



# Introduction to the FLL Guidelines for the Planning, Construction and Maintenance of Green Roofing

- 2008 Edition of the Green Roofing Guideline –

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Presents

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## PREFACE

The FLL Green Roofing Guideline first appeared in 1982 as the “Principles of Green Roofing” and since 1992 has been reworked many times as “Guideline for the Planning, Construction and Maintenance of Green Roofing – Green Roofing Guideline.” It is recognized as the benchmark set of regulations for green roofing in Germany. The FLL Roof Greening Guideline is also widely accepted abroad and serves in some neighboring countries as the basis for developing their own regulations.

The FLL Green Roofing Guideline is linked into the DIN and EN standards and other regulatory publications and is therefore closely bound to the given building and construction standards. This interdisciplinary relationship and the many changes contained therein form the basis to the revision of the Green Roofing Guideline.

With this 2008 edition, the proven contents of the 2002 edition have been retained and expanded upon with the newest developments and knowledge. Together with editorial adaptations and the alignment to changed or revised regulations, such planning values as the load bearing and water storage of various materials have been extended and updated.

Most alterations affect the vegetation substrates (or growing media). An example is the development on the market of single-layer intensive greening vegetation construction which has been duly integrated into this work. This guideline now recognizes the differences in substrates required for intensive and extensive vegetation and intensive and extensive vegetation with single-layer construction. This single-layer construction technique should not be used without critical evaluation. The maintenance in respect to plant selection is worthy of special consideration.

Various investigative methods and reports, and the varying interpretations of the results, demanded a comprehensive extension to the specifications for the investigation of the testing methods, the test samples, the content and structure of the investigation and test result, together with their period of validity.<sup>1</sup>



## INTRODUCTION

The preceding page is a segment from the opening preface of the 2008 edition of the FLL Green Roofing Guideline. The preface clearly states the importance and relevancy of the Guideline and the constant diligence taken to adapt and outline the newest developments in the green roofing industry. The Guideline is the result of unpaid technical and scientific cooperative work and is intended to be a recognized code of practice or State-of-the-Art; it is a basic tool for the planning, construction and maintenance of reliable and high quality performing green roofs. The Guideline also includes transparent, consumer oriented testing methods for the investigation of vegetation substrates and aggregate drainage materials and the investigation of resistance to root penetration of roof membranes and protective layers.

The North American green roof market has grown rapidly in the last decade and is only beginning to emerge from its infancy. Innumerable companies are designing, specifying, installing and maintaining green roofs for the first time. Unlike in Germany, where green roofs are highly standardized, many projects in North America are experimental or use antiquated technologies and inappropriate materials unsuited for modern green roofing. For the individual, the evaluation of research results and technical information from manufactures and material suppliers remains convoluted and difficult to interpret.

The development of the German green roof market has been slow when compared to the North America market. Because modern green roofing technology originated in Germany in the late 1970's, standards have been able to evolve simultaneously to the technological progress. The rapid importation of foreign green roofing technologies did not allow for such a harmonious evolution with North American building standards. The variety of North American green roofing definitions, requirements, standards and testing methods remains prohibited for many manufactures, designers and installers. The goal of any building guideline and codes should be to provide a common basis for everyone involved in the industry and to avoid potential roof failures.

In the following three sections, this paper will provide a brief summary of the three major components of the Green Roofing Guideline: Planning, Execution, and Maintenance. It is important to note that the Guideline requires a fundamental background in horticultural science and engineering principals. The Guideline is not an IKEA step-by-step construction manual designed to enable any Do-It-Yourself project.



## PLANNING

Welcome to the fascinating world of green roofing. Everywhere you look, you will now say to yourself, 'that should have a green roof.' In Chapters 1 through 6 the Green Roofing Guideline will prepare you to plan any type of green roof your mind can imagine.

**Chapter 1** opens the Guideline and begins with 'Area of Validity.' This section succinctly points out what the Guideline will be outlining and its purpose.

