Old Gas Stations - New Fuel for Environmental Awareness

by

Alexandre Man-Bourdon

B.L.A. Mississippi State University, 2006

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE OF

MASTER OF ADVANCED STUDIES IN LANDSCAPE ARCHITECTURE
in
THE FACULTY OF GRADUATE STUDIES

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

April 2008

Abstract

According to Environment Canada, across the country there are currently over 1400 abandoned gas station sites that are contaminated. Unbeknownst to local residents, many of these sites are undergoing remediation. Temporary interventions called remedial landscapes can be designed by landscape architects to communicate to the public the remediation activities, which are otherwise hidden from view. Environmental psychologists note that pro-environmental behaviour stems from increased awareness of environmental degradation. Furthermore, by presenting first hand information in the form of a landscape, people can make their own decisions concerning their role in unsustainable practices.

This thesis posits that by experiencing remedial landscapes, people will change their environmental attitudes and or behaviours. Remedial landscapes also offer opportunities for public art and further exploration of alternative forms of remediation. It includes not only precedent studies of other remedial landscapes, but a public perception survey concerning a gas station undergoing remediation in Kerrisdale, Vancouver. The survey indicated that the remediation of contaminated sites is a community concern and that the remediation should be made more visible. Participants also agreed that the use of a designed landscape would be a viable tool for communicating the status of the site.

This research informed a set of design guidelines for the Kerrisdale 'test site.' A remedial landscape has been designed using these guidelines and is included as part of the thesis.

Table of Contents

page no.

List of Tables **page no.**

List of Figures **page no.**

List of Drawings **page no.**

Acknowledgments

I would first like to thank my parents who provided me constant encouragement to not only pursue my education, but to create my own path within my field and follow it. I would like to thank my father, who although never pushed me into landscape architecture, I'm sure is happy seeing me continue the family business. This thesis for me was an opportunity to further pursue my own ambitions within the field, but to add to body of work within the profession he has dedicated his life. To my mother, whose expectations I know I don't have to meet, but take in pride achieving anyways.

Thanks to my advisor Susan Herrington, who's judgement to this day has never been wrong and whose guidance has led me to accomplish my goals. Thanks to Jill Satin for the help with the statistical data. Lastly I want to thank my committee, Mari Fujita, Daniel Roehr, and Patrick Mooney for their patience and objective criticism.

1.0 Introduction

1.1 Defining Remedial Landscapes

From stormwater to sewage treatment, recycled cans to garbage dumps, petroleum pumping to electric energy, we are rarely forced to examine the cycles and flows which shape the everyday urban experience. Invisible infrastructure and opaque processes contribute to a disconnected and disassociated public that is unaware of the detrimental environmental and ecological impacts of everyday actions (Strang 1996).

While landscape architects often discuss sustainable design, we should make it our responsibility to use the landscape as a tool to engage the public in discussions concerning hidden processes that comprise the contemporary urban experience. One such opportunity is provided by remedial landscapes.

REMEDIAL LANDSCAPES are designed to repair contaminated sites and communicate the repair to the public. This communication to the public can potentially provide opportunities for inward reflection on our individual role in the contamination of the land.

This landscape offers opportunities to daylight processes of remediation on sites like abandoned gas stations and other sites within dense urban neighborhoods that often sit vacant for months, years or even decades. Using the remedial landscape to engage the public allows for an examination of the sources of contamination and our dependence on damaging industries and practices. Even when employed as temporary interventions, remedial landscapes can provide insight into our everyday actions and processes that result in devastating impacts within our communities and homes. By exposing contamination and remediation, the public is provided the opportunity to engage in community advocacy and lead more sustainable lifestyle.

Little research and design development has been devoted to examining the value of landscapes established on sites undergoing remediation (Thayer 1998, Haag 1998). As the issue of remediation of contaminated properties moves to the forefront of practice in landscape architecture, the development of innovative design alternatives must be further explored to increase the effectiveness of contaminated sites as models that elicit public awareness and action.

1.2 The Test Site

Throughout the following text many of the arguments provided in support of remedial landscapes will be examined concurrently using a test site. The test site is a former gas station at 41st and Larch in Vancouver. It is representative of thousands of sites across Canada that either stand in disrepair, or are being remediated without the public's knowledge. Given the pervasiveness of abandoned gas stations across Canada, it is hoped that this test site will also provide a model for similar sites.

The site is contaminated with petroleum hydrocarbons resulting from a leaking underground storage tank (LUST). Engineers have employed a standard pump-and-treat remediation system to remove the contaminants from the soils and underlying groundwater table. The site has been undergoing remediation for over 10 years and will continue into the undetermined future. In the meantime, the site occupies a corner lot and appears vacant except for a some equipment used in the remediation process. It is surrounded by a chain-link fence which is covered by opaque netting to partially block views into the site. The site resembles an abandoned lot and reveals little to the community regarding its status. Other reasons this site has been chosen include:

Figure 1: Evidence of the pump and treat system on the test site

Figure 2: Chainlink fence and filter fabric that masks the site at 41st and Larch's current activities

- according to Environment Canada and the United State Environmental Protection Agency (USEPA), approximately 60% of contaminated sites suffer from issues pertaining to the release of petroleum hydrocarbons from leaking fuel storage tanks; thus, the development of a potential solution or model could be employed at any of the 1400 contaminated gas station sites in Canada (Canada Gazette 2007, USEPA 2007)

- the site is currently undergoing remediation using a pump and treat system which is the most commonly employed system for groundwater remediation (USEPA 2002)

- gas stations are often located within residential neighborhoods and occupy highly visible corner lots. In this case, the test site occupies a corner that serves as a transition zone from the residential development to a mixed use commercial development within a community with a strong identity

- need for the construction and maintenance of gas stations is directly fed by the public's need to consume fuel; therefore, a direct connection can be made between our individual consumption of fuel and the contamination of local sites

- gas stations represent an integral part of our current infrastructural system and as a land use represent a large portion of service and support within the urban environment

1.3 Goals and Hypothesis

The goal of this thesis is to propose a temporary landscape that will both help remediate on-site contaminants and communicate to the surrounding community the remedial process. This landscape acts as a pause between phases of development, existing only between the commencement of remediation and its conclusion. This provisional landscape offers opportunities for reconnecting observers to the land upon which they live and depend.

Will day-lighting the processes of this temporary landscape:

1. influence the community's attitudes and behaviours to act more pro-environmentally through the recognition of local contaminated sites and by highlighting the individual's role in the contamination process?

2. create a stronger sense of community by revealing the remediation that benefits the entire community and reinforces shared values?

3. aesthetically enhance the site to make the landscape more readable and enjoyable for the public?

1.4 Public Perception Survey

To determine whether the recognition of landscapes in repair would influence the behaviour of local citizens and inspire them to think and act in a more environmentally conscientious manner, a survey was distributed throughout the community that surrounds the test site. The survey discussed the remediation of a former gas station (although it does not specifically identify the test site). It has been designed to determine whether newfound knowledge of the detrimental affects of gas stations and leaking fuel tanks would affect participants' fuel consumption. The public element is integral to the success of the remedial landscape. The ability of the remedial landscape to influence the attitudes and behaviours of the public will be a direct measure of the success of this temporary landscape intervention. "[M]ore sustainable environments will not be created if we only look at the environmental dimension: we

also have to address how people mix and connect, their motivations and whether they take responsibility and 'own' where they live and change their lifestyles appropriately (Landry 1995, 6)."

1.5 Summary

a. Contemporary Practices of Remediation

The first section will document current practices and techniques of remediation as well as their aesthetic impacts. It will discuss possibilities for enhancement of both function and aesthetics in order to create more readable informative landscapes. This section will also discuss the role of pubic art within the urban environment and how remedial landscapes can serve the same function as public art.

b. Role of the Landscape Architect

The second section will examine the role of landscape architects in revealing the processes of landscapes undergoing remediation by reintegrating lost, displaced, or forgotten space back into the public realm. Precedent studies in landscape architecture, or more specifically eco-revelatory design, will also be examined.

c. Public Perception and Environmental Attitudes

The third section will discuss public perception and how remedial landscapes, can influence public opinions and instigate public response. By revealing the sources of environmental blight and the systems used to treat them, information accrued by environmental psychologists will be applied to affect change through the landscape medium.

d. Public Perception Survey

Section four will provide an analysis of the returned surveys. The surveys provide direct evidence that the local population believes that contaminated sites are a community concern and supports the use of landscape interventions.

e. Development of Design Strategies

Section five will outline 5 design strategies that have been developed throughout the research and design process to provide guidelines for designing successful remedial landscape interventions.

f. Test Site Design Intervention

Section six will provide information that pertains to the test site intervention. It will include conceptual information, plans, diagrams, images and a material palette pertaining to the design intervention.

2.0 The Remedial Landscape in a Larger Context

2.1 Brownfield Abundance

A brownfield site as defined by the British Columbia Ministry of Environment is a site in which "abandoned, vacant, derelict or underutilized commercial and industrial properties where past actions have resulted in actual or perceived contamination and where there is an active potential for redevelopment (BCMoE 2007)." Legislation has been recently adapted to place blame as well as financial accountability on the individual or corporate entity responsible for the contamination. However, once commenced, the process of remediation is often quite lengthy and takes years to complete. According to a USEPA study that examined 28 sites undergoing remediation using a pump and treat groundwater system (the most commonly used system for remediation and the one employed on the test site), the average time for remediation and post-remediation monitoring lasts between four and twelve years (USEPA 1999). During this time, the clean-up of these sites is not announced to the surrounding community.

According to Environment Canada there are approximately 23 000 contaminated sites in Canada (Canada Gazette 2007). Of these sites, the Ministry of Treasury indicates that approximately 1400 sites are former gas stations.

On-line databases of the Canadian Treasury estimate that approximately 428 former gas station sites have moved beyond initial phases of testing and are currently being remediated. This number is not precise because the federal government has not yet appointed a task force responsible for compiling data on all contaminated sites within the country.

2.2 Opportunities Provided by the Remedial Landscape

Sites undergoing remediation should be regarded as opportune "moments" for day-lighting and further examining the process of remediation. As well, they provide opportunities to study the impacts of contaminated sites on the local public. The presence of a site undergoing remediation within local communities may also prompt indices for living more sustainable lifestyles.

Sites undergoing remediation should not stand as eye-sores or unproductive lands, but should be seen as an opportunity to educate the public and engage them in

pro-environmental discussion and action. By addressing non-sustainable lifestyles these sites should not act as a threat to the public, but act as a motivator to think and act in an environmentally conscience manner.

3.0 Contemporary Practices of Remediation

3.1 Current Practices

> "Historically public space has helped remediate its context at all levels of society, whether it be commercial, cultural, educational, or reform based; the critical question is how contemporary public space can be produced to safely and responsibly enable a continuation of its remedial and regenerative agency. Remediation is an actively produced strategy (Benites and Lyster 2005, 8)."

Until now, "design" of remediation strategies has not been an actively produced strategy, but strictly an engineered solution (Hill 1998). Contemporary systems of remediation are not "designed" in the same sense that landscape architects design public spaces, or architects design a hotel lobby. Design in the sense of engineering concerns entering variables into mathematical formulas, determining the most time efficient, the most cost efficient manner in which to remediate the site. The systems designed and implemented by engineers do not act to recover lost landscapes or augment the landscape on a social level nor aesthetic level. The time has come to include an additional set of variables into the "design" of remedial systems. Although restoring soils and water quality can be quantified and calculated through complex equations, restoration of the landscape cannot. The following section will further discuss contemporary practices in remediation as well as the use of public art as a communicative tool.

It is not the position of the landscape architect to question the process of remediation to remove contaminants specified by the consultants. However, there are ways to further increase chemical or contaminant restoration of the site by using several methods of treatment in unison. These secondary methods although not as effective as primary systems for contaminant removal, can augment the system in place and also fulfill the social values of remediation. Unfortunately, the most common way to treat contaminated sites is to either remove the contaminants from the site through excavation, or to simply cap the site leaving the pollutants beneath the surface. These two methods are often chosen because they allow for rapid redevelopment of the site. Although there are serious environmental implications resulting from both, the methods will not be further discussed since this research examines sites currently undergoing on site (in-situ) remediation where the community is provided opportunities to witness the contaminant removal process.

Figure 3: View of the site looking east along 41st ave.

Sites undergoing remediation often stand idle for several years outside the visual and perceptual fields of the public. Due mostly to issues of client confidentiality, the existence of contaminants as well as the process at work to remove them are masked behind opaque chain-link fences, gravel lots, and no trespassing signs. The processes at work to rid the community of potential hazards should be made visible to the public as these are issues that directly affect their lives and homes. We should seek to employ more dynamic site design and remediation responses that provide general indices of the process of contaminant removal. The design and implementation of remediative systems should be further explored by landscape architects in collaboration with the environmental consultants and engineers who typically deal with contaminated sites. Exploration of design interventions on sites undergoing remediation offer opportunities to expose additional layers of meaning within the urban environment.

3.2 Natural Alternatives

Figure 4: Medicago sativa (Alfalfa grass)

Photo from

Figure 5: Lollium perenne (Perennial rye)

Photo from

An emerging approach to conventional remediation is the use of phytoremediation. Phytoremediation is a system by which the contaminants within the soil are treated by planting certain plant materials such as grasses, shrubs and trees. In the case of former gas station sites, phytoremediation cannot be employed as the primary system for contaminant removal, but it can augment conventional remediation systems. Depending upon the contaminants present, there are documented plant materials responsible for the break-down or volatilization of harmful chemical compounds. Secondly, the addition of plants, especially grasses due to increased root surface area, greatly increases biotic activity within the organic layer of the soil which also enhances the break-down or removal of many contaminants. For example, in the case of petroleum hydrocarbons (from fuel and oil based compounds) the use of alfalfa grass and perennial rye greatly increases the propagation of a certain bacteria that actually digests the hydrocarbons (Kirk at al. 2005). Thus the plant materials themselves are not only responsible for the removal of contaminants, but are responsible for the development of other soil organisms which increase the rate of remediation.

Most engineered systems remove contaminants within the soils and groundwater of a site and are designed to mitigate contaminant migration through these sub-strata. To protect the public from contaminants, the most common measure is the erection of a fence. The chain link fence that often surrounds the site, separates it from the surrounding environment and prohibits the public's ability to access the site. Although a fence will mitigate site disturbances by the public, contaminants can still

leave the site via air-born particles from wind disturbance of site run-off. The use of plant material reduces off-site migration of contaminants by creating a vegetative cap.

