The Causeway, the Landfill, and the River: shaping Moncton's Environs

by

Michaela MacLeod

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authors' declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

abstract

The decommissioned Riverside Landfill, located on the Petitcodiac River in Moncton, New Brunswick, has been closed for over ten years. Lack of proper dumping and closure procedures has left the ground and the water surrounding the site contaminated. The waterfront, shaped by the processes of industry and hydrology remains a neglected space within the city.

The river's edge was once the main focal point of activity and interest of the city, facilitating more than 250 meters of public wharves along its riverbank. The exploratory design is for a new park that will restore ecological integrity of the river and introduce the individual scale to the landscape, while revitalizing its spirit within the city. Initially in the study, the site is mapped in relation to the region, the province, the city, the urban fabric, and the landscape. Considering the river's hydrology and the landfill's toxicity, the project aims to weave the degraded site back into the natural and cultural patterns that exist in the larger scale of the region.

Public spaces can no longer derive their form solely from economic or aesthetic doctrines. They must be developed with an understanding of natural process and used to regenerate the cityscape. The formal order shaping the park will be founded on the process of bioremediation. Additive and subtractive, cultural and biological processes are implemented over time to transform the terrain. Artificial and natural become inseparable, and develop a new relationship between urban systems, natural process, and public space.

Ongoing monitoring and management of the site will allow evolving adaptations of the project and support complexity and change.

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dedication

to my family, for their constant support and encouragement.

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preface

"When visitors arrived, they invariably wanted to visit the town dump to see the bears that were always present, snuffling and rooting through the garbage. But the dump itself intrigued me.

That tangled mound of refuse contained every conceivable relic of human usage, as though a tornado had torn through the town, uprooted everything, in its path, jumbled it all up, crushed and then dropped the whole lot in this spot. Pieces of furniture, threadbare ties, rusty appliances, amputated branches from year maintenance projects, and ragged clothing formed a microcosm of our society. And scattered throughout the dump, all sorts of food wastes tumbled from torn plastic garbage bags making tasty morsels for the bears.

In a small town with no movies or bowling alleys, the dump served as an unofficial social center. Neighbors chatted with each other as they unloaded bulky items from trailers or car trunks. Kids rummaged through the refuse seeking treasure. And many came to enjoy the bears. The dump also competed with the local garage as the site for changing oil, with local do it yourselfers parked on slight inclines emptying old crank house onto the ground.

The dump was usually veiled by smoke from fires that smoldered in one area or another. In the fall the temperature inversion often held the smoke close to the ground like a blanket. The eerie smoke and pungent smell drifted far our along the highway, announcing the presence of our town long before you reach it.

During my teenage years my pals and I would sneak into the dump after dark where, armed with powerful flashlights and 22 caliber rifles, we hunted rats. Sometimes we threw handfuls of bullets into the burning parts of the dump and scrambled to hide behind cars or trees where we expectantly awaited the ensuing explosions. We also experimented with batteries, gasoline, and other interesting fluids to create a sizzle, bang, or pyrotechnical display.

After a heavy rain, a murky liquid seeped from the dump into a nearby stream that meandered about a half a kilometer through a stately pine forest until it reached the river. No one was concerned since the cloudy seepage usually cleared up in a few days. Occasionally, the health department placed restrictions on the amount of fish that could be eaten, but we were sure any problems were caused by industries up the river and not by our little dump." [1]

Hans Tammemagi's *"little dump"* represents a universal problem of any city's waste crisis that can be no longer ignored.

fig. 0.1 *petitcodiac river causeway*

introduction

The Petitcodiac River, located in New Brunswick, connected to the Atlantic Ocean through the Bay of Fundy, is in severe crisis. There are numerous sources of pollution along its banks causing severe degradation to the river's ecosystem. According to a study done by the Petitcodiac Riverkeepers, the Causeway (route 114) is cited as the number one pollution source. Completed in 1970, the structure is a 1 km rock-filled dam constructed as a secondary vehicular link between the City of Moncton and the Town of Riverview. It is owned and operated by the province of New Brunswick. The link, a convenience for citizens, actually functions as a barrier to the river's natural tidal range: the flow of the river and the rising tides are restricted. All estuaries above the structure have been destroyed creating a fresh water ecosystem; while downstream it remains a salt-water ecosystem.

Consequences that have occurred since the construction completion of the causeway are numerous. By limiting the passage of water through the structure, the standing wave of the tidal bore has subsided from two meters to five centimeters.

The causeway, by altering the natural course of the river and restricting the waters' free flow, has created enormous silt deposits downstream. The sediment in the river's water is unable to flush and as a result the river's channel has been reduced from its original width of 1kilometer to 100 meters at the point of the structure. The siltation problem created by the structure extends from Shepody Bay, 35 kilometers downstream to the Bay of Fundy. Also as a result of the extreme siltation buildup, the river has lost its role as a navigable waterway. Where once the city celebrated the river, with its shipbuilding economy and public wharves, commercial and recreational boating activity are no longer possible. Where once the river channel was nine meters deep, currently it is filled with eight meters of sedimentation. The city has lost the river as it becomes more narrow and shallow with each passing year. Furthermore, the restricted flow of water creates an obstruction to fish passage. The incorporated fishway of the causeway is ineffective. Five aquatic species have seen been eliminated from the river: the Dwarf Wedgemussel, American shad, Striped Bass, Atlantic Tomcod, and the endangered Inner Bay of Fundy Salmon.

Treatment of the river and the marshlands with a disregard to nature's inherent rhythms and cycles, has created a crisis that the city is still trying to ignore. The decommissioned Riverside Landfill built-up on the marshes directly adjacent to the causeway, located on the Petitcodiac River, has been closed for over ten years. Improper dumping and closure procedures have left the ground and the water surrounding the site contaminated. Decision-making based on short-term economic benefit alone has resulted in too great a cost in environmental damage. Finger pointing over matters of blame and accountability have shifted the critical focus from finding a solution to the problem to one of monetary liability. Numerous government studies on the condition of the land and the water have been employed as stall tactics and have failed to indicate a clear course of action. Waving their agendas in hand, departments war over technicalities and politics. Inaction and indifference threaten to be even greater destructors.

The river's edge, bordered by more than 250 meters of public wharves, was once the city's hub of activity and interest. After decades of abuse by industry the waterfront was abandoned by the city. The consequences remain; the land scared by unconscious progress. Ronald Wright, in *A Short History of Progress* asserts:

.

> *Material progress creates problems that are- or seem to be- soluble only by further progress. Again the devil here is in the scale: a good bang can be useful; a better bang can end the world.* [2]

position Maintaining the status quo of the existing conditions on the study site is disastrous. The continued environmental damage caused by the causeway and the landfill to the integrity of the river's ecosystem is needless. Civilization's continued existence hinges upon how it decides to engage these toxic places. The obvious task is to reclaim the unwell region and to provide therapeutic care. Survival is dependant upon judicious guardianship. Ronald Wright further states:

> *The 10 000 year experiment of the settled life will stand to fall by what we do, don't do, now. The reform that is needed is not anti-capitalist, anti-American, or even deep environmentalist: it is simply the transition from short-term thinking to long-term thinking from recklessness and excess to moderation and the precautionary principle.* [3]

Man convinces himself that what is buried and forgotten can no longer have an effect on him. When the hidden is revealed and it can be no longer be overlooked, he is displeased. The Riverside landfill is contaminating the site with leachate pooling beneath the dump that flows directly into the river. James Corner, in *Recovering Landscapes, Essays in Contemporary Landscape Architecture*, has cautioned:

> *In mistakenly conceiving of the environment and its many effects and maladies as being outside and not within the cultural world, environmentalists tend only to repair and perhaps forestall damage while cultural ways of being and acting in the world (which lie at the very root of environmental problems in the first place) remain relatively unchanged. As with stitching up wounds to the skin that are only recurring symptoms of some larger failing, the continual patching over problems is a well intentioned and praiseworthy effort but one that fails to adequately address their source.* [4]

Current methods of dealing with contamination are merely extensions of the waste crisis. Using a procedure such as "dig and dump" for ex-situ contamination treatment simply transfers the problem to another location. The "cap and contain" method makes assumptions that the shield protecting the environment from contamination is perfect, and that it will never falter or fail. Both operations simply prolong the effects of these actions with their consequences and perpetuate the problem for future generations.

Waste is considered as something useless, something that no longer has value; something sufficiently degraded so that the cost of reclamation seems higher than the cost of disposal, in other words, something unprofitable. The chosen study site is a discarded area, an abandoned space within the city. The site will be used to transform perceived "waste" into "resource".

The thesis proposal is an exploratory design for a new municipal park that makes visible that process used to remediate the degraded land of the decommissioned Riverside Landfill site. It will restore the ecological integrity of the river and provide amenity while revitalizing the spirit within the city. The park is a place for the city to witness the process of remediation, in consequence seeking to positively affect subsequent practices in generating, producing, and disposing of waste.

approach Considering the river's hydrology and the landfill's toxicity, the planning and design of the intervention aims to weave the degraded site back into the natural and cultural patterns that exist at the scale in the larger landscape. Landscape is used as a medium to affect change at the scale of the city. The SOHO (self-organizing holarchic open-ended) ecosystem's method was used as a foundation for the organization of the site because of its inherent ability to adapt and change.

These systems exhibit loose hierarchical structures, various emergent phenomena, and relatively sudden reconfigurations from one state of system organization to another, some changes in these systems are inherently unpredictable.[5]

Ecosystem theory was applied to the site by implementing a strategic bioremediation process; these self-organizing processes occur over an extended period of time. The biological functions used to remediate the leachate would in turn, transform the terrain. The landscape would dramatically grow, change, and reorganize itself depending on encouraged conditions. As presented in the paper "An Ecosystem Approach for Sustainability: Addressing the Challenge of Complexity" by James Kay et al:

Self-organizing structure dissipative processes emerge whenever sufficient exergy is available to support them. Once a dissipative process emerges and becomes established it manifests itself as structure. These structures provide a new context, nested within which new processes can emerge, which in turn beget new structures, nested within which….Thus emerges a SOHO system, a nested constellation of self-organizing dissipative process/structures, organized about a particular set of sources of exergy, materials, and information, embedded in a physical environment, that give rise to coherent self-perpetuating behaviors.[6]

Simultaneously a series of cultural interventions would be implemented on the site that would constantly alter and rework the existing pattern of programs and activity. The plan will be complex, precise in form, but flexible enough to allow degrees of change and chance to occur. Flexibility is necessary as the scope of the project extents over a hundred-year period. Unpredicted results must be accommodated into the plan, some outcomes will be unstructured and random.

Underlying the system is the operation of complex systems over various spatial and temporal scales. At the scale of the landscape the site functions as a filter. At the scale of the city the site functions as a park.

assumptions Several assumptions were made at the beginning of the design process. First, that information presented in the Closure of the Moncton Landfill Report (1995) prepared for the City of Moncton, by GEMTEC Limited, was accepted as true, specifically, those recorded statistics concerning leachate and gas generation.

Second, that bioremediation (adding bacteria and other organisms to consume or neutralize contaminants) is a viable method that could be used to restore the landscape on the study site, given that ideal growing conditions and the correct mix of species was encouraged. Living Machine projects developed by biologist John Todd support this method of remediation.

Third, the stages of the remediation process of the design project are based on the existing and successful method employed at the Regional Halifax Municipal Leachate Treatment Facility. In addition, the sum of the wetland areas needed to remediate the leachate at the study site will be generated based on the areas needed to remediate leachate produced at the Halifax site.

structure The thesis is separated into three parts. The first part examines the environmental crisis, its causes and effects. The second part examines the effects of the environmental crisis particular to the study site, as presented through analytical mapping. The data gathered in part two informs the design proposal that is part three. The third concluding part, the exploratory design, is illustrated through a mapping series of site processes, systems, and types.

fig. 0.2 image of freshwater headpond created by the restricted tidal flow of the petitcodiac river. photo by author

fig. 0.3 salt water marsh, created from the silt deposits downstream of the causeway, photo by author

Our power to transform the Earth has promoted the illusion that we control nature, that we are somehow separate from it…Our survival as a species now depends upon whether we can adapt our environment in new ways. The resolution of this fundamental issue of our age will determine our viability as a species. We must adapt our institutions and our buildings, landscapes and settlements to this end. [7]

Spirn, Architecture in the Landscape: Toward a Unified Vision

01: the waste crisis

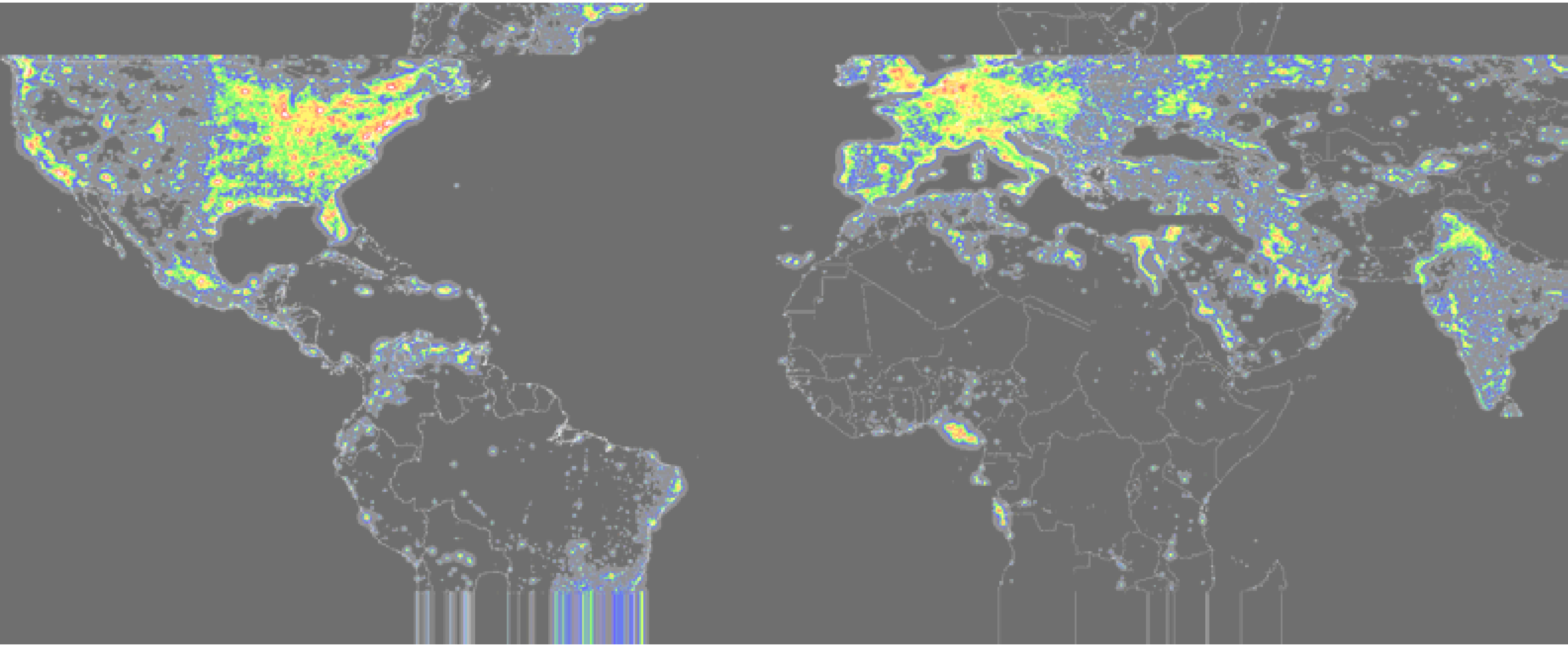


fig. 1.1 satellite image of consumption, Light Pollution Science and Technology Institute. CONCAM project

Following the attacks of September 11th, 2001, the world media and politicians focused understandably on terrorism...Three thousand died in the United States that day: 25 000 die every day in the world from contaminated water alone. [8]

1.1 what crisis

The global environmental crisis is the greatest single threat confronting the survival of civilization on the planet. The environment's degradation has now passed the point of no return, where human activity has caused irreparable damage to the environment. The effects are no longer local but have assumed global dimensions and consequences. The environment deteriorates dramatically each day.

> *Ecological markers suggest that in the early 1960's, humans were using about 70 per cent of nature's yearly output, by the early 1980's, we'd reached 100 per cent, and by 1999, we were at 125 per cent.* [9]

In *A Short History of Progress*, Ronald Wright adds:

> *...pollution is a problem of scale. The biosphere might have been able to tolerate our dirty old friends coal and oil if we'd burned them gradually. But how long can it withstand a blaze of consumption so frenzied that the dark side of this planet glows like a fanned ember in the night of space?* [10]

"Life magazine fashionably heralded the advent of the 'throwaway society' in 1955" [11]

fig. 1.2 landfill site. waste on an enormous scale

To further emphasize the scale of the environmental crisis he notes: "We're logging everywhere, fishing everywhere, irrigating everywhere, building everywhere, and no corner of the biosphere escapes our hemorrhage of waste."[12] The undesired was dumped in depressions or ravines in close proximity to population centers. For centuries this approach was accepted as the earth had the capacity to absorb the impact of a small civilization. Two developments upset the balance. First, was the explosion of the earth's population in the last decades of the 20th century, that resulted in a sudden increase in waste generated. Parallel to population growth, the technological revolution led to the creation of the hazardous products of synthetic organic substances such as pesticides and PCB's. The Age of Consumerism, following WWII, hastened the advent of the waste crisis. Erna Bennett reiterates in *The Environmental Crisis: Past the Point of No Return*:

> *In a modern capitalist society where more is spent on advertising than is spent on medical and agricultural research combined, it is not at all surprising that consumerism leads to waste on an enormous scale.* [13]

Since electronic waves infiltrated the homes of most families during the 1950's, television became the perfect tool to implement the advance of consumerism. The perspective of the Great Depression made full employment an agreed public policy. Society's vision encompassed consumerism as 'the good life'. Some advocated that consumption should be the new spirituality. A mid-fifties marketing consultant Seymour and Girardet, specifically states:

> *Our enormously productive economy demands that we make consumption a way of life, that we convert the buying and use of goods into rituals, that we seek our spiritual satisfactions in consumption...We need things consumed, burned up, worn out, replaced and discarded at an ever-growing rate.*[14]

Toffler, in *Future Shock*, chronicles indicators of change and forced consumption. He refers to the 'the economics of permanence' being replaced by 'the economics of transience'. His basic outlook was that: "Automation made it cheaper to produce new than repair old; advancing technology meant 'new-improved' versions appeared at ever increasing rates; and the rate of change demanded short-life products - just to keep pace with change. " [15] The producers of those throw away items were not required to factor the cost of disposal of their goods due to publicly funded waste services. Never before in history had there been a period where products were rapidly mass produced, consumed, and discarded. The interest of the private sector was furthered at the cost of environmental damage: the result was a flood of new materials entering the waste stream. The composition of garbage altered as new technology produced higher levels of pollution from sophisticated radioactive waste from nuclear power plants and the manufacture of nuclear weapons. As addition, the increased volume and toxicity of hazardous substances, made possible by the creation of synthetic organic compounds, eventually found their way into the air, the ground, and the water. In *Rubbish! the Archaeology of Garbage,* Rathje and Murphy warn that the technology of disposing of waste has not caught up to with the technology of producing it. Like Toffler, they believe that: "Operating under the assumption that there will always be enough space to easily hide our seemly endless stream of waste, landfills have reached enormous scales." [16]

With the massive quantity of rubbish piling up in our cities, contaminating the land and water, the global environment is in severe waste crisis.

Each Canadian, on average, produces 4.9 pounds (2.2 kilograms) of waste each day.[17]

1.2 what is waste

All aspects of our daily lives, the processes of living, eating, working, and playing, all utilize consumer products and generate waste that become invisible. North America is dotted with tens of thousands of landfills that become the final resting place for human discards. Environmentalists concerned with this global trend speak to this issue:

> *People put their garbage in the can under the kitchen sink, in the bathroom, in the den, and then someone collects in and takes it out. The garbage that is taken out is eventually left at the curb or in the alley, and very soon it is gone. Other garbage quickly replaces all of this garbage. Garbage passes under our eyes virtually unnoticed, the continual turnover inhibiting perception. One of the handful of things that every American does every day- throw garbage away- is among the least likely to register.* [18]

> *We are surrounded by all kinds of consumer goods. And yet we are profoundly detached from the sources of those things. Our lifestyles are made possible by industries all around the world, but we take them for granted, as background to our existence.*[19]

fig. 1.3 one day waste log. macleod residence,august 13th, 2005

The Oxford dictionary defines *waste* in the following ways:

• verb 1 use carelessly, extravagantly, or to no purpose. 2 fail to make full or good use of. 3 (be wasted on) be unappreciated by. 4 (often waste away) become progressively weaker and more emaciated. 5 literary lay waste to. 6 N. Amer. informal kill or severely injure. 7 wasted informal under the influence of alcohol or illegal drugs.

• adjective 1 eliminated or discarded as no longer useful or required. 2 (of an area of land) not used, cultivated, or built on.

• noun 1 an act or instance of wasting. 2 unusable or unwanted material. 3 a large area of barren, uninhabited land.

— PHRASES go to waste be wasted. lay waste (to) completely destroy. waste not, want not proverb if you use a commodity or resource carefully and without extravagance you will never be in need.

— ORIGIN Old French, from Latin vastus 'unoccupied, uncultivated' [20]

fig. 1.4 historical landfill, 1900. horizontal expansion of garbage

Throughout most of time human beings disposed of garbage in a very convenient manner: simply by leaving it where it fell. To be sure, they sometimes tidied up their sleeping and activity areas, but that was about all. This disposal scheme functioned adequately because hunter-gatherers frequently abandoned their campgrounds to follow game or find new stands of plants (and of course, because there weren't all that many hunter-gatherers to begin with. [21]

1.3 when it began

Rathje and Murphy assert in *Rubbish! the Archaeology of Garbage* that "our species faced its first garbage crisis when human beings became sedentary animals." [22] From that point on the principle of dump and move was no longer viable.

History, as recorded by Tammemagi in *The Waste Crisis,* reveals that from 3000 to 1000 BC the Minoan civilization in the capital of Knossos had the first recorded regulations to control municipal waste. Refuse was placed in large pits within the city and covered with earth. By 500 BC the city of Athens required that each household was responsible for its own garbage. It had to be collected and disposed of outside the city walls at a minimum distance 1.5 km. [23]

During the 1800's, in Europe and North America, threat of disease made garbage removal a public responsibility. In the early 1900's the first solid waste management program was implemented in response to rapid industrialization and urbanization. Most methods of disposal included land filling, water dumping, incineration, or piggeries. [24] At the turn of the century, it was common to landfill by reclaiming wetlands and tidal marshes near cities. The waste in these landfills was approximately one meter thick and expanded horizontally until it began to

fig. 1.5 modern day landfill site

interfere with urban development, at which point a new disposal location was found. [25]

Over this century, awareness grew of the danger of toxicity from municipal landfills and its capacity to cause cancer, neurological disorders, and damage nervous and reproductive systems. As a direct result of this knowledge, procedures were implemented to deal with the crisis.

> *In the 1950's to counter the escalating criticism of landfills near growing urban areas and water supplies the concept of the 'sanitary' landfill was introduced. This concept implied principles of 'science' and 'engineering' applied to a method of waste disposal. Each day the waste was covered with a thin layer of fill, compacted and covered over at the end of the day. This method did not address groundwater contamination, gas emissions, and health concerns. The solution was temporary. The increased use of engineering techniques would only postpone, not prevent, the onset of groundwater contamination.* [26]

Unfortunately, the practice of land filling remains fundamentally unchanged to the present day where waste is dumped on the least desirable land, covered up, and forgotten. This concept of 'dilute and disperse' is predicated on the myth that natural and biological processes will render the waste safe as it decomposes and percolates through the underlying soils.

fig. 1.6 fresh kills landfill site, staten island, new york

Pounds of paper used to produce 400 hard copies of New York City's report on the Fresh Kills landfill's closing: 14,800. [27]

1.4 where it was thrown

Fresh Kills is a sanitary landfill. It is the largest landfill in the world covering 3000 acres. It opened in 1951 on Staten Island in New York. Robert Moses, the New York City Parks Commissioner, intended a three year dumping period, enough time to fill the vast marshland so it could be residentially developed. Mr. Moses expressed that Fresh Kills represents:

> *…not merely a means of disposing of the city's refuse in an efficient, sanitary and unobjectionable manner pending the building of incinerators. We believe that it represents the greatest single opportunity for community planning in this City.*[28]

In May of 1996 Mayor Giuliani announced that the landfill would close to receipt of solid waste. The final shipment of household garbage occurred on March 22, 2001. Fresh Kills received more than 44 million pounds of garbage from New York every single day. It is the largest man-made structure in the world with heights from 30m to 70m and an estimated mass of 100 million tons and volume of 2.9 billion cubic feet. It operated around the clock 6 days per week at a cost of $100 million per year. [29] A system of tidally influenced creeks flows through the site. Debate continues over how the location will be developed. The NYC

fig. 1.7 "lifescape" winning competition entry of fresh kills, designed by urban planning firm, Field Operations

"lifescape: a model of public engagement and creative reuse" [30]

Department of Sanitation states:

> *Fresh Kills will be transformed into a vastly different place than it is today. The Landfill will likely become a more tranquil and pastoral area, one with rolling green hills and marshlands. A place that teems with birds, animals and water life. A place that Staten Islanders, indeed all New Yorkers will one day visit in large numbers. In short, Fresh Kills will likely evolve into the one of the most attractive areas in this region and a jewel in the City's crown of world-class parks.*[31]

A large vegetated wall bordering the Fresh Kills Landfill site obscures the view of shoppers at the Staten Island Mall. Meirle Laderman Ukeles considers it symbolic of "the basis of our whole culture—buy, buy, buy, and waste, waste, waste." [32]

fig. 1.8 youth demonstrate at love canal

a city dump is a record. It contains relics of every person who has lived there and every phase of the town's history. [33]

1.5 what is left behind

Fresh Kills was not an isolated occurrence. Love Canal is a 16-acre former landfill in the southeast corner of the City of Niagara Falls. In 1890 a canal was excavated to provide hydroelectric power, instead it was used by Hooker Electrochemical for disposal of over 21 000 tonnes of various chemical wastes, including pesticides and refuse from chemical weapons research. [34]

At capacity, in 1953, the landfill was covered over with earth, and purchased for the price of one dollar by the Niagara Falls Board of Education. Included with the deed was the warning that toxic chemicals were buried at the location. Regardless, extensive development occurred. The Board of Education built the 99th Street Elementary School directly on the site. The architect questioned the safety of building on the land after finding chemical pooling on the field. He noted that it might weaken the foundation of the building. The Board of Education ignored the warning and continued to build. Unlike the board, new homeowners were not alerted to the potential hazards associated with residing close to the toxic landfill. 20,000 tons of poisonous chemicals were buried there, including 130 lbs of dioxin. 3 ounces can kill more that one million people. [35]

fig. 1.9 love canal evacuation

" in the early afternoon someone showed me a newspaper headline reading: White House blocks Love Canal evacuations. everyone around me was angry, upset, cursing, and swearing. A few began to cry saying: what the hell do they need, dead bodies in the streets?" [36]

Over the next twenty years the hazardous chemicals began to leach to the surface. The residents filed complaints based on the presence of obnoxious odors and the bubbling up of liquid substances in their yards. Officials from the city visited the sites and covered over the offending patches with dirt. Children and pets developed skin irritation after playing in the field around the school. Rocks from the playground would explode when dropped. Incidences of deformities, birth defects, miscarriages, seizures, learning disabilities, skin rashes, deafness, chronic headaches, respiratory discomforts, and cancers rose in the community. [37]

On August 2, 1978, the New York State Commissioner of Health, Robert M. Whalen, M.D. declared a medical State of Emergency at Love Canal and ordered the immediate closure of the 99th Street School. In 1988 after extensive testing the area was still declared uninhabitable by NYS Dept. of Health. In 1990, nine homes on the edge of Love Canal went up for sale. Today, the majority of the remaining homes are on the market. Chemicals at the site will not decompose for 20 000 years, the genetic mutations will survive indefinitely. [38] Four families occupied one home over a 15 year span. Medical records show, in the first family, the wife suffered a nervous breakdown and had hysterectomy due to uterine bleeding. In the second family, the husband underwent a nervous breakdown, the wife had a hysterectomy due to uterine cancer, the daughter developed epilepsy, and the son developed asthma. In the third family, the wife experienced a nervous breakdown and both of her children suffered from bronchitis. In the fourth family, the wife endured severe headaches and had a hysterectomy due to uterine bleeding, and pre-malignant growth. The fourth family lived in the home less than two years. The New York State Department of Health indeed upholds that no conclusive evidence exists linking Love Canal to illness. The Environmental Protection Agency has identified an additional 74 000 contaminated sites in the United States of which 32 000 are rated as bad or

fig. 1.10 "waste city". smokey mountain , manila

worse than Love Canal.[39]

Improper development of toxic sites continues around the world today. Smokey Mountain landfill, in the Philippine capital of Manila, covers four acres and rises seven stories. The waste city became the home of 25 000 squatters who lived in cardboard houses erected on silts constructed on the heap of refuse. They choked on the smoke from the fires fueled by the decomposing waste and survived by rummaging through the garbage for anything edible or saleable.[40] Much of the garbage remains, yet the landfill has been converted into a low-income housing project. Waste mountains rise in third world countries because western cultures export their consumption mode in addition to their consumer products.

More sophisticated contemporary thinking, in contrast to past global and garbage disasters, is a 'cradle to grave' concept in dealing with waste. The British High Commission on Environment Pollution advocates this philosophy as 'care of duty'. Its misconception, however, is that disposal is where the responsibility ends- out of sight, out of mind. K.A Gourlay, in *World of Waste: Dilemmas of Industrial Development,* disagrees with this attitude and poses the question:

> *But are these the true beginning and end of the waste process? Is there not, in terms of the metaphor "life after death"? Or even questions to be asked about the possibility of a monstrous birth? …when hazardous chemicals are buried in the landfill this consignment to the grave is unfortunately by no means the final act.*[41]

Unless there is a change in the way people believe they are integrated with the environment and rethink manufacturing, disposal, and garbage treatment future generations will inherit a wasteland.

human beings are mere place-holders in time, like zeros in a long number: their garbage seems to have more staying power, and a power to inform across the millennia that complements that of the written word. The profligate habits of our country and our time-the sheer volume of garbage that we create and must dispose of-will make our society an open book. The question is: would we ourselves recognize our story when it is told, or will our garbage tell tales about us that we as yet do not suspect? [42]

1.6 what are the consequences

We leave behind vast gardens of ashes and poisons. Remaining deadly for more than 250 000 years, this legacy will last for 10 000 generations. It will be impossible to use this land for urban, commercial, industrial, or agricultural development. In his book, *Wasteland* David Hanson reinforces this concept:

> *Geologist estimate that the North American continent as we know it has existed for some 60 million years. What we have managed to do to it in a mere 200 years defies the imagination. Driven by our distorted notions of progress, we have realized the logical conclusions of our Manifest Destiny, and have transformed our natural world from wilderness to pastoral landscape to industrial site and now to wasteland.*[43]

Ed Burtynsky notes in a recent interview, "our dependence on nature to provide materials for our consumption and our concern for the health of our planet sets us into an uneasy contradiction." [44]

The aboriginal tribe of Australia, the Earth's oldest known continuous civilization, dating back 40 000 years does not share this confusion.

"although out of sight, the waste is not as dormant as it appears to the casual eye. Instead, a landfill has a life of its own- the pulse is slow. but it ticks quietly and resolutely. Deep inside, microbes are feeding on organic materials and producing chemical changes. Settlement takes place as the lower parts of the landfill are compressed by the weight from above. the landfill settles, festers and slowly decomposes" [45]

fig. 1.11 leachate pooling around perimeter of the petitcodiac riverside landfill

when asked why his culture had left behind no structures that compared with the pyramids, the Parthenon, or other great monuments of recent civilizations, replied that his people had strived to leave the land just as they had found it: that was their most enduring monument. It seems frighteningly appropriate that the most enduring monuments the West will leave for future generations will not be Stonehenge, the Pyramids of Giza, of the cathedral at Charters, but rather the hazardous remains of our industry and technology. [46]

Hazardous waste sites exemplify the contradiction that exists between the public's reverence for nature and their inability to respect the land they inhabit.

the odds are no better than fifty-fifty that our present civilization…will survive to the end of the present century…unless all nations adopt low-risk and sustainable policies based on present technology.. [47]

1.7 how is it handled

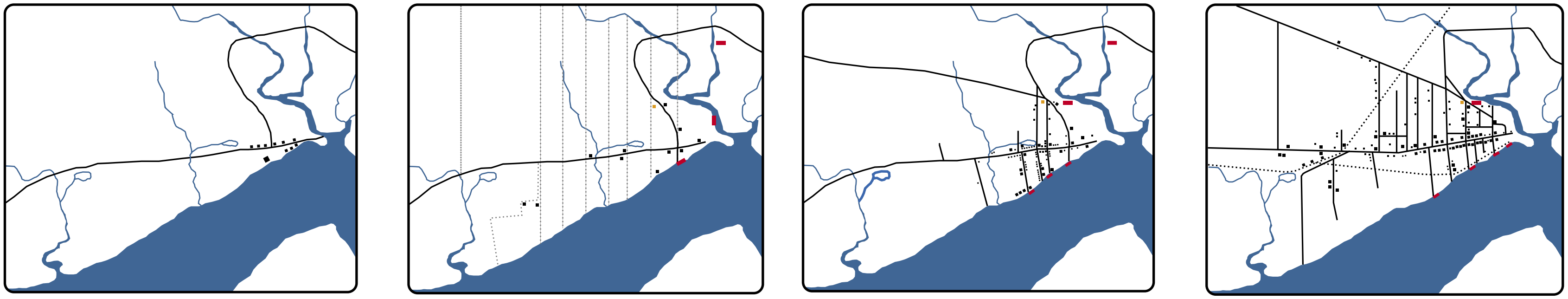
Canada enjoys an international reputation as an unspoiled country with strong environmental policy. Nevertheless, there are currently 3 600 toxic waste sites identified by the Canadian government under federal responsibility. The sites were red flagged thirteen years ago. The aim of the list was to inventory sites under their control in order to account for liabilities. This list presented several omissions, not named were contaminated sites previously owned and operated by the federal government. To date there is no action plan, money set aside, or person in charge to clean them up. Environment Canada has already rejected a key recommendation that would require government agencies to clean up or contain toxic sites. Johanne Gelinas Environment Commissioner of Canada cautions that "By failing to deal in a timely manner with contaminated sites in its own backyard, the government is leaving a legacy for future generations with a huge health and environmental price tag." [48]

Blame can be assigned to all levels of government but individual citizens of Canada must concede that ultimately, "the responsible party is the owner of the waste, not the owner of the site." [49]

fig. 2.1 crowd gathered to watch the incoming tidal bore of riverfront wharf, moncton, circa 1900.

02: the site

An historical perspective of the city and the study site is needed for comprehension of how the situation of the causeway and the landfill on the Petitcodiac River has arisen .The narrative begins with Moncton's foundation as an agricultural community, evolution to a shipbuilding center, and transformation to a prominent railway hub. Through a series of maps, the development of the urban fabric and the city's relationship to the Petitcodiac River is traced. At a smaller scale, the development of the site is shown through a series of aerial photos. This perspective is an illustrated guide of citizen neglect and indifference and of various political decisions that left their mark on the landscape of city. All contributed to the present degraded condition of the Petitcodiac River's ecosystem. The narrative outlines the ongoing politics and policies that have created the circumstances contributing to the ecological crisis. Today, the site remains locked in a controversy of legal battles, conflicts between various levels of government, and numerous studies that have been negligent in providing a development strategy for positive action that would address that issue of the contaminated lands.



1700 1750 1829 1850

fig. 2.2 site development series

fig. 2.3 early map of moncton, 1881

2.1 city development

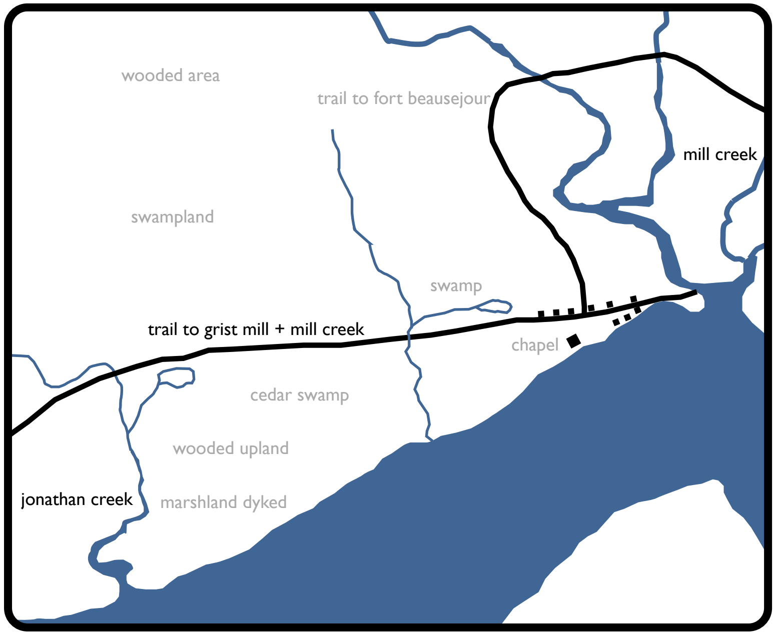


fig. 2.4 le coude of the petitcodiac 1750 *the acadian settlement era*

The modern day City of Moncton grew from an early Acadian settlement situated in the fertile valley land of the Petitcodiac River. The Acadian Period of settlement in the Three Rivers area began in 1698 when Pierre Thibodeau and Pierre Gaudet first sailed up the Petitcodiac in search of new lands for their families. The colony was named Le Coude or The Bend after its unique position on the river.

The Acadians were organized in a peasant society, living from the land and the river. Spartina and eelgrass were harvested from the salt marshes and used as hay and insulation in homes. Tidal marshlands were dyked to grow rich crops of wheat along the banks of the Petitcodiac between Hall's Creek and Jonathan Creek. This process removed much of the natural vegetation native to the tidal marshland.

The British continually raided Acadian land in the region until the time of their ultimate victory and their decision to initiate the Acadian Deportation. After the Acadians were transported by the British to Fort Beausejour to be deported, most of their homes were burned so that they could never return. Some Acadians fled to the forests, concealing themselves, but many of those died from exposure. The burning of their church, 'La Chapelle', in 1758 marked the end of the Acadian settlement at Le Coude. [50]

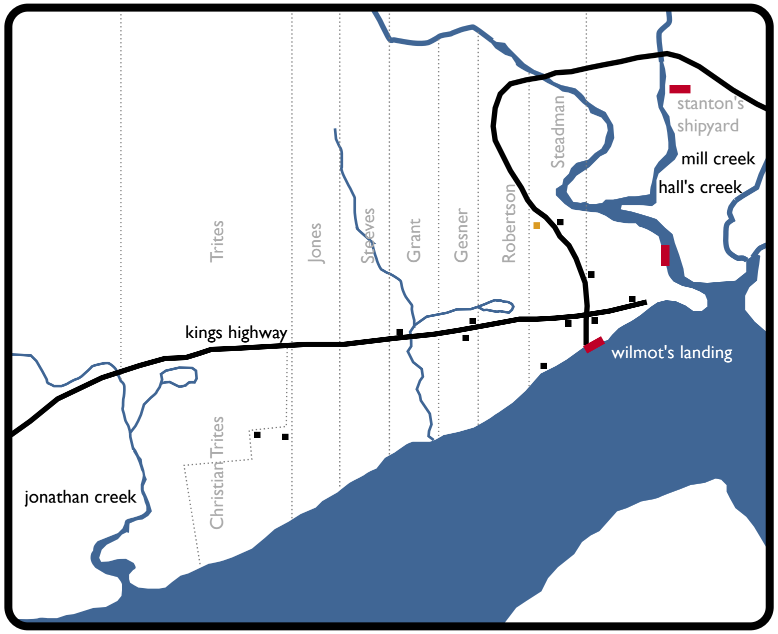


fig. 2.5 the bend of the petitcodiac 1829 *the british settlement era*

Ten years later, British settlers from Pennsylvania landed on the banks of Hall's Creek where evidence of the Acadian farmlands still remained. These new permanent settlers owed much of their survival to the Acadians, whose dykes made it possible to immediately utilize the land. The land was redivided between the new colonists using the original French dykes as reference points and boundaries of their new properties.

Creeks and rivers played a prominent part in determining the boundaries of the properties granted to the original eight families settling the Bend. There were nine parcels of land from 2190 acres to 1700 acres. On all the properties the Petitcodiac River was designated as the southerly boundary. Hall's Creek and Jonathan Creek were the eastern and western boundaries. [51]

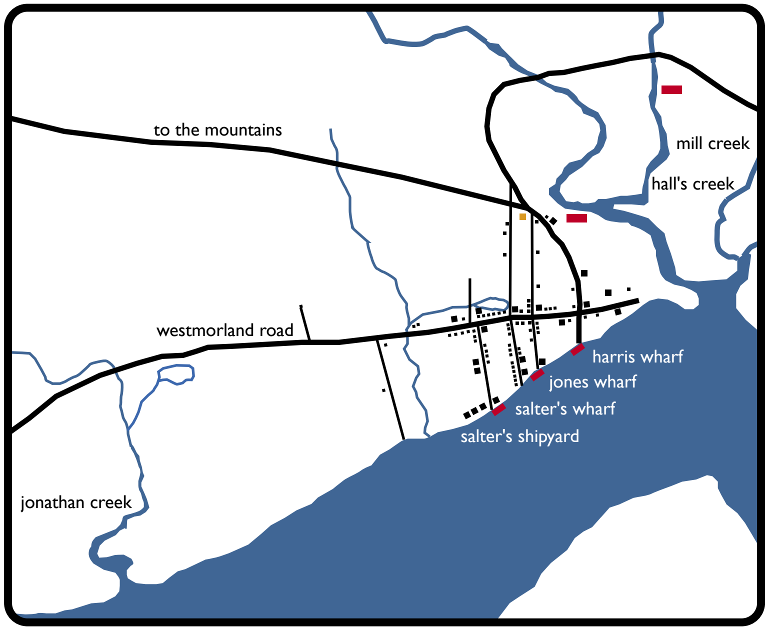


fig. 2.6 the bend in the petitcodiac 1850 *the shipbuilding era*

The shipbuilding era initiated during the first decade of Bristish colonization, reached its peak around 1840. Timber for the vessels was carefully chosen from neighboring forests found in close proximity to the shipyard. Three mast ships were the most common type of ship construction. Many of the ships made journeys between The Bend and Saint John Harbor or Saint John Harbor and New England. At this time, clear cutting had begun with intensity; the land was transformed. Large areas were scratched out to provide accommodation for the influx of New England immigrants to the area of Three Rivers. The largest exports from the small port village were timber and fish. Extensive contracts for timber were filled to the West Indies and Caribbean countries, ushering in the first decade of great prosperity in The Bend. Salter's Shipyard became the largest shipyard and constructed massive commercial trading ships. There are records of 58 vessels having been built in Moncton during the shipbuilding era from 1820-1880. The village population exploded, reaching 1000, with half the men employed in the Salter shipyard. Building growth around the waterfront expanded to accommodate all the new shipyard workers and their families. Moncton was at its peak during the shipbuilding and river shipping industry. The waterfront was the main focal point of activity and interest facilitating more than 800 feet of public wharves along the riverbank. [52]

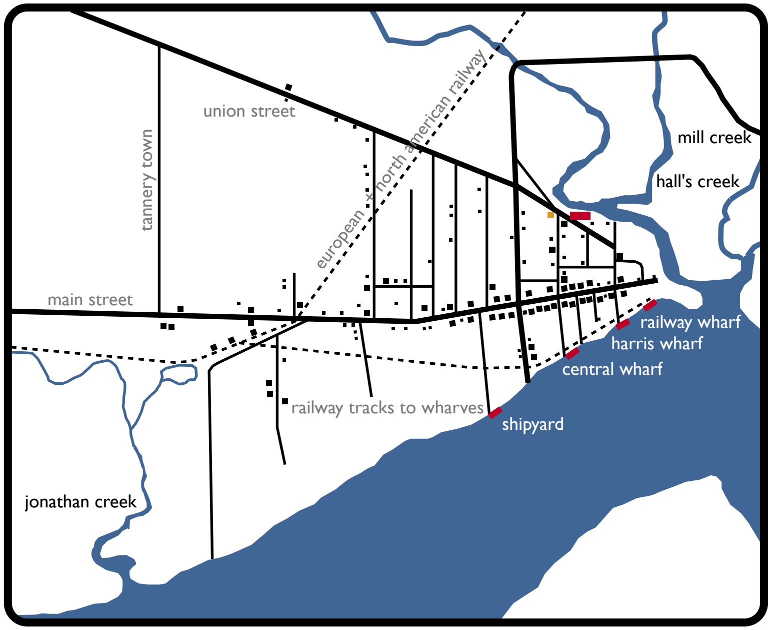


fig. 2.7 the bend of petitcodiac 1862

the industrial era

Around 1860 the shipbuilding industry deteriorated due to lack of foreign demand. Salter's Shipyard declared bankruptcy with the majority of the ship workers moving away from the riverfront to start farming beyond the city limits. Many businesses collapsed after the economic decline and the population dropped from 2000 to 500. On March 22, 1862, The Bend repealed its act of incorporation and lost its town status.

