Landscape Beneficial Management Practices: The contribution of landscape design to the sustainability of livestock operations

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in partial fulfillment of the requirement for the degree of:

Master of Landscape Architecture

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Abstract

This practicum explores the potential role that landscape planning and design can play in improving the relationship between the public and farmers whose method of production involves an intensive livestock operation.

The work involves five areas of exploration: bioremediation, odor control, climate mitigation, biosecurity, and aesthetics. Bioremediation is explored in the context of constructed wetlands for wastewater treatment. A new shelterbelt design, an eco-buffer, is reviewed for its applicability in odor control and climate mitigation. Biosecurity is addressed through site planning while design interventions and vegetation selection address aesthetics.

The site is that of the Glenlea Research Station (GRS) belonging to the Faculty of Agricultural and Food Sciences, University of Manitoba. The GRS is home to a major undertaking of the Faculty, the National Centre for Livestock and the Environment. A new addition to the site is a visitor centre, The Bruce D. Campbell Food and Farm Discovery Centre.

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This practicum is dedicated to Jack Brogan

Long-time employee of the Glenlea Research Station

And station manager from 1999 to 2009.

He has a good heart.

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Acknowledgements

I would like to extend my appreciation to:

- My husband, Randy Baldwin, for supporting me financially and emotionally during my long journey to obtaining my Masters Degree, and for only once or twice asking me why cutting colored pieces of paper and gluing them onto board had anything to do with Landscape Architecture, when it seemed better suited to kindergarten.
- My daughter, Amanda, with whom I exchanged assessments of the university experience and commiserated about professors' ridiculous expectations. When I got off track she reminded me, "Get on with it, Mom." And who graduated long before I did.
- My parents for raising me to have the intestinal fortitude to complete this journey.
- My committee members, Karin Wittenberg, Associate Dean, Research, Faculty of Agricultural and Food Sciences, for the unbelievable opportunity she gave me in allowing me to use the Glenlea Research Station as my site; to Derek Murray, partner in Scatliffe + Miller + Murray, for his advice on keeping it real and teaching site grading, which I put into practice; and to Jean Trottier, committee chair, for his immense amounts of patience and insight, and for hanging in when I am sure he thought I would become his permanent grad student. He also deserves special recognition for giving of his sabbatical time to continue to assist me in reaching the conclusion of this journey.
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- All those people in academia, government agencies, non-governmental organizations, and the private sector who responded to my questions so quickly and willingly, especially those who took me on tours of their facilities. The Internet is an amazing place where one minute you can be reading about something, and the next have an email conversation with the author. I cannot say enough about all these "other" people who were so forthcoming with their assistance.
- Marcella Eaton, whom I did not always understand and with whom I did not always agree, but whom I have always respected, for her amazing teaching talent and dedication to helping students understand and see the bigger picture, and for introducing me to Saskatchewan-born artist Agnes Martin – I will never look at a prairie sky the same way again. It's a beautiful world.
- The Manitoba Rural Adaptation Council for funding a portion of this practicum.

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Prologue

My journey towards a Master in Landscape Architecture was, I thought, a journey away from agriculture. Landscape Architecture was something I had considered pursuing many years ago, just after completing my Bachelor of Science in Agriculture. For whatever reason, most likely due to the vagaries of youth, I chose to spend my career in the field for which my undergraduate degree had trained me.

After spending what I had come to believe were too many years in agriculture watching more years of low prices than high, experiencing friends and family battle weather and unpredictable markets, and seeing a public who wanted agriculture's products but not its method of production, I quite literally crossed the road and entered the J. A. Russell Building, intending to turn my back on the Faculty of Agricultural and Food Sciences.

I didn't realize that I had started down the road to this practicum several years ago when I attended an annual meeting of the Canadian Society of Landscape Architects and heard Cornelia Hahn Oberlander speak about a wastewater treatment wetland she had designed on the campus of the University of British Columbia.

Then there was Dan Nuttall's ecology course that made me a touch less anthropocentric and a touch more ecocentric. Finally there was the course The Art and Science of Sustainable Agriculture, taught by Martin Enns back in "my" faculty, that propelled me further down the track to this practicum.

I found myself pulled back to agriculture. It had been a journey from science to nature and back again, but now with a little less science and a little more nature in the mix.

This practicum was also a journey in learning how to see elements as part of a whole, rather than in isolation. My design process moved from looking at individual elements to understanding how they fit together to create a holistic design.

Finally, the site, the Glenlea Research Station, is near and dear to my heart as it is where I had my first summer job as a member of the Hort Crew – and where my daughter followed in my footsteps some 35 years later.

Chapter I

Introduction

Background

Intensive livestock operations (ILOs), known as concentrated animal feeding operations CAFOs in the United States, are now an integral part of the rural countryside. ILOs are described as those farm enterprises where large numbers of animals, more often than not one species per farm, are maintained in environmentally-controlled facilities.

Figure 1: A hog ILO.
Some ILOs lack any aesthetic enhancements.

From a farmer's perspective, ILOs allow enhanced care of livestock that otherwise may be at risk of death or injury from predation, diseases in the environment, or adverse weather conditions. Intensive livestock operations allow farmers to monitor large numbers of animals to ensure each one receives sufficient nutrition, feeding those separately who, due to lower social status, would otherwise be "bossed" away from the food source. Animals in ILOs are removed from predation by wildlife or their own species, in the case of hogs and poultry. They don't have to respond to the vagaries of weather. ILOs also offer farmers the ability to become familiar with and focus on one species. Additionally ILOs allow farmers to raise livestock in a humane manner in numbers that allow farm families to remain financially viable.

Farmers have in common with the non-agricultural public (NAP) a concern for the well-being of the livestock under their care. The NAP also wants to be assured that farmers are concerned about the environment, including land and water stewardship and resource conservation, and the production of safe, wholesome food.

There is a portion of the NAP that views ILOs as counterproductive in achieving the well-being of animals and the environment and, consequently, humans. It is natural when one is removed from, or unfamiliar with, a facet of society to view it in the context of one's own experience or perspective. For some, ILOs represent the antithesis of acceptable food production practices.

Agriculture is an ever-evolving entity. As with other parts of society, there are always some who are on the leading edge, the innovators and early adopters, who are willing to change. Others follow their lead.

In the case of ILOs, where there are demonstrated benefits for both farmers and domestic food animals, there is potentially the opportunity to make changes that could be regarded as more in tune with natural systems and a more holistic approach to animal agriculture.

Consequently this practicum, Landscape Beneficial Management Practices: the contribution of landscape architecture design to the sustainability of livestock operations, explores some of those opportunities to determine the role that landscape architecture can play in indentifying and demonstrating beneficial management practices that build bridges between the NAP and farmers involved in ILOs.

The site

The Glenlea Research Station (GRS) is a natural location to explore beneficial management practices in the context of landscape design. A component of the Department of Animal Science, Faculty of Agricultural and Food Sciences, University of Manitoba, the GRS has been home to the National Centre for Livestock and the Environment since 2007. In December 2009, earth was turned for the Bruce D. Campbell Farm & Food Discovery Centre, which is scheduled to open in the spring of 2011.

The National Centre for Livestock and the Environment (NCLE) has its feet in both the real and virtual worlds. At the GRS, NCLE has several very concrete facilities – conventional and alternate hog barns, a feed mill, a dairy research laboratory, and manure handling facilities. The centre is virtual in that it links a number of researchers across disciplines, departments, the campus, the province and the country.

NCLE is a one of a kind research facility in Canada in that it will do long-term studies of up to 25 years in length when most research projects last five years and occasionally 10. More significantly, though, for the purpose of this practicum, its approach to research is holistic. Research programs at NCLE are intended to look at agricultural production as a system rather than individual units in isolation – to follow crop production from the field through the animal and back to the field; to investigate the interrelationships between livestock and soil, water, micro-organisms and human health. The goal is to indentify and develop environmentally sustainable livestock production practices. The landscape is an integral part of environmental sustainability.

The Bruce D. Campbell Farm & Food Discovery Centre is a place of exploration for the public. It is intended to highlight the links between agricultural research, agricultural production and the food we eat.

Figure 2: Artist's rendering of the Bruce D. Campbell Farm & Food Discovery Centre.

The Glenlea Research Station is a place to both explore and profile ways in which landscape architecture can assist with beneficial management practices that link natural cycles and the sustainable use of resources.

Chapter 2

Scope of this practicum

Governing principle

The governing principle of this practicum is to find ways, where possible, to introduce natural systems into the intensive livestock operation. While this may appear to be an oxymoronic undertaking – introducing natural practices to a mechanically structured production system – there is value in agricultural production rediscovering its roots in nature.

Five areas of exploration

This practicum revolves around five areas of exploration and the interrelationship between agriculture and landscape architecture. Those five areas identified at the outset as having potential application to ILOs and being of interest to both the client[1] and the investigator are the following:

- Bioremediation
- Odor control
- Climate mitigation
- Biosecurity
- Aesthetics

Bioremediation

Bioremediation refers to the use of living organisms to reduce or remove pollutants in the environment. In the context of this practicum, bioremediation refers specifically to the investigation of the use of constructed wetlands to improve the quality of domestic and barn wastewater and overland run-off.

[1] The client is considered to be Dr. Karin Wittenberg who was director of the Glenlea Research Station during the initial stages of this practicum prior to becoming Associate Dean, Research in the Faculty of Agricultural and Food Sciences. She has been instrumental in securing funds for the establishment of the National Centre for Livestock and the Environment and the Bruce D. Campbell Farm & Food Discovery Centre.

Odor control

Odor can become an issue where livestock are raised intensively. Odors can come from any number of places: vented air from inside climate-controlled barns; external manure storage facilities; and bedding used to overwinter livestock outside. Shelterbelts and their siting are investigated for their potential to reduce livestock odors.

Climate mitigation

Reducing wind velocity and snow deposition are important considerations in making a site efficient and comfortable for humans and animals and reducing heat loss in buildings. Shelterbelts have long been used for such purposes; however, the prairie climate often means that establishing a successful shelterbelt takes time and effort. As part of this practicum, an innovative style of shelterbelt is explored.

Biosecurity

In defining biosecurity, "The Food and Agriculture Organization of the United Nations has a 100-word definition of biosecurity which can be summarized as 'preventive measures for the management of invasive alien species, genotypes and viruses which threaten livestock, poultry and plants and which can have adverse consequences for human health.'" [www.agbiosecurity.ca]

In the case of research, biosecurity has an additional meaning – securing facilities to reduce the likelihood of research trials being contaminated or compromised. In the case of this practicum, site design is investigated as a directional control for human traffic.

Aesthetics

How we perceive and feel about a place is greatly influenced by aesthetics. "Socio-psychological factors play a role in livestock odor being perceived as a nuisance. … those farms that appeared to be more subjectively attractive were perceived to be less odorous." [Tyndall 2008]

A significant portion of this practicum explores design interventions that improve the aesthetics of the site.

Three components

The hypothetical

Given that this is a practicum for Landscape Architecture, design interventions are integral to the undertaking. For the most part, the design interventions developed for the site are hypothetical because they explore what could be done not necessarily what will be done. The hypothetical is valuable because it allows one to see what is possible when there are no constraints. It is in the hypothetical where one can explore the "big" ideas that lead to innovation.

The possible

The practicum was undertaken with the specific intention of exploring two interventions which could be realized: the use of constructed wetlands as a treatment for waste water, both domestic and agricultural, and the use of shelterbelts modified from the traditional use of multiple rows of single species, including conifers.

In addition, through site planning, it was the wish of the client that a master plan of the site be prepared that could provide guidance for future redevelopment as buildings become redundant or need replacement.

The practical

At the outset, it was not anticipated that this practicum would live up to the roots of its name:

> prac-ti-icum (prak' ti kəm), n. (in a college or university) the part of a course consisting of practical work in a particular field [1900-05; < L. neut. of practicus PRACTIC] [Random 1517]

However it did, in spades.

The practical aspect involved inventorying the health of plant material on the site and providing advice to site staff on how to care for it; walking the site with arborists to confirm plant material that needed major pruning or removal; contracting with landscape companies for pruning or removal of trees on two occasions; discussing tree protection for construction sites; contracting the moving of a tree; and advising horticultural summer staff on appropriate plant material and its maintenance.

The practical component reinforced my conviction that interventions should not be put where staff don't want them to be put because if they are moveable, they will disappear.

Chapter 3

Site inventory

Background

The Glenlea Research Station (GRS) was opened in 1966, 20 km south of the University of Manitoba's Fort Gary campus. The research station was originally three farms which were purchased in 1962. The station is located in the Rural Municipality of Richot, 5 km south of Provincial Highway 210, on Highway 75. The building site is located between the highway and the Red River.

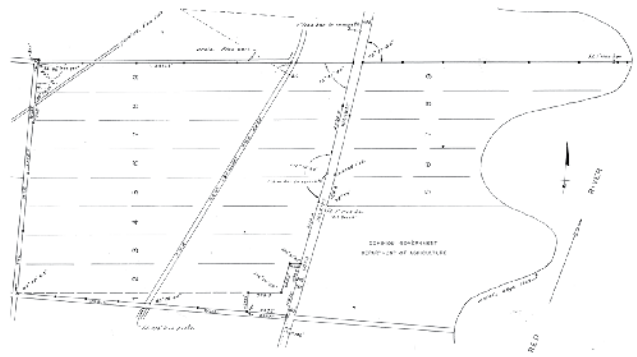


Figure 3: Glenlea Research Station land base, survey plan,1963.

