Green Roofs as Layer Cake

Addressing Urban Issues Through Green Roof Design

Paul Peters, B.A., MLA Candidate

ABSTRACT Green roofs by their very nature are highly manipulated landscapes. Their designs therefore call for a clearly defined set of goals and objectives in order to be successful. This paper uses a case study of Potsdamer Platz in Berlin, Germany to examine a rigorous approach to achieving a set of clearly defined goals throughout the green roof design process. Through examinging the objectives and success of a water-based design in Berlin along with its applicability to the Vancouver context and emerging theories in regarding rooftop habitat creation, this study begins to suggest a heavily layered and intertwined set of green roof objectives for Vancouver.

INTRODUCTION

Urban development, whether it be on brownfield or greenfield sites, creates intense negative pressures on our natural environments. It hides existing stream channels, creates concrete deserts for wildlife, and handcuffs species from migrating throughout a region (Dreiseitl). As humans we live within the natural environment and rely upon its health for ours: we rely on the return of rainwater to underground aquifers for our drinking water, and we rely on pollenators and biodiversity for our food supplies. This paper examines the ability for green roofs to address current issues in the contemporary urban environment including the loss of habitat and decrease in pervious surfaces in order to reveal the full potential of green roofs. It examines the weaknesses in our current applications of green roofs and investigates how they might become more environmentally, financially, and socially valuable places.

CASE STUDY: POTSDAMER PLATZ, BERLIN

Completed in 1998, the Daimler Chrysler portion of Potsdamer Platz, encompassing over 40,000 cubic metres of intensive green roof (shown in Figure 1), supports an integrated rainwater management system (Kolher). This site was chosen as a case study based on its clear goals and objectives which were laid out in the initial stages of the project, allowing one to critically analyze its success and failures. Furthermore, detailed documentation from the early stages of design through to its maturation provide sufficient and well-rounded data for drawing conclusions about the overall effectiveness of this green roof.

With increased pressures from urban development and a reduction in green space within the city, Berlin's planning department wanted the Potsdamer Platz development to address issues related to lack of space for leisure and recreation (Dreiseitl). To address this, a series of intensive green roofs were implemented within building courtyards and patios to provide a multitude of spaces for public and private leisure. In order to more effectively deal with urban runoff, extensive green roofs were used in areas where public access was limited.

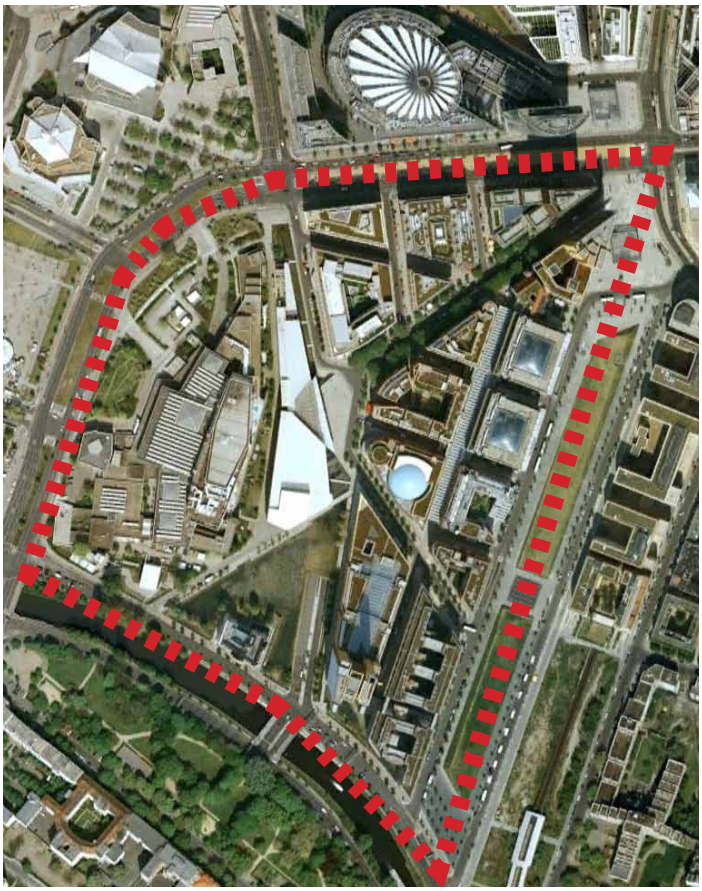

Figure 1. Potsdamer Platz in Berlin, Germany (Google Earth)