Despite the collapse of shipbuilding, the beginning of the 1850's marked a new era in The Bend when the European and North American Railway began constructing an east-west line between the two pivotal ports of Pointe-du-Chene and Saint John. The first train passed over the new rails August 19, 1857 during the town's first economic depression. During the initial three years it had little economic impact on the town. Later, wood began being purchased from farmers along the train's route to burn in the locomotives. August 1, 1860, saw the link from Saint John to Moncton complete and the slow transition of the town from a shipping center to a railroad hub.[53]


1953


1962


1965


1967

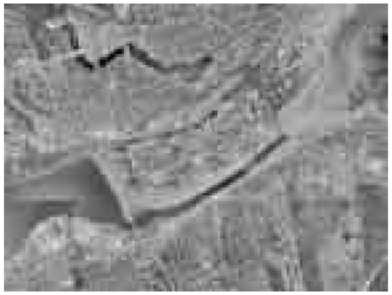

1978


1982


1993


1996

1976



2001

fig. 2.8 site develoment series 1953-2001

2.2 site development

Expanding the city's historical perspective of the study site to the contemporary condition, is a compilation of aerial photographs and descriptive text that traces the changing river channel of the Petitcodiac River and records the site changes over the last 50 years.

> *Increased satellite imaging, combined with massive media coverage of natural disasters and the rise of environmental activist groups, has increased public awareness of and concern for environmental issues. These range in scale from local problems of waste, pollution, and decreased diversity of habitat to global trends of ozone depletion, deforestation, extinction of species, nuclear waste, and resource depletion. In each case, landscape provides the idea around which such concerns are made visible and subsequently contested and engaged.* [54]

1953

The height of the Tidal Bore during the "Saxby Gale". That day, October 4th 1869 ...during the night, the tide, which was high due to the full moon, came in just as the winds sprang up and quickly increased to gale strength. The Tidal "Bore" on that night must have been something to see. The Bore, according to various sightings, was estimated to have been between seven and nine feet in height and the roar as it came up the river could be heard for over a mile ...

1869 – Daily Times, Moncton[37]

fig. 2.9 gunningsville bridge, built for horse and carriage, 1907

fig. 2.10 aerial photo, riverside site, 1953

1860

Travel between The Bend and neighboring communities across the river was by boat. Those impatient for scheduled service between the two banks traversed on rafts that were pulled across the river at low tide. Unfortunately the force of the oncoming powerful wave of the Tidal Bore made for many disastrous crossings. After the death of several citizens, a proposition for the construction of a bridge to span the river was put forth. The project was tabled due to lack of support and funding. Years later, the government accepted the proposal for a new wooden bridge, which was completed in 1867. In 1869, the Saxby Gale caused a ten foot high tidal bore to rush up the Petitcodiac River and demolished the recently established wooden bridge.

1915

The Gunningsville Bridge is erected to replace the ruined one. It remained the only crossing of the river until the construction of the Petitcodiac River Causeway in 1968.

1939

Commercial fishing was an influential industry on the Petitcodiac River waters. Jack Powell started fishing in 1939 to augment the family income. "We fished straight time, night and day when the run was on, it was a city out there." [55]

1962

1960

Connie Bleaker, a Federal Fisheries Officer, notes that the commercial catches of salmon were between 1500 to 4000 kilograms per year. They were so abundant as many as 500 fish were encountered in the same pool.

Population growth necessitated an additional way to traverse the river so at a city council meeting in Moncton the province was requested to conduct a Petitcodiac River Causeway feasibility study. The following year, under the jurisdiction of the Department of Agriculture, the Maritime Marshland Rehabilitation Administration produced a report that proposed three possible construction sites for the solicited connection. Eventually one of these was selected. The Marshland Administration, because of its technical and engineering expertise, was well positioned to make causeway recommendations. The municipal and provincial governments could access federal monies and advance an agenda whereby upstream water levels could be regulated to protect agricultural land. This transportation link model was patterned after the dams and causeways of the Netherlands that engineers used to control the sea in 1950's and 1960's.

1963

Three years later, at a city council meeting the Moncton Town Planning Commission, the City of Moncton engineers, the Department of Health, and Public Works are cautioned that tidal silt deposits caused by the damming of the Petitcodiac River will cause the stream bank width to decrease due to restricted water flow. The warning is ignored and the proposal for a causeway crossing is passed. [56]

In November of that same year the Marshland Administration was formally contracted to complete the engineering crossing specifications. The New

fig. 2.11 aerial photo, riverside site, 1962

1965

Brunswick Wildlife Federation, alarmed at the prospect of disrupting the myriad migrations of fish upstream, lobbied for a fishway to be included in the design. Despite this lobby, when work started on the causeway in February 1966, the federal fisheries department had not granted approval for a fishway. This would not come until a year later.

There is no evidence that a bridge was proposed as a solution to Moncton's transportation demands. [57]

fig. 2.12 aerial photo, riverside site, 1965


1967

1967

1968

The construction of the Petitcodiac River Causeway, a one-kilometer rock-filled dam, is completed. It provides a vehicular link between Moncton and Riverview and is owned and operated by the Department of Transportation. The five gates of the causeway are closed in the fall, meeting the criteria established by the Department of Agriculture to control flooding upstream.

1969

The Petitcodiac River and Shepody Bay natural ecosystem is transfigured, as evidenced by a Tidal Bore that stops at the Causeway, creating longer periods of slack water and thousands of acres of mud flats and marsh. The barrier impeded fish migration and did not allow smelts, gaspereau, and shad to pass. Salmon navigated the six openings of the fishway with difficulty. During the summer the fish were found stranded on the mud flats below the causeway where people gathered them by hand. "Federal fisheries officials collected salmon carcasses and sent them to the Biological Station to determine cause of death, as if left being high and dry were not reason enough."[58]

fig. 2.13 aerial photo, riverside site, 1967

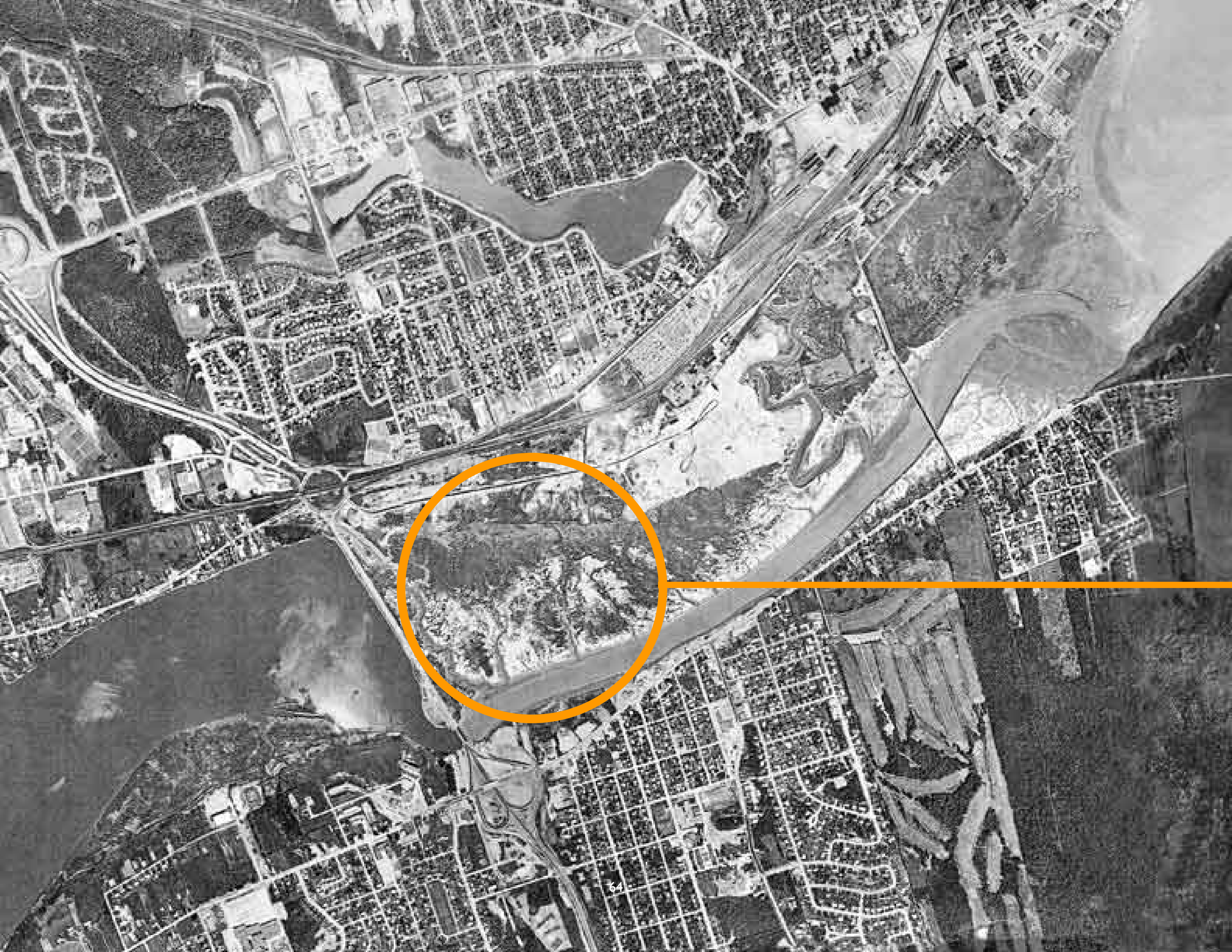
1976

1970

The virtual collapse of the commercial salmon fishing is documented by statistics: the catch plummeted from a thousand to fifty kilograms of fish in one year.

After the construction completion of the causeway, the Moncton Riverside landfill opened for operations on tidal marshlands adjacent to the Petitcodiac River, downstream from the Causeway. [59]

fig. 2.14 aerial photo, riverside site, 1976



1978

1978

Ten years after the construction of the causeway a New Brunswick Department of Transportation survey showed an extreme siltation problem below the causeway.

1979

As the headpond filled in, the Department of Federal Fisheries scientist recommends to the local MLA that "the preferred solution for the fish passage problem would be to leave one or more gates permanently opened." [60] The recommendation is totally ignored.

1980

The Atlantic Salmon Organization and Department of Fisheries spend one million dollars on repairs to the Causeway fishway. In conjunction, a salmon-stocking program costing three million dollars releases hundreds of thousands of juvenile salmon into the Petitcodiac River headwaters; the salmon continue to perish. The program is terminated in 1990. [61]

fig. 2.15 aerial photo, riverside site, 1978

1982

fig. 2.16 *aerial photo, riverside site, 1982*

1986

Five hectares along the east face and south face of the Riverside Landfill site are hydro-seeded with the goal of improving the appearance of the location.

1988

Three years after a scathing commentary by American humorist, Emma Bombeck, Moncton's Tidal Bore is unofficially renamed the "Total Bore".

The causeway gates are opened by the Department of Transportation in an effort to allow the stocked salmon to leave the river for the Bay of Fundy. As a result the Tidal Bore regained some of its previous splendor and several more fish species were apparent above the causeway. Momentum gathered for the permanent opening of the gates. Critics, however, lobbied vigorously so the process would not be repeated the following year. "Lakefront" property owners were adverse to their lake draining twice daily to reveal muddy riverbanks. Their boating and other recreational activities would be disrupted if silt were permitted to navigate to the headpond; these critics prevailed.

1990

The garbage in the Riverside Landfill site reaches a height of 12 meters. [62]

1992

Twenty-six years after the construction of the causeway, public opinion prompts provincial bureaucrats to respond to pressure to have the river restored. The province of New Brunswick tables a report. The seven options with economic and political implications were cited concerning the Petitcodiac River Causeway: keeping the gates closed (the status quo), operating the gates more effectively, improving the fish way, permanently opening the gates, replacing the causeway with a bridge, and separating the river from the head pond. Also included was a

1993

brief by the chief scientist for Fisheries and Oceans, John Ritter. He wrote that the department's preference for the Petitcodiac Causeway was "to allow free flow in the river from April 1 to December 15 each year. Restoration of fish production to pre-causeway levels may never be possible, but a free flow system clearly offers the greatest chance of achieving those levels" [63].

The Riverside Landfill is closed after twenty years of operation with the opening of the new Westmorland/ Albert Solid Waste Management Facility outside the city's current limits.

1993

Gemtec Limited, Neil and Gunter Limited, and Basic Designs Associates Ltd. are commissioned by the City of Moncton to conduct a study for the closure of the Riverside Landfill. The report's aim was to perform site analysis and recommend an "environmentally acceptable closure plan compatible with long term land use objective and to identify various sources of funding which might be utilized to implement the closure" [64].

1994

The Gemtec Landfill Closure Report identifies several environmental concerns regarding the decommissioned landfill.

2000

Samples of leachate discharging from the landfill site were collected and analyzed for metals and polychlorinated biphenyls (PCB) at the environmental fisheries laboratory in Fredericton. The quantity of leachate is estimated at upwards to 500 000 liters a day according to the city's own figures. [65]

fig. 2.17 aerial photo, riverside site, 1993

1996

2001

Most of the site has now been reclaimed by natural vegetation. The city has constructed a pedestrian path over the mounds that form a portion of the Trans Canada Park Trail Network.

2002

Riverkeepers release a report entitled "10 worst pollution sources of the Petitcodiac River System". These sources include the Petitcodiac Causeway, the Primary Sewerage Treatment Plant, the former Moncton Riverside Landfill, the Memramcook Causeway, untreated sanitary sewage discharges, storm water discharges, habitat destruction, watercourse alterations, and sediment pollution.[66]

Charges are laid by Environment Canada under the Federal Fisheries Act relating to toxic leachate being discharged into a tributary of the Petitcodiac River from a decommissioned landfill owned by the City of Moncton. The four parties charged are asked to make their first appearance in Provincial Court in Moncton on April 3, 2002 at 9:30 am. [67]

The National Geographic declares that the Petitcodiac River is the most endangered waterway in Canada. [68]

2003

City of Moncton pleads guilty to charges and agrees to a court order and a closure plan that would eliminate the discharge of toxic leachate into the river. With six days left to federal Election Day, candidates from all political parties line up to promise swift action for the Petitcodiac River once the EIA study is completed. The thirteen candidates run for office in the three federal ridings located in the Petitcodiac River watershed. Ten candidates indicate their

fig. 2.18 aerial photo, riverside site, 1996

2001

willingness to champion the Petitcodiac River by committing to swift action [69]

The EIA study release is delayed until the spring of 2005.

2004

With the completion of the approaches to the new bridge scheduled for next year, the last remaining 40 acres of the original Jonathan Creek wetland will disappear. Development will be contrary to New Brunswick's policy for compensating the loss of wetlands, at a ratio of 10 to 1. The Department of Transportation and the City of Moncton, however are not expected to follow policy. [70]

2005

To date (september 20th, 2005) the findings of the EIA study have not been released to the public.

fig. 2.19 aerial photo, riverside site, 2001

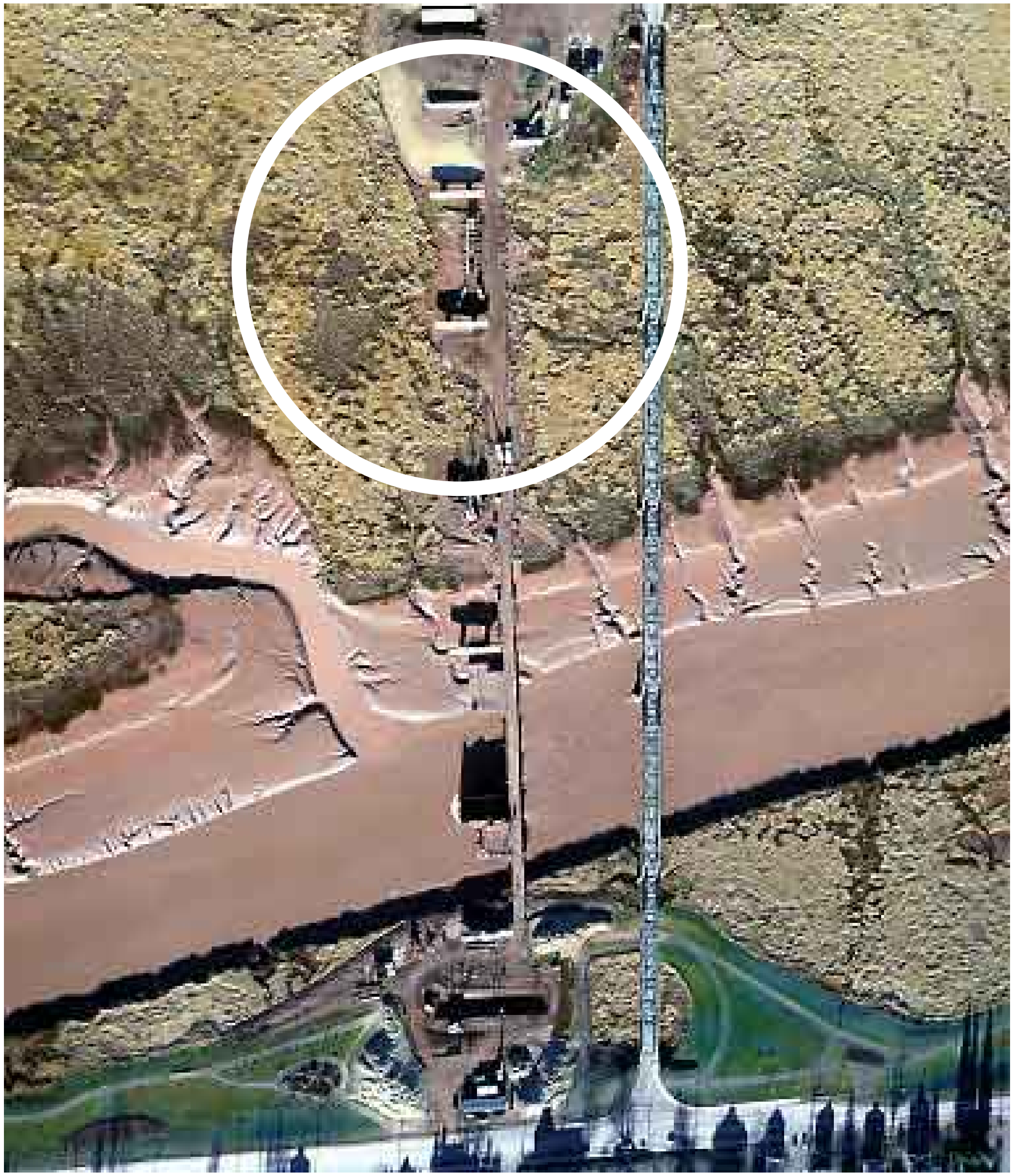


fig. 2.20 the last remaining 40 acres of the original Jonathan Creek disappearing with the ongoing construction of the new Petitcodiac River bridge approaches, 2005

2.3 river context analysis

The local landscape of the thesis site is first analyzed, in the context of the larger environment. An even larger investigation has been conducted at the scale of the maritimes, the province, the city, the river context, and the site. The materials are located in the appendices 01-03.

In this section the ecosystem analysis maps complex abiotic, biotic, and cultural systems surrounding the study site. The Petitcodiac River and Moncton context are examined through its matrix- river pollution sources, hydrology, green spaces network, transportation network, urban density, and river edge conditions.

fig. 2.21 satellite image, riverside site, 2001

The site is composed of many complex systems. It is a matrix, a composite, of many cultural and natural system processes at work. The river site context diagrams map this dynamic relationship.

In the system, the Petitcodiac River collects water from all the tributaries throughout the City of Moncton and flows towards the Atlantic Ocean. There are several point sources of pollution along the river banks. The unique hydrological conditions of the region act as a carrier for the contaminants created by the landfill. These point sources of pollution are then distributed to other regions in province.

The green spaces network diagram documents existing and proposed park spaces within the city. The city's plan to create a new network of park spaces is undermined by large transportation routes that break linkages. Unless a new system of access and links is proposed, park connectors will be unsuccessful. Of this network of open green space, the largest linear park within the city is the TransCanada Park Trail, which traverses the study site. The trail's various conditions are documented with photographs. They show empty spaces created by the generic park design.

fig. 2.22 aerial photograph, composite

city + river context matrix

fig. 2.23 *aerial photo of petitcodiac river causeway, number one pollution source*

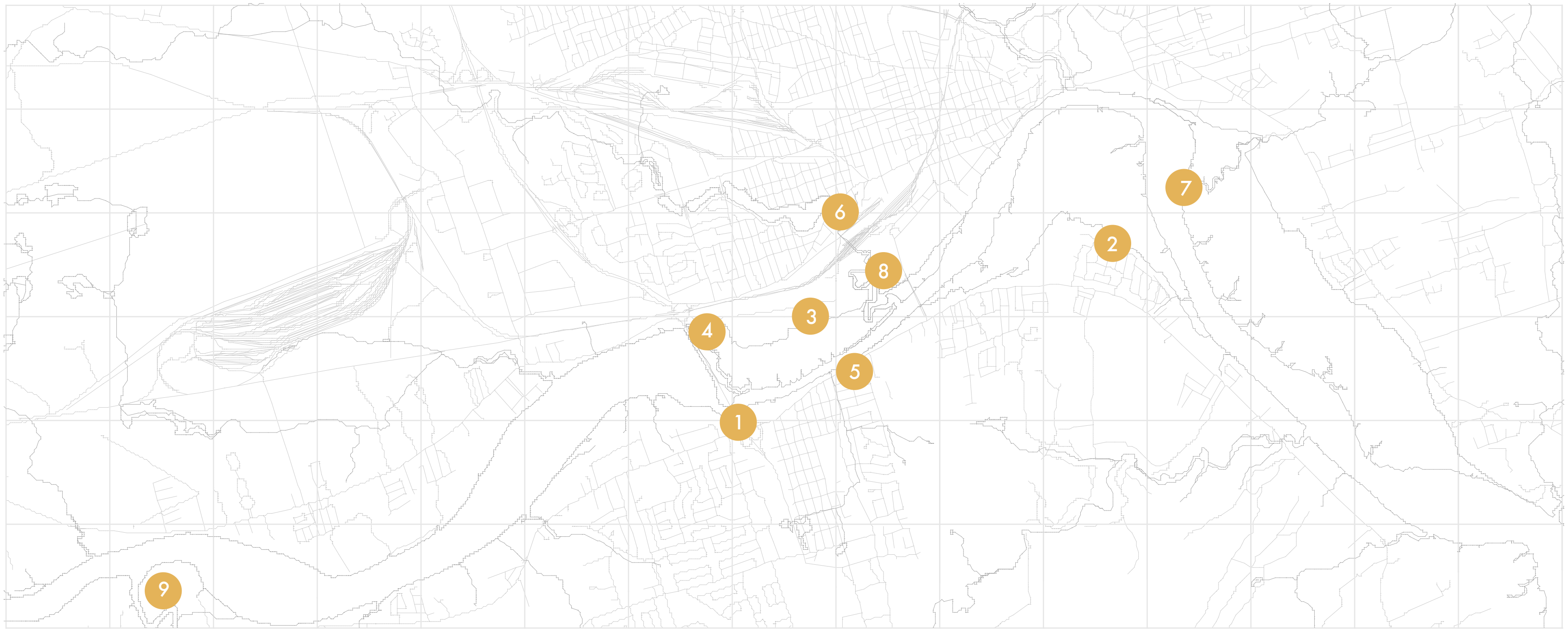


fig. 2.24

petitcodiac river pollution sources

petitcodiac river causeway 1
greater moncton sewerage treatment plant 2
former riverside landfill 3
untreated sanitary discharge 4
stormwater discharge 5
habitat destruction + watercourse alteration 6
sediment pollution 7
wetland destruction 8
cosmetics pesticides 9

fig. 2.25 *photo of petitcodiac river causeway, number one pollution source, by author*


DANGER
HIGH VOLTAGE
HAUTE TENSION

fig. 2.26 petitcodiac river causeway, floodgates.
photo by author

The City of Moncton is located on the banks of the Petitcodiac River. The Petitcodiac River, through the Bay of Fundy, connects to the Atlantic Ocean. The Bay of Fundy has a semi-diurnal tidal sequence. The bay experiences a high and low tide twice daily. It has the highest tides in the world with water levels fluctuating between nine and fourteen meters.

The shoreline of the Bay is made up of soft sandstone that is easily eroded by the powerful tides. The eroded soil becomes suspended sediment in the water column creating brown murky water. The enormous amounts of sediment are carried up the river during high tide and deposited on the banks, returning only to the river as the tide recedes. At low tide vast mudflats are uncovered nourishing the estuaries. These ecosystems are the most productive ecosystems in the world and home to many integral species of the tidal system of the Petitcodiac River.

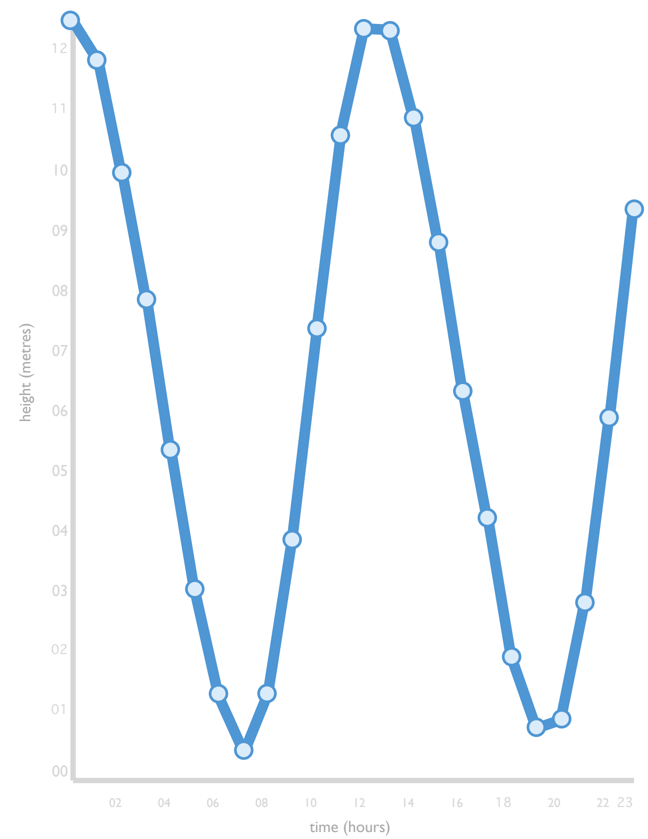


fig. 2.27 tides, currents, and water levels, Dover station # 173, march 21, 2004, illustrating semi diurnal tidal sequence

fig. 2.28

petitcodiac river hydrology

marsh
open waterway

The Acadians recognized the extraordinary fertility of the salt marshes. Their culture and settlement was based upon the technology of dyking. As many as 10 000 established homesteads along the riverbanks of the Petitcodiac. The families worked together to build dykes to separate the sea (and the salt) from the land to exploit the productive soil, to reclaim the land from the rising tides of the bay. [71]

The Acadians began by embedding logs in the marsh mud as a core around which they compacted more mud. It was then faced with permangues, a plant with a tenacious root system that biologically stitched the structure together. The two meter high wedge-shaped wall was five meters at the base and sixty centimeters with a tidal gate installed at the foot of the dyke. The gate was known as the "aboiteau" which consisted of a hollowed out log sluice fitted with a hardwood flapper at one end. The flood tide forced the flapper shut, thereby preventing salt water from reaching the land, and when the tide ebbed away, pressure from the standing fresh water forced the flapper open and allowed drainage in the other direction. The Acadians built dykes until they spaned across the Bay of Fundy.[72] Many of these original dykes remain.

Conkling writes a description of the formation of the tidal bore, *From Cape Cod to the Bay of Fundy: An Environmental Atlas of the Gulf of Maine:*

> *Fundy's high waters are given their impetus on the outer edge of Georges Bank, where the ascent tide can be felt but not seen, a force pushing against a scallop drag signaling the captain to use more throttle or more wire to settle the gear on bottom. Here the tide may rise a mere meter, but by the time it sweeps by the corner of southwestern Nova Scotia and begins pushing into the Bay of Fundy proper, it reaches a height of 3.5 meters. Inch by inch, it drowns the shaggy seaweed-draped coastline, changing its shape like a compulsive cartographer constantly redrawing*

fig. 2.29 *existing dykes along the petitcodiac river*

the acadian aboiteau system of hydrology

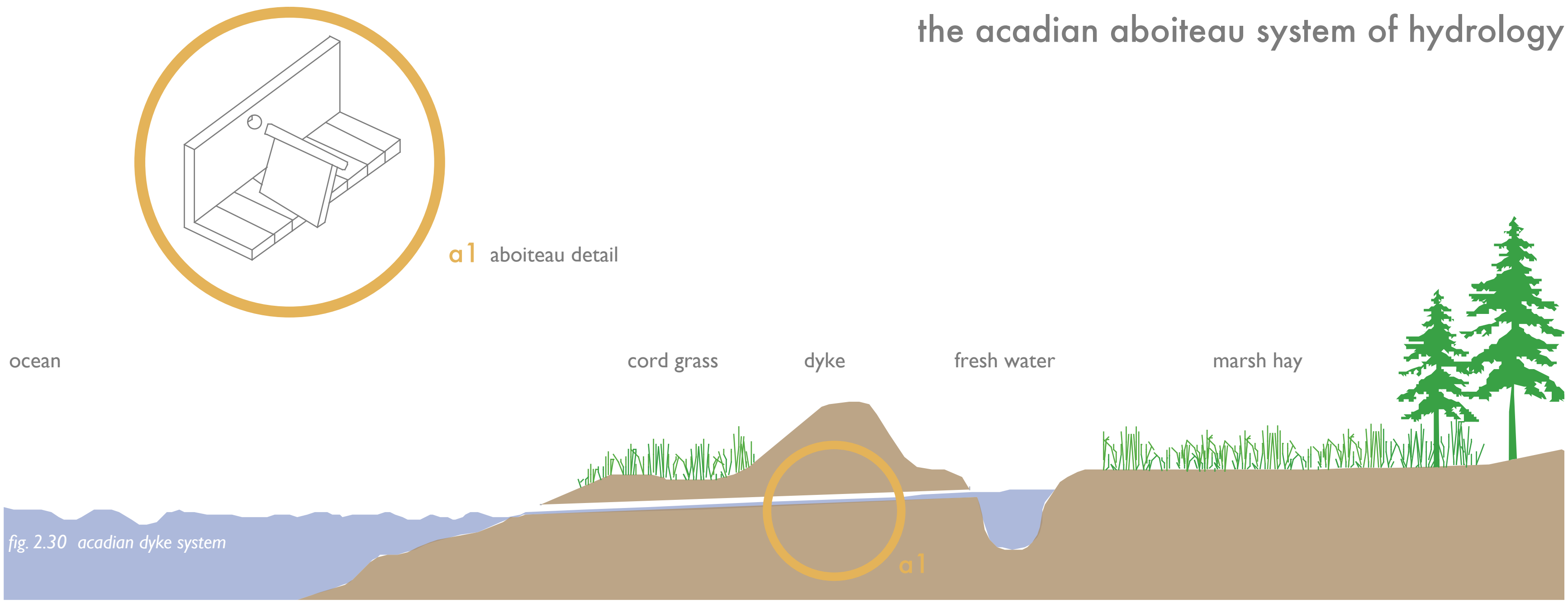


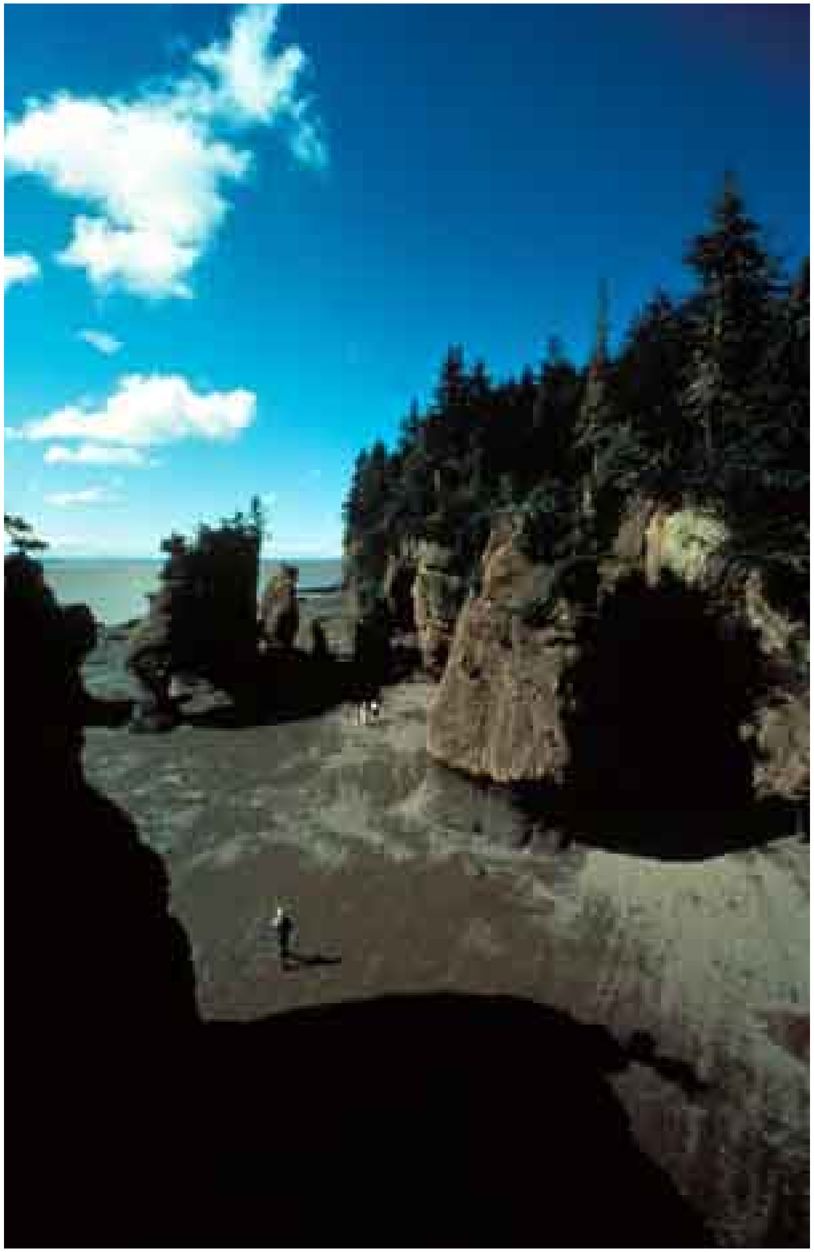
fig. 2.30 acadian dyke system

his charts. At the North Head on Grand Manan Island, at the mouth of the Bay, the tide creeps under the keels of boats, lifting them off their wharf-side cribs, past tide-marked pylons, until their cabins bob above the wharf deck. Half an hour later, the tide streams by the lighthouse at Cape d'Or, creating the white capped rips which local fishermen fear but which are the playground of harbour porpoises. Here, the tide reaches a height of 8 meters. As it meets the resistance of the narrow Minas channel, the swelling water piles up and pushes through under protest, creating a maelstrom at the base of the imperious headland at Cape Split. Once by Blomidon, it floods freely, inundating plains of brick-red mud impressed at ebb tide with the torturous meandering of creeks. The basin becomes a read sea of muddy boils and gyres. Near the head of the Bay, the tide attains a height of 12 meters and begins to run out of room. In its final advance, it submerges emerald fringes of spiked marsh and presses against the bulwarks of 300-year-old Acadian dykes, like the breath of a surfacing diver pushing against near bursting lungs. It looks desperately for a place to go. It leaps up at the mouths of the Fundy rivers, and for the first time, the tides becomes a visible standing wave, a foaming hustling, hissing wall that reverses the seaward flow of the rivers and bores at their soft lipped clay banks. Finally, far inland and out sight of the sea, it swirls its salt with the fresh waters of the salmon pools. Its energy dissipated, the tide is briefly at rest before it begins again to ebb toward the sea. [73]

fig. 2.31 (opposite) Hopewell Rocks, Bay of Fundy, low tide

fig. 2.32 (opposite) Hopewell Rocks, Bay of Fundy, high tide

fig. 2.33 Hopewell rocks, Bay of Fundy, staircase giving access to the ocean floor



Surrounding the City of Moncton large areas of forests remain. These forests are composed of a unique mixture of hardwoods and softwoods. The forests are dominated by fir, white spruce, and black spruce and deciduous species such as red oak, American Beech, black ash, red maple and white birch. This temperate mixed forest, known as the Acadian Forest, situated in the Atlantic Maritime forest ecozone, is one of the only three regions in the northern hemisphere where the northern boreal forest merges with the southern deciduous forest. Trees of the Maritimes have adapted well to the diverse combination of land and water, soils, climate and topography of this region. Many environmental conditions have made these trees hardy and capable of surviving and flourishing under various extreme-growing conditions.

fig. 2.34 transcanada trail network

The TransCanada Trail, running along the river, is part of a larger park network that attempts to link every province in Canada. Development of the trail will include a permanent installation of over 2,000 interpretive panels along the route of the Trail, with each panel featuring a specific topic of flora, fauna or geography that is indigenous to a particular Trail segment. There are fifty-four pavilions along the trail inscribed with the names of donors who have contributed financially to the Trail's advancement.

At present, the City of Moncton Parks and Recreation Department has ambitions to connect all the large parks throughout the city using this linear park trail system. Many of these trails will run adjacent to the rivers, streams, and creeks located within the city. In addition the city is beginning to convert many of its abandoned industrial lands to parklands.

fig. 2.35

green spaces network

mixed forest
municipal park
neighborhood park
transcanada park trail
existing park trail
proposed park trail

fig. 2.36 transcanada trail network, moncton portion. remains of wharves to the left indicate previous location of riverbank. photo by author

fig. 2.37 *dangerous pedestrian conditions along the transcanada trail network adjacent to the petitcodiac river causeway. photo by author*

fig. 2.39 *transcanada trail river edge conditions, photos by author*

fig. 2.38

transcanada trail river edge conditions

Irving industrial tanks 1
generic information pavillion 2
river art installation 3
pedestrian bridge 4
tidal bore park. lookout deck, under construction 5
executive condominiums 6
generic amphitheatre 7
trail along river 8
sports fields 9
transcanada trail on study site 10

fig. 2.40 *Chateau Moncton's boarwalk, only example of extended landscape along the river*

Four major transportation arteries bound the site: to the North, the VIA railway corridor, to the east the Gunningsville Bridge, to the south, Coverdale Road, to the West, the Petitcodiac River Causeway. Although these routes were necessary for the economic growth of the city, they now limit the access to pedestrian walkways. Future development depends on increased accessibility.

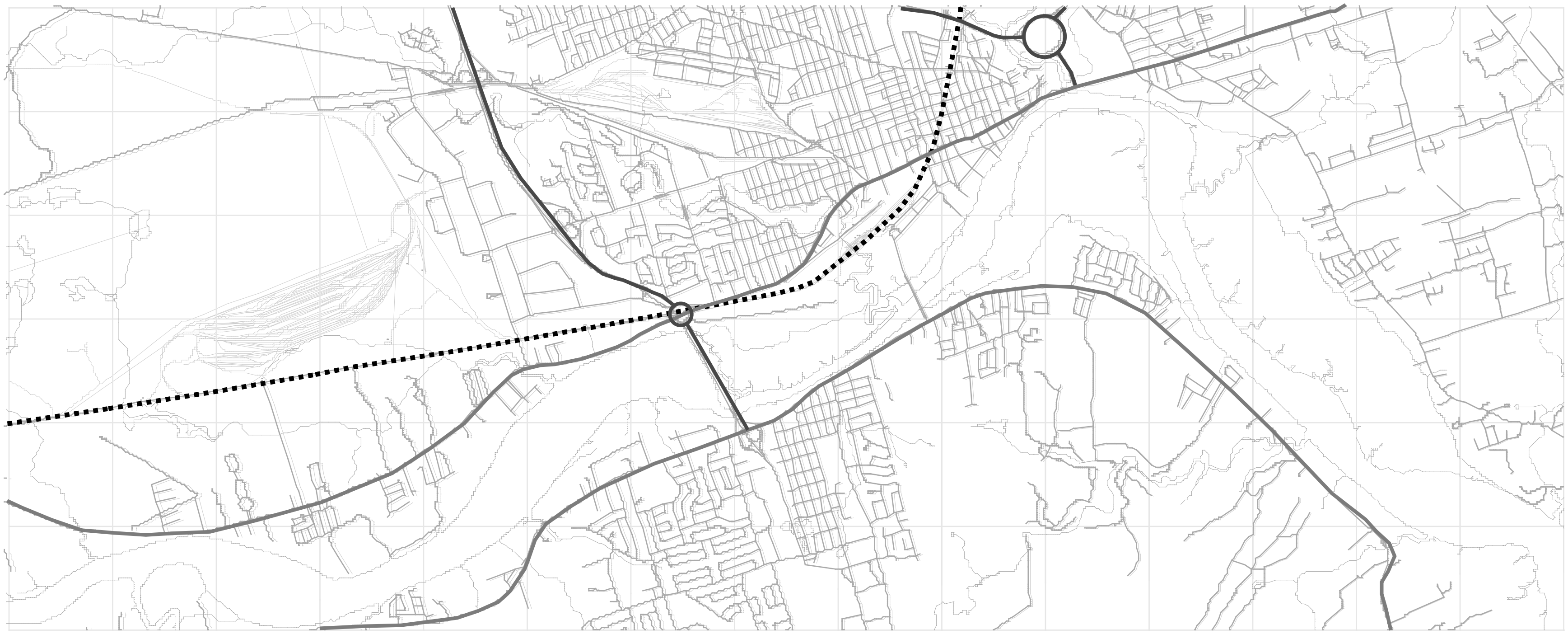


fig. 2.41

transportation network

freeway
main street
secondary street
railway line

fig. 2.42 aerial photo, the rail corridor bordering the Petitcodiac River Landfill site to the north, restricting pedestrian access

fig. 2.43 *aerial photo, gunningsville bridge bordering the site to the east and adjacent sports fields.*

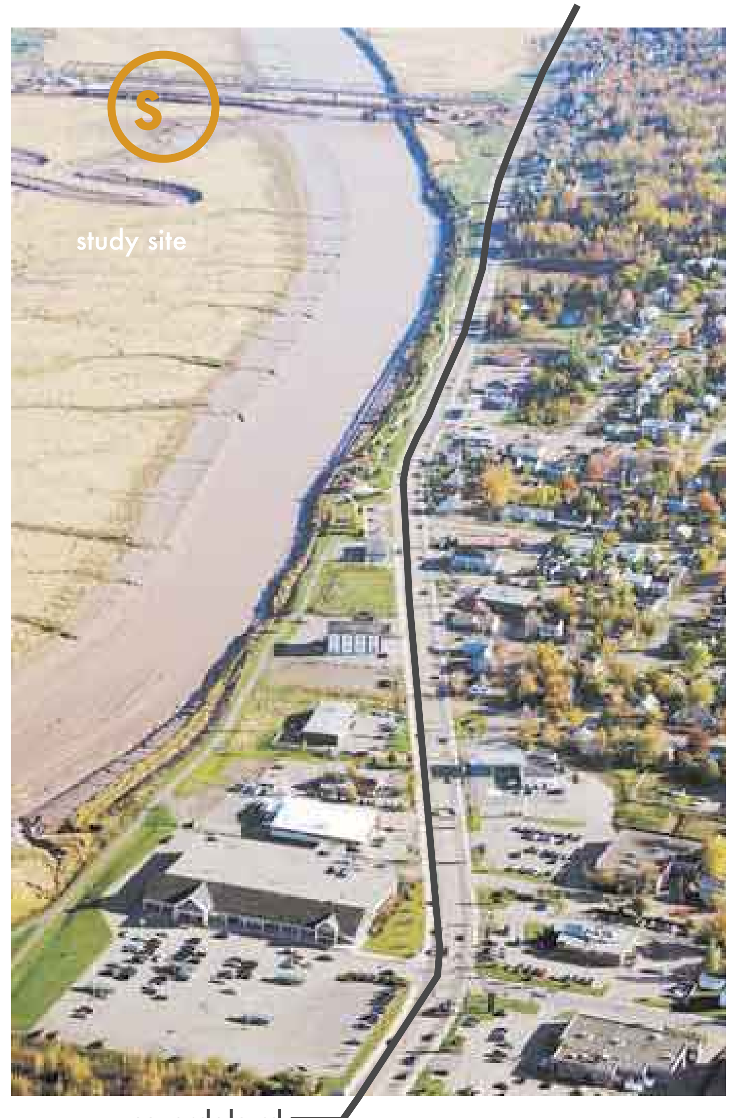


fig. 2.44 aerial photo, Coverdale Road adjacent to Petitcodiac River, the most southern boundary of the study site.

fig. 2.45 aerial photo, Petitcodiac River Causeway, headpond upstream, salt-water marsh downstream.

