hydro power. The use of one source over the others will depend on the natural resources available, and the specific weather conditions on the site.

In order to comply with international standards, such as LEED Core & Shell, it is highly advisable that Vesta's Industrial Parks use renewable energy sources to provide for at least 1% of its total energy consumption.

444.51 *Photovoltaic systems*

Solar power is one of the most promising renewable energy sources in the world, it is non-polluting, requires little maintenance, PV panels have a light span of over 20 years and a relatively short return of investment. Therefore, it is advisable to install photovoltaic systems in VESTA's Industrial Parks.

VESTA's office buildings can integrate photovoltaic panels in their design, generating enough energy to satisfy its lighting consumption. As in the case of industrial park it is proposed to install a grid connected photovoltaic power system for VESTA's offices, because it does not require an additional investment in batteries. The energy produced by the PV panels will be used for lighting and if in a particular moment more power is being produced than required, the extra power will be sent (sell) to the grid, at night when insufficient power is being produced, the required electricity will be drown from the grid.

The lighting design of the basecase office building indicates that decorative spots are being used. It is advisable to replace decorative spots for LED spots to reduce energy consumption, and therefore, the number of solar panels required to provide energy for illumination.

Office building photovoltaic system requirements	
Component	***Description***
Selected lamp	Decorative spots (as found on basecase building)
Required power for current lighting fixtures	21 kW
Required modules	91 – to satisfy all lighting energy consumption 17 – to satisfy lighting consumption during peak hours
Initial investment	$84,000 – for all consumption $44,000 – for peak consumption
Required power for proposed lighting fixtures (LED spots)	8 kW
Required modules	34 – for all lighting energy consumption 17 – for peak lighting consumption
Initial investment	$32,000 – for all consumption $16,000 – for peak consumption

Table 49: Propose photovoltaic array for Vesta's Industrial Parks.

The photovoltaic panel considered for the solar field array at VESTA Office Buildings can be seen on the following table. For further details about the panel go to appendix 5. For further details about grid connected photovoltaic systems refer to section 431.31.

Proposed PV panel – electrical specifications		
	Provider	Bioconstrucción y Energía Alternativa S.A. de C.V.
	Product	Xtp60_60 photovoltaic panel
	Features	High module conversion efficiency Positive tolerance Slender appearance Low PID rate Smart auto-recognition of weak light performance Steady resistance to strong hailstone, wind and snow loads Shinetime sorting standards Certified manufacturing facility

Table 50: Proposed PV panels

For further information about the initial investment cost of renewable energy system, and the payback period of such systems refer to section 500.

445 Public facilities

To comply with international sustainability standards public facilities such as bicycle racks and a waste center for the collection of recyclables should be included in the facility.

- *Secure bicycle storage should be provided for 5% or more of regular building occupants to promote the use of alternative transportation. The bicycle racks should be located within 180 meters from the building main entrance. Changing rooms should also be provided for those employees arriving by bicycle.*

Figure 78: Secure bicycle racks should be provided for employees.

- *A waste center for the collection of recyclables should be provided to divert the facility's waste from landfills. The waste center should provide separate containers for paper, cardboard, glass, plastic, metals.*

Figure 79: Separate paper, cardboard, glass, plastic and metal containers should be provided.

446 Exterior areas

Refer to section 432 for suggestions and requirements regarding exterior vegetation and materials. Information about exterior lighting can be found in section 431.21. Information regarding ways to trigger the use of alternative transportation among employees, including recommendation regarding accessibility to public transportation can be found on section 313 of this handbook.

450 Commissioning Plan

Building commissioning is the process of verifying, that all the subsystems for HVAC, plumbing, electrical, fire/life safety, building envelopes, interior systems, cogeneration, utility plants, sustainable systems, lighting, wastewater, controls, and building security are installed and performing according to design.

The Commissioning Plan is the master planning, management and communications tool relating to commissioning. It specifies the process and methodology for successful commissioning of the project. The objective of the commissioning plan is to provide a fully functional facility whose systems, equipment and components have been proven to meet all Client's functional requirements, and operates consistently at peak efficiencies and within specified energy budgets under normal loads. The commissioning plan also intends to provide fully trained personnel for the operation and maintenance of the systems.

Among the benefits of developing a Commissioning Plan are reducing construction expenses and potential delays, fewer warranty claims and call backs, operational energy savings, consistently reliable systems operations, enhanced building productivity, extended service life of components, reduction of future maintenance activity and costs.

Commissioning process activities must be completed at least for the following energy-related systems:

- *Heating, ventilating, air conditioning and refrigeration (HVAC&R) systems and associated controls*
- *Lighting and daylight controls*
- *Domestic hot water systems*
- *Renewable energy systems*

A commissioning plan can usually be divided into design phase, construction phase, acceptance phase and occupancy or post-acceptance phase. The following table summarizes the main activities to consider during each phase. For a sample outline of a commissioning plan refer to appendix 7.

Design Phase
Review of design development submittals.
Commissioning specifications are created and incorporated into tender documents.
Review of construction tender documents.
Construction Phase
Commissioning scope meeting held.
Contractor submits Commissioning Plan.
Drawing submittals are reviewed in parallel by consultants and review team members.
Commissioning meetings are scheduled with consultants and/or contractors as required.
Commissioning Equipment Forms submitted and reviewed.

Commissioning Installation Forms submitted and reviewed.
Project Operation & Maintenance manuals and as-built drawings submitted and reviewed.
Functional Performance Testing.
Commissioning Performance Forms submitted and reviewed.
Integrated Systems Review
Acceptance Phase
Project turnover meeting - Construction Management to Facilities Management.
Training and orientation of personnel is scheduled and conducted.
Systems are formally accepted and warranty period begins.
Finalized Commissioning Plan documents turned over to owner.
Consultant / Contractor performance reviews completed.
Occupancy Phase
Off-season functional testing is scheduled and performed.
Preventative maintenance work orders are added.
Managers coordinate any remaining warranty work.
Re-commissioning is schedule.

Table 51: Commissioning Plan activities by phase

500 RETURN ON INVESTMENT ANALYSIS

A Return on Investment (ROI) analysis for the main eco-technologies proposed on this Handbook was conducted to evaluate the financial consequences and payback period of integrating such technologies on VESTA's industrial properties. This section provides further information about the ROI for main eco-technologies proposed for VESTA Industrial Parks' common areas and facilities, and Office Buildings. For information related to ROI of eco-technologies proposed for VESTA's warehouses refer to VESTA's Sustainable Construction Handbook: Building Shells.

510 Renewable Energy Systems

511 Industrial Park

For the ROI calculations a typical night schedule for street lighting was considered during summer and winter time in order to calculate energy consumption (kWh). An HM (medium voltage) rate was considered for this analysis.

Table 52 shows monthly energy consumption for street lighting on VESTA's industrial parks. Energy consumption is divided into three possible scenarios, according to the three possible rates of CFE (base, middle and peak), 464W sodium vapor street lamps were considered for the basecase calculations (current luminaries used on VESTA's Industrial Parks).

Month	Power (kW)	464 W Sodium Vapor Lamp with ballast			
		Base	Middle	Peak	Total
Jan	22	4,312	1,584	880	6,776
Feb	22	4,312	1,584	880	6,776
Mar	22	5,390	1,980	1,100	8,470
Apr	22	4,312	1,584	880	6,776
May	22	5,390	1,980	1,870	9,240
Jun	22	4,312	1,584	1,496	7,392
Jul	22	4,312	1,584	1,496	7,392
Ago	22	5,390	1,980	1,870	9,240
Sep	22	4,312	1,584	1,496	7,392
Oct	22	4,312	1,584	1,496	7,392
Nov	22	5,390	1,980	1,100	8,470
Dec	22	4,312	1,584	880	6,776
Total		56,056	20,592	15,444	92,092

Table 52: Energy consumption for sodium vapor street lamps on VESTA's industrial park.

Table 53 shows energy consumption for VESTA's industrial park if current luminaries are substituted by more efficient lighting fixtures (180W LEDs luminaries).

Month	Power (kWh)	LED Lamp Energy Consumption			
		Base	Middle	Peak	Total
Jan	10	1,960	720	400	3,080
Feb	10	1,960	720	400	3,080
Mar	10	2,450	900	500	3,850
Apr	10	1,960	720	400	3,080
May	10	2,450	900	850	4,200
Jun	10	1,960	720	680	3,360
Jul	10	1,960	720	680	3,360
Agu	10	2,450	900	850	4,200
Sep	10	1,960	720	680	3,360
Oct	10	1,960	720	680	3,360
Nov	10	2,450	900	500	3,850
Dec	10	1,960	720	400	3,080
Total		25,480	9,360	7,020	41,860

Table 53:Energy consumption for LED street lighting on VESTA's industrial park.

Table 54 illustrates electricity monthly cost according to consumed power (kW) and time-of-use (base, middle and peak), considering an HM (medium voltage) rate.

Month	MXN $/kWh			MXN $/kW
	Base	Middle	Peak	Power
Jan	0.8299	1.0131	1.745	165.64
Feb	0.8438	1.0302	1.7605	166.63
Mar	0.8709	1.0633	1.795	167.35
Apr	0.9096	1.1104	1.8402	167.89
May	0.9194	1.1223	1.8574	167.24
Jun	0.8917	1.0884	1.8353	167.69
Jul	0.916	1.1181	1.8555	167.98
Aug	0.9377	1.1445	1.8812	168.37
Sep	0.9308	1.1363	1.8798	168.76
Oct	0.9895	1.2078	1.9437	169.15
Nov	0.9787	1.1947	1.9501	169.54
Dec	0.9913	1.2101	1.9757	169.93

Table 54: Electricity cost by month

According to the previous information, three different scenarios were considered to calculate the ROI:

1. ***All:*** *This scenario considers that all energy consumed for street lighting in VESTA's Industrial Parks is produced through PV panels.*
2. ***Middle + Peak:*** *This scenario considers that energy produced through renewable energy systems will be used to satisfy street lighting demand during peak and middle time (the higher cost electricity rates).*
3. ***Peak:*** *This scenario considers that PV panels will only satisfy the electricity demand for street lighting during peak time.*

In accordance to the previous scenarios, and taking into consideration energy consumption shown on tables 52 and 53, the required PV panels were calculated. Table 55 show photovoltaic panels requirements for the three scenarios for both LED luminaries and Sodium vapor lamps. As can be seen on the following table, the number of required PV panels is greatly affected by the type of luminary; since LED lighting requires 54% less energy than vapor sodium lamps.

Energy Generation Scenarios						
Scenario	**Energy Consumption**	**Percentage Produced with solar modules**	**Power required**	**Modules required**	**Minimum area requirement**	**Percentage of total area available**
All	kWh	kWh	kW	modules	m2	m2
Sodium vapor	92,092	100%	57	247	485	6%
LED	41,860	100%	26	113	222	3%
Middle+Peak						
Sodium vapor	36,036	39%	22	95	187	2%
LED	16,380	39%	10	43	84	1%
Peak						
Sodium vapor	15,444	17%	9	39	77	1%
LED	7,020	17%	4	17	33	0.4%

Available area	8,000	m2

Table 55: Energy generation scenarios

The ROI for the three scenarios considering sodium vapor and LED lighting fixtures was calculated. Table 56 shows ROI for PV panels in case current lighting fixtures are considered (sodium vapor lamps). The first part of the table shows the initial investment, in PV panels, to satisfy energy demand for the three scenarios (all, middle + peak, and

peak). The middle part of the table indicates annual operation cost for street lighting on the park. The bottom part of table 56 shows operation cost for lighting if PV panels were installed (results for the three scenarios are included). According to the calculations the payback period for the PV panels are 19, 17 and 14 years depending on the scenario (if PV panels are installed to satisfy all energy consumption, energy consumed during the middle and peak period, or only during peak time). Additionally a Net Present Value (NPV) analysis was developed, indicating savings in energy consumption, after reaching the return of investment for the PV panels, considering a life cycle of 25years for the PVs.

Scenario	*Modules*	*Power*	*Initial Investment (USD)*
All	247	57	$ 256,500
Middle+Peak	95	22	$ 99,000
Peak	39	9	$ 40,500

Vapor Sodium Lamps	MXN	USD
Annual energy expenses	$ 147,698	$ 11,361.40

	MXN		*USD*		*ROI*	*ROI*	*NPV (USD)*
Scenario	*with solar modules*	*Savings*	*with solar modules*	*Savings*	*Years*	*Rate*	
All	$ 42,138	$ 105,560	$ 3,241	$ 8,120	19	7.52%	$ 167,593
Middle+Peak	$ 93,606	$ 54,092	$ 7,200	$ 4,161	17	8.54%	$ 83,012
Peak	$ 116,685	$ 31,013	$ 8,976	$ 2,386	14	9.17%	$ 34,126

Table 56: ROI Analysis

Table 57 shows the ROI results in case luminaries are substituted by LEDs.

Scenario	*Modules*	*Power*	*Initial Investment*
All	113	26	$ 117,000
Middle+Peak	43	10	$ 45,000
Peak	17	4	$ 18,000

LED Lamps	MXN	USD
Annual energy expenses	$ 67,136	$ 5,164.27

	MXN		*USD*		*ROI*	*ROI*	*NPV (USD)*
Scenario	*with solar modules*	*Savings*	*with solar modules*	*Savings*	*Years*	*Rate*	
All	$ 19,154	$ 47,982	$ 1,473	$ 3,691	19	7.34%	$ 73,116
Middle+Peak	$ 42,548	$ 24,587	$ 3,273	$ 1,891	17	8.54%	$ 37,733
Peak	$ 53,039	$ 14,097	$ 4,080	$ 1,084	14	9.37%	$ 15,866

Table 57: ROI Analysis for LED lamps

512 Office Building

The ROI for the office building considered a typical office operation schedule (8:00 am. to 6:00 pm.) to calculate energy consumption. An HM (medium voltage) rate was considered for the analysis. Table 58 shows monthly energy consumption for lighting on VESTA's office building, considering the basecase luminaries. Table 59 shows energy consumption in case current fixtures are substituted by more efficient lighting (LED Spots).

Month	Power (kWh)	Energy consumption with current decorative spots			
		Base	Middle	Peak	Total
Jan	5	-	1,240	1,440	2,680
Feb	5	-	1,240	1,440	2,680
Mar	5	-	1,550	1,800	3,350
Apr	5	-	1,240	1,440	2,680
May	5	-	1,550	1,800	3,350
Jun	5	-	1,240	1,440	2,680
Jul	5	-	1,240	1,440	2,680
Ago	5	-	1,550	1,800	3,350
Sep	5	-	1,240	1,440	2,680
Oct	5	-	1,240	1,440	2,680
Nov	5	-	1,550	1,800	3,350
Dec	5	-	1,240	1,440	2,680
Total		-	16,120	18,720	34,840

Table 58:Energy consumption for decorative spots on VESTA's office building.

Month	Power (kWh)	LED lamp energy consumption			
		Base	Middle	Peak	Total
Jan	5	-	496	576	1,072
Feb	5	-	496	576	1,072
Mar	5	-	620	720	1,340
Apr	5	-	496	576	1,072
May	5	-	620	720	1,340
Jun	5	-	496	576	1,072
Jul	5	-	496	576	1,072
Ago	5	-	620	720	1,340
Sep	5	-	496	576	1,072
Oct	5	-	496	576	1,072
Nov	5	-	620	720	1,340
Dec	5	-	496	576	1,072
Total		-	6,448	7,488	13,936

Table 59:Energy consumption if current lamps in office building are substituted by LEDs

Three different scenarios were considered to calculate the ROI for the PVs:

4. ***All:*** *This scenario considers that all energy consumed for street lighting in VESTA's Industrial Parks is produced through PV panels.*
5. ***Middle + Peak:*** *This scenario considers that energy produced through renewable energy systems will be used to satisfy street lighting demand during peak and middle time (the higher cost electricity rates).*
6. ***Peak:*** *This scenario considers that PV panels will only satisfy the electricity demand for street lighting during peak time.*

In accordance to the previous scenarios, and taking into consideration energy consumption shown on tables 58 and 59, the required PV panels were calculated. Table 60 show photovoltaic panels requirements considering the three scenarios for the current lightings system and table 61 if luminaries are upgraded to LEDs. As can be seen on the tables if current luminaries (wallpack + streetlight) are kept the required number of PV panels will be considerably higher than if luminaries are replaced by LEDs, due to the amount of energy savings of LED lamps.

Table 60 shows ROI for PV panels in case current lighting fixtures are considered (sodium vapor lamps and wallpacks). The first part of the table shows the initial investment, in PV panels, to satisfy energy demand for the three scenarios. The middle part of the table indicates annual operation cost for lighting. The bottom part of the table shows operation cost for lighting if PV panels were installed (results for the three scenarios are included). According to the calculations the payback period for the PV panels are 14, 12 and 12 years depending on the scenario (if PV panels are installed to satisfy all energy consumption, energy consumed during the middle and peak period, or only during peak time). Additionally a Net Present Value (NPV) analysis was developed, indicating savings in energy consumption, after reaching the return of investment for the PV panels, considering a life cycle of 25years for the PVs.

With current lighting fixtures				
Scenario	***Modules***	***Power Required***	***Initial Investment (USD)***	
All	91	21	$	84,000
Middle	43	8	$	32,000
Peak	17	11	$	44,000

Decorative Spots	MXN	USD
Annual energy expenses	$ 62,982	$ 4,844.79

Scenario	***MXN***		***USD***		***ROI***	***ROI***	***NPV (USD)***
	with solar modules	***Savings***	***with solar modules***	***Savings***	***Years***	***Rate***	
All	$ 9,577	$ 53,405	$ 737	$ 4,108	14	10.96%	$ 128,953
Middle	$ 27,644	$ 35,338	$ 2,126	$ 2,718	12	12.92%	$ 63,954
Peak	$ 27,644	$ 35,338	$ 2,126	$ 2,718	12	12.64%	$ 86,736

*Middle and Peak are similar due to absence of energy consumption during "base" hours

Table 60: ROI analysis with current lighting fixtures

Table 61 shows the ROI results in case LED luminaries are considered.

With updated luminaries			
Scenario	***Modules***	***Power Required***	***Initial Investment***
All	34	8	$ 32,000
Middle	17	4	$ 16,000
Peak	17	4	$ 16,000

LED luminaries	MXN	USD
Annual energy expenses	$ 25,193	$ 1,937.91

	MXN		***USD***		***ROI***	***ROI***	***NPV (USD)***
Scenario	***with solar modules***	***Savings***	***with solar modules***	***Savings***	***Years***	***Rate***	
All	$ 3,831	$ 21,362	$ 295	$1,643	14	11.29%	$ 52,328
Middle	$ 11,058	$ 14,135	$ 851	$1,087	11	13.56%	$ 36,077
Peak	$ 11,058	$ 14,135	$ 851	$1,087	11	13.56%	$ 36,077

*Middle and Peak are similar due to absence of energy consumption during "base" hours

Table 61: ROI Analysis if current lighting fixtures are substituted by LEDs

520 Efficient lighting

521 Industrial Park

The ROI for lighting on VESTA's Industrial Park is based on the additional investment it would require for VESTA to update its lighting fixtures to LEDs. Table 62 shows typical acquisition and installation cost for vapor sodium lamps and LED street lighting. For calculation purposes 1 USD = 13 MNX.

Quantity	***Lamp***	***Unit Price (USD)***	***Total (USD)***
46	Sodium Vapor Lamps	$ 32.31	$ 1,486.15
46	Ballast	$ 140.00	$ 6,440.00
	Total		$ 7,926.15

Quantity	***Lamp***	***Unit Price (MXN)***	***Total (MXN)***
46	LED	$ 430.77	$ 19,815.38
	No Ballast		

Table 62: LED luminaries vs. sodium vapor lamps

Table 63 shows a life cycle analysis based on typical operation of LEDs and sodium Vapor Lamps. As it can be seen LED lamps have an average life cycle of 50,000 hours (approximately 12.5 years), while the current lighting system has an average life cycle of 20,000 hours (approximately 5 years), meaning it would take 2.5 replacement of the current system for each replacement of LED luminaries. On table 64 the life cycle cost of

the current system is shown. If initial investment and replacements cost of the current system is considered it would take only 1.4 years for the payback of upgrading the system to LEDs.

Life Cycle Analysis				
Lamp	***Life***	***Hr/year***	***Years***	***Replacements during life***
LED	50,000	4,004	12.5	0
Sodium Vapor	20,000	4,004	5.0	2.5

Table 63: Life cycle analysis for LED luminaries

Life Cycle Cost			
Lamp	***Lamp + Ballast***	***Replacement***	***Currency***
Sodium Vapor	$ 7,926	$ 3,715	USD
LED (no ballast)	$ 19,815	$ 0.00	USD
Additional Investment in LED Technology		$ 11,889	USD

Yearly Savings	***USD***
O&M	$ 6,197
Ballast	$ 2,576
Total	$ 8,773

ROI	***1.4 years***

Table 64: ROI for LED luminaries

522 Office Building

The ROI for lighting on VESTA's Office Building is based on the additional investment it would require VESTA to update its office current lighting fixtures to LEDs. Table 65 shows typical acquisition and installation cost for current decorative spots and LED street lighting.

Quantity	***Lamp***	***Unit Price (USD)***	***Total (USD)***
21	Decorative Spot A	$ 3.85	$ 80.77
58	Decorative Spot B	$ 4.62	$ 267.69
14	Decorative Spot C	$ 3.85	$ 53.85
	Total		$ 402.31

Quantity	***Lamp***	***Unit Price (USD)***	***Total (USD)***
21	LED Spot A	$ 130.33	$ 2,736.87
58	LED Spot B	$ 103.24	$ 5,988.14
14	LED Spot C	$ 103.33	$ 1,446.58
	No Ballast		
	Total		$ 10,171.59
* The price for decorative spots include the ballast cost			

Table 65: Cost of current decorative spots vs. LED spots

The life cycle analysis shown on the table below indicates the expected life (in hours) of each lighting system. As shown in the table, LED luminaries have longer life than decorative spots; it would take 33 replacements of current decorative spot for a replacement of a LED luminary.

Life Cycle Analysis				
Lamp	***Life***	***Hr/year***	***Years***	***Replacements during life***
LED	50,000	6,968	7.2	0
Decorative spots	1,500	6,968	0.2	33

Ballast	***Life***	***Hr/year***	***Years***	***Replacements during life***
LED	50,000	4,004	12.5	0
Decorative spots	20,000	4,004	5.0	2.5

Table 66: Life cycle analysis of current and proposed lighting fixtures for VESTA's office building

Table 67 indicates the additional investment it would be required to replace current decorative spots for LEDs.

Life Cycle Cost			
Lamp	***Lamp + Ballast***	***Replacement***	***Currency***
Decorative Spots	$ 402.31	$ 13,410.26	USD
LED (no ballast)	$ 10,171.59	$ 0.00	USD
Additional Investment in LED Technology		$ 9,769.28	USD

Table 67: Additional investment to replace current lighting in VESTA's office

For the ROI analysis energy savings and operation & maintenance savings (replacement of luminaries, without considering labor cost) were considered. Results indicate that a total of 2 years would be needed to recover the initial investment of upgrading the lighting system.