The use of phytoremediation as an additional system for remediation also fulfills the second goal of this project/research which is to create community connections. A landscape that only consists of an engineered solution can only be read and interpreted by engineers. The use of plant materials exhibits the ability of the site to support life. The re-inclusion of natural activity and public space will encourage public use of the site. However it is not simply in the recognition of the site's ability to support and sustain life that invites the observer to enter. The plant materials and other elements must be arranged in a manner that communicates visitors are welcome. Joan Nassauer notes that "a designed response with an established visual order further reintroduces the site as a viable public space" (1995 163).

Why then, is the passive low-energy input approach of using plants to enhance a system of remediation not considered? Is it simply that there has not been enough success is the testing of phytoremediative systems? Or is it simply that we as problem solving beings trust the abilities of a human engineered system over that of a natural system? According to Robert Thayer, the use of nature (i.e. phytoremediation and plants) is counter-intuitive or even counter evolutionary. We have a "hard-wired predisposition to invent tools and use them creatively to solve problems" (Thayer 1994, 32). Since the emergence of homo-sapiens, we have differentiated ourselves from the rest of the animal kingdom through the use of our ingenuity and tool manipulation. After thousands of years it would seem that we have more trust in our own technologic processes that have allowed us "not only to survive, but to thrive overwhelmingly at the expense of other species" (Thayer 32, 1994). However, with the continued success of phytoremediative systems, we can only hope that the use of a system that requires a substantially lower energy input would become more common place.

3.3 Reference to Test Site and Current Conditions

The test site is located in a community called Kerisdale. Its location at the intersection of Larch and West 41st marks the transition point from single family homes and park on the west side to the main commercial district containing mixed use multi story, commercial street-side and residential units above. This site, like many gas stations, occupies a corner lot, thus exposing two sides to the street. The community of Kerrisdale is the oldest community in the city.

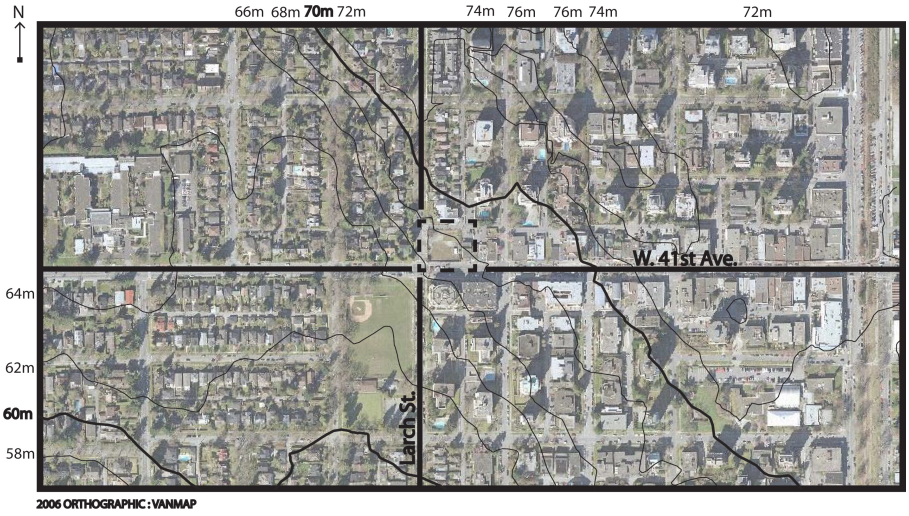


Figure 6: Context map indicating site location and extents of Kerrisdale Village

The site is surrounded by a chainlink fence partially covered by a green vinyl tarp. A look inside the site reveals the remediation equipment against the wall of the adjacent lot and several white pvc pipes emerging from the surface of the site.

Figure 7: View inside the chainlink fence from Larch St.

The former gas station was selected because it represents a typical corner lot station often found within residential neighborhoods. Because of the mix of land-uses that surround the site, migrating contaminants have the potential to affect a large portion of the community through a variety of channels and media. The site is also sloped sending surface and groundwater contaminants across the street to the park and

surrounding residences. Secondly, the site is currently undergoing remediation using a pump and treat system which is the most commonly employed system for groundwater remediation at former gas stations (USEPA 2002).

Figure 8: Test site current conditions indicating location s of remediation equipment and treatment and testing wells

After a preliminary investigation of the site and through the survey, local residents indicated that the site had been in its current state for 15 to 20 years although many residents believed that the site had been abandoned. According to Wesley Joe, a representative of the City of Vancouver Planning Council, no permits or applications for development have been issued for the property.

Site History

According to the 1962 Fire Plan, the test site is only one of four gas stations located along 41st Ave. However, throughout the 1970's and 80's the other gas stations were removed and replaced with the existing developments. Although there is a possibility that these gas stations also suffered from some of the same contaminant issues (except methyl tertiary butyl ether which was not introduced to gasoline on a wide scale until the mid 90's), no documentation indicating issues of contamination from the other sites has been found. However, their redevelopment occurred in an era

where site profiles, or soil and contaminant testing, was not a mandatory practice for redevelopment or property change of ownership.

The gas station changed ownership on several occasions and according to the 1962 Fire Plan and aerial images from 1994, the location of the pumps has changed. How many times the pumps changed location is undeterminable based on the sparsity of historical information. However, ownership changes and the movement of the pumps does not necessarily indicate that the underground storage tanks were replaced or moved.

The site is currently owned by Imperial Oil. According to Brenda Cantner of Devon Estates , a property management company under Imperial Oil, the site has been "sitting idle" since 1998. However, site information reports from the British Columbia Ministry of Environment indicate that the site has been in its current condition since 1989, nine years longer than Mrs. Cantner indicated.

Due to issues of confidentiality and public appearance, Imperial Oil, is not willing to share any information regarding the site history, contamination, remediation, or future development plans. Nonetheless, it can be inferred from on-site remediation equipment that this site suffers from situations similar to other former gas station properties.

Contamination

Figure 9: Removing a leaking underground tank

Photo from U.S. E.P.A.

Leaky underground storage tanks, or LUST, affects approximately 23% of underground tanks. According to the Environment Canada, approximately 66% of contaminated sites have underground petroleum tanks that are leaking (Canadian Centre for Energy, 2007). The issue is so widespread in the United States the Environmental Protection Agency (EPA) created the Office of Underground Storage Tanks in 1985 to be responsible for the remediation of LUST sites. Since the majority of underground tanks are located at gas station sites, they make up a significant portion of LUST sites. Canada however, has not developed an agency solely responsible for LUST sites and sites are handled on a case by case basis dependent upon which ministry is responsible for the site.

According to the EPA, underground storage tanks have a high propensity to contaminate groundwater because the contaminants, BTEX (benzene, toluene, ethyl-benzene and xylene) and MTBE (methyl tertiary butyl-ether), move easily through the soil strata (USEPA 2007).

Primary Contaminants

As indicated, the two major contaminants that are potentially affecting the site are:

- **BTEX (benzene, toluene, ethyl-benzene, and toluene 1,2,3 and 4) -** BTEX makes up only 1% of fuel however, it is the most dangerous element in gasoline in regards to human and animal health. Benzene is a known carcinogen and can have severe impacts on human health if ingested in high enough quantities. However, benzene is not soluble in water therefore, if BTEX is the only contaminant on site, it often passes through the groundwater table and collects in the soil strata (USEPA 2007).

- **MTBE (methyl tertiary butyl ether)** - MTBE is an oxygenate, or a fuel additive that provides a more complete combustion of fuels. MTBE was introduced to the majority fuels in the mid 90's, but has been removed from most fuels and banned in many US states. MTBE has a very high propensity for moving to the groundwater table and traveling to municipal water supplies. Although at this point, there is no documentation indicating MTBE to be a major health risk, many municipalities have been increasingly cautious using MTBE because of its incredible persistence in public water supplies. Secondly, when MTBE is in the presence of BTEX, MTBE causes the Benzene (carcinogen) to become soluble in water, thus severely increasing the possibility of benzene being ingested by human and animals (USEPA 2007).

Remediation System

Figure 10: Contaminant storage tank on the test site

The site currently employs a groundwater pump and treat system to remove the contaminants from the soils and underlying groundwater table. As perviously stated, according to the USEPA, the pump and treat system is the most commonly employed system from treatment of petroleum hydrocarbons and is relatively effective if properly designed and installed. The system in the test site includes two supplemental treatment methods; a chamber for carbon adsorption which enhances the systems ability to remove MTBE and an air stripper which aids in the removal of the BTEX.

The pump and treat system simply pumps water located within the groundwater system to the surface where it is treated and released into the municipal wastewater system. The system is also effective for ensuring that contaminants do not continue to leave the bounds of the site. The individual pumps are located more densely

Figure 11: PVC pipes indicating locations of pumping and testing wells on test site

near the edge of the site where the groundwater exits the site. Thus, the cluster of pumps along the south-eastern boundary create a hydraulic trap which is quite effective at stopping further migration of contaminants.

The Local Community

According to the 2005 Community Vision document, Kerrsidale Village begins at the corner of 41st and Larch which includes the test site. Currently the west entrance to the community is marred by the existence of this vacant lot surrounded by a chain-link fence. Kitty-corner to the subject site is Elm Park, a large open space with a baseball diamond. The intersection, aside from the subject site is an excellent portrayal of values shared by community members which includes an excellent blend of public and private spaces. Several multi-story residential complexes surround the subject site. The towers which range from 7 to 18 stories in height are set back so as to not disturb the small town community feeling provided along 41st Ave.

Along the remainder of 41st Ave. throughout the commercial district are wide sidewalks, public benches and street trees planted along both sides of the street. The former gas station site breaks up the visual continuity of Kerrisdale Village along 41st because it has no street trees nor benches. The side walks adjacent to the site on both of its exposed faces are not intact because while the gas station was in operation, there were two entrance and exit ramps on the side of 41st Ave, and one on the side of Larch. The site, in general, stands in opposition to the shared values represented throughout the rest of the community. While other commercial property owners have followed community guidelines for the aesthetic treatment of individual sites, the subject site has not been forced to follow similar guidelines.

The neighborhood of Kerrisdale is part of a larger network of connected communities known as ARKS (Arbutus Ridge, Kerrisdale and Shaughnessy). In 2005 City Council members with the Director of City Plans, local community officials, and community members developed the ARKS Community Vision Plan which outlines guidelines and necessary changes for the communities. The following points were highlighted in the Community Vision Plan and coincide with this thesis

Public Art

The Community Vision Plan discusses the encouragement of public artwork that promotes and reflects the history and heritage of the community as well as public

artwork that could be used to hide or defer attention from construction sites (ARKS 2005, 61).

Good Environmental Practice

Under the heading "Environment," the ARKS Community Vision plan approved a motion to promote good environmental practice. Through education and awareness the community encourages "publicity campaigns and demonstration displays" as well as "establishing an education centre promoting sustainable practices" (ARKS 2005, 78). Therefore, the document reveals that the intentions of this thesis to provide opportunities for art and eco-education are in agreement with the intentions of the ARKS plan.

3.4 Aesthetics of Remediation

Since the public does not have the ability to recognize a site in repair or have information pertaining to local point sources of contamination, a prominent issue to the local citizens concerning sites undergoing remediation is their existing aesthetic impact. According precedent studies, local residents often feel that the current process of remediation marres the community by leaving the site in a state of seeming abandonment for extended periods of time. According to a survey conducted by the Energy, Environment and Resource Center at the University of Tennessee, after being provided substantial amounts of information and options concerning the remediation of a local site, the public preferred that the contaminated site be remediated in-situ instead of having the soils removed and treated off-site (Feldman and Hanahan 1996). Residents chose this option fully understanding that in-situ remediation would take years to complete. Residents felt it necessary to display the remediation process for a period of time to ensure outsiders and newcomers that the matter had been properly dealt with and any negative stigma associated with the site would be alleviated (Feldman and Hanahan 1996).

Although Feldman and Hanahan conclude that surveyed residents wanted to know and be involved in the remediation process, it is rare for site owners to divulge information concerning the remediation. The most likely reason for this is that sites in a state of seeming abandonment draw little attention. After years of vacancy, empty lots often fail to be cognitively recognized within our mental maps. On the other hand, the development of the remedial landscape allows the possibilities for the creation of site-

observer connections which create a stronger lasting impression on our community map. However, from the perspective of the site owner, to publicly declare that a landscape is undergoing remediation implies that it is contaminated. This is the case of Imperial Oil and the test site.

3.5 Possibility for Public Art

Public art projects can communicate the four fundamental values of community development. Through shared history, identity, needs and aspirations, "public art can act as a vehicle through which a 'sense of community' can be developed and promoted" (Hall and Robertson 2001, 10). Although all may not agree upon the four values as stated, these are crucial to the social connectivity of the community which can be tied and strengthened through the use of a public foci. "Such a foci, physical or otherwise, is said to possess a communicative function, generating and communicating ideas between people and across physical space" (Hall and Robertson 2001, 11). Arguments that contend that public art can be used to create social connections within the community can also be used to describe the connections created by a designed public space and a remedial landscape because discussion and action in both revolve around the focal point. As Nassauer states,

> We need to recognize that the landscapes of city dwellers' homes, neighborhoods, parks, roadsides, and businesses are public portraits of themselves. The expectation that I represent myself as a citizen in the landscape of my home is etched deeply into popular culture (Nassauer 1995, 162).

What then is the tie between public art and the remediation that the test site seeks to express? As previously discussed, the opportunities offered by remedial landscapes are rooted in re-establishing the broken social connections between the site and the public. Hall and Robertson state that "public art can intervene and help rejuvenate severed social connections... by promoting community discovery and awareness" (Hall and Robertson 2001, 10). It is through this stage of discovery and awareness that the public is allowed an opportunity to discuss community held values. "Public art addresses community needs by helping communities understand their problems and facilitate their solutions" (Hall and Robertson 2001, 14).

As discussed by Robert France, art that acts not only to aestheticize the site but also acts to reveal the functional basis for the site through creative means has the potential to "inspire action beyond the bounds of the site" (France 2002, 6). Regarding the individual elements of the remediation system as parts of a larger piece of artwork adds public interest and is capable of commandeering the attention of the public simply through curiosity. "The roots of [public art] lie in its visibility, which in turn influences how we perceive the urban environment" (Sharp et al. 2005, 1020). Secondly, the artwork instigates discussion among the public about meaning therefore acting as "both a catalyst and a conduit for the generation and communication of public discourse" (Hall and Robertson 2001, 12). It is through this visibility that public art acts to articulate and respond to shared community values.