In 2001, just over 64% of the nation's population, 19,297,000 people lived in the 27 census metropolitan areas. Moncton is one of the least dense metropolitan cities in Canada with a population of 117,727 per 2,177.23 km^2 with a density of 54.1 persons per km^2. In comparison, Toronto, has a population of 4,682,897 per 5,902.74 km^2 with a density of 793.3 person per km^2. [74]

Few residential developments are located along the banks of the river. On the study site there are only two industrial buildings.

Both the main commercial areas located in the downtown cores of the City of Moncton and the Town of Riverview are in close proximity to the site and the river. The current core of Moncton was founded upon the early Acadian settlements that grew up on the river.

fig. 2.46

urban density

non-residential buildings

fig. 2.47 industrial buildings on study site

2.4 study site analysis

In more detail, the specific decommissioned landfill on the river is examined through its matrix of river contamination, hydrology, testing points, emergent plant species, and access points.

fig. 2.48 satellite image, riverside site. 2001

A mapping of river contamination, hydrology, testing points, and emergent plants species present further information on the health of the ecosystem. Results from the soil samples in the testing points indicate how the landfill contaminants, in conjunction with the hydrological conditions, have spread throughout the area and degraded the site. The emergent plant species are a direct indication of the habitat provided by the water and the soil. Most of the species are common to fields, pastures, roadsides, clearings, waste places, and oil fields. These species are the first to colonize and spread rapidly. Many of the species were introduced from Europe and many are considered weeds.

fig. 2.49

site context matrix

The Riverside Landfill site serviced a former population of 70 000 people from the communities of Moncton, Riverview and Dieppe. Total waste received each year is estimated at 45 240 tonnes.

The waste was a combination of residential, commercial, institutional, and construction refuse including a diverse mixture of highly toxic materials. All waste was end-dumped on grade, compacted, and covered daily. An effort was made to limit the working face of the landfill, however, there was no system of filling or grading. Waste oil from numerous gas stations in the city was dumped at the landfill along with large volumes of petroleum-contaminated soil. These soils originated in the Westmorland and Albert Counties and were often used as daily cover material. Hub Meat Packers of Moncton disposed of 3 400 m^3 of barn cleanings, 12 000 m^3 of manure, 12 000 m^3 of tail end screenings, and 10 000 gallons of blood. Moncton Riverside Landfill also became the designated disposal site for highly toxic materials such as asbestos and Urea- Formaldehyde foam insulation. 535 m^3 of double-bagged asbestos insulation from Moncton's CNR shop was disposed of at the landfill in addition to an unknown quantity of UFFI. Sodium hydroxide sludge, also known as SCA-134, a waste cleaning solution, was deposited at the site. These materials came from a local mobile equipment repair shop with quantities reaching 54 500 liters per year. Septic waste, sewage treatment sludge, and medical wastes were disposed of at the site; the quantities of these wastes are unknown.[75]

Minimum procedure in closure operations is implemented on the landfill location. These included litter collection, preliminary grading, and covering of a thin layer of soil over the waste. [76]

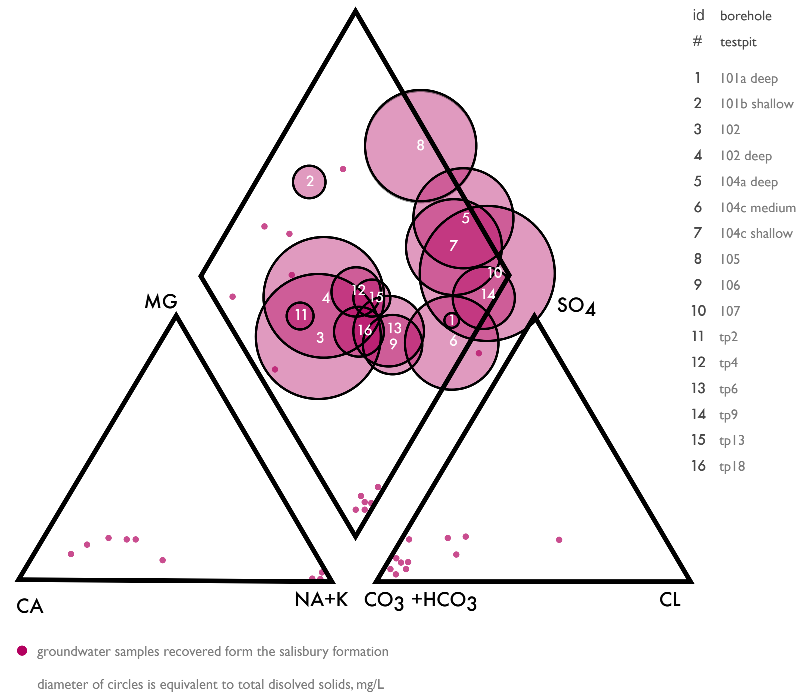


fig. 2.50 comparative results of water testing on the riverside landfill site

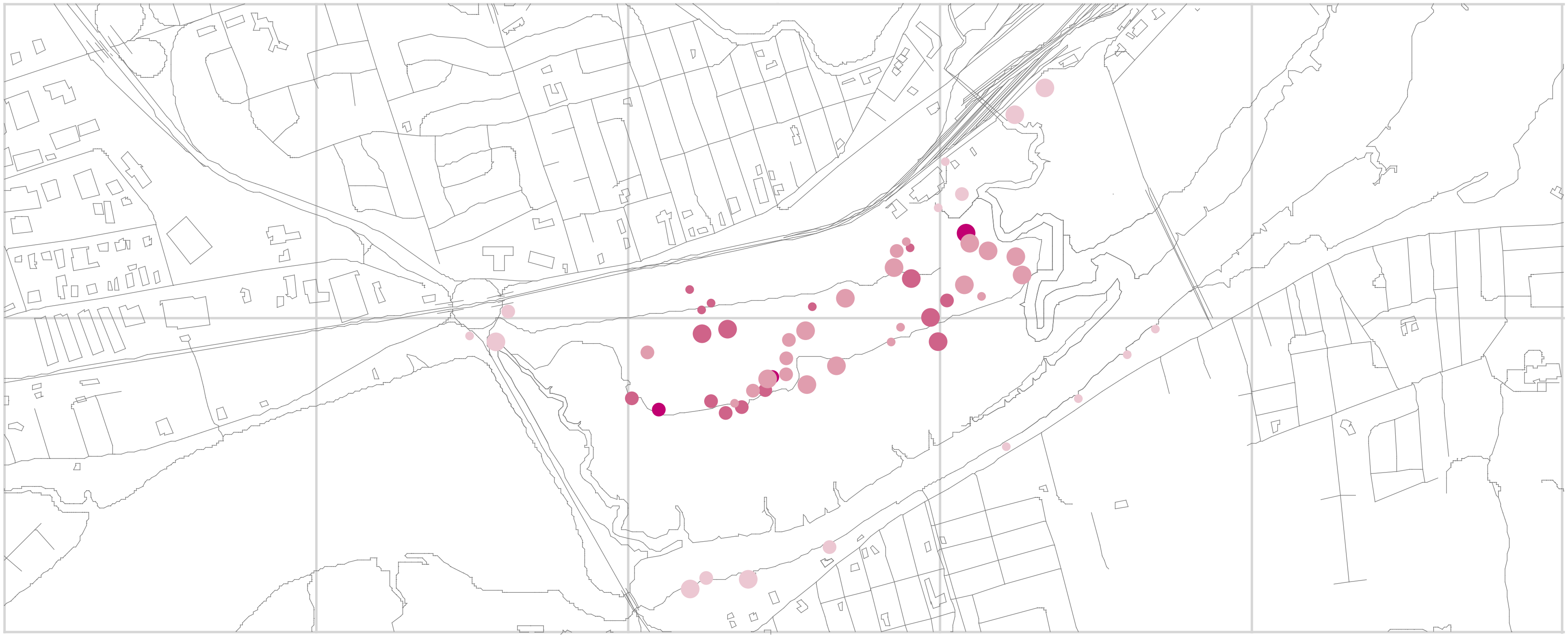


fig. 2..51

river contamination

slope failure- exposed garbage
ground water contamination
surface leachate seeps
sewer outfall

A drainage channel divides the landfill mounds between the older 19m high eastern section (covering an area of 19 hectares) and the newer 17m high western section (covering 16 hectares). A drainage swale was constructed along the northern edge however works inefficiently because the area is extremely flat and the water has begun to pond. Prior to the beginning of the operations of the landfill there existed natural channels in the mud flats. These channels are currently buried under the garbage and function as preferential routes for seepage generated within the waste to the river. [77]

The weight of the garbage is compressing the soft tidal flats that lie beneath it, producing depressions, resulting in the pooling of leachate between garbage and the silt. An investigation conducted by the Environmental Bureau has revealed that 500 000 liters of toxic leachate is discharging daily into Jonathan Creek and in turn flowing into the river. [78] In several areas around the perimeter the seepage can be seen (appendix a6).

Samples of leachate discharging from the landfill site were collected and analyzed for metals and polychlorinated biphenyls (PCB) at the labs in Fredericton. The daphnia magna bioassay test was performed. All samples were found to be of lethal levels (100%) of mortality. Ammonia tests reveal levels exceeding the Canadian Water Quality Guidelines by as much as 15 times.[80]

Buchanan Environmental LTD, Fredericton, performed the rainbow Trout Bioassay test on a sample from a Jonathan Creek pipe. The report revealed that trout became stressed immediately and died in less than 24 hours when exposed to 25% to 100% concentrations of the water sample. [81]

fig. 2.52 evidence of contamination, seepage around perimeter of landfill, photo by author

2.15 million cubic meters of garbage[82]

fig. 2.53 landfill mounds built up on the marshes of the petitcodiac river. distressed vegetation and leachate seepage around perimeter visible

The decomposition of waste produces landfill gas. In three borehole tests, drilled into the waste itself, performed by Gemtec LTD. the presence of landfill gas was immediately evident. During these tests, hydrogen sulphur odors were detected particularly where the vegetation was showing signs of distress. [83] It was also evident bubbling up through the surface water in various locations between the mounds in the drainage channel. Maintaining the status quo on this site will lead to gas migration off-site and possible explosions. The release of gas into the environment increases problems of global warming and increases health problems in the local communities.

Borehole tests performed by Gemtec Ltd, for the Closure of the Moncton Landfill Report reveal that the thickness of the garbage located at the site is between 10-12m. [84] The weight of the garbage is compressing the soft tidal flats made up of slit and clay that lie beneath it, producing depressions, resulting in the pooling of leachate between the garbage and the silt. Estimates indicate that 2.65 million cubic meters of fill has been dumped at the site with 2.15 million cubic meters being garbage.

The earth beneath the landfill is made up for several layers. The types of soils are analyzed. [85]

Silt: The soils of the newly in filled portion of the river channel are a combination of silt and clay. These soils are soft, fine grained, easily eroded, and are relatively impermeable in the vertical direction.

Sands and Gravel: Gravel extends along the original Petitcodiac River Channel and rests directly on the glacial till.

Glacial Till: The glacial till is sandy in nature and contains sandstone pebbles, and

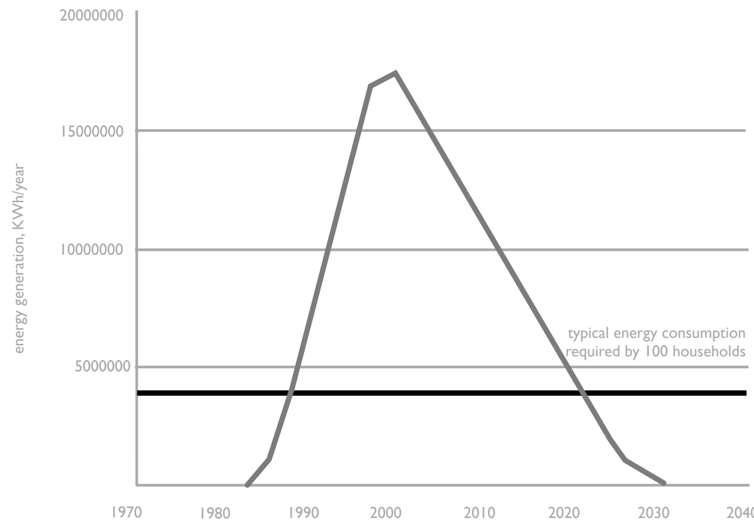


fig. 2.54 total possible energy generation at the west section as compared to households

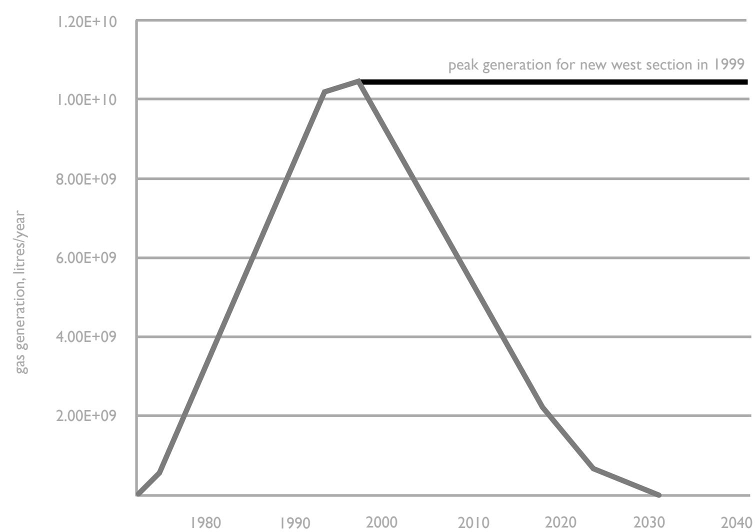


fig. 2.55 predicted gas generation at west section of the landfill

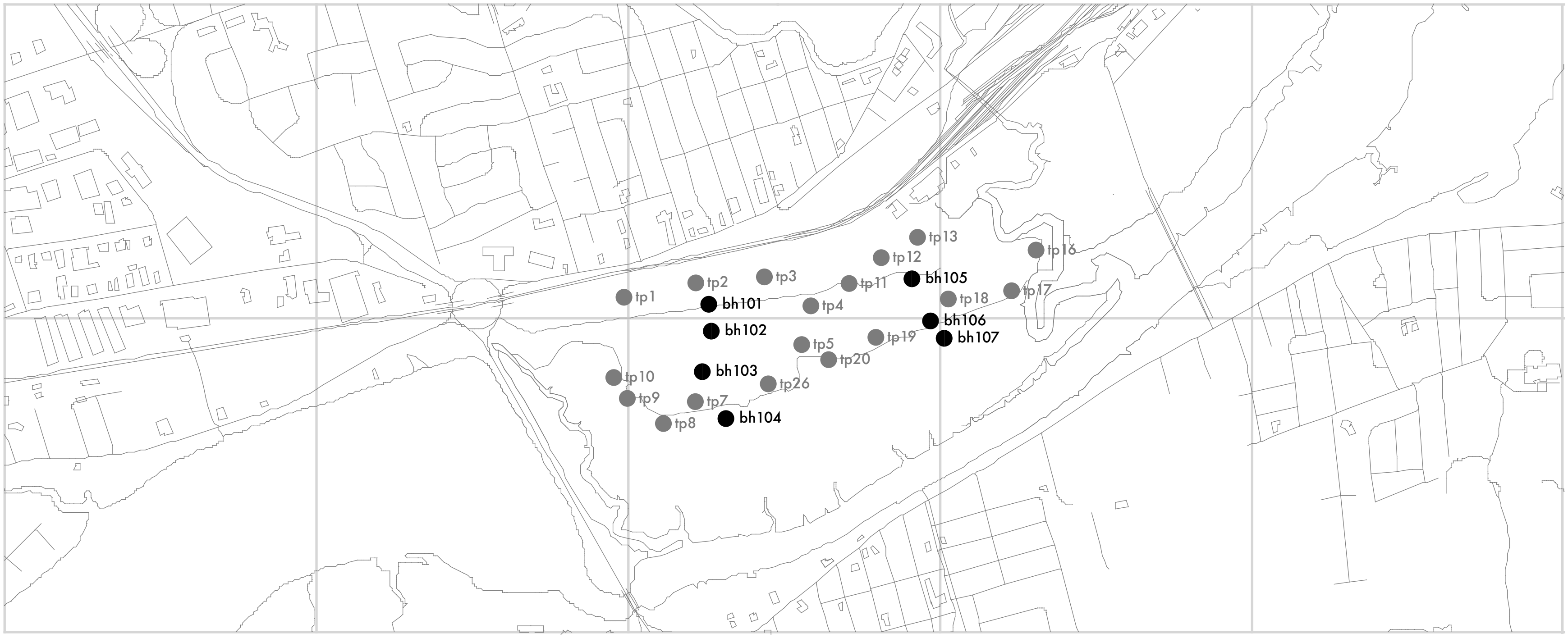


fig. 2.56

testing points

test pits
boreholes

occasional boulders. The surface of the glacial till occurs at shallow depths to the north of the disposal site, dipping southwards to reflect the original river channel geometry.

Bedrock: Pennsylvanian Bedrock was discovered under the waste and belongs to the Salisbury formation.

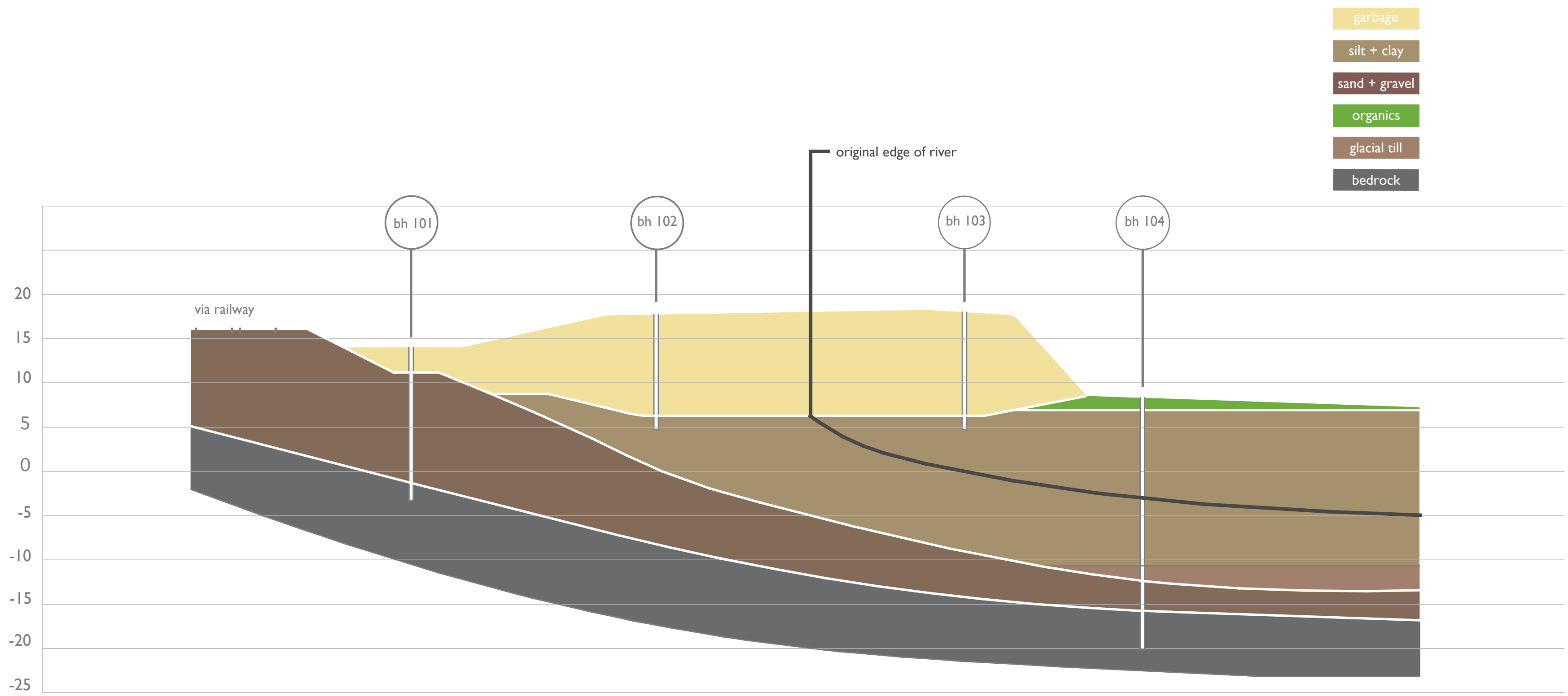


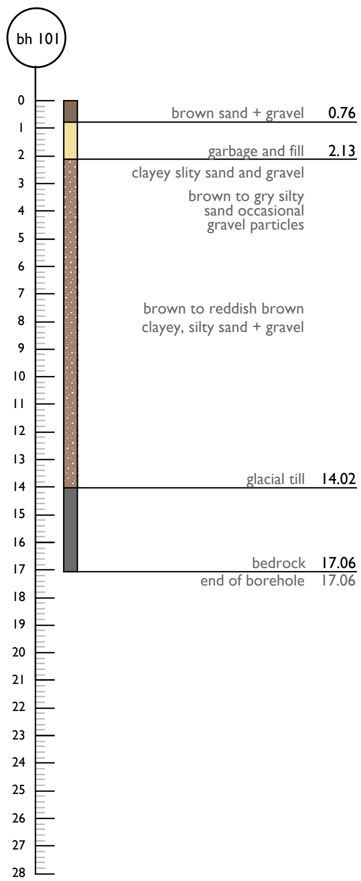
fig. 2.57 conceptual section indicating soil composition

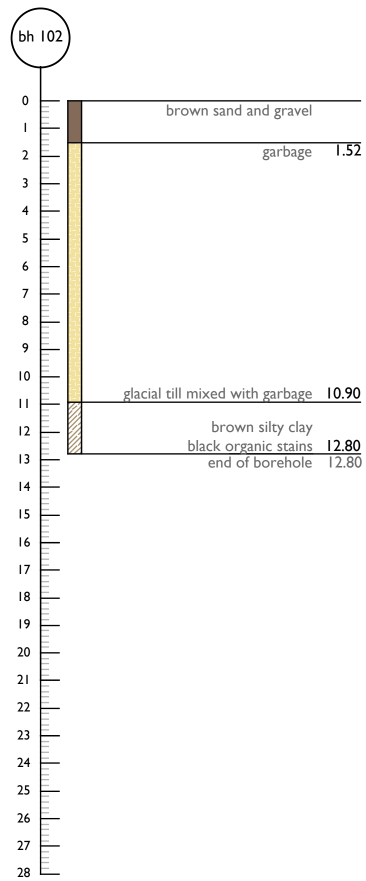
fig. 2.58 borehole log, bh 101

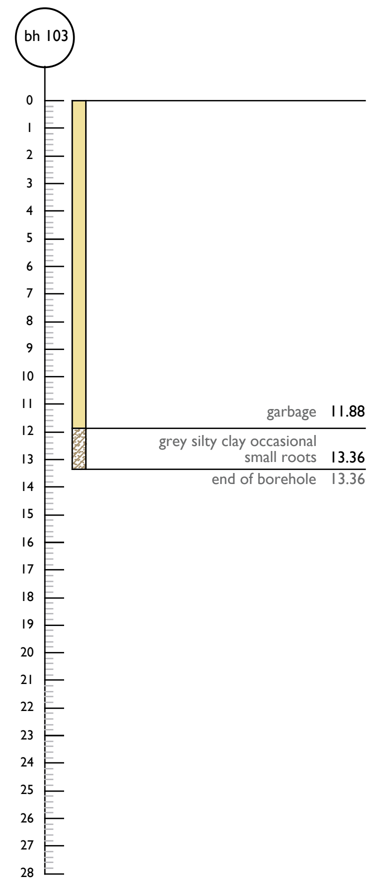
fig. 2.59 borehole log, bh 102

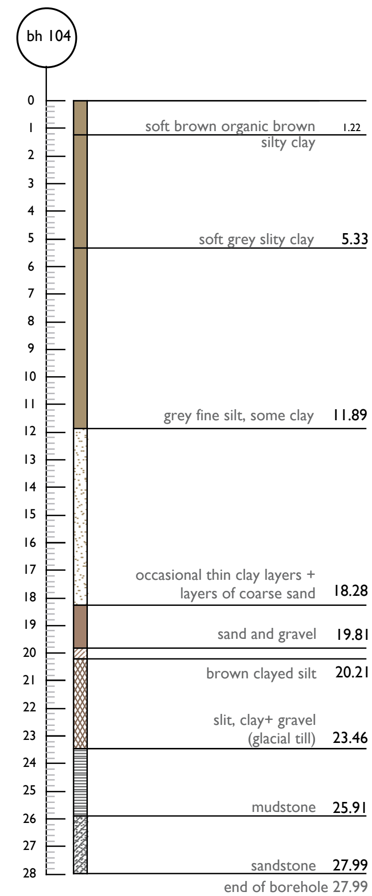
fig. 2.60 borehole log, bh103

fig. 2.61 borehole log, bh 104









The site is located within the Johnathan Creek Watershed, situated within the larger watershed area of the the Gulf of Maine (appendix a5). The tidal bore is a single wave that advances on the incoming tide twice daily from the Bay of Fundy where it pushes upstream towards Moncton. The water in the bay rises at a rate of 2 to 3 meters an hour as one hundred billion tonnes of water from the Atlantic forces its way back upstream. This natural phenomenon is influenced by a combination of factors including the river slope, downstream flow, seasonal change of moon and the wind cycles. [86] The strong flushing action of the tides and river flow is slowed by dams obstructing the natural flow of the water within this watershed along the Bay of Fundy, Bay of Shepody, and the Petitcodiac River. Downstream sediment build-up, which causes the narrowing of the river channels, and changes the entire flow of the water system, dramatically alters the river ecosystem. Reduced flow leads to reduced mixing of fresh and salt water in the bay. Less tidal flushing in the river leads to lower water quality and lower biological diversity.

The Jonathan Creek Watershed area is approximately 50 km^2. The upper stretches of the creek are mostly forested, lying outside the boundary of the city of Moncton. The lower reaches lie within the chosen study site of the decommissioned Riverside Landfill. The creek flows from the upper region through to Centennial Park Pond, Jones Lake, then into the Petitcodiac. Urbanization has major impact on Jonathan Creek's water quality, due to the creek's proximity to the Moncton Industrial Park and residential and commercial storm sewer outlets which discharge into the creek. The lower areas of the creek are highly sedimented from bank erosion and runoff emitting from ditches which make the water murky, a characteristic of the region. Fish passage through the creek is restricted because of the two barriers located at the outfalls of Centennial Park Pond and Jones Lake. These barriers have serious impacts on anadromous fish species that have no access to spawning grounds upstream. [87]

fig. 2.62 tidal bore, moncton, 1950. pre-causeway height 2m

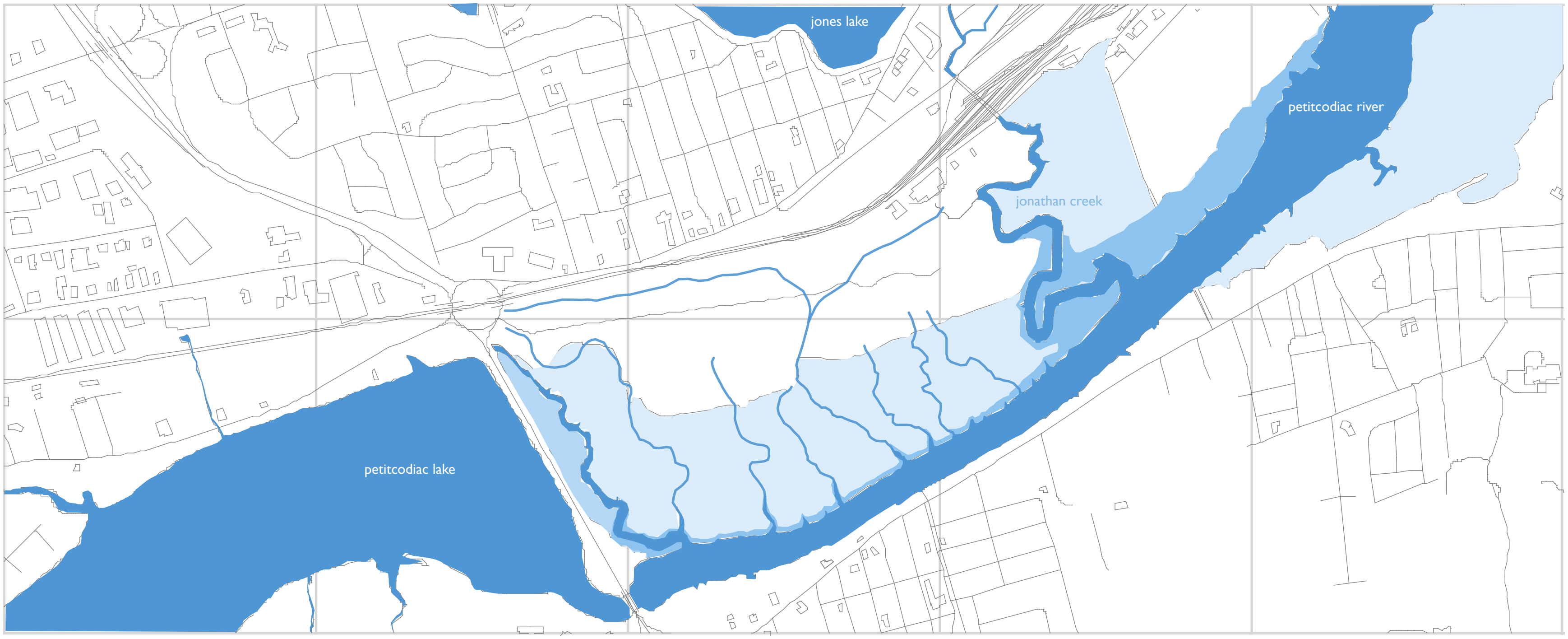


fig. 2.63

hydrology

marsh
tidal marsh
open waterway
drainage channels

Pet-Kout-Koy-ek

In the beginning was the Great Spirit, who created everything in the sky, in the ocean and on the earth. He created the first man, whose name was Glooscap. And he created Pet-Kout-Koy-ek, the River That Bends Like a Bow.

One day a monster Eel swam down the river, pushing all the fish and fresh water into the salty bay.

Turtle told Glooscap about the wicked Eel's misdeeds and the harm he had inflicted upon the river and its creatures. So Glooscap gave great powers to Lobster, who grew gigantic and strong enough to fight the Eel.

Their battle stirred up the mud of Pet-Kout-Koy-ek, turning the water brown, and sent waves far up the river. They fought long and hard, until Lobster prevailed and Eel was killed.

Even today, however, the battle takes place twice a day on the river now called the Petitcodiac. The wave, which forms as Lobster pushes Eel back inland, is known to most as the tidal bore. [44]

Legend told by the late Micmac artist Michael Francis from Big Cove, whose parents were originally from Beaumont on the Petitcodiac River.

fig. 2.65 (opposite) photo of tidal bore

tidal bore generation

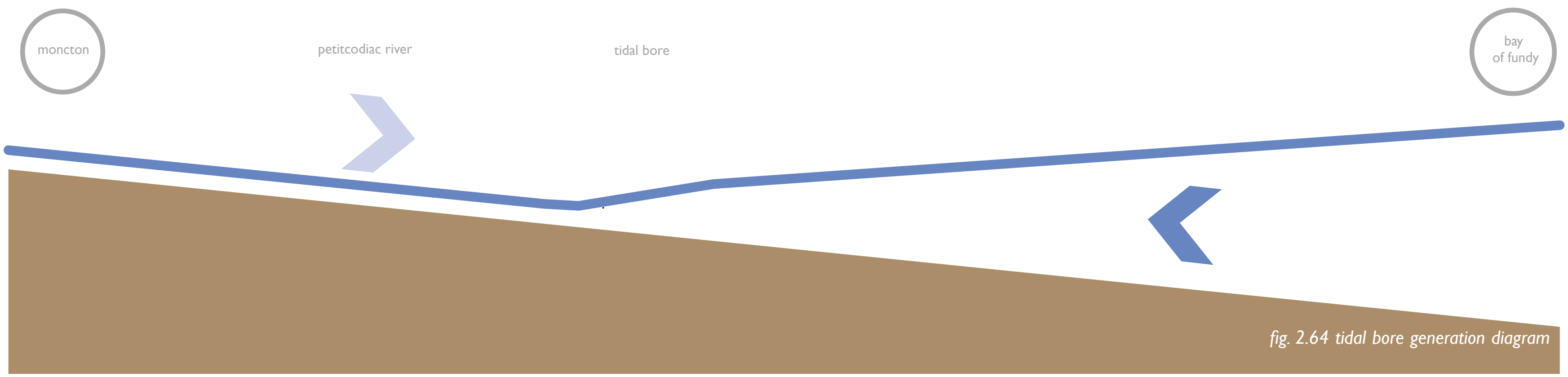


fig. 2.64 tidal bore generation diagram

fig. 2.66 hourly tide interval series, july 27, 2004

06:00 extremely low tide
river flowing towards ocean

07:00 arrival of the tidal bore 07:15
reversal of tides, ocean tide flowing upstream

shortly after arrival of the bore
river bed basin is covered and tide rises very quickly

08:00 high tide

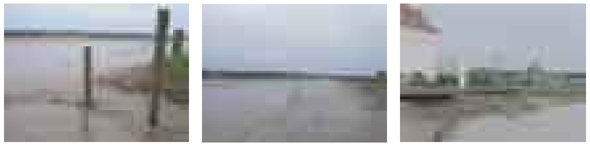
09:00 high water level

10:00 water level begins to recede
reversal of tides, river flows downstream towards ocean

11:00 low water level

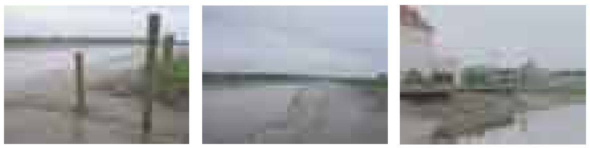
12:00 low water level

petitcodiac river tide intervals 27.07.04

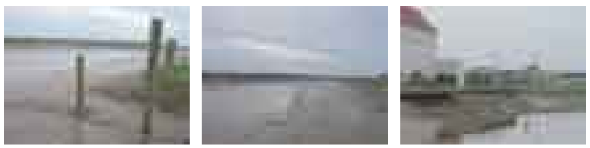


13:00 low water level

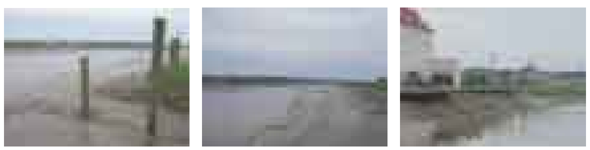
14:00 low water level



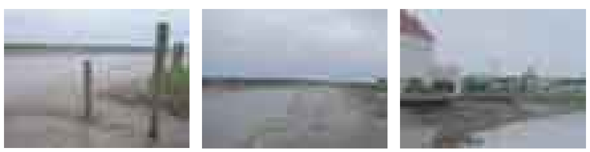
15:00 low water level



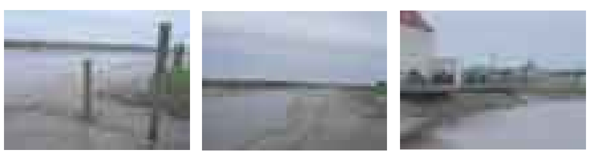
16:00 low water level



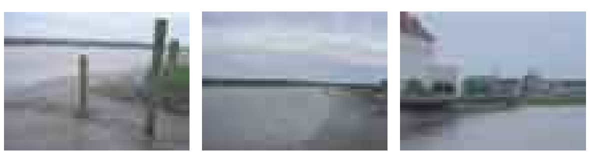
17:00 low water level



18:00 low water level



19:00 low water level



20:00 arrival of the tidal bore

shortly after arrival of the bore
river bed basin is covered and tide rises very quickly

The Petitcodiac River Valley was formed during the Mississippi era over 250 million years ago. A number of eruptions occuring during the last glacial period have caused the spectacular topography of the region. The riverside landfill lies at the basin of the river valley condition and all the city's run off flows through the site and towards the river.

fig. 2.67 exisitng site secitons,river valley condition, river + landfill highlighted

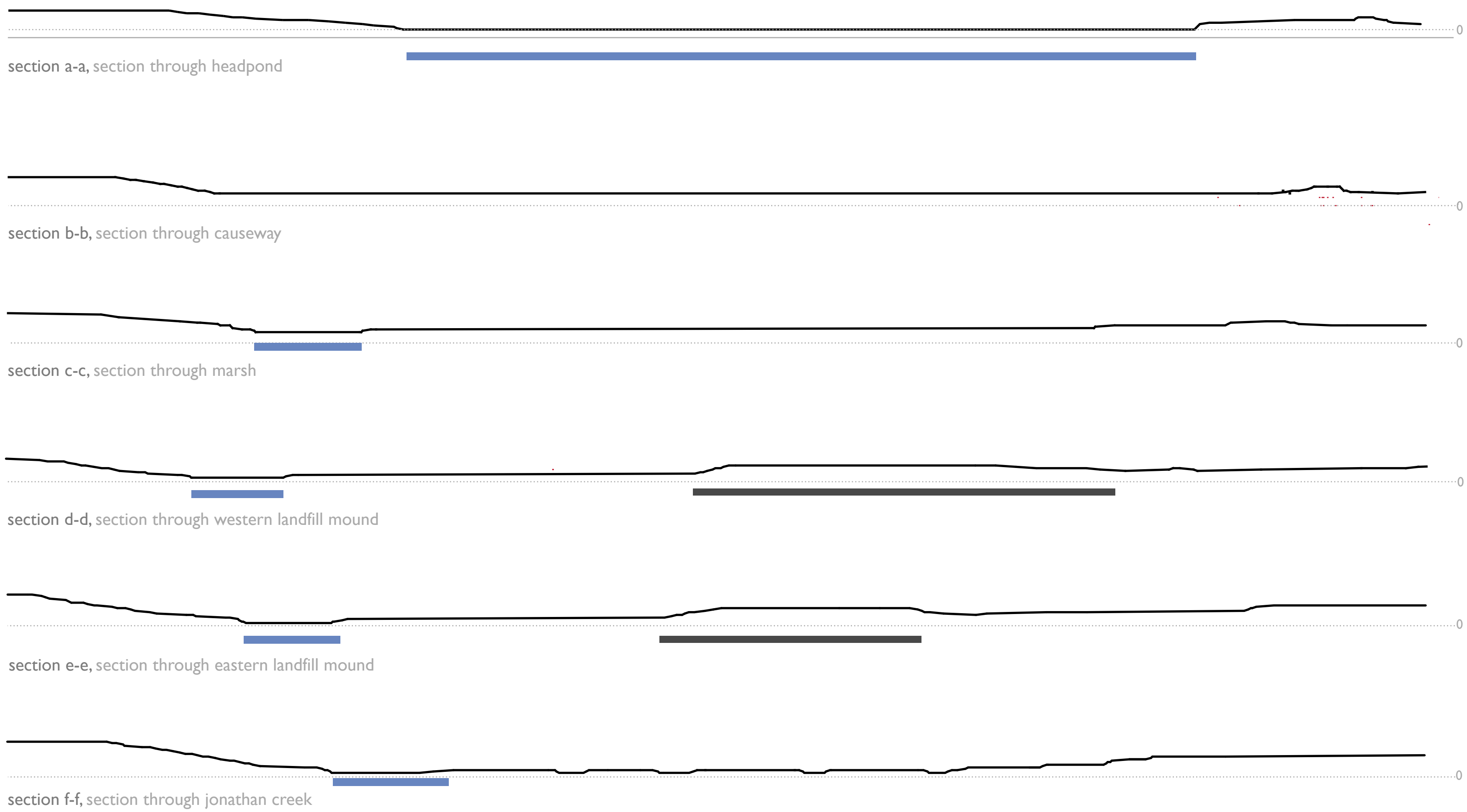


fig. 2.68

topography

fig. 2.69 emergent plant species along riverbank

fig. 2.70

emergent plant species

Refer to appendix a7 for plant species identification and pertinent information including the soil conditions which determine types of emergent species.

landfill plant	01-41
roadside plant	42-47
railway corridor plant	48-61
riverbank plant	61-69
garden plant	70-78
park plant	79-91

fig. 2.71 vegetative cover of riverside landfill

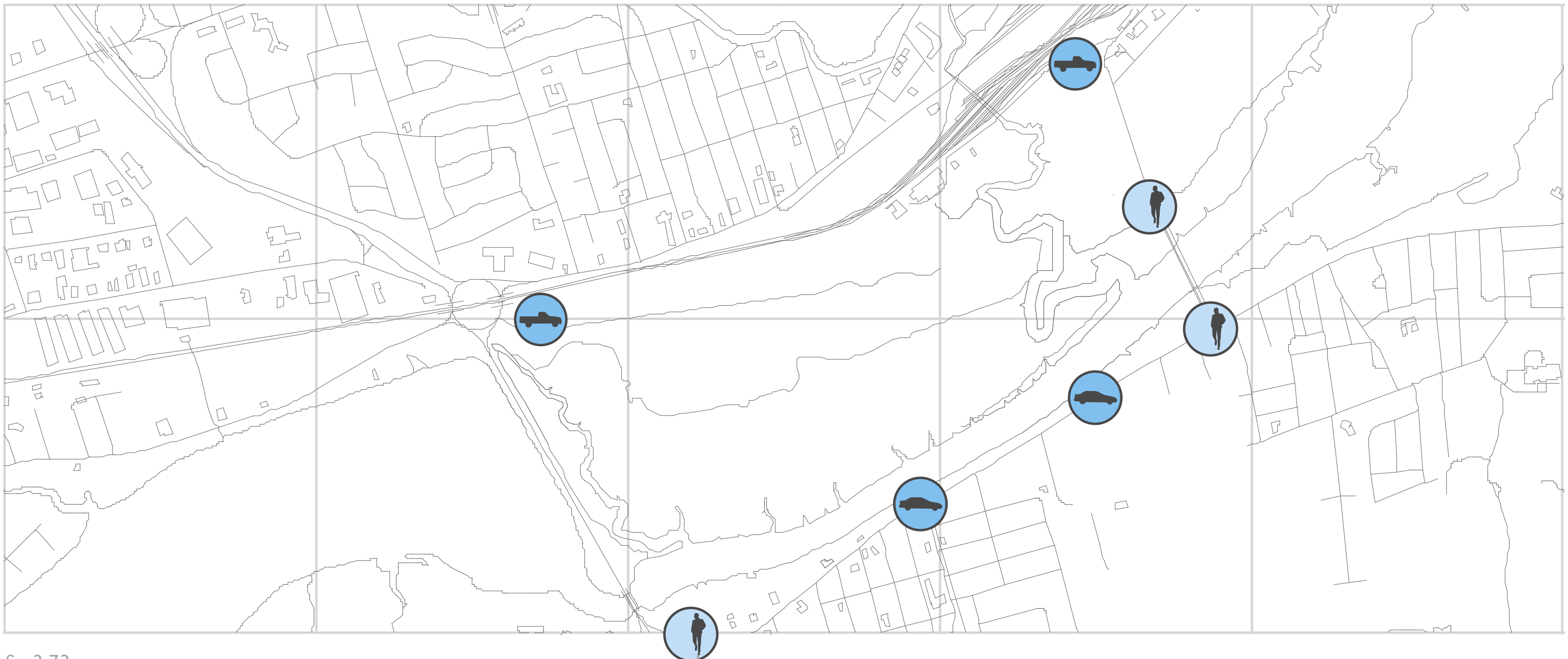


fig. 2.73

access points

public vehicular entrance
service vehicular entrance
pedestrian

fig. 2.72 access point. pedestrian path adjacent to causeway. view to river is blocked and is directly adjacent to vehicular traffic.

fig. 2.74 access point to the site. pedestrian route along gunningsville bridge

The preceding study provides a base of information upon which a sensitive intervention to both biological and cultural systems can be proposed for the design exploration for decommissioned landfill site in the third chapter.

fig. 2.75 *existing condition of decomissioned landfill site.*

03: the design exploration

fig. 3.1 greek island of mykonos, seamless intergration of natural and cultural conditions. photo by author, 2001

James Corner's philosophy must be revisited. "Environmentalists tend to repair and perhaps forestall damage while cultural ways of being and acting in the world (which lie at the root of environmental problems in the first place) remain relatively unchanged." [88] His reference to 'continual patching over problems' aptly describes Moncton's actions to date. Alex Wall also recognizes the connection between the physical and the cultural. In *Programming the Urban Surface*, he expands on the traditional definition of landscape:

> *the term landscape no longer refers to prospects of pastoral innocence but rather invokes the functioning matrix of connective tissue that organizes not only objects and spaces but also the dynamic processes and events that move through them. This is landscape as active surface, structuring the conditions for new relationships and interactions among things it supports.*[89]

The thesis proposal, in this chapter as well as in the preceding analytical outlook, envisions the landscape in such extended terms. This definition of landscape is useful because it contrives affect change at the scale the region, the city, and the urban fabric. The intervention is conceived as a continuous landscape matrix. In *Recovering Landscapes as a Critical Cultural Practice*, Corner, supports the potential of landscape to alter our environment:

> *Landscape reshapes the world not only because of its physical and experiential characteristics but also because of its eidetic content, its capacity to contain and express ideas and so engage the mind. Moreover, because of its bigness- in both scale and scope- landscape serves as a metaphor for inclusive multiplicity and pluralism, as in a kind of synthetic 'overview' that enables differences to play themselves out.* [90]

Current conditions of landscape are often propelled by economics. 'Landscape' is often thought of as a commodity, something people find useful, something that

fig. 3.2 ravenna, italy. highly developed landscape of work, intergration of natural and cultural systems. photo by author, 2001

adds value, and something that can be bought and sold.