Yearly Savings	***USD***
Energy Savings	$ 2,906.87
O&M	$ 1,868.85
Ballast	$ 53.85
Total	$ 4,829.57

ROI	2.0 años

Table 68: ROI for LED lighting in VESTA's office building

530 Efficient plumbing fixtures

531 Office Building

A Return on Investment (ROI) analysis was conducted to estimate the time it would take VESTA to recover the initial cost of acquiring water efficient plumbing fixtures for its office buildings.

The ROI analysis considered the following water fixtures for the calculations:

Toilet	
Traditional fixture	***Water efficient fixture***
 Orion toilet 2.64 liters per flush $21.50 USD	 Castel toilet Dual flush system (1 and 1.6 gallons per flush) $115.15 USD
Lavatory faucets	
 Rugo 2.75 gallons per minute (aprox.) $14.55 USD	 Moen (low flow fixture) 0.5 gallons per minute (aprox.) $75.25 USD
Kitchen faucets	
 Rugo 3 gallons per minute (aprox.) $17.60 USD	 Moen (low flow fixture) 2.2 gallons per minute (aprox.) $66.85 USD
Showerheads	
 Stretto 7 gallons per minute (aprox.) $2.15 USD	 Glacier bay (watersense) 2.5 gallons per minute (aprox.) $315.30 USD

Table 69: Water fixtures considered for ROI analysis

Taking into consideration water fixtures on table 69, and considering an average of six employees on the office building, the payback period of acquiring water saving fixtures was calculated, resulting in an ROI of 5.07 months for upgrading the toilet, faucets and showerhead of the office building. Water utility cost for Tijuana during June 2012 was considered for the calculations (refer to http://www.cespt.gob.mx/Tarifas/Tarifas.aspx for further details about water cost).

Plumbing Fixture	Water Consumption		Average use		Users	Monthly water cost		Monthly water savings (pesos)	ROI	Savings per year
	Traditional fixture	Efficient fixture				Traditional fixture	Traditional fixture			
Toilet	2.64	1.6	5	flushes/ person/day	6	$ 73.92	$ 31.13	$ 42.79	5.07	$ 296.72
Lavatory faucets	2.75	0.5	5	minutes/ person/day	6					
Kitchen faucets	3	2.2	2	minutes/ person/day	6					
Showerheads	7	2.5	8	minutes/ person/day	1					

Table 70: ROI considering one shower per employee per day

The ROI analysis calculated a payback of little over 5 month considering Tijuana's water industrial rate. It also estimated savings of around $42.79 per month, for a total of $296.72 during the first year.

540 Efficient landscape design

541 Industrial Park

The implementation of efficient landscape is not necessarily associated with an increased cost, but it will rather result from adequate planning and design.

The following principles will contribute to reduce irrigation and maintenance of green areas without additional cost; they should be considered during the development of landscape design:

- *Develop a site plan that considers topography, orientation, shading, sun and wind exposure of green areas.*
- *Cluster vegetation by water use (low, moderate or high water requirements).*
- *Reduce turf areas, since turf has high irrigation and maintenance requirements.*
- *Include a diverse vegetation palette to discourage disease or insect infestations.*
- *Select plant species that need little to non fertilization.*
- *Regularly check irrigation systems to verify they are performing according to design.*
- *Use mulching to conserve moisture and prevent water loss due to evaporation.*
- *Select native or adapted plants with minimum maintenance and irrigation requirements*

If an efficient water irrigation system is going to be implemented it will have to be analyzed on a case by case scenario to determine its ROI, since it will be directly affected by the proposed design, and the amount of green areas available.

It is highly advisable to start by implementing those strategies without additional cost and then (if still necessary) move on to efficient landscape technologies that require additional investment.

Studies about the cost of xeriscaping (landscape design that incorporates native or adaptive vegetation) indicate a payback period of one to three years, depending on the design and the establishment period of the plant. If vegetation is going to be used as shading device to reduce energy consumption, it is estimated a payback period of around 8 years, in part due to the time it takes for a tree to mature and start providing shading for buildings.

600 CONCLUSIONS

This handbook is meant to contribute to incorporate sustainability principles in VESTA's industrial properties with the purpose of reinforcing the company's commitment with the environment and society, contributing to strengthen the company's image before investor, strategic partners and potential clients.

As previously detailed on the methodology section, this handbook was developed following world renowned sustainability standards (LEED™ Core & Shell 2009 Certification, and standards established by institutions mentioned in the LEED™ Reference Guide for Green Building Design and Construction, such as ASHRAE or EPA), which in addition to the analysis of case studies and current VESTA's properties, resulted in the identification of opportunity areas for the development and implementation of sustainability strategies for VESTA's Industrial Parks and Office Buildings.

The sustainability strategies covered on this handbook focus on the development of best practices for the selection and development of the site, best practices for the achievement of energy efficiency, best practices for the selection and management of materials and resources, development of a commissioning plan to verify that the project's energy-related systems are installed, calibrated and perform as designed.

Although each project will have to be individually evaluated to see if it can reach LEED certification, the implementation of the principles established on this guide will contribute towards the achievement of LEED credits in all of its main categories. The following table summarizes the LEED credits that are covered on this guide:

Sustainable Sites		**Address on the handbook**
Prereq 1	Construction Activity Pollution Prevention	*
Credit 1	Site Selection	*
Credit 2	Development Density and Community Connectivity	*
Credit 3	Brownfield Redevelopment	
Credit 4.1	Alternative Transportation—Public Transportation Access	*
Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	*
Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	
Credit 4.4	Alternative Transportation—Parking Capacity	
Credit 5.1	Site Development—Protect or Restore Habitat	*
Credit 5.2	Site Development—Maximize Open Space	*
Credit 6.1	Stormwater Design—Quantity Control	*
Credit 6.2	Stormwater Design—Quality Control	*
Credit 7.1	Heat Island Effect—Non-roof	*
Credit 7.2	Heat Island Effect—Roof	*

Credit 8	Light Pollution Reduction	
Credit 9	Tenant Design and Construction Guidelines	
Water Efficiency		
Prereq 1	Water Use Reduction—20% Reduction	*
Credit 1	Water Efficient Landscaping	*
Credit 2	Innovative Wastewater Technologies	
Credit 3	Water Use Reduction	*
Energy and Atmosphere		
Prereq 1	Fundamental Commissioning of Building Energy Systems	*
Prereq 2	Minimum Energy Performance	*
Prereq 3	Fundamental Refrigerant Management	*
Credit 1	Optimize Energy Performance	*
Credit 2	On-Site Renewable Energy	*
Credit 3	Enhanced Commissioning	
Credit 4	Enhanced Refrigerant Management	
Credit 5.1	Measurement and Verification—Base Building	*
Credit 5.2	Measurement and Verification—Tenant Submetering	
Credit 6	Green Power	
Material and Resources		
Prereq 1	Storage and Collection of Recyclables	*
Credit 1	Building Reuse—Maintain Existing Walls, Floors, and Roof	
Credit 2	Construction Waste Management	*
Credit 3	Materials Reuse	
Credit 4	Recycled Content	*
Credit 5	Regional Materials	*
Credit 6	Certified Wood	*
Indoor Environmental Quality		
Prereq 1	Minimum Indoor Air Quality Performance	
Prereq 2	Environmental Tobacco Smoke (ETS) Control	*
Credit 1	Outdoor Air Delivery Monitoring	
Credit 2	Increased Ventilation	
Credit 3	Construction Indoor Air Quality Management Plan—During Construction	*
Credit 4.1 – 4.4	Low-Emitting Materials	*
Credit 5	Indoor Chemical and Pollutant Source Control	
Credit 6	Controllability of Systems—Thermal Comfort	
Credit 7	Thermal Comfort—Design	
Credit 8.1	Daylight and Views—Daylight	*
Credit 8.2	Daylight and Views—Views	*

Table 71: LEED credits covered on this handbook

610 Sustainability Checklist:

The following checklist intents to provide a guideline to verify that sustainability principles and strategies provided on this Handbook for VESTA's Industrial Parks are being met. In case of a negative answer refer to the corresponding section of this Handbook, double-check the reason why the proposed strategy was not applied, and proceed to corrective measures if applicable.

Preliminaries	Yes	No
1. Was an Owners Project Requirement document developed in the beginning of the project? (Section 210)		
Sustainable sites		
2. Was the development of an industrial park avoided on prime farmland, sites with an elevation lower than 1.5 meters above the elevation of the hundredth year flood, land identified as habitat for endangered species, land within 30 meter of wetlands, land within 15 meter of water bodies, land that used to be public parkland? (Section 311)		
3. During the site selection phase, was preference given to sites within an existing urban fabric? (Section312)		
4. Is public transportation accessible for personnel of the Industrial parks? (Section 313)		
5. Were strategies to promote alternative transportation such as preferred parking and bicycle racks considered? (Section 313)		
6. Is open space equal to 20% of the Industrial Park gross area? (Section 314)		
7. Were materials that contribute to minimize the heat island effect chosen (e.g. materials with high SRI, green roofs, etc.)? (Section 314, 432.11)		
8. Are stormwater quantity and quality control strategies being implemented on the facility? (Section 315, 432.11)		
9. Was an erosion and sedimentation plan developed before construction? (Section 421)		
10. Was a habitat protection plan developed during the design phase? (Section 422)		
Indoor environmental quality		
11. Is smoking inside the building and within eight meters of entries, air intakes and operable windows prohibited? (Section 321)		
12. Were the following strategies to minimize exposure of building occupants to potentially hazardous pollutants considered: installation of permanent entryway track-off systems, containment drains to control hazardous liquids, MERV 13 filters? (Section 322)		
13. Were daylight strategies considered during the design phase of the buildings? (Section 323)		
14. Have occupants within the buildings accessibility to exterior		

views? (Section 324)

15. Was a construction indoor air quality management plan developed before construction started? (Section 423)
16. Were minimum ventilation rates established on section 444.4 considered during the selection of HVAC equipment?

Materials

17. Are at least 10% of products and materials used in the construction of the buildings regionally extracted (within an 800 kilometer radius)? (Section 411.11)
18. Do at least 10% of materials used for construction incorporate recycle content? (Section 411.12)
19. Are wood-based materials FSC certified? (Section 411.13)
20. Were VOC limits considered during the selection of interior finishes? (Section 411.2, 442, 443)
21. Was a construction waste management plan developed before construction started? (Section 424)
22. Is a waste center for the collection of recyclables considered in the project (Section 445)

Energy

23. Was adequate thermal insulation procured during the selection of materials and finishes for the building envelope? (Section 411.3, 441)
24. Was a measurement and verification plan developed? (Section 431.1)
25. Were LEDs luminaries considered for street lighting? (431.21)
26. Were efficient lighting fixture considered for the buildings? (Section 444.21)
27. Were photovoltaic systems installed on the industrial park? Do they follow the recommendations established on section 431.3 to guarantee sufficient energy for exterior lighting?
28. Were refrigerants with low Ozone Depletion Potential and low Global Warming Potential for HVAC systems considered? (Section 444.4)
29. Were the Seasonal Energy Efficiency Ratio (SEER) and Energy Efficiency Ratio (EER) considered during the selection of HVAC equipment? (Section 444.4)
30. Was a commissioning plan developed to verify that equipment and systems will perform as designed? (Section 450)

Water

31. Was water harvesting systems implemented on the industrial facility? (Section 431.4)
32. Was native vegetation that contributes to reduce water irrigation requirements considered? (Section 432.2)
33. Were green roof considered for office buildings to minimize stormwater runoff? (section 441.42)
34. Were water efficient fixtures considered for offices building? (Section 444.3)

700 Referenced Standards

- *2003 EPA Construction General Permit*
- *ASHRAE/IESNA Standard 90.1-2007, Energy Standard for Buildings Except Low-Rise Residential*
- *The Energy Policy Act (EPAct) of 1992*
- *The Energy Policy Act (EPAct) of 1995*
- *International Association of Plumbing and Mechanical Officials Publication IAPMO/ANSI UPC 1-2006, Uniform Plumbing Code 2006, Section 402.0, Water-Conserving Fixtures and Fittings*
- *International Code Council, International Plumbing Code 2006, Section 604, Design of Building Water Distribution System*
- *ANSI/ASHRAE Standard 62.1-2007: Ventilation for Acceptable Indoor Air Quality*
- *ASHRAE Standard 55-2004: Thermal Comfort Conditions for Human Occupancy*
- *SMACNA IAQ Guidelines for Occupied Buildings Under Construction, 2nd Edition, Chapter 3, November 2007*
- *ANSI/ASHRAE Standard 52.2-1999: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*
- *South Coast Air Quality Management District (SCAQMD) Amendment to South Coast Rule #1168, VOC Limits, effective January 7, 2005*
- *Green Seal Standard GS-36 (commercial adhesives), Effective October 19, 2000*
- *South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings*
- *Green Seal Standard GC-03 (anti-corrosive and anti-rust paints)*
- *Green Seal Standard GS-11 (commercial flat and non-flat paints)*
- *Carpet and Rug Institute Green Label Plus Testing Program*
- *South Coast Air Quality Management District (SCAQMD) Rule #1168, VOC Limits*
- *South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings*

800 Appendixes

810 Appendix 1: Owner's Project Requirement Outline

Owner's Project Requirement

Owner and User Requirements

A) **Description of the project:** [Include a paragraph with a brief description of the project here]
B) **Sustainability and design goals:** [Include a paragraph with a general description of the sustainability and design goals of the project here]
C) **Type of project:** [In a sentence describe the type of project being developed e.g. commercial building, office building, parking garage, etc.]

General Project Information:

Project name:	[Include project's name here]
Owner:	[Include owner's name here]
Type and use:	[Include type of building being developed and the use/uses it will have]
No. of units:	[Include number of units of the project here, if applicable]
No. of floors:	[Include number of floors of the project here]
Square footage:	[Include square footage of the project here]

Construction Schedule Target:

Construction budget:	[Include construction budget here]
Schematic design:	[Projected date for the conclusion of the schematic design]
Design development:	[Projected date for the conclusion of the design development]
50% construction drawings:	[Projected date for the conclusion of 50% of construction drawings]
100% construction drawings:	[Projected date for the conclusion of 100% of construction drawings]
General merchant pricing (GMP):	[Projected date for the conclusion of GMP]
Construction commence:	[Projected date for construction commence]
CO date:	[Projected CO date]

Project purpose, vision and statement:

A) **Project performance and sustainability goals:** [Include main project's performance and sustainability goals]
    a. **Probable performance goals:** [Enlist all performance goals that wish to be achieve in the project]
B) **Building occupant and O&M personnel expectations:** [Include expectations for building occupants and operation and maintenance personnel]

Appendix 2: Construction Indoor Air Quality Management Plan Outline

This is a sample outline of a typical Air Quality Management Plan. You can use it as a guide to developing your own.

Construction Indoor Air Quality Management Plan

I *(Include General Contractor or Other Responsible Party name here)*, declare to USGBC that an Indoor Air Quality (IAQ) Management Plan has been developed and implemented for the construction and pre-occupancy phases of the building. The following filtration media was used during construction (if air handlers were operated) and installed after construction:

Installed during Construction

Filtration Media Used	Manufacturer	Model Number	*MERV Value

***Minimum MERV 8 required.**

Installed at the end Construction

Filtration Media Used	Manufacturer	Model Number	*MERV Value

***Minimum MERV 13 required.**

I have provided the following supplementary documentary to support the declaration:

EITHER:

A. *(Photographs – photographs taken on different occasions during construction AND identification of the SMACNA approach featured by each photograph, in order to show consistent adherence to the credit requirements.)*

B. *(I certify that the five Design Approaches of the SMACNA IAQ Guidelines for the Occupied Buildings Under Construction, 2nd Edition 2007, ANSI/SMACNA 008-2008 Chapter 3, were used during building construction AND I have included a brief description of some of the important design approaches employed.)*

Example A:

This plan describes the measures to be taken to provide good indoor air quality (IAQ) during construction and after construction is complete and the occupants have moved into the building. This plan is based on the SMACNA standard IAQ Guidelines for Occupied Buildings Under Construction, 2nd Edition 2007, ANSI/SMACNA 008-2008 Chapter 3, and the requirements of LEED™ Core & Shell 2009 Certification.
The plan addresses construction IAQ procedures in five areas of concern, which in turn will allow the building to achieve one LEED program point:

(1) Ventilation system protection
(2) Contaminant source control
(3) Pathway interruption
(4) Housekeeping
(5) Scheduling

[Include a paragraph for each point with a brief description and at least 18 pictures]

Appendix 3: Construction Waste Management Plan Outline

This is a sample outline of a typical Waste Management Plan. You can use it as a guide to developing your own.

Construction Waste Management Plan

Company: [Include Company's name here]
Project: [Include project's name here]
Designated Recycling Coordinator: [Include coordinator's name here]

Waste Management Goals:
- [Define and describe goals here]

Communication Plan:
- [Define and describe communication plan here]

Expected Project waste, Disposal, and Handling:

Demolition Phase

Material	Quantity	Disposal Method	Handling Procedure

.

Construction Phase

Material	Quantity	Disposal Method	Handling Procedure

.

Appendix 4: Energy's Annual Measurement and Verification Report Outline

Annual Report Outline

Contract #/ Delivery Order #/ Task#:
Performance period dates covered: _____to_____
Contract year #:

1. **Executive Summary**
   - **1.1 Project Background**
     - 1.1.1 Provide an overview of project background, including:
       - Contract #/ Delivery order #/ Task #/ Modification #
       - Dates of relevant delivery order modifications
       - Performance period dates covered
       - Project acceptance date
   - **1.2 Brief Project and ECM Descriptions**
     - 1.2.1 Provide an overview of what was done and how savings are generated
     - 1.2.2 Note any changes in project scope between the Final Proposal (including any relevant delivery order modifications) and as-built conditions as recorded in post-installation report.
   - **1.3 Summary of Proposed and Verified Energy and Cost Savings**
     - 1.3.1 Compare verified savings for Performance Year # to Guaranteed Cost Savings for Year #. State whether guarantee is fulfilled for year. If not, provide detailed explanation.
     - 1.3.2 Define performance period.
     - 1.3.3 Summarize information in Table 1 and Table 2.

Table 1. Proposed Annual Savings Overview
(Include all applicable fuels/ commodities, e.g., electric energy, electric demand, natural gas, fuel oil, coal, water, etc.)

ECM	Total energy savings (MBtu/yr)	Electric energy savings (kWh/yr)	Electric demand savings (kW/yr)*	Natural gas savings (MBtu/yr)	Water savings (gals/yr)	Other energy savings (MBtu/yr)	Total energy & water cost savings Year# ($/yr)	Other energy related O&M cost savings, Year# ($/yr)	Total cost savings, Year# ($/yr)
Total Savings									
Year # guaranteed cost savings: $									

Notes:
MBtu= 10^6 Btu
*Annual electric demand savings (kW/yr) is the sum of the monthly demand savings
If energy is reported in units other than MBtu, provide conversion factor to MBtu for link to delivery order schedules.
Guaranteed cost savings for project are defined in cost schedule DO-1 in delivery order.
The proposed savings for each ECM are included in schedule DO-4 in the delivery order.

Table 2. Verified Savings for Performance Year #

(Include all applicable fuels/ commodities, e.g., electric energy, electric demand, natural gas, fuel oil, coal, water, etc.)

ECM	Total energy savings (MBtu/yr)	Electric energy savings (kWh/yr)	Electric demand savings (kW/yr)*	Natural gas savings (MBtu/yr)	Water savings (gals/yr)	Other energy savings (MBtu/yr)	Total energy & water cost savings Year# ($/yr)	Other energy related O&M cost savings, Year# ($/yr)	Total cost savings, Year# ($/yr)
Total Savings									
Year # guaranteed cost savings: $									

Notes:
MBtu= 10^6 Btu
*Annual electric demand savings (kW/yr) is the sum of the monthly demand savings
If energy is reported in units other than MBtu, provide conversion factor to MBtu for link to delivery order schedules.

1.4 Savings Adjustments

- Provide summary of any energy and/or cost savings adjustments required.

1.5 Performance and O&M Issues

- Note impact of operating deficiencies or enhancements on generation of savings.
- Note impact of maintenance deficiencies on generation of savings.

1.6 Energy, Water, and O&M Rate Data

1.6.1 Detail energy and water rates used to calculate cost savings for this period.
1.6.2 Provide performance period rate adjustment factors for energy, water and O&M cost savings, if used.
1.6.3 Report actual energy and water rates at site for same period (optional).

1.7 Verified Savings to Date

- Summarize information in Table 3.

Table 3. Verified Savings for Performance Period To Date

(Include all applicable fuels/ commodities, e.g., electric energy, electric demand, natural gas, fuel oil, coal, water, etc.)

Year #	Total energy saving (MBtu/ yr)	Electric energy savings kWh/yr	Electric demand savings (kW/yr)*	Natural gas savings MBtu/yr	Water savings (gals/yr)	Other energy savings MBtu/yr	Total energy & water cost saving ($/yr)	Other energy related O&M cost savings, ($/yr)	Total cost saving ($/yr)	Guaranteed cost savings for year
Total Savings										

Notes:
MBtu= 10^6 Btu
*Annual electric demand savings (kW/yr) is the sum of the monthly demand savings
If energy is reported in units other than MBtu, provide conversion factor to MBtu for link to delivery order schedules.

2. Details for ECM (name/#)

- Develop section for each ECM

2.1 Overview of ECM, M&V Plan, and Savings Calculation for ECM

2.1.1 Summarize the scope of work, location, and how cost savings are generated.
- Describe source of all savings including energy, water, O&M, and other (if applicable).

2.1.2 Discuss any changes in scope/ results recorded in post-installation M&V report.

2.1.3 State M&V guideline and option used.

2.1.4 Provide an overview of M&V activities for ECM.
- Explain the intent of M&V plan, including what is being verified.

2.1.5 Provide an overview of savings calculation methods for ECM.
- Provide a general description of analysis methods used for savings calculations.

2.2 M&V Activities Conducted on this Period

- Detail measurements, monitoring, and inspections conducted this reporting period in accordance with M&V plan.

2.2.1 Measurement equipment used.

2.2.2 Equipment calibration documentation.

2.2.3 Dates/times of data collection or inspections, names of personnel, and documentation of government witnessing.

2.2.4 Details to confirm adherence to sampling plan.

2.2.5 Include all measured values for this period. Include periods of monitoring and durations and frequency of measurements. (Use appendix and electronic format as necessary). Include description of data format (headings, units, etc.).

2.2.6 Describe how performance criteria have been met.

2.2.7 Note impact of performance deficiencies or enhancements on generation of savings.

2.3 Verified Savings Calculations and Methodology

2.3.1 Provide detailed description of analysis methodology used.
- Describe any data manipulation or analysis that was conducted prior to applying savings calculations).

2.3.2 Detail all assumptions and sources of data, including all stipulated values used in calculations.

2.3.3 Include equations and technical details of all calculations made. (Use appendix and electronic format as necessary). Include description of data format (headings, units, etc.).

2.3.4 Details of any baseline or savings adjustments made.

2.3.5 Detail energy and water rates used to calculate cost savings.
- Provide performance period energy & water rate adjustment factors, if used.
- Report actual energy and water rates at site for same period (optional).