At the time of Potsdamer Platz's construction, Berlin was already revered as being a leader in green roofs for several reasons including its utilization of green roofs for rainwater retention, filtering airborn pollutants, providing patch habitats within 'concrete deserts', and reducing roof surface temperatures (Kohler). The objectives of Potsdamer Platz aimed to push this reputation further by addressing issues of urban ecology, specifically water quality and use, by reducing the potable water needed for irrigation. Rainwater throughout the site is captured after percolating through the green roof systems into an intensive water recycling system designed by Dreiseitl. For the purpose of this paper, the inner workings of Dreiseitls pond designs will not be explored. Instead, the relationship between the green roofs and cistern system need to be recognized so that it can be understood that a holistic approach to stormwater management was sought and achieved.

In order to avoid the mixing of sewage and rainwater during heavy storm periods a series of measures were adapted at Potsdamer Platz:

- Extensive and intensive roofs were both used throughout the site
- Roof water runoff was collected for toilet flushing and irrigation
- And rain events were used to refill the artificial lake which doubles as a water retention feature

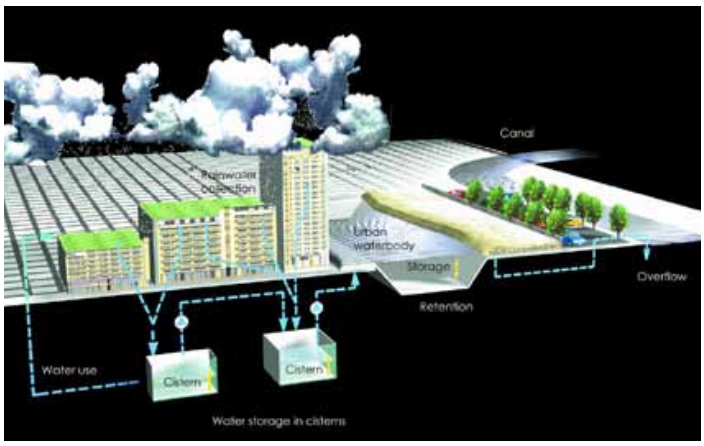

Figure 8. Water Recycling System (Dreiseitl)

COMPARING CLIMATES

A climate comparison between Vancouver and Berlin is shown on the opposite side of this page as a means of examining the validity of a similar water management system within the Vancouver context.

TEMPERATURE COMPARISON: Berlin to Vancouver

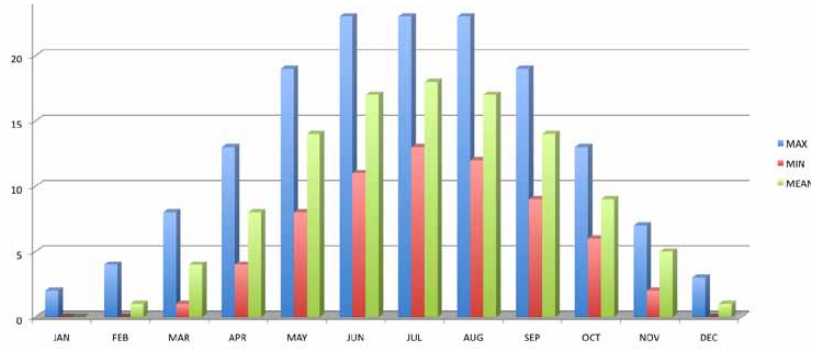

Figure 4. Berlin Temperature (C)
Data adapted from The Weather Network based on 30 year data from 1961 to 1991