> *The unprecedented power and private purpose of corporate culture must be recognized… corporate agendas and corporate visions increasingly manipulate the formation of significant, productive realities around the world. They call for landscapes to aid in the consumption of goods and services, landscapes formed to enhance themed or trademarked realities.* [91]

Public spaces can no longer derive their form from economic doctrines. Landscapes formulated in these terms have often created generic places that neglect unique local attributes or civic identity. By ignoring the landscape sense of collective identity is lost, resulting in spaces that have "…typically not only of experientially deadening effect…but also of a depressing cultural atrophy whereby all hope for the future is replace by too high a regard for past accomplishments." [92]

We are disconnected from the larger natural processes that sustain our lives in the city making us strangers in the landscape that we inhabit. As consequence large tracts of land within the city have often been abused then abandoned after their resources have been exploited. We have a multiple obligation to restore these neglected spaces, to develop a new contract with the land, and to lessen our impact on the environment. Public spaces, like parks, must be designed with an understanding of local natural and cultural systems and used to regenerate the cityscape. A new municipal park should enrich place, enhance public space, and give form to the idea of shared resources and a collective. This interaction continuously produces a public event. This stewardship of the land constructs the artificial public domain: as a thesis site this will be a place for the city to witness the process of remediation and in consequence, seek to affect future practices in generating, producing, and disposing of waste. The processes on the site will be exposed. Making visible the transformation from 'unwanted' to

fig. 3.3 main piazza, ravenna, italy. public space at the scale of the landscape, photo by author, 2001

'valued'. The processes of bioremediation, used in the site strategy, breakdown contaminants as food for living organisms in natural succession processes. The site will, in the end, become a physical expression of the remediation process and a new place for social interaction in the city. An opportunity will be created for direct experience with hydrological processes within the city, making people aware of the river's source and purpose. By exposing and integrating the natural processes used to treat the contamination into the fabric of the city, a new relationship develops between urban systems, natural processes and public space.

> *It is in this deeper sense that landscape as place and milieu may provide a more substantial image than that of the distanced scenic veil, for the structures of place help community to establish collective identity and meaning, this is the constructive aspect of landscape, its capacity to enrich the cultural imagination and provide a basis for rootedness and connection, for home and belonging.*[93]

The thesis site demands a new language, a new form, a new way of seeing the relationship of the natural and the artificial. Its unfitting to conceive of recreating Central Park on the site, or other older models that no longer have relevance.

> *Certainly the attention being paid to landscape today assumes more that character of sentimental recollection- with attendant demands for either the re-creation or preservation of past landscapes- than of visionary of ambitious projects. A combination of nostalgia and consumerism drives this desire while suppressing ambitions to experiment and invent.*[94]

The focus of the planning and design intervention is not its representation or its aesthetics, but rather the site's functioning, its efficacy. The formal order shaping the park will be founded on the process of bioremediation, specifically treating the toxic leachate pooling beneath the landfill. Cultural and biological processes

fig. 3.4 Frederick Law Olmsted. (top) Riverway, Boston, "view during construction, from Longwood Avenue Bridge looking southwest 1892, Photograph by J.G Langdon. (bottom) Riverway, Boston, "view from Longwood Bridge, 1920, 28 years after construction" Photograph by Thomas Ellison. Both photographs courtesy of the National Park Service, Frederick Law Olmsted Historic Site.

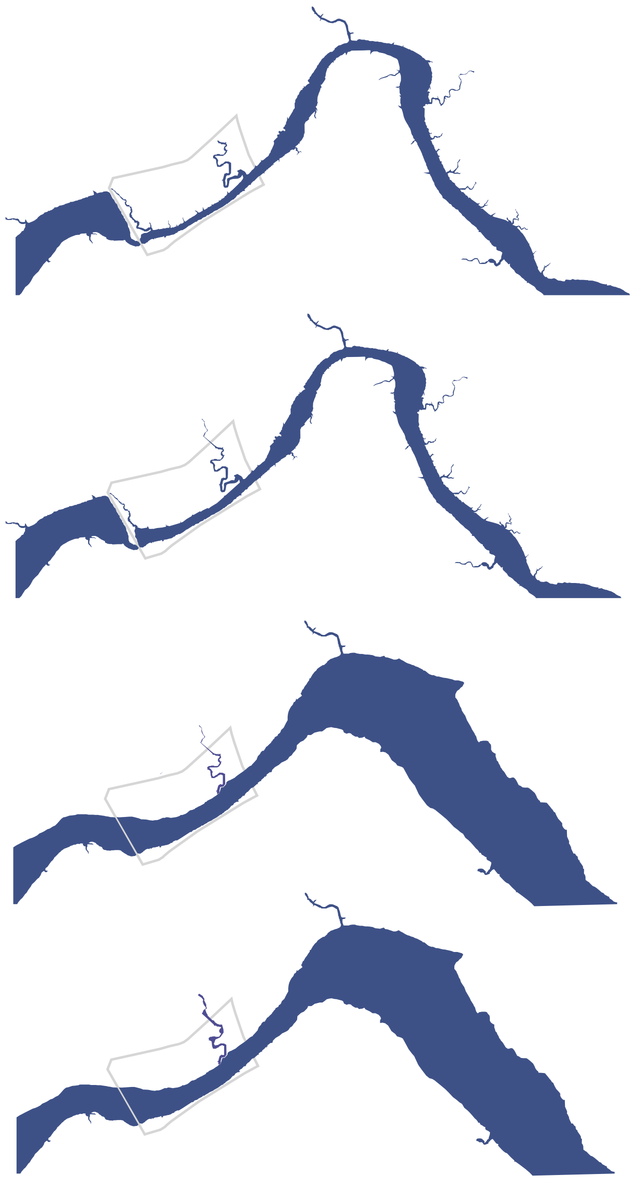


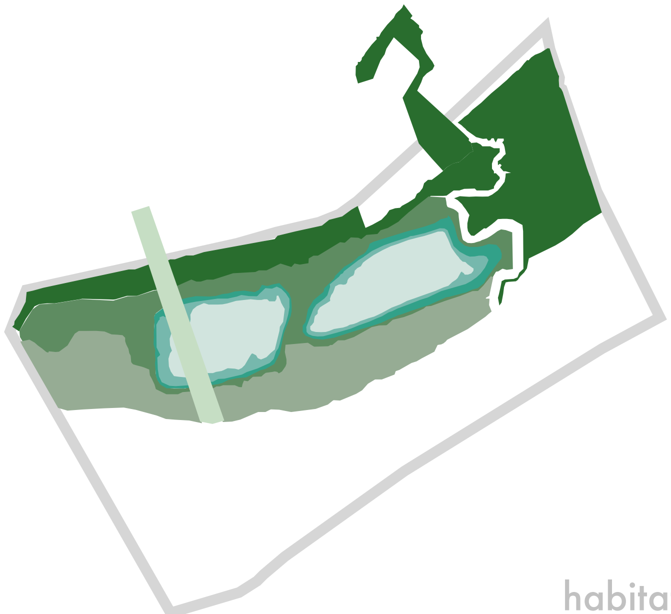
fig. 3.5 hydrological conditions of the site, 2005-2105

are implemented in phases to transform the terrain over time. Woodlands, wetlands and walkways structure the movement of water and activities through the park while providing flexible spaces or 'scales of undecidability' that will allow evolving adaptations. In her essay, "Scales of Undecidability", Anita Berrizbeitia, explains the term:

Instead of flexibility, thus we might now think, more precisely, in terms of scales of undecidability. By this I mean a landscapes' capacity for precision of form notwithstanding flexibility of program- for the precisely open rather than the vaguely loose. Through this framework we are able to reject the notion that landscapes are either naturalistic and formless or objectlike and form-full. Instead we can conceptualize landscapes where there is space and time for process to unfold and for stable meanings to come forth. We can imagine landscapes with "right mixture of rigid structures, supple structures and self-organizing processes" that are in some ways the ultimate solicitation of chance, in others the ultimate suspension of process, and yet in others something in between. [95]

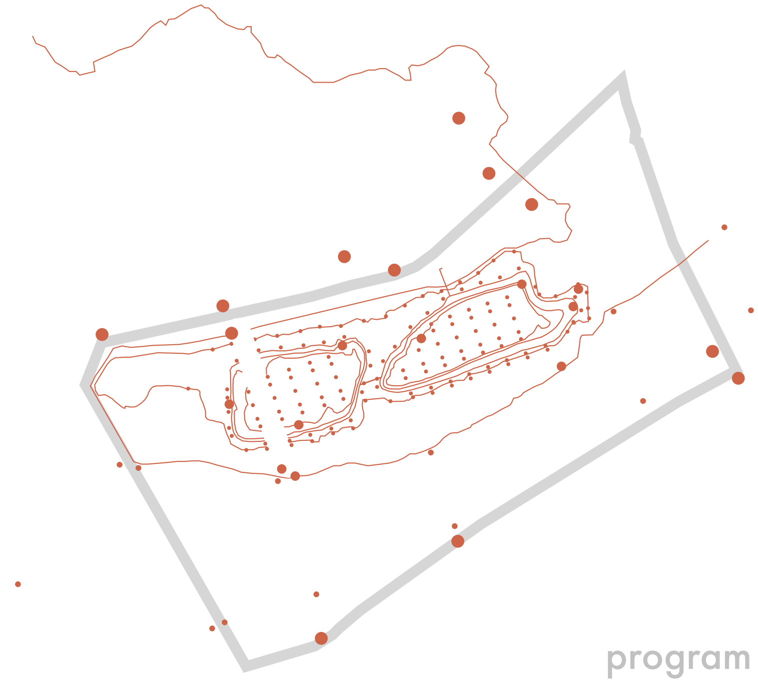
As a landscape project the Riverside Landfill site has the potential to become an integrated part of the urban fabric of Moncton. The plan is a multileveled proposal that creates amenity for the city from a perceived waste site. With collaborative effort, the dump will be transformed into an active public space that generates commitment from the city. The success of the intervention may be evaluated in the following terms:

The reclaiming of site might be measured in three ways: first, in the terms of retrieval of memory and the cultural enrichment of place and time; second, in terms of social program and utility, as new uses and activities are developed, and, third, in terms of ecological diversification and succession. In this threefold way, the inventive traditions of landscape architecture actively renew the significance of those cultural and natural processes that undergrid the richness of all life on earth. [96]



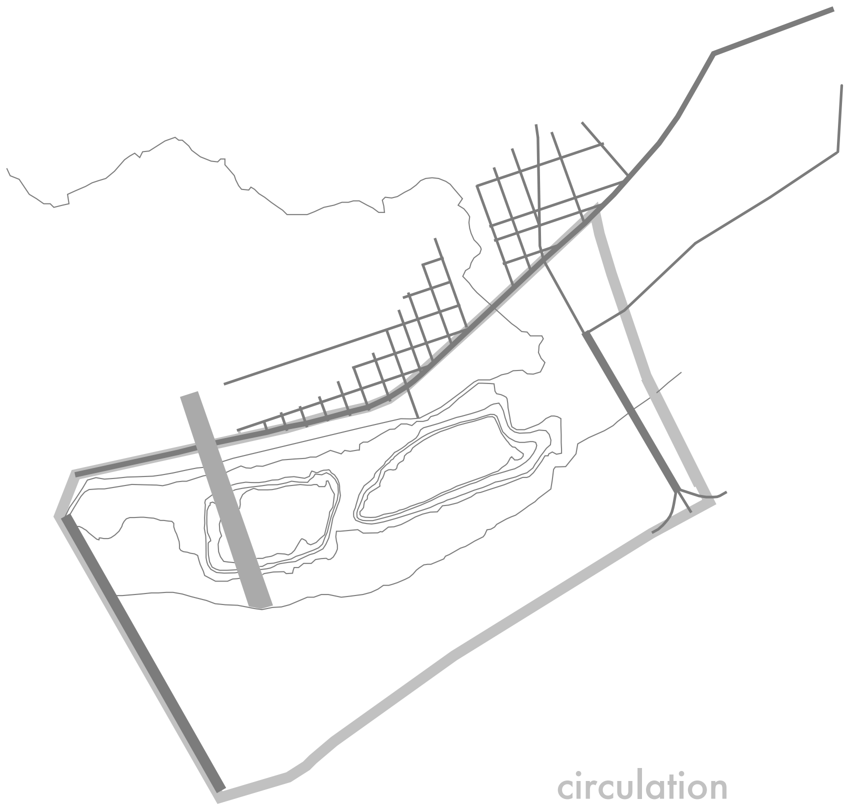
habitat

woodlands
wetlands
meadowlands
open water



program

green spaces network
urban density
testing points
hydrology



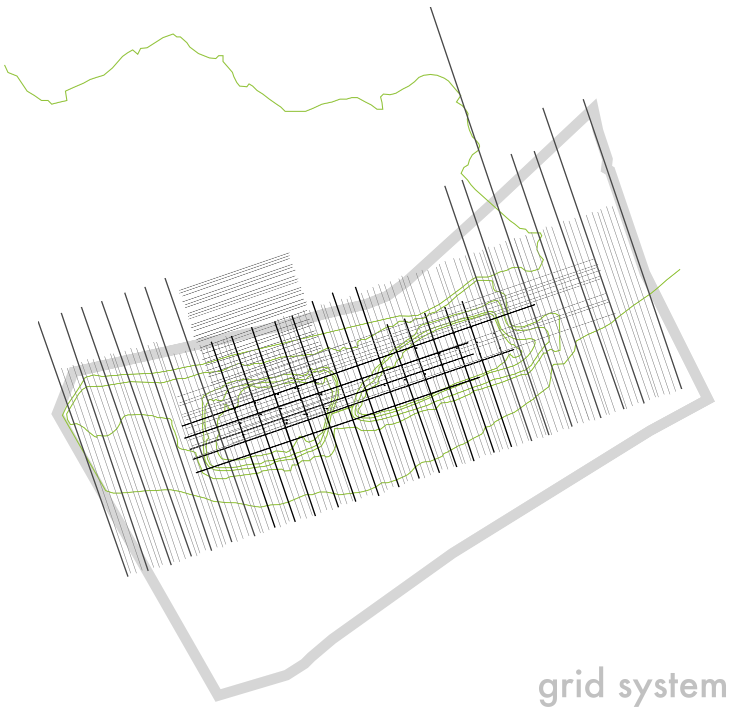
circulation

transportation network
access points

3 systems of intervention

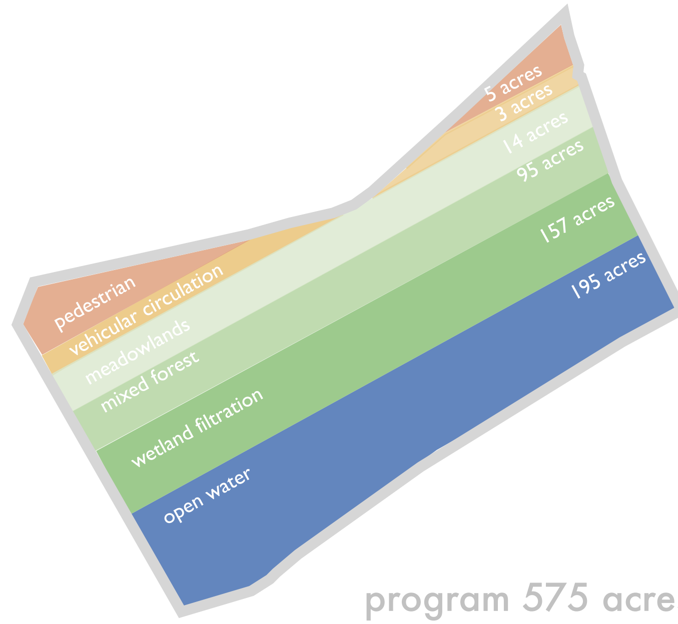
The park is constructed as a series of layered interventions implemented over time. These systems of intervention (habitat, program and circulation) are further subdivided into stratum based on the themes initially used to map the site (green spaces network, urban density, testing points, hydrology, transportation network, and aceess points).

fig. 3.6 layers of intervention

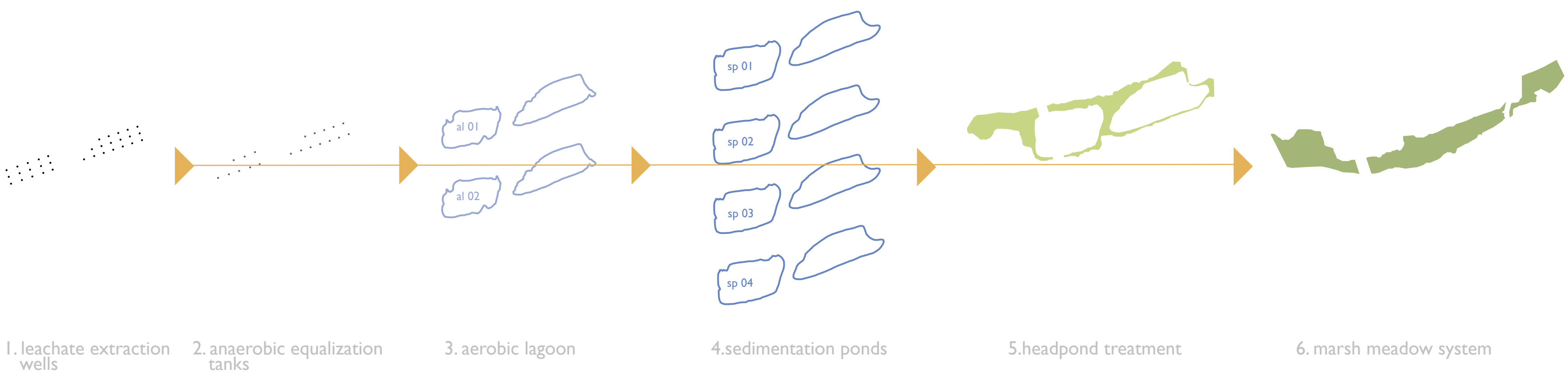


grid system

large scale city grid
small scale landscape grid



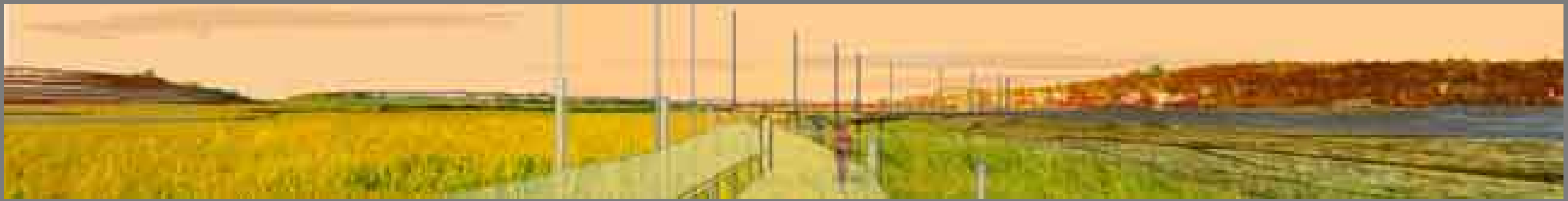
program *575* acres



spatial organization

At the larger scale of the landscape, the existing grid of the city is used to structure the spatial organization of the park's program. The formal order shaping the park will be founded on the process of bioremediation and uses the existing landfill contours as a foundation for the organization of the filtration process. The leachate filtration process occurs in six steps. Each stage of the process produces different spaces in the park with varying qualities of light, texture, enclosure, and movement. At a smaller scale, a landscape grid was implemented at intervals between the city grid to provide organization for elements of amenity on the individual.

fig. 3.7 spatial organization



" the lesson that I read in the past is this: that the health of land and water-and of the woods, which are the keepers of the water- can be the only lasting basis for any civilizations survival and success." [97]

fig. 3.8 (opposite) the changing landscape, view along TransCanada trail, 2005-2105

3.1 site processes 2005-2105

Considering the river's hydrology and the landfill's toxicity, the project aims to weave the degraded site back into the natural and cultural patterns that exist in the larger scale of the region.

Additive and subtractive, cultural and biological processes are implemented in phases to transform the terrain over time. The landscape will alter dramatically and change constantly. Artificial and natural become inseparable, and develop a new relationship between urban systems, natural process, and public space. The site design processes are developed with an understanding of nature's inherent rhythms and cycles and used to regenerate the cityscape.

A timeline is developed as a starting point for the design intervention. It is broken down into four phases and is used as a tool to coordinate the complex abiotic, biotic, and cultural systems on the site. The project begins in 2005 and spans 100 years. At which point there is a period of reevaluation. Ongoing monitoring and management of the site will allow evolving adaptations of the projects development and will support complexity and change.

perceived conditions 2005

The city denies the crisis of the river created by the causeway and the landfill. This map of the city illustrates how the river is perceived. The consequences of the city's actions are not shown. The Petitcodiac riverbanks are shown in their 1968, pre-causeway condition. There is no sedimentation build-up along the riverbanks and the Riverside Landfill is curiously missing.


106
114
114
1A-B
0
WHEELER
MAIN
SALISBURY
COVERDALE
Harold Page Field
GUNNINGS

2005

fig. 3.9 map of perceived conditions

existing conditions 2005

The aerial photo shows the true, existing conditions of the river. It illustrates the narrow condition of the river channel caused by the sediment infill that has occurred since the construction of the causeway. The Riverside Landfill is also plainly visible. The study site boundary is indicated.

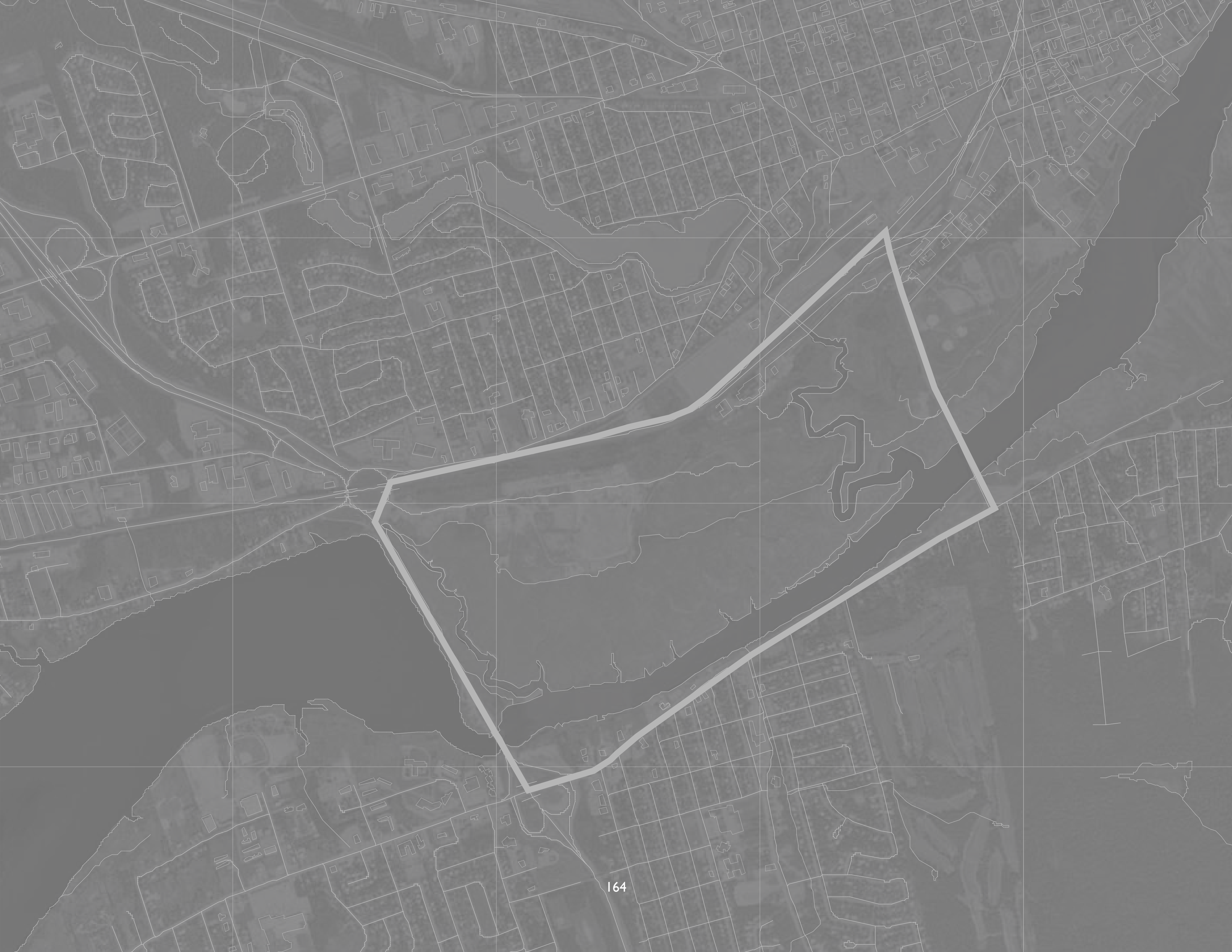


fig. 3.10 map of existing conditions

fig. 3.11 collage, new vehicular bridge, existing gunningsville bridge, perimeter trail

groundwork 2005

Public access is restricted to the perimeter trail and forest buffer zone along the northern edge of the site.

Habitat: This stage lays the foundation for the development of the site. The northern edge of the site is initially seeded to promote the growth of the native Acadian Forest and Fog Forest types. Its edge will act as a buffer to the park and as a primary filter for the city's water run off.

Program: The new perimeter trial links the city's two major existing park systems. At the Jonathan Creek entrance a new park services pavilion is constructed. The ground is reshaped, the landfill mounds are regraded with clean fill. In addition to the clean fill, the top of the landfill has a vegetative cover to promote growth of emergent meadowland plant species. Tidal monitoring wells are installed along the river and the new perimeter boardwalk as a part of the TransCanada Trail extension. These devices are necessary to gather information to inform next stages in the development of the site. They monitor fluctuating tides and oceanographic conditions, information necessary for coastal zone engineering projects. This changing information is visible to the visitors along the boardwalk. Gas monitoring wells are installed along the outer edges of the landfill to examine off-site migration.

Circulation: For construction access, Upton Street is extended to the site boundary and parking is provided. The completion of the new Petitcodiac Bridge currently under construction will be complete in summer of 2006.


P

fig. 3.12 map of 2005 design intervention

fig. 3.13 conversion of gunningsville vehicular bridge to a pedestrian bridge

initial propogation 2010

Public access within the park is restricted to the perimeter trail, forest buffer zone, and the urban link. The causeway gates will be opened to allow primary flushing of sediment build-up and unrestricted passage for fish upstream.

Habitat: From the initial seeding of the mixed forest buffer, two different woodland types native to the region (the Acadian Forest and Fog Forest) will emerge based on their sustaining soil conditions. The Acadian Forest along the northern boundary remains dry while the Fog Forest will occasionally be inundated by the river. The Fog Forest will support animal and plant species that thrive in wetter conditions. Both will be in the process of self-organization.

In addition to the emergent plant species that will grow from good soil conditions from the new clean fill deposited at the site, the initial seeding of remediating species for the coastal wetlands will take place. These coastal wetlands are compromised of the fresh water headpond and salt water marsh meadow. These wetlands are the final two stages in the leachate remediation process. This allows ten years for the wetlands to develop and become hardy before the introduction of the leachate.

Program: In addition to the TransCanada trail extension, a secondary urban link between the city and the river is constructed. This terraced, vegetated, linear strip, acts as a large boulevard to connect the residential neighborhoods north of the site and the Petitcodiac River to the south. Park services pavilions are constructed at the new park entrances. Reinforcing the connection of the two major park systems through the city, Jonathan Creek is raised to the surface, making visible the source of the water. The creek flows from Jones Lake into the Petitcodiac River. Gas extraction probes are installed around the perimeter of the landfill to begin LFG collection. Leachate extraction wells are burrowed and capped in preparation for extraction in the succeeding design implementation.

Circulation: After the completion of the Petitcodiac River Bridge, the existing Gunningsville Bridge is converted to a pedestrian bridge, linking the existing TransCanada Trail and the new Perimeter Trail. Bus shelters are constructed along existing bus routes. All residential streets are extended to the south to meet the boundary of the site, promoting urban density along the edge.


P
P

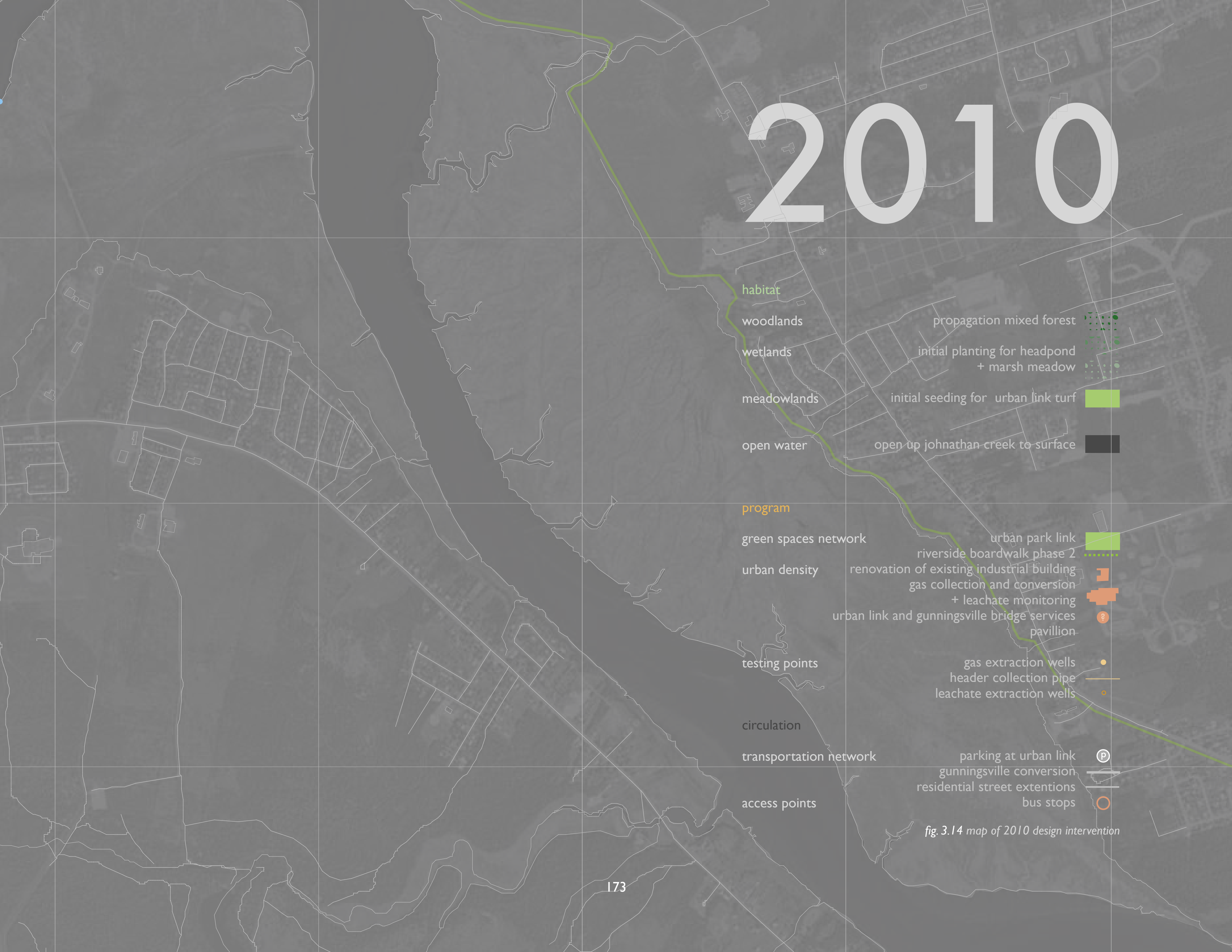


fig. 3.14 map of 2010 design intervention

self-organization 2020

Leachate extraction begins. All spaces in the park are accessible, at all times to the public. The citizens may witness the extended process of remediation from various park spaces- meadowlands to trial perimeters.

Habitat: Succession of the wetlands, meadowlands, and mixed forest continues. The aeration ponds and sedimentation ponds are flooded before the leachate extraction begins.

Program: A portion of the causeway is replaced with a suspension bridge that spans 500m of the river. The full tidal range to the river will be restored. A pool is constructed at the end of the urban link. Several installations along the park circuits are also constructed. These amplify the different qualities of the filtration process.

Circulation: Horizontal street connections form a network to promote urban density along the park's northern boundary. Main street is diverted for the same purpose.

fig. 3.15 new suspension bridge that replaces causeway, tidal range restored downstream

fig. 3.16 map of 2020 design intervention

continued adaptation 2105

As there is less leachate generated by the landfill the landscape will constantly change, the vegetative areas will adapt and evolve at various stages of succession. As time progresses the landscape will dramatically alter because less wetland area will be required to cleanse the smaller amount of leachate generated from the landfill. The land constantly affected by the toxicity of the landfill and the hydrology of the river.

This stage is open ended. It remains flexible. It is a time to reevaluate project goals and results, actions and outcomes. Ongoing monitoring and management of the site will allow for complexity and diversity to occur.


P
P

fig. 3.17 map of 2105 design intervention

habitat intervention

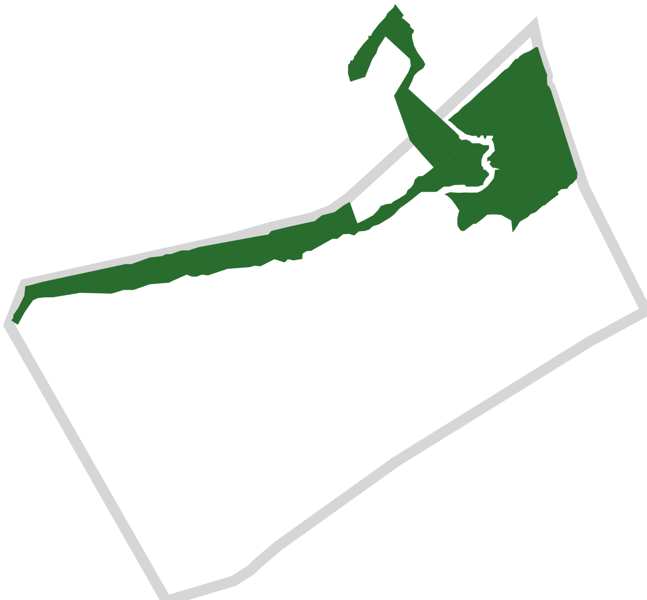
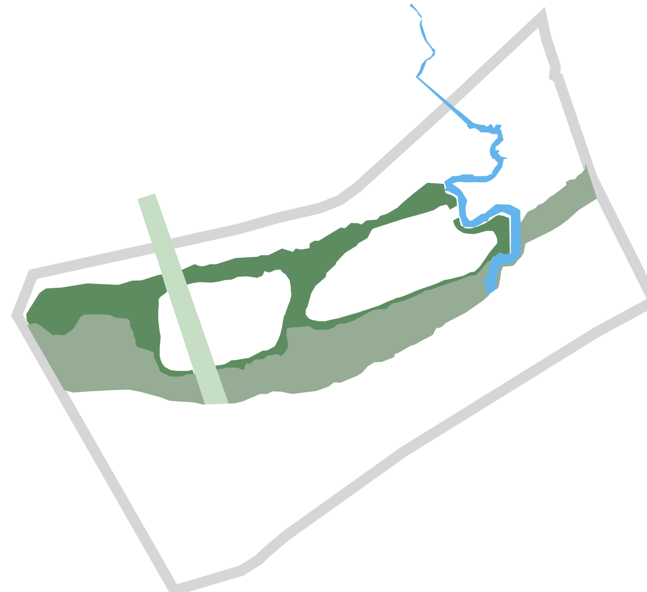


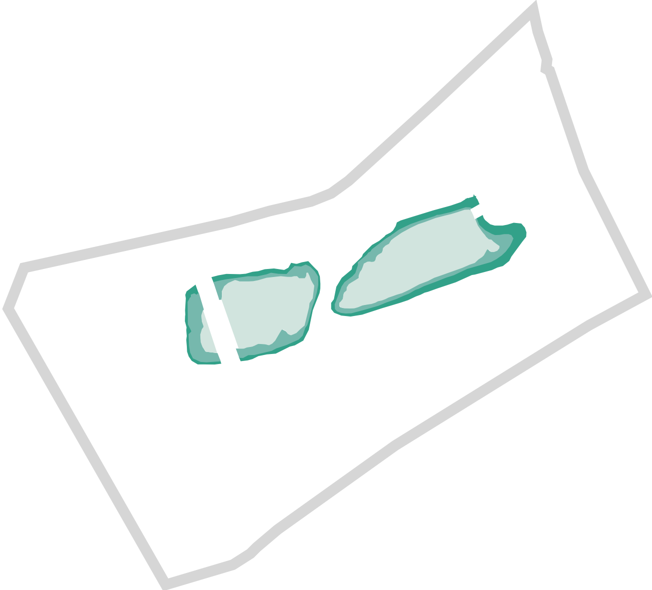
fig. 3.18 diagram, habitat intervention

2005



2010

		timeline — 5 years	10 years
biotic	habitat	ground work	initial propogation
	woodlands	initial seeding for woodlands	
	wetlands		initial seeding for wetland species
	meadowlands		initial turf seeding of urban link
	open water		



2020

75 years

self organization

initial seeding for meadowlands

aeration sedimentation ponds flooding

2105

XXX years

continued adaptation

habitat

program intervention

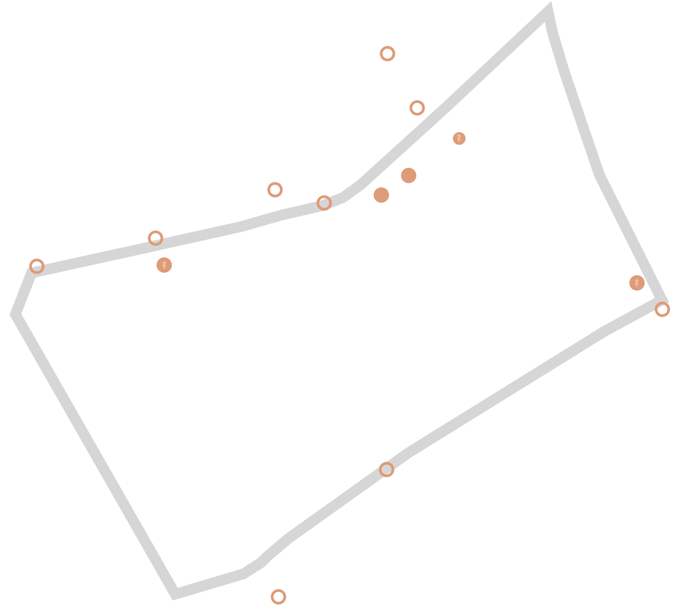


fig. 3.19 *diagram, urban density*

2005

2010

		timeline	
		5 years	10 years
cultural	program	ground work	initial propagation
	urban density	jonathan creek park services pavillion	renovation of existing industrial building for gas collection and leachate monitoring urban link services pavillion gunningsville bridge services pavillion

2020

75 years

self-organization

2105

XXX years

continued adaptation

urban density

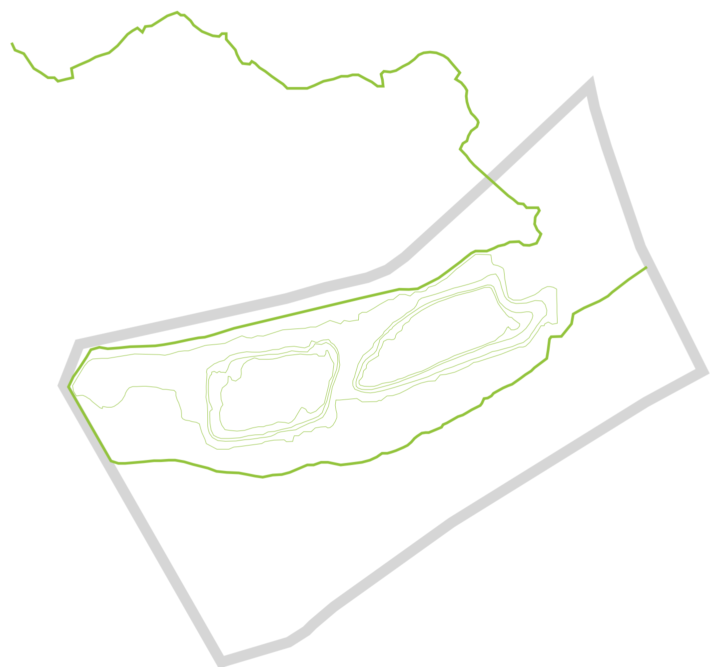
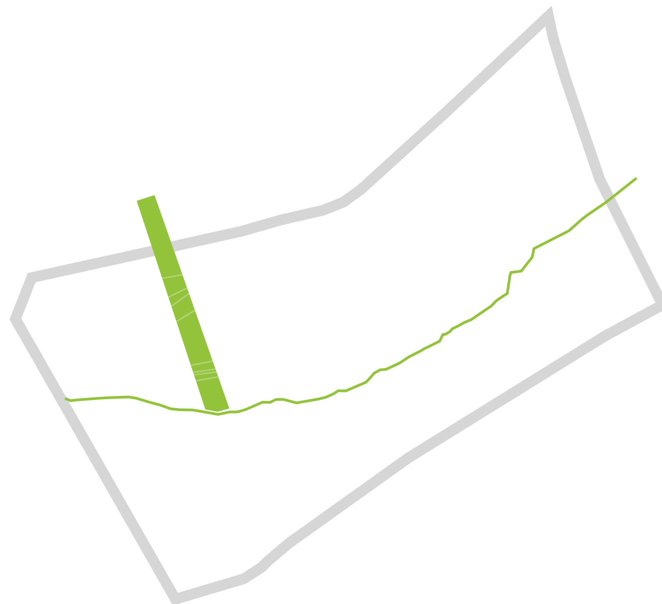
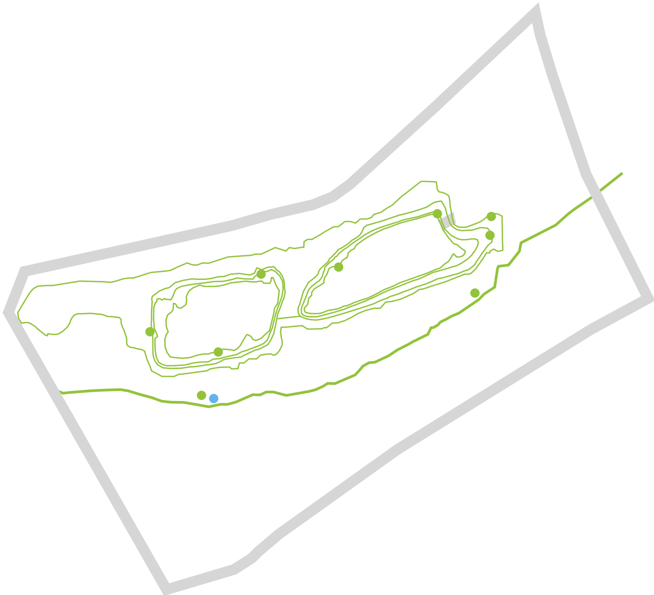


fig. 3.20 diagram, park spaces



2005				2010
		timeline	5 years	10 years
cultural	program		ground work	initial propagation
	park spaces network		4.5 km perimeter trail jones lake trail link regrading of landfill slope (no public access)	urban park link addition to riverside boardwalk trail