2.3.6 Detail verified savings for this energy conservation measure for performance year.
- Include Table 4.

2.4 Details of O&M and Other Savings (if applicable)

2.4.1 Describe source of savings, if applicable.
- Describe verification activities.
- Provide performance period O&M savings adjustment factors, if applicable.

2.4.2 Describe source of other savings, if applicable.
- Describe verification activities.
- Provide performance period adjustment factors, if applicable.

Table 4. Verified Annual Savings For ECM for Performance Year #
(Include all applicable fuels/ commodities, e.g., electric energy, electric demand, natural gas, fuel oil, coal, water, etc.)

	Total energy use MBtu/yr	**Electric energy use** kWh/yr	**Electric energy cost Year#** ($/yr)	**Electric demand *** (kW/yr)	**Electric demand cost Year#** ($/yr)	**Natural gas** MBtu/yr *	**Natural gas cost Year#** ($/yr)	**Water use** (gals/yr)	**Water cost Year#** ($/yr)	**Other energy use** MBtu/yr	**Other energy cost Year#** ($/yr)	**Other energy related O&M cost Year#** ($/yr)	**Total cost Year #** ($/yr)
Baseline use													
Performance Year# use													
Savings													

Notes:
MBtu= 10^6 Btu
*Annual electric demand savings (kW/yr) is the sum of the monthly demand savings
If energy is reported in units other than MBtu, provide conversion factor to MBtu for link to delivery order schedules.

2.5 O&M and Other Activities

2.5.1 Operating requirements:
- State organization(s) responsible for equipment operations. If appropriate, detail how responsibilities are shared.
- Summarize key operating procedures and any related verification activities.
- Note impact of operating deficiencies or enhancements on generation of savings.

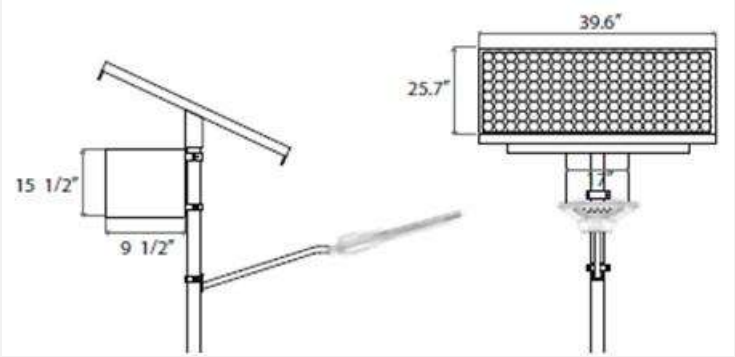
2.5.2 Preventive maintenance requirements:
- State organization(s) responsible for performing maintenance. If appropriate, detail how responsibilities are shared.
- Note impact of maintenance deficiencies on generating savings.

2.5.3 Repair and replacement requirements:
- State organization(s) responsible for repair and replacement. If appropriate, detail how responsibilities are shared.
- Note impact of maintenance deficiencies on generating savings.

Appendix 5: Eco-technologies Technical Specification

I. STREET LIGHTING

GRUPO ECOS: Photovoltaic Street Lighting

Lámpara de LEDs ECOKIT 2018	
Ventajas y Beneficios	
- Completamente autónomo - Más de 10 años de vida útil del sistema (excepto baterías) - Mínimo mantenimiento - Encendido y apagado automáticos - Fácil instalación	
	
Características	
Panel solar	Módulo FV de Silicio Cristalino
Lámpara	Lámpara de LED's ONILED 2018 de 12 VCD, 24 W, 1.9 A
Banco de baterías	Batería de gel ciclo profundo, sellada, libre de mantenimiento
Tempo-controlador	Controlador de carga FV con encendido automático
Autonomía sin recarga	3 días
Temperatura de operación	-25°C hasta +55°C
Color de la luz	Blanco frío 5000°-8000°K
Índice de rendimiento de color	>75
	

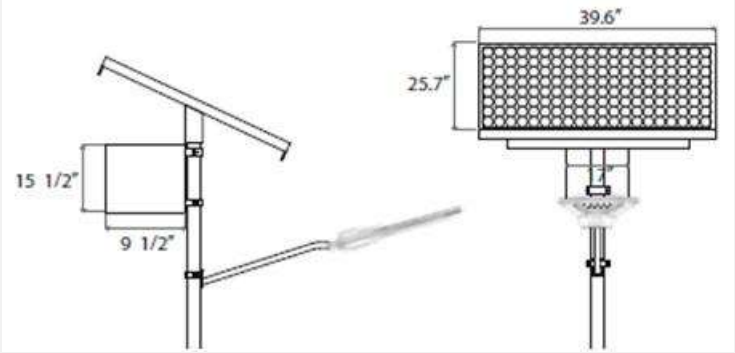
Lámpara de LEDs ECOKIT 2036

Ventajas y Beneficios

- Completamente autónomo
- Más de 10 años de vida útil del sistema (excepto baterías)
- Mínimo mantenimiento
- Encendido y apagado automáticos
- Fácil instalación

Características

Panel solar	Módulo FV de Silicio Cristalino
Lámpara	Lámpara de LED's ONILED 2036 de 24 VCD, 43.2 W, 2.1 A
Banco de baterías	Batería de gel ciclo profundo, sellada, libre de mantenimiento
Tempo-controlador	Controlador solar de carga FV con encendido automático
Autonomía sin recarga	3 días
Temperatura de operación	-25°C hasta +55°C
Color de la luz	Blanco frío 5000°-8000°K
Índice de rendimiento de color	>75



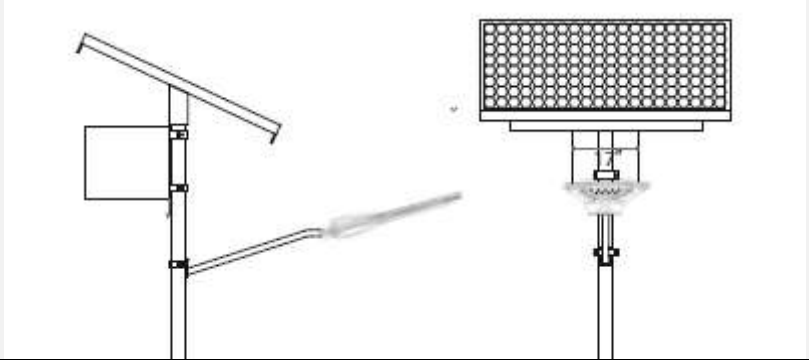
Lámpara de LEDs ECOKIT 2054

Ventajas y Beneficios

- Completamente autónomo
- Más de 10 años de vida útil del sistema (excepto baterías)
- Mínimo mantenimiento
- Encendido y apagado automáticos
- Fácil instalación

Características

Panel solar	Módulo FV de Silicio Cristalino
Lámpara	Lámpara de LED's ONILED 2054 de 24 VCD, 67W, 2.8 A
Banco de baterías	Batería de gel ciclo profundo, sellada, libre de mantenimiento
Tempo-controlador	Controlador solar de carga FV con encendido automático
Autonomía sin recarga	3 días
Temperatura de operación	-25℃ hasta +55℃
Color de la luz	Blanco frío 5000°-8000°K
Índice de rendimiento de color	>75



BIOCONSTRUCCIÓN Y ENERGÍA ALTERNATIVA: Hybrid Street Lighting

Arbotante Híbrido Solar-Eólico

El arbotante híbrido Solar-Eólico para alumbrado público es un sistema de iluminación inteligente, de baja escala y totalmente independiente a la red eléctrica. Está compuesto de módulos solares y una turbina de viento, baterías de ciclo profundo, un controlador y una lámpara LED para exterior.

El arbotante híbrido LED produce y almacena la energía proveniente del viento y el sol. No son necesarios cables al aire o bajo tierra. En el tope del poste, se encuentra la turbina eólica que cultiva la energía del viento de manera silenciosa, sin importar la dirección de choque. Junto con la turbina de viento se encuentra un panel solar en un brazo articulado que está óptimamente posicionado durante el proceso de instalación para obtener la mayor cantidad de irradiación solar. Toda la energía generada se almacena en la batería encontrada en la base del poste. La lámpara es de alta eficiencia LED que es tan brillosa y con la misma intensidad que una tradicional lámpara de vapor de sodio.

Características del Arbotante Híbrido Solar-Eólico

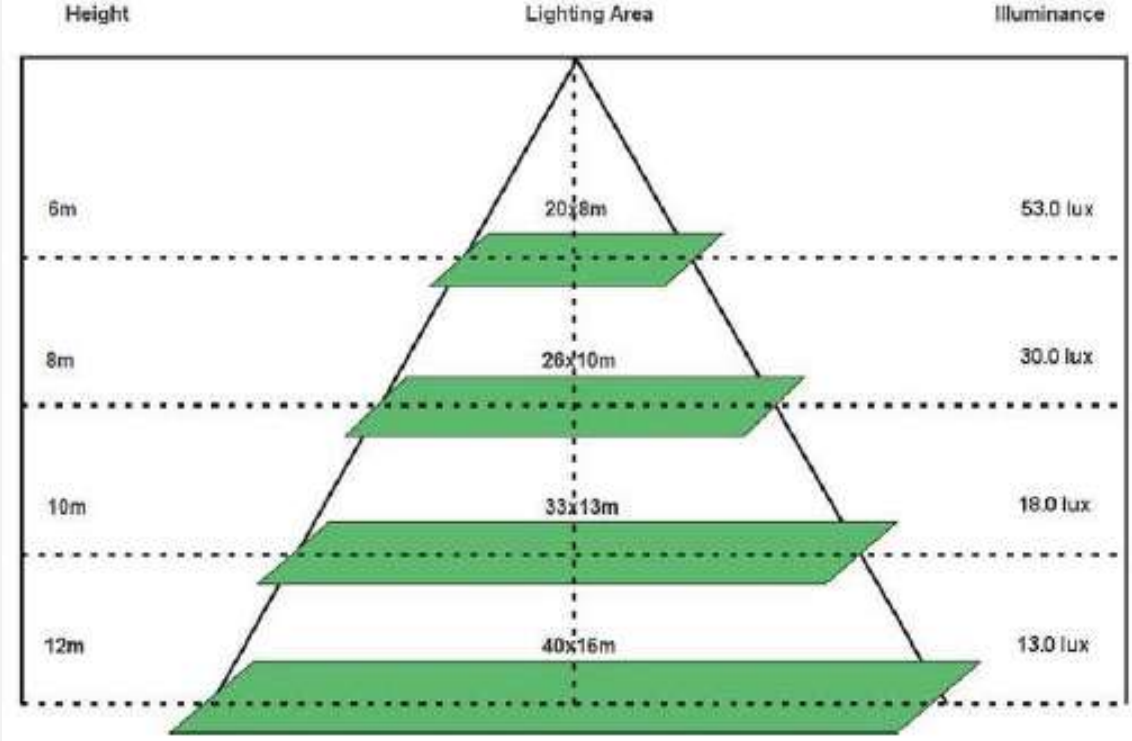
Arbotante Híbrido LED	SW120W, 24 VDC
Panel Solar	150 W policristalino (2)
Turbina de viento	600 W 24V
Batería	260 Ah, 12 V (2)
Controlador	600 W, 24 V, Controlador solar
Poste	6 m alto, acero galvanizdo
Período de funcionamiento	12 h/día, 3 días
Resistencia del viento	129 km/h
Aprovechamiento de energía diaria supuesta	3 horas

Características fotométricas de la lámpara LED

Factor de potencia	>.9
Voltaje de operación	24 VDC
Potencia lámpara LED	112 W
Eficiencia Luminosa LED	>80 lm/W
Flujo luminoso incial	10,000 lm
Flujo de la lámpara	8,400 lm
Área iluminada efectiva (6 m)	20m x 8m
Temperatura de color	Blanco Puro: 5,000-7,000; Blanco cálido: 3,000-4,000
Índice de color (CRI)	Ra>75
Vida de la lámpara	50,000 h

Características físicas del producto

Descripción	Peso (kg)	Dimensiones (mm)
Turbina eólica	27.5	1500 x 520 x 305
Controlador	1	1500 x 520 x 305
Panel fotovoltaico	30	1620 x 845 x 150
Lámpara LED 120 W	26	770 x 414 x 222
Batería	130	610 x 320 x 340


Height
Lighting Area
Illuminance
6m
20x8m
53.0 lux
8m
26x10m
30.0 lux
10m
33x13m
18.0 lux
12m
40x16m
13.0 lux

II. PHOTOVOLTAIC PANELS

BIOCONSTRUCCION Y ENERGIA ALTERNATIVA: Photovoltaic Panels

Xtp6_60 Photovoltaic Panel

Features

High module conversion efficiency
(Up to 14.97 %), through superior cell technology and religious quality control.

Positive tolerance
Guaranteed positive tolerance from 0 to 4%.

Splendid appearance
Meticulous systemized appearance control meeting the highest quality regulatory standards.

Low PID rate
Minimizing potential induced declaration rate with high glass transmission, low interconnected transmission loss and high EVA absorption rate.

Smart auto-recognition of weak light performance.
Smart light auto-recognition under the condition of low irradiance and hazy light (mornings, evenings and cloudy days)

Steady resistance to strong hailstone, wind and snow loads.
Special frame construction certified to ensure high wind loads (2400 Pascal) and hailstone, snow loads (5400 Pascal)

Shinetime sorting standards.
All Shinetime modules sorted and packaged by power reducing mismatch losses of up to 3%.

Certified manufacturing facility.
Manufacturing facility certified by TÜV Rheinland to ISO 9001:2008, ISO14001:2004.

Warranty

5 years warranty on 95% of nominal power output.
12 years warranty on 90% of nominal power output.
25 years warranty on 80% of nominal power output.
5 years material and workmanship warranty.

Packing Configuration

Module Size (mm)	1650*992*50
Packing Size (mm)	**Packing Type**
1690*1010*110	2 Pcs/Ctn, 17 Ctns/Pallet, 204 Pcs/20'GP
	2 Pcs/Ctn, 17 Ctns/Pallet, 442 Pcs/40'GP
1690*1030*860	15 Pcs/Ctn, 390 Pcs/40'GP
1690*1030*1120	20 Pcs/Ctn, 520 Pcs/40'HQ

Certifications and standards:
IEC 61215, IEC 61730, conformity to CE.

Electrical Specifications

Electrical Specifications at STC (1000w/m², AM1.5, cell temperature 25℃)

Type		XTP6-60-220	XTP6-60-225	XTP6-60-230	XTP6-60-235	XTP6-60-240	XTP6-60-245
Max. Power	P_{MAX}(Wp)	220	225	230	235	240	245
Max.Power Voltage	U_{MPP}(V)	29.8	29.9	30.0	30.1	30.2	30.3
Max.Power Current	I_{MPP}(A)	7.38	7.53	7.67	7.81	7.95	8.09
Open-Circuit Voltage	V_{OC}(V)	36.0	36.1	36.2	36.3	36.4	36.5
Short-Circuit Current	I_{SC}(A)	8.11	8.22	8.34	8.46	8.56	8.64
Cell Efficiency	(%)	≥15.54	≥15.89	≥16.24	≥16.60	≥16.95	≥17.30
Module Efficiency	(%)	≥13.44	≥13.75	≥14.05	≥14.36	≥14.66	≥14.97
FF	(%)	75.35	75.82	76.18	76.52	77.03	77.69

Mechanical Properties

Frame	Aluminium anodized, screwed design
Dimensions	1650*992*50 mm (156*156 mm cell)
Weight	19.5 kg
Front Cover	3.2 mm ultra clear, low iron tempered glass, with high light transmittance.
Backside Cover	TPT
Cells per Module	60 pcs
Cell Type	Polycrystalline 156*156mm

Thermal Characteristics

Norminal Operating Cell Temp. (NOCT)	47℃(±2℃)
Temp. Coefficient Voltage (Voc)	-0.35%/℃
Temp. Coefficient Current (Isc)	+0.04%/℃
Temp. Coefficient Power (Pm)	-0.48%/℃

System Integration

Class of Usage (IEC 61730)	A
Fire Rating (IEC 61730)	C
Tolerance Range (%)	+4%
Max. Series Fuse	15 A
Cable (TÜV Checked)	2 * 900 mm, 4mm²
Type of Connector (TÜV Checked)	MC4 Compatible
Junction Box (TÜV Checked)	IP 67, 6 Bypass Diodes
Allowable Hail Load	242 steel ball fallen down from 1m height
Max. Systems Voltage (DC)	1000 V (IEC)

860 Appendix 6: Materials and Finishes Technical Specifications

III. PERMEABLE PAVING

ECKO: Concreto Permeable Ecológico

EKECO

SPECIFICATIONS

TECHNICAL CHART PERMEABLE ADDITIVE
EKECO®

ADDITIVE BASE:	Different types of polymers.	
CONCRETE AGGREGATES:	Any source stone or metal, with clean heavy-duty and particle size	
	from 6 to 18 mm	
CHARACTERISTICS:	a) Resistance to compression 150 to 300 kg/cm2	
	b) Resistance to bending 25 to 55 kg/cm2	
	c) Weight volumetric 1,700 kg/m3 (average)	
	d) Permeability 100%	
FINISHED PRODUCT:	Prepped on site or precast pieces (the cobblestones can be 6-10 cm thick). The mixture can be made on site or at the plant and it can be "stamped"	
NOT AFFECTED BY:	Aliphatic hydrocarbons	Alcohols
	Aromatic hydrocarbons	Vegetable oils
	Chlorinated solvents	Mineral oils
	MIBK (methyl isobutyl ketone)	UV rays
	MEK (methyl ethyl ketone))	Salinity
	Ethyl acetate	Alkali
	Isophorone	

RESISTANCE IN DIFFERENT APPLICATIONS

Pedestrian Sidewalks
6cm, con fc = 200 kg/cm²

Parking Lots
6cm, con fc = 250 kg/cm²

Low traffic roads
8cm con fc = 250 kg/cm²

High traffic roads
8 a 10cm con fc = 250 kg/cm²

Cargo Areas
12 a 15cm con fc = 250 kg/cm²

WATER RECOVERY ECOLOGICAL SYSTEMS

EKECO

LAB TESTS BY ATEC

Report Date: 7-Nov-2009

DATA OF ESPECIMEN				
	Diameter (cm.)	7.60		7.60
	Section (cm².)	45.36		45.36
	Casting Date	30.10.09		30.10.09
	Breakdown Date	06.11.09		06.11.09
	Days	7		7
	Breakdown load (kgs.)	10,400		10,000
	Resistance (k/cm².)	229.3		220.4

Report Date: 14-Nov-2009

DATA OF ESPECIMEN				
	Diameter (cm.)	7.60		7.60
	Section (cm².)	45.36		45.36
	Casting Date	30.10.09		30.10.09
	Breakdown Date	13.11.09		13.11.09
	Days	14		14
	Breakdown load (kgs.)	12,800		12,600
	Resistance (k/cm².)	282.2		277.8

Report Date: 29-Nov-2009

DATA OF ESPECIMEN				
	Diameter (cm.)	7.60		7.60
	Section (cm².)	45.36		45.36
	Casting Date	30.10.09		30.10.09
	Breakdown Date	27.11.09		27.11.09
	Days	28		28
	Breakdown load (kgs.)	13,400		13,200
	Resistance (k/cm².)	295.4		291.0

WATER RECOVERY ECOLOGICAL SYSTEMS

AESTHETIC ADVANTAGES

This system allows an endless number of aesthetic advantages, while keeping its properties of compression, resistance, flexibility and durability.

COLORS:

Gray, in its natural form, or can be dyed with any color.

TEXTURES:

Can work with precast cobblestone pieces (the cobblestones can be 6-10 cm thick).

It also works with other textured aggregates such as: marble, silica, and almost any decorative stone.

IT CAN BE "STAMPED" AS WELL

EKECO

WATER RECOVERY ECOLOGICAL SYSTEMS

EKECO

CONSTRUCTION SYSTEM

Permeable pavements are built following a procedure different to that of traditional floors; they are built with stone aggregates which must be included in the conbined base.

- Open box 40 cm deep.
- Manual compaction of the natural terrain.
- Open absorption wells of 1.0 x 1.0 x 1.0 m. One per each 100 m2.
- Filling of ballast (stones 4 "-8"). This filing is applied in wells and throughout the whole area.
- Compacting of the filing by mechanical means. The thickness of the filing after compacting will be 25 cm.
- Gravel filing of 3/4 "..
- Compacting of the filing by mechanical means. This padding thickness will be of 5 cm.

Bases must be free of fine materials such as sand, since these would dissolve and be swept away by the water, which could cause breakage in the finish, possibly forming potholes.

As an example of a typical procedure we present the following example proposed for a high traffic city with a rainfall such as that of a street in Mexico City:

1-Ecological permeable concrete garrison

2-Ecological Permeable concrete carpet

3-Gravel base ¾

4-Ballast Sub-Base

5-Natural terrain

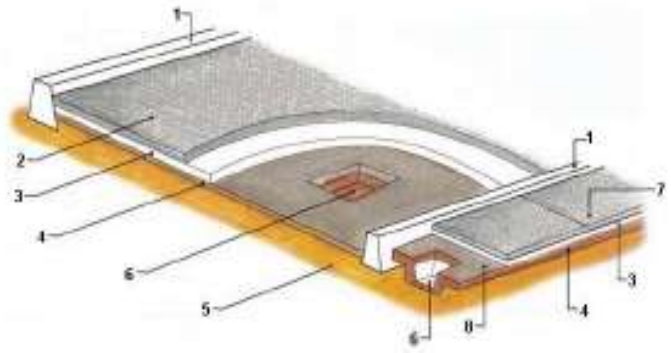
6-Absorption well

7-Ecological permeable concrete sidewalk

8-Compacted terrain

Regarding wells referred to in the preceding example, we must note the following:

- *Number of wells depends of the permeability of the floors .*
- *Form is not important. What matters is that the deeper they are, the better they will work.*
- *The purpose of the wells is to create higher hydrostatic loads.*



HERKO: Concreto Permeable Verdecreto

INFORMACIÓN TÉCNICA	
Descripción: Se trata de un pavimento 100% permeable de concreto. Es producto de la mezcla de concreto tradicional sin arena y el aditivo VERDECRETO, con lo que se obtiene una mezcla muy seca, fácil de colar que a fraguar deja una carpeta de aspecto granular, muy porosa y con una permeabilidad del 100% a los líquidos. Se trata de una tecnología 100% desarrollada en México, patentada, que se exporta a varios países desde hace 9 años.	
Ventajas: Es el único pavimento ecológico, 100% sano al medio ambiente ya que permite la libre infiltración del agua de lluvia al subsuelo sin que se provoquen charcos, baches o deformaciones de la carpeta debido a un innovador método de construcción de sus bases con gravas vibro compactadas.	
Sistema Constructivo: Consistente en un grupo de pozos de absorción excavados sobre el terreno compactado, rellenos de boleos en diámetros de 3 a 4 pulg. Y dos capas de agregados pétreos en diámetros de 1.5" y ¾" con espesores variables, vibro compactadas y niveladas. Sobre estas bases se cuela la carpeta final de pavimento permeable VERDECRETO, se cubre con plástico durante 5 días para evitar la rápida deshidratación, se cortan juntas frías y se aplica el colorante de acabado final.	
Producto:	Concreto permeable VERDECRETO
Usos:	Pavimentos de calles y carreteras, banquetas, guarniciones
Composición:	Mezcla de cemento, grava de 3/8", agua y aditivo VERDECRETO en proporciones según el manual de instalación
Composición del aditivo:	Mezcla de polímeros modificados, no es inflamable ni venenoso
Agregados:	Cualquier tipo de agregado pétreo o metálico limpio , de alta resistencia y en granulometría entre 6 y 18 mm
Características:	Resistencia a la compresión200 a 250 kg/cm2 Modulo de ruptura 42 kgs Resistencia a la tensión 30 a 50 kg/cm2 Peso volumétrico1,700 kg/ m3 (promedio) Permeabilidad 100 %
Presentación del aditivo:	Liquido de consistencia cremosa de color café claro y olor característico. Se entrega en cubetas de 19 lts o tambores de 200 lts.
Producto instalado:	Carpeta de color gris de aspecto granular colada en grandes áreas y cortada con disco en juntas frías o en forma de adoquines pre fabricados en distintas formas y tamaños.
Colores:	Al natural es gris tono cemento o se pueden mezclar con colorantes para cemento y obtener tonos artificiales. Se puede pintar con un impregnante especial que se fabrica sobre pedido según el tono solicitado.
Ventajas:	Menor tiempo de instalación Limpieza de obra al no dejar residuos Se evitan los drenajes pluviales Se eliminan los charcos No hay acua planeo de los automóviles en lluvia Es un piso anti derrapante
Usos más comunes:	Avenidas Calles vehiculares de transito pesado o ligero Estacionamientos Andadores peatonales Banquetas o guarniciones Muros de contención

CONCRETO ECOLÓGICO DE MÉXICO S.A. DE C.V.: Hidrocreto

INFORMACIÓN TÉCNICA	
Descripción:	El material, que es similar al concreto hidráulico común, se fabrica sin materiales finos como la arena, la cual es sustituida por el aditivo HIDROCRETO® (en su primera etapa fue conocido como ECOCRETO®) el cual reacciona con el cemento, potencializándolo y provocando un rápido aumento de su resistencia durante los primeros minutos del fraguado. El resultado es una mezcla porosa, muy maleable, fácil de usar y colar, de muy alta resistencia a la compresión(más de 250 kg/cm2) y una extraordinaria resistencia a la flexión (hasta de 60 kg/cm2).
Ventajas:	Todas las superficies son 100 % permeables Reduce en forma notable la temperatura de las superficies. Reduce en forma notable el ruido provocado por la circulación vehicular. Permite la reducción o incluso eliminación los drenajes pluviales. Adquiere sus características de resistencia entre 24 y 72 horas. Resistencias a la compresión hasta de 300 kg/cm2. Resistencia a la flexión de 40 kg/cm2. Aplicación del aditivo desde la planta de concreto o control del fraguado hecho en revolvedora.