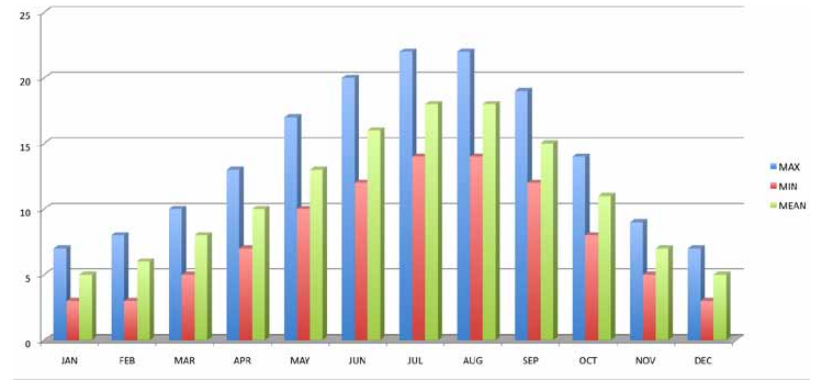

Figure 6. Vancouver, BC Temperature (C)
Data adapted from The Weather Network based on 30 year data from 1961 to 1991

PRECIPITATION COMPARISON: Berlin to Vancouver

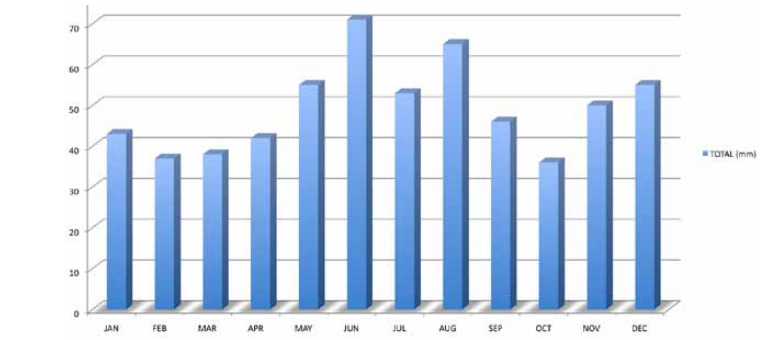

Figure 5. Berlin Precipitation (mm)
Data adapted from The Weather Network based on 30 year data from 1961 to 1991

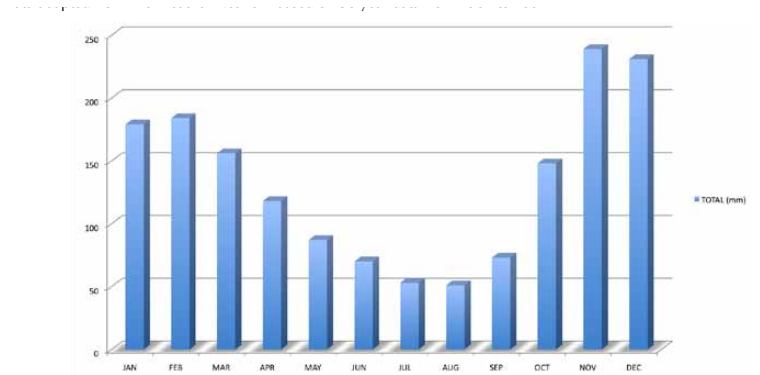

Figure 7. Vancouver, BC Precipitation (mm)
Data adapted from The Weather Network based on 30 year data from 1961 to 1991

First, looking at the relationship between Berlin's temperature and precipitation it is apparent that as summer temperatures rise, the green roofs are still supplied with a moderate amount of rainfall during the warmer months. In Vancouver, however, there is a shortage of rainfall in the summer months during warm temperatures. It can therefore be assumed that some form of irrigation will be required to offset this deficit in rainfall. The difference in the required irrigation methods for the summer months is just one example of the need for green roof design to be site specific and adaptive. Each green roof calls for not only a unique set of goals and objectives, but also a unique design that enables the roof to meet those objectives within its climatic constraints.

The performance of the Potsdamer Platz green roof in managing water is exemplary. It captures 20,000 cubic metres of rainfall every year (Kohler) through its integrated use of intensive and extensive roofs. Water is not only captured and retained in the soils and plants on the green roofs, it is also filtered, stored in cisterns, and reused for toilet flushing and irrigation. Additional excess water is also used to fill an artificial lake. Through these means, Potsdamer Platz is able to achieve its urban ecology objectives which included decreasing the reliance on potable water and improving water quality.