The GRS owns five full and four partial river lots in the Parish of St. Norbert. Lots five through nine begin at the Red River and run west of Highway 75. The remaining four lots run west of Highway 75. The area related to the livestock research component of the site comprises about 35 acres[2], with another four acres for staff housing. To the south of the building site is an area of 12 acres that has been used in the past by the Department of Psychology for waterfowl studies. Currently, the Department of Physics and Astronomy runs the Ewen Remote Observing Site through the Glenlea Astronomical Observatory for research that is geared towards observations of Near Earth Asteroids (NEAs). In addition, about 1,240 acres are used for

Figure 4: Ewen Remote Observing Site.

[2] In this document, the metric system is used for measurement as that system has been generally accepted across Canada, and it is the format used in the Department of Landscape Architecture, Faculty of Architecture, University of Manitoba for plan preparation. In the agricultural community, however, Imperial measure remains the generally accepted form of measurement for land area, largely because the Prairies were square-surveyed in the late 1800s, creating a grid system on the landscape of land parcels of one square mile which contains 640 acres.

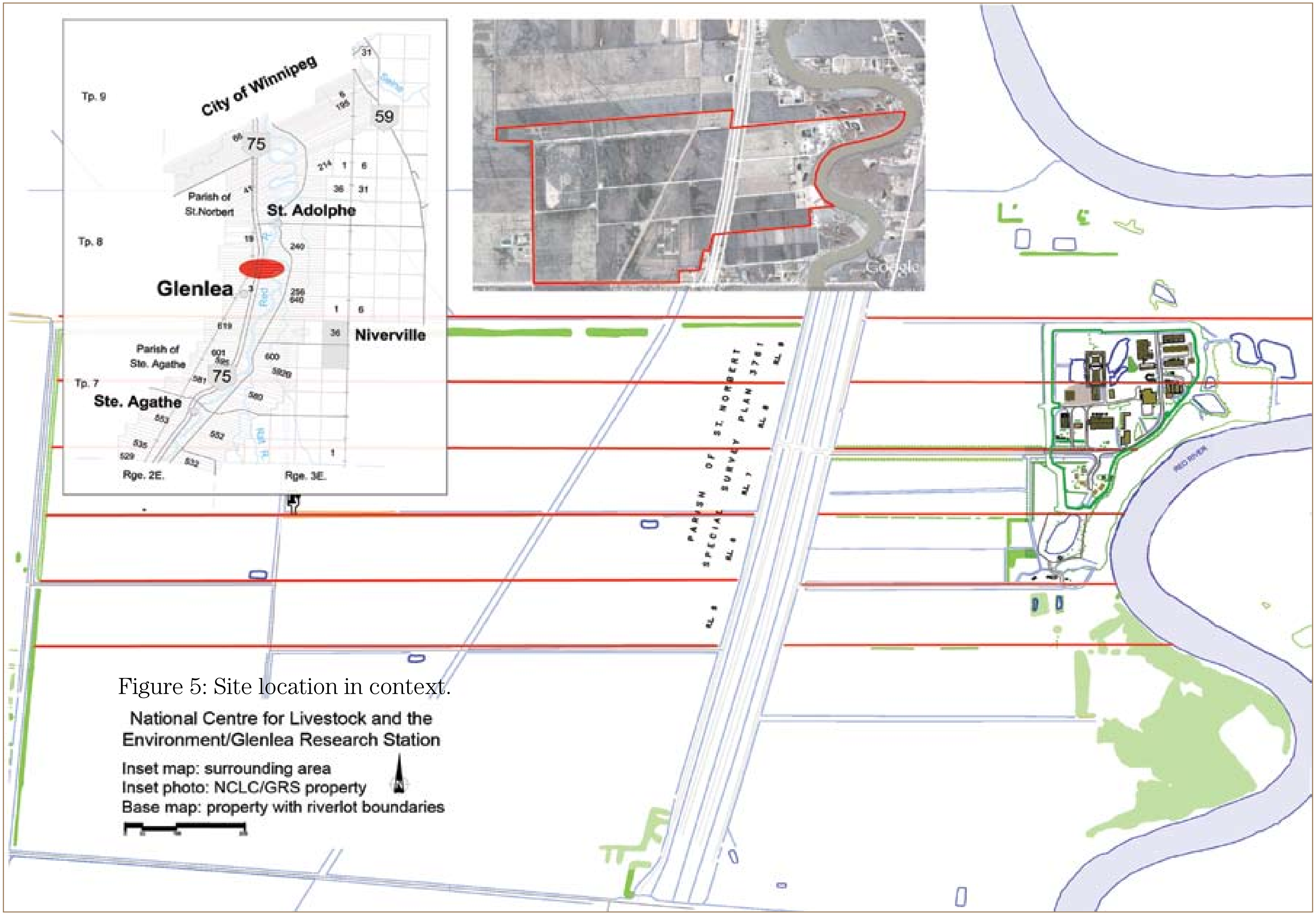
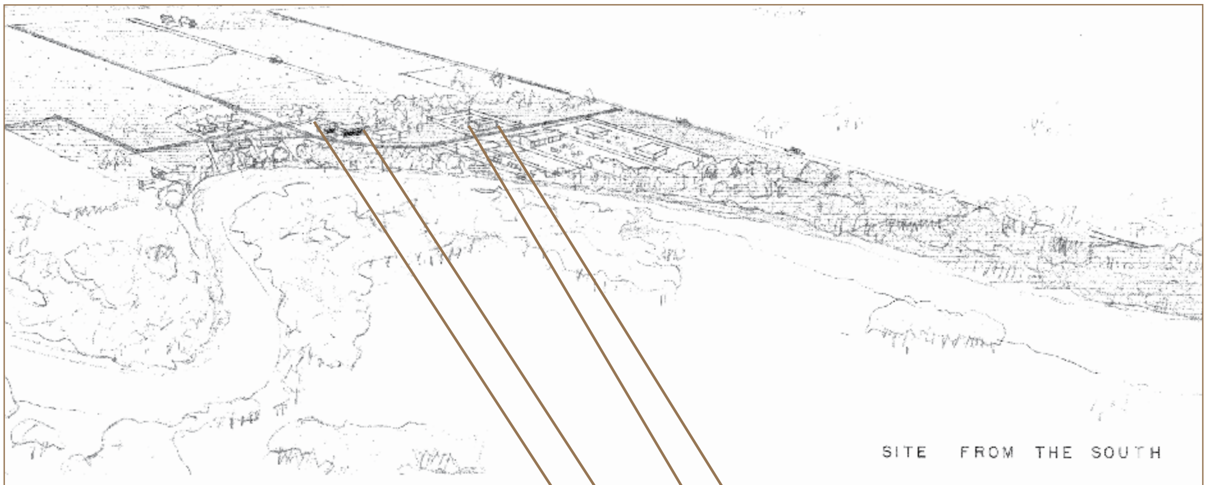


Figure 5: Site location in context.



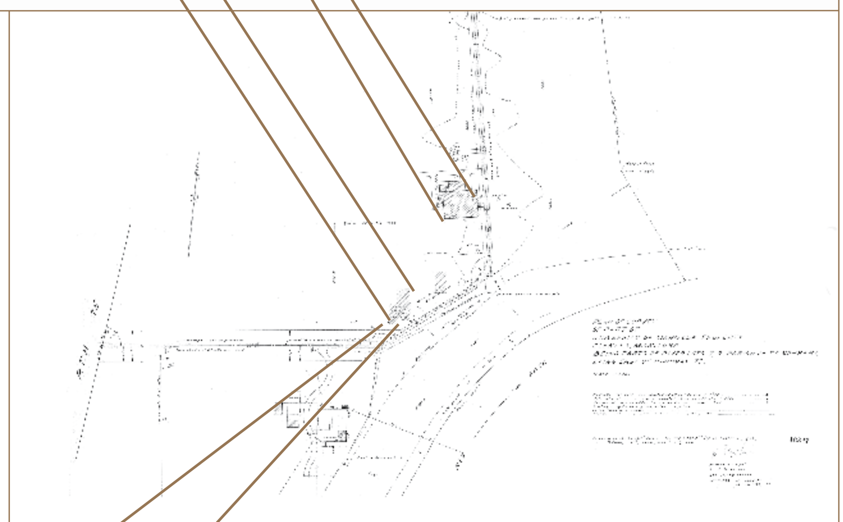
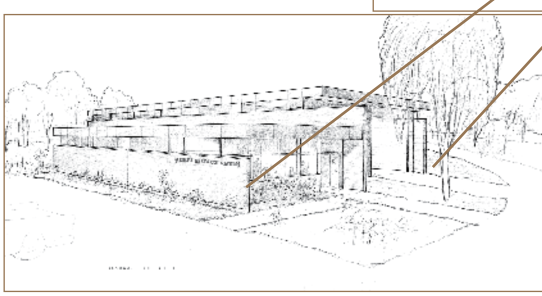


Figure 6: Architectural rendering, GRS site, 1963.

Figure 7: GRS site survey, 1964.

Figure 8: Architectural rendering, GRS administration building, 1963.



crop production and crop-related research, located on both sides of Highway 59.

The main building site, referred to as "the site" for the purposes of this practicum, is enclosed by just over 1.6 km of dike which was rebuilt after the major flood of 1997 to about two metres above the high water level.

Facilities on the site include both original buildings from the 1960s and facilities built within the last ten years for the work done as part of NCLE research.

Original facilities:

- a 68-cow stanchion or tie-stall dairy barn
- a decommissioned hog barn
- an office and attached shop and machinery storage area
- loose housing cattle sheds

- storage sheds
- granaries
- five houses for staff

New facilities:

- a feedmill,
- two 130-sow farrow to finish hog barns
    - conventional using slatted floors and mechanical ventilation
    - alternative using straw bedding and natural ventilation
- a swine research barn located on the west side of Highway 75

Figure 9: Alternate hog facilities, Glenlea Research Station.

Inventory process

Initial site visits were done through the late summer and fall of 2007. Conversations were held with key staff members on the site – those in charge of units of the station. The discussions revolved around what they liked and didn't like about the site; particular issues related to climate, aesthetics, and functioning of the site; and where they would make improvements if given the opportunity.

Numerous trips were made over the subsequent two-and-one-half years observing seasonal changes; human/site interactions; animal/site interactions; traffic circulation and influences on the site.

Complicating the inventory process was the fact that the site was in a state of flux with construction that had been started in 2004 reaching completion; new construction being undertaken; and physical changes being made to the site itself. It almost became a

Figure 10: Administration building landscaping.
The Amur maple on the far left was lost to construction, while the maple in the centre was severly damaged during contruction of the waste water treatment plant.

case of “first you see it, then you don’t” in that items initially taken into account in the inventory were moved, removed, adjusted or added to.

Figure 11: Waste water treatment facility.

Over the period of this practicum, a wastewater treatment facility was constructed, becoming operational in 2008; a hay storage shed was built in 2008; internal borrow pits resulting from building the dike were filled in during 2008 and 2009; a new service roadway was built; and construction on the Bruce D. Campbell Farm & Food Discovery Centre was started in the fall of 2010.

Staff changes also occurred on the site leading to different human/site interactions. For example, one of the staff with young children moved off site altering initial safety concerns.

Extensive observations were made of the vegetation on the site, which is a mix of planted and natural trees and shrubs. There are few perennial flowering plants. Annual bedding plants are planted every summer to a limited degree.

Site control and maintenance

Although a facility of the University of Manitoba, and therefore under the jurisdiction of the university’s Physical Plant for construction and major maintenance issues, the fact that the GRS is removed from campus has resulted in a complicated arrangement of site oversight. Larger projects remain under the purview of Physical Plant staff, but being distant from campus means that staff is not always on the site at opportune times.

Smaller projects, for expedience, have in the past been undertaken by local contractors under the direction of station staff. This has resulted, at times, in detailed plans being unavailable for reference. For some aspects of the site there are no plans at all. This has resulted in staff memories being the repository of information about the site.

Lack of accurate mapping of underground services – water, electrical and waste – has resulted in lines being broken resulting in costly repairs or the need to resurvey to ensure the accurate location of utilities.

On the research side, the site is under the direction of the Head of the Department of Animal Science; however, researchers from other departments of the Faculty of Agricultural and Food Sciences (FAFS) use the site, store equipment there, and expect assistance from the GRS staff with equipment maintenance and field access.

Introduced recently to the mix has been NCLE with its associated buildings and new research directions. That effort is directed by a cross-departmental team, chaired by a professor from the Department of Soil Science.

The Bruce D. Campbell Farm & Food Discovery Centre, scheduled to open early in 2011, is directed from the Office of the Dean of FAFS.

Layout of the site

Movement within the site is constrained by the dike which has resulted in crowding of some of the original buildings such as the office and the shop. New construction has also contributed to crowding in some areas of the site and removal of both planted and native trees. Many of the recent developments on the site have occurred on an as-needed rather than a planned basis, consequently; there, is a sense of disorder about the site.