Robert Thayer differentiates between art that simply comments on and design that can solve environmental problems. He states, "art may be content only to comment on unstable, unsustainable, or consumptive conditions, responsible design should remedy them" (Thayer 1998, 118). Therefore designers must be certain that their remediation designs go beyond simply commenting on the unstable practices. The remediated landscapes then stand as an outward expression of environmental stewardship and as a reminder of past transgressions that imposed threats upon the community and guide the public in a common direction towards a more sustainable community.

3.6 The Remedial Landscape as an Experience

As previously stated, remedial landscapes are not simply public art projects that comment on sustainability or current trends in remediation. Remedial landscapes provide experiences that reveal layers of information and meaning to be drawn out by the observer. These experiences are comprised of both the aesthetic function of the site as well as the educational or informative aspects of the newly designed landscape. According to John Dewey this newfound aesthetic perception "enables art to reach more people and shape interests that are instrumental to their daily lives" (Herrington 2007, 24). It is through the experience of entering, passing, or being in the site that should act to set remedial landscapes apart from their surroundings. While immersed within this new environment the observer is provided an opportunity for a different perspective or reality of the common practices that resulted in contamination of local sites. According to Dewey "the work of art - temple, painting statue, poem is not the work of art. The work of art takes place when a human being cooperates with the

product so the outcome is an experience" (Herrington 2007, 24). Remedial landscapes alone are simply materials arranged on a site undergoing remediation. However, it is the interaction between the site and the observer, the change incurred by the experience of the landscape that leaves the bounds of the site and manifests itself in the individual's daily life.

4.0 The Role of the Landscape Architect

4.1 Beyond Sustainable Design - Environmental Advocacy and Public Engagement

As we enter the 21st century, landscape architects are actively engaged in promoting environmental and ecological sustainability. As designers with an understanding of site interactions from the microcosms of bacterial interactions, to the macrocosms of regional planning, landscape architects sit at a critical junction for the implementation of sustainable design and practice. However, the role of eco-designer and enviro-advocate could extend this realm of design into the lives of the public to influence their individual environmental actions and awareness. In the case of remedial landscapes, a form of experiential education can be achieved by providing opportunities for observers to recognize the long-term results of unsustainable practices through site interactions. Experiential education is a means by which design initiatives extend beyond the physical boundaries of the site and reach into the lives of the public in order to affect their awareness and behaviour.

Although landscape architects are not qualified to select the method of remediation, the contextual and planning strategies of the landscape architect can be employed to properly design the site to maximize readability and usability. Also included in the skill set of the landscape architect are the tools necessary for public engagement. Landscape architects are commonly involved in public workshops, charettes, and public perception surveys which grant them the ability to better determine the needs and desires exhibited by the public. These tools also provide landscape architects with the language necessary to properly communicate to the public through the landscape.

The concepts of sustainable, regenerative, restorative, and ecological design are implied and all fall under the umbrella of the term landscape architecture. As stated by Robert France in his 2003 article "Green World, Gray Heart," to add the term green or sustainable "before landscape architecture create[s] a redundancy or an oxymoron" (France 2003, 3). The public realm should be a multi-dimensional arena that provides access and function to not only accommodate for the needs of the users, but must also educate and act to improve the quality of the air, the soils, natural habitat, and more importantly, water. An additional layer of information must also be inserted into all landscape designs that contain some message about our landscapes, a commentary on our use of land resources. Thus, the landscape no longer acts "as a passive naturalistic stage but as a necessary player that actively contributes to the daily

operations of the city with real pressure to conserve and remediate its context" (Benites and Lyster 2005, 5).

As landscape architects we have a duty not only to the public we serve, but to the environment. Design of the built world through the eyes and hands of landscape architects should not only represent, but promote stewardship of land, water conservation and environmental protection and restoration. It is our responsibility to inspire the benefits of environmental stewardship to the public who use the spaces we design. "The single most effective action that can be accomplished for the future of nature [and the environment] is to motivate and inspire large numbers of people" (France 2003, 4).

Due to an understanding of not simply the system and process of remediation, but of the larger picture in which remediation is established, landscape architects have the ability "to synthesize, to connect, to gauge impacts across different spheres of life, to see holistically, to understand how material changes affect our perceptions, to grasp the subtle ecologies of our systems of life and how to make them sustainable" (Landry 1995, 11). Knowledge and understanding of both natural systems and systems that restore nature should be treated as compositional elements that rest on our artistic palette, to be arranged and revealed in an artistic manner. It is by no means the single responsibility of landscape architects to act as aesthetic translators of the engineered world. However, the creative talents of the landscape architect lay in understanding the function of a system and is thereby granted the ability to aesthetically enhance the engineered to add new layers of meaning. Robert Thayer, in Gray World Green Heart, states that "sustainable landscapes need conspicuous expression and visible interpretation, that is where the creative and artistic skills of landscape architects are most critically needed" (1994, 102). By aesthetically revealing the process of remediation, sites can accommodate the public and create more points for connection between the public and their landscapes. Landscape architects should strive to not only promote sustainability through design of the site alone, but should seek to engage the public with sustainable concepts they may apply elsewhere.

This thesis project calls forth the emerging role of the landscape architect as a mediator between process and function, and a profession that reactivates sites within the community that previously acted as visual blights and unmapped properties. A newfound level of social and environmental awareness can be reached through experiential education or by directly engaging people in the recognition and repair of damaged landscapes. The creative abilities of landscape architects to engage the public through direct exposure to remedial landscapes must be employed as a means of

informing the public of the negative impacts of their lifestyles and the direct impacts of these actions upon their community.

4.2 Eco-Revelatory Design

Eco-revelatory is design that reveals and interprets processes and relationships that exist within the landscape. Richard Haag describes eco-revelatory design as the "logical progression of our profession (landscape architects), which was born of necessity in response to maltreatment of the land by architects and engineers of an earlier time (1998, 72)." The Eco-revelatory design that Haag describes is exhibited by the work of Kristina Hill in Senftenberg, Germany and Julie Bargmann and Stacy Levy's Vintondale Mine project. These two projects share a central theme; they arose out of a need to remediate a contaminated site and resulted in creative works that supplemented remediation and communicated process to observers. In this sense, eco-revelatory designs share many similarities with remedial landscapes. Remedial landscapes carry the virtues of these precedents into a more constrained urban environment but maintain the ability of eco-revelatory design to communicate through the landscape. Remedial landscapes are a type of eco-revelatory designs that are represented in the landscape in multiple instances like the gas station test site. More importantly, remedial landscapes are intended to address issues of contamination and remediation in a manner that reveals the observer's role in the creation of the problem.

The following is a precedent study of the eco-revelatory designs of Kristina Hill and Julie Bargmann and Stacy Levy. They will be examined to provide a better understanding of the implications of my test site.

Kristina Hill - Ring Parks as Inverted Dikes - Senftenberg Germany

Ring Parks as Inverted Dikes is a response to the system of remediation employed around Senftenberg Germany, a former mining city that although deserted after the Second World War, has been recently expanding. Functioning as a mine, the underlying water table was lowered by pumps to facilitate the extraction of materials. However, since pumping ceased, the water table is incrementally returning to its original levels bringing with it a myriad of toxic substances left-over from the mining operations. Surrounding the city are several mapped plumes of contamination, but there are also many toxic dump sites that were buried and not recorded. To treat the plumes individually was ruled out because of the danger posed by unknown dumping sites. Therefore, the system of prevention installed is designed to protect the entire city from the possibility of contaminant movement.

Hill's design response was a series of linear parks around the city along which are placed testing and monitoring wells. The parks are tree-lined raised berms laid in forms that mimic the landscapes cut by the heavy mining machinery. These parks serve as recreation corridors that allow local residents to explore the landscape surrounding the city. The wells act as a series of alarms that can be converted into pumping wells if contaminants exceed certain levels. Several pumps acting together create a hydraulic trap, or a conical depression in the water table. This prevents contaminants from entering the city. Attached to each well is a series of coloured flags which serve as indicators of the water quality as tested at that particular well. Observers can then determine the quality of the water surrounding the city as they move along the linear parks.

This project exhibits an innovative combination of remediation techniques and landscape uses. The scale of the project from wells to berms and trenches is reminiscent of the dikes constructed in the Netherlands and surely provides local residents with the comfort of knowing that they are being protected. The flag system in place also allows the observer to make his/her own assumptions about their safety within the "walls" of the landscape (Hill, 1998). As discussed in section 5.2, information collected directly by the observer is more likely to make an impact (Kollmus and Agyeman 2002).

Julie Bargmann and Stacy Levy - Testing the Waters - Vintondale, PA, USA

Ravaged by the mining processes, Vintondale is now contaminated by acid leaking from the mine. Acid mine drainage or AMD continuously leaks out of the mine and affects local ecosystems and threatens the quality of water bodies surrounding the mine. Bargmann and Levy's design involves an innovative approach to what alternately would have been a highly engineered system of remediation.

They designed a system of six treatment ponds, each responsible for adjusting pH levels and removing heavy metals. The water flows through pond 1 (the holding pond) and then to ponds 2-4 (the wetland cells) which promote biological activity. The water then moves into pond 5 (the vertical flow pond) which removes heavy metals, and into pond six (the aerator and pH regulator). The water that leaves pond 6 has a pH of about 6.5 and is deemed clean. The passive system, which incurs substantially lowers financial and energy costs, has been designed to effectively treat the acid and provide substantial insight into how the system works.

This system is exhibited by the litmus garden. The garden runs parallel to the six ponds and through color illustrates the transformation of the water as it passes from one stage to another. The plant palette in the garden and color of the water transition from orange at pond 1 to blue-green at pond six. At each stage of the garden and ponds there is a sign that briefly explains the activities of the particular pond and how the water quality is enhanced (AMD and Art, 2007).

Gobster et al. present the argument that through a better understanding of ecological process, the aesthetic perception of the observer is altered (2007). Bargmann and Levy's project at Vintondale supports this argument. The litmus garden and treatment ponds take on an entirely different form of beauty when the observer makes the correlation between their colors and their function. The ponds and associated plant materials are transformed in the mind of the observer from typical landscape elements into natural "streamlined" machines, incrementally, methodically, and magnificently treating the water for the protection of local communities and ecosystems.

Eco-Revelatory Design and Remedial Landscapes

As addressed by both the projects of Hill and Bargmann / Levy, the key to eco-revelatory design lies in the ability of the designer to use the landscape as a medium for communication about the remediation process. This adds an interpretive dimension to what could otherwise be a simply engineered system treating the ground and the water without the appreciation of its onlookers. Eco-revelatory design aesthetically enhances the function of the system, but more importantly, creatively informs the observer of its function by making the information visible.

The success of both projects lies in their ability to draw the user into the landscape and their ability to function as useable landscapes. The landscapes can be enjoyed independently of the remediation process although the opportunities to engage in learning about the landscape abound. The designs also fulfill the public's need for passive recreational green space. Secondly there are the indicators of remediation found through further exploration of the site. Indicators like Hill's flags and Bargeman/Levy's coloured ponds provide the first-hand information that is easy to understand and allow the observer opportunities to understand on a basic level the function of the remediation system.

5.0 Public Awareness and Affecting Change in Perceptions, Attitudes and Behaviours

5.1 Environmental Psychology - Affecting Behaviour

The public as a whole, although perceptive, are often unaware of the direct or secondary influences of their actions upon their environment. As described in the following, one of the major barriers between public perception of environmental issues and public action is immediacy, both locally and temporally. Through the repair and remediation of damaged landscapes the public can be exposed to the immediacy of environmental issues and potentially alter their current unsustainable lifestyles and chart a path towards both community and environmental stewardship. The following section describes the studies of environmental psychologists and sociologists who have examined why people act pro-environmentally, what the barriers are to pro-environmental behaviour (behaviour which mitigates an individual's impact upon the environment), and how landscapes can be used to highlight these issues and affect change on both an individual and community level.

Environmental psychologists do not address landscape architecture design in their research. However, their data can be examined in order develop a set of guidelines that can be included as basic programmable elements in the design of remedial landscapes. Just as the system imposed on the site for remediation will be calculated and specified by an engineer, the form and communicative properties of the site rely upon the creative aptitude of landscape architects.

To get people to change their attitudes or behavior one must first attract their attention. This has serious design implications. Remedial landscapes must draw people's attention, then hold it. Although we often describe landscapes as passive or active in terms of program, remedial landscapes must be active in the sense that they actively attract the attention of the public and initiate the discussion between the site and the observers.

The information conveyed to initiate change must be provided vividly. "Vivid information increases the likelihood that the information will be attended to initially as well as recalled later. If the information is only remembered fleetingly, it is not likely to have any lasting impact upon our attitudes and behavior" (McKenzine and Mohr 1999, 17). It is for this reason the outward appearance of remedial landscapes must be designed to attract attention each time observers pass by. Constant repetition of the

message communicated by the landscape will be more likely to affect change in the individual behaviour of community members.

Although this primary initiative set by environmental psychologists doesn't necessarily describe a design directive, it does suggest some design ideas for the site. A highly visible aesthetic must set the remedial landscapes apart from the surrounding context, just as the invisible contamination has acted to silently differentiate the site from the surrounding landscape.

Direct Experience vs. Indirect Experience

Public education about environmental problems through secondary information generally leads to a weak change in attitude or behaviour when compared to experiencing the negative affects of environmental degradation firsthand (Kollmus and Ageyman 2002). Contrary to initial beliefs, when the material is presented in a general or indirect manner, "only a small fraction of pro-environmental behavior can be directly linked to environmental knowledge and environmental awareness" (Ibid., 250). Remedial landscapes provide direct experience and can be accompanied by education programs. For individuals to change their behaviour they must first recognize that a problem exists and more so, that it exists locally. Again, the distribution of former gas station sites in neighborhoods provides opportunities to exploit the localness of contamination. Although placing signage around a site that is being remediated does fulfill the requirement of the direct experience, it seems an ineffective way to invite the observer to enter the site and reclaim the landscape for public use.