Ejemplos de Aplicación:

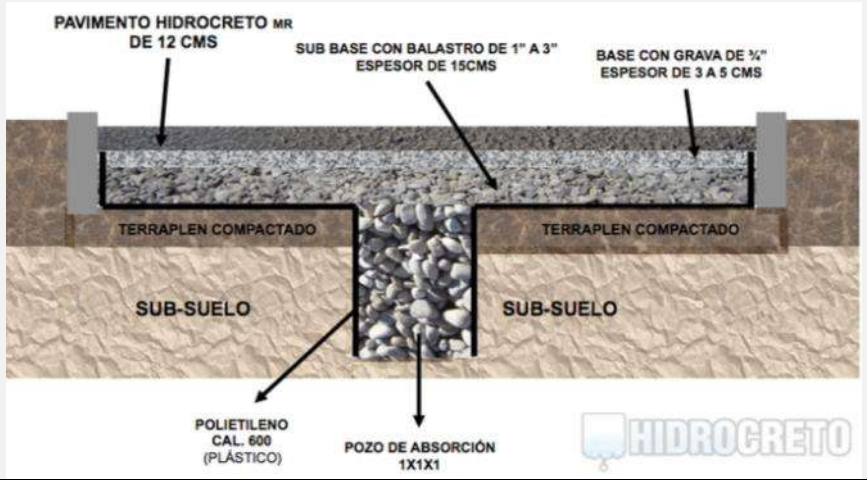
Procter & Gamble Planta Talismán (patio de maniobras)

Bacardi y Cia, Tultitlán, Edo. de México (patio de maniobras)

Schnyder Electric, planta Tlaxcala (estacionamiento)

Fraccionamiento Dos Bocas, Veracruz (vialidades)

Croquis del Sistema Constructivo:



Especificaciones Técnicas

Resultados obtenidos bajo DIT No.184/11 del organismo nacional de normalización y certificación de la construcción y la edificación (ONNCCE)

ESPECIFICACIONES	VALORES OBTENIDOS	REFERENCIA
Permeabilidad	8 L /min	La prueba de permeabilidad, consiste en suministrar un flujo continuo de agua que simule un haz de lluvia a un espécimen de prueba de área de 0,0625 m2, con un espesor de 7 cm, en donde se mide la cantidad de agua que pasa por la pieza por minuto.
Compresión simple a 7 días	200 kg/cm2	NMX-C-083-ONNCCE-2002
Compresión simple a 14 días	249.6 kg/cm2	NMX-C-083-ONNCCE-2002
Compresión simple a 28 días	291.3 kg/cm2	NMX-C-083-ONNCCE-2002
Modulo de ruptura a 7 días	31.9 kg/cm2	ASTM C 293
Modulo de ruptura a 14 días	38.5 kg/cm2	ASTM C 293
Modulo de ruptura a 28 días	43.1 kg/cm2	ASTM C 293

Componentes

El HIDROCRETO, está compuesto por los siguientes elementos:

COMPONENTE
Agregado pétreo de ½" a ¼"
Cemento CPC 40R
Aditivo para concreto permeable HIDROCRETO
Agua

Información Global

Resultados obtenidos bajo DIT No.184/11 del organismo nacional de normalización y certificación de la construcción y la edificación SC (ONNCCE)

Resistencia a la compresión	291.3 kg/cm2
Resistencia a la flexión	43.1 kg/m2
Permeabilidad	100 %
Revenimiento	0.0 cm
Hidrocarburos alifáticos	Alcoholes
Hidrocarburos aromáticos	Aceites vegetales
Solventes clorados	Aceites minerales
MIBK (metil isobutil cetona)	Resistente a los rayos
MEK (metil etil cetona)	ultravioleta
Acetato de Etilio	Resistente a la salinidad
Isoforona	Resistente a álcalis

Espesores recomendados

Uso	Espesor
Vialidades de tráfico pesado	15 cm
Areas de carga, patios de maniobras	15 cm
Vialidades de tráfico medio	12 cm
Vialidades de tráfico ligero	10 cm
Estacionamiento vehicular ligero	8 cm
Andadores de uso peatonal, banquetas, explanadas	6 cm
Ciclopistas	6 cm

CEMEX: Concreto Sin Finos

SF
SIN FINOS

CONCRETO PROFESIONAL[MX]
SIN FINOS

LA RESPUESTA INTELIGENTE A TUS NECESIDADES

El Concreto Profesional[MX] Sin Finos, es la mejor solución para pavimentar vialidades y andadores peatonales con tránsito ligero.
Este concreto se desarrollo especialmente como una posible solución para la recolección y captación pluvial.

PRODUCTOS ESPECIALES
PE
TECNOLOGÍA DE LA CONSTRUCCIÓN

FT-MX-CSF-V1.0

1. Andadores para conjuntos habitacionales. 2. Alta capacidad de filtración

LA RESPUESTA PERMEABLE A TUS NECESIDADES

O2 Footprint

USOS

- Estacionamientos privados
- Calles con tránsito ligero
- Banquetas, pasillos y andadores
- Patios
- Plazas, parques y explanadas
- Canchas deportivas
- Ciclopistas
- Zonas contiguas a albercas

VENTAJAS

- Puede ser ofertado como sistema integral incluyendo la colocación del mismo, asegurando un óptimo desempeño y funcionamiento
- No requiere de agregados especiales, puede ser producido en cualquier parte del país
- Puede ser diseñado con diferentes colores, de acuerdo a las necesidades particulares de cada cliente
- Evita la concentración de calor
- Este concreto cuenta con características sustentables*

DATOS TÉCNICOS

Concreto Fresco:

- Revenimiento menor a 4 cm
- Masa Unitaria de 1,900 a 2,100 kg/m³
  Tiempo de fraguado inicial de 2 a 6 horas

Concreto Endurecido:

- Resistencia a la compresión de 100 a 250 kg/cm²(1)
- Módulo de ruptura desde 24 hasta 32 kg/cm²(1)
- Pérdida a la abrasión menor a 40g (ASTM C 944)

(1) La resistencia a compresión y módulo de ruptura varían dependiendo el tipo de elemento.

*HUELLA ECOLÓGICA PE's CEMEX

CEMEX CONCRETOS

IV. BUILDING MATERIALS
BLOCK HEBEL

INFORMACIÓN TÉCNICA

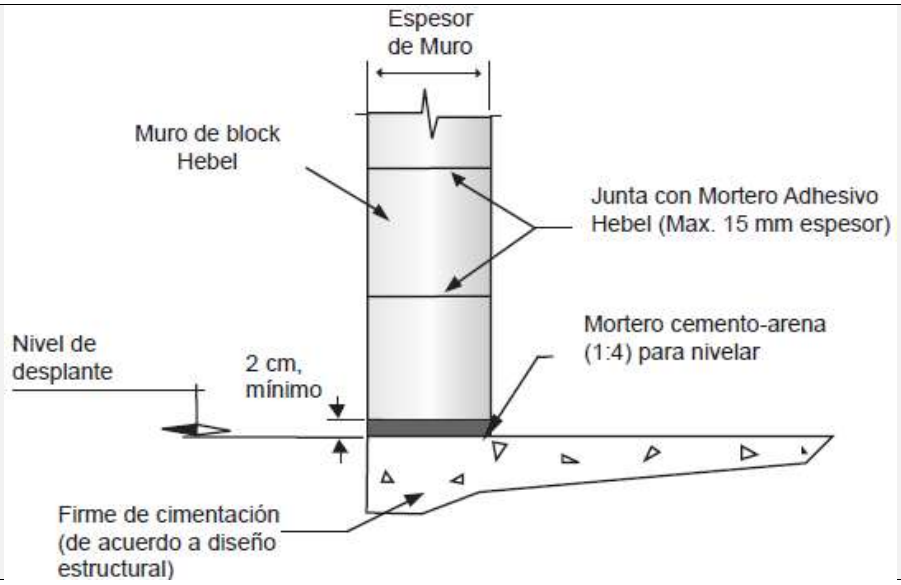
Descripción: Los Blocks Hebel para muros de mampostería son elementos prefabricados de concreto celular en autoclave, (AAC-Autoclaved Aerated Concrete) sólidos, sin refuerzo interior. Se utilizan en la construcción de muros de mampostería tanto cargadores como no cargadores. Entre sus principales ventajas se encuentra la resistencia al fuego hasta por cuatro horas y una alta capacidad de aislamiento térmico de por vida, que refleja importantes ahorros en equipo de aire acondicionado y consumo de energía.

Características	Unidad	Block Hebel AAC-4	Block Hebel AAC-6
Resistencia a la compresión (f'_{aac})	kg/cm²	40.8	61.2
Densidad nominal	kg/m³	500	600
Peso de diseño	kg/m³	600	720
Contracción por secado	mm/m	0.20	0.20
Coeficiente de expansión térmica	1/°K	8×10^{-6}	8×10^{-6}
Conductividad térmica	W/m-k	0.1167	0.1402
Permeabilidad al vapor de agua	ng/Pa.s.m	0.223	0.226
Adsorción de humedad	% en masa % volumen	2.90 1.47	2.87 1.73
Módulo de elasticidad	kg/cm²	20,800	26,500
Módulo de ruptura	kg/cm²	8.1	10.0
Esfuerzo de aplastamiento permisible	kg/cm²	24.5	36.8

Información

Espesor	Peso de Diseño		Peso por Pieza [1]		Pallet (Tarima)		
	AAC-4	AAC-6	AAC-4	AAC-6			
cm	Kg/m²	Kg/m²	Kg/pza	Kg/pza	Pzas.	M²	M³
10.0	60	72	7.32	8.78	180	21.960	2.196
12.5	75	90	9.15	10.98	144	17.568	2.196
15.0	90	108	10.98	13.18	120	14.640	2.196
17.5	105	126	12.81	15.37	96	11.712	2.050
20.0	120	144	14.64	17.57	84	10.248	2.050
25.0	150	180	18.30	21.96	72	8.784	2.196
30.0	180	216	21.96	26.35	60	7.320	2.196

[1]Basado en Peso de Diseño


Espesor
de Muro
Muro de block
Hebel
Junta con Mortero Adhesivo
Hebel (Max. 15 mm espesor)
Mortero cemento-arena
(1:4) para nivelar
Nivel de
desplante
2 cm,
mínimo
Firme de cimentación
(de acuerdo a diseño
estructural)

PANEL LOSA HEBEL

INFORMACIÓN TÉCNICA

Descripción: Los paneles Hebel para losas sobre mampostería son elementos prefabricados de concreto celular curado en autoclave (AAC-Autoclaved Aerated Concrete). Se utilizan en la construcción de losas de entrepiso y azotea que trabajan simplemente apoyados sobre muros de mampostería de block Hebel, block de concreto, ladrillo de barro, elementos de acero, concreto reforzado o madera. Sus principales ventajas son la rapidez de construcción logrando rendimientos de instalación de hasta 220 m^2 por jornada, resistencia al fuego hasta por cuatro horas y una alta capacidad de aislamiento térmico, que refleja importantes ahorros en equipo de aire acondicionado o calefacción y consumo de energía.

Propiedades:

Características	Unidad	Panel Hebel AAC-6
Resistencia a la compresión (f'_{cc})	kg/cm^2	61.2
Densidad nominal	kg/m^3	600
Peso de diseño	kg/m^2	720
Contracción por secado	mm/m	0.20
Coeficiente de expansión térmica	1/°K	8×10^{-6}
Conductividad térmica	W/m-k	0.1402
Permeabilidad al vapor de agua	ng/Pa.s.m	0.226
Absorción de humedad	% en masa % volumen	2.87 1.73
Módulo de elasticidad	kg/cm^2	26,500
Módulo de ruptura	kg/cm^2	10.0
Esfuerzo de aplastamiento permisible	kg/cm^2	36.8

Sobrecargas Máximas de Servicio
Panel Hebel AAC-6
[Kg/m^2]

Longitud [m]	Losa de Azotea				Losa de Entrepiso			
	Espesor de Panel (cm)				Espesor de Panel (cm)			
	10.0	15.0	17.5	20.0	10.0	15.0	17.5	20.0
	Peso de Diseño [Kg/m^2]				Peso de Diseño [Kg/m^2]			
	72.0	108.0	126.0	144.0	72.0	108.0	126.0	144.0
2.0	725	1209	1469	1759	754	1219	1481	1770
2.5	560	917	1103	1310	430	935	1120	1324
3.0	316	736	878	1036	220	761	901	1055
3.5	174	615	727	853	---	625	754	877
4.0	94	529	620	723	---	385	650	751
4.5	---	352	540	627	---	239	480	657
5.0	---	228	462	552	---	---	315	517
5.5	---	145	316	496	---	---	205	354
6.0	---	87	214	366	---	---	---	240

Longitud: Hasta 6.0 mt
Ancho: 61.0 cm
Espesores: 10.0, 12.5, 15.0 17.5, 20.0, 25.0 y 30.0

Clase AAC-6:
Resistencia a la compresión = 61.2 kg/cm^2
Peso de Diseño = 720 kg/m^3

2 Guía de Instalación

2.1 Introducción

Los paneles se entregan a la obra en paquetes de varias piezas flejadas entre sí. Se descargan mediante una grúa o montacargas y se almacenan sobre barrotes o tarimas de madera en una zona plana del terreno.

Cada panel se puede identificar mediante la información que se localiza en un extremo (número de proyecto) y determinar su número de posición en la losa de acuerdo a los dibujos Hebel (ver Fig. 2).

Los paneles trabajan simplemente apoyados sobre elementos cargadores que pueden ser muros de block Hebel, blocks de concreto, vigas de acero, concreto reforzado, madera, etc. En cualquier caso, los paneles se apoyan directamente sobre el elemento cargador. El montaje de los paneles se realiza con grúa, eslingas o tenaza de montaje de acuerdo a cada proyecto en particular.

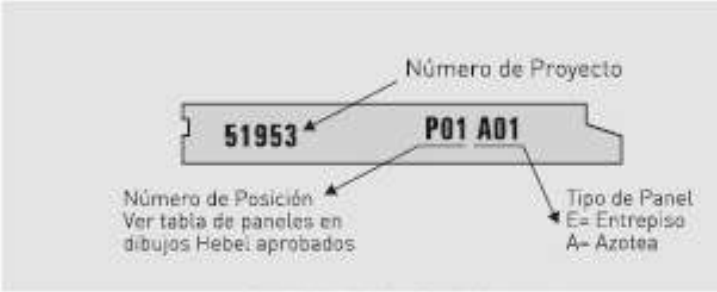


Fig. 2: Identificación de Panel Hebel para losa.

2.2 Actividades previas al montaje de paneles

Verificación física de dimensiones

- Checar el enrase de los muros cargadores. Los enrases que se realicen sobre mampostería Hebel no deberán ser menores a 6 cm de altura, de lo contrario se deberá usar mortero cemento-arena (1:4).

En caso de que el panel se apoye directamente sobre block de concreto, las celdas de la hilada de apoyo se deben rellenar con concreto.

- Checar la nivelación de los elementos de apoyo.

– IMPORTANTE: Revisar las dimensiones del claro interior entre elementos de apoyo para garantizar el apoyo mínimo de los paneles.

Despejar área para descarga y almacenamiento provisional de paneles

- Definir superficies planas para la descarga de los paquetes, buscando localizarse lo más cercano posible a su ubicación final.
- Colocar los paquetes de paneles sobre barrotes o tarimas de madera.
- Proteger el material de la lluvia y lodo.

Revisar la logística de montaje

- Dibujos Hebel aprobados para construcción (última revisión) con despiece e identificación de paneles.
- Plan de montaje de paneles para definir el orden de instalación y logística de almacenamiento.
- Tipo, capacidad y tiempo de grúa a contratar (ver Fig. 3).
- Mano de obra requerida.

Verificación de existencia de herramientas, accesorios, equipo y consumibles recomendados*

Herramienta:

- Martillo de uña o hacha.
- Martillo de goma.
- Cepillo de ixtle.
- Llana lija.
- Serrucho Hebel.
- Escuadra Hebel para cortes.
- Ranurador manual de instalaciones.
- Flechas para ranuración circular.
- Llana metálica, espátula, laina o similar.
- Tiralíneas.
- Cinta métrica (flexómetro).

Accesorios:

- Malla de fibra de vidrio (rollo de 14 cm).
- Estrella separadora de varilla.

Equipo

- Eslingas (2 pza).
- Tenaza T800, T1400 ó Tijera 675.
- Sierra circular con disco de pasta de 8-1/4" diámetro, para corte de metal o pulidor 9" diámetro.
- Grúa de brazo telescópico o similar.
- Taladro 1/2" diámetro de baja RPM.
- Ranurador eléctrico "Router" (opcional).

Material consumible:

- Concreto f'c =200 kg/cm²
- Mortero cemento-arena (1:4).
- Mortero Adhesivo Hebel.
- Mortero Reparador Hebel.
- Acabado tipo estuco o similar para afinar.
- Acero de refuerzo (alambrón, #3, etc).
- Placas de conexión (sólo sobre estructura de acero)
- Colocación de hojas de material compresible (poliestreno) sobre la corona de los muros no cargadores de un espesor de acuerdo a lo especificado en dibujos y ancho similar al del muro. (ver Fig. 17)

Especificación de Tenaza para montaje:

Tenaza Tijera: Para la instalación de paneles con espesores de 10.0 y 12.5 cm y una longitud menor o igual a 3.0 m -Capacidad 675 Kg. - (ver Fig. 4a, 7 y 8).

Tenaza 800 Kg: Para montaje de paneles para losas con espesores de 15.0 y 17.5 cm y longitud menor o igual a 4.0 m. (ver Fig. 4b) - Capacidad 800 Kg.

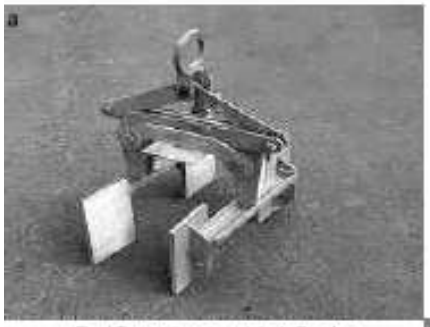


Fig. 4 Tenazas para montaje de Paneles Hebel para Losa.

(a) Tenaza para 675 Kg.
(b) Tenaza 800 Kg.
(c) Tenaza 1400 Kg.

Tenaza 1400 Kg: Para montaje de paneles para losas con espesores igual o mayor a 20.0 cm y una longitud máxima de 6.0 m. (ver Fig. 4c y 11) - Capacidad 1400 Kg.

Fig. 5: Montaje de Panel con eslingas o bandas.

Precaución:
Usar equipo de seguridad: Casco, Lentes, guantes, faja, arnés, cuerda de vida, etc.

- Pintura anticorrosiva (para cortes).
- Mateterial de acabado.

* El listado de materiales es informativo. Los requerimientos reales dependerán de cada proyecto en particular.

Trazo

- Marcar líneas-guía para el montaje de los panel sobre los muros cargadores o elementos de apoyo según las longitudes de apoyo mínimas marcadas en los dibujos Hebel.

Fig. 6: Instalación de Panel de Azotea con banda.

2.3 Procedimiento constructivo

Instalación de Panel Hebel para Losa de 10 y 12.5 cm de espesor.

1. Identificar el paquete de paneles a colocar de acuerdo al orden previamente establecido en logística.

2. Marcar el centro de los paneles.

3. Cortar el fleje de los paquetes con el martillo de uña.

4. Limpiar los bordes macho y hembra con la ayuda de la llana lija y un cincel para eliminar rebabas de material.

Fig. 7: Montaje de panel Hebel mediante tenaza tijera en losas de vivienda de interés social.

Fig. 8: Colocar el seguro y retirar la tenaza.

5. Enganchar la Tenaza Tijera (675 Kg) con estrobo o banda de lona al gancho de la grúa y presentarla en contacto con el panel de tal forma que el centro de la tenaza quede alineado con el centro longitudinal del panel.

6. Indicar al operador de la grúa el izamiento del panel cuando todo lo anterior este listo. Asegurarse de que la parte superior de la tenaza (placa) esté en contacto con el panel y que las placas estriadas laterales cierren uniformemente para sujetar por ambos lados el panel. Para cargar el panel, quite el seguro de la tenaza (desenganchar).