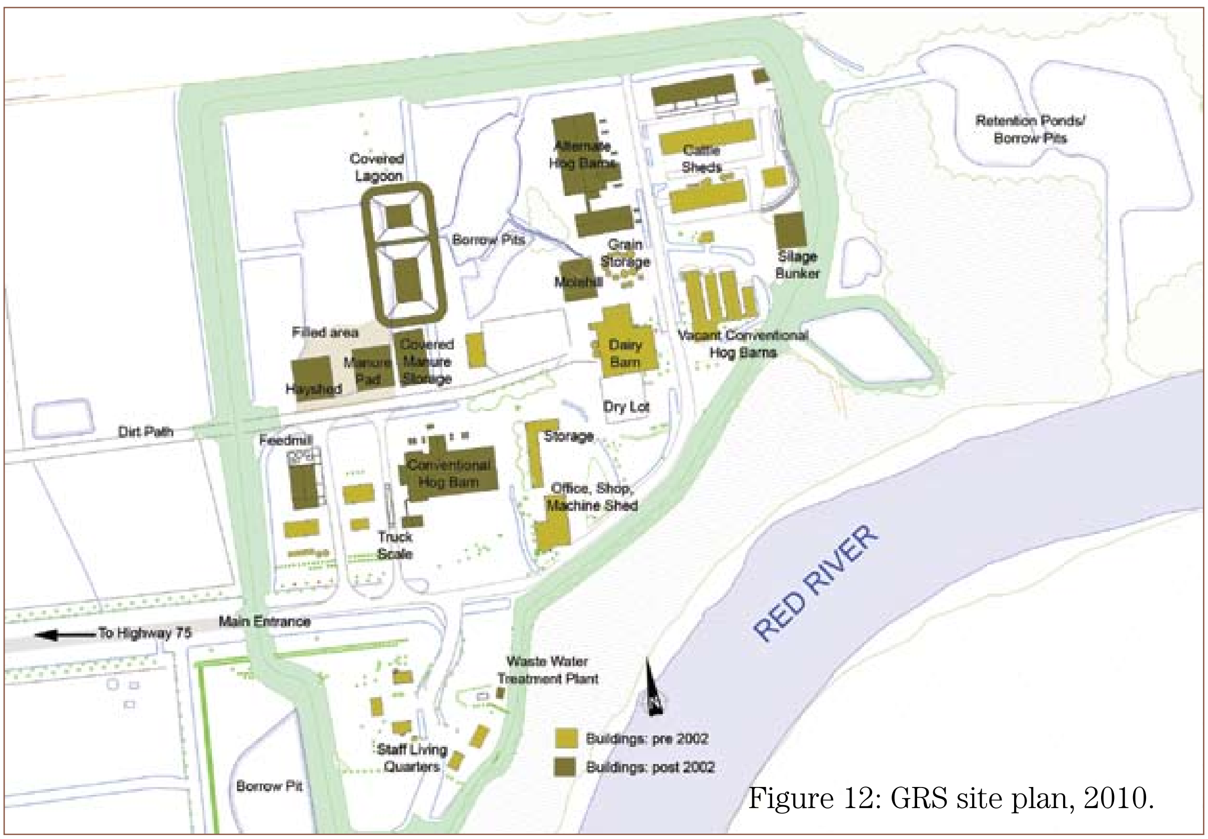


Figure 12: GRS site plan, 2010.

A borrow pit and a low lying marshy area in the north-west region of the site has constrained the placement of buildings to some degree. Much of the unbuilt land required fill or significantly improved drainage to make it suitable for building construction.

The site has been served by one main road running east approximately one kilometre from Highway 75 to the station's office. A secondary road, initially nothing more than a dirt path used for livestock and field equipment, is located approximately 140 m north of the main road. Internal circulation within the dike is constrained by dike location, unplanned site development, location of original roads, and lack of funding for the development of an effective road system.

Climate

The meteorological condition of the site was determined by site visits throughout the years of this practicum; discussions with staff on their observations; review of data collected by the Department of Soil Science from a meteorological station located west of Highway 75 on university property; and review of windroses from the Canadian Wind Energy Atlas. [Environment Canada]

Vegetation

Survey plans from 2002 show a considerable treed area on the site. Several north-south planted tree belts were located in the centre of the site, while substantial stands of native bush were located in the mid-third of the site.

South and west of the main entrance a significant portion of a mature spruce shelterbelt was removed to accommodate a temporary building site that existed for no more than three years.

Figure 13: Entrance road. A replication of the Avenue of the Elms on campus?

A row of elms, back-planted with green ash, runs the length of the main road into the site. Reminiscent of the Avenue of the Elms (Chancellor Matheson

Drive) leading to the main campus, this is one of the few visible connections to the University of Manitoba, aside from signage at the highway.

Figure 14: Mature spruce.

Vestiges of spruce and pine shelterbelts run about 85 m to the east of the dike entrance on the main road.

Five mature spruce, some of which could be specimen, sit on the "lawn" immediately south of the location for the Discovery Centre. Five Discovery Elm, of about ten years in age, stand north and west of the spruce.

Other significant trees include two Scotch pines, one north of the treatment plant and one just south of the decommissioned hog barn; a multi-stemmed silver maple in close proximity to the second Scotch pine, and two Willows outside the dairy barn. A stand of bur oak is located just to the south of the decommissioned hog barn, as well as a remnant stand north-west of the office building.

For a listing of plants and a discussion of plant material please refer to the section: The practical practicum and Appendix 1.

Fauna

The site has a serious deer problem. Deer are brazen enough to stand on the dike and watch people on the site. They have also been known to root up the same bedding plant night after night, as if in a contest to see which will give up first, the horticultural crew, the plant, or the deer. Raccoons are present occasionally. Rabbits are less of a problem than they have been in the past.

Figure 15: Evidence of the presence of deer.

Chapter 4

Site analysis

Beyond the site

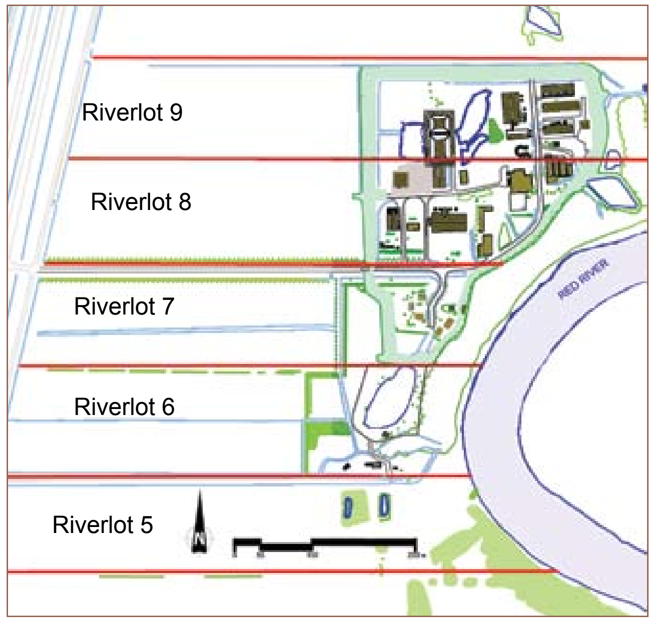


Figure 16: Riverlots.

As indicated earlier, the GRS land demarcation is not typical of prairie survey geometry in that it is river lot rather than square survey, hearkening back to early Métis and Quebecois settlement patterns along the Red River and its tributaries in the region.

Evidence of that pattern remains at the GRS despite the fact that lot lines have been largely erased by new field patterns on the property west of the highway. On the east, the main entrance road to the site is along the line dividing river lots 7 & 8. The north line of the dike follows the dividing line between lots 9 & 10. A shelterbelt demarcates the boundary between lots 6 & 7, while an access road follows the boundary between lots 5 & 6. Interestingly, more by accident than design, the south end of the dike aligns itself with the line dividing lot 6 & 7.

There are several areas external to the dike that offer opportunities for program integration with the site. East of the dike is a river-bottom forest two to three metres below an escarpment. On the escarpment is a meadow area of about 3.6 acres in which are situated two pseudo wetlands, comprising 2.5 acres. This area could be developed as a walking corridor.

The south end of the forested area opens to the Ewen Remote Observing Site of the Department of Physics and Astronomy. With appropriate signage, this area could shed light on another component of the university's activities. Adjacent to the observatory is a pond previously used by the Department of Psychology that now has become home to a couple of muskrat houses. The pond could be used as a wetland ecology demonstration area, providing the muskrats are removed if they still inhabit the site. Muskrats will destroy wetland vegetation using it as a food source and potentially damage the integrity of the dike, which the pond abuts on its north side.

Three distinct regions

In gaining an understanding of how the site works through observation of site activities, it became apparent that there are three distinct areas or regions within the site: the private, the public, and the semi-public.

The private area, south of the main road, is where staff housing is located.

The public area encompasses the area north from the main road to the "dirt" path. The office and its attached machine/workshop, to the south-east of this space, are the hub of activity on the site. Researchers come here looking for assistance; service people check in for directions; staff members congregate for lunch and meetings; visitors gather for tours.

The office location is also the pivot point for entry/exit for the research/livestock facilities and moving deeper into the site.

The semi-public area lies to the north of the dirt road. Only authorized visitors are supposed to enter this area; however, up until recently it was barrier-free allowing anyone access during and after hours.

While these three regions are functionally separate and should be, they are not physically separate or separated.

The private area is screened partially by a remnant shelterbelt

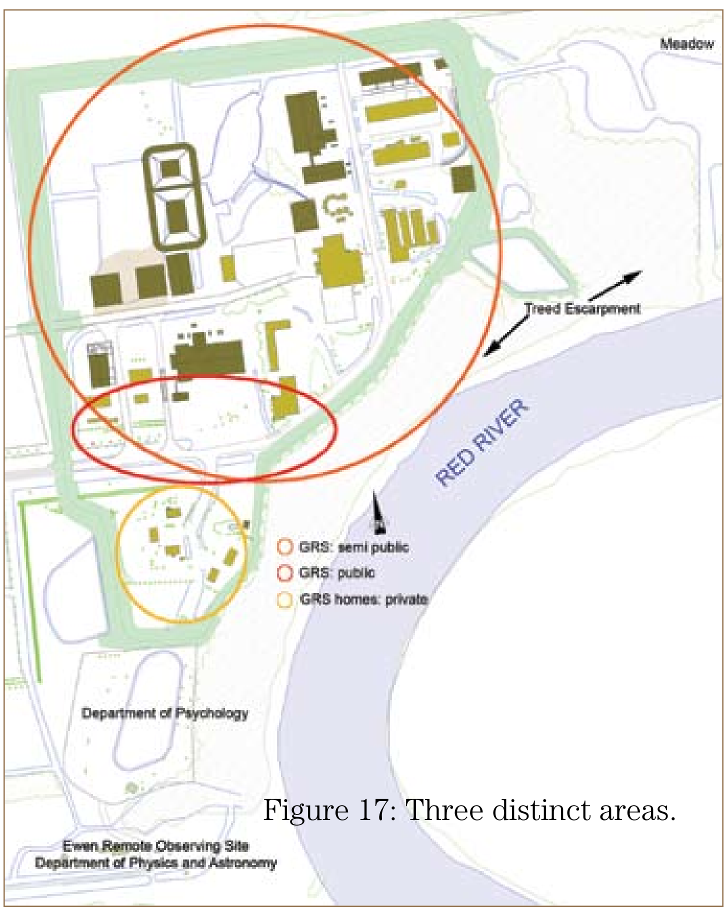


Figure 17: Three distinct areas.

on its north-west side. Vegetation that provided some screening to the north and east was removed in preparation for construction of the wastewater treatment facility. At the roadway into the area, there is no evidence that the space is private and should be respected as such. Staff reported that on weekends and after hours, the public has come into the space asking directions or wondering what can be seen on the site. Since the staff's workplace is in such close proximity to their homes, they would prefer not to be reminded of work when they are at home.

Figures 18 & 19: Proximity of play structure to main road.

The openess of the private area and its adjacency to the main road also creates safety risks for young children who may be resident in the homes. Until 2009, there was a family with young children living in the house closest to the road. Their play structure was located very close to the road.

The public area will become even more public once the Discovery Centre is opened. The public will be encouraged to visit the centre; consequently, it is crucial that the public clearly understand where they are and are not welcome without making them feel unwelcome. The public cannot be in certain areas unaccompanied for reasons of safety, biosecurity, and research integrity.

Figures 20 & 21: Blind corner.

The semi-public area or the "working" part of the site regularly has farm equipment moving through it; service vehicles making scheduled and unscheduled visits; and researchers gathering data. Traffic to and from this area, including crop harvesting equipment, manure hauling equipment, and livestock carriers, is all funnelled through one narrow roadway of approximately 10 metres in width, directly adjacent to the machine shop driveway where staff often fix equipment. This creates a dangerous, blind corner. It is easy for vehicle drivers, particularly those not on the site regularly, to forget that people congregate in this area. Similarly, pedestrians can forget that this is a main roadway.

Drainage/ water

Site drainage is by open ditch. Ditches have been compromised by a shortage of money for upkeep and by heavy construction equipment travelling on the site without the attendant repair of drainage channels after the construction period.

Figure 22: Floodwater surrounds the site, April 2009.

Increasingly the site is challenged by flooding of the Red River; twice during the period of this practicum the dike had to be closed by earth moving equipment to prevent floodwaters from engulfing the site. Closing and opening of the dike for each flood event is estimated to cost $15,000. This also requires the closing of eight covered outlets that drain the site, which results in storing any snow melt or rainwater water on the site for the period of the flood or pumping it over the dike.

Drainage is constrained by the dike in that to fully move water from the site, the elevation of channels can be no lower than the bottom of the opening of the external outlets if the ditches are to drain completely without mechanical assistance. Elevation of the two outlets on the west of the site at the main entrance are 233.4 m; on the extreme south in the private sector, 233.97 m; and on the north and east in the semi public sector elevations are 233.11 m at the extreme north east, followed by 232.96 moving south and then 233.41 m. The easterly two outlets in the public sector measure 233.76 m and 233.70 m, contrary to the natural drainage pattern where lower elevations are lower towards the river. Sufficient slope in many of the ditches cannot be achieved to clear the ditches by gravitational movement and evaporation must be depended on.

On the north-east side of the semi-public sector, a concrete channel carries run-off from the cattle sheds to one of the outlets which empties into a vegetated channel outside the dike that leads to the two north-east external ponds.