The purpose of the guidelines is to set out the basic principles and requirements which apply in general terms to the planning, execution and maintenance of such schemes, taking full account of current knowledge and the most advanced technology. They deal with additional basic principles relating to the planning and construction of properties, and the emphasis is on technical requirements in respect to construction and vegetation. These guidelines are intended for the use of professionals and trades people working in all relevant sectors and trades.<sup>ii</sup>

**Chapter 2** simply outlines all the quoted standards and other regulations cited throughout the Guideline. It is essential to familiarize yourself with these standards and other guidelines and codes of practices to gain a complete working knowledge of green roofing. The standards and guidelines also lay down general standards and requirements that provide a basis for agreements between clients, planners and contractors. Most of the standards and codes used in the Green Roofing Guideline originate in Germany but typically fall in line with international standards.

**Chapter 3** outlines the three types of greening, their different forms of vegetation, structure-dependent factors and plant specific factors. Green roofing is divided into three different types, depending on use, construction factors and the method used to carry out the work. These play a critical part in determining both the plant types which are selected and how the vegetation will look.<sup>iii</sup> The three types of greening are intensive greening, simple intensive greening, and extensive greening.

**Chapter 4** is an informational section that educates the reader on the functions of a green roof and the positive effects they have on the surrounding environment.

**Chapters 5 & 6** are titled 'Requirements related to Construction and Material' and 'Technical Requirements for the Roof Construction' respectfully. Contained within these chapters are sections that deal with the following topics.

- What roof slopes are appropriate
- How design loads have to be adjusted
- How the drainage and watering facilities are affected
- That green roofs must be accessible for maintenance staff
- That protection devices must be provided if there is a danger of potential falls
- That green roofs need a root resistant membrane
- How the membrane can be protected against mechanical impact



- How roof outlets should be constructed
- How high the membrane has to be brought up above the surface of the green roof
- How hot or cold air from vents, AC-units or exhausts from chimneys will affect the green roof
- How loads effect different areas of the roof
- When a green roof can be considered fire-resistant
- When sloped roofs need special measures to prevent slipping of the green roof
- How paved areas should be construct

While not a comprehensive list of every topic covered in Chapters 5 & 6, the preceding list is an appropriate summary of the keys sections. It is important to mention that each topic is covered individually but is also considered for its interactions with every other topic.

Considerations: roof pitch, design load, draining, irrigation, compatibility of materials, environmental compatibility and plant tolerance/risk of phytotoxicity.



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## EXECUTION

"The construction of vegetation areas consists of several functional layers/courses. These layers are made from various materials and fulfill clearly defined roles in the construction. They are combined in a way to achieve full functionality and harmonise together to the best possible effect."<sup>iv</sup>

Taken from Chapter 7, section 2, the above quote summarizes the task at hand which is described in chapters 7 through 12.

**Chapter 7** is titled 'Requirements for the Construction of Vegetation Areas' and begins by defining the different working courses of a green roof. It goes on to provide a list of factors that need to be taken into consideration when determining the depth of the drainage and vegetation support courses. It is worth noting that the FLL Green Roofing guideline does not provide any product names or material sources, only a list of material groups and types and a very precise description of material specifications and performance requirements for each course. Multiple sections are dedicated to water retention and water storage. Information on water retention takes into account maximum water capacity, water permeability and coefficients of discharge depending on system specifications. This section is essential for stormwater calculations. Information on water storage takes into account the availability of water to support the vegetation layer.

**Chapters 8 & 9** discuss the 'Drainage Course' and 'Filter Layer'. The chapter on the drainage course contains three sections that outline acceptable materials, requirements and construction information. In these sections you will find information on acceptable aggregate types, frost resistance, pH-value, carbonate content, salt content and more. The chapter on filter layers is outlined in a similar manner. In the sections on the filter layer you will find information of required density, mechanical stress resistance, resistance to microorganisms, tensile strength and more. Construction details are provided too.

**Chapter 10** discusses the 'Vegetation Support Course.' Outlined in a similar manner in three sections, the chapter on the vegetation support course is among the most detailed and longest in breadth, which is not hard to imagine because the media is the most important component of a successful green roof. Contained within the chapter is an extensive listing of every detail that must be taken into consideration when engineering a green roof media.