7. De una a dos personas recibirán el panel, guiándolo a su posición final sobre el muro cargador con el lado hembra hacia el punto de inicio. (ver Fig. 7)

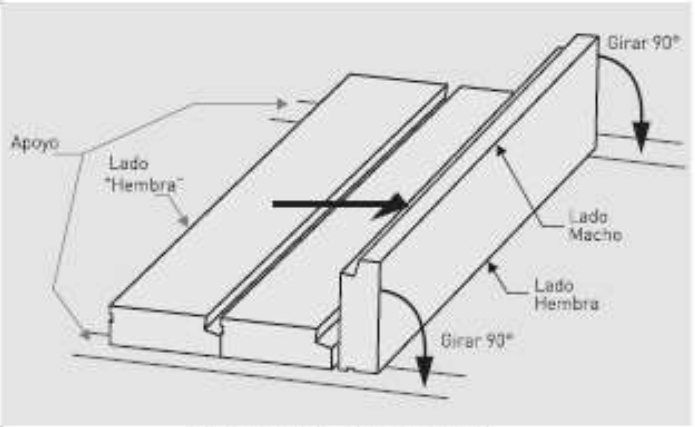


Fig. 9: Dirección de instalación de paneles

Elemento de Apoyo	Longitud mínima de apoyo "l_a" (cm)
Mampostería Hebel	7.0 ó > L_n/80
Concreto	5.0 ó > L_n/80
Madera	5.0 ó > L_n/80
Acero	3.2 ó > L_n/80

Nota: L_n= Claro de diseño, l=Claro interior, l_n=l+L_n

8. Girar manualmente el panel 90°, revisando que cumpla con las longitudes de apoyo (ver Tabla 3).

9. Colocar nuevamente el seguro de la tenaza para permitir su retiro.Una vez colocado el primer panel, se procede de la misma forma con los siguientes (ver Fig. 8 y 9).

10. Al colocar cada panel es posible que quede despegado del adyacente por lo tanto se deben juntar y alinear de forma manual mediante una barra y hasta dejar una junta a hueso (cerrada).

Precauciones:
- Manejar paneles con cuidado para evitar dañarlos.
- El apoyo sobre el muro cargador debe estar lo más uniforme posible para evitar topes entre las juntas de panel.
- Evitar golpes o caídas del panel.
- No permitir el libre tránsito de personal de obra directamente abajo del área donde se instalan los paneles.
- Realizar los resaques, cortes y perforaciones necesarios con anticipación al montaje.

2.4 Procedimiento constructivo

Instalación de Panel Hebel para Losa de 15.0 cm de espesor o mayor.

1. Identificar la posición del panel a colocar de acuerdo al orden elegido para el montaje. El paquete debera estar sobre barrotes de madera.

2. Retirar el fleje del paquete con martillo de uña.

3. Girar el panel 90° (macho hacia arriba), limpiar los bordes laterales y eliminar rebabas de material en el lado hembra (ver Fig. 10).

Fig. 10: Girar los paneles 90° y marcar el centro.

Instalación con eslingas:
Los paneles pueden instalarse directamente con la ayuda de 2 eslingas o bandas de lona colocadas a los tercios de la longitud del panel Hebel (ver Fig. 5). Dejar un espacio temporal entre paneles para el retiro de las bandas, posteriormente juntar los paneles a hueso.

Instalación con tenazas Hebel:
Opcionalmente se puede utilizar la tenaza Hebel para losa (T800 ó T1400) para el montaje de paneles (ver Fig. 4b, 4c y 11).

Procedimiento:
4. Marcar el centro del panel (longitud entre 2).

5. Enganchar la tenaza a la grúa con estrobos o banda de lona y colocarla sobre la marca al centro del panel.

6. Utilizar la(s) polea(s) de la tenaza para ajustarla uniformemente al ancho del panel.

7. La tenaza deberá colocarse sobre el panel sujetando la parte hembra y la parte superior del macho.

8. Colocar las dos cadenas de seguridad. Las cadenas deberán queda holgadas para facilitar retirarlas.

Fig.11: Soltar las cadenas de seguridad de la tenaza antes de llegar a su posición final.

9. Bajar la palanca de seguridad para cargar el panel.

10. Indicar al operador de la grúa el izamiento del panel cuando todo lo anterior esté listo. Izar el panel lentamente, evitando movimientos o giros bruscos.

11. Dos trabajadores deberán guiar el panel y presentarlo cerca de su posición final. Retirar con precaución las cadenas de seguridad (ver Fig. 11).

12. Recibir y guiar el panel para ser colocardo sobre los muros cargadores, respetando la marca previamente trazada, a fin de garantizar el apoyo mínimo indicado en dibujos (ver Fig. 12 y Tabla 3)

13. Girar la polea para aflojar la tenaza y levantar la palanca de seguridad para evitar que la tenaza se cierre.

14. Izar la tenaza y regresarla al punto de partida para la instalación del siguiente panel.

15. Repetir el procedimiento (paso 3 al 14).

Precauciones:

- Evitar golpes y caidas que dañen el panel.
- Girar el panel 90° con precaución y con la ayuda de varios trabajadores (3 mínimo).
- El apoyo sobre el muro cargador debe estar lo más uniforme posible para evitar topes o interferencias con puntas de varillas, restos de mortero, etc.
- Siempre garantizar el apoyo mínimo del panel.

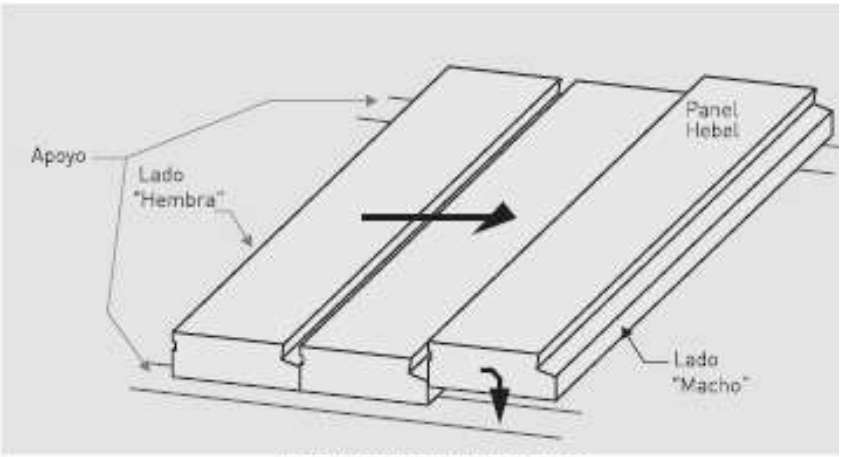


Fig. 12: Dirección de instalación de paneles.

- No permitir el libre tránsito de personal de obra directamente abajo del área donde se instalan los paneles. Siempre utilizar equipo de seguridad.
- Realizar los resaques, cortes y perforaciones necesarios con anticipación al montaje.

2.5 Armado y vaciado de las juntas longitudinales y anillo perimetral

Una vez terminado el montaje de paneles se procede a colocar el armado de las juntas longitudinales y el armado y cimbra del anillo perimetral de acuerdo a diámetros

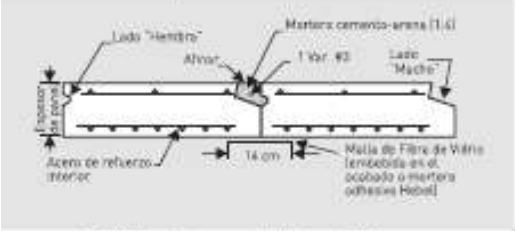


Fig. 13: Sección transversal de Losas Hebel.

y especificaciones señaladas en dibujos de construcción.

Para las juntas longitudinales entre paneles (juntas de cortantel se requiere un armado con 1 Var. #3 calzada con estrellas separadoras espaciadas a los tercios de cada panel y un colado de mortero cemento-arena proporción 1:4 y revenimiento entre 8 y 10 cm. Humedecer la junta previo al vaciado del mortero.

El anillo perimetral requieren un armado de 2 Var. #3 a lo largo y Var. #2 @ 40 cm (separador diagonal) y un colado de concreto f'c=200 kg/cm². Se recomienda utilizar un agregado de tamaño máximo de 10 mm (gravilla) y un revenimiento entre 10 y 12 cm. Las superficies donde se hará el colado se deben humedecer previo a la colocación del concreto, éste se coloca y se compacta manualmente.

En ambos casos, juntas y anillos, las superficies se deben rebosar para lograr una acabado superior de losa lo más uniforme posible. Una vez que las juntas y anillo hayan secado (24 hrs posterior al colado) se deberán afinar para mejorar su impermeabilidad (ver Fig. 13 y 14).

recubrimiento anticorrosivo del refuerzo de los paneles.

- No se pueden realizar ranuras por la parte superior del panel en el sentido transversal.
- Para tuberías de diámetro ≤ 25 mm, se puede alojar a través de las juntas longitudinales por la parte superior del panel.
- Para tuberías de diámetro > 25 mm, se puede ensanchar la junta longitudinal entre paneles por la parte inferior o superior de los mismos.

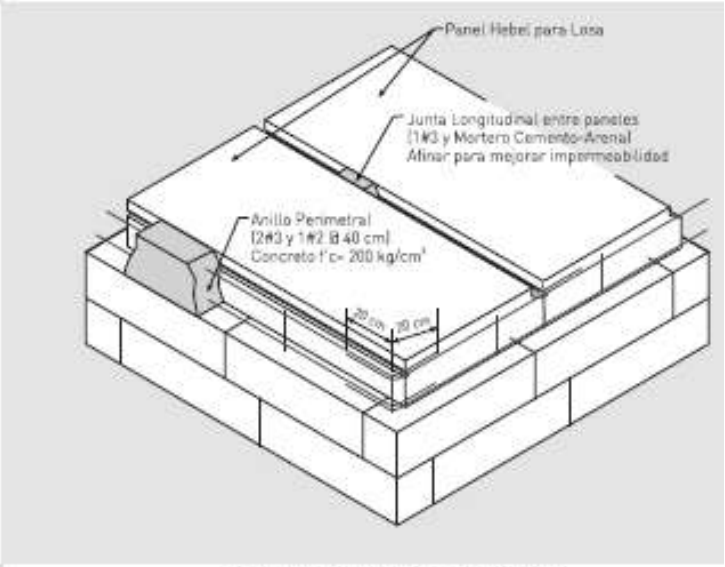


Fig. 14: Juntas longitudinales y anillo perimetral.

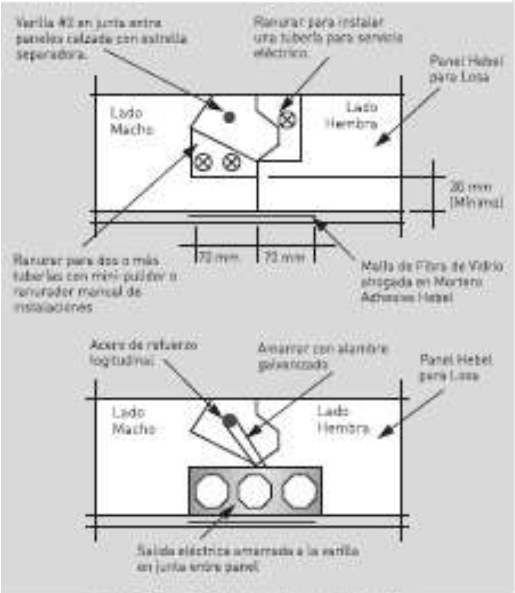


Fig. 15: Colocación de tuberías y salidas en losa.

2.6 Instalaciones de servicios

Huecos en losa

Los huecos en losas Hebel para ductos de aire acondicionado, escaleras, domos, etc., se pueden solucionar de diferentes maneras. Para mayor información consultar con el Departamento Técnico de Xella Mexicana (ver Fig. 19).

Instalaciones eléctricas

- Se puede alojar tuberías de diámetro ≤ 13 mm, a través de ranuras en las juntas por la parte inferior del panel en sentido longitudinal y en sentido transversal al panel, cuidando de no cortar varillas o dañar el
- Las cajas octagonales para focos se deben fijar al panel con 2 ó 3 clavos piramidales Hebel en forma inclinada o mediante amarre con alambre galvanizado desde la varilla de la junta (ver Fig. 15).

Instalaciones hidráulicas y sanitarias

- Para el paso de tuberías de PVC o metálicas se pueden hacer perforaciones hasta de 15.0 cm de diámetro en un solo panel o de 30.0 cm en la junta entre dos paneles. El único requisito para hacer varias perforaciones es que estén acomodadas en línea (ver Fig. 19).

Afectaciones al refuerzo de los paneles

- En los cortes o perforaciones, se permite cortar solamente una varilla del refuerzo longitudinal en la parrilla inferior del panel evitando al mínimo estos casos y respetando las dimensiones e indicaciones ilustradas.

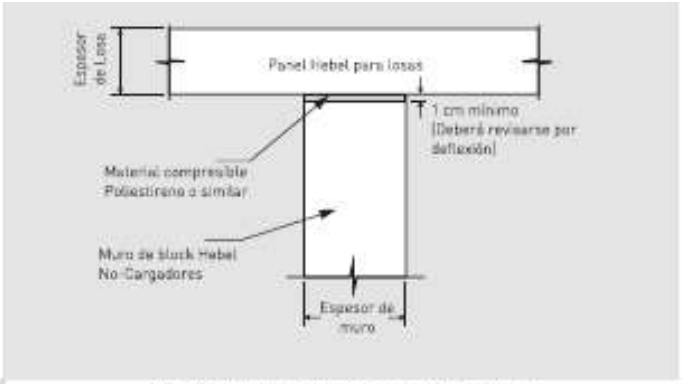


Fig. 17: Aislamiento de muros divisorios (No Cargadores).

Fig. 18: Panel Hebel para Losa de entrepiso.

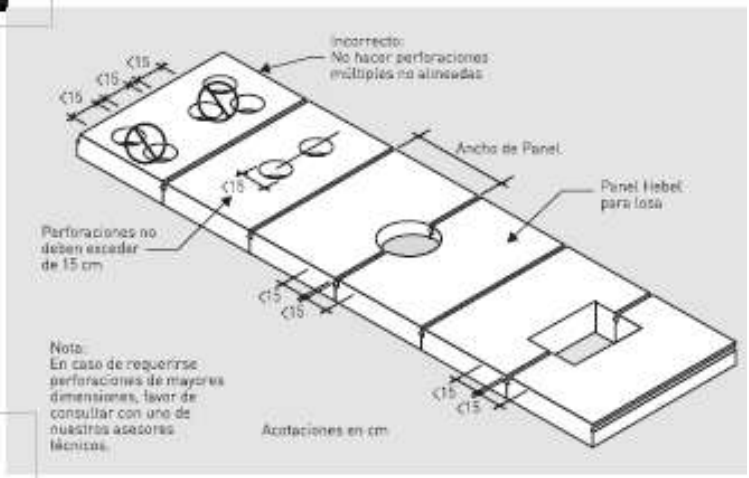


Fig. 19: Dimensiones máximas de perforaciones en panel Hebel para losa.

3 Rendimientos

Concepto	Rendimiento Promedio (Pza/Jor)	Fuerza de Trabajo
Instalación de Panel Hebel para Losa de Vivienda de Interés Social. Longitud ≤ 3.0 y espesor de 10 y 12.5 cm.	96 a 120	1 Of. + 3 Aytes.
Instalación de Panel Hebel para Losa de longitud > 3.0 hasta 4.5 m. Espesor de 15.0, 17.5 y 20.0 cm.	48 a 80	1 Of. + 4 Aytes.
Instalación de Panel Hebel para Losa De longitud > 3.0 hasta 6.0 m. Espesores de 25 y 30 cm.	48 a 64	1 Of. + 5 Aytes.
El rendimiento puede variar de acuerdo a consideraciones particulares de cada proyecto como accesibilidad y tamaño de grúa, cortes del panel, etc.		

Tabla 4: Rendimiento promedio de instalación.

4 Acabado e Impermeabilización

4.1 Malla de Fibra de Vidrio

La malla se coloca en las juntas entre paneles por la parte inferior y embebida en el espesor del acabado o mortero adhesivo Hebel (recomendado) en un ancho de 14 cm (7 cm a cada lado de la junta). En acabados aparentes o con falso plafón por la parte inferior del panel, la malla de fibra de vidrio se omite.

4.2 Acabados en Losa

Por la parte inferior, los paneles Hebel pueden recubrirse con acabados comerciales tales como: estucos, yeso (interiores), pastas acrílicas, etc. Sobre los paneles puede instalarse todo tipo de acabados, como alfombras, pisos cerámicos o de pasta, mármol, duela de madera, etc. y sin necesidad de un empastado previo (excepto pisos vinílicos). Se recomienda utilizar adhesivo de capa gruesa para una mejor nivelación

4.3 Impermeabilización

Las superficies de losa Hebel expuestas a la lluvia deben recibir imperativamente un acabado de impermeabilización adecuado. Se pueden manejar las pendientes de desagüe con los paneles Hebel, de lo contrario, las losas planas deben prepararse con una sobrecapa de mortero ligero dando pendiente hacia los drenes y sobre ésta colocarse el sistema de impermeabilización.

Independientemente del sistema, la impermeabilización se debe extender sobre los pretiles perimetrales. Las coladeras, gárgolas y ventilas deben fijarse y sellarse correctamente para impedir el paso del agua hacia la losa. Se deberán construir chaflanes de mortero cemento-arena en remates de pretil, salidas eléctricas e hidro-sanitarias, bases, así como evitar topes o huecos.

El exito de una impermeabilización depende mayormente de una buena instalación o supervisión que de su costo. Las recomendaciones antes descritas son comunes para cualquier tipo de sistema constructivo.

La amplia variedad de productos disponibles en el mercado puede ser utilizados directamente sobre el Panel Hebel para losa con pendiente pluvial.

Impermeabilizaciones Acrílico-elastoméricas base agua o solventes

Productos:
Thermotek, Acriton, Impac, Acril-Techo, etc.

Procedimiento de instalación:

Limpieza y preparación de la superficie:

Las superficie del Panel Hebel deberá estar seca, limpia de polvo, grasa o suciedad. Se deberá resanar con cemento plástico sobre grietas, áreas críticas o uniones con otros materiales.

Sellador:

Aplicar un sellador base o "primer" de acuerdo a las especificaciones del proveedor del impermeabilizante. Dejar secar siguiendo las recomendaciones del proveedor.

Malla de Refuerzo:
Utilizar membrana de poliéster de alta resistencia, tejida bidireccionalmente para un mejor refuerzo del sistema de impermeabilización.

Juntas entre paneles:

Aplicar una capa de impermeabilizante y malla de refuerzo, únicamente sobre las juntas afinadas entre panel (20 cm de ancho), chaflanes, salidas en losa, etc. Dejar secar según recomendaciones del proveedor del impermeabilizante.

1ra. Capa:

En toda el área de losa, aplicar una primera capa general del producto impermeabilizante y malla de refuerzo en sentido transversal a la juntas entre paneles. Colocar malla de refuerzo en el 100% del área de losa.

2da. Capa:

Aplicar una segunda capa de producto impermeabilizante (sin malla de refuezo) en sentido transversal a la aplicación de la segunda capa. Se deberá dejar secar y libre de tráfico por lo menos 24 hrs. o más preferentemente.

Impermeabilizaciones prefabricadas tipo membranas.

Productos:

Tipo SBS, APP, TPO, marcas Al-Koat, Imperquimia, Morter-Plas (texsa), etc.

Las impermeabilizaciones prefabricadas ofrecen mayores ventajas costo-beneficio sobre otras impermeabilizaciones, entre las principales ventajas se encuentran una mayor resistencia mecánica, elasticidad y flexibilidad, larga duración y menor mantenimiento (ver Fig. 20).

Xella Mexicana recomienda evaluar como una mejor alternativa de impermeabilización el uso de membranas prefabricadas de asfalto modificado SBS (poliéster) o similar.

Fig. 20: Impermeabilización tipo membrana SBS

FOAMULAR RIGID INSULATION

TECHNICAL DATA SHEET

Product Data Sheet

Energy-Saving, Moisture Resistant XPS Insulation

ASTM C578 Type X, 15 psi minimum

Description

Owens Corning™ FOAMULAR® 150 extruded polystyrene (XPS) insulation is a closed cell, moisture-resistant rigid foam board well suited to meet the need for a wide variety of building applications.[3] FOAMULAR® 150 XPS insulation is ideal for many residential and commercial construction applications such as wall furring, perimeter/foundation, cavity wall, pre-cast concrete, crawl spaces, sheathing and other applications[3]. FOAMULAR® 150 XPS insulation is classified as a Type X product when tested in accordance with ASTM C578 and provides a long-term thermal performance of R-5 per inch.

Like all FOAMULAR® XPS products, FOAMULAR® 150 XPS insulation is made with Owens Corning's patented Hydrovac® process technology under strict quality control measures, which makes it highly resistant to moisture and permits the product to retain it's high R-value year after year even after prolonged exposure to moisture, and freeze/thaw cycling.

Key Features

- Excellent long-term stable insulating performance at R-5[1] per inch
- Exceptional moisture resistance, long-term durability
- Limited lifetime warranty[2]—maintains 90% of R-value and covers all ASTM C578 properties
- The only XPS foam to be GREENGUARD Children & Schools Certified℠
- The only XPS foam with certified recycled content—certified by Scientific Certification Systems (SCS) to contain a minimum 20% recycled content
- Will not corrode, rot or support mold growth
- Zero ozone depletion potential with 70% less global warming potential than our previous formula
- Reusable
- Lightweight, durable rigid foam panels are easy to handle and install
- Easy to saw, cut or score
- Versatile applications: sheathing, foundation walls, masonry cavity walls[3]
- Not for use in roofing. For roofing applications, use FOAMULAR® THERMAPINK® Extruded Polystyrene Insulation

Product type

- Minimum compressive strength of 15 psi
- Wide selection of sizes and thicknesses
- Available in square, tongue and groove or scored square edge
- Compliant with building codes and standards

Product Applications

High-performance FOAMULAR® 150 XPS insulation:

- Retards the transmission of water vapor and moisture in masonry walls
- Provides continuous insulation over steel stud framing, in insulated concrete sandwich panel walls, or in masonry unit cavity walls, or when used with non-penetrating, surface mounted furring systems over masonry or concrete walls
- Insulates and retains its properties in below grade perimeter and foundation applications, to complement the insulating sheathing envelope around the building framing
- FOAMULAR® 150 XPS insulation is ideal for below grade applications. Extruded polystyrene (XPS) is resistant to degradation from the components of common soils and will retain its insulating performance characteristics even after prolonged exposure to moisture.

Product Data Sheet

- Provides a weather resistant barrier (when joints are sealed) to enhance the building resistance to air and moisture penetration.

Technical Information

This product is combustible. A protective barrier or thermal barrier is required as specified in the appropriate building code. For additional information, consult MSDS or contact Owens Corning World Headquarters at 1-800-GET-PINK®.

All construction should be evaluated for the necessity to provide vapor retarders. See current ASHRAE Handbook of Fundamentals.

FOAMULAR® 150 XPS Insulation is a non-structural material and must be installed on framing which is independently braced and structurally adequate to meet required construction and service loading conditions.

FOAMULAR® insulation can be exposed to the exterior during normal construction cycles. During that time some fading of color may begin due to UV exposure, and, if exposed for extended periods of time, some degradation or "dusting" of the polystyrene surface may begin. It is best if the product is covered within 60 days to minimize degradation. Once covered, the deterioration stops, and damage is limited to the thin top surface layers of cells. Cells below are generally unharmed and still useful insulation.