It is not known why the internal channel is concrete, however, it is in disrepair. The area arund the sheds and the channel needs to be regraded as the water pools in this area after snow melt and rain. Consideration needs to be given to removing the concrete and planting the channel with wetland species.

Figures 23: Cattle shed drainage.
Upper left, clockwise: alley way draining, early spring; manure stockpile from cleaning sheds; area in summer; concrete drainage channel. Inset: location on site.

In 2002, a survey done in preparation for construction of the NCLE facilities showed that the site had two internal "ponds" and four external ones: two in close proximity to the dike and two some 70 m to the north east of the dike. All are borrow pits resulting from dike construction. One pond immediately east of the dike has been used as a standby water source in the event of fire. A portion of the larger of the two internal ponds was filled to allow the construction of manure composting facilities. The second internal pond was partially filled in 2008 and completely filled in 2009 in order to reclaim land for future building construction. Portions of the two ponds were taken for the construction of a hog waste lagoon.

There are three visibly low areas on the site: in the public sector south and south-east of the feedmill; in the semi-public sector south of the decommissioned hog barn, where there is both a septic field and an area that slopes towards an external culvert; and in the semi-public area north and west of the lagoon. (Figure 24)

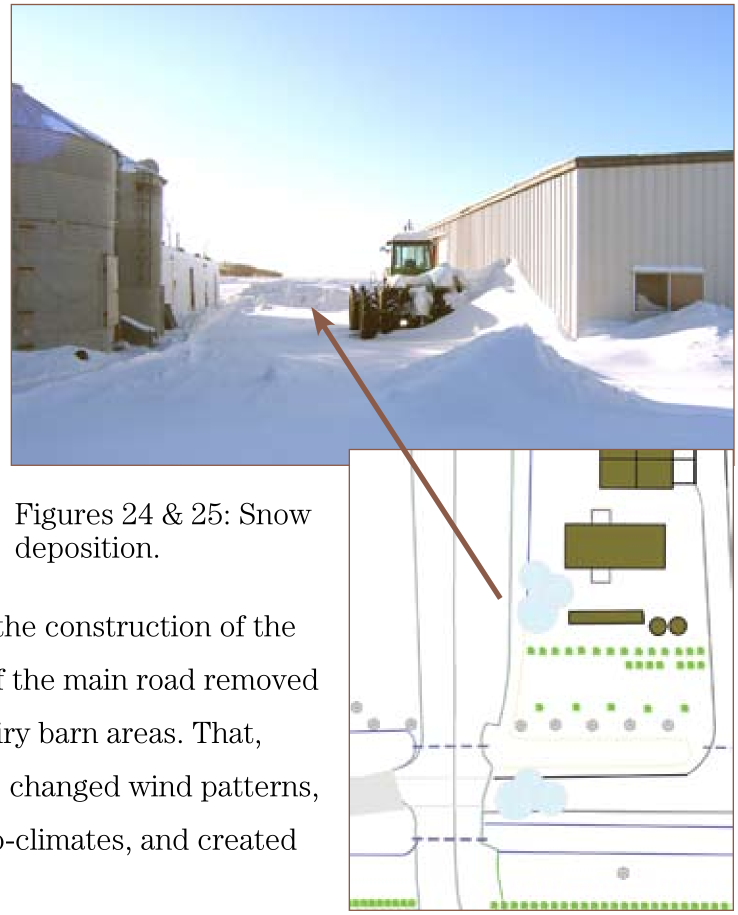
The unfenced, external borrow pit to the south-west of the site poses a safety hazard to the staff housing area if young children live in the houses. Up until 2009, one of the houses

Windrose for area of GRS, December to February.

Figure 24: Drainage patterns and dominant wind direction.

with a yard that backed onto that area of the dike was home to two children under the age of10.

Developing a drainage plan has not been attempted because of the complexity of the site. Professional expertise is required to prepare a drainage plan.



Figures 24 & 25: Snow deposition.

Climate

The removal of north-south shelterbelts and natural bush with the construction of the new conventional hog barn north of the main road removed shelter from the office/shop and dairy barn areas. That, combined with raising the dike, has changed wind patterns, created wind tunnels, altered micro-climates, and created new snow dump areas.

The wind direction is predominantly from the northwest throughout the year. It is most frequently from that direction except in June, July and August when a southerly wind is the most frequent. The greatest wind tunnel effect occurs through an east-west opening that was created when bush was removed to build the covered manure storage building and the new conventional hog barn. Winter wind can also be uncomfortable on the north-south road that runs past the livestock facilities. The wind here is not as severe because the area is more sheltered by natural bush outside the dike. Wind from the south has less effect on the site because of the riverine forest directly outside the dike on the south and the mature trees planted in the private sector.

Snow creates a problem on the main road around the entrance cut through the dike as there is no vegetative shelter and the dike alters wind patterns.

Topography

From the western edge of the GRS property to the river, the elevation drops 3.7 m over 3.14 km. For all intents and purposes, the topography inside the dike is flat. The highest spot elevation is 235.01 m and the lowest spot elevation is 234 m, neither appears to be a natural topographical occurrence but rather the result of pond or ditch digging. The two lowest areas of the site are located north-west of the hog lagoon and south of the feed mill.

The dike rises approximately 2.4 m above grade. Given the amount of earth moving that has occurred on the site, grade has been arbitrarily set at 234.4 m for design purposes.

Aesthetics

Aside from the general post-construction condition of the site, there are a number of key areas that need aesthetic improvement.

After the initial inventory gathering, it became obvious that before any design work could be done, efforts should be made to improve the health of some of the key remaining trees and remove those that were unsightly to ensure that there was a vegetative palette of some description remaining on the site.

The entrance to the site, or the foyer, needs substantial improvement. The biggest impediment to making the area aesthetically pleasing is the recently commissioned wastewater treatment plant.

Figures 26: View from front of Discovery Centre.

During the construction of the treatment plant and connecting piping to it, Amur maple, which added fall color, and several shrub beds were removed. It is unclear whether the contractor was contractually required to return the site to “as before construction” condition; however that has not been done. From the perspective of aesthetics, the plant is nothing short of an eyesore. The only saving grace, and it is a slight one, is that the building was moved a short distance south of the main road on the east dike. The initial siting plans called for the plant to be sited much closer to the main road. As it is, it has an overwhelming presence in the foyer of the site.

Compounding the aesthetics problem is that the building is within the view-shed of the Bruce D. Campbell Farm and Food Discovery Centre.

Vegetation

Vegetation on the site can only be described as having been under siege for most of the past 10 years, if not longer. Little thought was given to maintaining or protecting existing vegetation when any construction was undertaken. Unfortunately the prevalent attitude of those directly involved with overseeing or undertaking the construction was: “They’re just trees, replant them, they’ll grow back.” Comments of this nature were heard on more than one occasion during the progress of this practicum.

Trees, shrubs and flowering plants have suffered for many years due to lack of appropriate care and attention. This state of affairs has been due to a shortage of funding, a shortage of horticultural staff, and a shortage of skilled horticultural staff.

When the GRS was first established, the Faculty had an active horticultural program during the summer and the station was under the auspices of the Dean’s Office. Faculty and students with a background in horticultural or plant science were responsible for maintenance of the grounds. Over the years, the horticulture program of the Faculty diminished and the station became the responsibility of the Department of Animal Science. Other areas took higher priority than grounds maintenance.

Figures 27: Poorly maintained Siberian elm.

That is not to say that well-meaning staff has not attempted to improve the appearance of trees and shrubs. Unfortunately a lack of awareness, in particular of proper pruning techniques, has damaged many of these plants making them more susceptible to disease. Although well-intended, the maintenance has done more harm than good in many cases. There were numerous examples of trees cut mid-branch with the remaining limbs dying back because they had no physiological capability to heal the wound. This left entry points for pests and there was ample evidence of that. A row of Siberian elms suffered from advanced stages of canker, which had for all intents and purposes killed several.

Figure 28: Shelterbelt north of main road.

Figure 29: Shelterbelt south of main road.

The east-west shelterbelts north and south of the main road that guard the entrance to the site are in varying stages of disrepair. The northerly belt consists of two rows of Scots pine and one of Colorado Spruce. They were planted much too close together and no thinning took place over the years, reminiscent of many farmyard shelterbelts. The lower third of many of the trees are branchless, particularly the spruce, making the rows unsightly. The two-row spruce belt south of the road is older and in better condition, although many bottom branches have died.

Row ends of both shelterbelts and the row of sentinel elms have been impacted over the past ten years by dike and road construction.

East of the office/shop complex is a large grassed area which could add significantly to the aesthetics of the site. The north of the space is bounded by an unkempt belt of lilac, backed on the east end by several mature poplar in varying states of decay and fronted on the west end by dying caragana. Running the western boundary of the space are eight Siberian elm suffering from varying diseases due to improper pruning over the years.

Toward the end of the practicum period, construction began on the Bruce D. Campbell Food and Farm Discovery Centre, removing or putting more trees at risk.

Forces influencing the site

The dike and the river are two powerful forces that impact the site, and therefore should be considered in the design.

The dike is an overpowering presence regardless of where on the site one is. It separates the site from the surrounding landscape. It contains and constrains the activities that occur within it.

Figure 30: Water and the dike, spring flood 2009.

The river controls the site because it is the river that determined there must be a dike around the site. It can determine when and how activity will take place on the site. When in flood, it controls cropping activities and determines when livestock and their products can leave the site. When it will take control of the site is always unknown.

Conclusion

For design consideration, the site analysis stimulated several ideas to explore and suggested a number of desirable intervations as follows.

1. The three functional regions of the site need better definition and separation.
2. An alternate entrance to the site is needed for reasons of safety and circulation efficiency.
3. Biosecurity, with respect to restricting the general public's movement on the site, needs to be addressed.
4. Aesthetics in the "foyer" need to be improved, particularly with respect to "disguising" the water treatment plant.

5. Better use of water needs to occur, either through its use for aesthetic purposes or irrigation on the grounds.
6. There needs to be an incorporation of the dike into the site.
7. Some buildings need relocating to make use and access more efficient.

Research

Constructed wetlands for treating domestic and agricultural wastewater

"In an ideal world, landscape ecology would help define and support the role of constructed wetlands in any setting, and would assist in effort to mesh seamlessly with adjacent land uses and to integrate with greenways, wildlife corridors and buffer zones." [Campbell and Ogden]

Background

Looking to wetlands for wastewater treatment is not new. Whether intended or not, wetlands have been used since ancient times as a repository for dirty or wastewater. In the United States, several marshes have been receiving wastewater since early in the last century. In Canada, the sewage treatment plant in Dundas, Ontario, near Hamilton, began discharging into the Cootes Paradise natural wetland in 1919. [Kadlec and Wallace 2009 11]

In 1904, an Australian named Nemo wrote a note to the Hornsby Literary Institute decrying the waste disposal habits of Sydney's householders who apparently dumped their wastewater in the closest and easiest spaces – downhill to the neighbors, into the gutters or into the nearest stream.

Nemo suggested that, with just a bit of effort, natural systems could be used effectively by the individual home owner.

> Anyone who has a little ground about his house can dispose of his dirty water as follows: Dig up a plot of ground thoroughly to a depth of fifteen to eighteen inches. Cut a channel leading from the kitchen and washhouse into the highest side of the plot and let all the dirty water drain into it. Plant the plot with plants that grow rapidly and require a great deal of water such as Arum Lilies, for instance. The dirty water will be all absorbed by the roots of the plants and a most luxuriant garden will be produced which will defy the hottest weather and will always be green and beautiful. By this means a

> curse will be transformed into a blessing. Twenty or thirty feet square properly worked would be enough for any ordinary family. [Brix 1993 211]

It wasn't until the 1950s, that researchers began to investigate constructed wetlands as a potential for wastewater treatment. Initial work was done at the Max Planck Institute in West Germany; research began in the Western Hemisphere in the 1970s.

> Implementation of wetland technology has been accelerating around the world since 1985, primarily because treatment wetlands, while mechanically simple, are biologically complex systems capable of achieving high levels of treatment. Furthermore, treatment wetlands can be constructed using local materials and local labor, which is a major advantage in developing countries. [Kadlec and Wallace 2009 211]

Both by accident and design, natural wetlands have been used for wastewater treatment over the years.

> In North America, observations of the assimilative capacity of natural wetlands led to the experimentation with different designs of constructed wetlands in the seventies. Most of the initial work was related to the use of natural wetlands for treatment of wastewater or as receivers for treated effluents. However it soon became obvious that application of wastewater to natural systems is likely to cause significant changes in species composition, community structure and function, and therefore the wetland's overall value. [Brix 1993 212]

In today's environmentally-conscious world, regulating authorities take a dim view of such activities. Consequently, research in the past ten to twenty years has focussed on constructed wetlands, particularly in North America where wetlands for wastewater treatment have not been as widely adopted as in Europe.

While interest in constructed wetlands is growing rapidly, it is still a young science, as evidenced by the fact that about 90 percent of the papers on the topic have been published since the mid-90s. Consequently, many engineers and scientists are not familiar with the technology. [Wallace 2009a. 37]

What is a wastewater treatment wetland?

A wetland contains water during part or all of the year, but the defining feature is that it contains plants, more specifically plants that are adapted to saturated soils. Without plants, the area is just a wet spot, and without aquatic plants, the area cannot function to its true potential.

Evidence of this is the two "evaporative" ponds east of the northeast corner of the Glenlea Research Station's dike. The ponds started life as borrow pits, or holes, used as a source of earth for the dike. They are now used as settling and evaporative ponds for handling surface run-off from the northeast portion of the diked site. Initial observations of the ponds, in 2006, showed very little evidence of macrophytic, emergent plants, although duckweed was evident on the ponds' surface, depending on the season, as well as submerged plants. It was obvious that there had been no strategic planting of wetland plants to enhance the activity of the ponds. By the fall of 2009, a few macrophytes had begun to appear.