The use of gas stations as the medium for addressing our individual responsibility in the contamination of the landscape is partially derived from Robert Thayer's argument that we often create a mental separation between what he refers to as good technologies and bad technologies. In truth, there is no difference between good technology or bad technology. Good and bad are only labels we place on individual technologies that are dependent upon context and situation. In many ways, our separation of technology into these categories falls in line with the NIMBY concept, or Not In My Back Yard. For example, we are fully willing to accept the positive aspects of a certain technology such as nuclear power which acts to make our lives easier, but often regard it as bad technology when the nuclear facility is erected near within our neighborhood. "By separating the personal, intuitive "good" realms of technology upon which we individually depend from the intellectualized field of "bad" technologies "out

there" which cause social and environmental problems, we dissociate personal technologies benefits from real costs" (Thayer 84, 1994). Remedial landscapes are a reconciliation of both the good technology (gas station and associated benefits - automobiles) and the bad technology (leaking fuels - contamination). This reconciliation offers opportunities for observer to recognize the advantages and costs of gasoline dependence.

This separation of good and bad technology is exactly the issue explored through the survey. The survey asks whether residents, once recognizing local sources of contamination from gas stations (bad technology), whether it would affect individual consumption of fuels and the use of a personal vehicle (good technology). Through direct experience, the often unrealized environmental responses to our actions, are made visible for observers to contemplate. It is believed that by reconciling the realms of "good" and "bad" technology we can influence the individual to better weigh the benefits and pitfalls of an individual technology use.

Locus of Control

The locus of control "represents an individual's perception of whether he or she has the ability to bring about change through his or her own behaviour. People with a strong internal locus of control believe that their actions can bring about change" (Kollmus and Ageyman 2002, 253). People with an external locus of control, on the other hand, feel that their actions are insignificant, and that change can only be brought about by others (Ajzen and Fishbein 1980, 247). Can the redesign of indicators on remedial landscapes affect the locus of control? Ajzen and Fishbein state that people who don't act environmentally often feel that they cannot influence the situation or should not have to take responsibility for it. This is difficult to accomplish with larger issues like ozone depletion. However, examining a more specific issue such as gas consumption could provide a more tangible example of an individual's role in environmental degradation. A site such as a gas station could influence individual locus of control since community members most likely used the resources of that particular gas station. Therefore, the individual may feel like they contributed to its prolonged existence and in turn, its negative environmental impacts. The contaminant type or process by which the land was degraded must however reach out to the individual on a personal level to create the connection necessary to establish a strong locus of control. The locus of control is affected most when the actions of the individual are placed within the context of a greater problem. This tactic is commonly used to relate large scale issues of pollution or environmental degradation to individual habits.

Social norms and cultural traditions, according to Ajzen and Fishbein, are the ultimate determinants. Behavioural and normative beliefs concerning the consequences of environmental action, both positive and/or negative, are strongly based upon the prescriptions of other members of one's social network and environment (Ibid., 239). Therefore, if normative influences affect attitudes and behaviours, the site must act to influence large numbers of people to develop a recognizable trend among the local populous. According to Ajzen and Fishbein, a catalyst must be introduced to act as the epicenter around which both community engagement and pro-environmental behaviour can revolve (1980). remedial landscapes can provide a local focus around which the community acts by standing as both a physical representationof environmental degradation and a symbol of shared community values. Fuhrer et al. agree with the normative influences but ascribe a hierarchy based upon the size and relationship between the individual and his or her community (as quoted in Lehman 1999).

> A person's values are more influenced by the 'microsystem', which is comprised of the immediate social network family, neighbors, peer-groups. Values are influenced to a lesser extent by the 'exosystem' such as media and political organization. Least strong, but nevertheless important is the influence of the 'macrosystem', the cultural context in which the individual lives (Fuhrer et al., as quoted in Lehman 1999).

Cognitive Limitations of Environmental Awareness

In most cases, issues of environmental degradation or deterioration are not tangible to the individual. The depletion of the ozone or global warming, for example, are both issues that most people are aware of. However, because they are both intangible and invisible, the negative affects of both often go unnoticed and therefore do not immediately impact our individual actions. As with both issues of global warming and ozone depletion, their immediacy is reduced in scale, their rate of change is incremental and their effects upon our immediate environment are virtually imperceptible to the lay-observer.

Secondly, due to their intangibility, for individuals to accept and act upon most environmental issues, they must rely upon secondary information. The issues then take on an almost abstract quality (Kollmuss and Agyeman 253, 2002). By removing the individual as the primary observer of the action-causation relationship, emotional involvement is reduced or removed, resulting in less cause for pro-environmental action. Therefore, the immediacy of visible degradation often provides enough incentives to influence pro-environmental behaviour (Kollmuss and Agyeman 253,

2002). By making environmental degradation both tangible and immediate (visible within the community) the public is more likely to react with positive environmental action.

Emotional Investment

"The emotional reaction is stronger when we experience the degradation directly" (Kollmus and Ageyman 2002, 255). In this case the emotional involvement stems from the public's tendency to protect the community in which they live, be it for the sake of the community or for their own well-being. Although there may be no existing emotional tie between the remedial landscape and the observer, the design may prompt emotional responses and an emotional relationship may develop with other members of the community

This research seeks to activate the public as an important member of the remediation process. By exposing and unearthing issues of contamination within the community, the consequences of people's daily actions and habits are also uncovered. The landscape should be used as tool for communication and should inspire us to live more sustainably. According to Kollmus and Agyeman, in order for individuals to change their habits, they must be able to focus beyond themselves and be concerned about the community at large (2002). By exposing problems within the direct vicinity of their homes and within their communities, the re-mediative landscape can provide indications of the immediacy of environmental issues.

5.2 Public Survey

According to Feldman and Hanahan (1996), contaminated sites undergoing remediation were a concern to people living around the site. Their study showed that when notified of contamination and future plans for remediation, surveyed individuals were interested in the decision making process and the immediate future of the site. However, what Feldman and Hanahan did not address is how the residents would be notified and through which medium site activities would be communicated to residents. This public survey is a means by which the results of Feldman and Hanahan could be further tested within the context of a former gas station and the subject site.

Secondly, the survey was designed to establish whether participants believed that the establishment of a demonstration garden on the premises would be a viable tool for communicating site activity. The survey then determined whether the experience of a demonstration garden on a former gas station site undergoing

remediation would influence the participants use of gasoline and the automobile. Demonstration garden was substituted for remedial landscape because the general public is more aware of this term.

The following section contains research by environmental psychologists regarding influencing environmental behaviour. The information was applied in both the development of the survey and the development of guideline for the test site's design.

The survey findings and analysis are located in section 5.3 and a copy of the survey and cover letter are located in Appendix 1.

5.3 Results of the Survey

Although the survey attempted to determine the applicability of remedial landscapes, the term was replaced in the survey by "demonstration garden." Since participants do not have access to this thesis, they are likely to not understand the implications of remedial landscapes. The term demonstration garden is more commonly used.

Survey Hypothesis

Hypothesis 1: Residents believe that they should be notified of remediation within the community and that remediation of a local property is a community concern.

Hypothesis 2: Participants believe the remediation activities should be made more visible to the local community.

Hypothesis 3: The use of a demonstration garden would be supported as a viable tool for communicating site activities.

Hypothesis 4: Participants would indicate that a demonstration garden on a former gas station site would affect their gasoline and automobile dependence.

Methods

The survey, which consisted of 6 questions, was delivered to 500 residences surrounding the test site (see fig. 12). Participants were given one month to return the surveys. Of the 500 delivered surveys, 86 surveys were returned however only 84 surveys were analyzed. Two surveys were excluded from the data sets due to incongruities in their answers. Additionally, 51 participants provided further written responses. Although the questions were designed for simple yes or no responses, many participants answered the questions with additional information. A record of additional comments and responses can be found in Appendix 1.

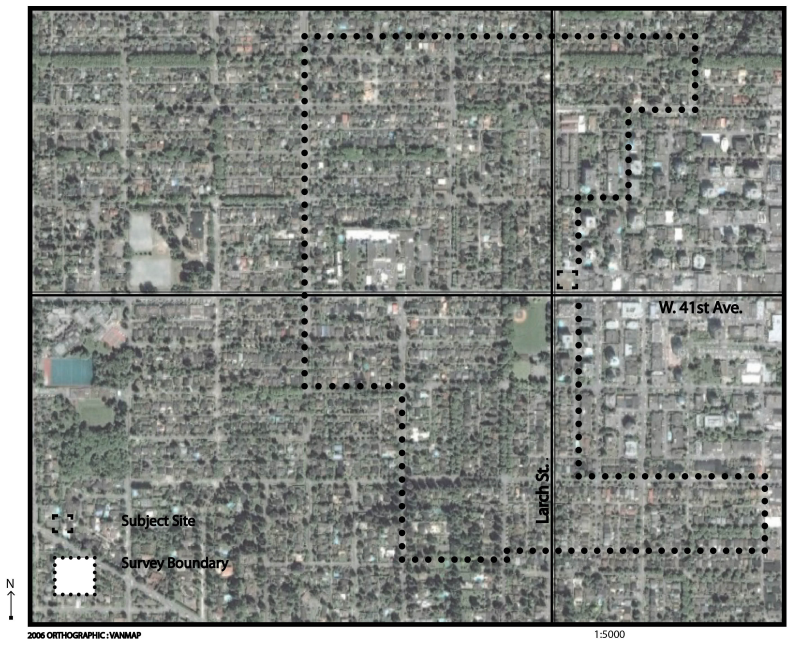


Figure 12: The area surrounding the site included in the survey area

Five surveys were received after the completion of the analysis. The written responses to these surveys have been included in Appendix 2, however their responses were not included in statistical analysis.

The hypotheses yielded the following research questions that were then put into a survey:

Question 1: Do you believe that the public, especially local residents, should be notified when a former gas station site is being cleaned?

Question 2: Do you think that the clean-up process (remediation) should be made more visible to residents?

Question 3: Would you be interested in learning about the clean-up process through a demonstration garden?

Question 4: Do you think that a demonstration garden revealing the clean-up taking place at the site would lessen your dependance on gasoline and the car?

Question 5: Do you think that a demonstration garden revealing the clean-up taking place at the site would increase your dependance on gasoline and the car?

Question 6: Do you think that the issue of a contaminated site in the neighborhood is a community concern?

Data Analysis

If the answer provided was clearly yes, no, or some variation (i.e. positively, of course, surely), the data was kept. However, answers such as maybe, I'm not sure, or potentially, were not entered into the data set. These surveys however were not entirely discounted. In the case of answers that were not simply positive or negative, no data was entered for that particular question. The data was entered and analyzed using SPSS statistical analysis program at the D.T. Kenny building on the U.B.C. Point Grey campus.

Initial Results

Table 1 - Initial Results of Statistical Analysis

	Question Label	Number of Responses	Number of Positive Responses	Percent of Positive Responses
Question 1	**Notify**	**81**	**68**	**83.95 %**
Question 2	**Visible**	**75**	**55**	**73.33 %**
Question 3	**Garden**	**78**	**49**	**62.82 %**
Question 4	**Less Gas**	**66**	**8**	**12.12 %**
Question 5	**More Gas**	**73**	**1**	**1.37%**
Question 6	**Concern**	**82**	**74**	**90.24 %**

Discussion:

Question 1

Of the 84 surveys analyzed, 81 participants answered question number one. The results indicated in Table 1 demonstrate that a substantial majority, (84 %) of participants believe that local residents should be notified when a site in the community is remediated. These results partially validate hypothesis 1 and agree with the findings of Feldman and Hanahan. Through analysis of additional written responses, it becomes more apparent that since most residents were unaware or unsure of the site's activities, they considered it dangerous or a health risk. One participant indicated the level of anxiety the site posed in her comments; " I don't want my kids biking or playing near it" (unknown participant).

Question 2

Of the 84 surveys analyzed, 75 participants answered question number in manner that could be statistically analyzed. The results indicated in Table 1 demonstrate that a majority, (73 %) of participants believe that the activities of the site should be made visible to local residents. These results validate hypothesis 2 and agree with the findings of Feldman and Hanahan which indicated that residents preferred methods of remediation that took place on site. According to their discussion, Feldman and Hanahan indicated that making the activities visible was a response to the desire of

community members to alleviate potential stigmas surrounding the site and contamination (Feldman and Hanahan 1996, 1349).

Question 3

Of the 84 surveys analyzed, 78 participants answered question number three. The results indicated in Table 1 demonstrate that a majority, (63 %) of participants would be interested in learning about the remediation of the site through a demonstration garden. These results partially validate hypothesis 3. Although 63 % of respondents answered positively to question 3, the argument for the use of a demonstration garden as a tool for communication could be improved upon. There are several reasons why the results were not as strong as desired. Six surveys provided answers to question 3 that could not be analyzed statistically. One of the six surveys provided a written response that could perhaps provide insight into why 37% of respondents that did not answer this question positively.

> "I'd be interested in learning about the process, but is a demonstration garden the right vehicle? What does a demonstration garden have to do with the clean-up process? Seems that there is a lot more to the process than just a garden." unknown participant

The definition of remedial landscapes is included within this thesis, however, for the purpose of the survey, the term was replaced with the term "demonstration garden." It is quite possible that participants understood a demonstration garden as a place that demonstrates how to garden, or how a gas station affects a garden. Unfortunately, the survey was not clear enough in its description of what exactly a demonstration garden does or is. Inversely, the 63% of participants that positively responded to question 3 may have done so simply because they preferred any type of garden over the current conditions of the site. However, the question as posed on the survey discusses learning about processes of the site through the use of a demonstrative garden. Therefore, it can be inferred that most of the positive responses were in support of the garden as a communicative or educative tool. This inference is supported further by one participants additional comments: "the public deserves to be better educated and therefore informed as to how the system can and should work." unknown participant

Question 4

Of the 84 surveys analyzed, 66 participants answered question number four. The results shown in Table 1 demonstrate that only 8 % of participants indicated that their dependence on gasoline would be lessened after experiencing a demonstration garden that reveals the clean-up process. These results do not validate hypothesis 4. Although the demonstration garden addresses issues of the cognitive limitations of environmental awareness as discussed by Kollmus and Agyeman (2002), participants' indicated viewing the clean-up process would not substantially decrease their gasoline dependence. There are several possible reasons why hypothesis 4 failed to be validated.

The lack of desired results may be due to the distinction between reading about a demonstration garden, and a first-hand encounter with a demonstration garden. As indicated by one participant, " I would not be able to answer this until I had seen/ learned from the demo garden (unknown participant)."

It is also possible that respondents failed to make a clear connection between their individual use of a car and dependence on gasoline and the cause of site contamination. This potential pitfall is made more evident by a comment made by one participant; "I don't see the link, except as a general recognition of the need to lessen dependence of fossil fuels (unknown participant)."