2020

75 years

self-organization

pool construction
recreational piers
filtration installations
addition to riverside boardwalk trail
access steps from perimeter trail, eastern mound
(public access to circuits)

2105

XXX years

continued adaptation

addition to riverside boardwalk trail

park spaces network

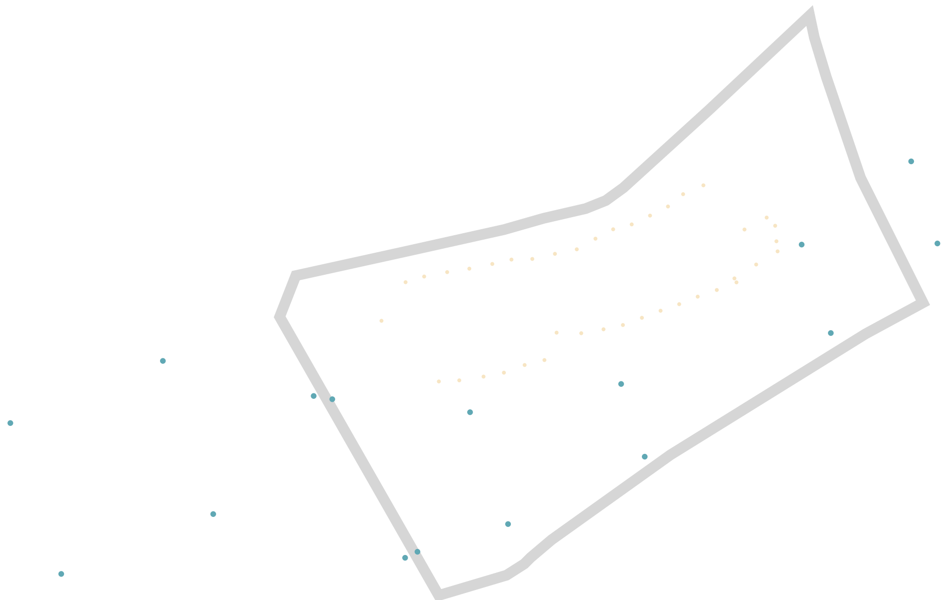
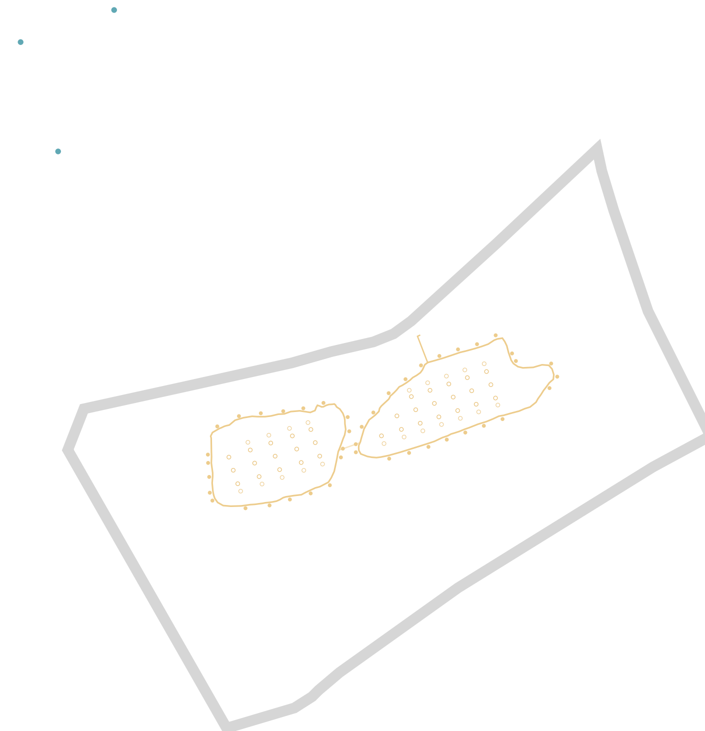


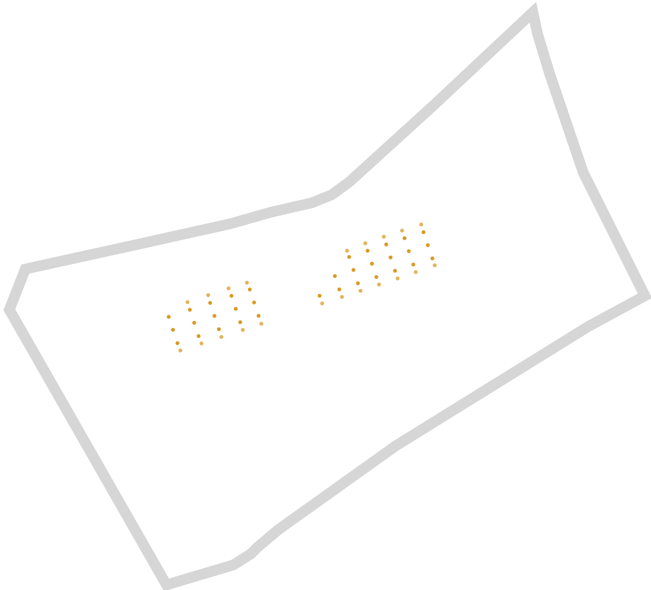
fig. 3.21 diagram, testing points

2005



2010

		timeline	
		5 years	10 years
cultural	program	ground work	initial propagation
	testing points	gas monitoring wells tidal monitoring meters	LGF extraction wells LFG header leachate extraction wells burrowed and capped anaerobic tanks installed



2020

75 years

self-organization

leachate extraction wells in operation
anaerobic tanks in operation

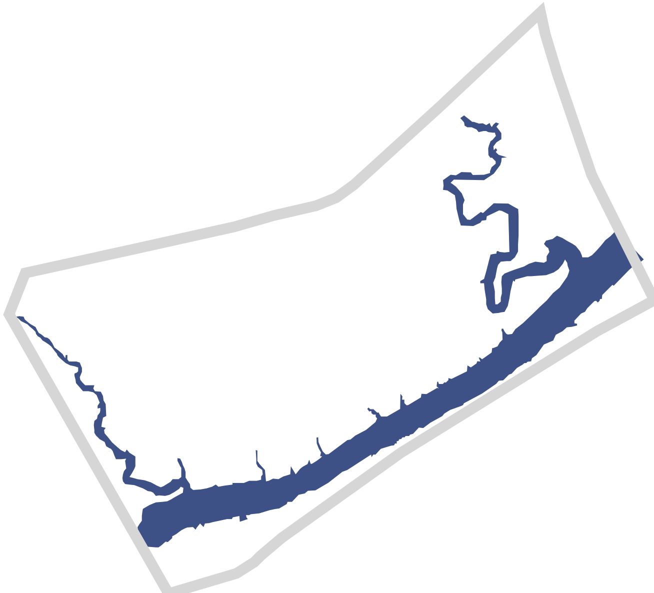
2105

XXX years

continued adaptation

closure of specified outfall gates

testing points

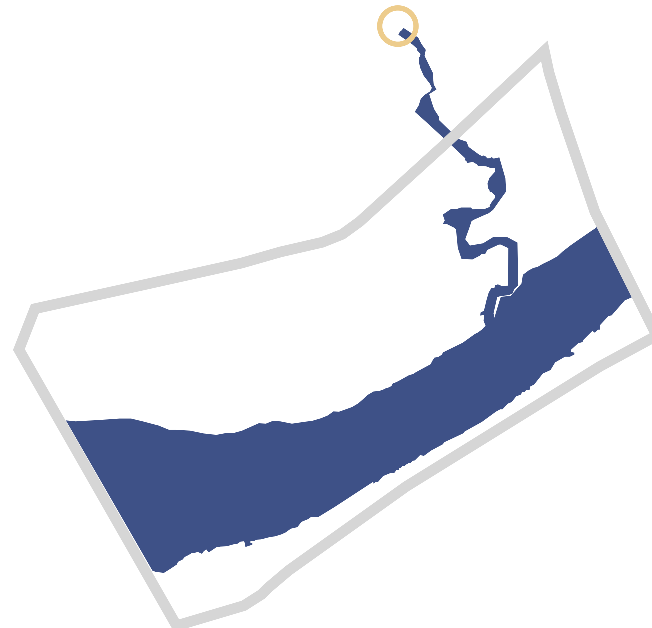


2005

2010

fig. 3.22 diagram, hydrology

		timeline 5 years	10 years
cultural	program	ground work	initial propagation
	hydrology	status quo	opening of causeway gates open up jonathan creek to surface



2020

75 years

self-organization

begin leachate filtration
causeway demolition and suspension bridge construction

2105

XXX years

continued adaptation

removal of dam at jones lake

hydrology

circulation intervention

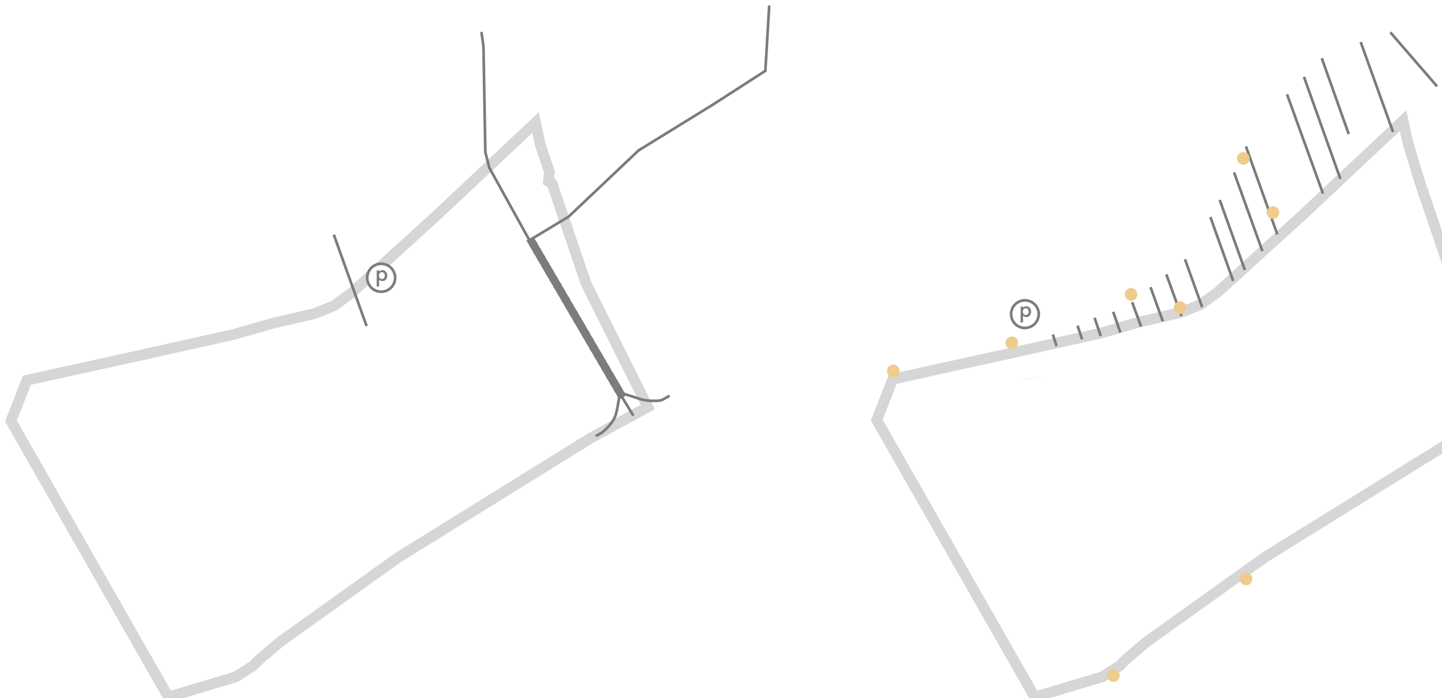
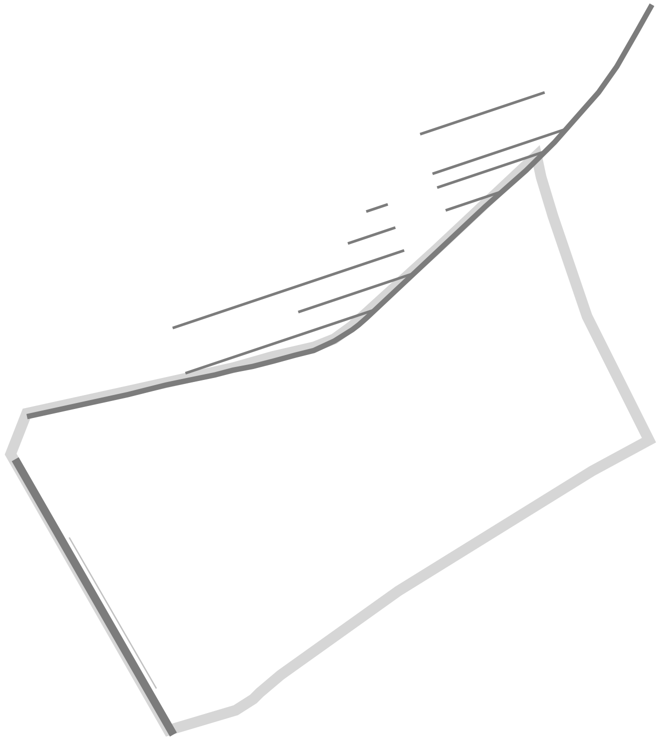


fig. 3.23 diagram, transportation intervention

2005

2010

		timeline — 5 years	10 years
cultural	circulation	ground work	initial propagation
	transportation network	completion of petitcodiac river bridge and approaches uptonr st. extension parking at upton st.	gunningsville bridge conversion to pedestrain bridge vertical street extensions bus stops and shelters parking at urban link



2020

2105

75 years

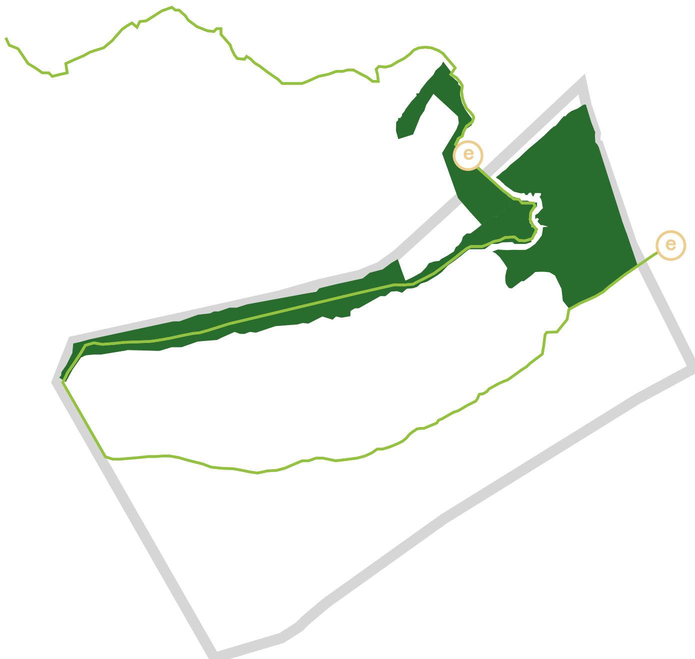
self-organization

main st. extension
demolition of causeway
construction of riverside albert suspension bridge
horizontal street extensions

XXX years

continued adaptation

transportation network



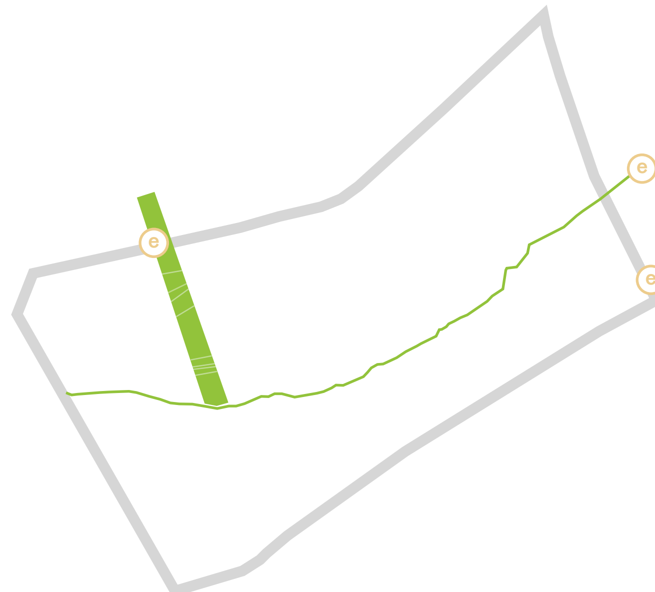
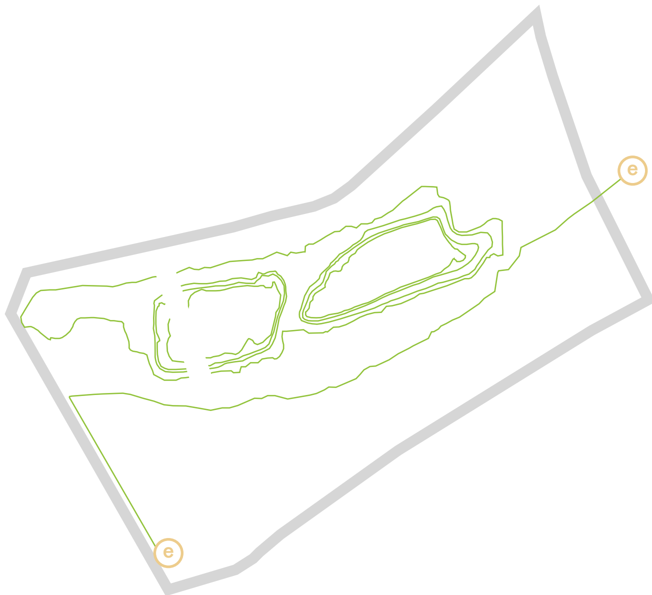


fig. 3.24 diagram,access intervention

			2005	2010
		timeline	5 years	10 years
cultural	circulation		ground work	initial propogation
	pedestrian park access points		acess at jones link trail acess at riverside boardwalk	acess at urban link access to jones riverside boardwalk addition
	pedestrian park access spaces		access to mixed forest buffer acess to perimeter trail	entrance to urban park link acess to perimeter boardwalk trail



2020

75 years

self organization

acess at new suspension bridge
access at perimeter trail

access to circuits
access to perimeter boardwalk trail

2105

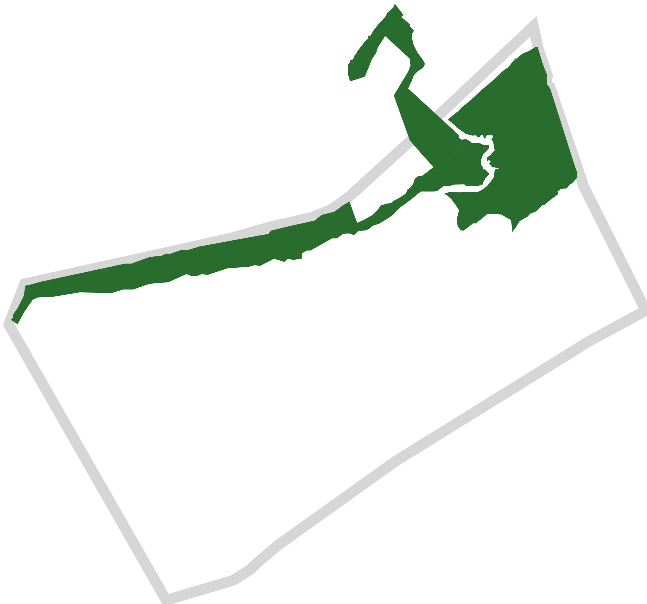
XXX years

continued adaptation

access to perimeter boardwalk trail

access points

3.2 habitat types



woodland

fig. 3.25 woodland type, fog forest

fig. 3.26 woodland type, acadian forest

habitat	temperate mixed forest
species	acadian forest coniferous fir, white spruce, black spruce deciduous red oak,american beech,black ash, red maple, white birch fog forest white spruce, balsam fir, white birch, red maple, black spruce ,white pine ,fundy coast red spruce, the understory: shreber's moss, bunchberry, starflower,and twinflower

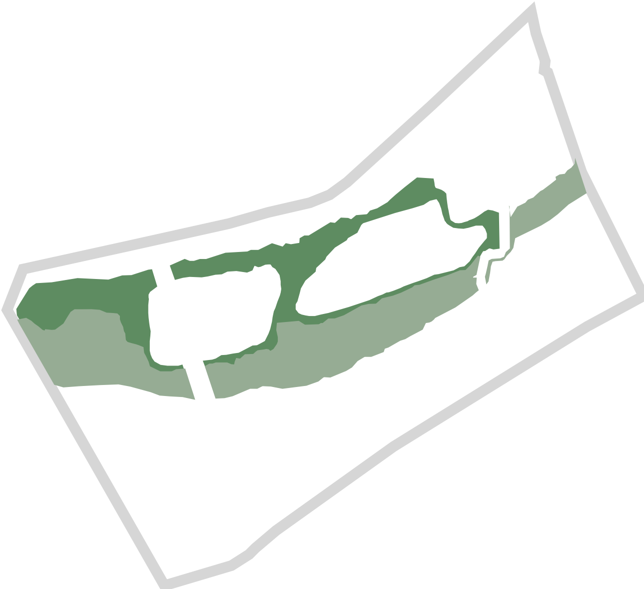


fig. 3.27 *right, coastal wetland type, marsh meadow*

wetland

fig. 3.28 *below, coastal wetland type, headpond*

habitat	coastal wetlands
species	fresh water headpond species that remediate ammonia, iron, copper, and TOC (indicators of the presence of leachate) salt water marsh meadow species that remediate ammonia, iron, copper, and TOC (indicators of the presence of leachate)

meadowland

fig. 3.29 meadowland type, flowering prairie

habitat	
species	**turf** indian sweetgrass **flowering prairie** species from emergent landfill plants 1-41 (appendix a7)

fig. 3.30 meadowland type, turf

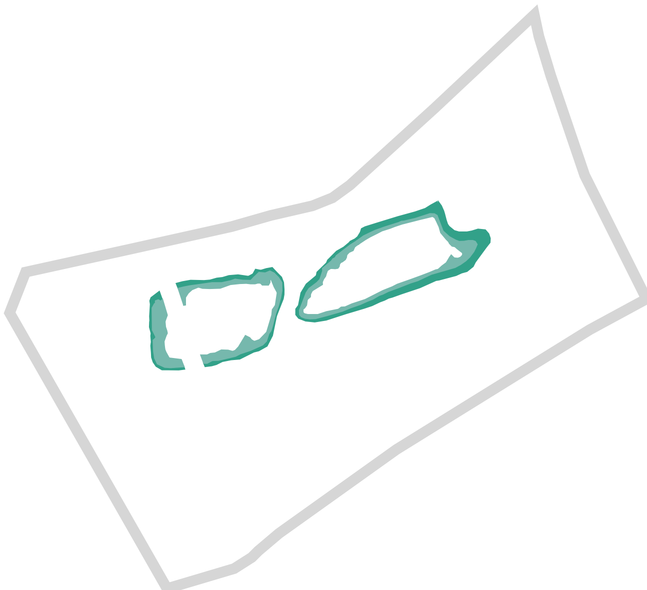


fig. 3.31 open water, sedimentation pond

open water

habitat		
species	aeration pond	
	sedimentation pond duck weed	

fig. 3.32, open water type, aeration pond

remediating plant species

Various highly toxic chemicals have been found at the Riverside Landifill site. [98] Waste oil was chosen as an example of a substance that could be remediated using specific plants species for bioremediation purposes on site. Waste oil was found to be in concentrations of <0.5-86 mg/l, [98] requiring a dilution factor of 25 to meet Canadian Water Quality Standards. Alfalfa and Italian Ryegrass are planted in the headpond. These species use the mechanism of rhizodegradation to breakdown contaminants in the soil.

contaminate: waste oil

emergent remediating species: alfalfa

mechanism: rhizodegradation

Common Name: Alafalfa

Scientic Name: Medicago sativa L.

Family: Fabaceae (leguminosae)

Phytoremediation potential: demostrated phytoremediator

Growth Habitat: erect herb, 1m tall

Morphology: taproot: leaves alternate, compound, raceme: flowers irregular, bisexual, simple pistil; superior ovary; legume

Life Cycle: perennial, monoecious, biotic pollinator; abiotic seed dispersal

Primary Habitat: terrestrial

Habitat Description: tolerant of a wide range of moisture conditions, although best adapted to deep well drained soils; low tolerance to acidity, along roadsides and in waste areas

Salinity Tolerance: moderately sensitive

World Range: North America; origin=Eurasia

North American Occurrence: cultivated in temperate Canada and US

Cultural Information: forage crop

Impact Description: an invader, but not extensively; introduced as a fodder crop for southeastern europe in the early 1800's and is now common throughout the Prairie Provinces. can be weedy in cultivated crops.[99]

Plant-assisted remediation of soils contaminated with organics including petroleum hydrocarbons is generally believed to occur through one or more of the following mechanisms: phytostabilization, phytodegradation, phytovolatilization, and rhizodegradation.

Rhizodegradation (also referred to as rhizosphere biodegradation, enhanced rhizosphere biodegradation, and plant-assisted biodegradation) involves the breakdown of contaminants in the soil as a result of microbial activity that is enhanced in the presence of the rhizosphere. Plants and microorganisms are involved-both directly and indirectly-in the degradation or transformation of petroleum hydrocarbons into products that are less toxic and less persistent in the environment than the parent compounds.[100]

fig. 3.33 alfalfa, emergent plant species

remediating species: italian ryegrass

Common Name: Annual Ryegrass, Italian Ryegrass

Scientic Name: Lolium Multiflorum Lam

Family: Poaceae (Gramineae)

Phytoremediation potential: demonstrated phytoremediator

Growth Habitat: herb, to 1m tall

Morphology: fibrous roots leaves alternate; simple; spike; flowers regular, bisexual, compound pistil; superior ovary; caryopsis (grain)

Life Cycle: annual or biennial, flowering time May to July

Primary Habitat: terrestrial, monoecious, abiotic pollination and seed dispersal

Habitat Description: cold hardiness; tolerance to low fertility soils; lawns, pastures, roadsides, and waste areas.

Salinity Tolerance: unknown

World Range: Europe + North America

North American Occurrence: Maine to Montana, south of Oklahoma, Kansas, BC to Quebec

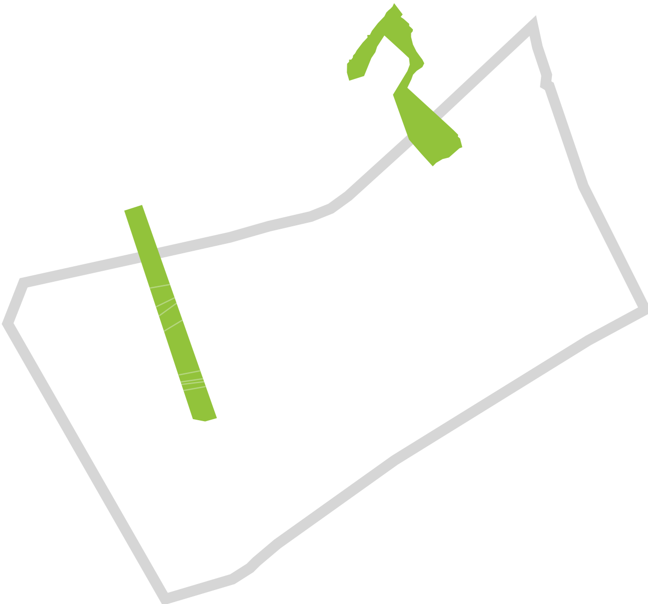
Cultural Information: horticulture (lawns)

Impact Description: native to Europe, introduced and naturalized and North America

Natural History Notes: Grows rapidly [101]

fig. 3.34 italian ryegrass, emergent plant species

3.3 park space types

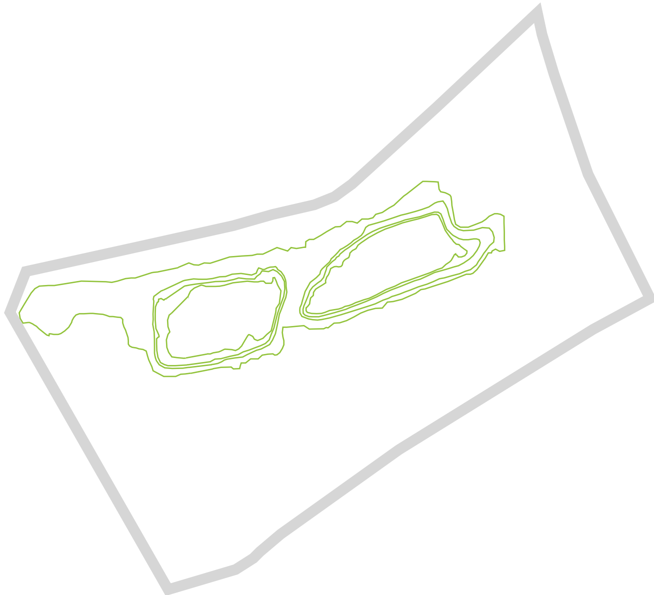


urban links

pgs 216-211

meadowlands

pgs. 228-233



circuits

pgs. 234-247

perimeter trail

pgs. 248-259

fig. 3.35 diagram, park space types


SELF STORA

fig. 3.36 site photo. existing condition, jonathan creek flow exiting cultverts under main street

fig. 3.37 site photo. existing condition, jonathan creek flow towards Petitcodiac River

fig. 3.38 jonathan creek link, aerial

Jonathan creek's surface water begins at Centennial Park. The Creek water flow is controlled in two places with floodgates to make two lakes: Centennial Pond and Jones Lake. From Jones Lake it flows under Main Street in culverts. In the 2010 site intervention plan, the creek is raised and opened to the surface, making people aware of its source and flow. The intervention reinforces the pedestrian link along the creek connecting the Centennial Park trail system and the TransCanada trail. A mixed forest buffer is seeded along the creek to act as a primary filter for city run-off into the creek. In 2105, the floodgate is removed to allow salmon spawning upstream.

fig. 3.39 jones lank link plan

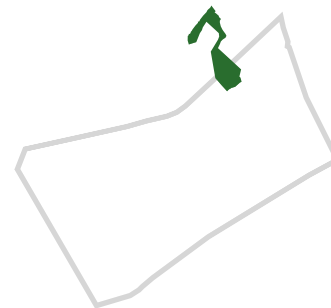
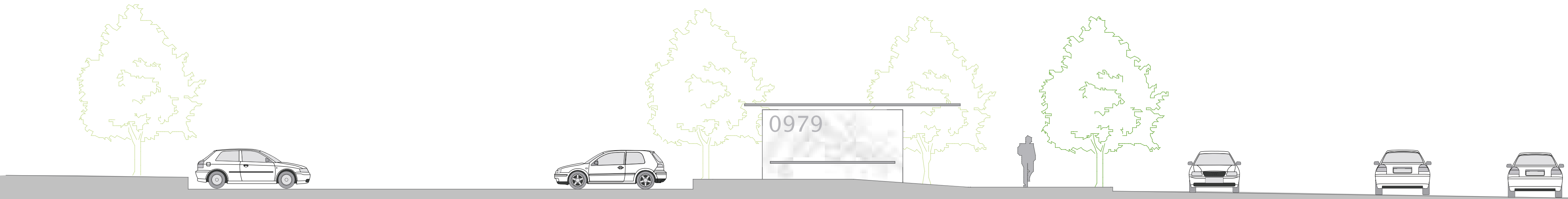


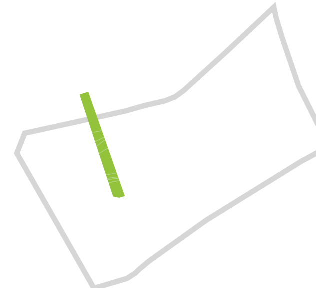
fig. 3.40 jones lake pedestrian link



transportation network

A new parking lot is constructed off the highway for visitors from outside the city. All cars must be left outside the boundary of the new park. New bus shelters, bus stops, and bus routes are located along Main Street, the northern boundary of the site. Additions to the transportation network provide easy access to the park and accommodate citizens not within walking distance.

fig 3.42 habitat: acadian mixed forest



rail underpass

To facilitate pedestrian access, an underpass is constructed below the VIA railway tracks. This is a direct connection from the neighborhoods in the city to the park and the river.

fig. 3.42 site section, urban link

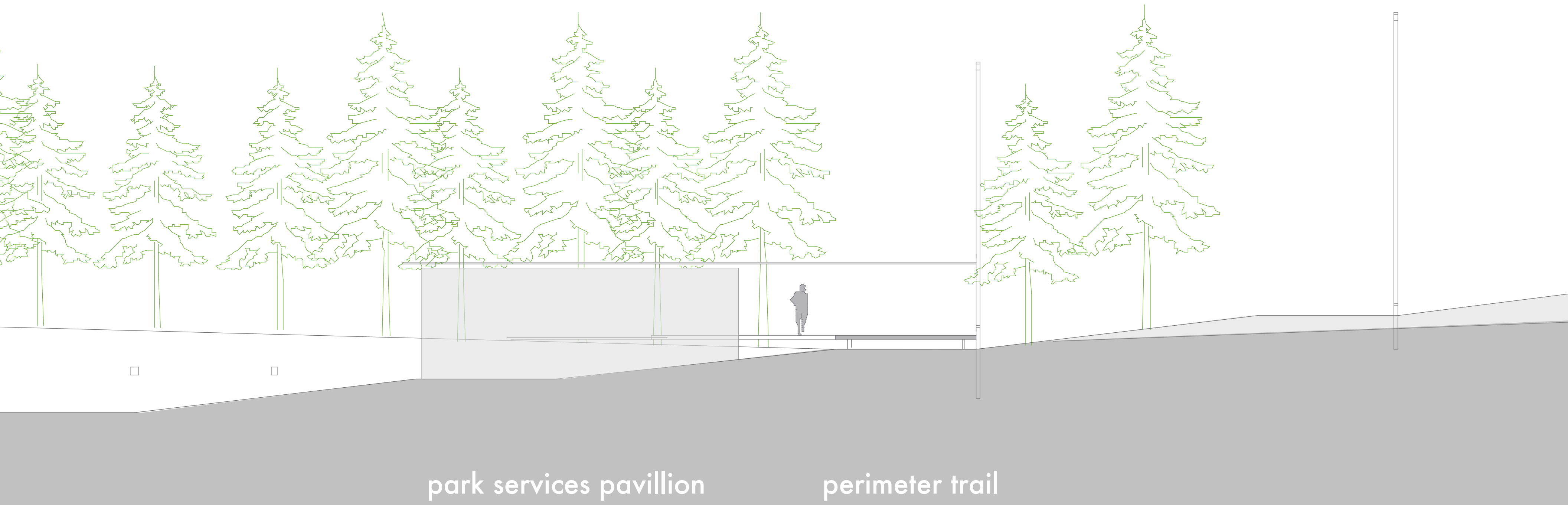
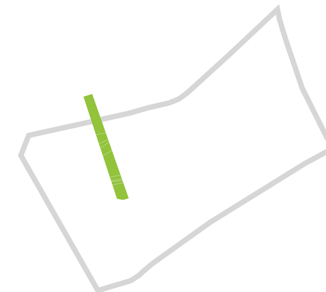
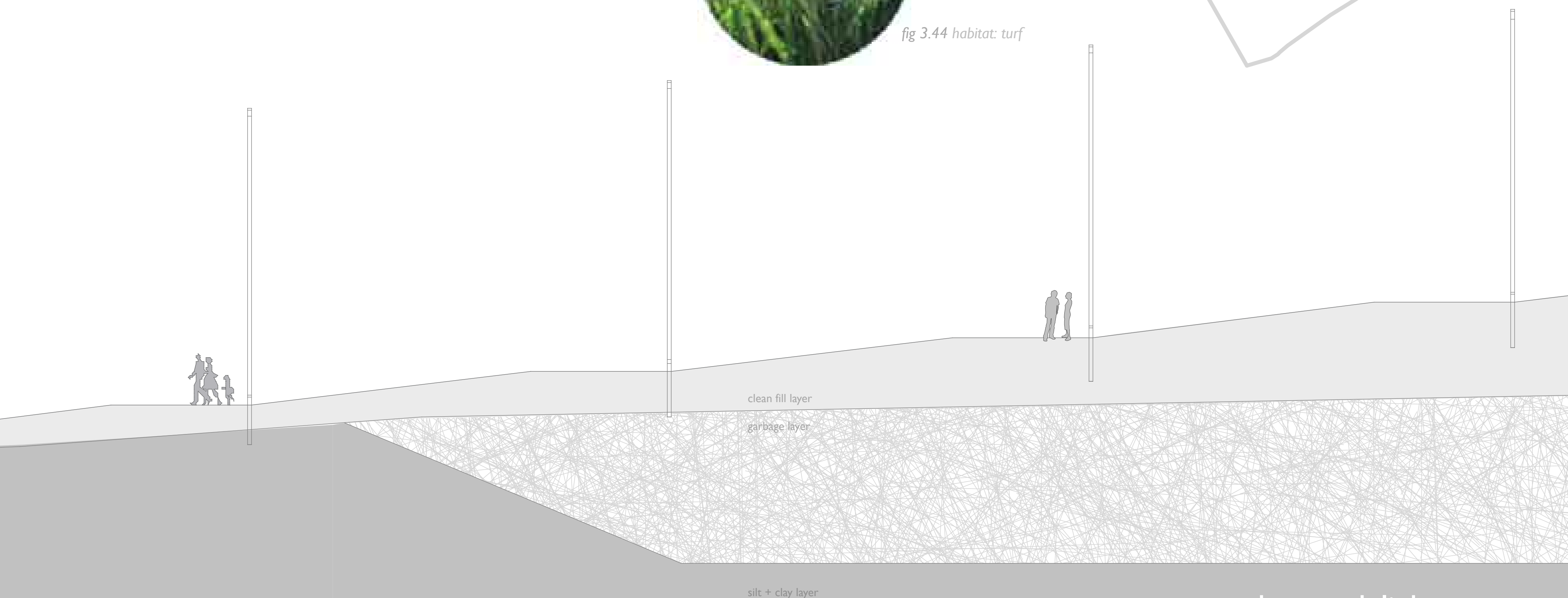

park services pavillion
perimeter trail

fig 3.44 habitat: turf





urban park link

fig. 3.44 site section, urban link

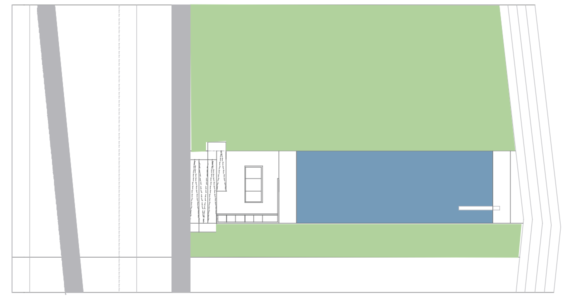


fig 3.45 urban link pool plan

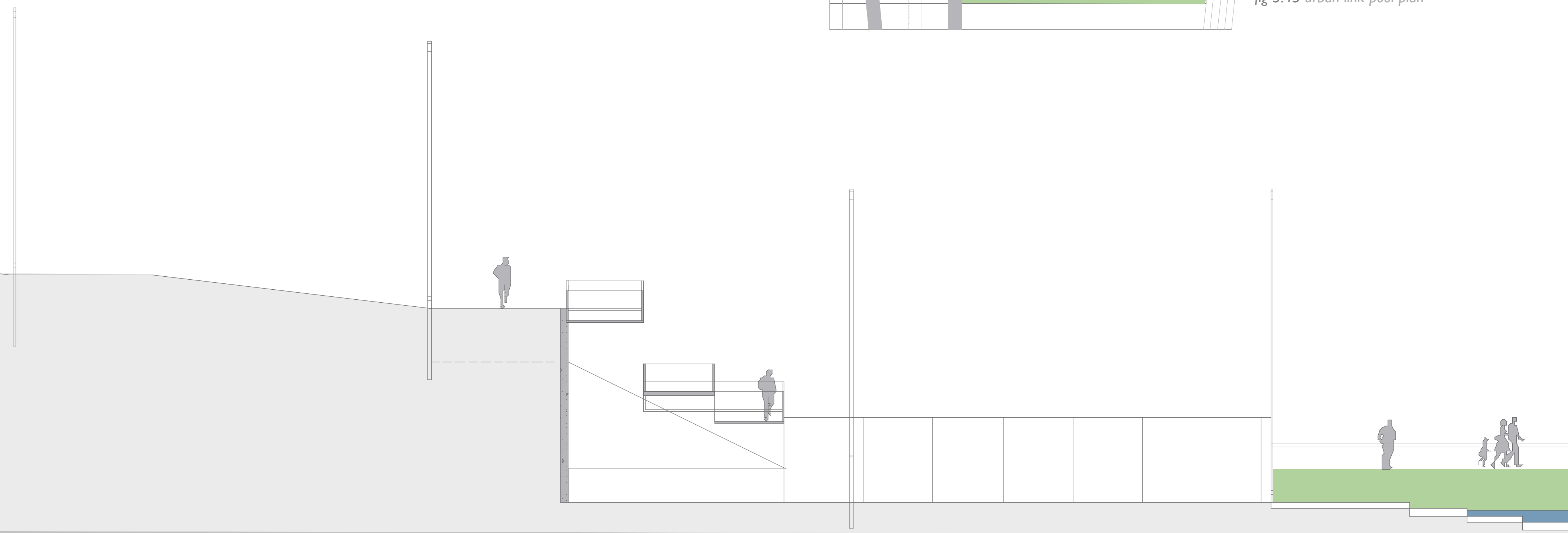
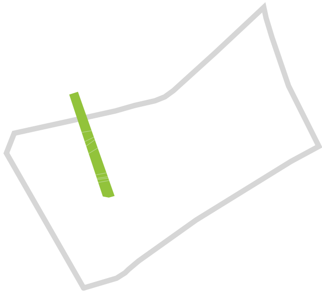


fig 3.46 urban link, pool



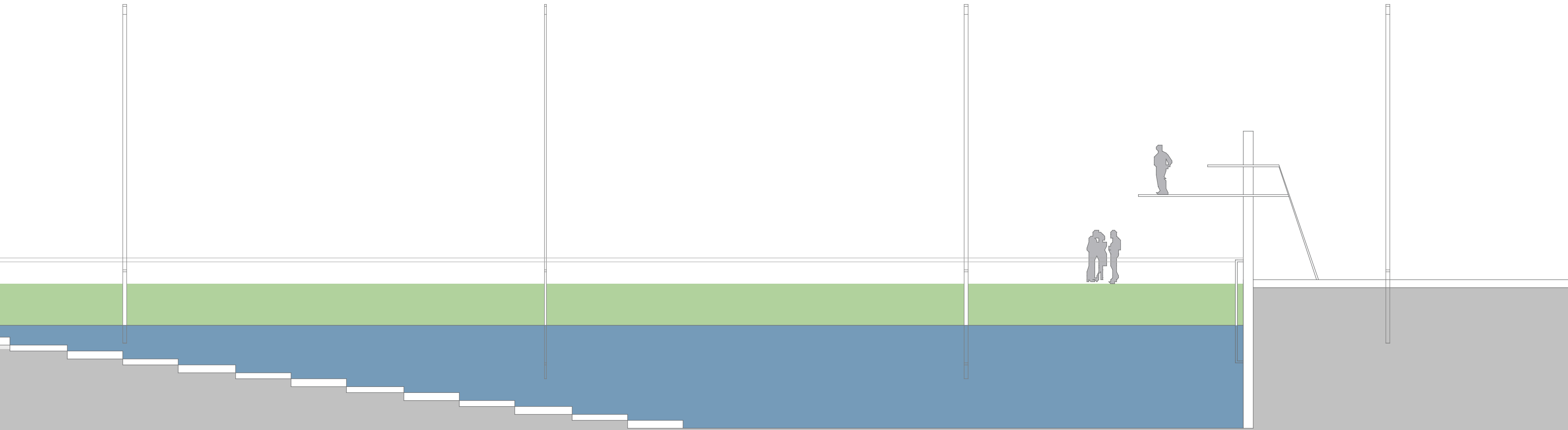
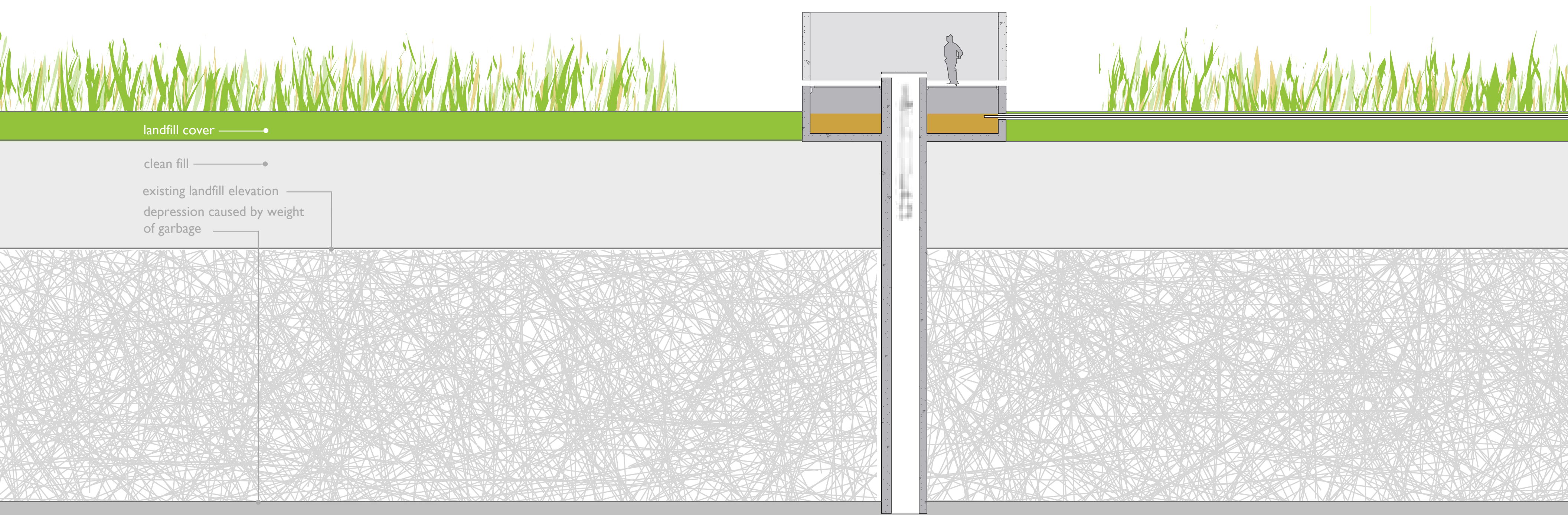


fig. 3.47 site section, urban link

fig. 3.48 existing condition, meadowlands
photo by author



landfill cover

The landfill cover is a medium to sustain vegetative growth. It is compromised of three layers: 200mm vegetative cover, 600mm basal till, 300mm gravel grading course. The grading course repairs areas of slope failure created by improper dumping procedures.

vertical extraction wells

Small concrete shells are constructed to house the pneumatic pumps. These pumps extract the leachate, pooling on the clay liner, created by the weight of the garbage. The upper portion of the shell is made of transparent concrete so that the meadowland spaces on top of the landfill will be illuminated at night.

pneumatic pump

The pneumatic pump was selected for its self-regulating capability. If insufficient depth of leachate remains in the borehole, the float will not rise and the pump will cease to operate, regulating the flow to the anaerobic tanks.