Figure 31: West external borrow pit.

Figure 32: East external borrow pit.

Wetland plants are physiologically adapted to take oxygen from the surrounding water and move it throughout the plant. The physiological activities of the plants, their interaction with the surrounding media, and their relationships with other organisms in the wetland allow them to purify water.

It should not be concluded, though, that constructed wetlands are simple in construction or maintenance.

> At any given time, the water quality, hydraulics, water temperature, soil chemistry, available oxygen, microbial communities, macro-invertebrates, and vegetation each greatly affect the treatment capabilities of the wetland. Inside the wetland each of these components plays a functional role and the treatment outcome

> depends upon how the various components interact. Vegetation plays a uniquely important role in water treatment […] vegetation management is critical for achieving and sustaining optimal treatment function. Effective water treatment function and good wildlife quality within a surface-flow constructed wetland depend upon the health and sustainability of the vegetation. [Thullen et al 2005 583]
>
> Wetland systems reduce many contaminants, including organic matter, suspended solids, nitrogen, phosphorus, trace metals, and pathogens. Pollutants are removed through combination of physical, chemical, and biological processes including sedimentation, precipitation, adsorption to soil particles, assimilation by plant tissue and microbiological transformations."[Benham and Mote 1999 495. citing Brix, 1993; Watson et al., 1987]

There are several types of constructed wetlands including free water surface (FWS), horizontal subsurface flow (HSSF), also called vegetated submerged bed (VSB); and vertical flow (VF) and a combination of HSSF and VF. In this practicum, FWS and HSSF wetlands are explored.

A free water surface wetland is what people most commonly think of when wetlands are discussed. A FWS wetland has areas of open water with aquatic plants in the water and on the surrounding banks. In many cases, plants such as duckweed float on the water's surface. A FWS wetland can be many hectares in size.

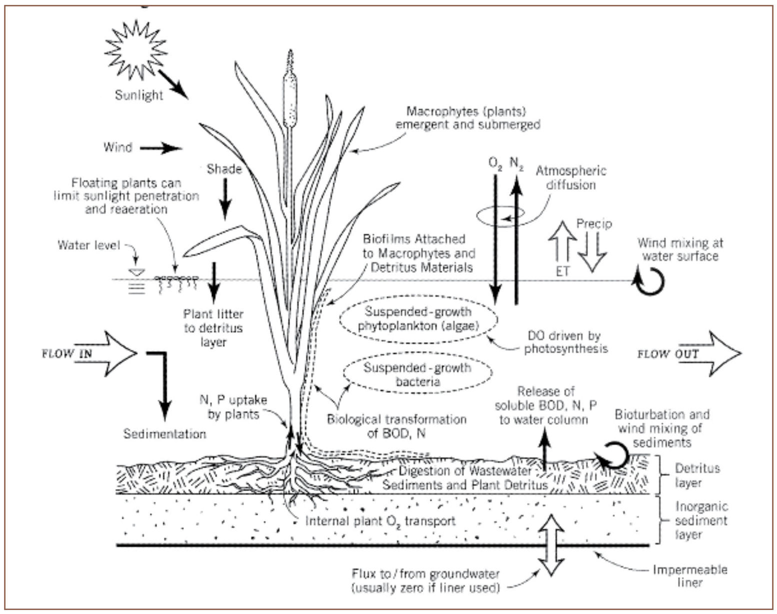


Figure 33: Major ecological processes in FWS wetlands.

Horizontal subsurface flow wetlands are significantly smaller, taking as little as less than one hectare in space. Water flows horizontally from the inflow site through a filtering medium, over which and into which aquatic plants are planted. As the name implies, there is no open water associated with this type of wetland. Treated water then filters into the soil through what is known as a drain field, is stored for use in irrigation or is released into a body of water.

FWS wetlands were the first to be researched and built in Europe; however, it was the HSSF wetland that caught on and has dominated constructed wetlands there. It has been the reverse in North America. [Editorial 2005 475]

Constructed treatment wetlands incorporate at the head end of the system a holding tank or settling cells for the removal of solids and heavy particulate material. From there, the effluent flows into the wetland that has been sized to accommodate the volume and type of effluent from the holding tanks.

In the case of a horizontal subsurface flow wetland, the effluent flows below grade through a medium appropriate to the type of wastewater to be cleaned. The medium bed is planted with aquatic plants. Flow through the bed is controlled to ensure that the effluent remains in the bed for a sufficient period of time to be cleaned.

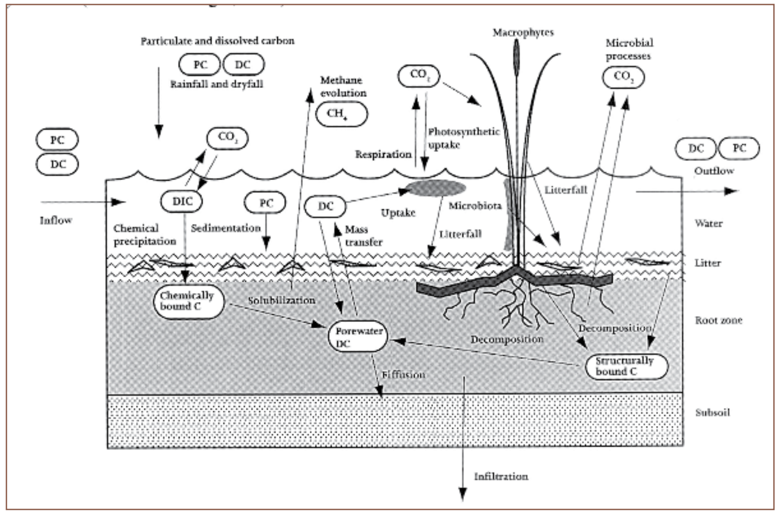


Figure 34: Carbon cycling in FWS wetlands.

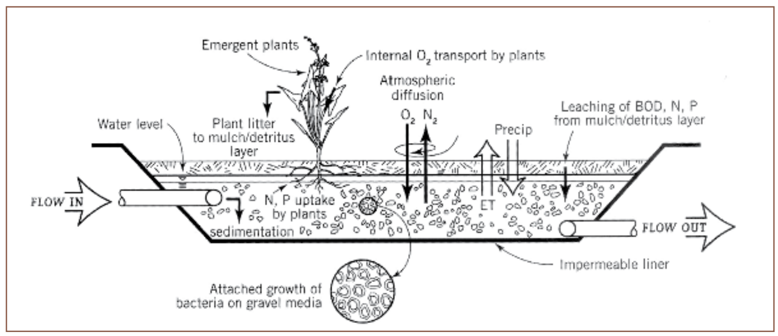


Figure 35: HSFF wetland schematic.

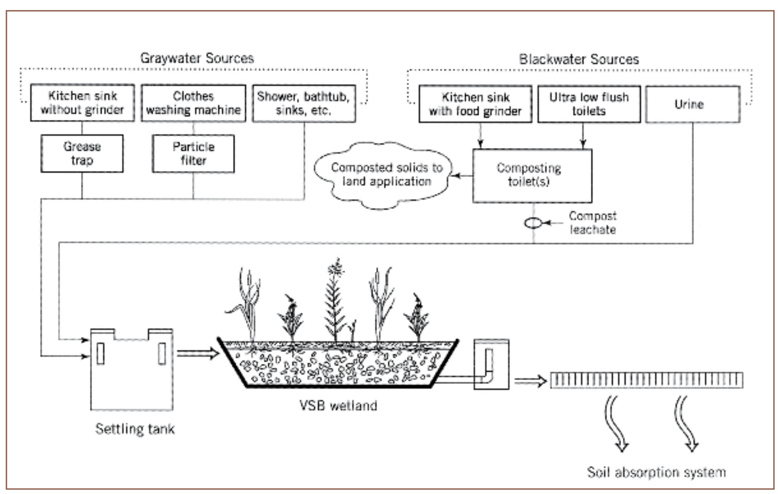


Figure 36: Use of a HSFF wetland with greywater/ blackwater separation.

Application of constructed treatment wetlands

It is not the purpose of this practicum to design operable constructed wetlands for the site as that is a complicated undertaking requiring the involvement of hydrological engineers and biologists.

Rather, the intent is to raise the profile of the concept, identify some of the related issues, indicate that the concept is workable based on the body of knowledge currently available, and demonstrate where on the site that constructed treatment wetlands are suitable.

Precedents

In Minnesota, several rural housing developments have chosen to use constructed wetlands for waste treatment to avoid the cost of building treatment plants. First to be established was The Fields of St Croix located between Stillwater and Lake Elmo on a 241-acre site of which 144 acres are open space. The development has 125 homes on lots of .35 acres to one acre in size. The metropolitan council of Lake Elmo had decided that sewer services would not be extended to the area. [Minnesota Land Trust 2005]

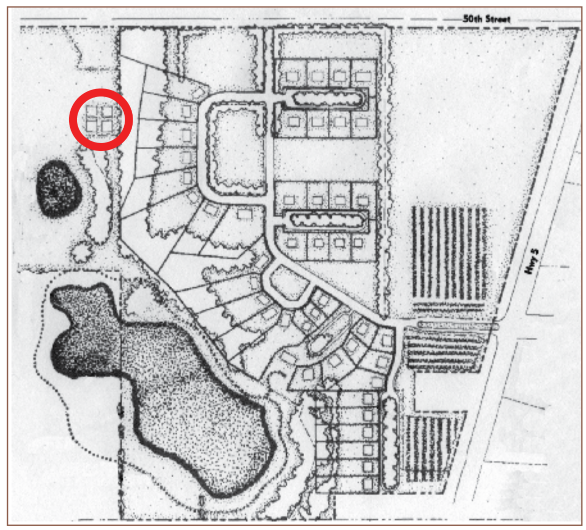


Figure 37: Plan for Phase 1 of the Fields of St. Croix. Treatment cells are circled in red.

Phase 1 of The Fields of St Croix, completed in 1997, was the first development approved by the Minnesota Pollution Control Agency to handle its waste via a constructed wetland system. The wastewater system for the 49 homes of the first phase includes two subsurface flow constructed wetlands (836 m^2 cells) and two unlined, at-grade, 836 m^2 wetland infiltration beds. Phase 2, for 88 homes, uses a vertical flow wetland and was completed in 2000. [NAWE]

By 2005, there were more than 200 such systems proposed or in use in Minnesota. [Minnesota Land Trust 2005]

Closer to home, Ducks Unlimited Interpretive Centre near Stonewall, wetland to treat grey and brown water built in 1993.

The treatment system uses three cells: for the final cleaning or "polishing" of Hammock Marsh. Each cell is about an

Water from the wetland cell is only and October 31 each year. Between the primary and secondary cells is process the effluent in the secondary released into the wetland cell. Water wetland to a depth of 0.45 m where it is into the marsh. The cycle is repeated two more times. From the end of October, over the winter and into spring, the wastewater collects in the primary and secondary cells. About 0.30 m of water is retained in the wetland cell over winter.

© Ducks Unlimited Canada

Figure 38: Ducks Unlimited Canada wetland wastewater treatment, Oak Hammock, Manitoba. The two bottom ponds are for settling solids; the upper is the treament wetland.

The effluent is tested and meets or surpasses current provincial standards before it enters the wetland compartment for polishing. The wastewater is also tested for BOD (biological oxygen demand), fecal coliform and sodium before it is released into Oak Hammock Marsh. The cell water and marsh water is tested regularly as part of the annual environmental monitoring program at the Oak Hammock Marsh Interpretive Centre.

The wetland cell was planted with *Typha sp*. (cattails) on one metre centres. *Scirpus sp.* (bulrush) was introduced with the transplanted cattails. *Eleocharis sp*. (spike rush) was introduced by seed. [3]

The HSSF wetland and its application in domestic wastewater situations are of particular interest to this practicum.

---

[3] Personal communication, Larry Leavens, regional wetlands engineer, Ducks Unlimited Canada, Oak Hammock Marsh. 2007.

An example is the CK Choi Building, which houses the Institute of Asian Research on the campus of the University of British Columbia. About 100 people work in the three-storey, 2,800 m^2 building. Opened in 1996, it is totally "off the grid" when it comes to waste treatment in that none of its solid or liquid waste enters the Vancouver sewer system.

Six composting toilets are used, with the solids composted in a series of five trays in the building's basement. The liquid portion, as well as water from the sinks, is filtered through a subsurface treatment channel at the front of the building, after which it is stored for use as irrigation water.

The "wetland" was designed by the renowned landscape architect Cornelia Hahn Oberlander.

The treatment channel is 0.3 m deep and approximately 28 m long and 1.25 m wide. A perforated pipe runs the length of the channel, allowing the effluent to move through the channel. Vegetation includes irises and reeds, which go dormant in the winter. Plant growth is obviously heavier near the intake end.

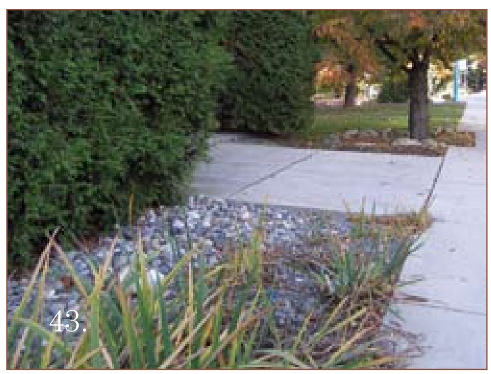
This system of waste treatment saves about 1000 litres of water daily. The quality of the effluent is tested regularly, and "water at the end of channel is cleaner than Vancouver beaches."[4]

Issues in using wetlands for wastewater treatment

Maintaining emergent macrophyte vegetation

In a natural FSW wetland, plant species arrange themselves into three zones, and within those zones according to water depth: deep open water, greater that two metres in depth; shallow water, less than two metres in depth; and riparian, transition from wet to dry land. Depending on the species, emergent wetland plants (those that break the water's

[4] Personal communication, George McLaughlin, facility manager, CK Choi Building University of British Columbia, 2006.