For remedial landscapes or demonstration gardens to be successful they must implicate the observer in the process of remediation. As Kollmus and Agyeman (2002) state, experiencing the negative affects of environmental degradation firsthand is a key to influencing individuals' environmental behaviour. Although the experience of a demonstration garden may achieve this, the results are not supported through the survey which discusses an unbuilt demonstration garden.

Question 5

Of the 84 surveys analyzed, 73 participants answered question number five. The results indicated in Table 1 demonstrate that only 1 % of participants indicated that their dependence on gasoline would be increased after experiencing a demonstration garden that reveals the clean-up process. As indicated in hypothesis four, the effects of the demonstration garden were to mitigate the observer's dependence on gasoline. Therefore, having only 1% of respondents indicate their gasoline dependence would increase does not support hypothesis 4. One explanation for why 1 respondent indicated that his/her gasoline dependence would be increased is that after experiencing

a garden that reveals remediation, the observer may come to the conclusion that it can clean-up any contamination and there is no need to mitigate gasoline usage.

Question 6

Of the 84 surveys analyzed, 82 participants answered question number 6. The results indicated in Table 1 demonstrate that a substantial majority (90 %) of participants believed the issue of remediation to be a community concern. These results agree with the findings of Feldman and Hanahan (2002), which indicated that residents felt it was a community issue since the remediation of a contaminated site could potentially affect the community, but also the marketability of the community and real-estate values. One participant's comments provide insight into the extent to which the site was a local concern; "I had the health department check the water" (unknown participant).

However, 10 participants indicated that remediation was not a concern of the community. Participants that answered no to question 6 offered explanations such as "it should be in the hands of the experts" and "it is a concern of the city council" (unknown participants).

Initial conclusions

The statistical analysis indicates that hypotheses one, two, and three are supported, Hypothesis four however is not supported by the data.

Several surveys recognized the test site although it was not discussed in the survey nor cover letter. The cover letter informed participants that my research was based on looking at former gas station sites being "cleaned" or remediated but does not name the test site. Fifteen percent of the surveys had comments related to the test site providing information on their views of site activities or questions pertaining to the site's remediation. Through examination of these comments, which can be found in Appendix 1, it becomes more clear that this particular site has been a mystery to local residents for over 2 decades and is a shared concern throughout the community.

Correlatory Results

The data entered from the surveys was then cross-correlated using a Pearson Correlation 2-Tailed test to determine what if any were the trends that appeared in the statistical data. As indicated in Table 2, there was one positive significant correlation at the 0.05 level or 95 %, and 6 positive significant correlations at the 0.01 level, or 90 %.

Table 2 - Correlatory Results of Statistical Analysis

		1	2	3	4	5	6
		Notify	Visible	Garden	Less Gas	More Gas	Concern
1	Notify	1	.517**	.305**	.073	.054	.261*
2	Visible	.517**	1	.373**	052	.073	.392**
3	Garden	.305**	.373**	1	.126	-.156	.360**
4	Less Gas	.073	.052	.126	1	.334*	-.041
5	More Gas	.054	.073	-.156	.334**	1	.036
6	Concern	.261*	.392**	.360**	-.041	.036	1

*** Correlation is significant at the 0.05 level (2-tailed)**

**** Correlation is significant at the 0.01 level (2-tailed)**

Discussion

The most significant correlation is the participants belief that they should be notified when a site undergoes remediation and that the issue of remediation is a community concern.

The second most significant correlation is exhibited between question one and question three. This strong correlation indicates that over 90 % of the participants believe the community should be notified of remediation and that they would be interested in learning about the process through a demonstration garden. This correlation provides a strong argument for the development of remedial landscapes on sites undergoing remediation.

There also existed a relatively high correlation between respondents who answered positively to question three and question six. Therefore, the majority of

respondents who believed that the contamination is a community concern, also indicated they would be interested in learning about the process through a demonstration garden.

Survey Conclusions

Although the statistics did not provide strong evidence that a demonstration garden would affect the observers' dependence on gasoline, the fact that a high correlation exists between questions one, two , three and six indicates that the well-being of the community ranks highly among resident's concerns. Therefore it is quite possible that although participants did not indicate a change in their fuel consumption after attaining information in written form (survey), their gasoline dependence is subject to change through the direct experience of the demonstration garden.

The data indicates that participants showed concern for the site and the community and they believed they should be informed when a site undergoes remediation. Residents most likely want to be informed about issues that pose potential health risks to their homes and community. It is also likely that residents did not indicate a change in their fuel consumption because they do not believe the leaking of fuel into the ground is their fault. Although their fuel needs support the sustained existence of gas stations, residents are apt to place blame for leaking tanks on site owners.

Implications for Future Research

Research studying the type of landscapes that might change environmental behaviour would be beneficial to landscape architecture and the planet. Although this thesis describes the use of remedial landscapes to change observers' behaviour, very little research has been conducted previous to the current survey.

6.0 Remedial Design interventions

6.1 Development of Design Guidelines

Although hypothesis 4 was unsupported by the statistical data, research indicates that first-hand experiences of the immediate effects of environmental degradation have the potential to influence environmental behavior and attitudes (Kollmus and Agyeman, 2002). The survey results indicated that residents strongly believe they should be informed of site activities and supported the implementation of a demonstration garden on a site undergoing remediation. Whether or not their fuel consumption will be affected after experiencing the remedial landscape could be later determined. The design of the test site is therefore primarily meant to provide residents notification of the remediation activities in the form of a remedial landscape or "demonstration garden." Nonetheless, cues taken from the research of environmental psychologists have been included in the design to provide opportunities for an experience that may lead to changes in environmental behaviour.

The following guidelines have been developed for the test site. As stated in the definition of remedial landscapes, the temporary design must "addresse both the existing processes of remediation and the processes responsible for the contamination of the site." A measure of success of remedial landscapes lies in their ability to communicate through the landscape and potentially influence the attitudes and behaviours of observers. This is where the creative talents of landscape architects are the most needed. Through exploration of the site, the observer should gain a basic understanding of the message that lies in the landscape, or to use a term coined by a communications giant Marshal McLuhan, uncover the message that exists in the medium.

The following guidelines have been developed through a combination of research and precedent studies. These guidelines were used when designing the remedial landscape for the test site.

1. the design must attract people visually and invite them to spend time on the site

2. the information must be revealed in a manner that enables people to discover the extent of remediation

3. the design should aid the observer in recognizing the scale and/or immediacy of the issues addressed by the design (i.e. contaminant type, responsible industry, etc.)

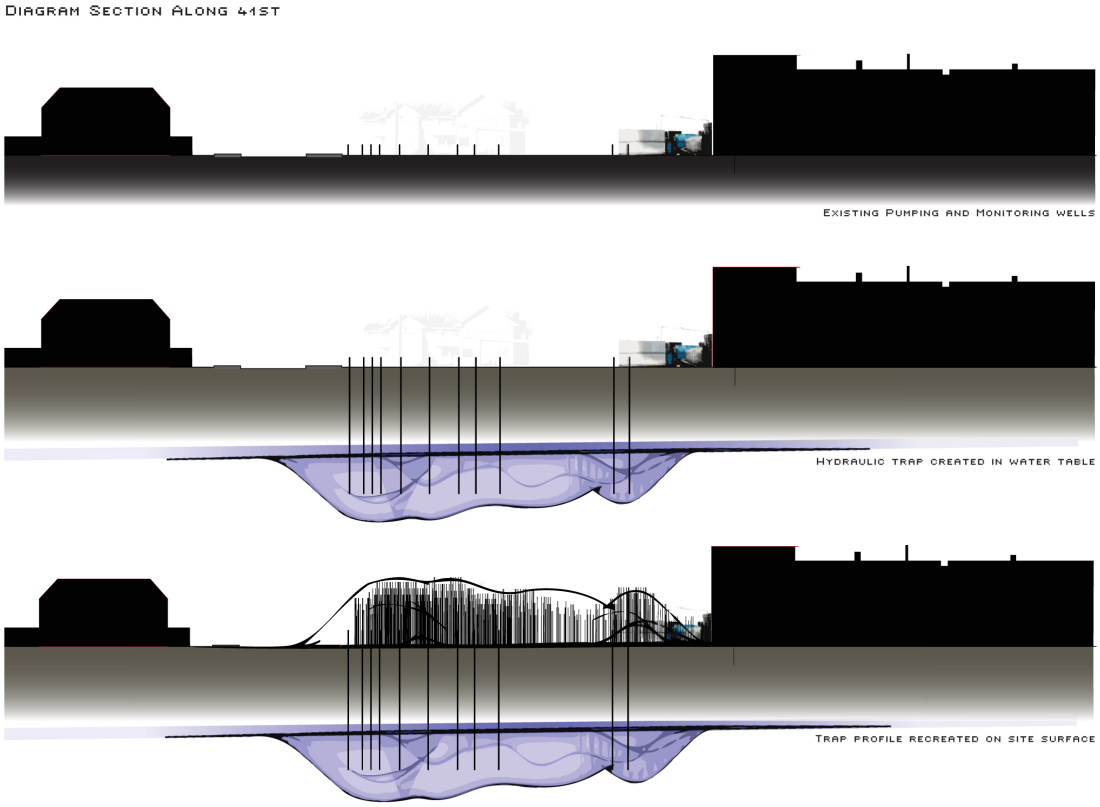
4. the design should include the use of secondary or alternative methods of remediation other than the primary system designed by the environmental engineers

5. since remedial landscapes are being used as models of sustainability, they should employ as much recycled material as possible, especially when designed for temporary situations.

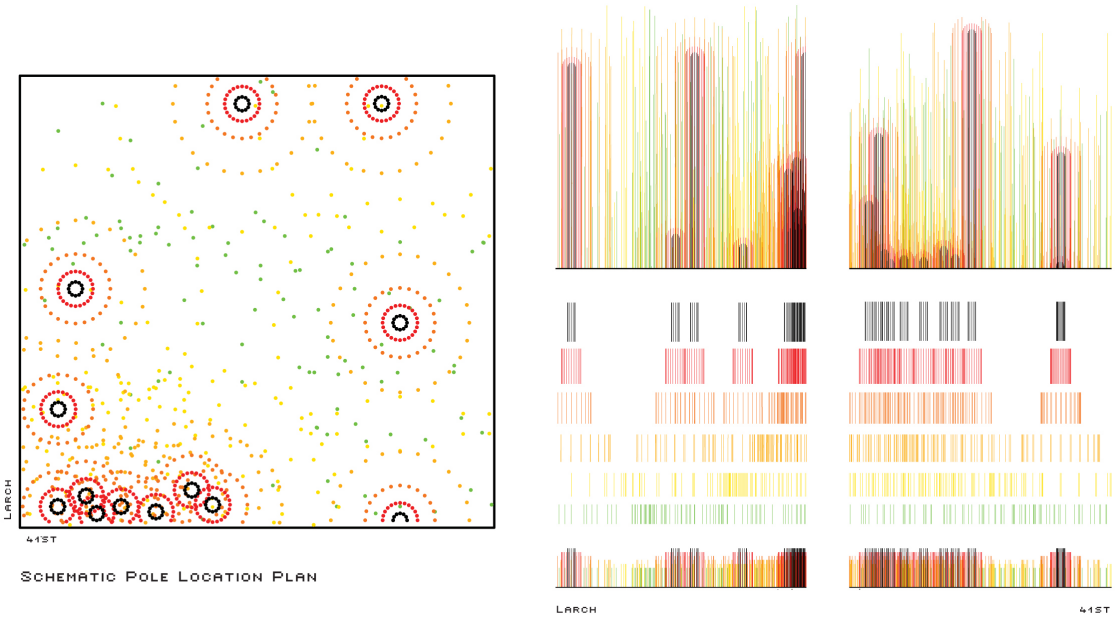
These guidelines will be further explained using specific examples from the design of the test site found in section 6.2.