One of the main features is the section on the granulometric distribution of green roof media. It provides charts showing the grain percentage by mass as a percent of the total volume in relation to grain diameter. This method for describing the grain size distribution is basically the same as determining the percentage of material being retained by different sieves, as is common in the United States. The results of the FLL method are much easier to interpret though. By comparing the graphical results of your sample to the given grading curve of a substrate distribution, it is easy to see if your sample is within required range.

The Green Roofing guideline also sets clear limits on the content of organic matter, structural and bedding stability, water permeability, maximum water capacity, air content, pH-value, salt and nutrient content and more. The section is long and dense with a dizzying amount of specifications. Additionally,



in Appendix 2 there is an incredibly detailed outline of the 'Investigative methods for vegetation substrate and drainage aggregates for green roof.' These are the test procedures used at universities and media blenders.

**Chapter 11** is titled 'Requirements of Seeds, Plants and Vegetation.' The title of the chapter is self-explanatory. A distinction is made between the following propagation and trading groups: seeds; shoots; perennials; bulbs; shrubs/bushes/woody plants; lawn turf; vegetation matting.

**Chapter 12** discusses greening and its execution. The chapter also outlines the requirements for ensuring the stability of trees and shrubs, prevention of erosion and all aspects of completing a green roof, the acceptance criteria, and turning it over to the proprietary owner.



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## MAINTENANCE

The maintenance objectives and the individual tasks that will need to be performed must be customized to the greening method, the type of vegetation, the development condition of the vegetation and the overall development goals. The range of greening objectives lies between aesthetic-ornamental gardens on the one side and ecologically optimized greening on the other.<sup>v</sup>

**Chapter 13** strongly recommends a maintenance plan and contract be developed. The Green Roofing Guideline lists all aspects that must be considered, differentiating between intensive greening and extensive greening. As stated above, the degree of maintenance required will depend on the type of greening system as well as the desired appearance—aesthetic-ornamental garden will require a higher degree of maintenance, while ecologically optimized systems will require less. These two approaches are not mutually exclusive to intensive roofs and extensive roofs. An ornamental extensive greening system may require a higher degree of maintenance than an ecologically optimized intensive greening system. All contractual maintenance arrangements should set out long-term aims and objectives for the green roof.

**Chapter 14** is titled 'Erosion Protection' and outlines the additional measures that must be taken to ensure the safety and success of a green roof project during and after construction. There is always a risk of attack from wind and water; until the vegetation has firmly rooted the system layers together, the vegetation support course, plants, and seeds are at risk. High risk areas are site specific for each project and appropriate actions will have to be made, whether they are temporary or longer-term.

### Chapter 15

It is recommended to agree to the following contractual limitation periods for warranty:

- For the construction of structure and all technical installations 4 years;
- For the production of vegetation, if the contractor for the roof  
Greening will also be awarded the development care 2 years.

Should any claims arise after this contractual limitation period expires (e.g. loss of plants) the client is entitled to claim warranty only if the defects are due to faulty services provided by the contractor.<sup>vi</sup>

The above section is a direct quotation of chapter 15 in its entirety.



## SUPPLEMENTS

**Chapter 16** is titled 'Testing' and acts as an introduction and guide to the three appendixes. The chapter begins by summarizing the two different forms of testing, testing for suitability and inspection testing, and explains the structure of testing and their quantitative reports.

**Appendix I** – Informative orientation values for load bearing and water storage.

**Appendix II** – Investigative methods for vegetation substrate and drainage aggregates for green roofing.

**Appendix III** – Procedure for investigating resistance to root penetration at green-roof sites.

Each appendix, and the corresponding test, is too substantial to summarize here. Green Roof Service LLC has aided many universities and businesses to establish their green roof testing methods.

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<sup>i</sup> Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau e.V., Guideline for the Planning, Construction and Maintenance of Green Roofing, Release 2008.

<sup>ii</sup> Ibid.

<sup>iii</sup> Ibid.

<sup>iv</sup> Ibid.

<sup>v</sup> Ibid.

<sup>vi</sup> Ibid.