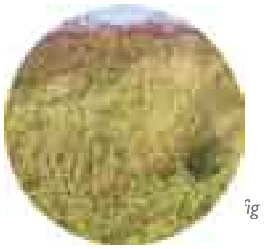


fig 3.49 habitat type: flowering prairie

habitat: flowering prairie

anaerobic equalization tank

Anaerobic digestion is a complex biochemical reaction carried out in a number of steps by several types of microorganisms that require little or no oxygen to live. This process takes place in the anaerobic equalization tanks.[102] Caustic soda is added to the influent on a constant basis, a ph controller measures the pH of the incoming leachate and controls the addition of caustic accordingly.

meadowlands

0 1 2 3 4 5

fig. 3.50 site section, meadowlands

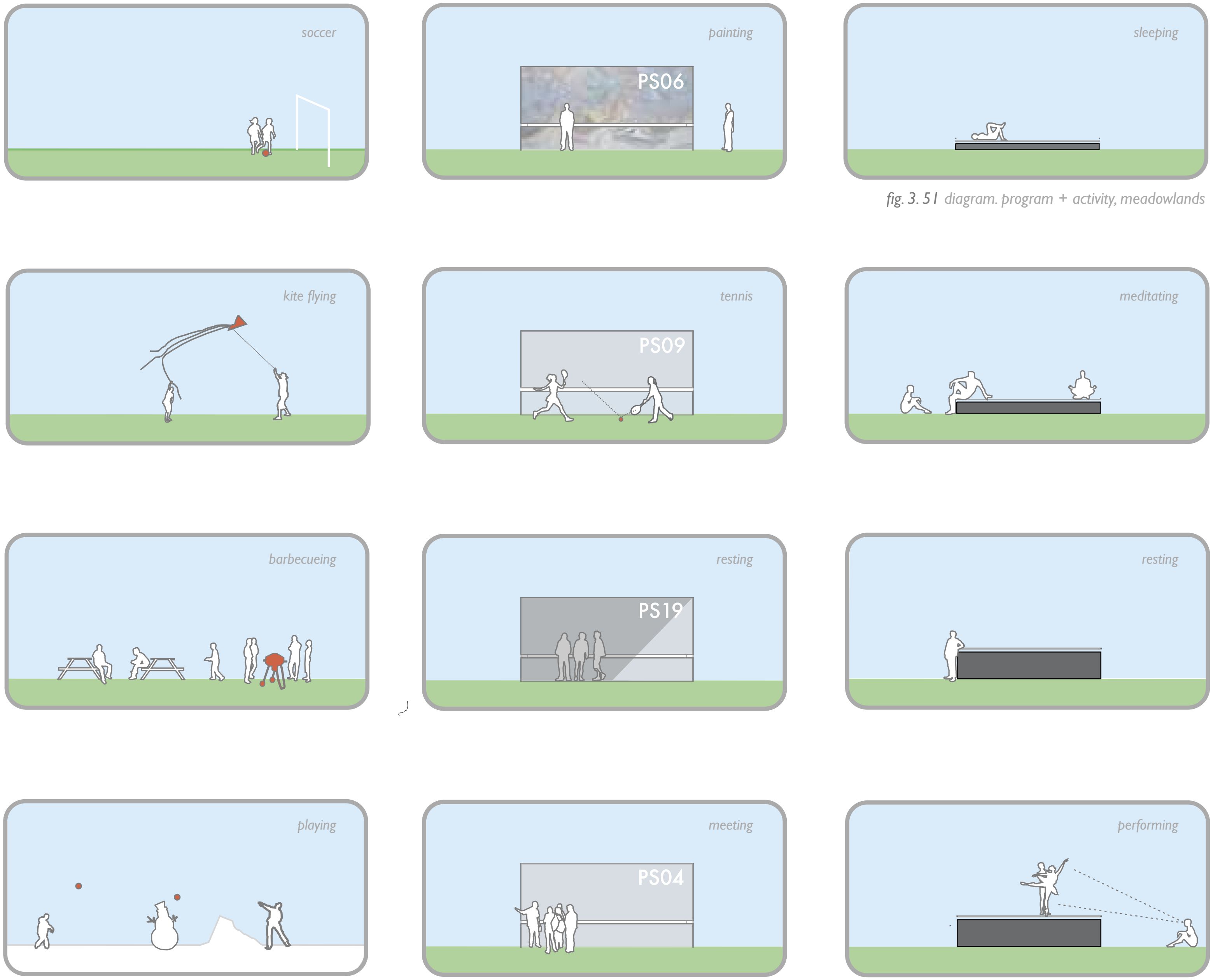


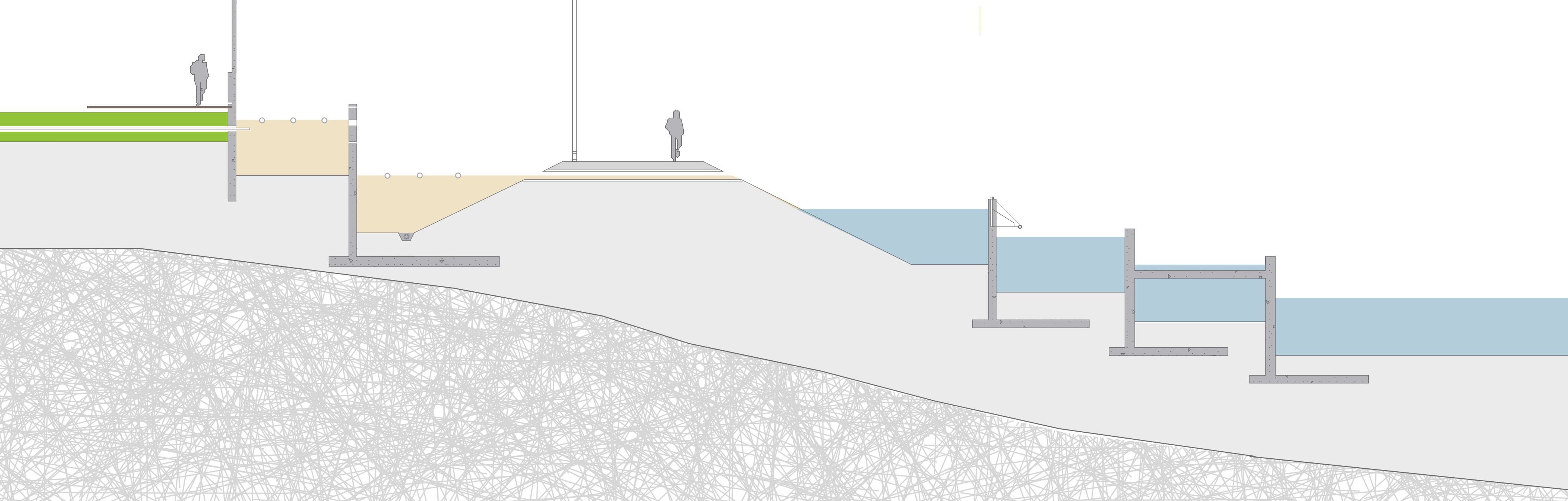
fig. 3.51 diagram. program + activity, meadowlands

fig. 3. 52 collage. meadowlands

fig 3.53 aerobic lagoons

fig 3.54 sedimentation ponds

fig 3.55 outfall gates, halifax municipal treatment plant



aerobic lagoons

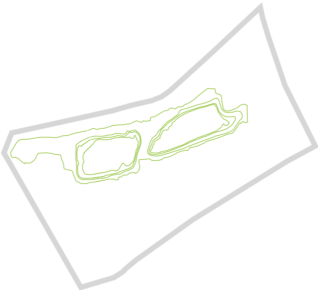
Effluent from the anaerobic tanks flows in series through two aerated lagoons. Further removal of COD, carbonaceous BOD, and ammonia nitrogen is accomplished by means of extended aeration; a process involving the breakdown of wastes by microorganisms in the presence of dissolved oxygen. Oxygen is supplied to the lagoons by means of three 2400 scfm centrifugal blowers. Lagoon 2 incorporates an integral clarifier which allows beneficial biosolids to settle. These settled solids (activated sludge) can be recirculated back to the head of the lagoon system to provide an increase of microorganisms for further degradation of organics. *103*

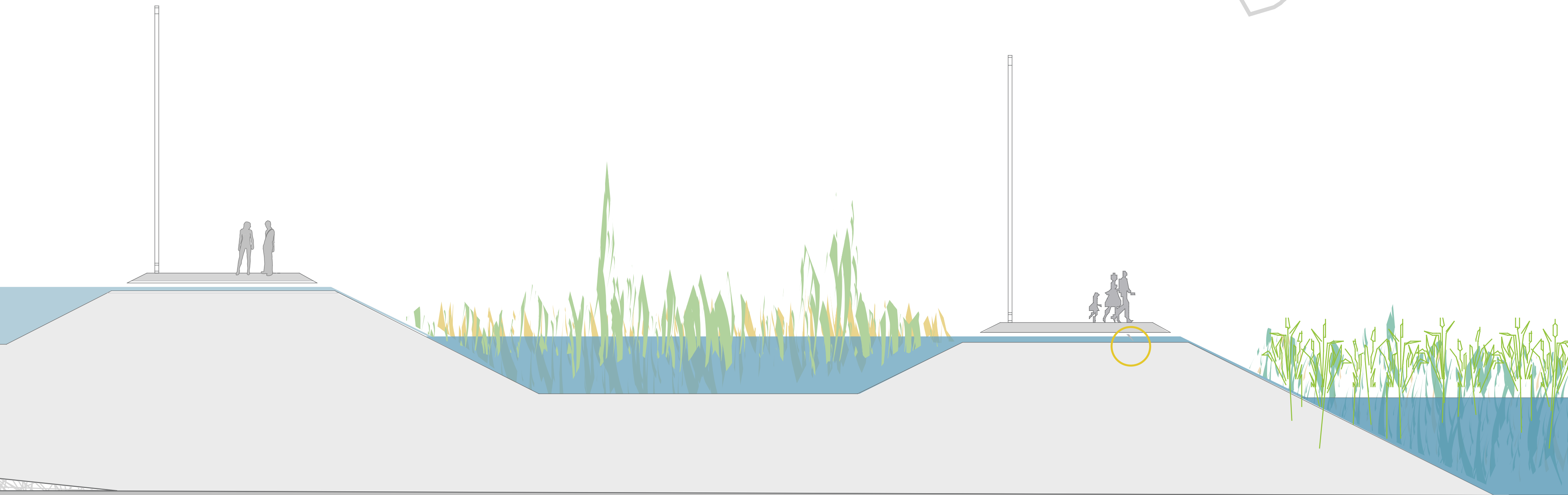
sedimentation ponds

Lagoon effluent flows in series through four sedimentation ponds. The purpose of these ponds is to provide sufficient residence time for solids to settle out of the waste stream. These ponds also provide facultative treatment, the breakdown of waste by microorganisms that can thrive in both aerobic and anaerobic environments. [104]

fig 3.56 headpond

fig 3.57 aboiteau detail





habitat: headpond

The wetlands system is compromised of two sections, the head pond and the marsh meadow. These two sections are equipped with adjustable outfall gates for seasonal process optimization. [105]

aboiteau drainage system

The last path circuit separating the marsh meadow and the headpond is constructed using dyking technology invented by the Acadians. The tides rising from the Atlantic Ocean, through the Bay of Fundy, force the flapper shut, preventing salt water from entering the headpond. When the tide ebbs away, pressure from the standing fresh water forces the flapper open and allows the headpond to drain into the marsh meadow.

circuits

fig. 3.58 site sections, circuits

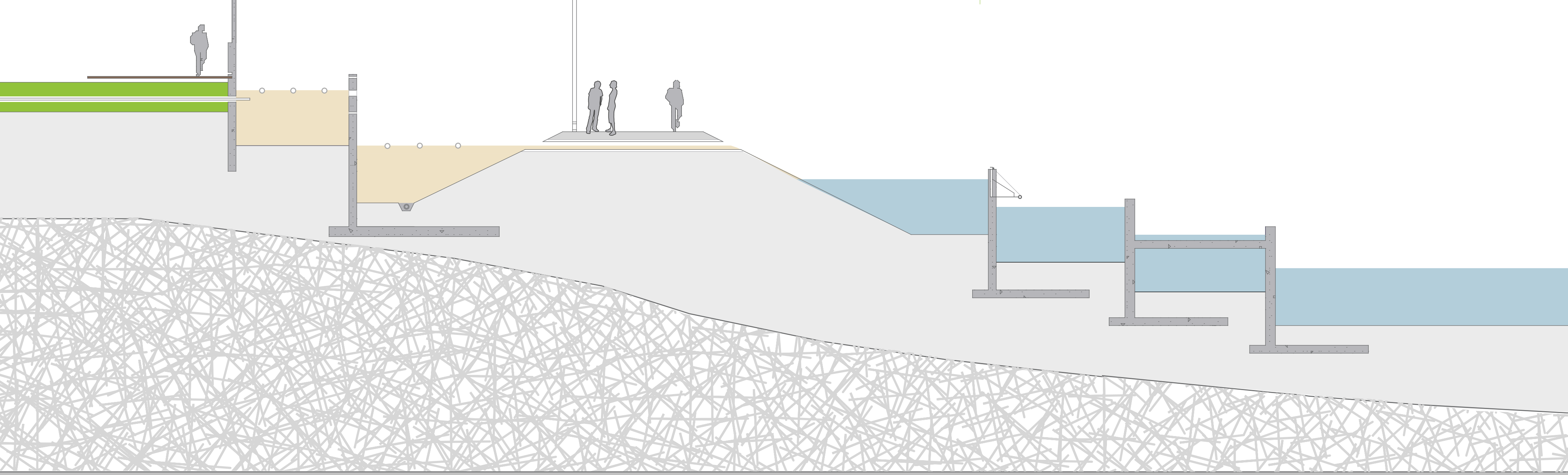
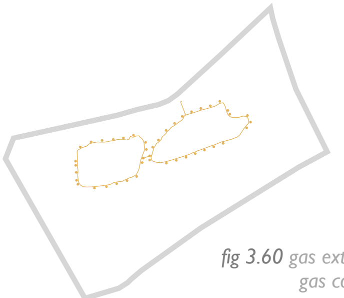
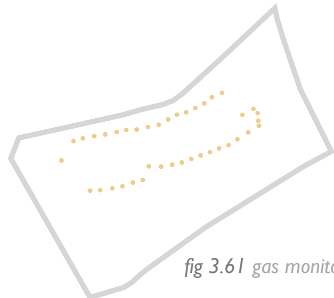


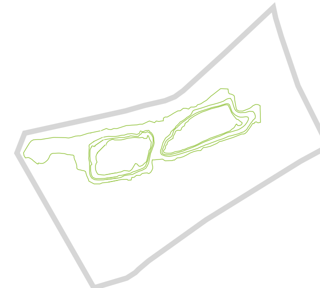
fig 3.59 moncton's natural gas pipeline

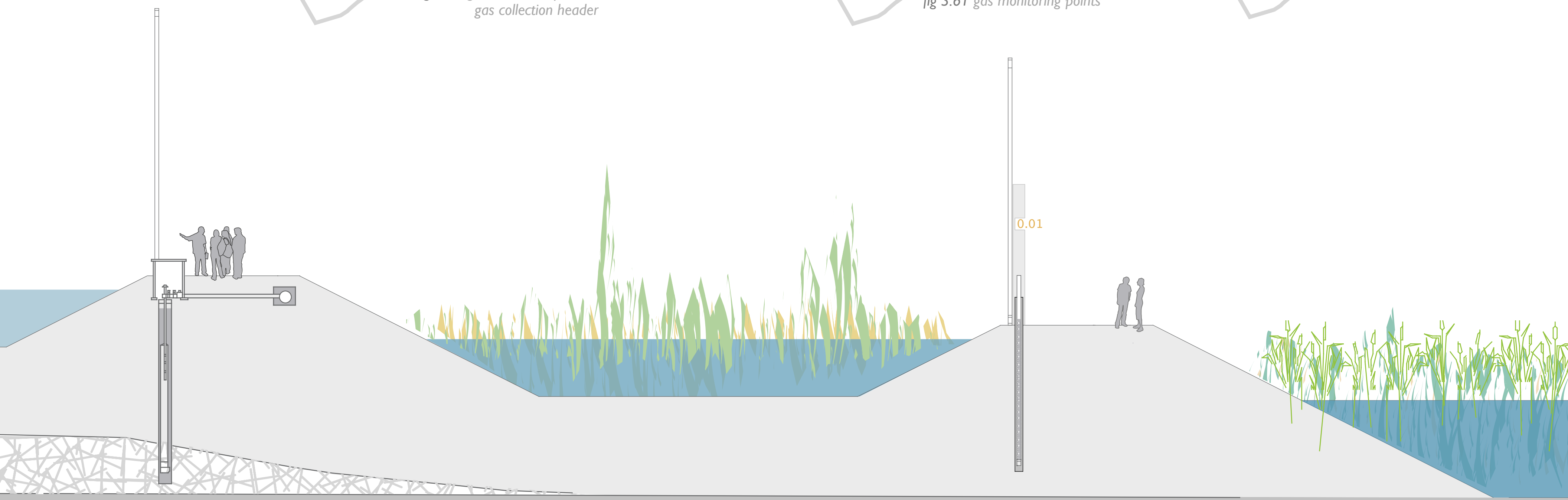
LFG collection

LFG is collected on the study site: to protect against odor emissions, to protect against gas migration into buildings, to reduce GHG emissions to the atmosphere, and to optimize LFG recovery for use as a fuel or energy product. The City of Moncton could enter into a joint venture with Enbridge to develop the collected LFG as a resource. Gemtec estimates that at its peak generation 175 000 kwh/ year will be produced. This is the will supply 400 households with gas based on typical consumption.









gas extraction

Forty-six vertical LFG extraction wells as installed around the perimeter for the existing landfill, positioned on the line of the extended city grid. LFG is collected, pumped through the collection header, and sent into to the renovated industrial buildings. On site, it is cleaned and pumped into the Enbridge natural gas line running adjacent to the site boundary.

gas monitoring

Forty-four migration monitoring probes are installed past the outer edges of the landfill on the last circuit trail, each is positioned on the line of the extended city grid.

circuits

fig. 3.62 site sections, gas monitoring + extraction

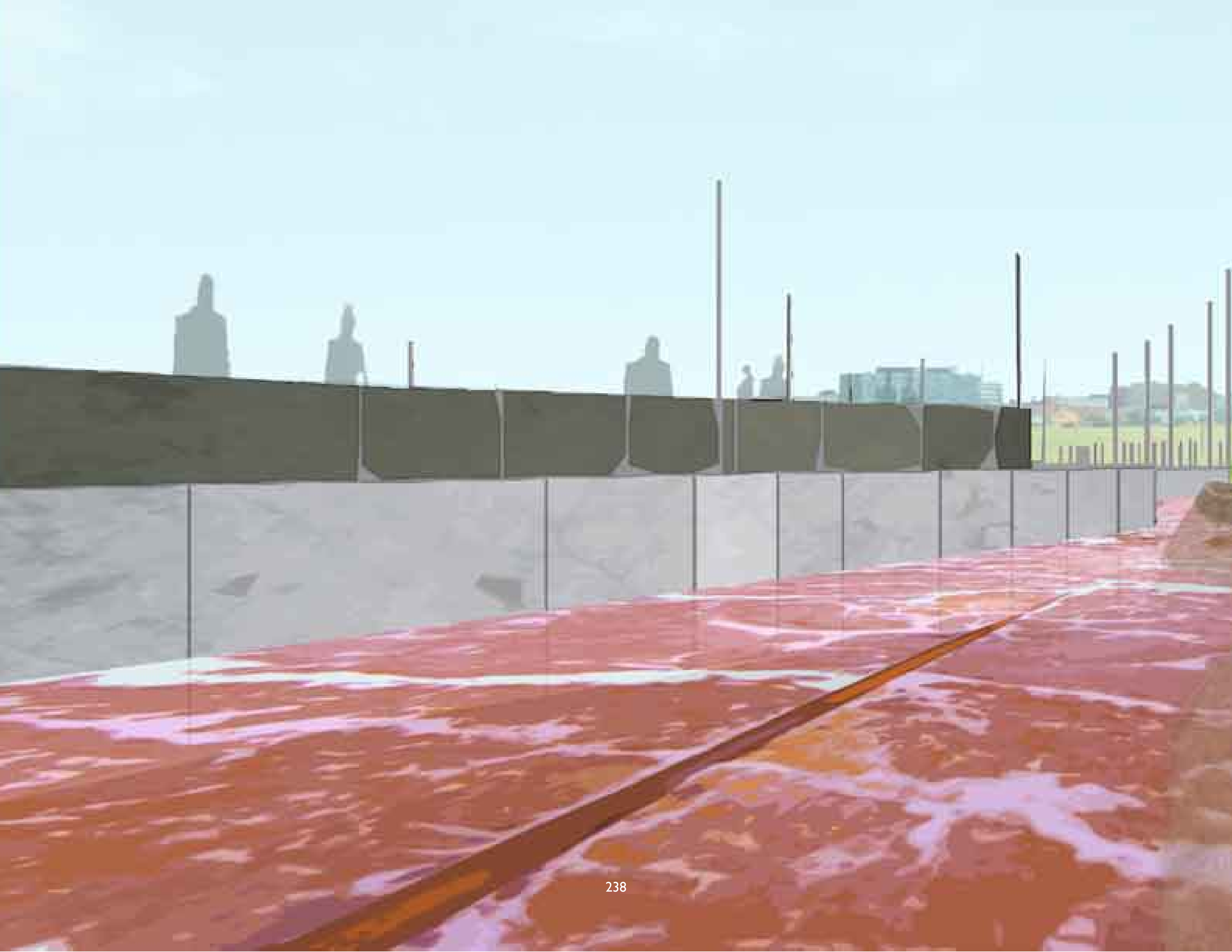


fig. 3.63 view from highest circuit.foreground: aerobic lagoon. background: headpond, gunningsville pedestrian bridge

fig. 3.64 circuits
foreground: sedimentation pond + headpond
background: marsh meadow

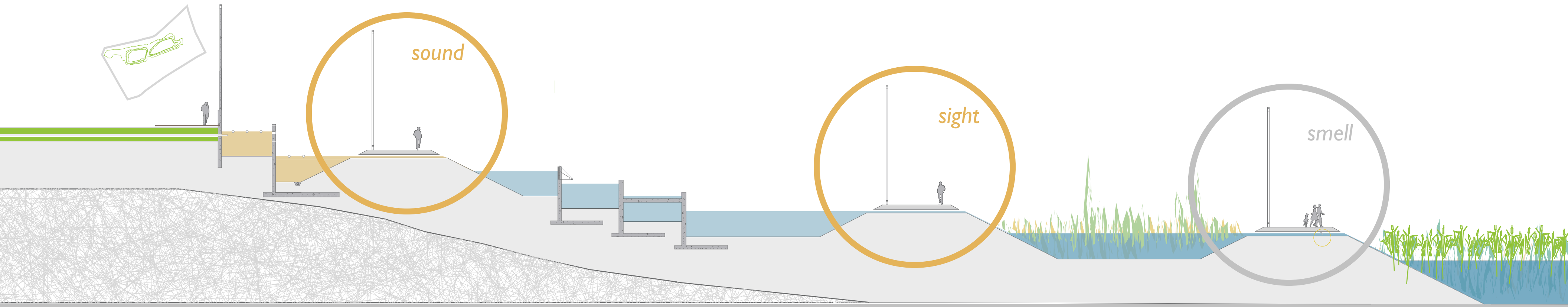
circuit installations

Each circuit path amplifies different senses associated with the leachate filtrating process: *sound*, *sight*, *smell*, and *touch*. Along each path are permanent and temporary installations that enhance these qualities. As the visitors descend the landfill mounds, the leachate progressively becomes cleansed and they are more able to engage in the filtration process. On the highest circuit, visitors are restricted to the sound of the water because its toxicity. On the lowest circuit visitors may be choose to be immersed within the water, as it is fully cleansed.

sound: Sound is amplified by mechanical and natural means on the path adjacent to the aeration pond. Small concrete shells are located along the path to provide shade and a place to rest. The sound of the aeration will be amplified off the walls of the enclosure. Where these installations occur, there will be more cuts in the retaining walls that will amplify the sound of falling water.

fig. 3.65 sound installation. exterior view

fig. 3.66 sound installation. interior view



sight: the outfall gates create rhythm and splash along the circuit path.

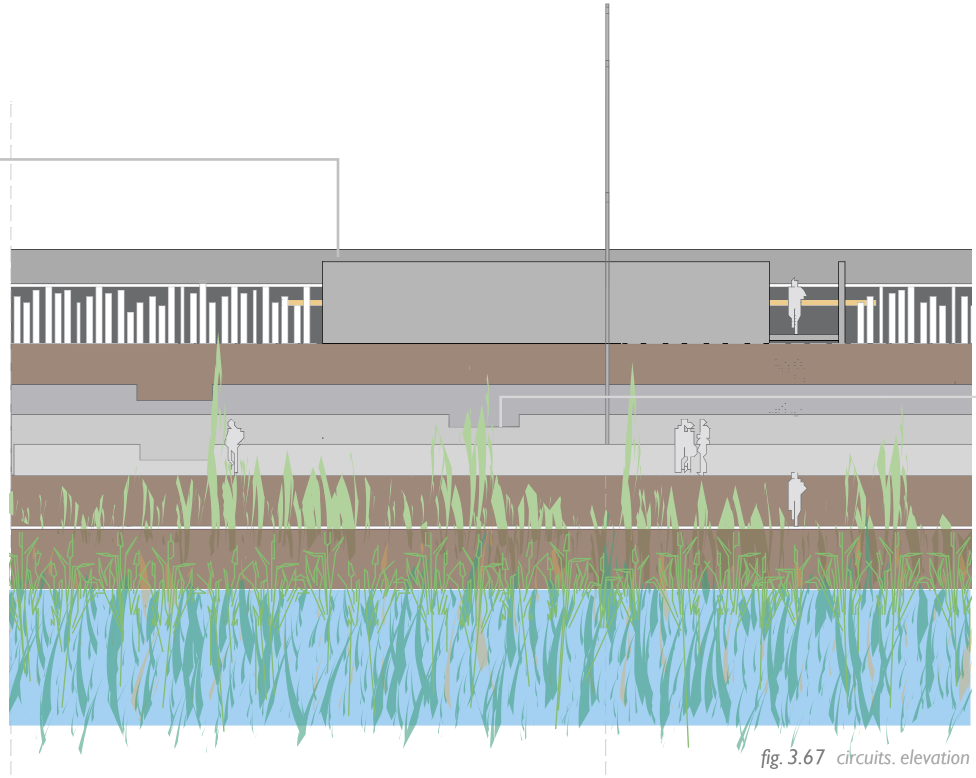


fig. 3.67 circuits. elevation

fig. 3.68 outfall gate

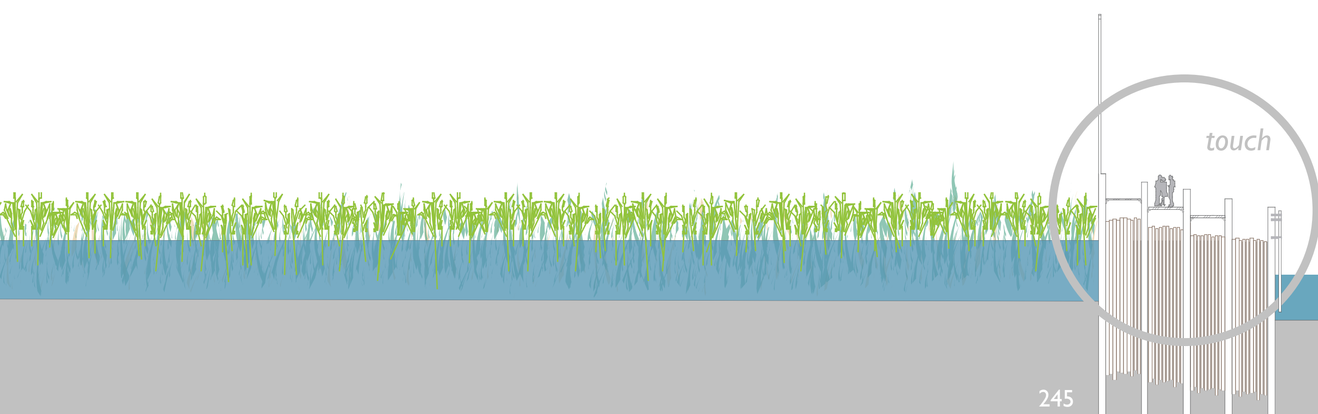


fig. 3.69 site locator section. senses installations

smell: Smell is the strongest sense held by memory. There will be many varieties on wild roses and lilies that will grow on the site. These emergent plant species have different flowering times over the year that will enhance each visit to the park.

fig. 3.70 smell. pasture rose emergent plant species

Virginia Rose

(Rose virginiana)
Rose Family (Rosaceae)

Description: the hairy stem is this bushy shrub have scattered, stout, curved thorns, pink flowersm and pinnately compound leaves.

Flowers: 5-7 cm wide; sepals 5; petals 5; stamens numerous.

Leaves: divided into 5-9 dark green amooth, shining, oval, toothed leaflets 2.5-6.3 cm long. The leafstalk "wings" (stipules) are narrow and flaring.

Fruit: red, fleshy hip

Height: 30-180cm

Flowering: June-August

Habitat: clearings, thickets, and shores.

Range: Southern Ontario and Newfoundland and Nova Scotia; south to Virginia and North Carolina; west to Alabama, Tennessee, and Missouri.

Comments: Numerous species of Roses occur in a variety of sites, from dry uplands to wetlands and sand dunes. Their fruit, the Rose hips, is rich in vitamin C and can be eaten, made into jams, or steeped to amek Rose hip tea. Another pink species, this one of wet sites, is swamp rose (R.palustris), which grows to 2.1 m, has flowers 3.8-6.3 cm wide, very narrow stipules, adn stout, hooked thorns. Pasture Rose (R. carolina) is a shorter shrub, not more than 90cm tall, with pink flowers, dull green leaves, very narrow stipules, and straight thorns. It is found is dry pastures and open woods throughout most of our range. 108

fig. 3.71 smell. wood lily emergent plant species

Wood Lily

(Lilium philadelphicum)
Lily Family (Liliaceae)

Description: an erect stem bears whorled leaves and 1-5 upward opening, orange flowers with purplish-brown spots.

Flowers: 5cm wide; 6 segmented , with 3 petals and 3 petal-like sepals, each tapering to a stalked base with spaces between the stalks; stamens 6.

Leaves: 2.5-10cm long; lanceolate, usually in whorls of 3-8

Fruit: an oblong capsule, 2.5.5cm long.

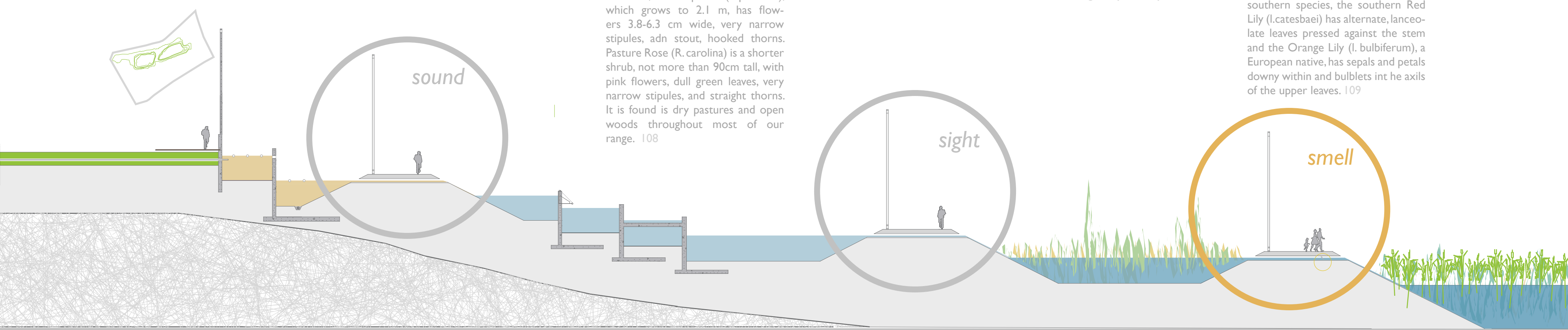
Height: 30-90cm

Flowering: June-August

Habitat: Dry woods and thickets

Range: Southern Ontario and Quebec to maine, southern New England, Delaware, Maryland, West Virginia, and in the mountains, to North Carolina and Kentucky.

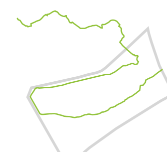
Comments: This bulbous Lily, one of our trylu showy woodland species, is usually found in relatively dry sites. The bulbs were gathered for food by the indians. A variety of this species found in the Midwest, has leaves scattered along the stem. Among several southern species, the southern Red Lily (l.catesbaei) has alternate, lanceolate leaves pressed against the stem and the Orange Lily (l. bulbiferum), a European native, has sepals and petals downy within and bulblets int he axils of the upper leaves. 109



touch: Once the leachate is fully cleansed, the water is used to fill the public pool located on the urban link, adjacent to the riverside perimeter trail. As well, on the lower portion of the riverside boardwalk, flow from the incoming high tides will splash vistors along the path.

fig. 3.72 touch. public pool. race.

fig. 3.73 touch. public pool



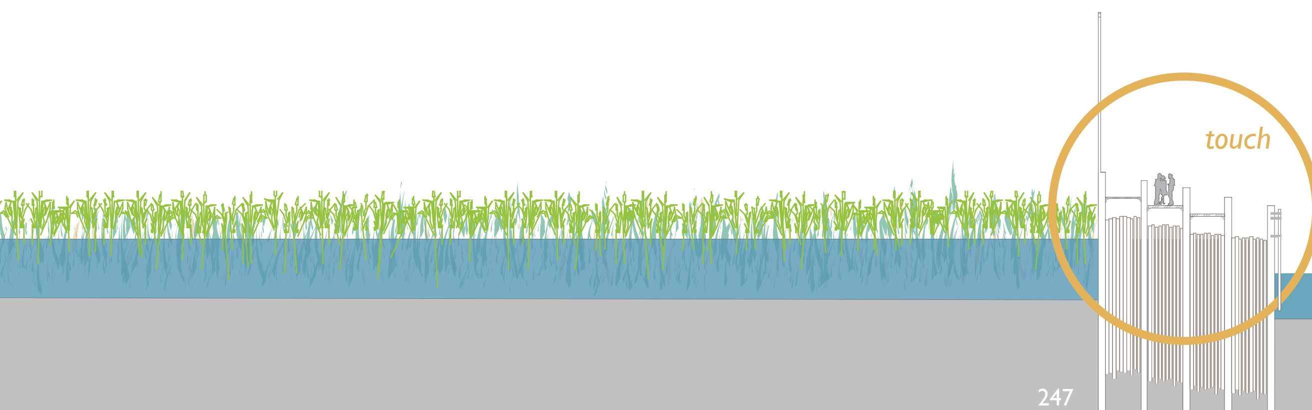


fig. 3.74 site locator section. senses installations

fig 3.75 marsh meadow

fig 3.76 groyne, high tide

fig 3.77 groyne, low tide

habitat: marsh meadow

Flow from the sedimentation ponds enters the engineered wetlands. This is a free-water surface type of wetlands system, which utilizes indigenous vegetation to remove any remaining COD, carbonaceous BOD and to provide nitrification/denitrification of the waste stream. Plants absorb nutrients and oxygen within the water by means of natural biological processes. *106*

groynes system

The construction of the perimeter trail is based of the technology of the groyne. It is the most common method of countering lateral erosion in an outer bank. High velocity currents are diverted away from the riverbanks preventing or minimizing erosion. They also encourage sediment deposition in the gaps between them. Because they are comparatively inexpensive and simple to build, groynes are commonly installed during the initial phases of a regions development. Maintenance cost decrease over time. [107] The structure of the groynes is made from prefabricated concrete. The structure will support the boardwalk, the extension of the TransCanada trail.

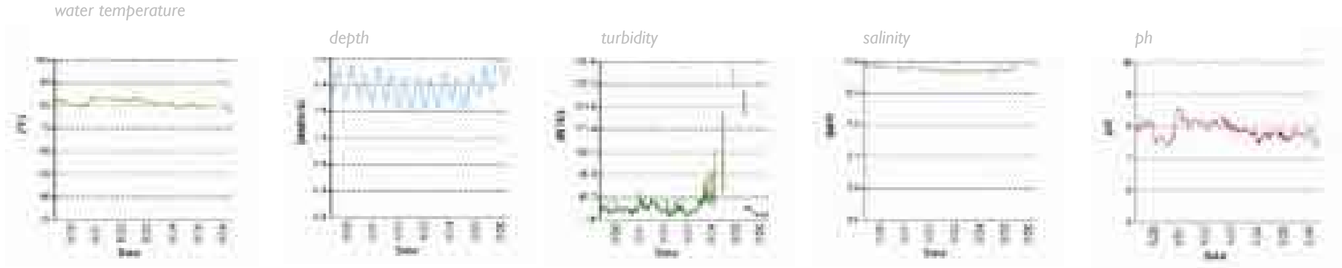
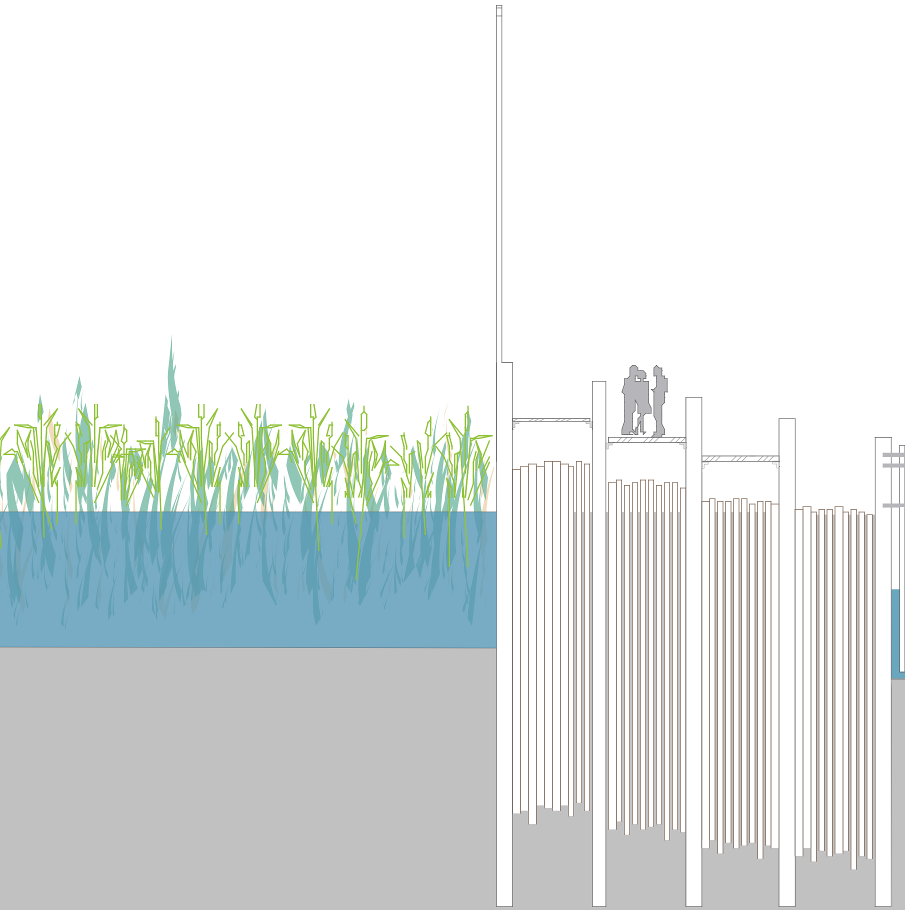


fig 3.78 graphs, petitcodiac river water conditions



petitcodiac river, low tide

fig. 3.79 perimeter trail. site section

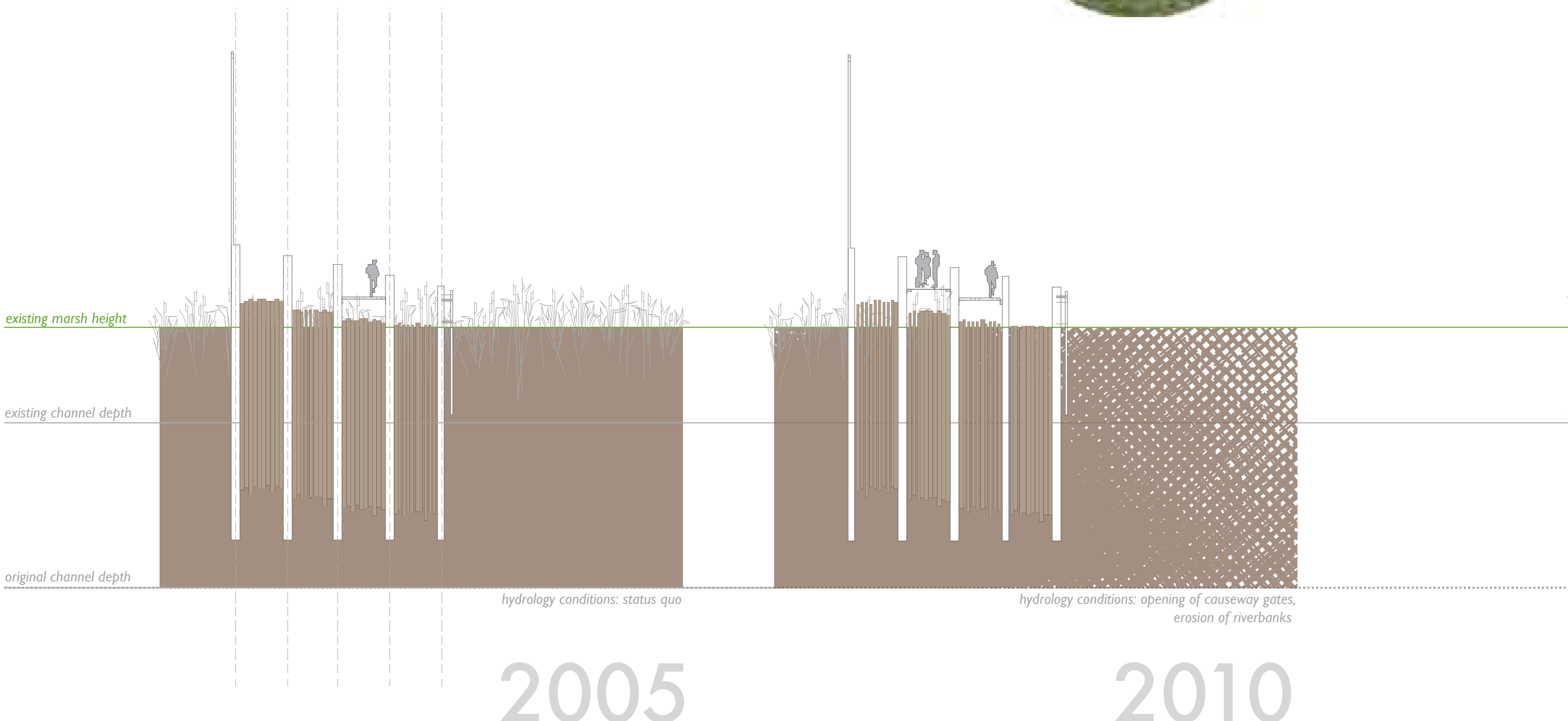
tidal monitoring system

perimeter trail

Tidal monitoring wells are installed along the river and the new perimeter boardwalk as a part of the Transcanada trail extension. These devices are necessary to gather information to inform the next stages in the development of the site. They monitor fluctuating tides and oceanographic conditions, information necessary for coastal zone engineering projects. Recorders send an audio signal down a sounding tube. It measures the time it takes for the reflected signal to travel back from the water's surface. The sounding tube is mounted inside a protective well. The stations collect data every six minutes and transmit their data to the tidal monitoring headquarters located further down the Bay of Fundy. All data is accessible over the internet, available to the public, and is visible to visitors along the riverside boardwalk.