6.1 Test Site Design Intervention

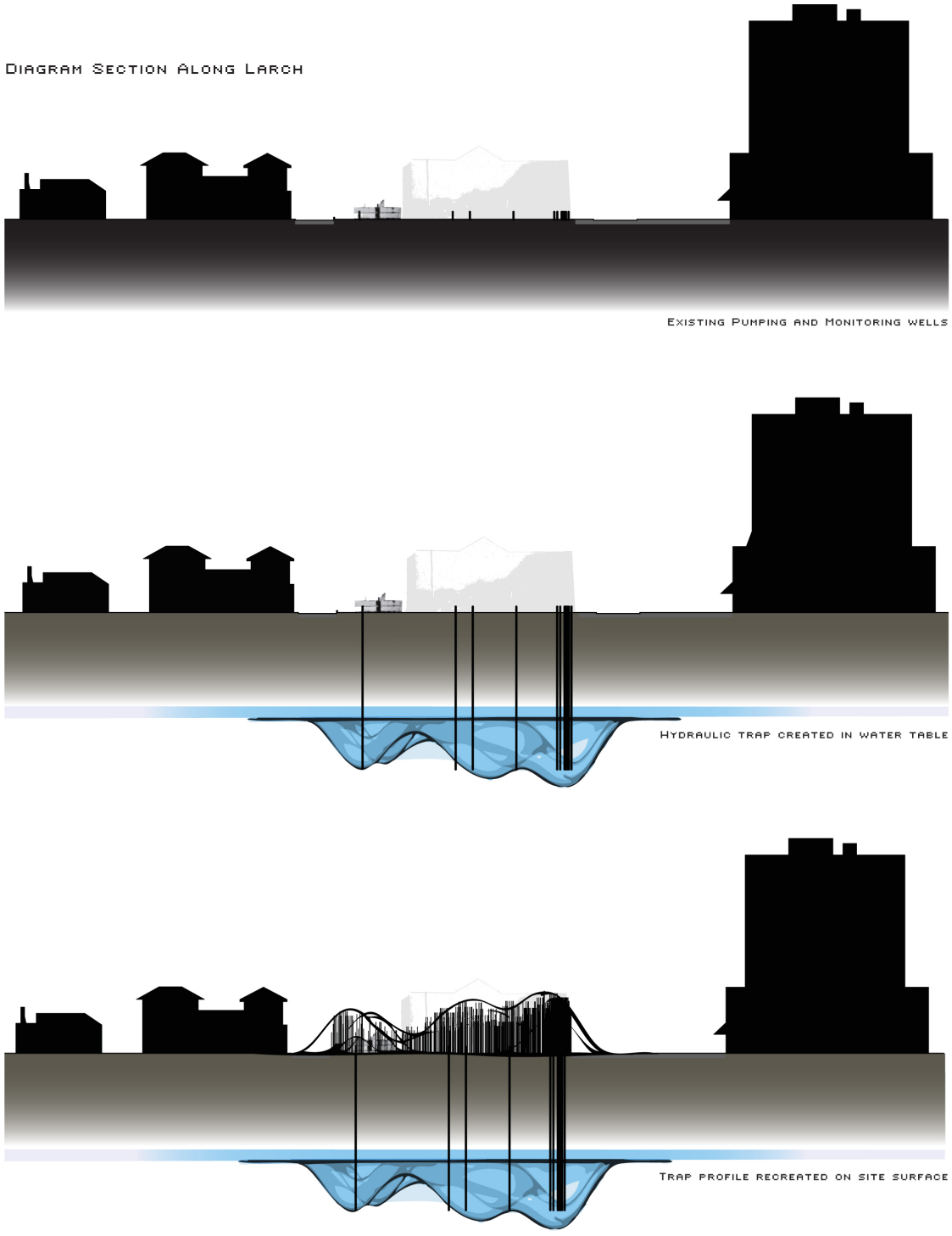
Drawing 1 - Diagram Section Along 41st



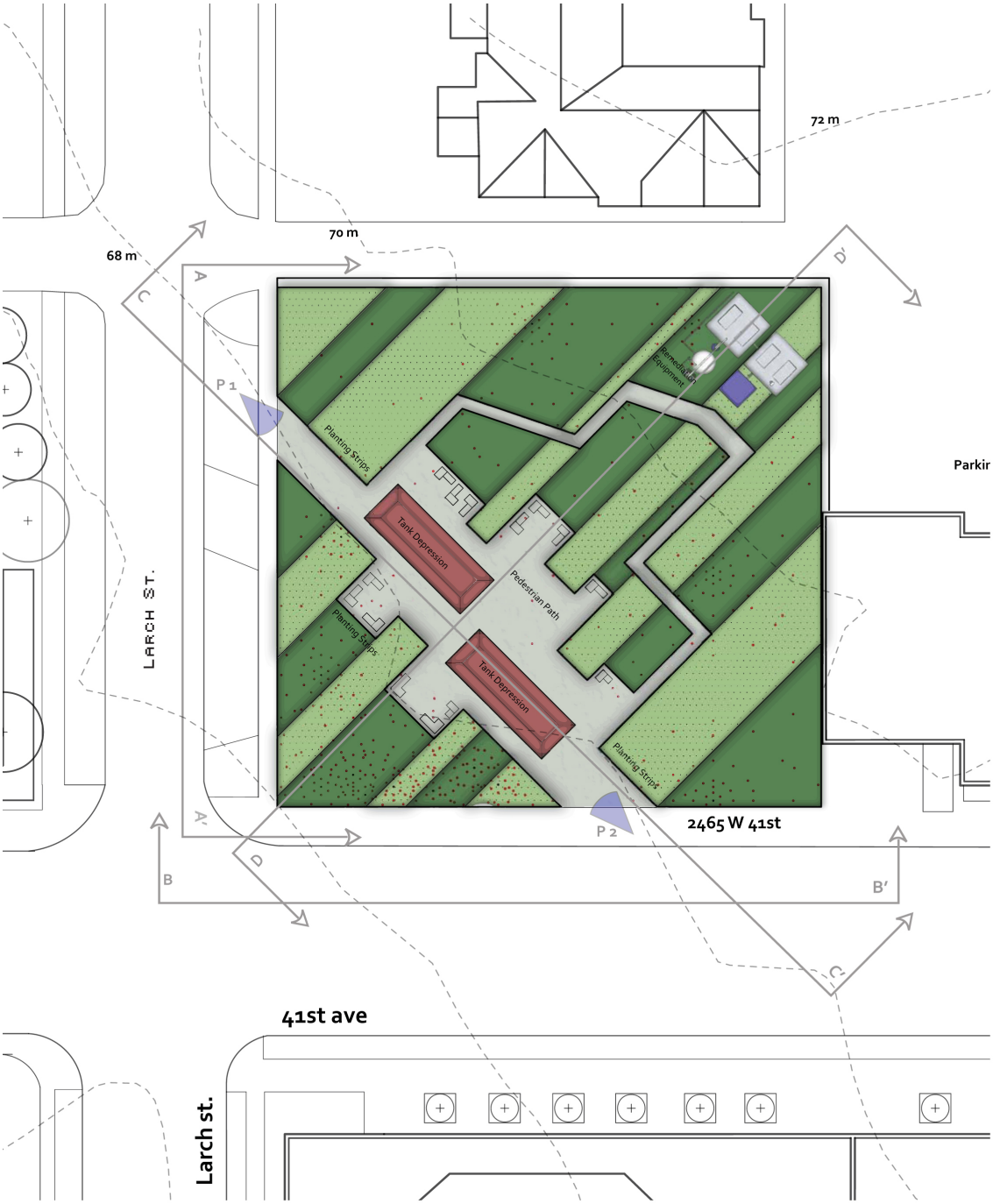
Drawing 2- Schematic Pole Location Plan



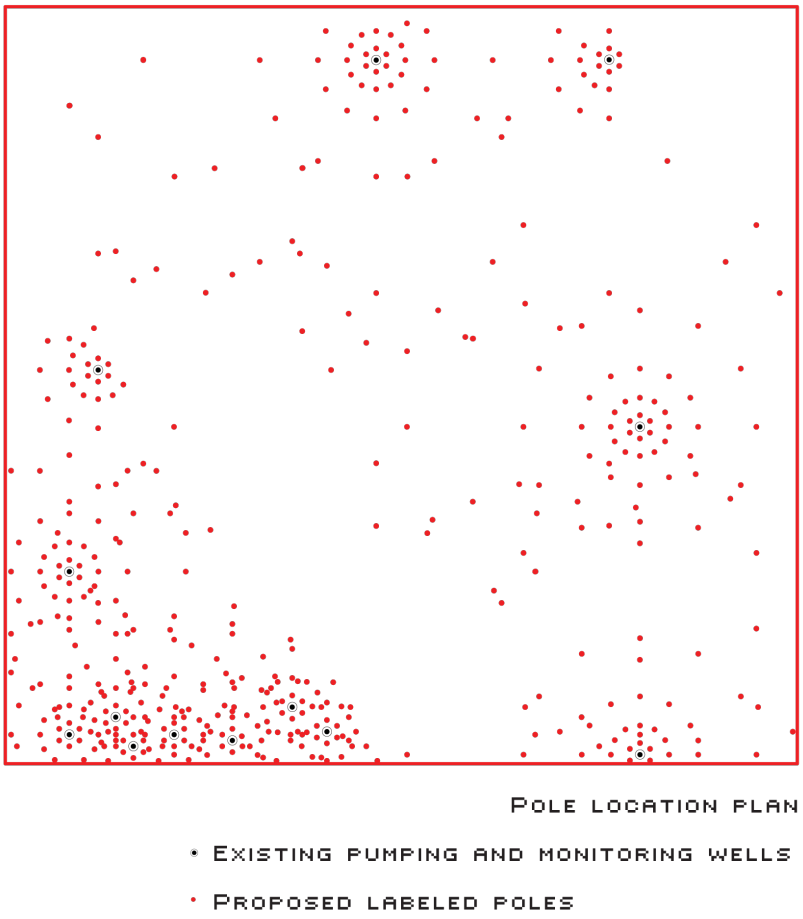
Drawing 3 - Diagram Section Along 41st



Drawing 4 - Test Site Landscape Plan



Drawing 5 - Pole Location Plan



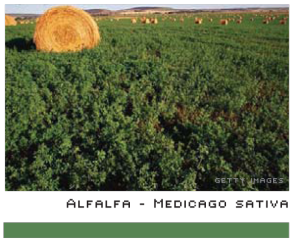

ALFALFA - MEDICAGO SATIVA

Figure 13 - Alfalfa

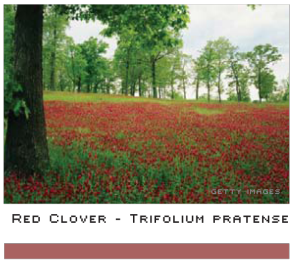

RED CLOVER - TRIFOLIUM PRATENSE

Figure 14 - Red Clover

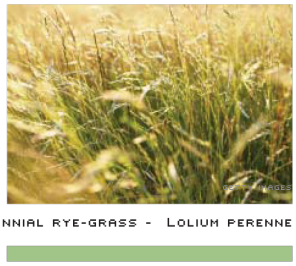
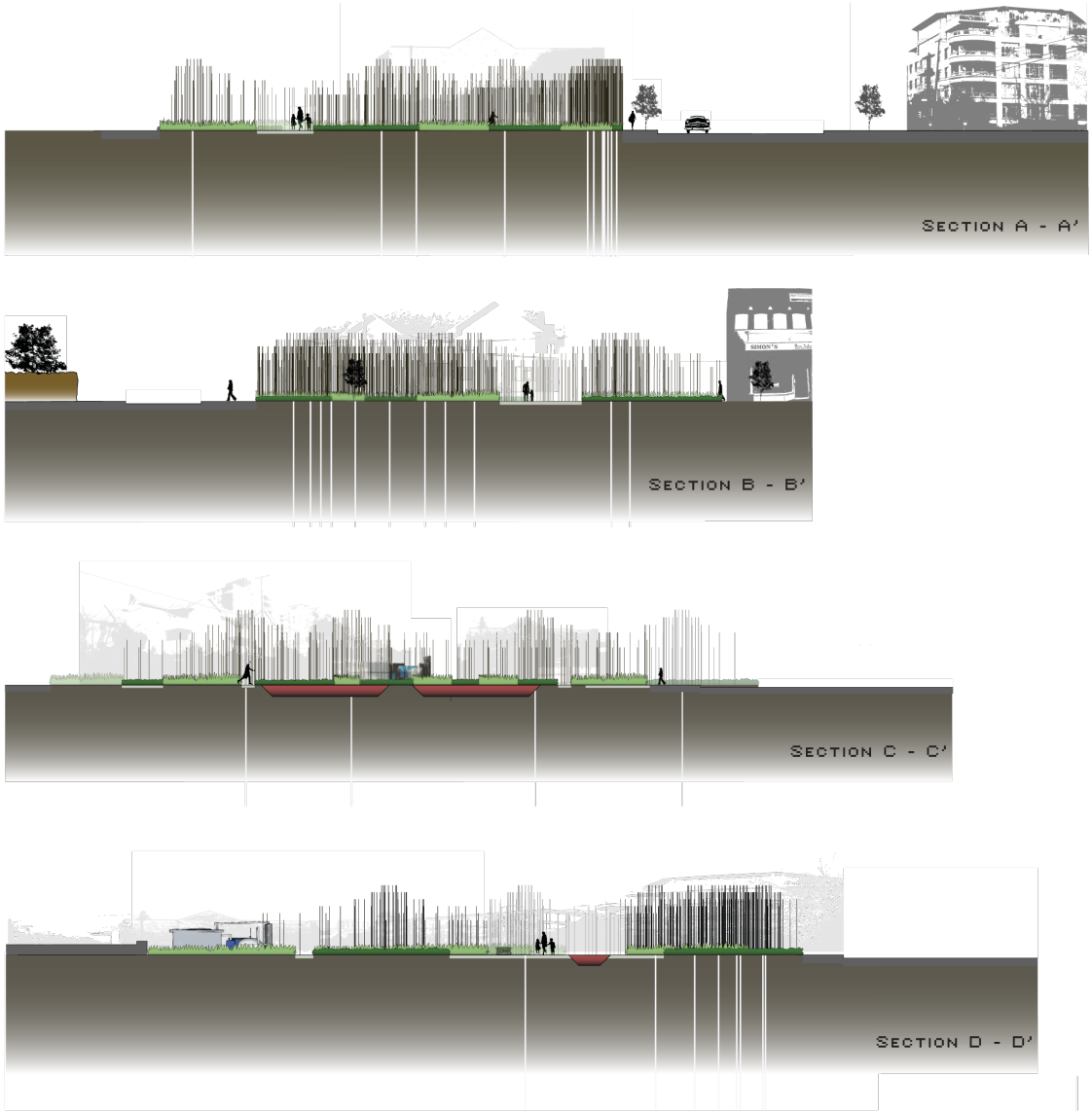
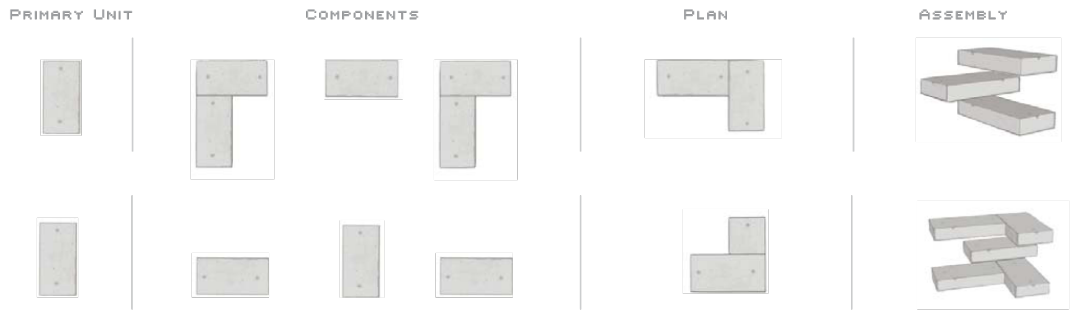

PERENNIAL RYE-GRASS - LOLIUM PERENNE

Figure 15 - Perennial Rye

Drawing 6 - Section Elevations



Drawing 7 - Site Furniture Construction



Drawing 8 - Perspective from 41st

P1 - Perspective from 41st

Drawing 9 - Perspective from Larch

P2 - Perspective from Larch

6.2 The following is an explanation and description of the elements included in the redesign of the former gas station site at 41st and Larch.

The Poles

According to the Canadian treasury there are approximately 428 former gas station sites currently undergoing remediation in Canada. Each of these sites is represented by a pole inscribed with its location. The poles provide an opportunity for the observer to recognize the scale of the issue as it impacts the entire country.

The use of pvc poles reference the poles that can be found extruding from the surface of sites undergoing remediation. The poles used on sites undergoing remediation indicate the location of pumping and monitoring wells. The pvc poles at the test site act as indicators so that the observer can begin to recognize other sites undergoing remediation.

The pole heights and arrangement density create a vertical profile of the hydraulic trap created by the underlying groundwater table. The trap, which is generated by the pump and treat system, acts both a means of collecting contaminants and preventing their migration off-site. The poles recreate this protective barrier on the site's surface depicting the strongest part of the trap which stops contaminants from moving across the street to Elm Park.