Typical Physical Properties[1]

FOAMULAR® 150 Extruded Polystyrene Insulation

Property	Test Method[2]	Value
Thermal Resistance[3], R-Value (180 day) minimum, hr•ft²•°F/Btu (RSI, °C•m²/W)		
@ 75°F (24°C) mean temperature	ASTM C518	
1" Thickness		5.0 (0.88)
1½" Thickness		7.5 (1.32
2" Thickness		10 (1.76)
2½" Thickness		12.5 (2.20)
3" Thickness		15 (2.64)
@ 40°F (4.4°C) mean temperature		
1" Thickness		5.4 (0.95)
1½" Thickness		8.1 (1.43)
2" Thickness		10.8 (1.90)
2½" Thickness		13.5 (2.38)
3" Thickness		16.2 (2.85)
Long Term Thermal Resistance, LTTR-Value[3] minimum hr•ft²•°F/Btu (RSI, °C•m²/W)		
@ 75°F (24°C) mean temperature	CAN/ULC S770-03	
1" Thickness		5.0 (0.88)
1½" Thickness		7.8 (1.37)
2" Thickness		10.6 (1.87)
2½" Thickness		13.4 (2.36)
3" Thickness		16.2 (2.85)
Compressive Strength[4], minimum psi (kPa)	ASTM D1621	15 (103)
Flexural Strength[5], minimum psi (kPa)	ASTM C203	60 (414)
Water Absorption[6], maximum % by volume	ASTM C272	0.10
Water Vapor Permeance[7], maximum perm (ng/Pa•s•m²)	ASTM E96	1.5 (86)
Dimensional Stability, maximum % linear change	ASTM D2126	2.0
Flame Spread[8, 9]	ASTM E84	5
Smoke Developed[8, 9, 10]	ASTM E84	45-175
Oxygen Index[8], minimum % by volume	ASTM D2863	24
Service Temperature, maximum °F (°C)	—	165 (74)
Linear Coefficient of Thermal Expansion, in/in/°F (m/m/°C)	ASTM E228	3.5 x 10⁻⁵ (6.3 x 10⁻⁵)

1. Properties shown are representative values for 1" thick material, unless otherwise specified.
2. Modified as required to meet ASTM C578
3. R means the resistance to heat flow; the higher the value, the greater the insulation power. This insulation must be installed properly to get the marked R-value. Follow the manufacturer's instructions carefully. If a manufacturer's fact sheet is not provided with the material shipment, request this and review it carefully. R-values vary depending on many factors including the mean temperature at which the test is conducted, and the age of the sample at the time of testing. Because rigid foam plastic insulation products are not all aged in accordance with the same standards, it is useful to publish comparison R-value data. The R-value for FOAMULAR® XPS insulation is provided from testing at two mean temperatures, 40°F and 75°F, and from two aging (conditioning) techniques, 180 day real-time aged (as mandated by ASTM C578) and a method of accelerated aging sometimes called "Long Term Thermal Resistance" (LTTR) per CAN/ULC S770-03. The R-value at 180 day real-time age and 75°F mean temperature is commonly used to compare products and is the value printed on the product.
4. Values at yield or 10% deflection, whichever occurs first.
5. Value at yield or 5%, whichever occurs first.
6. Data ranges from 0.00 to value shown due to the level of precision of the test method.
7. Water vapor permeance decreases as thickness increases.
8. These laboratory tests are not intended to describe the hazards presented by this material under actual fire conditions.
9. Data from Underwriters Laboratories Inc.® classified. See Classification Certificate U-197.
10. ASTM E84 is thickness-dependent, therefore a range of values is given.

Product Data Sheet

Product and Packaging Data

FOAMULAR® 150 Extruded Polystyrene Insulation

Material	Packaging
Extruded polystyrene closed cell foam, ASTM C578 Type X, 15 psi minimum	Shipped in poly-wrapped units with individually wrapped or banded bundles.

Thickness (in)	Product Dimensions Thickness (in) x Width (in) x Length (in)	Pallet (Unit) Dimensions (typical) Width (ft) x Length (ft) x Height (ft)	Square feet per Pallet	Board feet per Pallet	Bundles per Pallet	Pieces per Bundle	Pieces per Pallet	Edges
1	1 x 24 x 96	4 x 8 x 8	3,072	3,072	8	24	192	Square Edge, Scored Square Edge, Tongue & Groove
	1 x 24 x 96	4 x 8 x 8	3,072	3,072	8	24	192	
	1 x 48 x 96	4 x 8 x 8	3,072	3,072	8	12	96	
	1 x 48 x 96 (Half unit)	4 x 8 x 4	1,536	1,536	4	12	48	
	1 x 48 x 108	4 x 9 x 8	3,456	3,456	8	12	96	
1½	1.5 x 24 x 96	4 x 8 x 8	2,048	3,072	8	16	128	
	1.5 x 48 x 96	4 x 8 x 8	2,048	3,072	8	8	64	
2	2 x 24 x 96	4 x 8 x 8	1,536	3,072	8	12	96	
	2 x 48 x 96	4 x 8 x 8	1,536	3,072	8	6	48	
2½	2.5 x 48 x 96	4 x 8 x 8	1,152	2,830	4	9	36	
3	3 x 24 x 96	4 x 8 x 8	1,024	3,072	8	8	64	
	3 x 48 x 96	4 x 8 x 8	1,024	3,072	8	4	32	

1. Available lengths and edge configurations vary by thickness. See www.foamular.com for current offerings. Other sizes may be available upon request. Consult your local Owens Corning representative for availability.

Standards, Codes Compliance

- Meets ASTM C578 Type X
- UL Classified. A copy of UL Classification Certificate U-197 is available at www.foamular.com
- See ICC-ES ESR-1061 at www.icc-es.org
- ASTM E119 Fire Resistance Rated Wall Assemblies. See www.foamular.com for details.
- Meets California Quality Standards; HUD UM #71A
- Compliance verification by RADCO (AA-650)

Certifications and Sustainable Features of FOAMULAR® XPS Insulation

- FOAMULAR® XPS insulation is reusable
- FOAMULAR® XPS insulation is made with a zero ozone depletion formula
- Certified by Scientific Certification Systems to contain a minimum of 20% pre-consumer recycled polystyrene
- Certified to meet indoor air quality standards under the stringent GREENGUARD Indoor Air Quality Certification Program℠, and the GREENGUARD Children & Schools Certification Program℠
- Qualified as an ENERGY STAR® product, under the U.S. Environmental Protection Agency and the U.S. Department of Energy
- Approved under the National Association of Home Builders (NAHB) Research Center Green Seal of Approval
- Utilizing FOAMULAR® XPS insulation can help builders achieve green building certifications including the Environmental Protection Agency's ENERGY STAR®, the National Association of Home Builders' National Green Building certification, and the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED®) certification
- FOAMULAR® XPS insulation may qualify for The Buy American provision of the American Recovery and Reinvestment Act (ARRA)

Product Data Sheet

Environmental and Sustainability

Owens Corning is a worldwide leader in building material systems, insulation and composite solutions, delivering a broad range of high-quality products and services. Owens Corning is committed to driving sustainability by delivering solutions, transforming markets and enhancing lives. More information can be found at www.sustainability.owenscorning.com.

Warranty

FOAMULAR® XPS Insulation limited lifetime warranty maintains 90% of its R-value for the lifetime of the building and covers all ASTM C578 properties. See actual warranty for complete details, limitations and requirements at www.foamular.com or www.owenscorningcommercial.com.

Notes

1. R means the resistance to heat flow; the higher the R-value, the greater the insulating power.
2. See actual warranty for complete details, limitations and requirements.
3. Not for use in roofing. For roofing applications, use FOAMULAR® THERMAPINK® Extruded Polystyrene Insulation.

All products described here may not be available in all geographic markets. Consult your local sales office representative for more information.

For more information on the Owens Corning family of building products, contact your Owens Corning dealer, call 1-800-GET-PINK®, or access our web sites: www.foamular.com and www.owenscorning.com.

GREENGUARD® Indoor Air Quality Certified

GREENGUARD® Children & Schools Indoor Air Quality Certified

Seal and Insulate with ENERGY STAR — LEARN MORE AT energystar.gov

Recycled Content Minimum 20% — 20% Pre-consumer

NAHB RESEARCH CENTER GREEN APPROVED

OWENS CORNING FOAM INSULATION, LLC
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TOLEDO, OHIO 43659
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www.owenscorning.com

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V. ENVIRONMENTALLY FRIENDLY FINISHES

- **CARPET PROVIDERS**

  INTERCORP CONTRACT RESOURCES: Milliken Carpets

Milliken scientists invented a technology to keep carpet tiles in-place without the need for wet glues or "peel and stick" dry adhesives that contain VOCs. The invention was TractionBack® carpet backing, a high-friction coating that's applied to Milliken's modular flooring. Carpet tiles with TractionBack® carpet backing stay put underfoot yet can be easily moved and repositioned. No other modular carpet contributes more to LEED certification than Milliken modular carpet with TractionBack® carpet backing.

Materials & Resources (MR)

MR Credit 2.1 & 2.2 Construction Waste Management

Milliken reclamation program ensures that the replaced carpet is managed in an environmental and socially responsible way. It has a nationwide network of recyclers that specialize in recycling one or more carpet types including Milliken Earth Square® process of finding reuse/renewal outlets for carpet tiles.

MR Credit 4.1 & 4.2 Recycled Content

Milliken modular carpet contains a minimum of 24% post industrial recycled content.

MR Credit 5.1 & 5.2 Regional Materials

All projects within 500 miles of Richmond VA, Columbus OH, Shreveport LA, and Ft. Myers FL, can earn credits towards the regional materials point.

Indoor Environmental Quality (IEQ)

IEQ Credit 4.1 Low-Emitting Materials: Adhesives & Sealants

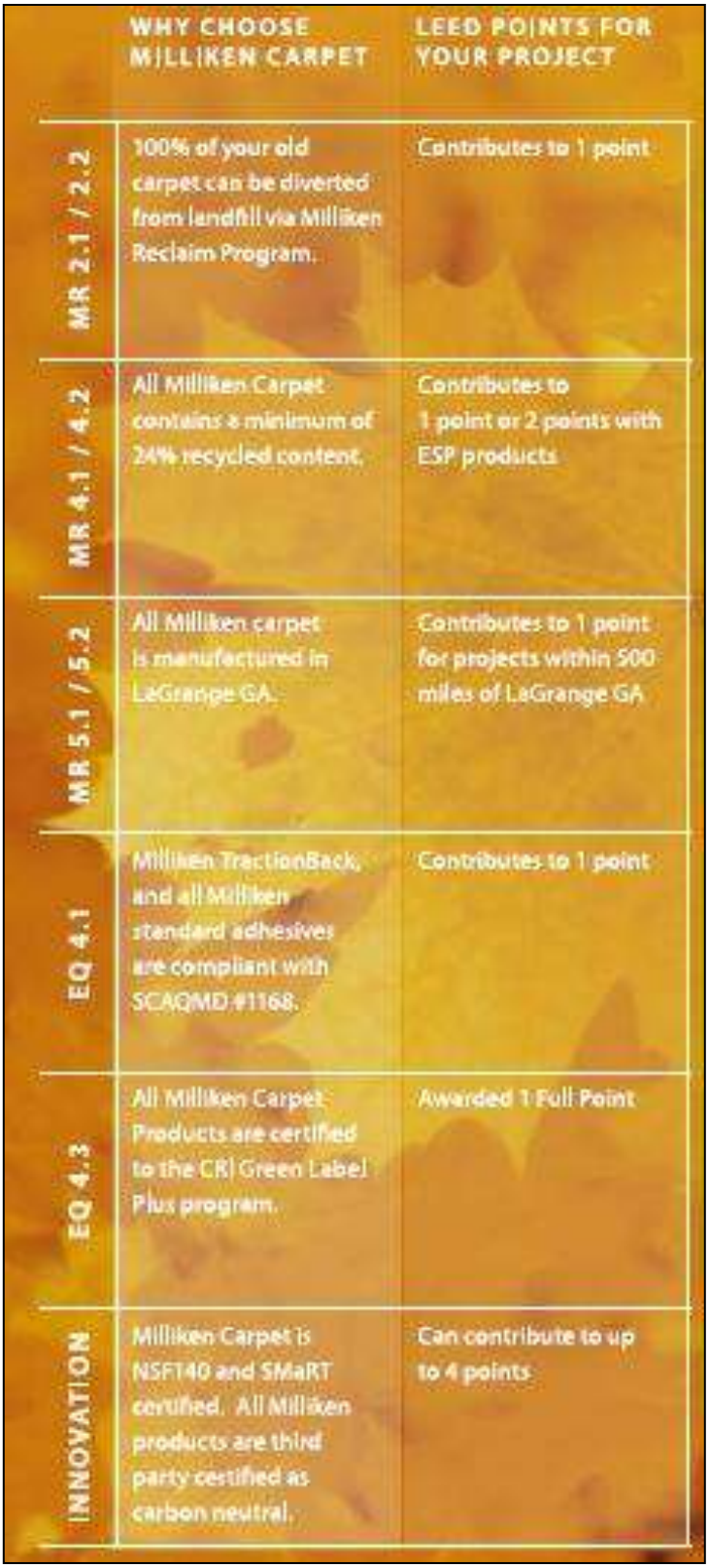
Projects shall receive one point if all adhesives and sealants used on the interior of the building comply with South Coast Air Quality Management District (SCAQMD) Rule #1168.

IEQ Credit 4.3 Low-Emitting Materials: Carpet Systems

Milken carpet products are certified by the Carpet and Rug Institute's Green Label Plus program.

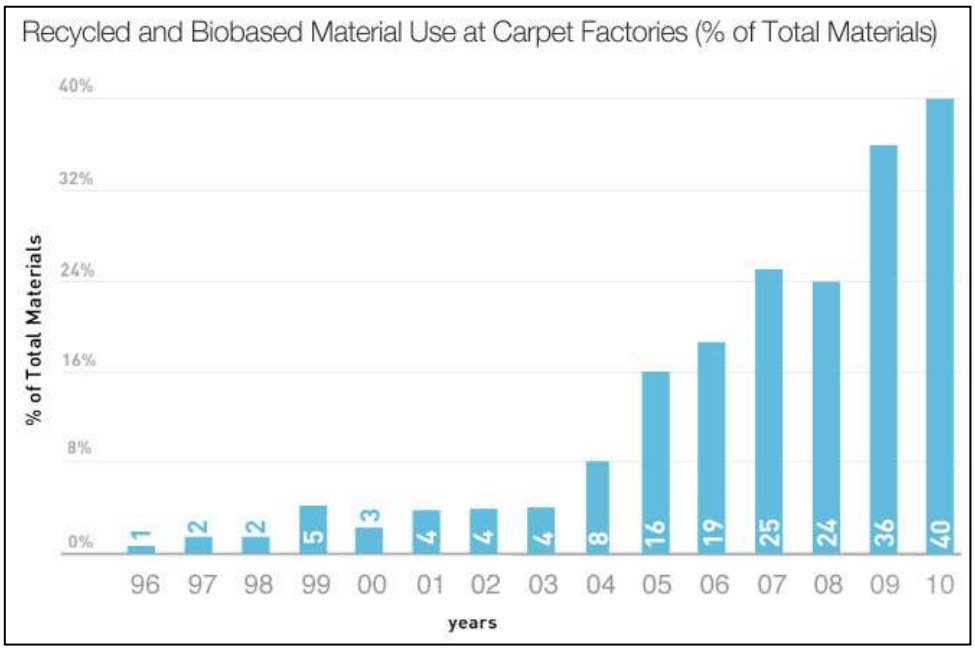
Innovation in Design Credits (ID)

Milken Commercial Carpet is NSF 140 and SMaRT certified. Milken Carpet is also third party certified as Carbon Neutral Products certified to third party standards for sustainability can qualify for innovation point credits.



	WHY CHOOSE MILLIKEN CARPET	LEED POINTS FOR YOUR PROJECT
MR 2.1 / 2.2	100% of your old carpet can be diverted from landfill via Milliken Reclaim Program.	Contributes to 1 point
MR 4.1 / 4.2	All Milliken Carpet contains a minimum of 24% recycled content.	Contributes to 1 point or 2 points with ESP products
MR 5.1 / 5.2	All Milliken carpet is manufactured in LaGrange GA.	Contributes to 1 point for projects within 500 miles of LaGrange GA
EQ 4.1	Milliken TractionBack, and all Milliken standard adhesives are compliant with SCAQMD #1168.	Contributes to 1 point
EQ 4.3	All Milliken Carpet Products are certified to the CRI Green Label Plus program.	Awarded 1 Full Point
INNOVATION	Milliken Carpet is NSF140 and SMaRT certified. All Milliken products are third party certified as carbon neutral.	Can contribute to up to 4 points

INTERFACEFLOR: Interface Carpets



Biobased Materials:
Our research into renewable materials led us to explore fibers made from polylactic acid (PLA), flax, hemp and wool. As we continue to explore the use of these materials, we will need to consider their complete impacts – particularly their relation to genetically modified organisms (GMOs) and food supplies, and the agricultural practices used to produce them. While current biobased products may not be the final answer in our quest for renewable fibers, they are a significant step in the right direction.

Recycled Materials:
Interface has significantly increased the recycled content in our products, both post-industrial and post-consumer, since we began our Mission Zero journey. Over the past few years however, we have made significant strides as a result of the ReEntry® and Cool Blue™ processes described below. Our current technologies allow us to manufacture product with 64-75% total recycled content, including more than 30% post-consumer recycled content.

An example of our use of post-industrial recycled materials is the replacement of virgin calcium carbonate (limestone) with aluminosilicate glass (ASG) in our carpet tile backing. ASG is a coal combustion byproduct (CCB) produced during the production of electricity at coal-fired power plants. Using ASG not only decreases the amount of virgin materials we use, but it also reduces the impact on landfills that would normally receive these CCBs.

Water Use
Interface has drastically reduced its water use through process changes and fixture replacement. The water intensity of our manufacturing process is relatively low, particularly for our modular carpet operations. While our broadloom manufacturing operations consume the largest amount of water at Interface, the facility has been shifting to a less water intensive yarn dyeing process, resulting in significant reductions. As of 2010, we decreased our water intake per unit of product by 82% since 1996.

ReEntry®

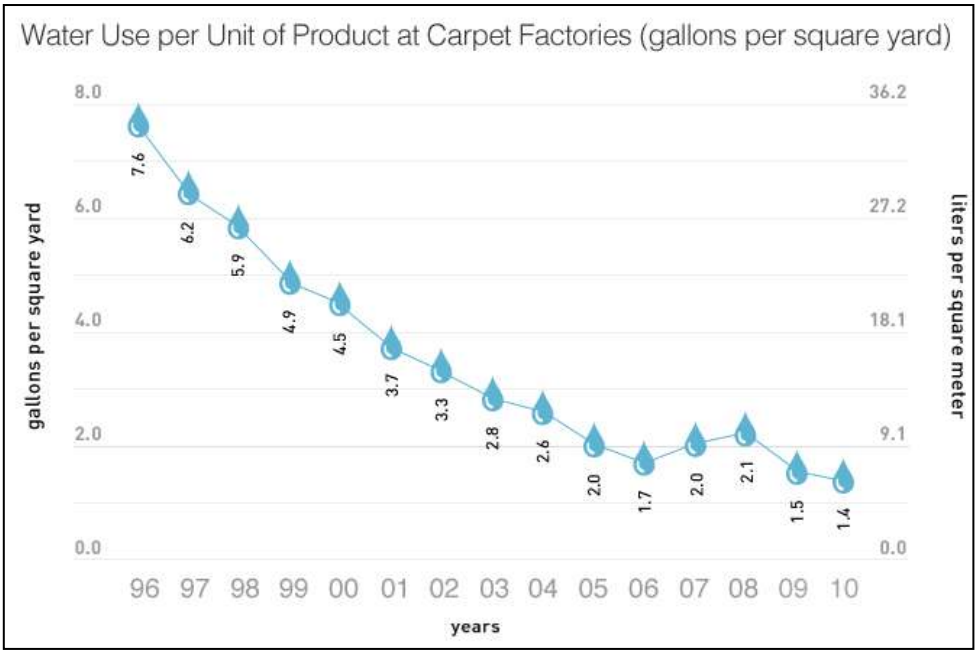
In 2007, Interface became the first carpet manufacturer to implement a process for the "clean separation" of carpet fiber from backing, allowing for a maximum amount of post-consumer material to be recycled into new products with minimal contamination. Through a process called ReEntry® 2.0, clean, post-consumer Nylon 6,6 fiber is returned to Interface's fiber supplier where it, in combination with some virgin materials, is recycled into new Nylon 6,6 for use in new carpet fiber. At the same time, the backing material is crumbled and transformed into new backing using our Cool Blue™ backing technology. Plastics that cannot be used for Interface processes or products are distributed to other industry suppliers for re-use in their material streams.

The ReEntry 2.0 process has lower embodied energy than other recycling systems in the carpet industry today. It will keep more carpet out of landfills, while providing a steady stream of post-consumer recycled materials across the industry.

Supply Chain

We quickly learned that the substantial majority of our product's footprint was incurred before our raw materials reached our receiving docks. It became clear to us that for Interface to be completely sustainable, we need to educate and actively engage our suppliers on our Mission Zero journey.

We began with Supplier Summits – conversations with our key suppliers to introduce them to our mission and sustainability goals. Today, we collaborate closely with our core strategic suppliers to address their own environmental impacts and, specifically, the impacts of the products they supply to Interface. This collaboration has resulted in solutions ranging from small steps to reduce our climate impacts to new and innovative technologies that increase the recycled content of our products.



DUPONT: DuPont Sonora Commercial Carpet

Sorona® renewably sourced™ polymers			
	Our Product	Conventional Product	Substitute Product
BACKGROUND INFORMATION			
Product Name	DuPont™ Sorona® renewably-sourced polymer	PTT-01	Nylon
Chemical Name	poly(trimethylene terephthalate)	poly(trimethylene terepthalate)	polyamide (Type 6)
Major Uses	Textile & carpet fibers	Textile & carpet fibers	Textile & carpet fibers
DuPont Manufacturing Location	Kinston, SC, USA; Jiangsu, China (DuPont licensee Zhenjijiang Glory)	n/a	n/a
CRADLE-TO-GATE MANUFACTURING PARAMETERS			
Greenhouse Gas Emissions kg CO2 equivalents/kg	3.38 [1, 2]	Propylene route: 4.42 [1] Ethylene oxide route: 4.04 [3]	9.1 [4]
Non Renewable Energy Consumption MJ/kg	83.8 [1, 5]	Propylene route: 101.2 [1,5] Ethylene oxide route: 94.6 [3]	120.5 [4,5]

PRODUCT PROPERTIES

Renewable content % by weight	37%	0%	0%
Biobased Carbon Content % by weight [6]	28%	0%	0%
Biodegradability [7]	n/a	n/a	n/a
Compostability [8]	No	No	No
Other Information	Recyclability of Sorona® in the PETE waste stream is being established via Association of Postconsumer Plastic Recyclers (APR) guidelines		

References

1 Peer-reviewed LCA of Bio-PDO / Sorona production (Peer reviewer: Prof. Konrad Saur, Five Winds International)

2 includes bio-based carbon stored in product

3 G. Elliott, L. Cisneros, R. Ramachandran "A Life Cycle Assessment of Corterra Polymer" (May 12, 2005)

4 PlasticsEurope (March 2005), A. Boustead, Ecoprofiles of the European Plastics Indusrty, Polyamide 6 (Nylon 6) (www.lca.plasticseurope.org/)

5 based on higher heating values (HHV)

6 ASTM Standard D 6852: Standard Guide for Determination of Biobased Content, Resources Consumption, and Environmental Profile of Materials and Products

7 ASTM Standard E1720 Standard Test Method for Determining Ready, Ultimate, Biodegradability of Organic Chemicals in a Sealed Vessel CO2 Production Test

8 ASTM Standard D6400 Standard Specification for Compostable Plastics

DuPont™ Renewably Sourced™ Materials contain a minimum of 20% renewably sourced ingredient by weight.

