



# Phytoremediation: An interim landscape architecture strategy to improve accessibility of contaminated vacant lands in Canadian municipalities

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## ABSTRACT

Many Canadian cities are faced with the challenge of contaminated lands that remain vacant due to high remediation costs. Redevelopment of these lots to greenspace enhances the character of cities and improves human and environmental health. Interim design strategies, while phytoremediation – the process of treating contaminated soil and water with plants – is taking place, were explored to improve the amenity value of contaminated vacant lands. Based on an integrative literature review synthesis and a phytoremediation example, design guidelines were formulated and then applied to three Canadian municipal sites. An expert panel, including phytoremediation specialists and municipal staff involved with open space planning and development, provided an evaluation of the guidelines. The comments received through the evaluation demonstrated that the design guidelines are an appropriate foundation for the application of phytoremediation as an interim strategy for transforming contaminated lands into usable green space within Canadian municipalities.

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## 1. Introduction

Cities worldwide have suffered over the last few decades from a decline in their industries; this decline has created both economic and aesthetic hardships (Waugh, 2011). In many cases, underutilized and abandoned lands in derelict centres now make up a substantial portion of the urban fabric. The vacant lands within the city core that are perceived to be or evidently are contaminated by the previous land use are not expected to change anytime soon due to redevelopment costs and associated liabilities.

In Canada, regional and local planning has faced challenges such as transportation problems, continuous urban sprawl, and simultaneous decline and regeneration of central areas (Grant, 2006). As a result, many underutilized vacant lands can be found in the Canadian urban landscape. To focus on the inherent value of these abandoned lots and integrate them into the urban landscape is one of many gradual improvements that can be achieved for a city and community. There are many benefits associated with the reuse of these sites that enhance the quality of life in the surrounding neighbourhood, including but not limited to decreased crime, improved local environmental quality, and increased property

value (Hollander et al., 2010). The profession of landscape architecture is interested in transferring vacant lands into green space (De Sousa, 2003). Studies have shown that people in a community prefer a vegetated landscape to vacant land, and the benefits on the mental and behavioural outcomes have been demonstrated (Kuo et al., 1998; Ulrich, 1986).

Before any vacant land transformation, contaminated sites need to be both restored and regulated. Depending on the mechanisms used for repair of the landscape, the process can be costly and intrusive to the ecosystem and community. Phytoremediation, the use of plants to remove or biostabilize contaminants in soil and water, is a low-cost remediation option (Russ, 2000). The restorative nature of plants has been recognized and understood for centuries, but the phytoremediation mechanism is viewed differently from the conventional horticulture or landscape architecture process (Kirkwood, 2001). Phytoremediation systems are typically designed and installed by environmental engineers and remediation specialists; if the site is to be developed into a green space, traditionally, a landscape architect joins the process after the remediation process is complete. In *Phytoremediation: Integrating Art and Engineering Through Planting*, Rock (Kirkwood 2001: p. 52), indicates that “on some sites it is possible to place planting in such a way as to allow for partial reuse of the site for public access.” In essence, phytoremediation should be viewed as landscape design,

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thus allowing it to be integrated into the public realm through earlier involvement from landscape architects.

The potential and benefit of phytoremediation for a community has been discussed in the literature (Tucker and Shaw, 2000), but there has been very little connection made to the role that landscape architects can play in establishing a phytoremediation system. This study explored the elements required for Canadian municipalities to utilize phytoremediation in partnership with landscape architecture as an interim strategy to transform contaminated vacant lands into a usable green space until a permanent use for the site can be established. Can an interim landscape architecture strategy be used during phytoremediation to transform contaminated vacant lands into usable public space in Canadian municipalities? If so, how?