Due to their height and the quantity of poles on the site, the design has the power to draw observers into the site primarily out of curiosity. The attracting power of the poles fulfills guideline 1. In passing, the dynamic pattern of the poles as they fall in and out of alignment creates the illusion of movement on the site. This perceived activity should attract the attention of the public.

In following guideline 2, the poles are arranged in increased density around the testing and monitoring wells that are part of the site's remediation system. The existing system of remediation is then visually amplified by the added poles.

In following guideline 3, the quantity of poles used on the site informs the observer of the abundance of similar sites throughout Canada. The connection between the 428 poles and other sites is strengthened by the address listed on each pole,

for example "41st and Larch, Vancouver B.C. Since many remediation systems include the use of several pvc pipes on site, the pvc poles act as a material reference to other sites undergoing remediation. The observer is then informed on one way to recognize other sites undergoing remediation.

Tank Depression

The depressions in the ground reference the former fuel tanks which existed on-site and are responsible for the release of gasoline into the ground. The volume of soil removed is equivalent to the volume of gasoline the on-site tanks held. The size of the tanks also expresses the local community's dependence on gasoline and the amount of fuel that could be potentially released into the ground.

The tank depressions partially fulfill guideline 3 by providing evidence of the source of contamination.

Plant Materials

Two primary plant materials are arranged in rows to indicate the direction of groundwater flow, the primary agent of both the contaminant movement off-site and the system of remediation employed. The bands alternate between perennial ryegrass (Lolium perenne) and alfalfa (Sativa medicago). The grasses are planted in bands measuring in multiples of 42". The bands provide opportunities for the grasses to be removed by sod cutters to be transported to another remedial site. Besides creating a vegetative cap for the site, these two specific species promote the growth and development of a bacteria that has been shown to dramatically reduce quantities of petroleum hydrocarbons in soils.

In following guideline 4, both plant species promote a bacteria that greatly reduces the amounts of petroleum hydrocarbons in the soils. Also, the tank depressions are planted with red clover (Trifolium pratense) which is commonly used on contaminated sites to return fertility to the soil and regulate pH. As described in section 3.2 , due to a large root surface area, grasses support greater bacterial activity than other plants. The grasses also create a thick vegetative cap that reduces the possibilities for the movement of surface contaminants.

Circulation

The site provides two paths for circulation into and through the site. Both paths are made of crushed gravel, a material permeable enough to allow rainwater to

flow through the soils, but sturdy enough to provide wheelchair or stroller accessibility. The primary circulation path cuts through the south-west corner of the site creating a pedestrian connection between Larch and 41st. This path provides entrance into the site and also invites local residents to use the site as a short cut through the corner lot. The secondary path is a thinner winding path that allows observers to pass by the equipment involved in the groundwater remediation system.

Observing and learning to recognize the equipment used in the remediation of contaminated sites partially fulfills the requirement set by guideline 2.

Seating

To invite people to stay, seating is provided along the primary circulation path and provides accommodations for individuals and groups. The seating is constructed of slabs of concrete cut from the original concrete surface of the former gas station. The concrete has been cut into slabs 6" thick and stacked to create backed and non-backed seating. The same type of seating has been provided along the secondary path to provide seating near the remediation equipment.

The seating partially fulfills guideline 1 by providing opportunities for observers to spend time within the redesigned space. The recycled concrete from the site also fulfills guideline 5.

7.0 Conclusion

The goal of this thesis was to develop a remedial landscape that would both help reduce on-site contaminants and communicate to the surrounding community the remedial process. Additionally, through research and a public survey this thesis attempted to establish that remedial landscapes could:

1. affect or influence the community's attitudes and behaviours to act more pro-environmentally through the recognition of local contaminated sites and by highlighting the individual's role in the contamination process

2. create a stronger sense of community by revealing the remediation that benefits the entire community and reinforces shared values

3. aesthetically enhance the site to make the landscape more readable and enjoyable for the public

This thesis primarily defined remedial landscapes as interventions designed to repair contaminated sites and communicate the repair to the public. The thesis then examined literature which indicated that increased awareness through exposure to environmental degradation could lead to changes in the public's environmental attitudes and behaviors. A public perception study indicated that residents living around the test site in Kerrisdale also believed that the remediation process was a concern and believed that the landscape would act as a viable tool for communicating the site's activities.

Possibilities for Future Research

Since abandoned, contaminated gas stations are so prevalent in Canada, remedial landscapes should be further explored as a tool for communication. Through an exploration of other land-uses, it could become more clear to the public the quantities of land that have been contaminated and allowed to degrade to a point that threatens surrounding communities.

Remedial landscapes also provide an opportunity for landscape architects to explore post-consumer pre-recycled prodcuts. Pre-recycled products require substantially less energy to construct compared to recycled materials that have been melted down or reprocessed. Secondly, pre-recycled items maintain some properties of their original function. Their past is left partially intact. The history of the item provides

opportunities for the public to examine the extent of our single-use materialistic needs. People are offered an opportunity to examine the quantities of single-use materials as well as question where the goods would have otherwise ended up.

As discussed in the survey conclusion, further research is needed to study what elements or landscapes result in a change in environmental behaviour. Although this thesis describes the use of remedial landscapes to change observers' behaviour, very little research has been conducted previous to the current survey.

Contrary to some studies and research in environmental psychology, the survey conducted in Kerrisdale did not indicate that a demonstration garden would affect their gasoline consumption. However, as previously discussed, it is quite possible that observers would be affected by being exposed first hand to a demonstration garden or remedial landscape as opposed to exposure to a written description. Further study could measure the actual affects of remedial landscapes on gasoline consumption or other issues that pertain to sustainability.

Future of the Community

An analysis of the written responses from the survey participants indicates that many of the residents are aware of the test site at 41st and Larch. The survey hopefully generated discussion among concerned residents. The survey could potentially act as a catalyst or a springboard for the community to demand information or action. The site owner is not required to disclose the remediation taking place and it is highly unlikely that Imperial Oil, the site owner, will take any action unless instigated by the municipality or public. The site will remain in its current condition until fully remediated. Perhaps after having read and contemplated the survey, when site in the community need remediation, the residents will demand that a remedial landscape or "demonstration garden" be established.

8.0 Bibliography

Ajzen, I. and Fishbein, M. 1980. Understanding attitudes and predicting social behaviour. Prentise Hall. Englewood Cliffs, NJ.

AMD and Art Webstie. 2007. *The Treatment System.* http://www.amdandart.org. Accessed March 30, 2008.

ARKS Community Vision. 2005. Vancouver City Council.

Banks et al. 2001. The Effects of Plants on the Degradation and Toxicity of Petroleum Contaminants in Soil: A Field Assessment. *Advances in Biochemical Engineering.* 78:75-96.

Benites, Cecelia, Clare Lyster. 2005. Regarding public space. *306090 09* New York, N.Y.: 306090 Inc; distributed by Princeton Architectural Press.

British Columbia Ministry of Environment. 2007. Land Remediation: Brownfield and Brownfield Development. http://www.env.gov.bc.ca/epd/remediation/brownfields/index.htm. Accessed February 3, 2008.

Canada Gazette. 2007. Canadian Environmental Protection Act. Vol. 141, No. 14. http://canadagazette.gc.ca/partI/2007/20070407/html/regle2-e.html. Accessed February 3, 2008.

Canadian Center for Energy. 2007. Land: Underground Storage Tanks. http://www.centreforenergy.com/silos/ong/ongEnvironment/dsPetroleumIndEnvLand02.asp. Accessed February 3, 2008.

Cantner, Brenda. Telephone interview conducted Nov. 14, 2007.

Cranz, Galen, and Michael Boland. 2004. Defining the Sustainable Park: A Fifth Model for Urban Parks. *Landscape Journal* 23, no. 2:102-120.

Denes, Agnes. 1993. Notes on Eco-Logic: Environmental Artwork, Visual Philosophy and Global Perpective. *Leonardo.* 26, no. 5:387-395.

Dewey John. 1934. *Art as Experience*. New York, New York. Minton Balch.

Environment Canada Freshwater Website. 2000. Leaking Underground Storage Tanks and Piping. http://www.ec.gc.ca/water/en/nature/grdwtr/e_lust.htm. Accesses February 3, 2008.

Feldman, David. Ruth A. Hanahan. 1996. Public Perceptions of a Radioactively Contaminated Site: Concerns, Remediation Preferences, and Desired Involvement. *Environmental Health Perspective*. 104, no. 12: 1344-1352.

France, Robert. 2003. Green world, gray heart?: the promise and the reality of landscape architecture in sustaining nature. *Harvard design magazine, no.18*[30]-36.

Galatowitsch, Susan M. 1998. Ecological Design for Environmental Problem Solving. *Landscape Journal.* 17, no. 2:99-107.

Gobster et al. 2007. The shared landscape: what does aesthetics have to do with ecology? *Landscape Ecology.* 22:959-972

Haag, Richard. 1998. Eco-Revelatory Design: The Challenge of the Exhibit. *Landscape Journal* 17, no. 2:72.

Hall, Tim, and Iain Robertson. 2001. Public Art and Urban Regeneration: advocacy, claims and critical debates. *Landscape Research* 26, no. 1:5-26.

Hill, Kristina. 1998. Ring Parks as Inverted Dikes. *Landscape Journal.* 17, no.2:35-41.

Havemann, Antje, and Argit Schild. 2007. 'You can use my tights' or: The phenomenon of temporary solutions. *Landscape Research* 32, no. 1:45-55.

Herrington, Susan. When Art is a Garden - Benny Farms by Claude Cormier. *Contemporary Garden Aesthetics: Creations and Interpretations*. Dumbarton Oaks. Washington D.C. 2007.

Jakle, John A. 1992. *Derelict landscapes : the wasting of America's built environment*. Savage, Md.: Rowman & Littlefield.

Kirk, Jennifer L., John N. Klironomos, Hung Lee, and Jack T. Trevors. 2005. The effects of perennial ryegrass and alfalfa on microbial abundance and diversity in petroleum contaminated soil. *Environmental Pollution,* 133, no. 3:455-465.

Landry, Charles. 1995. *The creative city*. London, England: Demos.

Kollmus, Anja, Julian Agyeman. 2002. Mind the Gap: why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research*, 8, no. 239-260.

Korda et al. 1997. Petroleum hydrocarbon bioremediation: sampling and analystical techniques, in situ treatments and commercial microorganisms currently used. *Applied Microbiological Biotechnology.* 48: 677-686.

Mckenzie-Mohr, D and Smith, W. 1999. Fostering Sustainable Behaviour: an introduction to community-based social marketing. New Society. Gabriola Island, Canada.

Mozingo, Louise A. 1997. The Aesthetics of Ecological Design: Seeing Science as Culture. *Landscape Journal* 16, no. 1:46.

Nassauer, Joan. 1995. Messy Ecosystems Orderly Frames. *Landscape Journal*. 14, no.2: 161-169.

Riser-Roberts, Eve. 1998. *Remediation of Petroleum Contaminated Soils: Biological, Physical, and Chemical Processes*. New York. Lewis.

Sharp, Joanne, Venda Pollock, and Ronan Paddison. 2005. Just art for a just city: Public art and social inclusion in urban regeneration. *Urban Studies* 42, no. 5:1001-1023.

Strang, Gary L. 1996. Infrastructure as Landscape. *Places.*10. 3: 8-15.

Thayer Jr., Robert L. 1998. Landscape as an Ecologically Revealing Language. *Landscape Journal* 17, no. 2:118.

Thayer, Jr., Robert L. *1994. Gray world, green heart : technology, nature, and sustainable landscape.* New York: Wiley.

Thayer, Jr., Robert L. 1989. Technophobia and Topophilia: The dynamic meanings of technology in the landscape. *Delicate Balance: Technics, Culture and Consequence*. Oct. 1989. 18-28.

Thompson, Catherine Ward. 2002. Urban Open Space in the 21st century. *Landscape and Urban Planning*. 60. 59-72.

United States Environmental Protection Agency. Office of Underground Storage Tanks. 2005. http://www.epa.gov/OUST/. Accessed February 4, 2007.

United States Environmental Protection Agency. Methyl Tertiary Butyl Ether. 2007. http://www.epa.gov/MTBE/. Accessed February 4, 2007.

United States Environmental Protection Agency. 2002. Elements for Effective Management of Operating Pump and Treat Systems. U.S. Cincinnati, OH. EPA National Service Center for Environmental Publications.

United States Environmental Protection Agency. 1999. Groundwater Cleanup: Overview of Operating Experience at 28 Sites. Cincinnati, OH. EPA National Service Center for Environmental Publications.

Van Epps, Amanda. 2006. Phytoremediation of Petroleum Hydrocarbons. Office of Superfund Remediation and Technology Innovation: U.S. Environmental Protection Agency.

Weisman, Wade. 1998. Analysis of Petroleum Hydrocarbons in Environmental Media. *Total Petroleum Hydrocarbon Criteria Working Group Series Volume 1*. Amherst Scientific.

9.0 Appendices

9.1 Appendix 1 - Public Perception Survey

Cover Letter

Greetings,

I am a graduate student at the University of British Columbia preparing my thesis for a master of landscape architecture degree. My studies are concerned with cleaning up contaminated sites. A contaminated site is one that has levels of toxins in the soil and water that are higher than established safety standards. For my research I am examining gas stations that are no longer in operation and are being cleaned.

I am hoping that you will participate in my research by answering the following questions. All individual responses will be confidential and will only be used as part of my academic study.

If you are at least 18 years old, you are eligible to participate in the survey.

If you agree to complete the survey, please do NOT write your name on it. By filling out the survey you are consenting to participate.

The results of my research will be available April 1, 2008. If you would like a copy of the results please contact me.

I realize that this is a busy time, but I hope that you will return this survey in the provided self-addressed envelope at your earliest convenience.

Please feel free to contact me with any questions, comments or concerns. I also encourage you to add comments to the questionnaire as any information you are willing to share is valuable.

Sincerely,

Alexandre Man-Bourdon

Graduate Student , Landscape Architecture

acm54@interchange.ubc.ca or at home : 778.737.7410

Survey

1. Do you believe that the public, especially local residents, should be notified when a former gas station site is being cleaned up?

2. Do you think that the clean-up process (remediation) should be made more visible to residents?

3. Would you be interested in learning about the clean-up process through a demonstration garden?

4. Do you think that a demonstration garden revealing the clean-up taking place at the site would lessen your dependence on gasoline and the car?