The perimeter riverside trail is a dynamic edge, constantly changing with the rivers' hydrology. Dramatic alterations will transform the landscape when the causeway is replaced with a bridge. The piers of the groyne system are made of concrete and are permanent. The structure is positioned along the extended landscape grid, perpendicular to the river's flow. The infill between the structures is logs. These will weather and may or may not be replaced to support the edge, depending on leachate generation. As less filtration area is needed the logs may be allow to wear then washed away by the river.

fig. 3.79 remaining structure of riverfront wharves along petitcodiac



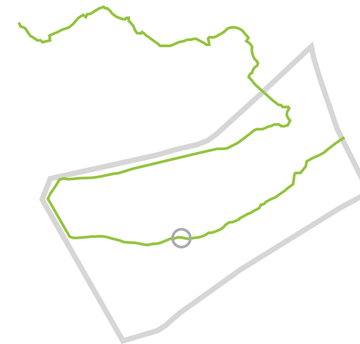


fig. 3.81 riverside perimeter edge, 2005-2105

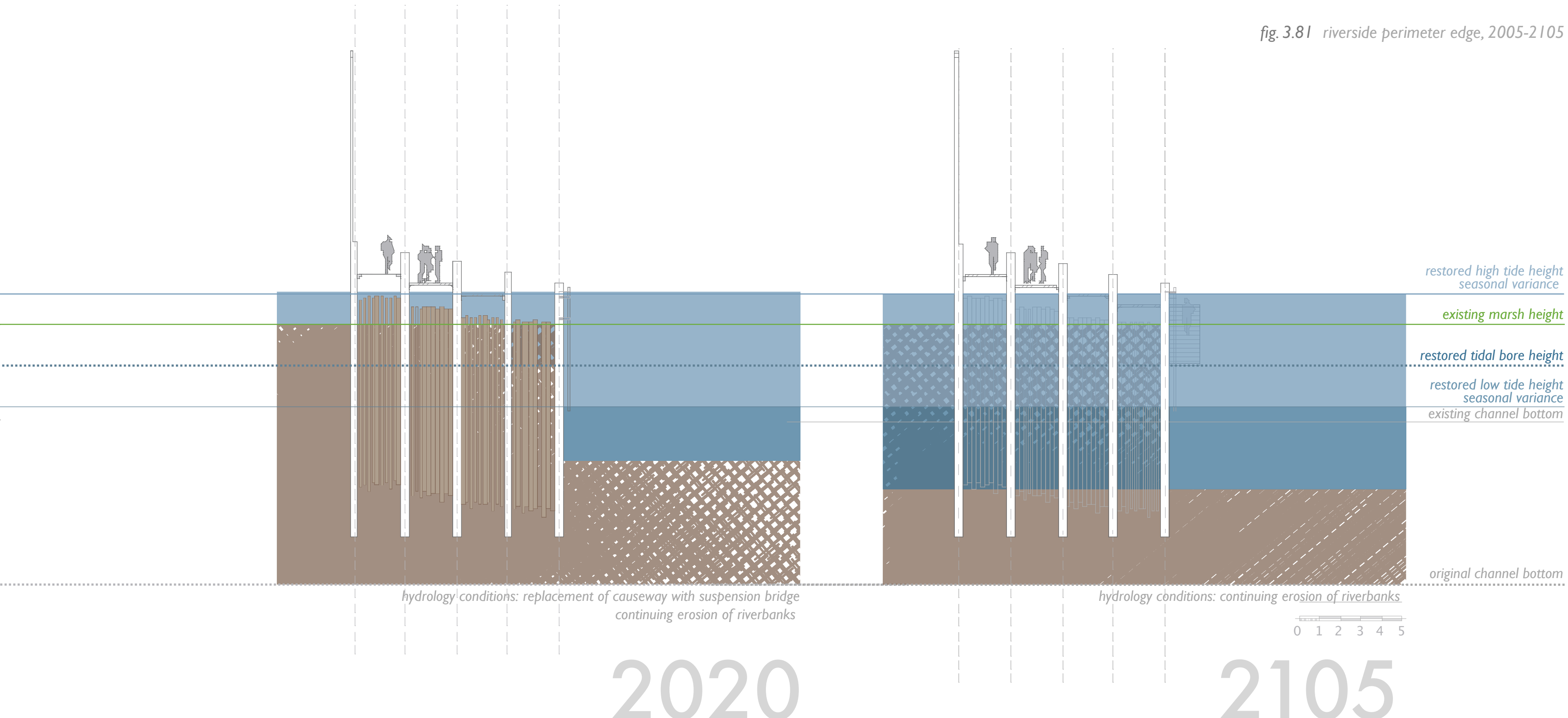
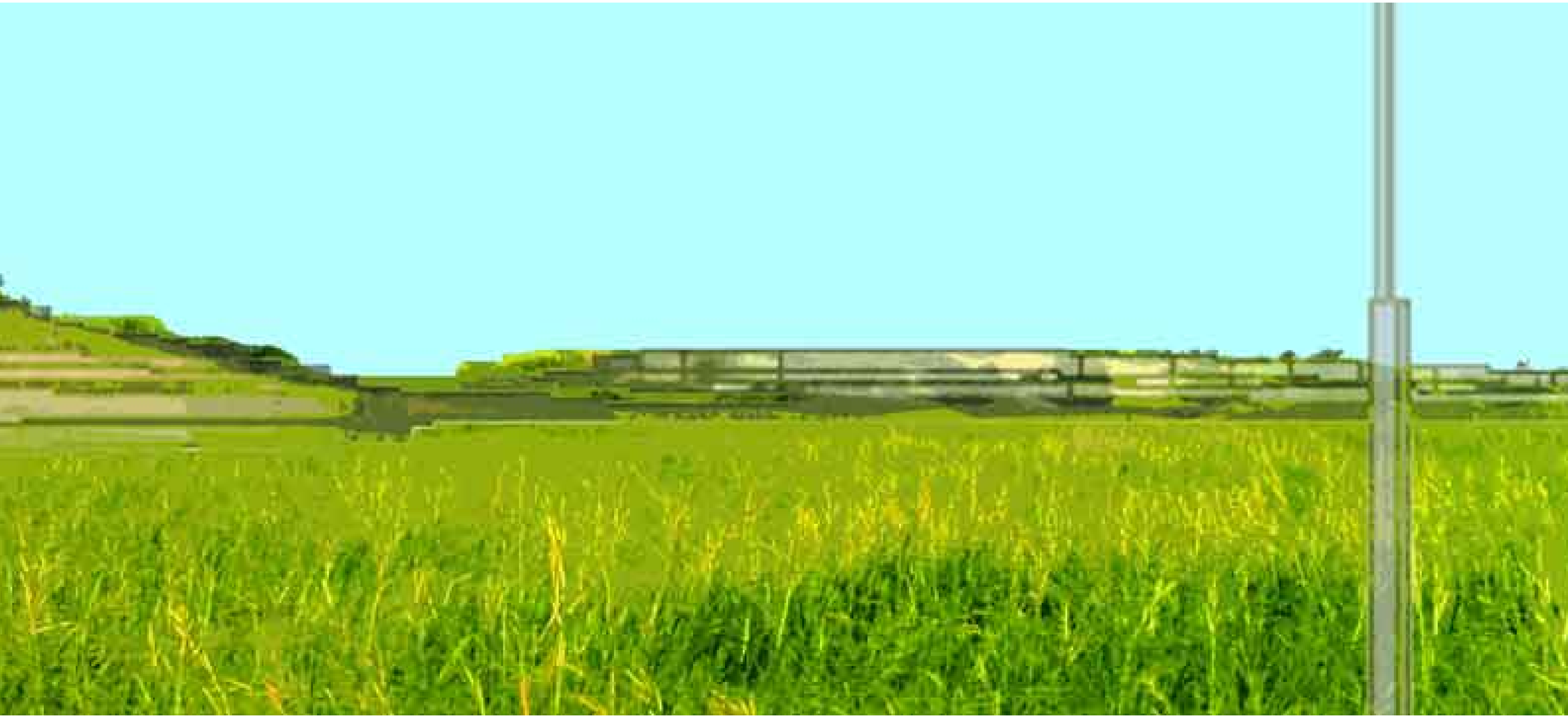


fig. 3.82 perimeter trail, summer afternoon, 2005



2005

fig. 3.83 perimeter trail, fall, dawn, 2010

2010

fig. 3.84 *perimeter trail, winter morning, 2020*

2020

fig. 3.85 perimeter trail, spring tide festival, midnight 2105

2105

cause ¦kôz¦

noun

1 a person or thing that gives rise to an action, phenomenon, or condition : the cause of the accident is not clear.

• reasonable grounds for doing, thinking, or feeling something : Faye's condition had given no cause for concern | [with infinitive] the government had good cause to avoid war | class size is a cause for complaint in some schools.

2 a principle, aim, or movement that, because of a deep commitment, one is prepared to defend or advocate : she devoted her life to the cause of deaf people.

• [with adj.] something deserving of one's support, typically a charity : I'm raising money for a good cause.

3 a matter to be resolved in a court of law.

• an individual's case offered at law.

verb [trans.]

make (something) happen : this disease can cause blindness | [trans.] we have no idea what has happened to cause people to stay away.

causeway ¦□kôz□w□¦

noun

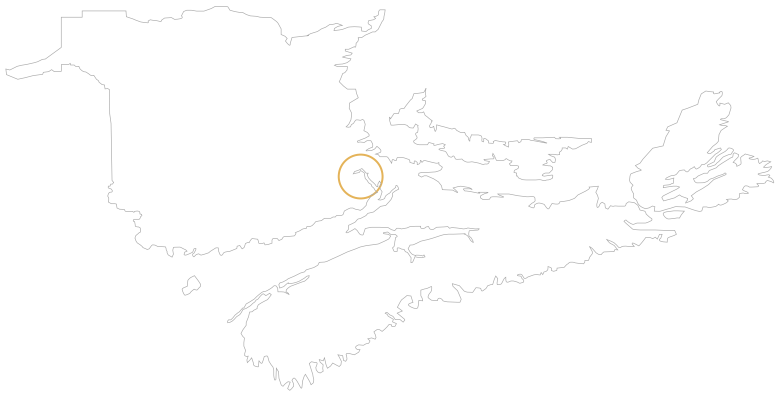
a raised road or track across low or wet ground.

ORIGIN late Middle English : from causey (from Anglo-Norman French causee, based on Latin calx 'lime, limestone' (used for paving roads)) + way [113]

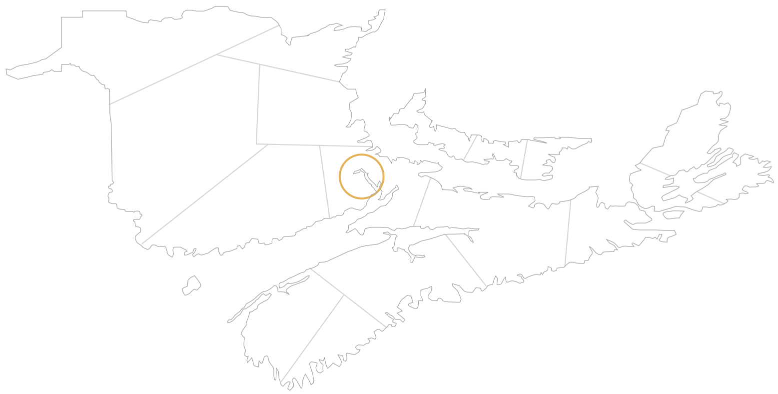
fig. 3.86 *entire site, collage*

"There was a need for a [landscape] whose guts would be able to focus our gaze upon the depths of dirtiness- upon what is apparently despised. Within it resides our ability to look towards the future, like a telescope that witnesses the expansion of the universe. It is without a doubt, the symbol of the motivation and the will to see it through to the end. In a way, it is a mirror of the planning and the emotional control of a city, bestowing its own personality upon it: advanced, clean. From the point of view of the built object, it is a conscious effort to imagine what has never before existed as an architectural element, and so it does not have a form that we hold in our memory." [114]

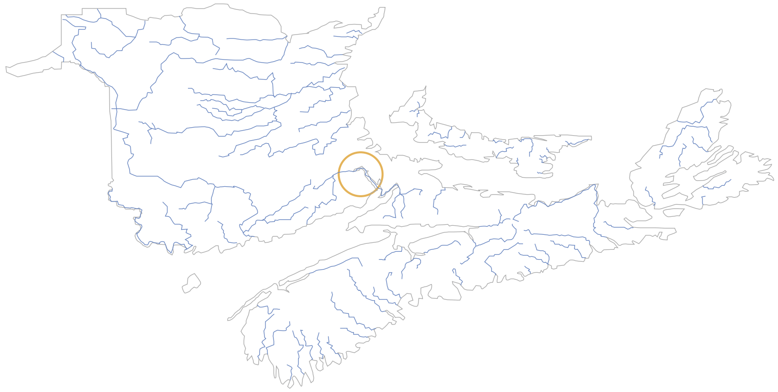
a1 maritime mapping



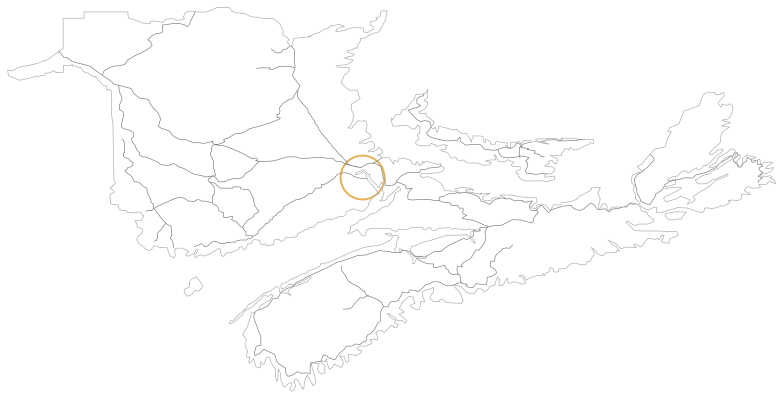
a1.01 political boundaries



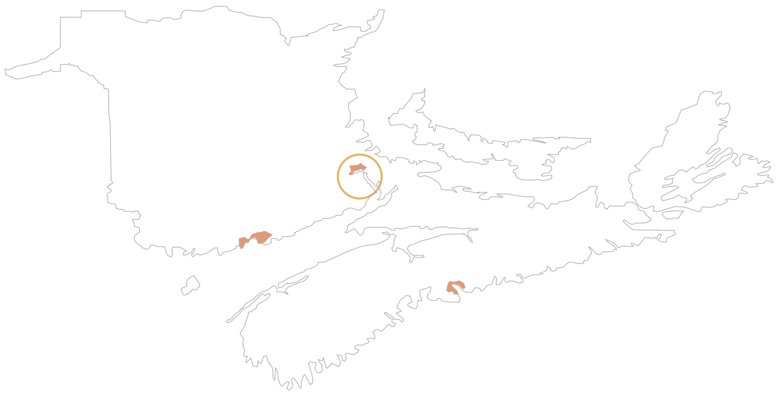
a1.02 land division



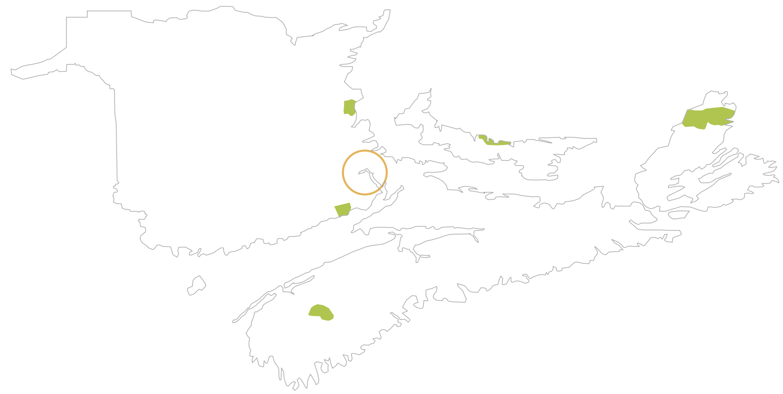
a1.05 drainage



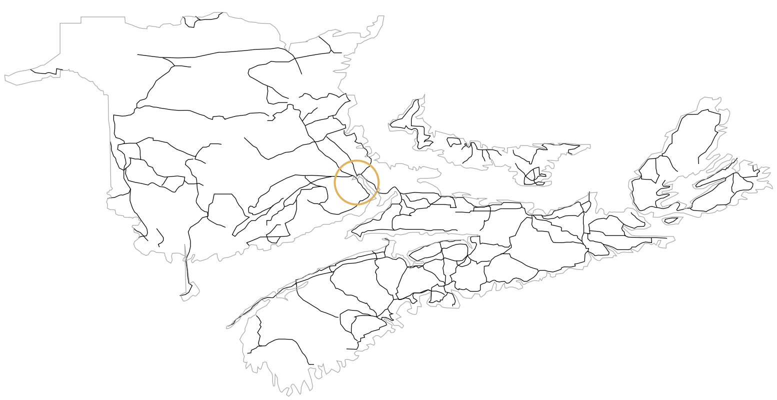
a1.06 rail network



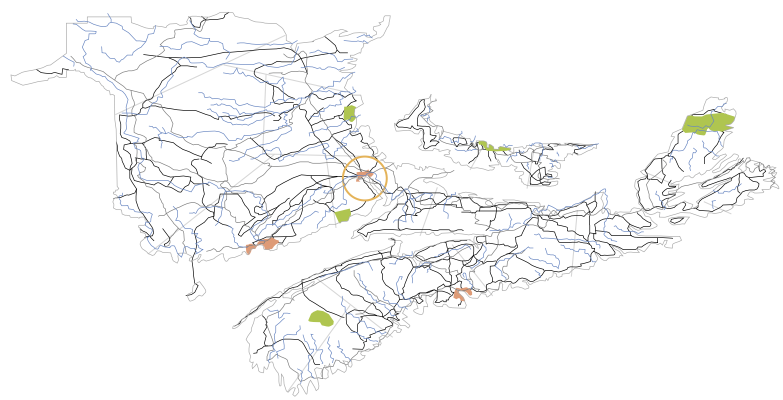
a1.03 cities



a1.04 federal parks



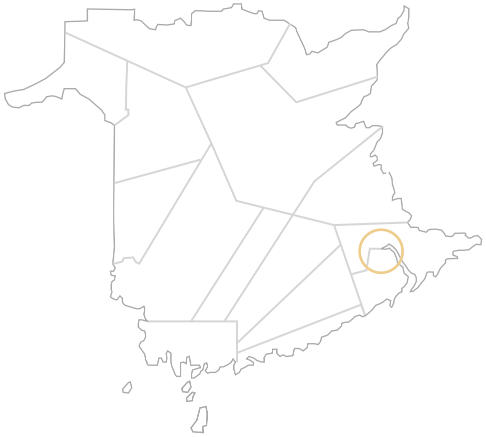
a1.07 road network



a1.08 composite

a2 provincial mapping

a2.01 political boundaries



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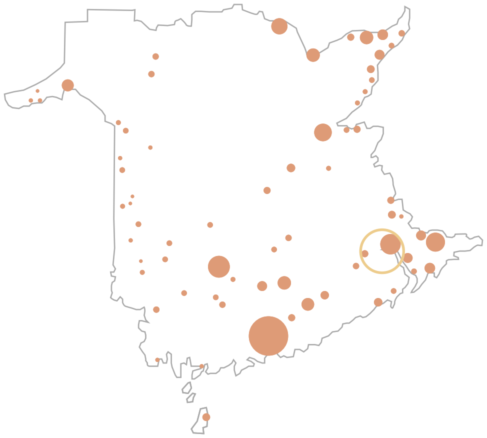

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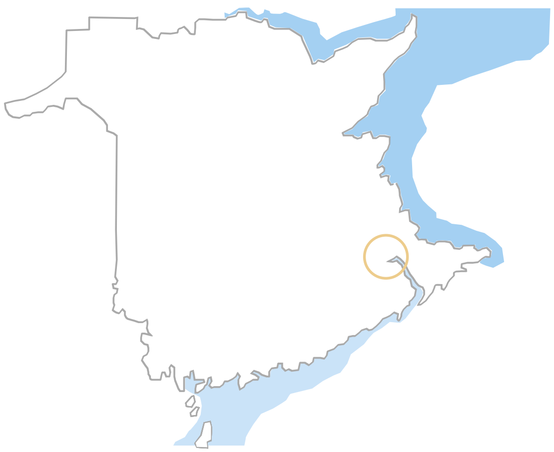

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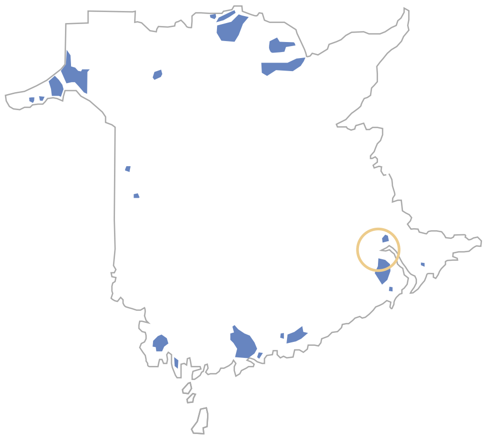
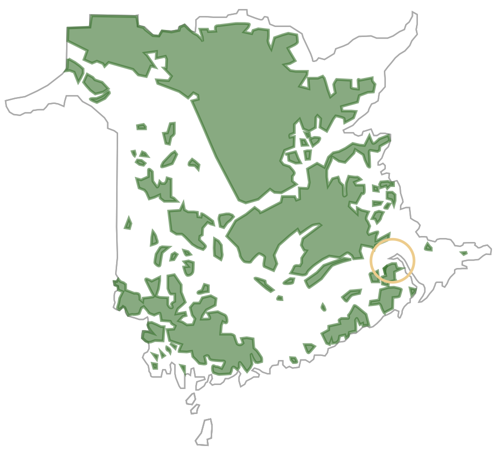


a2.08 protected watersheds

a2.09 protected areas



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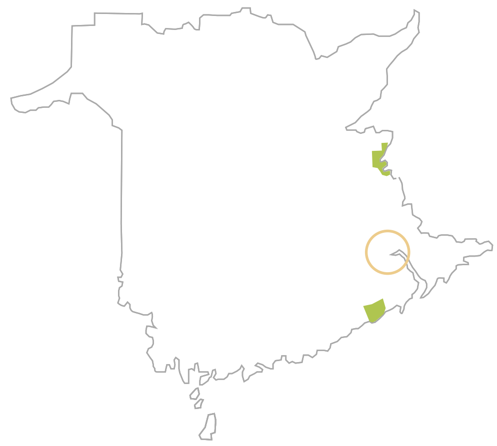

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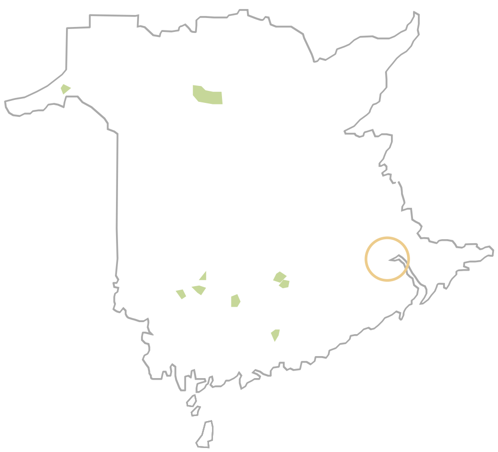

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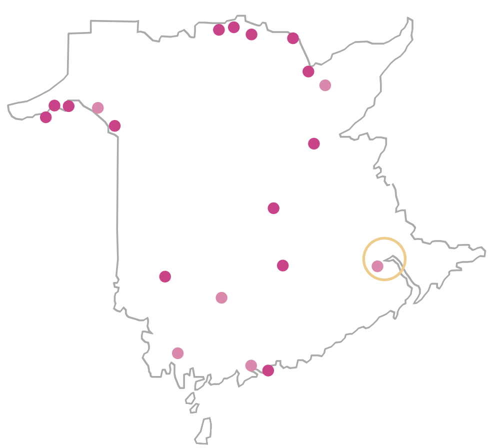
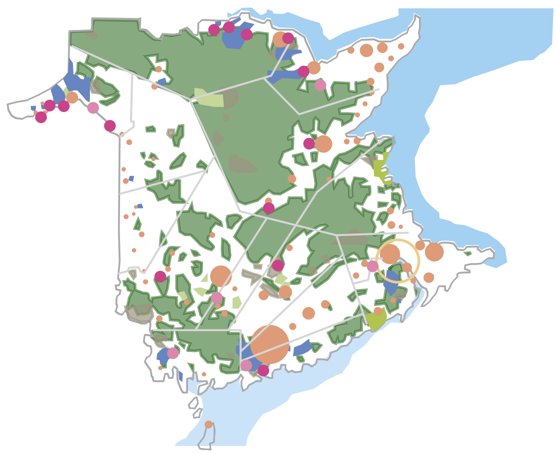


a2.10 approved municipal and industrial landfills



a2.11 composite

a3 civic mapping

fig. a3.01 political boundaries

fig. a3.02 transportation network

fig. a3.03 zoned industrial areas

fig. a3.04 existing landfills- closure dates / aperture date

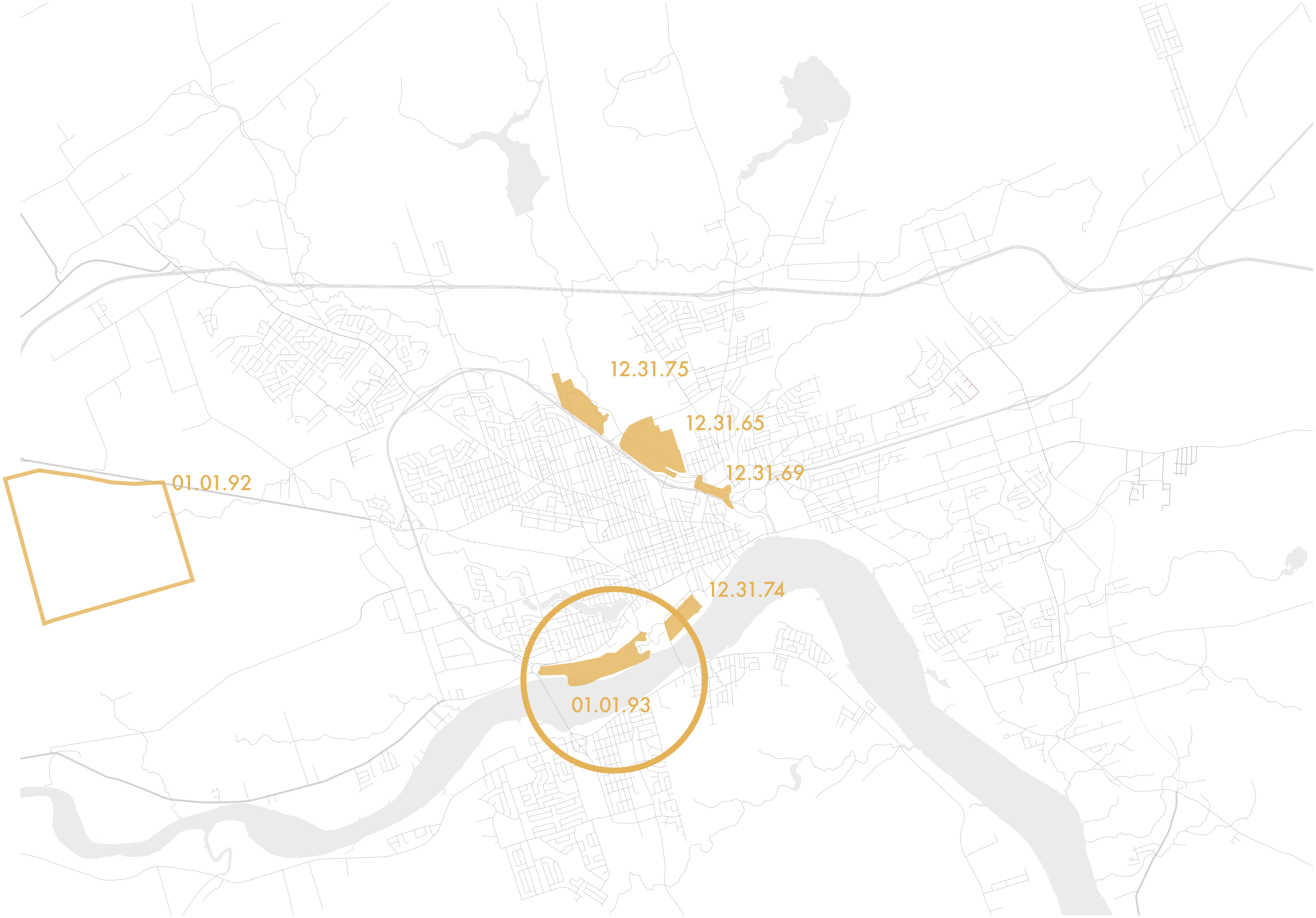


fig. a3.05 *built-up areas*

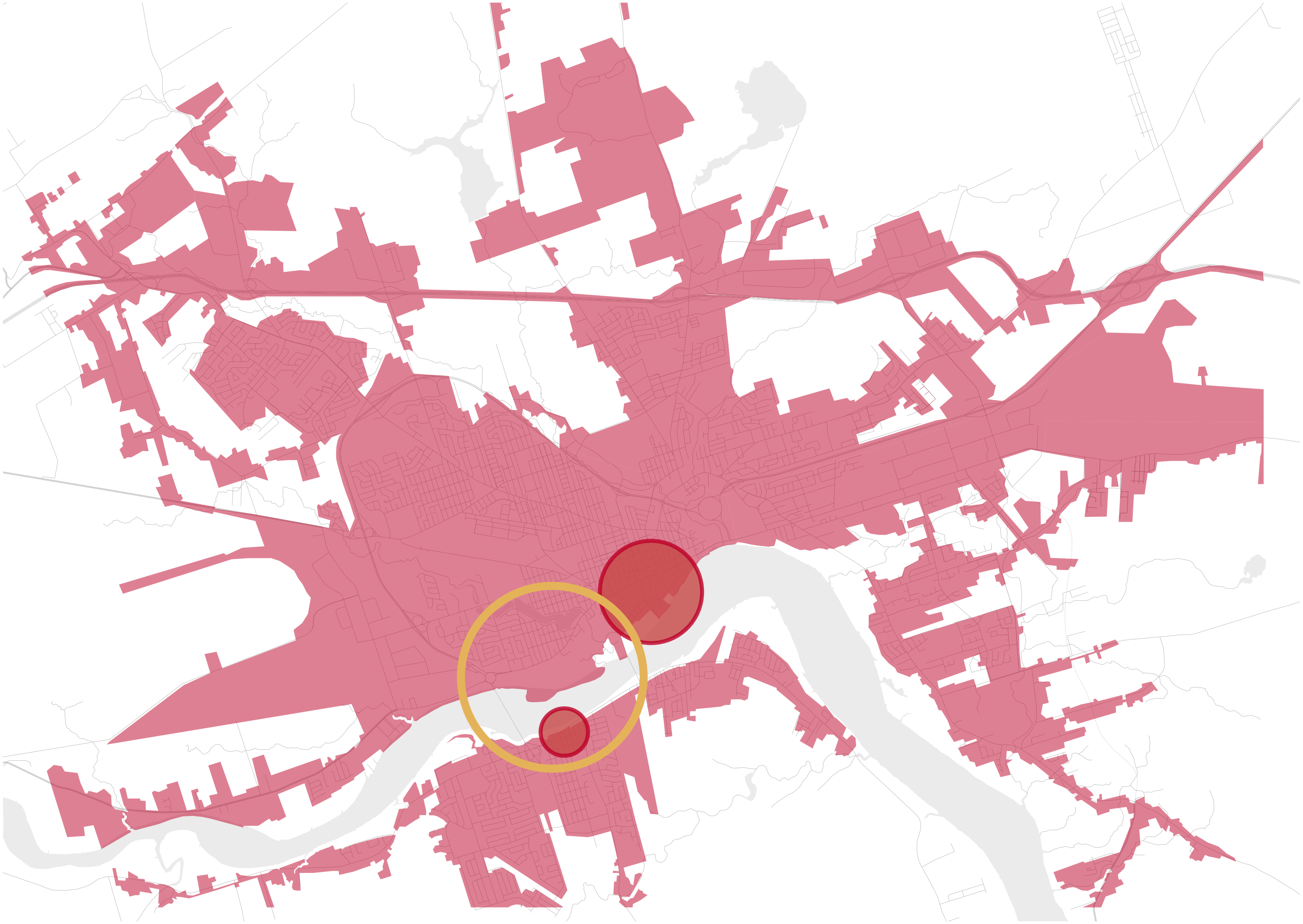


fig. a3.06 green spaces network

fig. a3.07 hydrology

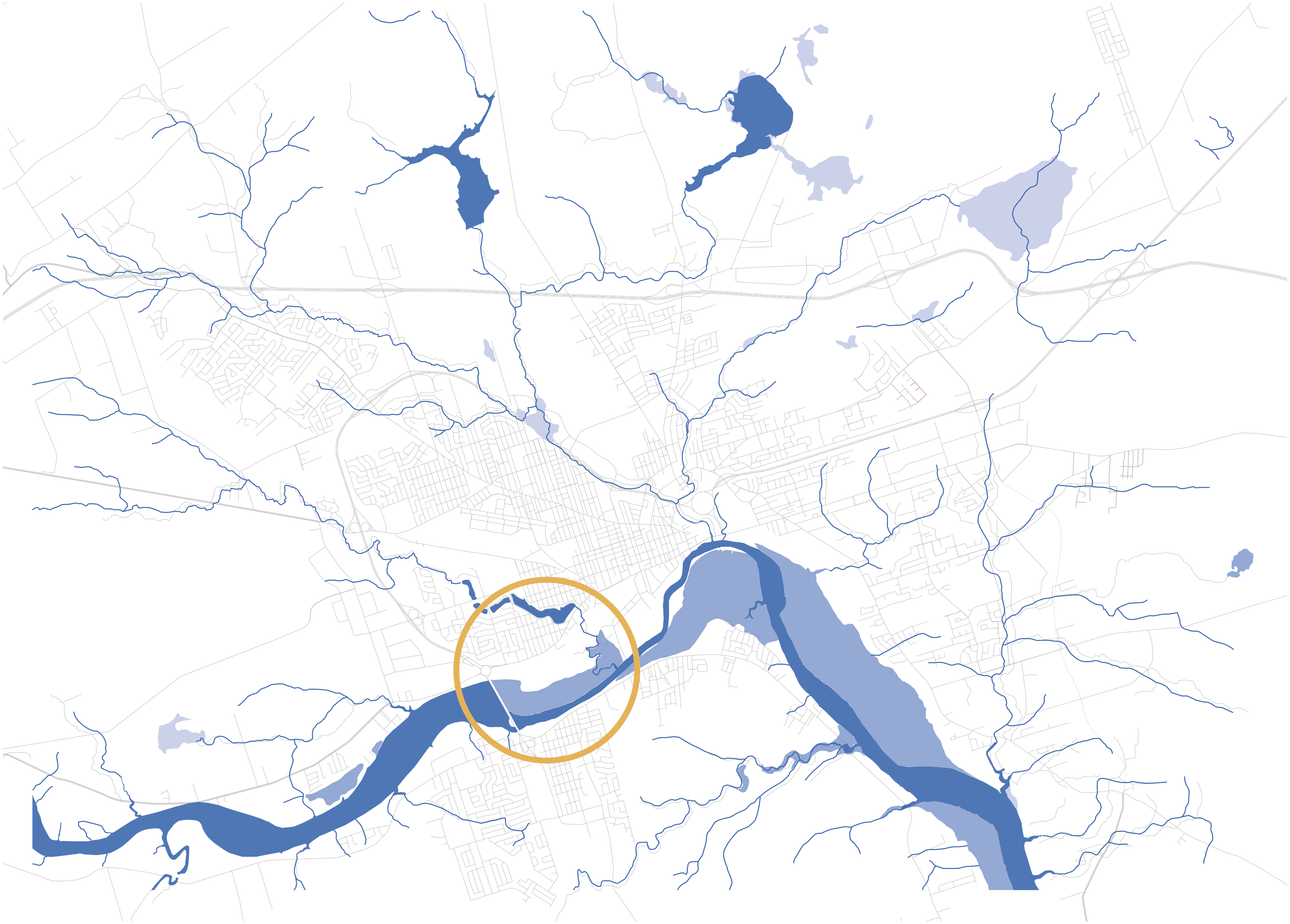
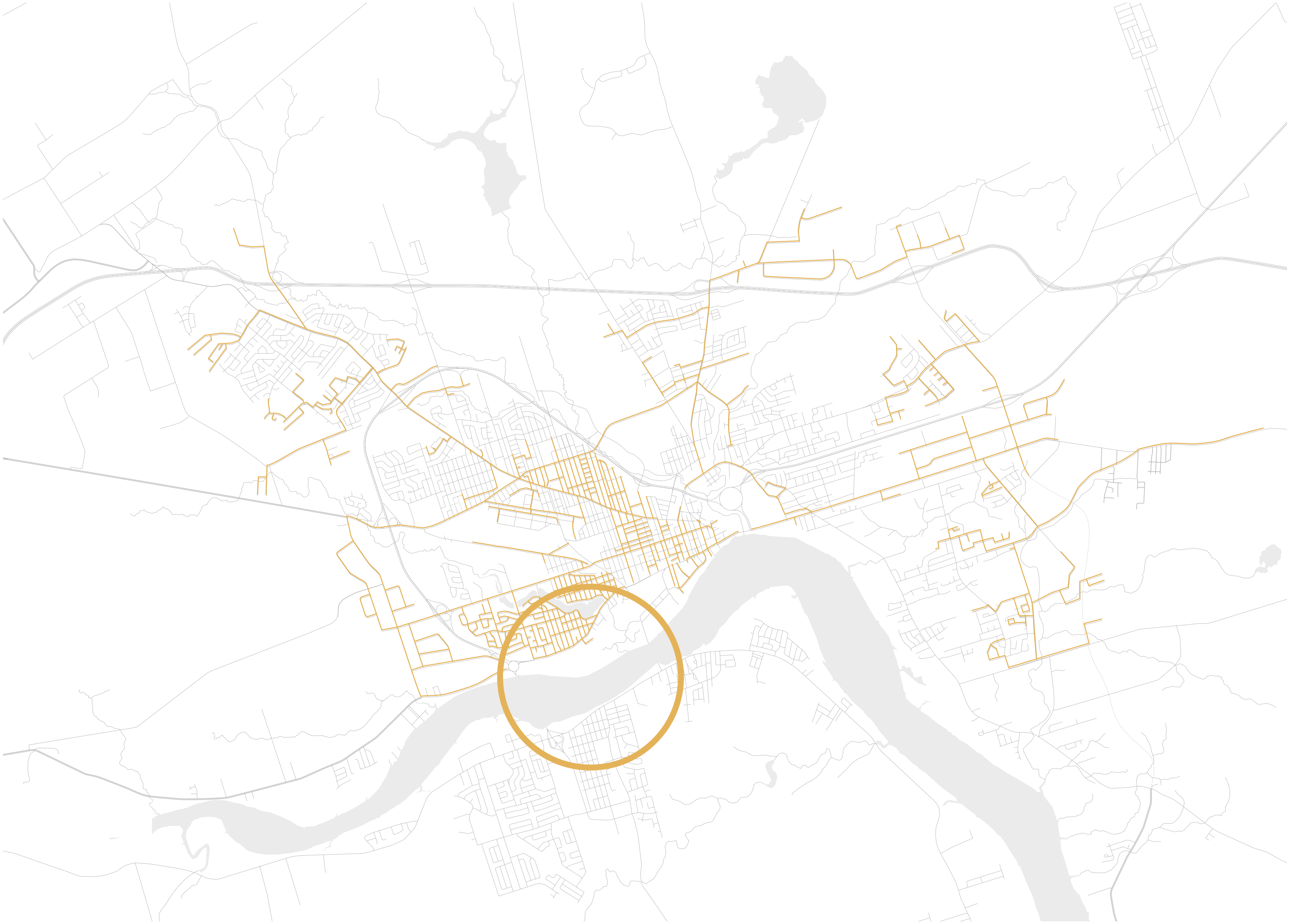


fig. a3.08 natural gas pipeline routes



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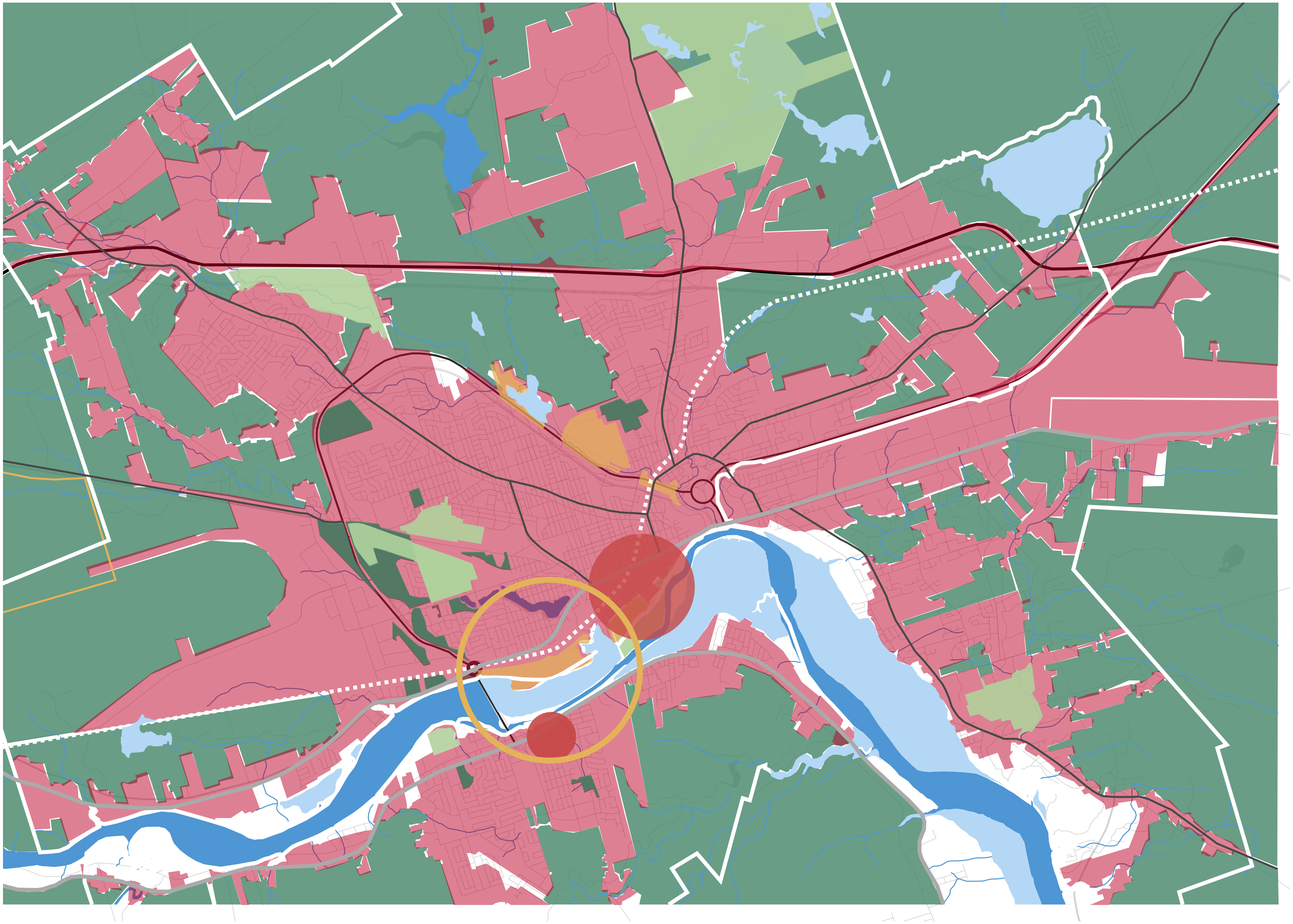


a4 petitcodiac river pollution sources

Petitcodiac Riverkeeper's Third Annual List of the: 10 Worst "Pollution Sources" of the Petitcodiac River System* in 2004

*The 3000 km2 Watershed and its tributaries that comprise the Petitcodiac River, Memramcook River and Shepody Bay

Methodology

The term "Pollution Source" in this document refers to an activity by individuals, corporations or government agencies that has caused and continues to cause a single or multiple negative impacts on the water quality, the habitat and the ecological integrity of the Petitcodiac River system.