## 2. Methods and materials

The approach to this research combined an integrative literature review, the development of design guidelines, case study application of the guidelines, and an assessment by key informant reviews of the guidelines for their probability of success. The design guidelines were developed based on the information compiled through the literature, which were then applied to three case studies in different regions of Canada. Selection criteria were developed to facilitate case study selection. These three cases and the design guidelines and their application were evaluated by a group of experts who were chosen based on key informant selection criteria. A key informant is one who is well informed on a topic (Deming and Swaffield, 2011). For the purpose of this study, the definition of green space includes vegetated areas either actively or passively used, and the terms brownfield and contaminated vacant land are used interchangeably.

### 2.1. Integrative literature review

A literature review on phytoremediation led to a broad study of the subject that increased the knowledge for establishing an interim phytoremediation project by a landscape architect in Canadian municipalities. Information collected was organized into three categories. An exploratory approach was selected; many other routes, such as conducting experiments, would not be suitable for the time demanding nature of a phytoremediation system.

The integrative literature review served the following three functions:

1. To analyze the relevant, current, and available published knowledge (Deming and Swaffield, 2011) to create the design guidelines.
2. To place the study into context with previous research and scientific knowledge (Babbie, 1998), to identify gaps within the literature, and to illustrate how this study addressed them (Marshall and Rossman, 2006).
3. To establish the importance of the study (Creswell, 1994).

Characteristics of the literature reviewed are:

1. Literature on mechanisms and opportunities and constraints associated with phytoremediation was analyzed to understand the phytoremediation process (Chaudhry et al., 1998; Pilon-Smits, 2005; Kirkwood, 2001; Russ, 2000).
2. Landscape architecture and urban design were explored to identify qualities that enable the application of phytoremediation into the public realm (Nagendran et al., 2006; Pilon-Smits, 2005; Tucker and Shaw, 2000).

3. Social issues and human environmental behaviour literature associated with contaminated sites and restorative processes were reviewed to be aware of human and environment interactions in case of a phytoremediation system (Dwyer et al., 1991; Kuo et al., 1998; Marcus and Sarkissian, 1986; Pincetl and Gearin, 2005).
4. Federal, provincial, and municipal policies were reviewed to understand resources available for contaminated site projects (Blumner, 2006; De Sousa, 2006b; Miller, 2009).

### 2.2. Design guidelines development

The major component of this study is the development of design guidelines and the subsequent key informant evaluation; this is recognized as significant for producing new critical directions in the application of phytoremediation (Deming and Swaffield, 2011) in Canadian municipalities. The guidelines require further local investigation and are to be adopted only as a basis for further research. Policies and regulations investigated in this study were representative of different Canadian jurisdictions to create a generalizable outcome. The design guidelines were developed based on the information compiled through the literature review, as noted above. The preliminary scan of the literature determined three categories of information: pre-design considerations, phytoremediation design considerations, and post-implementation considerations. As the literature was reviewed in more detail, information found appropriate for each category was selected.

### 2.3. Resulting design guidelines

Note: These design guidelines are meant to assist landscape architects in the implementation of an interim phytoremediation project in an urban setting. This includes both municipal landscape architects and private consultants hired by the municipality. Collaboration with remediation specialists during this process is required.

#### 2.3.1. Pre-design considerations

##### A Project Planning

1. Investigate the policies and processes of federal, provincial, municipal, and other jurisdictional agencies in support of contaminated land redevelopment.
2. Develop a project stakeholder group in which members must be involved, but may be more or less active at different stages of the process.
3. Suggested municipal representatives include: Local City Councilor, Park Planning and Design, Landscape Architect, Park Maintenance, Health, Environment, Planning, and Legal Representation.
4. Suggested non-municipal representatives include: Landscape Architect, Remediation Specialist, Environmental Health Assessor, Community Groups, Neighbourhood Residents and Business Owners, Local School Board Representatives.
5. Form a committee to pursue funding (e.g., federal and provincial funds, local stakeholders, private).

##### • Site Characterization

1. Consult a remediation specialist to obtain information on the types and concentration of contaminants within the site's soil and groundwater.
2. Assess, together with the remediation specialist, if phytoremediation is an appropriate contaminant mitigation strategy (based

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