Figures 39 to 43: CK Choi Building wastewater treatment.
39. Inflow end of the C.K. Choi wetland, vegetation is more abundant due to the higher level of nutrients than at the outflow end, (43). 40. Basement composters for solid waste. 41. Vegetation mid-way. 42. Close-up of iris species and rhizomes. 43. End of treatment channel, clean water filters into the ground subsurface.

surface) can survive water depths from 0.05 m to 2 m. Many plants depend on variation in water depth to survive and thrive in wetlands. Variation in water depth, either through mechanical manipulation or natural evaporation allows some plant species to remain competitive, maintaining biodiversity in the wetland. Cattails, for example, are aggressive, and can become invasive, and tend to out-compete other macrophytes. The less aggressive bulrush can survive in much deeper water than some cattail species. [Campbell and Ogden 1999 21-25]

In HSSW wetlands in cold climates, the need for an insulating layer adds another dynamic to the growth of plants in that there is a permanent unsaturated zone, changing the competitive dynamics of wetland plants. The HSSW could be considered similar to a wetland meadow. (There is less understanding of the role of wetland meadow plants in wastewater treatment than macrophytes in FWS wetlands.) From an aesthetic perspective, natural/native wetland plants may not be all that showy or have a shorter flowering period. Domesticated plants that are adapted to wet subsurface conditions can be added depending on the preference of the owner of the HSSF: "[…] the aesthetic quality of the plant community typically requires some 'gardening' from the system owner to maintain the best visual presentation." [Kadlec and Wallace, 2009 764]

Two macrophytes that are commonly used in Europe and had been recommended for wetland restoration under the American Conservation Reserve Program are *Phragmites australis* (common reed) and *Phalaris arundinacea* (Reed canary grass). Neither should be grown in Manitoba because they are aggressively competitive and will "take over." Phalaris is extremely difficult to eradicate once established.

Typha latifolia and *T. angustifollia*, native broadleaved and introduced narrow-leaved cattail, are common choices for FSW wetlands. The hybrid of the two, *Typha x glauca*, is considered an invasive species in Manitoba as it is more robust and competitive than either of its parents. [Invasive Species Council 2008 25] Other common wetland plants include the *Scirpus acutus* and *S. validus*, hardstem and soft stem bulrush, and *Sagittaria latifolia* (arrowhead).

If the HSSF is to be located in proximity to a residence, a balance should be struck between aesthetic and effectiveness. The least studied of the wetland plants with respect to their water treatment capacity are the wet meadow species.

Bulrush is particularly helpful in subsurface situations because it is deep rooted (0.60 to 0.90 m): "There would appear to be a direct correlation between the ability of a subsurface flow wetland to remove ammonia and the depth of root penetration, as enough oxygen must be present within the gravel bed to facilitate denitrification" [Campbell & Ogden 1999 20] "While not as vigorous or widespread as cattails, bulrushes are very efficient in removing nitrogen and tolerate a wide pH range." [Campbell & Ogden 1999 25].

Figure 44: *Typhus sp.* , cattail.

Plant species with rhizomatous rootstock may have a greater capability of storing nutrients.

For HSSW, native species that can be considered include the following.

Agastache foeniculum	Giant hyssop
Anemone Canadensis	Canada anemone
Apocynum cannabinum	Indian hemp
Aquilegia canadensis	Wild columbine
Asclepias incarnata	Swamp milkweed
Calamogrostis Canadensis	Marsh reed grass or Canada blue joint
Caltha palustris	Marsh marigold
Carex bebbii	Bebb's sedge (sedges are challenges to get started)
Dalea purpurea	Purple prairie clover
Eupatorium maculatum	Joe Pye
Galium boreale	Northern bedstraw
Gentian andrewsii	Closed or bottle gentian
Glyceria grandis	Manna grass
Iris versicolor	Blueflag iris
Liatris ligulistylis	Meadow blazing star
Lilium philadelphicum	Prairie lily or western red lily
Mentha canadensis	Wild mint
Monarda fistulosa	Bergamot
Rudbeckia hirta	Black-eyed Susan
Rudbeckia laciniata	Tall coneflower
Sagittaria latifolia	Broadleaved arrowhead or duck potato
Scirpus fluviatilis	River bulrush
Symphyotrichum sp	Asters
Veronia fasciculate	Ironweed
Zizia aurea	Golden Alexander

Figure 45: *Scirpus sp.*, bulrush.

Figure 46: *Sagittaria latifolia*, Broadleaved arrowhead or duck potato.

HSSF wetlands in cold climates

The question of performance usually comes up when wetlands are discussed for wastewater treatment in cold climates, particularly when the wetland is horizontal sub-surface flow.

Figure 47: *Anemone Canadensis,* Canada anemone.

Free surface water wetlands, as is the case with the Oak Hammock Marsh Interpretive Centre, have holding cells or tanks in order to keep effluent out of the treatment wetland during the winter months when the constructed wetland is frozen.

Figure 48: *Lilium philadelphicum,* Prairie Lily or Western Red Lily; Figure 49: *Rudbeckia hirta,* Black-eyed Susan; Figure 50: *Monarda fistulosa,* Bergamot; Figure 51: *Asclepias incarnata,* Swamp milkweed.

"Shutting down" the treatment wetland in the case of a HSSF system during the winter months is not necessary because the processing occurs under the surface and does not come into contact with freezing air. However, depending on how cold temperatures become, an insulating blanket of high-fibre content peat or well-composted yard-waste [Kadlec & Knight 2006 7-21] is necessary, as snow cover does not provide sufficient insulation. Insulation to a depth of 15 cm has been shown to be sufficient even during cold snaps of -45°C. [Kadlec and Wallance 2009. 131]

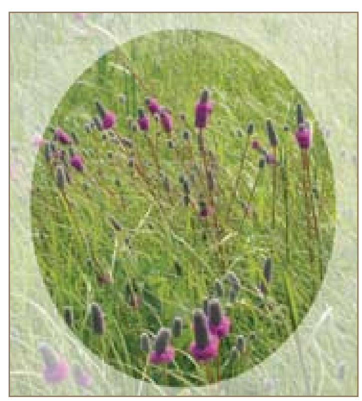


Figure 52: *Dalea purpurea*, Purple Prairie Clover.

Mander & Jenssen [2003], Kadlec et al [2003] and Wallace [2009b 14] all point to horizontal subsurface flow constructed wetlands as being workable in cold climates such as Norway, Minnesota and Canada.

The important consideration, in addition to insulating the wetland, when it comes to winter operation is to ensure that the head-end holding system and treatment bed have been engineered to take into account winter waste output from the source facility, nutrient load in the waste water, and the potential change in biotic activity. For example aerators may have to be installed at the source end to provide sufficient oxygen to allow for effective processing of nitrogen during the winter.

Horizontal subsurface treatment systems can continue to operate in the winter because plants are only part of the natural water purification system – micro-organisms remain functional if they are insulated from cold temperatures. Similarly, FSW constructed wetlands can continue to treat wastewater if they do not freeze to the bottom

Phosphorus removal

Phosphorus removal from wastewater has become of considerable concern in Manitoba given its impact on water quality in Lake Winnipeg. Unlike nitrogen, which cycles into the atmosphere, phosphorus removal from a water column is through plant and micro-biota uptake, sedimentation, or sorption onto media at the bottom of the wetland. Storage is the mechanism whereby phosphorus is removed from a wetland. Some phosphorus remains stored in living organisms until they die. Through chemical reactions with bed media, soluble phosphorus is bound to the media particles. The third method of storage and only sustainable way of removing phosphorus comes through phosphorus being incorporated into wetland sediment. [Kadlec & Knight 1996 449]

In cold climates, where emergent plant material dies each fall, the detritus falls to the bottom and decays, releasing the accumulated phosphorus taken up by plants during the growing season. How significant an issue this is in the overall removal or sequestering of phosphorus depends on sources consulted.

Surveys and monitoring of FWS wetlands have shown that phosphorus can be removed for periods of 30 years and longer. [Kadlec and Wallace 2009 386]

Addressing phosphorus removal in HSSF treatment wetlands is another matter because of the smaller volume of the overall wetland. Plugging of the bed media with adsorbed phosphorus is an expected outcome; however the timeframe to plugging is dependent on many factors. There appears to be little data on a time period for bed life. [Kadlec and Wallace 2009 388] When the bed becomes plugged, wastewater can no longer flow horizontally through the wetland and becomes overland flow.

Bed media is particularly important in maximizing phosphorus removal and prolonging the life of an HSSF wetland. In Norway, where HSSF wetlands are successfully used for phosphorus removal, research has shown that a kiln fired lightweight expanded clay aggregate has a high retention capacity. [Kaldec and Wallace 2009 389, 401] Further, when the media is eventually clogged and the bed needs rejuvenating, the media can be used as a fertilizer [Jennssen et al 2005 1350] Jennssen et al [2005 1344] indicate that the depth of a HSSF wetland should be a minimum of one metre to meet a discharge level of 1 mg/l of phosphorus, which is the level indicated in new standards being legislated in the Province of Manitoba.

How much of a concern the lower level of phosphorous removal in HSSF systems is depends on where the water ends up (water body, soil filtration bed, or vegetated swale), and how big a concern phosphorous levels are in the jurisdiction where the wetland is located.

Regulatory

Constructed FWS wetlands have been licensed in Manitoba for municipal wastewater treatment. Any treatment system that has a daily output of more that 10,000 litres per day requires a license under the Environment Act from the Director of Approvals, Manitoba Conservation.

HSSF wetlands for domestic wastewater treatment are not currently included in regulations for on-site wastewater treatment in Manitoba, not because they are unacceptable but because there has been no interest shown in such a system to date and consequently no need for coverage in legislation. Initiating such a system would require appropriate engineering, an indication that it can meet provincial standards, and a variance from the Environmental Services Branch of Manitoba Conservation.[5]

[5] Personal communication with Donna Smiley, Wastewater Specialist, Manitoba Conservation, July 21, 2010.

Opportunities for constructed wetlands in Manitoba

As environmental regulations tighten, FWS wetlands offer rural municipalities an alternative to mechanical wastewater treatment that is a less costly in the long run and a more natural method of treating domestic wastewater. Whether a municipality in Manitoba will have to move from a lagoon system, which is the most common method of treating municipal wastewater currently, will be determined by the size of the community, density of the population and the environmental sensitivity of the watershed where the water is treated. At the time of writing, the Province of Manitoba was in the final stages of establishing regulations that require phosphorus and nitrogen to be no more than 1 mg/litre and 15 mg/litre respectively, in water released into a body of water.[6]

Currently water leaving municipal lagoons in Manitoba must meet standards for BOD, E. choli and coliform bacteria before it can released into a body of water, and that release can only be at specific times of the year when there is natural flow in the receiving body.

Given that the industry average life expectancy for a mechanical plant is 25 years, while constructed wetlands have been operational for 30 years and longer, capital costs on an annual basis can be lower than for a mechanical plant.

While initial capital costs are governed by the size of wetland, which is determined by intended nutrient load, and may be equivalent to or less than a mechanical plant, operation and maintenance costs for a constructed wetland for wastewater are significantly less. As Scott Wallace put it, “The cost benefits of treatment wetlands can be summed up in a simple phrase: plants and bacteria work for free; people and machines don’t.” [Wallace 2009b 14]

Domestic wastewater remains a part of livestock operations, despite the fact that many hog farms and some poultry farms consist of barns without domestic buildings as part of the yard site. Awareness of handling domestic wastewater in rural areas has been heightened since the provincial government banned the installation of new ejector systems for handling brown water and required decommissioning of existing ejector systems on transfer of land title by amending the On-site Wastewater Management Systems Regulations on Sept 28,

[6] Personal communication with Robert Boswick, Environmental Engineer, Manitoba Conservation, July 20, 2010.

2009 (amendment 156-2009). Subsequently, on May 25, 2010, the government moderated the ban (amendment 60-201) to allow the retention of ejector systems in the case of land transfer providing the system met certain standards and passed inspection.

Ejector systems use a septic tank to receive and separate household liquid and solid waste. Wastewater is pumped at intervals from the tank through underground pipe to the ejector, essentially a standpipe with a nozzle at the top. Natural chemical reactions that occur when released water is exposed to air, sunlight, and soil improve the quality of the wastewater.

Concerns expressed in some quarters about ejectors include health risks due to potential human, pet, or wildlife contact with wastewater; potential odor problems resulting from siting systems too close to neighbors; or pollution of surface water from improperly maintained or sited systems.

There are a number of alternatives to ejectors for handling brown water. A septic field system is used by many rural residents. Solids are retained in a septic tank while wastewater is filtered into a vegetation-covered gravel field for purification prior to filtering into the soil. The size of the field is determined by the amount of wastewater to be treated and the hydrological characteristics of the receiving soil. Many landowners, in particular in the Red River Valley, hold that a septic field system is ineffective or too expensive because of the slowness of movement of wastewater through clay soils. From an ecological perspective, a septic field has none of the advantages associated with wetlands because the plant material used to cover the field, terrestrial grasses, do not have the same capacity as aquatic plants to remove nutrients and pathogens from the wastewater.