5. Do you think that an on-site demonstration of the clean-up taking place at the site would increase your dependence on gasoline and the car?

6. Do you think the issue of a contaminated site in the neighborhood is a community concern?

7. Additional comments: (feel free to use the back as well)

9.2 Appendix 2 - Additional Written Survey Responses

The following is an account of the additional responses provided by survey participants. As there was no demographic data nor were the surveys labeled or signed, the responses have been organized by question.

Question 1: Do you believe that the public, especially local residents, should be notified when a former gas station site is being cleaned?

- yes that was they would know and feel more comfortable with that
- yes, but only the neighbors of the property being cleaned
- more important to know when it is contaminated. does the clean up process cause a hazard
- yes; a notice similar to development permit sign could be placed at the site. Mail outs on such matters are useless and only end up in the garbage or recycling
- yes especially property owners beside gas station
- yes, signs at the site
- no, because environmental tests will be done as required by the municipality for permits and the bank for loans
- yes residents need to feel secure in the knowledge that the soil in their neighborhood is safe
- yes, but its not essential
- yes that way they would know and feel more comfortable with that
- yes, but only neighbors of the property being cleaned
- no, only if it represents an environmental hazard to the residents
- yes I think the health hazard is substantial and the site leeches to other areas

- The one lot on 41st and larch was a former gas station closed in the 1980's. Ground is still contaminated.
- yes, through the media for example
- I don't think it's necessary. When the gas station i closed off, it's obvious what's happening
- No, what good would that do maybe should should be notified when site is declared contaminated
- yes in principle, but no in practice. That is to say, I think it would be responsible to notify the public, but perhaps to much to ask of the public is to be notifies every time a site is being cleaned
- I don't want my kids biking or playing near it

Question 2: Do you think that the clean-up process (remediation) should be made more visible to residents?

- as long as its not an eyesore
- city should ensure its done correctly
- yes, in principle (especially for the residents who would be interested in learning about the clean-up process), but in reality I don't think most residents want to be bothered with such issues
- no residents hopefully can trust the experts that they are doing their job
- In what sense? As long as one can see there is appropriate, effective activity on the site. Perhaps understanding the steps being taken would help us to understand what progress may be made
- yes as long as safety is still the primary concern
- yes it should be signed with info about the process and there should be a web site with up to date information

- we never were informed about the clean-up at the site north-east corner Larch and 41st ave, it has been years !!

- no, if a neighboring property wants to know more, they should take responsibility for asking questions

- more visible as in noisier or messier??? How about more accountable? where is the contaminated ground going, how is it being treated, what are and how effective are the on-site remediation

- yes if it is risk to them. More importantly, if this is paid by taxpayers, they should be notified

- yes and perhaps if plants are involved, nearby residents should be encouraged/helped to plant appropriate vegetation and warned not to eat their produce

Question 3: Would you be interested in learning about the clean-up process through a demonstration garden?

- I'd be interested in learning about the process, but is a demonstration garden the right vehicle? What does a demonstration garden have to do with the clean-up process? Seems that there is a lot more to the process than just a garden.

- absolutely. The public deserves to be better educated and therefore informed as to how the system can and should work

- no this would cost money

- No, as I suspect with most people, I think we are all too busy (and/or lazy) with our lives to be bothered with such things

- it would be interesting but there are higher priorities on my time - not to de-value the importance of your work

Question 4: Do you think that a demonstration garden revealing the clean-up taking place at the site would lessen your dependance on gasoline and the car?

- no because we already are conscious about that: we only own/use one hybrid car in our family of 4
- yes- the reality of the impact would make me think twice
- perhaps. However, I try to use the public transit and walk whenever I can.
- This would heighten awareness and possibly deter driving cars as much
- perhaps, but there are many other factors which contribute to car/gasoline use
- hopefully. I am already very concerned and use my bicycle instead of my car whenever possible
- no idea, I would not be able to answer this until I had seen/learned from the demo garden
- No, I would use gasoline and my car to the same extent that I've always had (for convenience sake) Until electric/hydro/etc. cars become the norm, I don't expect to cut down on gasoline
- our dependent on gasoline at 90 + yrs nil
- no, I have already made decision on this based on general environment concerns and costs to travel
- probably not - although it might lead to a more fuel efficient purchase next time
- no, as I do not have or need a vehicle. I have always tried to respect the environment and be accountable for all my choices
- no I have already limited my dependance on a car for environmental and health reasons (better to walk)
- it would be nice if that was the case, but I can't say that it would be enough

- no we use our vehicle as little as possible and are already more than aware of our "dependence"
- Hardly, as I use my car minimally, mostly to transport my ailing husband to medical appointments, etc.
- I don't know the answer to this because I haven't seen a clean-up
- depends on what I learned there, but I'm not someone who would go to a demonstrations garden (unless I lived next to a gas station!)
- No, sorry, but this is too naive. How many drivers would view a clean-up garden? How many would take the bus? Unfortunately more negative info in general will not stimulate positive attitudes.
- I don't see the link, except as a general recognition of the need to lessen dependence of fossil fuels

Question 5: Do you think that a demonstration garden revealing the clean-up taking place at the site would increase your dependance on gasoline and the car?

- no, it will likely to reduce the dependance on gasoline and will likely to increase interests in alternate bio-fuels/ energy
- no. It would, however, help people make wiser, informed decisions that may impact the environment
- to know how electricity works...I just want the light it to come on when I flick the switch

Question 6: Do you think that the issue of a contaminated site in the neighborhood is a community concern?

- yes, i like to know the effects of a contaminated soil to the neighbouring grounds

- yes I think it would have benefit to residents to be aware of what clean-up is involved
- yes- some sites were never remediated and were redeveloped. Public should be made aware of these sites
- no, I think it's more local than an entire community
- yes, but should be in the hands of the experts
- yes, eg. 41st Ave and Larch, NE corner, former Texaco site. Hence the need for information board with a time line for de-contamination
- I think it is a concern of the city council
- very much, I garden and often get a bit of something I like, I know soil/water plants move
- yes because toxins in the soil and water will affect vegetation, air quality and overall health
- Yes, I think it definitely is of concern, but again, many people (like me) are too busy/lazy to get involved in bettering our environment, but hope that the government/laws and researchers like you take care of it.

Question 7: Additional comments:

- I think more fuss is being made than necessary
- considering that this site has been for the best part 8 to 25 years ? and we the neighbours have been given no information except what we can see and the odd reclamation team truck on the premises, I fear that we have been living on a time bomb for some time. Consider also that there were 3 other stations in the immediate vicinity where there was no rehabilitation and now the lots hold commercial and residential buildings, one is left to wonder! i believe the former Texaco site is the first or among the first gas stations in the country to be found contaminated - but nobody ever said so!

- I have owned a home in Kerrisdale for 22 years. The site on the north side of 41st and Larch, has been undergoing clean-up for about the last 15 - 20 years. I do not recall getting any information about what has gone on at this site. I have made my own assumptions, however, I do not know when the clean-up will be done. Seems like a very long tim already. There was some activity at the site about a month ago. I think there should be a sign in front of the site explaining to residents what is going on and the expected time line.

- why not clean up the site and bill the gas company?

- The city of Vancouver who provides permits for building on former gas station sites and financial institutions must have an environmental testing approval on the land so that any potential soil/water contamination is not overlooked.

- I have been extremely concerned since Jack the Texaco station was closed down. The land slopes downhill form that site to my home at xxxx Larch. I put in "raised beds" about 3 feet of the ground for my vegetables. I am not confident that the health of people in the community are even of the remotest consideration for the property owners.

- I want to participate but I think that you should have given me a brief introduction so I have something that helps me understand your questions (2,4,5). I understand "a contaminated site" ex 41st and Larch ex Shell gas station and a "demonstration garden" but for me the questions need rephrasing to make them understandable. I don't have time to phone an advisor. Sorry!

- advertise your survey at Kerrisdale community centre freeboard between the main and seniors corridor

- the contaminated site at 41st and Larch has sat unused for almost 20 years. The contamination/seepage affected some old trees at Elm Park and along 42nd Ave. at Elm St. The result was that an arborist had to remove the trees after determining why they died. Amazingly, 3 other gas stations on the south side of 41st from Larch to Balsam were torn down, property cleaned and have been developed (Van City on one site, apartments with shops on the other two). Any information the public receives may help put pressure on oil/gas

companies to store and utilize all their sites in a responsible and environmentally appropriate manner. Stewardship is everyone's responsibility.

- more information re any such concerns are always beneficial to the neighborhood. I'm sure residents wonder why, after 2 decades, the old Texaco gas station site is still behind fences. Demonstration gardens are always an excellent idea regardless of the reason. I am a fanatical gardener.

- remediation is a mystery, a gas station is closed fenced off and sits for 10 - 15 years (41st and Larch, Davie and Howe). Helping the local residents understand is important. These sites look ugly, "greening" them with the garden or natural vegetation would benefit all including the environment. Over a vacant decade maybe they become more carbon neutral

- there is a clean-up of a former gas station site at the corner of Larch and 41st in Kerrisdale that has been going on for fifteen years at least. The remedial mechanism has been on site all those years. Occasionally workmen visit and check gauges. This is crazy!!!

- the former Texaco station in Kerrisdale has been undergoing "clean-up" for years. When completed, the site will no doubt be covered with an ugly highrise. In the meantime, it provides some welcome open and quiet space. I think the 'need' for clean-up in greatly exaggerated

- generally a contaminated site is a community concern. My comments seem contradictory as i don't think residents need to be notified when a former gas station is being cleaned. This is better then having a gas station. I am somewhat familiar with this process and am comfortable that the clean-up process is set at high standards. Other less obvious contaminants are an issue for me. Also big ticket items should be flagged.

- this something which is very complicated no just one individual can change. Very much it's depend on city and community development planning.

- is a contaminated site contained within its boundaries (e.g.property lines)? How do we know, as residents, if contamination has spread beyond the site boundaries

- New stations should have better containment standards. General public does not need to be involved with the site operations, professionals review cleanup. Dependence will always remain a reaction to cost.

- We need more information on the issue: what or why is the site being remediated, for how long, what are the remediation processes, what research has been done, where, how far does the contamination spread

- we have a former gas station site in our immediate neighborhood that has been vacant for at least 30 yrs +. I have always been concerned why this piece of prime property (41st and Larch) has not been developed and sits behind a shrouded fence. This land is on a higher grade, what has happened to make it unviable.

- are owners of gas stations assessed in advance for possible future remediation

- demonstration garden near former gas station site, put it in the internet

- more aggressive and diligent application of rules and how long tanks may remain in ground, better rules around household storage tanks are needed

- cleaning up contaminated sites is important

- I don't think I can change much about my gasoline dependence. I try to walk as much as I can. I think a demonstration garden can bring a neighborhood together. If residents walk-by or visit the garden and begin talking to each other. That will also improve the neighborhood and make it safer. What will reduce my dependence on a car is moving the IGA/Safeway closer to Kerrisdale. Those parking lots will make great gardens. Don't you think.

- I believe more are need to be taken to notify residents and if polluted soil/water/leechins junk like oil/gas is a concern, adjacent residents should assist/ and be assisted. planting species that help remove toxins would help us all (I think driveways/garages, roads). Especially if there is the additional pollution of gas stations. Perhaps plants could be available. The demo gardens could be open for a few hours once or twice a week on site to encourage residents to make a similar plantings

- how exactly does a demonstration garden reveal the clean-up taking place? It demonstrates that a garden can grown on different types of soil. It would

definitely make the site more attractive while clean-up takes place. These sites are not public lands - so owners need to give permission for gardens

- I am moderately interested to learn about the process, but most of all would be reassured that experts in the field are doing a good job - as it should be the case for any profession. I don't think the public can give advice on any subject that requires specialized knowledge and expertise. However, I appreciate the availability of objective information.

- I think its good that gas stations do clean up the soil after the in-ground tanks have leaked, but it would be better if the tanks didn't leak at all! Homeowners are required to remove and clean-up old tanks when selling their property so I think it's good business do too.

- The site at 41st and Larch has been behind a fence for years and years. It hasn't really affected us at all. Maybe would be useful to hav info on how the contamination occurred and what exactly the danger is.

- I don't have any knowledge of the clean-up process: How long it takes, what type of testing is in place. etc. I would like to have a sense of this (eg site at Larch and 41st- when will it be available for use, if ever

- I would love to the site at 41st and Larch converted into a garden

- I had the health department check the water, etc. There were originally two gas stations. The one lot on 41st and Larch east side had condos built on top. Hope soil was tested before!

- The site @ 42st and Larch became publicly known as contaminated about 1 month after we bought our home here. I believe there has been maybe two articles about this site in the Courier in 20 yrs and one story on the news when it was discovered that gas/oil as leaking under the street from the Texaco site. To my knowledge, the company never communicated directly with residents in all this time.

The University of British Columbia
Office of Research Services
Behavioural Research Ethics Board
Suite 102, 6190 Agronomy Road, Vancouver, B.C. V6T 1Z3

CERTIFICATE OF APPROVAL - MINIMAL RISK

PRINCIPAL INVESTIGATOR:	INSTITUTION / DEPARTMENT:	UBC BREB NUMBER:
Susan Herrington	UBC/Applied Science/School of Architecture and Landscape Architecture	H07-02864

INSTITUTION(S) WHERE RESEARCH WILL BE CARRIED OUT:

Institution	Site
N/A	N/A

Other locations where the research will be conducted:
subject's home

CO-INVESTIGATOR(S):
N/A

SPONSORING AGENCIES:
N/A

PROJECT TITLE:
Community Awareness of Remediated Sites

CERTIFICATE EXPIRY DATE: February 20, 2009

DOCUMENTS INCLUDED IN THIS APPROVAL:		DATE APPROVED: February 20, 2008
Document Name	**Version**	**Date**
Protocol:		
Thesis Research Proposal	N/A	December 9, 2007
Questionnaire, Questionnaire Cover Letter, Tests:		
Public Perception Survey and Cover Letter	N/A	February 15, 2008

The application for ethical review and the document(s) listed above have been reviewed and the procedures were found to be acceptable on ethical grounds for research involving human subjects.

Approval is issued on behalf of the Behavioural Research Ethics Board and signed electronically by one of the following:

Dr. M. Judith Lynam, Chair
Dr. Ken Craig, Chair
Dr. Jim Rupert, Associate Chair
Dr. Laurie Ford, Associate Chair
Dr. Daniel Salhani, Associate Chair
Dr. Anita Ho, Associate Chair