In selecting the "10 Worst Pollution Sources" of the Petitcodiac River System in 2004, the following four criteria were applied:

1. Activities that have multiple negative impacts on the water quality, the habitat and the ecological integrity of the watershed;
2. Activities that are continuously negatively impacting the watershed;
3. Activities that have short and long-term negative impacts on the watershed;
4. Activities that have clearly identifiable parties responsible for these negative impacts on the watershed.

1. Petitcodiac Causeway (Province of New Brunswick)

Owned and operated by the Province of New Brunswick, the Petitcodiac causeway, built in 1968, has dramatically and extensively altered natural ecosystem functions in the entire 3000 km2 Petitcodiac River and Shepody Bay ecosystem. The causeway continues to create an obstruction to natural fish passage conditions to nearly half (1,340 km2) of the river system, and has caused the elimination of 21 km of upstream estuary, substituting the historical tidal range of the river from the Village of Salisbury to Moncton.

The Petitcodiac causeway is responsible for the elimination of at least five aquatic species from the river system: the Dwarf wedgemussel (the first case of a mussel being declared extirpated from Canada – the Petitcodiac River was its only known Canadian location), the distinct Inner Bay of Fundy Atlantic salmon (declared eliminated from the Petitcodiac in the mid-1990's and now declared Endangered in Canada), American shad (formerly a run of over 75,000 in the Petitcodiac and declared eliminated in the late-1990's), Striped bass and Atlantic tomcod. (Aubé, Hanson, Klassen, Locke, Richardson, 2000).

The Petitcodiac causeway is also responsible for the buildup of massive silt deposits downstream from the structure, reducing the width of the Petitcodiac River from an average of 1 km in 1968 to a mere 100 m currently at the Moncton level. The Petitcodiac causeway continues to be responsible for the ongoing buildup of massive deposits of silt reaching as far as 35 km downstream to Shepody Bay. The Petitcodiac has now acquired the unfortunate distinction of being one of the few rivers in North America where you can see man's destructive influence from space.

The Petitcodiac causeway has further caused the near elimination of the once world-renowned Petitcodiac River tidal bore, formerly Canada's most spectacular tidal bore and one of Atlantic Canada's top tourist attractions. Once the pride of Moncton's tourism industry, the Petitcodiac River tidal bore has become an embarrassment for local tourism operators, as well as the focus of ridicule by visitors and local residents.

Once home to a thriving and proud shipbuilding industry, natural navigational conditions for commercial and recreational boaters have been eliminated on the Petitcodiac River in Moncton as a result of the extreme silt buildups. Because of the Petitcodiac causeway, the community of Moncton has become one of the few in North America to lose its inherent right to a navigable waterway.

The battle to restore free flow to the Petitcodiac now spans four generations, making this one of the longest standing environmental battles in Canada. Throughout a 40-year period between 1961 and 2001, over 132 reports were conducted on the Petitcodiac River and its causeway. The account of these 132 reports on the Petitcodiac River constitutes one of the most documented cases of a declining ecosystem in Canada. In July 2003, as a result of the extensive ecological damage brought about by the Petitcodiac causeway, the environmental organization Earthwild International designated the Petitcodiac as Canada's Most Endangered River.

The overwhelming evidence demonstrating its multiple negative impacts on the entire ecosystem, its habitat, its water quality and all of its living species makes the Petitcodiac causeway (Province of New Brunswick) The Worst Pollution Source of the Petitcodiac River System in 2004.

Documented solution to correct the problem: Return the Petitcodiac River to free flow conditions in the interim (open gates advocated by Department of Fisheries and Oceans since 1979) while preparing the groundwork to replace the causeway with a partial bridge (permanent solution).

2. Sewerage Primary Treatment Plant (Greater Moncton Sewerage Commission)

Owned and operated by the Greater Moncton Sewerage Commission (GMSC), which is publicly owned by the municipalities of Dieppe, Moncton and Riverview, the Sewerage Primary Treatment Plant is responsible for treating the Greater Moncton region's wastewater effluent. Promoted in the early 1990's as a state-of-the-art plant that would eventually offer full wastewater treatment, the wastewater effluent continues to receive advanced primary treatment only (i.e. a removal of the solids) before being released directly into the Petitcodiac River. More than twenty years after the project was first initiated and eleven years after the plant was commissioned, the GMSC has still not made publicly available its plans to upgrade the plant to secondary or tertiary treatment.

On average, the plant discharges directly into the Petitcodiac River between 50 and 70 million liters of primary treated effluent every day. Not only are there suspected toxic substances and hormone-related chemicals entering the river at the outfall, but the extreme richness of this effluent's bio-load likely causes the water to be overloaded with nutrients. This can cause excessive microbial activity and deoxygenation. Trying to navigate a stretch of river lacking in oxygen is a big hazard to any fish that might try to swim upstream or downstream at this location. The coli form bacteria count at the outfall is also known to routinely exceed the Canadian Water Quality Guidelines set for recreational use.

Of growing concern since the last few years is the plant's wastewater dilution factor as the primary treated effluent reaches the Petitcodiac River. Initially calculated in the mid-1980's to account for a larger flow in the river, the dilution factor in the receiving waters of the Petitcodiac has continuously decreased as a result of the ongoing buildup of massive silt deposits in the river channel. Under low flow conditions during the summers of 2001, 2002, 2003 and 2004 (between 12 and 18 hours a day), the amount of discharge was estimated to be equal or superior to the amount of receiving waters available in the Petitcodiac River at the location of the outfall. This has increased the concentration of primary treated effluent in the river and increased the risk of environmental harm to aquatic species at this location during low flow periods.

The continued discharge of primary treated effluent directly into the Petitcodiac River, at an average rate of between 50 and 70 million liters a day, and with no public plans to upgrade the plant to advanced secondary or tertiary treatment, makes the Greater Moncton Primary Treatment Plant (Greater Moncton Sewerage Commission) our Number 2 Worst Pollution Source of the Petitcodiac River System in 2004.

Documented solution to correct the problem: Prepare detailed plans to upgrade treatment to advanced secondary and tertiary, and develop financial scenarios (federal/provincial/municipal partnerships, long-term borrowing arrangements, etc.) to achieve this objective.

3. Former Moncton Riverside Landfill (City of Moncton)

Owned and operated by the City of Moncton, the former Moncton landfill is located on 35 hectares (87 acres) of land along the Petitcodiac riverfront. It began operating shortly after the causeway was built in 1968, and was closed in 1992 after more than 20 years of operation. Historical records reference the following notable wastes disposed of at the facility: petroleum waste oil, liquid animal waste, asbestos pipe insulation, urea-formaldehyde foam insulation (UFFI), cleaning solution - sodium hydroxide SCA-134, septic waste, sewage sludge and medical wastes. (GEMTEC Report, 1995).

An environmental investigation conducted by the Environmental Bureau of Investigations (EBI) and the Petitcodiac Riverkeeper in the summer and fall of 2000, revealed that between 100,000 and 300,000 liters of toxic leachate was entering the Petitcodiac River every day from various discharge points of the former Moncton landfill along Jonathan Creek. In February 2002, charges were subsequently laid by Environment Canada's Enforcement Branch against the City of Moncton and a consulting firm in relation to this case (Gemtec case is still before the courts).

The City of Moncton plead guilty to these charges in September 2003, and agreed to a court order and a closure plan that would eliminate the discharge of toxic leachate into Jonathan Creek and the Petitcodiac River. This closure plan is still being reviewed by the federal and provincial regulatory agency, and until it is implemented the discharges of toxic leachate will continue.

The continuous discharge of toxic leachate directly into Jonathan Creek and the Petitcodiac River, at an estimated rate of tens of thousands of liters per day, makes the Former Moncton Riverside Landfill (City of Moncton) our Number 3 Worst Pollution Source of the Petitcodiac River System in 2004.

Documented solution to correct the problem (GEMTEC Report, 1995): Construct a leachate collection system and an impermeable cap to cover the landfill.

4. Memramcook and Shepody Causeways (Province of New Brunswick)

Owned and operated by the Province of New Brunswick, the Memramcook and the Shepody River causeways, built in 1973 and 1958 respectively, have completely altered natural ecosystem functions in the 400 km2 Memramcook and the 550-km2 river systems. These two causeways, designed with no fish ladders whatsoever, continue to create an obstruction to natural fish passage conditions to nearly two-thirds (approximately 250 km2) of the Memramcook and 90 percent (500 km2) and the Shepody River systems. Both causeways have also caused the elimination of several kilometers of upstream estuary, affecting the historical tidal range and the salt-fresh water exchange in the system.

Both the Memramcook and the Shepody causeways are responsible for the elimination of nearly every historical fish species in these river systems, including the distinct Inner Bay of Fundy Atlantic salmon (formerly a run believed to have been between 1,000 and 2,000 in each river), American shad, Striped bass, Atlantic tomcod, Sea run brook trout and others.

The Memramcook and Shepody causeways are also and continue to be responsible for the buildup of massive silt deposits downstream from the structure, reducing the width of the Memramcook and Shepody Rivers and affecting Shepody Bay's mudflats, a critical habitat for migrating shore birds.

Built against the will of the communities living in the Memramcook River valley in the early 1970's, the Province of New Brunswick initiated in the fall of 1999, at the request of these same communities, the steps necessary to restore free flow at the Memramcook causeway. Five years after this public commitment was made, the plan to operate the gates year-long on the Memramcook causeway (which entails rebuilding several of the marshland dikes) to allow free flow was still not operational in 2004.

The evidence demonstrating its multiple negative impacts on this entire river system, its habitat, its water quality and all of its living species makes the Memramcook and Shepody causeways (Province of New Brunswick) our Number 4 Worst Pollution Source of the Petitcodiac River System in 2004.

Documented solution to correct the problem: Return the Memramcook and Shepody Rivers to free flow conditions in the interim (year-round gate management plan) and undertake a detailed assessment to return these rivers to full tidal flow by replacing these causeways with a partial bridge (permanent solution).

5. Wetland Destruction (Province of New Brunswick, City of Moncton, City of Dieppe and various private developers)

One of the foremost examples of habitat loss in the Petitcodiac River system is the destruction of wetlands resulting from urban sprawl, pollution and drainage. The incremental loss of wetlands is not limited to Atlantic Canada. In fact, wetlands are among the most threatened habitats on earth. Since these had in the past no apparent use for human consumption, wetlands were traditionally perceived as wastelands. Consequently, they were filled in for development, transformed into solid waste dumps, or diked for agriculture.

In Moncton's Jonathan Creek watershed alone, over 90 % of the wetlands were lost to urban development between 1953 and 1996 (Petitcodiac Riverkeeper, 2004). In the Halls Creek watershed, over 70% of the wetlands were lost in this same period (Levesque et al, non-published document, 2002). Although the importance of wetlands has been officially recognized by the provincial and federal governments, their destruction continues in some areas of the Petitcodiac River system. This includes portions of the Jonathan Creek wetland (approximately 20 acres) to make way for the approaches to the new Gunningsville Bridge, and portions of the Chartersville wetland (approximately 5 acres), to build a new access for Virginia Street.

The importance of wetlands rests in several ecological functions. The first of these is the purification and filtration of contaminants destined for lakes, rivers, streams, coastlines and drinking water supplies. Secondly, they store water that can be released during droughts, absorb water during floods and serve as buffers against coastal storm surges. In addition, a variety of animals such as songbirds, fish, waterfowl, and plants depend on wetlands for their survival. Not only are wetlands the most productive ecosystems in Canada, they are considered among the most productive in the world.

The construction of an artificial wetland in Moncton's Centennial Park, for instance, illustrates the value of these services. In fact, the economic cost of this project puts the current value of wetlands at approximately $100,000 per hectare.

The evidence demonstrating its multiple negative impacts on the Petitcodiac River system, its habitat, its water quality and its living species makes wetland destruction (Various Private Developers) our Number 5 Worst Pollution Source of the Petitcodiac River System in 2004.

Documented solution to correct the problem: Implement urban planning policies to protect wetlands and increase the enforcement of environmental laws.

6. Watercourses and Habitat Destruction (Various Private Developers)

Environmentally insensitive developments carried out by residential, commercial and industrial developers with the endorsement of the watershed's Planning Commissions can have multiple, severe and irreversible impacts on the ecological components of river systems. And in the Petitcodiac River system, most of these environmentally insensitive developments occur in the Greater Moncton Planning Commission's territory of influence. The main impacts of these include habitat destruction and the alteration of watercourses.

The main habitats within watersheds upon which aquatic life and water quality depend are wetlands and riverine areas. The latter includes the watercourses themselves, the riparian zones (i.e. ecological buffers) and the surrounding forests.

These different components work together to assure the environmental integrity and the maintenance of adequate habitats for plants, fish and other animal species. The physical properties of streams and riverbeds, also called substrate, will determine what type of plant and animal life live and spawn there. Fish need certain types of substrate for the deposition of eggs during the spawning season, for adequate shelter and food. Vegetation along streams and riverbanks (i.e. the riparian zone) also has an important role to play in the river system. It filters water trickling down along the edge of a watercourse, reduces erosion and provides shade, keeping water temperatures cool in the summer time, thus promoting high levels of dissolved oxygen, which is crucial to fish survival.

The destruction of habitat and the region's watercourses continues at an accelerated rate in the Petitcodiac River system as a result of urban sprawl. This has both ecological and socio-economic consequences. The socio-economic and ecological consequences of the destruction of habitat are not as obvious as those seen by the destruction of wetlands but can be as severe. For example, piping brooks underground can hinder fish passage and restrict the access of anadromous fish to spawning beds upstream, which may lead to the reduction in commercial and sport fish populations. As a result, estuarine fishermen may suffer reduced catches, substantial economic setbacks and the eventual loss of livelihood. This last example illustrates the tight knit relationship between coastal and watershed ecosystems, and how the prosperity of communities depends on the health of the local environment.

The evidence demonstrating its multiple negative impacts on the Petitcodiac River system, its habitat, its water quality and all of its living species makes watercourse and habitat destruction (Various Private Developers) our Number 6 Worst Pollution Source of the Petitcodiac River System in 2004.

Documented solution to correct the problem: Implement urban planning policies to protect fish habitat, their watercourses and their riparian zones, as well as increase the enforcement of environmental laws.

7. Untreated Sanitary Sewage Discharges (Various Municipal Governments including the Greater Moncton Sewerage Commission)

Operated by various municipalities in the watershed including the Greater Moncton Sewerage Commission, sewerage systems are designed to direct sanitary sewage from residential and commercial users to dedicated treatment plants before being released into the environment. As a result of improper maintenance or poor design, untreated sanitary sewage continued to be discharged directly into streams of the Petitcodiac River watershed in 2004.

These discharges, which are concentrated in the greater Moncton area, can have severe environmental impacts. Due to the presence of disease causing agents (fecal coli form, ecoli, etc.), the discharge of sanitary sewage into our waterways is a threat to public health. Sanitary sewage also has an impact on aquatic organisms. It contains high levels of nutrients that contribute to the excessive proliferation of aquatic plants and algae. Microorganisms that decompose sewage and related organic matter require high levels of dissolved oxygen. Consequently, aquatic organisms that need high levels of dissolved oxygen for their survival, such as trout or salmonds, will leave the area or die in anoxic conditions (i.e. oxygen deficient).

In areas where oxygen levels have been depleted, anaerobic microorganisms, which do not require oxygen, will proliferate and further deteriorate water quality through the release of odorous compounds. The discharge of hormone and other potential endocrine disruptive substances through sanitary sewer discharges can also have a severe impact on aquatic organisms (June 2002 Humphreys Brook oil spill, August 2002 textile mill effluent spill being such examples).

Its multiple negative impacts on the Petitcodiac River system, its habitat, its water quality and its living species makes untreated sanitary sewage discharges (Various Municipal Governments including the Greater Moncton Sewerage Commission) our Number 7 Worst Pollution Source of the Petitcodiac River System in 2004.

Documented solution to correct the problem: Maintain sanitary sewerage infrastructure in proper working order, correct cross-connections defaults and design greater sewerage water retaining capacity to avoid overflows.

8. Storm water Discharges (Various Municipal Governments and the Province of New Brunswick)

Operated by various municipalities and provincial government agencies in the watershed, storm water systems are designed to direct rainwater from residential and commercial developments to settling ponds, dedicated treatment plants or directly into watercourses. As a result of poor design or detrimental development policies, storm water systems continue to discharge directly into our waterways a wide variety of pollutants throughout the Petitcodiac River watershed in 2004.

Storm water is water that is not absorbed into the ground but that rather trickles rapidly on impermeable surfaces before being discharged into watercourses. Due to the widespread presence of hard surfaces such as roads and parking lots, cities contribute a considerable amount of storm water runoff into our local waterways. The growing prevalence of impermeable surfaces also reduces groundwater infiltration, which in turn reduces water levels in rivers and streams.

Storm water outfalls can alter riverine habitats and reduce water quality. Storm water discharges can also reach high velocities during heavy rainfalls, thus leading to the erosion and widening of adjacent stream banks. Storm water discharges can elevate stream water temperatures during summer months, and these drastic temperature changes can in turn be lethal to a variety of aquatic organisms. Finally, the contents of storm water can also be very harmful to aquatic life. Pollutants, such as sediments, petroleum, metals, pesticides, bacteria and nutrients, accumulate on streets, buildings, lawns, parking lots and are carried off by storm water directly into our watercourses.

The evidence demonstrating its multiple negative impacts on the Petitcodiac River system, its habitat, its water quality and all of its living species makes storm water discharges (various Municipal Governments and the Province of New Brunswick) our Number 8 Worst Pollution Source of the Petitcodiac River System in 2004.

Documented solution to correct the problem: Develop and adopt standards, as in other jurisdictions in North America, to incorporate storm water filtration systems and storm water settling ponds to the design.

9. Various Abandoned Dams and Barriers of all Types (City of Moncton (Jones Lake Dam – 60 km2), Town of Riverview (Navy Dam – 50 km2), Tandem Fabrics Ltd. (Humphreys Brook Dam – 38 km2), City of Moncton (McLaughlin and Irishtown Reservoirs – 34 km2), Province of New Brunswick (Fox Creek aboiteau – 34km2)

Owned and operated by the City of Moncton, the Town of Riverview, one private owner (Tandem Fabrics Ltd.) and the Province of New Brunswick, abandoned dams and barriers of all types located on tributaries of the Petitcodiac River continue to create 100 percent obstacles to fish passage and are affecting the ecological integrity of these streams and the larger watershed.

The Jones Lake Dam (impacting 60 km2), the abandoned Navy Dam (affecting 50 km2), the abandoned Humphreys Brook dam (affecting 38 km2), the McLaughlin and Irishtown reservoirs (affecting 34 km2) and the Fox Creek aboiteau (affecting 34 km2) are believed to be responsible for the elimination of nearly every historical fish species in these tributaries, including the distinct Inner Bay of Fundy Atlantic salmon, Sea run brook trout and others.

All of these barriers and abandoned dams continue to be responsible for the buildup of silt deposits upstream from these structures, for the increase in water temperatures and the decrease in water quality in these reservoirs. Built for a variety of uses (aesthetic, energy, flood control, water supplies) as far back as the late 1800's and as late as the 1950's, some of these barriers have since been abandoned and no longer serve their intended purpose.

Decommissioning plans have now been prepared for the abandoned Navy Dam on Mill Creek (Riverview) and the abandoned dam on Humphreys Brook (Moncton), and await approval from the owners and funding before restoration projects can begin on these streams. One of the gates of the Fox Creek aboiteau could also be potentially opened to free flow conditions, an option that needs further study.

While the reservoirs of Irishtown and McLaughlin have long since been utilized for the purposes of supplying drinking water or emergency water to city residents, these dams continue to operate. Jones Lake in Moncton, in the meantime, has filled up with sediment as a result of development activities and the City is considering dredging it at the cost of millions of dollars.

The evidence demonstrating their multiple negative impacts on the tributaries of Jonathan Creek (Jones Lake), Mill Creek, Humphreys Brook, West Branch Halls Creek, Ogilvie Brook and Fox Creek, its habitat, its water quality and all of its living species makes these abandoned dams and barriers of all types (City of Moncton, Town of Riverview, Tandem Fabrics Ltd., Province of New Brunswick) our Number 9 Worst Pollution Source of the Petitcodiac River System in 2004.

Documented solution to correct the problem: Remove the abandoned dams on Mill Creek and Humphreys Brook, conduct assessment on restoring partial free flow conditions in Fox Creek, conduct assessment on the future of the Irishtown and McLaughlin reservoirs, and conduct a feasibility study on restoring fish passage and/or tidal flow in the Jones Lake estuary.

10. Widespread Cosmetic Pesticide Use (Cosmetic Pesticides Users)

The cosmetic use of pesticides (and herbicides) by individual, commercial and government property owners is widespread throughout the Petitcodiac River system. The synthetic organic compounds found in pesticides can find their way into groundwater by leaching into the soil or into surface water through runoff. Only a very small percentage of the 7000 pesticide products on the Canadian market have been tested for carcinogenic or mutagenic properties. Pesticides have been linked with the development of cancer, Parkinson's disease and birth defect. However, due to the diversity of interacting factors, such as age, heredity and so on, making the link between pesticide use and human health is not an easy task.

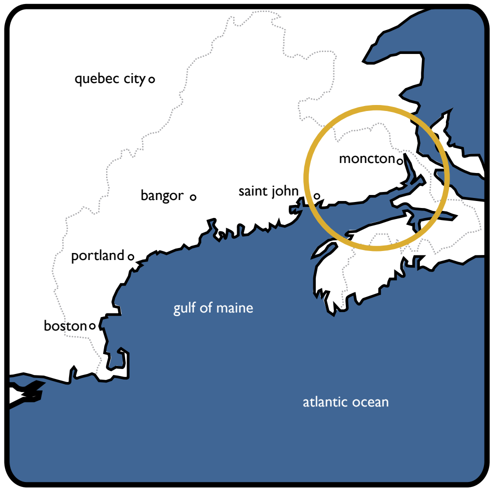
The non-lethal or indirect effects of pesticide exposure can be as devastating to a given population as those that kill immediately. These include the deterioration of reproductive function, behavioral change, loss of weight, and habitat loss. For example, a particular fish population can loose a vital food source if a particular insect species is eliminated from the local food chain. Similarly, these same fish species can decline from the loss of habitat as a result of the destruction of vegetation related to pesticide use, or a reduction in water quality.

Pesticides concentrate up the food chain through a process called bioaccumulation. Their impact on animal and plant species increases with time as these products build-up in living tissues. The problem is even more worrisome when we consider the widespread distribution of pesticides in our environment. According to a leading U.S. study, 96% of all fish, 100% of all surface waters and 33% of all aquifers tested had traces of one or more pesticides. The extensive dispersion of pesticides is not solely due to their cosmetic use. However, people should consider alternatives to cosmetic pesticide use when dealing with common household "pests".

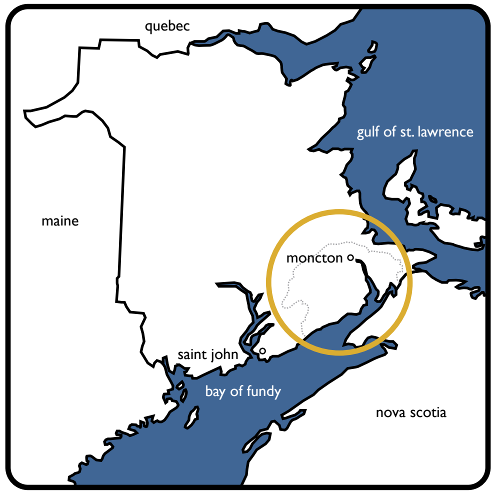
The documented and potentially devastative effects of pesticide use on the health of all organisms within the Petitcodiac River system and on human health makes Cosmetic Pesticides (Cosmetic Pesticide Users) our Number 10 Worst Pollution Source of Petitcodiac River System in 2004.

Documented solution to correct the problem: Enact municipal, provincial and/or federal regulations and legislation, as well as promote alternative and non-chemical lawn care methods, to eliminate the use of cosmetic pesticides in the watershed. [115]

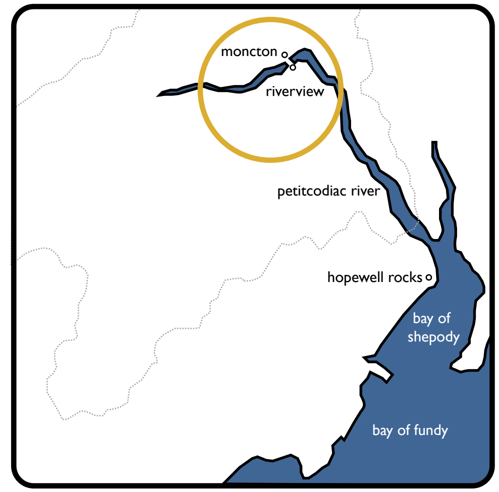
a5 watershed regions



a5.01 gulf of maine watershed



a5.02 petitcodiac, memramcook, and shepody bay watershed



a5.03 petitcodiac river watershed

a5.04 jonathan creek watershed (opposite page)

The Gulf of Maine watershed (above) includes pieces of three American states and three Canadian provinces: Massachusetts, New Hampshire, Maine, Nova Scotia, New Brunswick, and Quebec.

This watershed is natural boundary defined by ridgelines that separate this basin from another to make it a distinctive region.

Within the Gulf of Maine watershed is a highly complex set of processes where water is moved, circulated, collected, utilized, and filtered through the landscape. The interaction between diverse soil types, landforms, and water shape the landscape. Most of the region soil cover is a mixture of sand, gravel, silt and clay, that was deposited as the last glacier retreated, between 13 000 and 15 000 years ago. 3. It is theses highly evolved processes that create and sustain aquatic and terrestrial life that is vital to the industrial and social fabric of the region.

The Jonathan Creek watershed (opposite page) area is approximately 50 km2. The upper stretches of the creek are mostly forested lying outside the boundary of the City. The lower reaches lie within the chosen study site of the closed Riverside Landfill. The creek flows from the upper region through to Centennial Park Pond, Jones Lake, then into the Petitcodiac. The creek is used as a recreational area with many pedestrian park trails along its banks.

Urbanization has the major impact on the Jonathan Creek's water quality due to the creek's proximity to the Moncton Industrial Park and from residential and commercial storm sewer outlets that discharge into the creek. The lower areas of the creek are highly sedimented from bank erosion and runoff coming from ditches which makes the water murky, a characteristic of the region. Fish passage through the creek restricted because of two barriers located at the outfalls of Centennial Park Pond and Jones Lake. These barriers have serious impacts on anadromous fish species like Trout and Salmon that have no access to spawning grounds upstream.


moncton
dieppe
riverview

a6 photographic evidence of leachate contamination

a6.01 landfill perimeter leachate seepage, western mound


a6.02 landfill perimeter leachate seepage, western mound

a6.04 *landfill perimeter leachate*
eastern mound

***a6.04** landfill perimeter leachate seepage into marsh*

***a6.05** landfill perimeter leachate seepage into marsh*

a7 emergent plant species

01-41	landfill plant species
42-47	roadside plant species
48-61	railway corridor plant species
61-69	riverbank plant species
70-78	garden plant species
79-91	park plant species

Hieracium Pratense
Sunflower Family (Asteraceae)

Description: hairy mostly leafless stalk bears several heads of bright yellow ray flowers.

Flowers: heads 1.3cm wide, each surrounded by bacts covered with gland-tipped black hairs.

Leaves: basal leaves 5-25 long, oblong, untoothed, covered with stiff hairs.

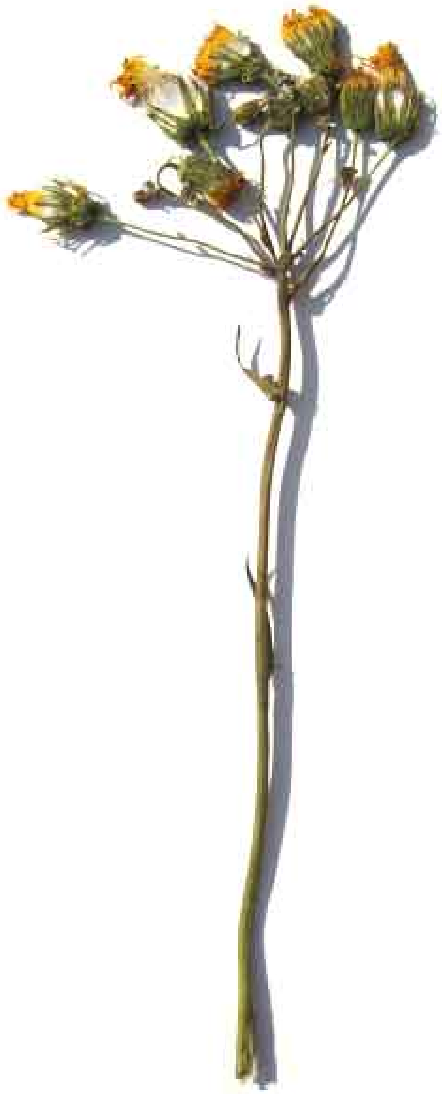
Height: 30-90cm

Flowering: May-August

Habitat: Pastures and roadsides

Range: Southern Ontario and Quebec to Nova Scotia; New England south to upland Georgia, west to Tennessee

Comments: this perennial is similar to the Orange Hawkweed (H. aurantiacum), differing primarily in flower color. Both introduced from Europe, they are considered weeds by farmers since they spread quickly by leafy runners.



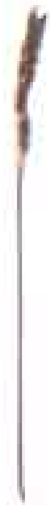
a7.07 yellow hawkweed

a7.01 st johnswort

a7.02 tansyleaf aster

a7.08 golden rod

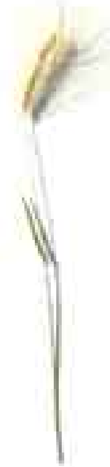
a7.09 alfalfa



a7.03 redtop

a7.04 vetch

a7.05 fireweed



a7.06 fox tail barley

a7.10 yarrow

a7.11 hop clover

a7.12 thistle

a7.13 raspberry

(Scirpus Cyperinus)

Sedge Family

Description: a compound umbel, amde up many spikelets on branching rays, is at the top of a triangular or nearly round stem and is surrounded by spreading green leaf-like bracts, spikelets wooly in fruit.

Flowers: about 6mm long, spikelets ovoid to cynlindric, their reddish to brownish scales ovate to land-ceollate, with 6 protruding bristles representing the sepals and petals; stamens 3; styles 3 cleft. Bracts under inflorescence unequal, dropping at the tips.

Leaves: up tp 60cm long and 1.3 wide; rough-margined

Height: 90-150 cm

Flowering: August-October

Habitat: Swamps, wet meadowns

Range: Newfoundland and Nova Scotia; south form New England to Florida; west to Texas; north to Minnesota

Comments: This is one of several species of important wetlands plants, many of them emergents, that provide food and cover for waterfowl and other wildlife. Nearly 30 species occur in the East.

a7.20 Wool Grass

a7.14 aspen

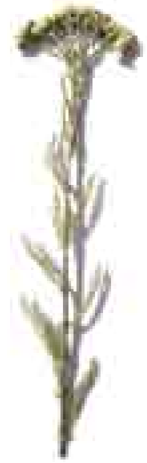
a7.15 honeysuckle

a7.21 meadow sweet

a7.22 meadow grass

a7.16 staghorn

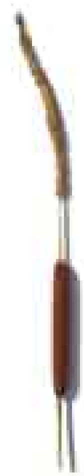
a7.17 common mullein



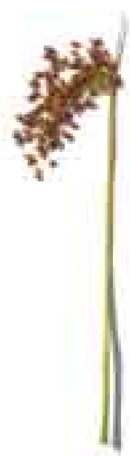
a7.18 yarrow

a7.19 common milk weed

a7.23 cord grass



a7.24 narrow leaf cattail



a7.25 scirpus

a7.26 burdock

Trifolium Agrarium
Pea Family (Fabaceae)

Description: small yellow, pea-like flowers clusteres in roundosh-oblong heads above leaves divided into 3 wedge-shaped leaflets; stems mostly smooth and erect.

Flowers: 6mm long, in heads 1.3-2.5 wide, with 20-40 flowers turning brown with age.

Leaves: leaflets 1.3-2cm long, lanceolate to oblong, stalkless.

Height: 15- 45 cm

Flowering: June-September

Habitat: Fields, roadsides, and waste places

Range: throughout, but most common in northern U.S.

Comments: this species, also known a T. aureum, is one of 3 annual yellow clovers in the United States, all introduced from Europe. They are primarily low plants, often found in lawns and gardens. Low Hop Clover (T. campestre) has sprawling hairy stems, and its terminal leaflet is stalked and notched. Lest Hop CLover (t.dubium) is similar but has a very small flower head with only 3-15 flowers.

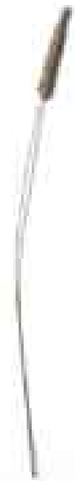
a7.33 hop clover

a7.27 purple loosestrife

a7.28 rough bedstraw

a7.34 red clover

a7.35 golden rod

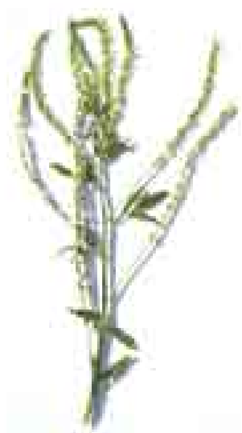

a7.29 timothy


a7.30 hop clover


a7.31 rabbits's foot clover


a7.32 birds foot trefoil


a7.36 northern bedstraw


a7.37 white sweet clover


a7.38 tansy


a7.39 bedstraw

Rumex Crispus

Buckwheat Family (Polygonaceae)

Description: a stout plant with small, reddish or greenish flowers in a long, slender, branching cluster at the top of a stem bearing leaves with very wavy margins.

Flowers: about 4mm long; sepals in 2 cycles of 3 petals absent

Leaves: 15-25cm long, oblong to lanceolate, margins, crisped.

Fruit: seed-like, brown, enclosed by calyx of 3 "wings" with smooth margins.

Height: 60-120cm

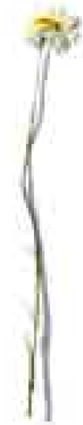
Flowering: June-September

Habitat: oil fields, waste places.

Range: throughout

Comments: These introduced species are common pasture, meadow, garden, or roadside weeds. The young leaves haev a rather pleasantly bitter, lemonish, flavour and can be used with other greens in salads.

a7.46 curly dock



a7.40 oxeye daisy

a7.41 trembling aspen

a7.47 cheeses (common mallow)

a7.48 sugar maple

a7.42 burdock

a7.43 narrow leaved cattail

a7.44 fireweed

a7.45 rose leaf

a7.49 rough golden rod

a7.50 leaf of tansy

a7.51 rattlesnake weed

a7.52 purple loosestrife

Pinus Banksiana

Description: open crowned tree with spreading branches and very short needles; sometimes a shrub

Height: 9-21cm

Diameter: 0.3m

Needles: evergreen 2-4cm long. 2 in bundle; stout, slightly flattened and twisted, widely forking; shiny green

Bark: gray-brown or dark brown; thin with narrow scaly ridges

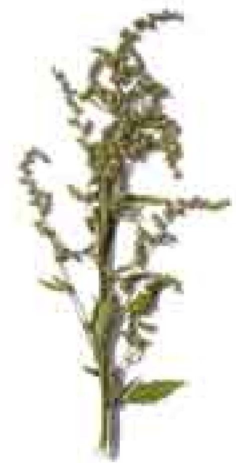
Cones: 3-5cm long, narrow, long-pointed, and curved upward; shiny light yellow; usually remaining closed in tree many years; cone-scales slightly raised and rounded, keeled mostly without prickle.

Habitat: sandy soils, dunes, and on rock ourcrops; often in extensive pure strands

Range: Mackenzie and Alberta, east to central Quebac and Nova Scotia, a southwest to New Hampshire, and west to N. Indiana and Minnesota; to about 610m.

Comments: Jack pine is a pioneer after fires and logging, slthough it is damaged or killed by fires. The cones usually remain closed for many years until opened by heat of fires or exposure after cutting. The northernmost New World pine, it extends beyond 65 degrees northern latittude in Mackenzie and nearly to the limit of trees eastward. Kirtland's warbler is dependent upon Jack Pine; this rare bird breeds only in northern central michigan, where it is confined to dense stands of young pines following forest fires.

a7.59 jack pine

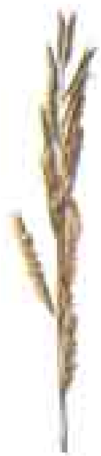


a7.53 lamb's quarters

a7.54 swamp squawweed

a7.60 pin cherry

a7.61 queen annes lace



a7.55 cordgrass

a7.56 grey birch

a7.57 redtop grass

a7.58 burdock

a7.62 orange day lily

a7.63 cow vetch

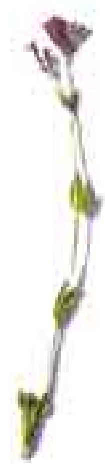
a7.64 wild strawberry

a7.65 rabbits foot clover

a7.72 brown eyed susan

a7.66 oyster plant

a7.67 rose mallow

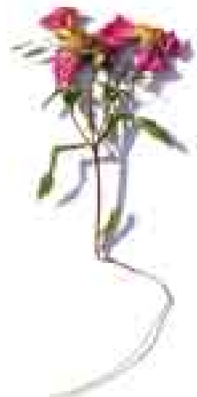


a7.73 aster

a7.74 orange hawkweed

a7.68 goldenrod

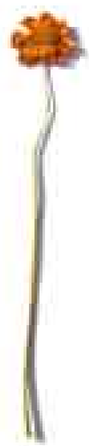
a7.69 red clover



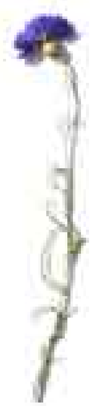
a7.70 pasture rose

71. orange day lily

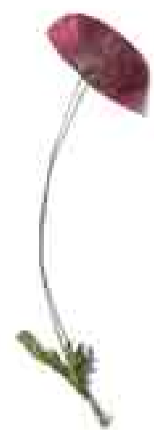
a7.75 pasture rose



a7.76 orange hawkweed



a7.77 aster



78. unknown

Oenothera Biennis

Evening Primrose Family (Onegraceae)

Description: at the top of a leafy stalk bloom lemon-scented, large yellow flowers. stem hairy, often purple tinged.

Flowers: 2.5-5cm wide, petals 4, sepals 4, reflexed, arising form top of long floral tube, stamns 8, prominent; stigma cross shaped

Leaves: 10-20cm, slightly toothed, lanceolate

Fruit: oblong capsule, 2.5 long, often persisting.

Height: 60-150cm

Flowering: June-September

Habitat: Fields, roadsides

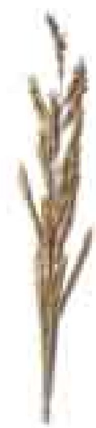
Range: throughout

Comments: the flowers of this night- flowering biennial open in the evening and close by noon. The plant takes 2 years to complete its life cycle, with basal leaves becoming established the first year, and flowering occuring the second. The roots are edible, and the seeks are important as bird feed. Of the 18 species occuring in our area, all but 2 species have yellow flowers. Showy Evening Primrose (O. speciosa) has pink or white flowers; Tooth-leaved Primrose (O. serrulata)

a7.85 evening primrose

a7.79 yellow birch

a7.80 meadow sweet



a7.86 cord grass

a7.87 golden rod

a7.81 sugar maple

a7.82 mountain ash

a7.83 spruce

a7.84 daisy

a7.88 daisy fleabane

a7.89 fireweed

a7.90 sumac

a7.91 scirpus sp. leafy three-square

Aerobic: Having molecular oxygen as part of the environment. Growing (e.g., aerobic bacteria) or occurring (e.g., aerobic decomposition) only in the presence of molecular oxygen.

Anaerobic: Absence of molecular oxygen. Growing (e.g., anaerobic bacteria) or occurring (e.g., aerobic decomposition) only in the absence of molecular oxygen.

Bioreactor: A controlled environment used to grow microorganisms.

bioremediation: the use of either naturally occurring or deliberately introduced microorganisms or other forms of life to consume and break down environmental pollutants, in order to clean up a polluted site.

Degradation: The breakdown of a compound into simpler compounds.

Ex situ: A site remediation strategy that involves excavation or extraction of contaminated soil or water. May involve transport of contaminated material away from the contaminated site, though not necessarily.

Garbage: A note on terminology. Several words for the things we throw away- "garbage", "trash", "refuse", "rubbish"- are used synonymously in casual speech but in fact have different meanings. Trash refers specifically to discards that are at least theoretically "dry"- newspapers, boxes, cans, and so on. Garbage refers technically to "wet" discards- food remains, yard waste, and offal. Refuse is an inclusive term for both the wet discards and the dry. Rubbish is even more inclusive: it refers to all refuse plus construction and demolition debris. The distinction between wet and dry garbage was important in the days when cities slopped garbage to pigs, and needed to have the wet material separated from the dry; it eventually became irrelevant, but may see a revival if the idea of composting food and yard waste catches on. Rubbish! The Archaeology of Garbage pg 9

In situ: A site remediation strategy that involves on-site treatment of contamination without excavation.

Leachate: Liquids that have moved downward through the soil and that contain substances in solution or suspension.

Soil structure: The combination or arrangement of primary soil particles into secondary units or peds, with secondary units being classified on the basis of size, shape, and grade.

Tidal Bores: Sometimes the front of the rising tide propagates up a river as a bore, a churning and tumbling wall of water advancing up the river not unlike a breaking surf riding up a beach. Creation of a bore requires a large rise of tide at the mouth of the river, some sandbars, or other restrictions at the entrance to impede the initial advance of the tide, and a shallow and gently sloping riverbed. Simply stated, the water cannot spread uniformly over the vast shallow interior area fast enough to match the rapid rise at the entrance. Friction at the base of the advancing front, plus resistance from the last of the ebb flow still leaving the river, causes the top of the advancing front to tumble forward, sometimes giving the bore the appearance of a traveling waterfall..

a8 definition of terms

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