Other systems involve biofiltration units which use a container filled with peat or a synthetic media to filter wastewater from a septic tank. The media treats the wastewater by physical filtration, adsorption and microbial activity. The treated wastewater is released into a subsurface gravel bed that disperses the water into the soil. (Figures 53 and 54.)

For cold-weather insulation purposes, the containers are covered with sand and then about 2.5 cm of soil and seeded to grass. Aesthetically, the result is a lump-like berm in the landscape.

HSSF treatment wetlands prevent potential mammalian contact with raw untreated wastewater while allowing the development of an aesthetically interesting vegetative space.

Figures 53 to 56: Biofilter systems for wastewater treatment. Top: filter containers are covered with sand and soil, creating a berm. The lids must remain uncovered. Figure 55: A buried system with a berm evident. Figure 56: a horizontal subsurface flow wetland in Minnesota. Which would you prefer?

Benefits to locating constructed treatment wetlands at the GRS

There are practical, philosophical and aesthetic reasons to consider including one or more wastewater wetlands at the site.

Philosophically, the predominant attitude in rural agriculture in Manitoba since the late 1800s has been to drain land to provide more "productive" acres. That mindset still continues today. In the agricultural community, the recognition of the virtues of wetlands in the landscape still has some distance to go before wetlands are universally accepted as worth saving or reintroducing.

The presence of treatment wetlands on the site would offer the public – agricultural, rural and urban – an opportunity to understand the role that wetlands play in the cycle of life and how a modified (constructed) natural system can work as effectively as "modern" technology.

Given that the mandate of the National Centre for Livestock and the Environment is to take a holistic approach to the sustainability of animal agriculture in the landscape, a demonstration of the use of a wetland for mitigation of run-off, liquid animal waste and the wash waters associated with the dairy operation is a logical component for the site. Water could be cleaned and reused/recycled on the site for irrigation or aesthetic purposes, rather than cleaning it through a mechanical wastewater treatment plant and discharging the clean water into the Red River.

Incorporating treatment wetlands into the GRS site and NCLE program offers a number of collaborative and cross-disciplinary teaching and research opportunities, as well as positioning the university on the leading edge of natural wastewater treatment.

A surface flow wetland for treatment of liquid livestock effluent would offer potential research projects for graduate students in the Faculty's Department of Soil Science and the cross-disciplinary research with students in the biological and environmental sciences.

The Department of Biosystems Engineering has undertaken research on the effects of harvesting of wetland plant material in removing nutrients from water in a wetland environment. There may be opportunities for collaborative research into composting plant material from an on-site wetland, given the rich sources of available nitrogen through livestock manure already available at the GRS.

In addition, there are potential external collaborators, given the growing interest in looking at wetlands for wastewater treatment.

Incorporating an HSSF wetland in the site would provide the ability to test and demonstrate a wastewater treatment option that could prove valuable to farmers and urban dwellers.

With the opening of the Discovery Centre, treatment wetlands will offer another aspect of sustainability to the public. There is the opportunity to teach the public that wetlands are more than pretty spots in the environment; they are the kidneys of the planet. There is also the opportunity to help the public understand the integral role that landowners, who are mostly farmers, play in maintaining a healthy environment.

Shelterbelts

An alternative shelterbelt

Shelterbelts are a traditional and integral part of building sites on the prairies. Not only are they iconic images on the landscape, but they serve a practical function in protecting the yard site from the elements.

For over 100 years, Agriculture and Agri-Food Canada, first through its research stations at Brandon, Manitoba and Indian Head, Saskatchewan and, after the drought of the 1930s, through the Prairie Farm Rehabilitation Act, which created the Prairie Farm Rehabilitation Administration (now the Agricultural Environment Services Branch), has provided seedling trees and advice on maintaining shelterbelts. Many of those trees are now fully mature and some are in decline.

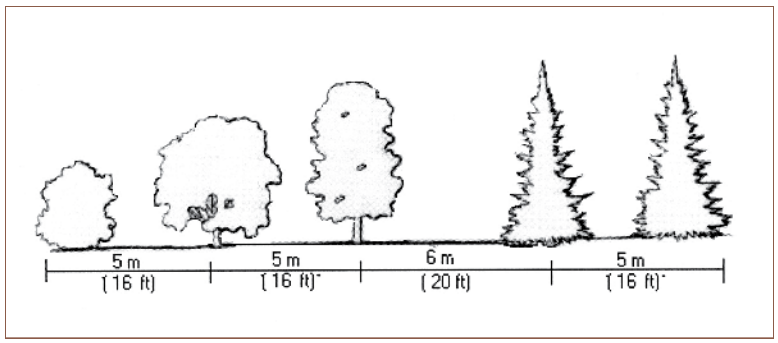


Figure 57: Traditional shelterbelt.

The traditional shelterbelts are three to five rows deep, five to six metres apart. The row spacing recommended by PFRA could take three to five acres of land out of production, depending on the size of the yard site. Every mile of traditional, five-row shelterbelt takes eight acres out of production. The wide row spacings require considerable upkeep in the first two to three years of establishment to keep weeds under control.

The traditional shelterbelt has other shortcomings. Rows are monocultures – one species per row – often with double rows of one species, making the belts susceptible to significant decline from a single pest. Shelterbelt trees often are of the same age, and species have similar life spans, which means the whole belt is affected when trees reach the end of their life cycle. Finally the standard recommendation is to include at least one, if not two rows, of spruce and/or pine in a shelterbelt for winter wind protection. In some cases farmers choose to plant only a coniferous shelterbelt. In the prairie climate, evergreens are notoriously slow to grow when produced from seedlings, upwards of 10 to 15 years before they make an appearance of any significance on the landscape.

These issues, particularly the growth rate of conifers, served as the impetus for investigating alternate shelterbelts in this practicum. Initially the idea was to consider tree species that could replace the conifers in a shelterbelt.

A trip to the AESB Shelterbelt Centre in Indian Head, Saskatchewan unexpectedly produced a solution that appears to have good promise. Since 2004, researchers at Indian Head have been assessing what is termed an eco-buffer, essentially a planting of trees and shrubs that mimics what is found in nature. The shelterbelt is of mixed species both within and between rows. Conifers are included in the plantings but alternated with other faster growing species so that there is vegetation in place while the evergreens are establishing themselves. The shelterbelt is comprised of outer rows that are heavily populated with low bushes, some shrubs, and then long-lived, slower growing trees every sixth plant. The interior rows are mixtures of shrubs, fast growing nurse trees, and again slower growing trees every sixth plant.

The compact eco-buffer requires half the space of a traditional shelterbelt and little maintenance after the year of establishment. The diverse genetic pool makes the eco-buffer more resistant to pests as a whole.

Figure 58: Five year old traditional shelterbelt, Shelterbelt Centre, Indian Head, Saskatchewan, early fall.

Figure 59: Five year old adjacent eco buffer, Shelterbelt Centre, Indian Head, early fall.

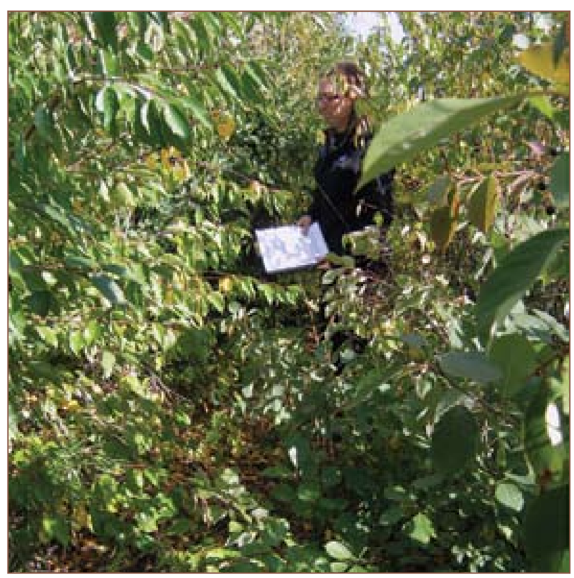


Figure 60: Interior of five-year old eco-buffer, virtually weed-free.

The incentive for researching alternate shelterbelts has been the move away from field shelterbelts by famers because of improved tillage practices that have reduced the effects of wind erosion. Shelterbelts have other benefits than just conserving soil. They have a role in enhancing biodiversity, protecting water quality and sequestering carbon. The issue has been to find planting designs that don't require a large commitment from already busy farmers.

Figure 61: Width comparison. The eco-buffer takes about as much space as the single row of spruce at the rear of the picture.

In the field trials conducted by AESB, the eco buffer was compared to a traditional shelterbelt after five years of growth. Neither the growth or survival rate of the eco-buffer plants suffered from the high density planting, including the spruce.

- The main difference between the traditional design and eco-buffer designs was species diversity and woody plant density. This is due to extensive suckering by shrubs in the eco-buffer designs. The eco-buffer design averaged between 5,059 and 5584 plants per 100 meters of buffer compared to 350 plants per 100 meters for the traditional design. [Schroeder et al 2009]

Figure 62: Young spruce. Although covered by the leaves of deciduous trees and shrubs, this five-year old spruce is healthy and growing.

Table 1: Tree density

Shelterbelt Design Type	**Trees/Shrubs planted per 100 m^2 (0.12 ha)**	**Trees/Shrubs present per 100 m^2 (0.12 ha) after five years**
Parkland EB	500	5059
Boreal EB	500	5084
Grassland EB	500	5585
Traditional	350	350

[Schroeder et al 2009]

Schroeder et al report the following features of eco-buffers:

- consists of a variety of species with different characteristics i.e. thorns, suckering, fast and slow growth, fruiting production, varying flowering periods;
- trees and shrubs of variable tree and shrub heights to create a layered structure;
- includes both fast and slow growing trees;
- includes a minimum of four to five shrub species; and
- every 6th plant is a long-lived tree.

Schroeder et al indicate that [s]pecies choice depends on the region and what grows naturally in the area.

a) trees

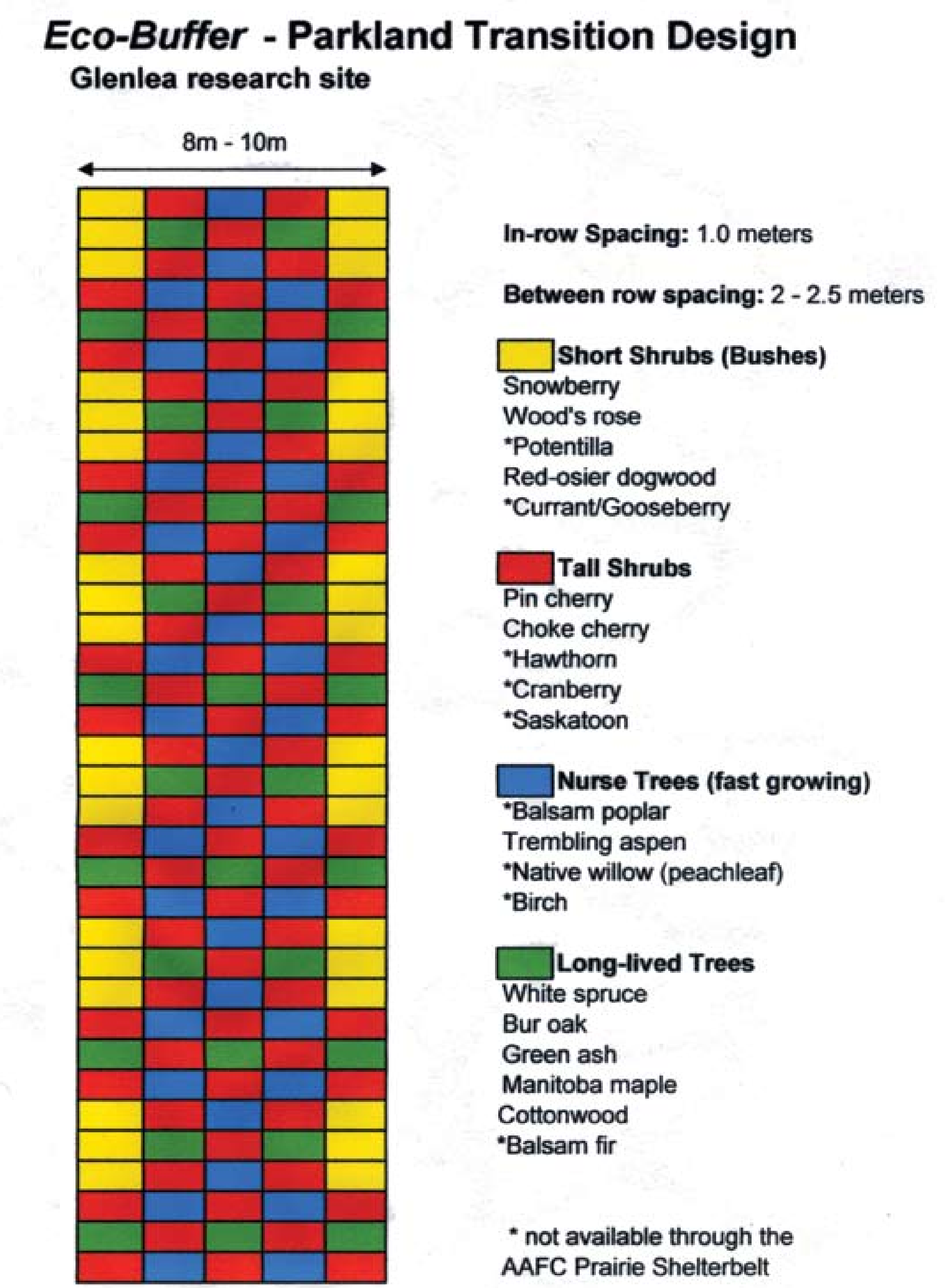
- mature height greater than 10-20 metres
- mixture of long an moderate lived species
- comprise 30 percent of plants in the buffer
- possible species include: ash, spruce, maple, oak, hackberry, basswood, pin cherry, poplar, aspen, willow, alder, mountain ash

b) shrubs

- mature height of one to five metres
- form understory of eco-buffer
- comprise 70 percent of plants in buffer
- possible species include: choke cherry, buffaloberry, dogwood, hawthorn, highbush cranberry, native plum, American plum, red elder, willow, nannyberry, hazelnut, snowberry, rose, wolf willow, potentilla, spiraea
- shorter flowering species are planted on outer rows