HABITAT: ADDING ANOTHER LAYER

While mitigating stormwater and decreasing potable water use is often a primary objective for green roof projects, recent research presents a compelling argument for their use as urban habitat as well. Stephan Brenneisen, a Swiss soil scientist, has been investigating how artificial systems on green roofs could potentially replace the habitat that is lost when brownfields are redeveloped in urban areas. He studied the activity of birds, beetles and spiders on 16 existing green roofs in Basel, Switzerland, making the following observations (Gilbert):

- 1844 sightings of 25 different bird species
- 172 species of beetles, 10% of which were Red List species
- 40% of the spiders found were determined to be rare

The results of Brenneisen's research revealed the following (Brenneisen):

- Thin areas of substrate provide habitat for a number of drought tolerant invertebrates
- Deeper areas retain more moisture and provide habitat for a variety of species and contain more structurally diverse vegetation
- By varying depths of the substrate microhabitats are created, thereby increasing biodiversity on the green roof

In the study Brenneisen compared the effective difference between varying soil types. Structured soils (those composed of locally source soils) revealed an ability to support habitat for beatles and spiders which unstructured soils (status quo green roof substrates) did not. Beetles and spiders are of importance because they provide food for birds, and can therefore be viewed as keystone species. Considering the elevation and limited access to green roofs, habitat for species is limited to avian species.

In Figure 11, a green roof design by Brenneisen illustrates the form of varying heights of substrate and t roof standard, this roof serves multiple functions. It reduces rainwater runoff into Basel's stormwater system, provides habitat for displaced birds due to brownfield site development, and provides visual aesthetic appeal from surrounding buildings.

Figure 11. Brenneisen's Design Based on Variable
Substrate Depth (Vertical Habitats)

DESIGN THINKING FOR GREEN ROOFS

In the case of Potsdamer Platz, the process for designing green roofs focused on stormwater management, aesthetics and use while constrained by economic feasibility. Conversely, in Brenneisen's model for green roof design, the focus was on habitat creation for insect and avian species. Both of these models demonstrate the use of clear goals and objectives to guide design. The following considerations were compiled as a means of helping identify potential goals and objectives for future green roof design:

Aesthetics

- Provide a visual amenity form many vantage points as visual access to nature is integral in maintaining psychological health
- Consider seasonal interest in planting design

Function

- Clearly identify restricted areas through visible design features to improve safety
- Allow people to easily move through and enjoy the space

Ecology

- Manage stormwater runoff through appropriate selection of soil types, depths and plants
- Integrate intensive and extensive roof types to maximize stormwater mitigation function
- Design for a diversity of species through plant and soil selection

By layering these multiple objectives, green roofs can begin to have a greater importance within our urban communities, especially where limited green space is at a premium.

CONCLUSION

City growth is currently reducing our access to leisure and recreation space within the city limits. It also displaces existing habitat for species and therfore reduces overall biodiversity within the city. With a decrease in open space and an increase in demand for real estate, the financial ability of cities and private companies to set aside open space for the public is a growing concern.

When Potsdamer Platz in Berlin faced these same challanges twenty years ago, its solution was to integrate both intensive and extensive green roofs into the heart of an urban development. This allowed people to move freely between buildings while moving in park-like spaces which also provided play areas for children. The design heightened the visual experience from inside the buildings by providing a pastoral landscape to office workers and residents. These aesthetic and programmatic considerations were all layered upon the primary design driver which was to create an integrated stormwater management system using the green roofs, along with water recycling ponds and cisterns, as a living system. The combination of these uses yielded an experientially, politically, and financially successful project.

The research by Brenneisen on green roof habitat provides an opportunity to add another layer to the green roofs design process, whereby green roof design can also be tailored to improve urban biodiversity. Through the layering of these multiple functions, green roofs can operate at a higher level, adding value as both a product and a service to urban communities.

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