- **PAINT PROVIDERS**
  PPG ARCHITECTURAL COATINGS: Porter Paints & Pure Performance®

UNDERSTANDING USGBC LEED® 2009

The United States Green Building Council (USGBC), through its Leadership in Energy and Environment Design (LEED®), is the nationally accepted benchmark rating system for the design, construction and operation of high-performance green buildings.

Your paint choice contributes to USGBC LEED® certification. PPG Architectural Coatings, through its PPG, PPG Pittsburgh Paints®, and PPG Porter Paints® brands can help you earn USGBC LEED® points with a wide range of green paint products.

LEED NC: New Construction & Major Renovations 2009

The LEED for New Construction Rating System is intended to direct and recognize high-performing commercial and institutional projects, including office buildings, high-rise residential buildings, government buildings, recreational facilities, manufacturing plants and laboratories.

Paint VOC Required (EQ Credit 4.2-1 point):

Primers: <200 g/L	Flat: <50 g/L
Non-Flat: <150 g/L	Anti Corrosive: <250 g/L

LEED CI: Commercial Interiors

LEED for Commercial Interiors is the green standard for tenant improvements. It is the accepted method for certifying high-performance interiors that promote health, productivity; cost savings; and a reduced environmental footprint. LEED for Commercial Interiors empowers tenants and designers to make sustainable choices in cases where they may not have control of total building operations.

Paint VOC Required (EQ Credit 4.2-1 point):

Primers: <200 g/L	Flat: <50 g/L
Non-Flat: <150 g/L	Anti Corrosive: <250 g/L

LEED CS: Core & Shell Development

LEED for Core & Shell is a high-performance rating system for designers, builders, developers and new building owners who want to undertake sustainable plans for new core and shell construction. Core and shell covers basic building components such as structure, envelope, and HVAC. LEED for Core & Shell is intended to be complementary to LEED for Commercial Interiors, as both rating systems establish building performance green criteria for developers, owners and tenants.

Paint VOC Required (EQ Credit 4.2):

Primers: <200 g/L	Flat: <50 g/L
Non-Flat: <150 g/L	Anti Corrosive: <250 g/L

LEED for Homes

A LEED-certified home is designed and built in conformity with the thorough guidelines of the LEED for Homes green rating system. LEED for Homes is a cooperative, third party- confirmed, voluntary certification program which encourages the design and construction of high-performance green homes.

Paint VOC Required:

Primers: <200 g/L	Flat: <50 g/L
Non-Flat: <150 g/L	Anti Corrosive: <250 g/L

LEED for Schools

The LEED for Schools Rating System realizes the distinctive nature of the design and construction of K-12 schools. Derived from the LEED for New Construction rating system, it tackles issues such as classroom acoustics, master planning, mold prevention and environmental site assessment. By focusing on the distinctiveness of schools and the health issues of children, LEED for Schools provides an exclusive, across-the-board tool for schools that want to build sustainably, with quantifiable results.

Paint VOC Required (EQ Credit 4.2- 1 point):

Primers: <200 g/L	Flat: <50 g/L
Non-Flat: <150 g/L	Anti Corrosive: <250 g/L

BEHR: Premium Plus Interior Paints & Primers
Premium Plus Ultra Interior Paints

BEHR PREMIUM PLUS® Interior Flat

- Low Odor, Zero VOC*
- Self-Priming: Seals Uncoated and Previously Painted Surfaces
- Easy-Clean Flat
- Non-Reflective Matte Appearance
- Excellent Touch-Up
- Ultimate Durability
- Exceptional Hide
- 100% Acrylic
- Mildew Resistant Finish
- Lifetime Guarantee*

No. 1050 Ultra Pure White®
No. 1012 Swiss Coffee
No. 1052 White
No. 1070 Linen White
No. 1300 Deep Base
No. 1400 Medium Base

1 Hr Dry Time
2 Hr Recoat Time

250-400 Sq. Ft. Coverage per Gallon

Soap & Water Clean-Up

Protect from Freezing

FOR TINT BASES – DO NOT USE WITHOUT THE ADDITION OF TINTING COLORANTS

WHERE TO USE

For low traffic areas. Ideal for Family Rooms, Living Rooms, Dining Rooms, Bedrooms and Ceilings.

PREPARATION

All surfaces should be properly prepared and cleaned. Remove loose paint, wash off dirt and grease with detergent, rinse and allow to dry. Remove mildew stains with a mildew stain removing product. Scuff sand glossy surfaces and repair imperfections. Remove all dust with a damp cloth, allow to dry. Allow new stucco, plaster and masonry to cure for 30 days before painting.

PRIME

BEHR PREMIUM PLUS® paint is self priming over properly prepared uncoated and previously painted Interior surfaces. On stains, over oil-based coatings or glossy surfaces, use a product such as BEHR PREMIUM PLUS® Stain-Blocking Primer & Sealer No. 75. For optimal color development, better hide, and to reduce the number of topcoats with deep colors denoted with a dagger (†) on the color chip, apply a custom tinted primer.

APPLICATION

Apply when air and surface temperatures are between 50-90°F (10-32°C). Stir paint occasionally. Intermix containers of same product to ensure color and sheen uniformity. Use a high quality 3/8-1/2" nap roller cover, nylon/polyester brush or airless sprayer (.015-.019" spray tip, 60 mesh filter). Do not thin if using a roller or brush; however, if using a sprayer and thinning is required, thin with water at a rate of no more than 1/2 pint per gallon. Certain colors may require more than one coat for complete hide. Darker colors may require additional dry time between coats. Cooler temperatures or higher humidity may prolong drying time. After 4 weeks, cured paint film may be cleaned with a mild, non-abrasive liquid detergent. Dry paint film is mildew resistant.

DISPOSAL

For disposal of empty containers, unused paint and soiled rags, contact your household refuse collection service.

Visit behr.com for painting tips, expert project advice and the perfect color coordination with COLORSMART BY BEHR™.

WARNING! If you scrape, sand or remove old paint, you may release lead dust. LEAD IS TOXIC. EXPOSURE TO LEAD DUST CAN CAUSE SERIOUS ILLNESS, SUCH AS BRAIN DAMAGE, ESPECIALLY IN CHILDREN. PREGNANT WOMEN SHOULD ALSO AVOID EXPOSURE. Wear a NIOSH approved respirator to control lead exposure. Clean up carefully with a HEPA vacuum and a wet mop. Before you start, find out how to protect yourself and your family by contacting the National Lead Information Hotline at 1-800-424-LEAD or log on to www.epa.gov/lead.

BEHR PREMIUM PLUS ULTRA®
Interior Flat Enamel

- Paint & Primer in One
- STAYS LOOKING NEW LONGER® Finish
- Scuff Resistant Finish
- Mildew Resistant Finish
- 100% Acrylic Latex
- Easy-Clean Low-Lustre Matte Sheen
- Low VOC

No. 1750 Ultra Pure White®
No. 1752 White
No. 1753 Deep Base
No. 1754 Medium Base

IMPORTANT: DO NOT OPEN CAN WITHOUT READING THESE INSTRUCTIONS. PROTECT FROM FREEZING.

FOR TINT BASES – DO NOT USE WITHOUT THE ADDITION OF TINTING COLORANTS

BEHR PREMIUM PLUS ULTRA® is a patent pending paint and primer in one coating that will change the way you paint. This exciting product features advanced NANOGUARD® technology with an extra-protective shell that offers excellent stain removal and resistance, outstanding water and scuff resistance, and great touch up, coverage and hide, creating an easy to clean STAYS LOOKING NEW LONGER® finish. It is ideal for use in high traffic areas and on surfaces where moisture, mildew, or fungus growth may be a problem. This sophisticated, hand-selected color palette delivers superior coverage in fewer coats.

WHERE TO USE

- Properly prepared coated and uncoated Interior surfaces. Ideal for Family Rooms, Living Rooms, Dining Rooms, Bedrooms, Hallways and Ceilings.

PREPARATION & PRIME†

- Remove loose paint, wash off any dirt and grease with detergent, remove mildew stains with a mildew stain removing product.
- Scuff sand glossy surfaces.
- Countersink nail heads, repair imperfections and sand smooth.
- Remove all dust with a damp cloth, allow to dry.
- Allow new stucco, plaster and masonry to cure for 30 days before priming.
- Use BEHR PREMIUM PLUS ULTRA as a primer for repaired or uncoated surfaces. Lock in stains with the first primer coat; if necessary, apply a second primer coat of BEHR PREMIUM PLUS ULTRA.
- For best performance with heavy stains and watermarks use a product such as BEHR ENAMEL UNDERCOATER PRIMER & SEALER NO. 75.
- For drastic color changes, apply a primer coat of BEHR PREMIUM PLUS ULTRA if needed.

APPLICATION

- Use product when the surface and air temperatures are between 50-90°F (10-32°C).
- Stir paint occasionally. Intermix containers of same product to ensure color and sheen uniformity.
- Use a high quality 3/8-1/2" nap roller cover, nylon/polyester brush or an airless sprayer (.015 - .019" spray tip, 60 mesh filter).
- Coverage is 250-400 sq. ft. (23-37 m^2) per gallon depending on the surface texture, porosity and application method.
- Do not thin if using a roller or brush; however, if using a sprayer and thinning is required, thin with water at a rate of no more than 1/2 pint per gallon.
- Certain colors may require more than one coat for complete hide.

DRY TIME

- Dries to touch in 2 hours at 77°F (25°C) and 50% humidity, re-coat in 4 hours.
- Longer dry time required in cooler temperatures and in higher humidity.
- After 4 weeks, cured paint film may be cleaned with a mild, non-abrasive liquid detergent.
- Dry paint film is mildew resistant.

CLEAN-UP & STORAGE

- Use soap and water.
- Properly dispose of all soiled rags and **protect unused product from freezing**.
- For disposal of empty containers and unused product, contact your household refuse collection service.

Refer to the BEHR Interior Paint Guide for additional tips or visit us at behr.com for expert project advice and perfect color coordination with COLORSMART BY BEHR™.

† **WARNING!** If you scrape, sand or remove old paint, you may release lead dust. LEAD IS TOXIC. EXPOSURE TO LEAD DUST CAN CAUSE SERIOUS ILLNESS, SUCH AS BRAIN DAMAGE, ESPECIALLY IN CHILDREN. PREGNANT WOMEN SHOULD ALSO AVOID EXPOSURE. Wear a

- **WOOD FLOORING PROVIDERS**
  RESYSTA: Resysta Aged Teak

»Resysta is extremely resistant and features an excellent eco-balance «

Technical and ecological assessment of the new material Resysta:

Resysta looks like wood and stands out for its high mechanical strength, thermal stability as well as **chemical resistance. Unlike wood, Resysta is swell-, splinter- and crack-free, does not gray or fade** and withstands pest infestation. Resysta products are therefore **very durable** without requiring special care or maintenance. Resysta is **a true alternative to tropical wood.**

It is therefore especially suitable for outdoor use like garden furniture and outdoor decking as well as for wellness and pool areas, where high strain, aggressive weather, temperature and environmental influences take effect. Resysta products furthermore provide for an exceptionally beneficial eco-balance. In short: **Resysta deserves the title »The better wood« in every sense.**

...PRODUCT PROPERTIES

- UV-resistance
- weather resistance
- water resistance
- salt- and chlorine-water resistance
- no cracking
- no pest infestation or fungal decay
- flammability classification B2 (with additives, B1 classification possible)

...SURFACE AND DESIGN

- wood feel and appearance
- skid resistance
- no splintering
- individual color scheme

... HANDLING
- easy installation
- customary tools
- easy to refinish

...SUSTAINABILITY
- no rotting
- 100% recyclable
- easy-care

Resysta Color Concept - FVG glazes

Density	ASTM D2395:2002	approx.1.46 kg/m³
Coefficient of Linear Thermal Expansion	ASTM D696	3.6x10(-5)mC
Water Absorption and Air Humidity Behaviour	ASTM D1037:2006a	none or very low water absorption (only surface wetting)
Weathering and UV Resistance	QUV Test	Resysta surfaces treated with glaze show extremely high resistance
Skid Resistance	DIN 51097	C Rating (highest rating)
Fire Behaviour (German Standard)	EN ISO 11925-2	B2, normal flammability (by adding flame retardants, a higher rating of B1 can be reached)
Fire Behaviour (US Standard)	NFPA	A Rating (flame propagation 25, smoke emission 450)
Fire Behaviour (British Standard)	BS 476 Teil 6&7	Rating 1
Durability (Resistance to Wood-Destructive Fungi)	DINV ENV 12038:2002	the material has not been affected, highest durability – Class 1
Emission	DIN EB ISO 9001/14001	passed
Brinell Hardness (HB)	EN 1534	81,1 N/mm²
Friction Coefficient μ untreated	EN 13893	0,46
Friction Coefficient μ with 2K	EN 13894	0,52

Globally renowned institutions carry out tests according to German, British, European and US standards.

RECITEC: Compuesto de Fibra de Plástico

Productos versátiles y confiables

¿Que és la fibra Plástica?

El Compuesto de FIBRA PLASTICA constituye un nuevo material, resultado de muchos años de investigación y desarrollo de materiales eficientes y amigables con el medio ambiente. Esta hecho a base de fibras naturales, resinas plásticas y aditivos especiales, utilizando en su fabricación la más alta ingeniería en mezclas de polímeros, así como diseño e ingeniería auxiliados por computadora (CAD/CAE); dando como resultado, un material altamente resistente al impacto, de gran rigidez y larga vida.

Las fibras naturales que pueden ser utilizadas incluyen: harina de madera y algunas fibras agrícolas, tales como cascarilla de arroz, cáscara de nuez, cáscara de coco, bagazo de café, etc.

En cuanto a los materiales plásticos, principalmente se utiliza Polietileno de Alta Densidad (PEAD), pero también puede usarse Polietileno de Baja Densidad (PEBD), Polipropileno (PP), PVC , ABS y Poliestireno.

¿Cuales son las características de la fibra plástica?

- Tiene propiedades físicas superiores a la madera natural.
- Es un material de gran duración, que mantiene sus características originales y no requiere ningún tipo de mantenimiento.
- Se puede cortar, atornillar, clavar, taladrar, y en general trabajar como la madera con las mismas herramientas.
- Se pueden fabricar perfiles en formas y medidas muy diversas, tales como: sólidos, huecos (cerrados y abiertos),espumados, con recubrimientos, etc.
- Por sus propiedades únicas, la FIBRA PLÁSTICA puede sustituir a la madera natural y en algunas aplicaciones a metales tales como aluminio y acero.

PROPIEDADES FÍSICAS DEL COMPUESTO DE FIBRA PLÁSTICA

Propiedad	Unidad	Método	Valor
Densidad	g/cm 3	GSX	1.1
Coeficiente de expansion térmica lineal-Ref20 oC	mm/mm/ oC	GSX	3.5E-05
Absorción de humedad	%	GSX	0.1%
Absorción de agua (24 hrs)	%	ASTM D570	0.2%
Absorción de agua con superficie rugosa (24 hours)	%	ASTM D570	0.3%
Prueba de flama	second	UL-94-V-0	0
Deterioro por radiación UV	mm/year	GSX	0.050

PROPIEDADES MECÁNICAS DEL COMPUESTO DE FIBRA PLÁSTICA

Propiedad	Unidad	ASTM	Mínimo	Máximo
Elongación a la ruptura	%	D790-92	3.6	4.2
Modulo de flexión	psi	D790-92	454,000	615000
Esfuerzo de flexión	psi	D790-92	7,100	7600
Módulo de compresión	psi	D790-92	170,000	260000
Esfuerzo de compresión	psi	ASTM D570	4,300	5700
Resistencia al impacto izod (sin ranura)	ft-lb/in	UL-94-V-0	1.06	1.16
Fuerza para desprender el tornillo (taladro piloto de 11/64",1"prof.)	lb	GSX	753	5 mm screw

- **CERAMIC TILES PROVIDERS**
  INTERCERAMIC: Ceramic Flooring Tiles

Productos Cerámicos y El Medio Ambiente

Ciclo de Vida
La loseta de cerámica y el piso porcelánico son productos de recubrimiento para pisos con la más larga duración en el mercado actual. A diferencia de las alfombras, el vinilo y los pisos laminados (los cuales tienen que ser reemplazados periódicamente), un piso de cerámica adecuadamente instalado puede durar toda la vida.

Calidad de Aire en Interiores
Este es un tema muy actual y por una buena razón. Los compuestos orgánicos volátiles (VOC's) ocasionan un sin fin de problemas de salud ya que son causa principal del "síndrome del edificio enfermo". Debido a que la cerámica pasa por un proceso de cocimiento a temperaturas extremadamente altas, no se presentan en el producto terminado compuestos orgánicos volátiles que puedan ser liberados en el aire que respiramos; siendo literalmente "CERO". Adicionalmente para su instalación, se encuentran disponibles adhesivos y boquillas que contienen CERO o con una cantidad muy pequeña de "VOCs". Aunque algunas alfombras, piso de vinilo o piso de madera contienen muy bajos niveles de compuestos organicos volatiles, nunca llegaran a CERO.

Reciclado
Actualmente las plantas productoras de cerámica se están enfocando en el reuso de agua y materiales. Logrando enviar cantidades muy pequeñas de residuos a confinamiento y desperdicio de agua a plantas tratadoras.

Disponibilidad Regional
Los productos cerámicos y de instalación son fabricados con materiales locales que se encuentran ampliamente disponibles, a diferencia de otras alternativas para recubrimientos de pisos, en las cuales los fabricantes tienen que transportar su productos miles de kilómetros para que el producto pueda llegar al cliente.
La disponibilidad regional contribuye a la reducción de consumo de energía y combustible, así como emisiones de contaminantes al ambiente asociadas con la transportación de estos productos al lugar del proyecto de construcción.

Hipoalergénicos
La loseta cerámica previene la formación de hongos o bacterias ya que es usada frecuentemente para reemplazar a otros materiales de recubrimiento de pisos tales como alfombras previniendo así alergias o asma en las personas.

Fácil Mantenimiento
A diferencia de otros materiales que requieren químicos y limpiadores con base de solventes, nuestros productos tienen la ventaja de que se pueden limpiar fácilmente utilizando materiales de limpieza a base agua.

Leed®

LEED® (Liderazgo en Energía y Diseño Ambiental) es un programa desarrollado por el U.S. Green Building Council (USGBC) que ha ganado reconocimiento en el mercado comercial e institucional. El programa LEED® ha desarrollado un sistema de puntos para construcción de edificios verdes que permite a los constructores y propietarios de los mismos, evaluar el impacto del diseño o energía utilizada en el proyecto de acuerdo a aspectos ambientales. Se pueden obtener puntos para lograr la certificación LEED® en un proyecto como resultado de diferentes alternativas que se toman al momento de diseñar, construir y operar un edificio nuevo, uno ya existente, una renovación, o diseño de interiores en escuelas o comercios.

Ningún producto puede obtener la Certificación LEED®, solamente los edificios pueden ser certificados. Sin embargo Los productos cerámicos pueden contribuir a la obtención de puntos en proyectos de construcción para lograr la certificación LEED®.

La loseta de cerámica contribuye a la certificación LEED® de la siguiente manera:

- Contenido de Materiales Reciclados (MR Crédito 4)
- Materiales Regionales (MR Crédito 5)
- Baja emisión de Material (Compuestos Orgánicos Volátiles) (IEQ Crédito 4.3)
- Efecto Isla de Calor (SS Crédito 7.1)
- Pueden existir formas adicionales que contribuyan a la obtención de puntos LEED®. Consulta a un profesional acreditado LEED®.

Al usar las series Interceramic puedes obtener hasta un máximo de 6 posibles puntos LEED® si el proyecto cumple con:

MR Crédito 4	Contenido de reciclado	10%	1 Punto
	Contenido de reciclado	20%	2 Puntos
IEQ Crédito 4.3	Baja Emisión de Material	Contenido de Compuestos Orgánicos Volátiles (VOC's)	1 Punto
MR Crédito 5	Materiales Regionales	10% extraído, procesado o manufacturado regionalmente	1 Punto
	Materiales Regionales	20% extraído, procesado o manufacturado regionalmente	2 Puntos
SS Crédito 7.1	Efectos Isla de Calor	SRI >29; Color de la cerámica	1 Punto

Otros estándares y lineamientos ambientales importantes se encuentran actualmente en desarrollo, tal es el caso de NABH National Association of Home Builders, The Collaborative for High Performance Schools, Green Globe y otras. La loseta de cerámica producida en Norte América contribuye a proporcionar un largo ciclo de vida, calidad de aire en interiores y beneficios regionales de fabricación a todos ellos.

El TCNA-Tile Council of North America (Consejo de Cerámica de Norte América es miembro de U.S. Green Building Council).

LAMOSA: Porcelanite Ceramic Tiles

Descubriendo Green Matters

Green matters. está enfocado al desarrollo de productos y servicios para ayudar a nuestros clientes en sus iniciativas y proyectos de construcción sustentable para reducir el impacto ambiental.

Durable

Los revestimientos cerámicos de Porcelanite-Lamosa durarán varias generaciones. Su larga vida y belleza permanente son la mejor razón del porqué es la mejor alternativa comparada con otros materiales de recubrimientos.

Ecológico

Nuestro proceso de manufactura utiliza grandes porcentajes de materiales reciclados (agua, material de proceso, calor de equipos) en todas las fases de producción. Además, Porcelanite-Lamosa prefiere adquirir productos de proveedores que utilicen porcentajes considerables de materiales reciclados en sus operaciones como papel y cajas.

Construcción verde - Contribución LEED

El revestimiento cerámico es la mejor opción de recubrimientos al construir sustentablemente.

El usar los productos de Porcelanite-Lamosa tendrá un potencial de contribución dentro de varias categorías de créditos LEED:

• **Crédito MR 1.2:** Construcción re-usable - mantener elementos interiores no estructurados. El re-uso de paredes, pisos y techos con revestimiento cerámico de antiguos propietarios puede contribuir enormemente a la adquisición de este crédito LEED.

• **Crédito MR 3:** Re-uso de materiales: Los productos de Porcelanite-Lamosa pueden recuperarse y colocarse en una nueva instalación para diferentes propósitos como recubrimiento de pisos y paredes, cubiertas, muebles y en piezas de decoración estilo mosaico.

• **Crédito MR 5:** Materiales regionales: Los materiales Porcelanite-Lamosa se encuentran frecuentemente disponibles alrededor de 800 Km de los proyectos de nuestros clientes.

• Crédito IEQ 3.1: Plan de manejo de construcción de la calidad del aire interior - durante la construcción. El uso de revestimiento cerámico puede simplificar el plan de manejo de la calidad del aire interior y por ende simplifica la adquisición de este crédito LEED.

• **Crédito IEQ 3.2:** Plan de manejo de construcción de la calidad del aire interior -antes de la ocupación. Una vez instalado, los productos de Porcelanite-Lamosa tienen un mayor efecto positivo en la calidad del aire interno que las superficies de recubrimientos de la competencia.

• **Crédito IEQ 4.3:** Materiales de baja emisión - sistemas de pisos: El revestimiento cerámico de Porcelanite-Lamosa es un material inerte que no emite compuestos orgánicos volátiles (VOC's).

- **CONCRETE FLOOR FINISHES**
  CORNERSTONE FLOORING DE MEXICO: Polyurethane & Polymer Flooring

Polyurethane & Polymer Flooring

Polyurethane flooring systems are high performance polymer materials with exceptional properties. Polyurethane flooring systems are designed to be durable and resilient and are engineered for applications where thermal, chemical or impact resistance are considerations. Polyurethane flooring systems offer low odor, low VOC installations and are designed to be non-porous while closely matching the same co-efficient of expansion as concrete. Contact a Corner*Stone*™ technical representative to find out more information about our polyurethane flooring systems or click a link below.

Polyurethane & Polymer Flooring Systems:

- CS 5000SB CornerCrete™ Slurry Matrix Polyurethane Flooring System
- CS 5000SB Q CornerCrete™ Slurry Matrix Decorative Quartz Polyurethane Flooring System
- CS 5000T CornerCrete™ Trowel Matrix Polyurethane Flooring System
- CS 5000F BioFloor Heavy Duty Decorative Paint Flake Polyurethane Flooring System

Green Building and LEED Certification

Corner*Stone*'s products can help architects and building contractors to achieve LEED Certification. We strive to employ the best performing and longest lasting solutions. This in turn equals better solutions for the environment.

LEED Credits Summary	Potential Points
Sustainable Sites	
SS Credit 4.2: Alternative Transportation - Bicycle Storage & Changing Rooms - Corner*Stone* Flooring can contribute by providing waterproof membranes and skid resistant finishes where necessary to assist with safety.	1

Sustainable Sites SS Credit 4.3: Alternative Transportation - Low Emitting & Fuel Efficient Vehicles - Corner*Stone* Flooring can contribute by providing chemically resistant coatings and linings where onsite fuel containment and protection is needed.	1
Water Efficiency WE Credit 2: Innovative Wastewater Technologies - Corner*Stone* Flooring can contribute by providing primary and secondary containment systems to capture various liquids and contaminants.	1
Energy & Atmosphere EA Credit 1: Optimize Energy Performance - Corner*Stone* Flooring can contribute by providing the option of floor and wall gloss finishes for greater reflectivity allowing for the use of lower wattage lighting.	1

Materials & Resources MR Credit 1.2: Building Reuse, Maintain 50% of interior non-structural elements	1-2
Materials & Resources MR Credit 5: Regional Materials, 10% to 20% Extracted, Processed & Manufactured Regionally - Corner*Stone* Flooring assembles our materials on site and manufactures at facilities within 500 miles of many project sites.	1
Indoor Environmental Quality EQ Credit 3.1: Construction IAQ Management Plan During Construction - Corner*Stone* Flooring can employ the use temporary air handlers and filtration media to assist with developing and implementing an Indoor Air Quality (IAQ) Management Plan.	1
Indoor Environmental Quality EQ Credit 4.2: Low-Emitting Materials, Paints & Coatings - Corner*Stone* Flooring can provide low odor and low/zero VOC flooring systems with low to zero off-gassing.	1

CURECRETE: Ashford formula

TECHNICAL DATA
Product Description: Colorless, Odorless, Non-toxic, Non-combustible, Non-flammable Contains no Volatile Organic Compounds (VOCs)
Uses: Concrete, new and old, rough or smooth surfaces Concrete Block Exposed Aggregate, Any Sand/Aggregate Cement Combinations
Functions: Seals, dust proofs, hardens, and cures. Protects against dusting, pitting, palling, efflorescence, temperature cracking in concrete. Inhibits freeze/thaw deterioration. Neutralizes excess internal alkali from concrete
Packaging: 55 Gallon Drum/208 Liters 5 Gallon Pail/19 Liters
Storage Life: Two years. Agitate drum or pail before using.
Surface Preparation: Freshly Finished Concrete: no preparation required. Existing Concrete: sweep, scrub, or strip concrete to remove any surface contamination or film. Product must be able to penetrate the surface without hindrance.
Application: Single application only. Apply with low-pressure sprayer (power), rollers, brush, or fine/soft bristled broom.
Coverage Rate: Approximately 200 square feet per gallon; 5 meters per liter.
Drying Time: One to three hours.
Appearance After Application: Smooth Troweled Concrete: permanent, marble-like sheen develops within 4-12 months. Burnishing the concrete surface with a propane burnisher will accelerate the sheen. All Other Concrete Surfaces: retention of natural finish.
Temperature Limits: Applicable in temperatures up to 135º F/57ºC or as low as 35ºF/1.7ºC if the concrete is covered by plastic and completely protected from freezing for a period of 6 days.
Thinners, Primers and Painting: No thinners or primers required. Painting on New Concrete: allow at least 7 drying days before applying Painting on Existing Concrete: allow 28 days for proper curing before painting
Colored Concrete: Apply to colored concrete only after the slab is fully cured. Do not get on glass or other finished surface.
Limitations: Do Not Apply the Ashford Formula to: Lightweight block or other extremely porous masonry containing actual holes or air pockets. Areas previously treated with curing or sealing agents, unless these coatings have completely worn off or have been removed by chemical or mechanical means.

- **ENVIRONMENTALLY FRIENDLY GRID CEILINGS**
  ARMSTRONG: Tierra

TIERRA™

Square Lay-in

fine texture

cradle to cradle CERTIFIED SILVER

This commercial ceiling tile has been certified for its material content, recyclability, and manufacturing characteristics. c2ccertified.com

Rapidly Renewable: 44% armstrong.com/greengenie

LEED® Credits

Energy	Waste Mgmt	Local Materials	Renewable Materials	Daylight & Views
✔	✔		✔	✔

Location Dependent

LEED for Schools

Acoustics	Low Emitting or CHPS
✔	✔

$$$$$

Tierra Square Lay-in (2' x 2') with Suprafine® XL® 9/16" grid

Key Selection Attributes

- Natural, BioAcoustic™ substrate
- 44% rapidly renewable substrate made from jute, a plant that grows from seed to harvest in 100 days
- Tierra is listed as a USDA BioPreferred® product
- The first and only *Cradle to Cradle Certified™ Silver* acoustical ceiling panel
- Outstanding acoustical performance for open plan areas, both Articulation Class (180) and NRC (0.85)
- Smooth, clean, durable finish – Washable, Impact-resistant, Scratch-resistant, Soil-resistant
- Energy-saving high light-reflective finish
- Non-directional visual reduces installation time and scrap
- 30-Year Limited System Warranty against visible sag, mold/mildew, and bacterial growth

Typical Applications

- Open plan spaces:
  - Office
  - Education
  - Healthcare – assists in addressing HIPAA requirements and FGI Guidelines (walls-to-deck)
- Corridors (walls-to-deck)
- Auditoriums
- Areas with indirect lighting

Color

White (WH)

Visual Selection

Performance Selection

Dots represent highest level of performance.

Edge Profile	Item No.	Dimensions		UL Classified Acoustics NRC	CAC	AC	Fire Rating	Light Reflect	Sag Resist	Anti-Microbial	Durable			
TIERRA Square Lay-In														
9/16" Square lay-in	**3462**	2' x 2' x 5/8"	☐	0.85 •	N/A	180 •	Class A	0.88 •	HumiGuard+ •	BioBlock+ •	Wash •	Impact •	Scratch •	Soil •
15/16" Square lay-in	**3460**	2' x 2' x 5/8"	☐	0.85 •	N/A	180 •	Class A	0.88 •	•	•	•	•	•	•

Suspension Systems

15/16" Prelude®

9/16" Suprafine

USG: Mars™ Clima Plus™ & Eclipse™ Clima Plus™

Sustainability Tables

USGBC LEED® credits		MR 4.1 & 4.2				EQ 8	EQ Pre 3 & EQ 9		
Product Family: Acoustical Panels and Tiles		Post-Consumer		Pre-Consumer		LR	NRC	CAC	Approx. Density (lbs/cft)
		Class A	FC	Class A	FC				
X-Tech.	Eclipse™ Clima Plus™	0%	0%	65%	69%	0.86	.65 / .70	35	17
	Millenia™ Clima Plus™	0%	0%	75%	62%	0.87	0.70	35	17
	Mars™ Clima Plus™	0%	NA	76%	NA	0.89	0.70	35	17

EQ 3.2 & EQ 4		MR 6	MR 5.1 / 5.2 & EQ 10
CHPS	Formaldehyde & VOC Emissions	Rapid Renew	Raw Materials / Comments (% by weight)
Pass	Low	1 - 2%	**X-Technology manufactured at Cloquet, MN.** Slag wool (Preconsumer %) from Red Wing, MN, 5% Acrylate Polymer (local), starch (Rapid Renew %) from Clinton, MN; Estimated embodied energy ~ 9kWh/SF for a 17 lb/cft 3/4" thick panel
		1 - 3%	
		2%	

Appendix 7: Outline for a Commissioning Plan

Commissioning Plan Outline

1. General Building Information

Project Name	
Project Address	
Building Type	
Square Footage	
Building Description	
Owner Agency	
Scheduled Completion Date	

2. Overview

2.1 Abbreviations and Definitions

The following are common abbreviations used in this document.

A/E	Architect and design engineers	FPT	Functional performance test
CP	Commissioning provider	GC	General contractor
CC	Controls contractor	MC	Mechanical contractor
CX	Commissioning	PF	Pre-functional checklist
EM	Energy Manager	PM	Project Manager
CX Plan	Commissioning Plan document	Subs	Subcontractors to General
EC	Electrical contractor	TAB	Test and balance contractor
MM	Maintenance Manager	Staff	Maintenance Staff

2.2 Purpose of the Commissioning Plan

The purpose of the commissioning plan is to provide direction for the commissioning process during construction, providing resolution for issues such as scheduling, roles and responsibilities, lines of communication and reporting, approvals, and coordination.

2.3 Commissioning Goals and Objectives

Commissioning is a systematic process of ensuring that the building systems perform according to the design intent and the owner's operational requirements. All equipment and systems should be installed according to manufacturer's recommendations and the best practices and standards of the industry.

Commissioning will include documenting the design intent, followed by activities in the construction, acceptance, and warranty phases of the project. The participation of the contractors in commissioning activities will follow the requirements defined in the specifications. The three main goals of the commissioning process are:

Energy Design Resources Commissioning Plan

1. Facilitate the final acceptance of the project at the earliest possible date.
2. Facilitate the transfer of the project to the owner's maintenance staff.
3. Ensure that the comfort systems meet the requirements of the occupants.

Commissioning is also intended to achieve the following specific objectives:

- Document that equipment is installed and started per manufacturer's recommendations.
- Document that equipment and systems receive complete operational checkout by installing contractors.
- Document system performance with thorough functional performance testing and monitoring.
- Verify the completeness of operations and maintenance materials.
- Ensure that the owner's operating personnel are adequately trained on the operation and maintenance of building equipment.

2.4 Commissioning Scope

The following marked systems will be commissioned in this project. All general references to equipment in this document refer only to equipment that is to be commissioned.

System	Equipment	Check
HVAC System	Chillers	
	Pumps	
	Cooling tower	
	Boilers	
	Piping systems	
	Ductwork	
	Variable frequency drives	
	Air handlers	
	Packaged AC units	
	Packaged HP units	
	Terminal units	
	Unit heaters	
	Heat exchangers	
	Computer room cooling units	
	Fume hoods	
	Lab room pressures	
	Exhaust fans	
	Chemical treatment systems	
	HVAC control system	

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	Fire and smoke dampers	
Electrical System	Sweep or scheduled lighting controls	
	Daylight dimming controls	
	Lighting occupancy sensors	
	Power quality	
	Security system	
	Emergency power system	
	UPS systems	
	Fire and smoke alarm systems	
	Fire protection systems	
	Communications system	
	Public address/paging systems	
	Low Voltage Distribution Cable	
	Distribution Panel Circuit Breakers	
	Ground Fault Detection	
	Automatic Transfer Switch	
Other	Service water heaters	
	Refrigeration systems	
	Kitchen Equipment	

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3. Commissioning Team Information

Function	Name/Address	Contact Info
Owner		
Project Manager		
Commissioning Provider		
Architect		
Mechanical Engineer		
Electrical Engineer		
General Contractor		
Mechanical Contractor		
Electrical Contractor		
Controls Contractor		
Maintenance Manager		

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4. Roles and Responsibilities

General Management Plan

In general, the CP coordinates the commissioning activities and reports to the owner's construction representative. The CP's responsibilities, along with all other contractors' commissioning responsibilities are detailed in the specifications. The Specifications will take precedence over this Commissioning Plan. All members work together to fulfill contracted responsibilities and meet the objectives of the Contract Documents.

4.1 General Descriptions of Roles

General descriptions of the commissioning roles are as follows:

CP: Coordinates the CX process, writes and/or reviews testing plans, directs and documents performance testing.

PM: Facilitates and supports the CX process and gives final approval of the CX work.

MM: Coordinates maintenance staff participation in commissioning activities.

GC: Facilitates the CX process, ensures that Subs perform their responsibilities and integrates CX into the construction process and schedule.

Subs: Demonstrate correct system performance.

Staff: Participate in commissioning tasks and performance testing, review O&M documentation, attend training.

A/E: Perform construction observation, approve O&M manuals and assist in resolving problems.

Mfr.: Equipment manufacturers and vendors provide documentation to facilitate the commissioning work and perform contracted startup.

4.2 Specifications and Commissioning

Commissioning language in the specifications details the scope of commissioning for this project. The following table lists the sections of the specifications that include commissioning related language with a brief description.

Table 4-1: Specifications Related to Commissioning

Section	Description

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4.3 General Management Plan and Protocols

The following protocols will be used on this project.

Issue	Protocol
For requests for information (RFI) or formal documentation requests:	The CP goes first through the PM.
For minor or verbal information and clarifications:	The CP goes direct to the informed party.
For notifying contractors of deficiencies:	The CP documents deficiencies through the PM, but may discuss deficiency issues with contractors prior to notifying the PM.
For scheduling functional tests or training:	The CP provides input and coordination of testing and training. Scheduling is done through the PM.
For scheduling commissioning meetings:	The CP selects the date and schedules through the PM.
For making a request for significant changes:	The CP has no authority to issue change orders.
For making minor changes in specified sequences of operations:	Any required changes in sequences of operations required to correct operational deficiencies must be approved and documented by the PM and A/E team. The CP may recommend to the PM changes in sequences of operation to improve efficiency or control.
Subcontractors disagreeing with requests or interpretations by the CP shall:	Resolve issues at the lowest level possible. First with the CP, then with the GC and PM. Some issues may require input from the A/E team.

5. Commissioning Process

This section sequentially details the commissioning process by commissioning task or activity.

5.1 Commissioning Scoping Meeting

The scoping meeting brings together all members of the design, construction, and operations team that will be involved in the commissioning process. Each building system to be commissioned is addressed, including commissioning requirements, and completion and start-up schedules. During the scoping meeting, all parties agree on the scope of work, tasks, schedules, deliverables, and responsibilities for implementation of the Commissioning Plan.

5.2 Final Commissioning Plan

The commissioning agent finalizes the draft Commissioning Plan using the information gathered from the scoping meeting. The initial commissioning schedule is also developed along with a detailed timeline. The timeline is fine-tuned as construction progresses.

5.3 Design Intent Documentation

The design requirements, relative to the building systems selected for commissioning, must be explicitly documented in order to establish a baseline of performance expectations to which the actual installed performance is compared. The commissioning provider, with the assistance of the building owner and design team, prepares a Design Intent Summary that documents the design intent for those building systems selected for commissioning. The Design Intent Summary reflects the underlying assumptions and requirements that become represented in the construction documents.

5.4 Submittals

The general contractor will provide the commissioning agent with a set of equipment and system submittals. This equipment data includes installation and start-up procedures, O&M data, performance data and temperature control drawings. The subcontractors, general contractor or A/E notify the commissioning agent of any new design intent or operating parameter changes, added control strategies and sequences of operation, or other change orders that may affect commissioned systems.

5.5 Site Observation

The commissioning agent makes periodic site visits to witness equipment and system installations. Each site visit will have a specific agenda and will be coordinated with the general contractor site supervisor. The commissioning agent attends selected planning and job-site meetings in order to remain informed on construction progress and to update parties involved in commissioning. The general contractor provides the commissioning agent with information regarding substitutions or change orders that may affect commissioned equipment or the commissioning schedule.

Energy Design Resources Commissioning Plan

5.6 Pre-functional Checklists and Startup Procedures

A Pre-Functional Inspection Checklist are developed and completed for all mechanical equipment being commissioned. The checklist captures equipment nameplate and characteristics data, and confirms the as-built status of the equipment or system. The checklists ensure that the systems are complete and operational and document the installation of components and completion of systems.

The checklists are prepared by the commissioning agent from manufacturer's data, drawings and specifications to include the required installation, checkout, and start up procedures. The installing subcontractors date and initial the checklists as the construction and start-up is completed. The commissioning agent reviews and verifies the completed checklists before scheduling the functional performance testing.

5.7 Development of Functional Test and Verification Procedures

Functional performance testing verifies the intended operation of individual components and system interactions under various conditions and modes of operation. The systems are run through all of the sequences of operation and the response of components is verified. Testing proceeds from components to subsystems to systems, and finally to interlocks and connections between systems.

The commissioning agent prepares functional performance test plans so that the complete sequence of operations is included. The commissioning agent obtains all documentation, including an updated points list, control sequences, and setpoints. If necessary, the commissioning agent may request clarifications from contractors and the design team regarding sequences and operation. Prior to execution, the commissioning agent provides a copy of the primary equipment tests to the installing subcontractor and general contractor who can review the tests for feasibility, safety, warranty and equipment protection.

5.8 Execution of Functional Testing Procedures

The commissioning agent schedules functional tests through the general contractor and subcontractors. Under the supervision of the commissioning agent, the installing subcontractor performs the hardware and/or software manipulations required for the testing. Owner maintenance staff may also be present in order to assist in system observations. The commissioning agent witnesses and records the results of functional performance testing.

Any deficiencies found from functional performance testing will be documented in a Deficiency Report. The report will include all details of the components or systems found to be non-compliant with the parameters of the functional performance test plans and design documents. The deficiency report will become part of the punch list. The report will detail the adjustments or alterations required to correct the system operation, and identify the responsible party. The deficiency report will be continuously updated. The commissioning agent schedules any required retesting through the general contractor. Decisions regarding deficiencies and corrections are made at as low a level as possible, preferably between commissioning agent, sub-contractor and general contractor.

5.9 Short-Term Diagnostic Monitoring

Short-term diagnostic testing, using data acquisition equipment or building automation system trends to record system operation over a two to three week period, may be used to investigate the dynamic interactions between components in the building system.

The monitoring occurs after occupancy to evaluate the building systems' performance under natural occupancy and ambient load conditions. The objectives of the monitoring are to evaluate scheduling, the interaction between heating and cooling, and the effectiveness of the system in meeting the comfort requirements of the occupants. .

5.10 Operations and Maintenance Manuals

The operation and maintenance manuals prepared by the contractors for the owner's maintenance personnel are reviewed for completeness. The contractors are encouraged to submit O&M manuals at the earliest possible date. Materials may be added, or requested from the contractors, to stress and enhance the importance of system interactions, troubleshooting, and long-term preventative maintenance and operation. A database of preventative maintenance information may also be created from the materials in the O&M manuals.

5.11 Training and Orientation of Owner Personnel and Occupants

Effective maintenance personnel training is critical to the long term performance of the new building. The commissioning agent will assist the owner and general contractor in organizing the training sessions by identifying the appropriate staff for each session and creating an overall training plan.

For each training session, the contractors provide a detailed agenda for each piece of equipment or system for which training is required. The agenda describes the training scope, duration, and methods, along with the name and qualifications of the trainers. The commissioning agent develops a plan for including in the training session contractors / trainers from different disciplines, when appropriate. The trainer documents each training session (duration, general subjects covered, and attendees). The commissioning agent may witness any of the training sessions.

5.12 Warranty Period

Seasonal variation in operations or control strategies may require additional testing during peak cooling and heating seasons to verify system performance. During the warranty period, seasonal testing and other deferred testing is completed as required to fully test all sequences of operation. The commissioning agent coordinates this activity. Tests are executed and deficiencies corrected by the appropriate subcontractors, witnessed by facilities staff and the commissioning agent. Any final adjustments to the O&M manuals and as-builts due to the testing are made.

The commissioning agent will request input from the owner's operations staff and occupants about the performance of the building systems. The commissioning agent also supports the general contractor's troubleshooting process during the warranty period. The general contractor's warranty team will first try and resolve the issues before requesting assistance from the commissioning agent.

5.13 Commissioning Report

A final Commissioning Report will be compiled which summarizes all of the tasks, findings, and documentation of the commissioning process. The report will address the actual performance of the building systems in reference to the design documents. All test reports by various sub-contractors, manufacturers and controlling authorities will be incorporated into the final report.

The commissioning report includes:

- An evaluation of the operating condition of the systems at the time of functional test completion,
- Deficiencies that were discovered and the measures taken to correct them,
- Functional test procedures and results,
- Reports that document all commissioning field activities as they progressed, and
- A description and estimated schedule of required deferred testing.

6. Schedule

6.1 General Issues

The following sequential priorities are followed:

1. Equipment is not "temporarily" started (for heating or cooling), until pre-start checklist items and all manufacturer's pre-start procedures are completed and moisture, dust and other environmental and building integrity issues have been addressed.
2. Functional performance testing does not begin until pre-functional, start-up and TAB is completed for a given system.
3. The controls system and equipment it controls are not functionally tested until all points have been calibrated and pre-functional checklists are completed.

Energy Design Resources Commissioning Plan

6.2 Project Schedule

Preliminary Commissioning Schedule

Commissioning Activity	Duration	Estimated Start Date	Estimated Completion Date
Document design intent and basis of design			
Commissioning Plan			
Preliminary Commissioning Plan			
Scoping Meeting			
Final Commissioning Plan			
Submittals and test writing			
Review Mechanical submittals			
Write Startup and PF checklists			
DDC program review meeting			
Write FPT Tests			
Construction Observation			
Site observations			
HVAC PF checklist completion			
Equipment startup			
Startup documentation			
Controls system checkout			
Test and Balance			
TAB air side			
TAB water side			
HVAC Functional performance testing			
Substantial Completion			
Post Acceptance Phase			
Owner move-in			
Short-term diagnostic monitoring			
O&M, training, reporting, warranty			
O&M Manuals submitted			
Review O&M manuals			
Review as-built documentation			
Seasonal testing			
Final commissioning report			

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