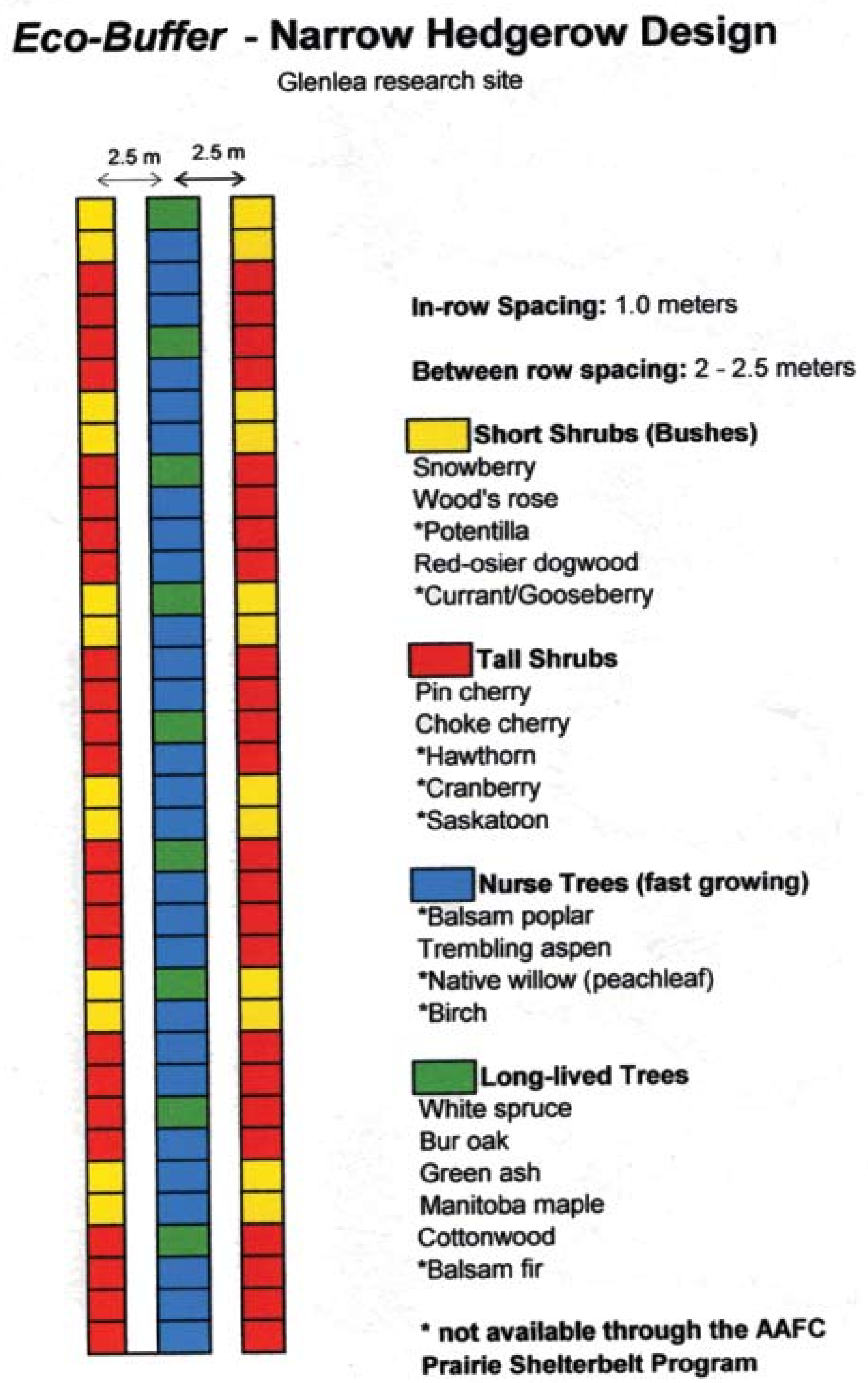
From an aesthetic perspective, there is much to be said for a kilometre or more of majestic, mature cottonwoods, spruce or willows. However the majesty is lost, when stretches of those trees succumb to disease, insects or old age. With a paradigm shift in expectations of what shelterbelts should look like, the eco-buffer has a lot to offer aesthetically. Seasonal flowers, leaf color, fruit, texture and form, not to mention the potential for a healthy stand for longer will produce a new aesthetic more in keeping with the natural context of the landscape rather than the traditional agricultural ethic.

Figure 63:



Plan prepared by Laura Poppy, AAFC Agroforestry Specialist, Indian Head, Saskatchewan.

Figure 64:



Plan prepared by Laura Poppy, AAFC Agroforestry Specialist, Indian Head, Saskatchewan.

Odor mitigation

Shelterbelts are considered useful in odor mitigation, particularly in the case of hog operations, either by reducing wind speed over lagoons or by acting as barriers to odour. Research on odour and shelterbelts or vegetative environmental buffers [Tyndall 2008] really only began in earnest in mid-2000.

Rural municipalities in Manitoba can and do require livestock operations to plant shelterbelts, primarily in an effort to reduce the odour for downwind neighbors. The rationale for the tree species, number of rows, and location of the belt is often more fancy than fact. Informal conversations with representatives of four municipalities with high hog populations in southeastern Manitoba in 2008 showed that three out of four required shelterbelts around hog operations.

- Those three indicated there was no rationale for the number of rows they required; two required three, one required 5.
- There were no specifications for tree species, other than they be fast growing in two cases and two different varieties in the other.
- There were no setback requirements in two cases; in the other, AESB guidelines were to be followed.

Perhaps the lack of scientific foundation is best summed up in the comment made by one of the RM representatives – you don't smell what you don't see.

Tyndall and Colletti [2007] in a review of shelterbelts and swine odor noted several authors referenced the visual as playing a role in odor perception.

Citing Kreis, "…psychologists have stressed that a priori bias either positive or negative towards an odor source often influences emotional responses to that odor source. It is further suggested that additional "aesthetic insult" from that odor source, be it other pollutants (such as water pollution), or other more cosmetic factors such as yard disorderliness or objectionable architecture may negate many odor amelioration attempts. Additionally, visual cues have been noted to be associated with higher incidences of odor nuisance complaints" [Kreis citing Eugene and Waller].

Citing *Mikesell et al* "interviewed all the neighbors within a variable radius (≤ 1 mile) of seven large swine farms in Pennsylvania and recorded an inverse relationship between the "attractiveness" of a farm and reported negative odor intensity ratings. That is, those farms that appeared to be more subjectively attractive were perceived to be less odorous." [Tyndall and Colletti 2007 56]

And finally, "Professionals involved with livestock agriculture generally accept that a well-landscaped operation, which is visually pleasing or screened from view by landscaping is much more acceptable to the public than one which is not [citing Lorimor; NPPC; Melvin]. It is this notion of visual screening that has made landscaping and shelterbelts a common suggestion from agricultural engineers with regard to minimizing odor problems. If it is made known to neighbors and local communities that a shelterbelt is being used as a pollution (air or water) control tool, it may serve as very visible proof that a livestock producer is making an extra effort to control odor." [Tyndall and Colletti 2007 56]

These references indicate the importance of aesthetics in contributing to the perception of odor control in livestock operations.

Livestock odor is comprised of chemicals and compounds, the majority of which adhere to particles 0.002 µm to more than 100 µm in size. [Tyndall & Colletti 2007 47] The odorous particulates can travel up to two miles depending on weather conditions.

There is a growing body of scientific evidence that addresses the control of odor by shelterbelts related to such characteristics as location, tree species, density of planting, and belt height and shape when the belts are used as downwind filters. Again referencing Tyndall and Colletti [2007 51], they bring forward the following information.

- Larger leaf surfaces capture more dust (particulates).
- The capture of particulates, 5 µm and less, increases with leaf surface roughness, which includes hairs and pronounced veins.
- Leaves with complex shapes and large circumference to area ratios (ex. conifers are the most efficient in capturing particulates.
- Conifers are generally more efficient in capturing particulates.

Research has also shown that "[the] total particulate capture of trees is dependent not only on the species-specific morphological capacity for particulate capture but also upon the particle loads in the airstreams." [Tyndall 2008 51] That is, the higher the particulate load in the wind stream, the more particulates are found to be captured and held by these plants.

Tyndall [2008 25] reports that a 6 to 15 percent reduction in odor can be achieved with shelterbelts, while in certain situations ammonia and particulates can be reduced by up to 50 percent.

Figure 65: Location considered for odor mitigation.

Design and aesthetic considerations aside, the initial assumption for this practicum was that positioning an eco-buffer between the alternative hog barns in the north-central part of the site and the area to the south of the site where the general public would be visiting would reduce odor for the public.

Prior to researching the issue, it was assumed that rows of trees would act as a physical barrier to odor and that the odor would be "deposited" on the windward side of the belt. In point of fact, the deposition of odor is counterintuitive in that the highest concentration of odor is deposited on the leeward side of tree rows due to wind turbulence created when an airstream is intercepted by a shelterbelt.

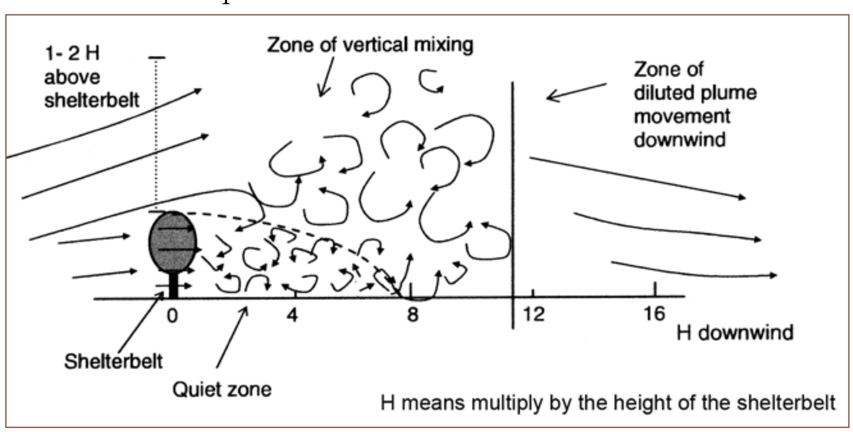


Figure 66: Schematic of air turbulence created by a shelterbelt.

The fact that an eco-buffer is comprised of a mix of species makes it well worth considering for odor mitigation where space and wind direction permit. It includes plants of varied, architecture, leaf type and longevity – all factors that affect the effectiveness of vegetation in odor control. On the other hand, because it is such a dense, compact planting, an eco-buffer, when used as a downwind filter, may inhibit odor mitigation by forcing odor laden air upwards and over the belt. There may also not be sufficient air flow through the vegetation or turbulence within the rows to allow particulate contact with plant material.

Tyndall and Colletti [2007 58] state, citing two researchers' work,

> "A shelterbelt that is too dense simply pushes most of the wind up and over and particulate capture efficiency diminishes significantly (Ucar and Hall). Total deposition of particulates to a shelterbelt is determined by a tradeoff between enough porosity promoting through flow of particulate-laden airstreams and enough density to promote particulate contact with tree surfaces, implying there exists an optimum value for porosity (Raupach et al).

John Tyndall indicates that there is a range of porosity/density values for vegetative material that will affect odor mitigation. The degree of odor mitigation is dependent on a complex set of dynamics that include such things as the windshed of a site's building(s), weather conditions, and the level of odor emitted from an operation. For this reason, there is no "standard" number, at this time anyway, that can be used when designing a shelterbelt to ensure a specific level of mitigation.[7]

Physical limitations and considerations when planting shelterbelts:

1. For odor control, when planting close to a mechanically ventilated barn, trees should be no closer than five to six times the diameter of the fan to prevent backpressure. For tree health, though, the trees should be no closer than 12 m. from the fans. For naturally vented barns, trees should not be placed where they will impede summer winds. [Tyndall 2008 25]
2. Shelterbelts are not a replacement for beneficial management practices that minimize odor – they are a complimentary technology.
3. Root structure and spread must be considered when planting in proximity to in-ground manure storage areas to avoid breaching the plastic liner.
4. To avoid snow drifts on roads or too close to buildings, shelterbelts should not be planted within 30 m of main buildings [AAFC] and 30 m to 50 m of roads – the further distance where winds are strong and frequent.[8]
5. A dense shelterbelt has two benefits related to snow control. The less porous the belt, the closer to the leeward side of the belt that the greatest concentration of snow is dropped by the wind. Secondly, the reduction in wind speed caused by a dense belt reduces the amount of snow "pick-up and carry" on the lee side.

[7] Personal communication with John Tyndall, November 22, 2010.
[8] Personal communication with Laura Poppy and Dr. John Kort, Shelterbelt Centre, Agro-Forestry Centre Agriculture and Agri-Food Canada, Indian Head, Saskatchewan. October 8, 2010.

6. Ends of shelterbelts experience wind turbulence, consequently consideration must be given to the proximity of shelterbelt ends to other objects. The ends of the shelterbelt will experience some wind speed acceleration for one or two shelterbelt heights. The uninterrupted length of a shelterbelt should exceed the height by a minimum factor of 10 to 1. This ratio reduces the influence of end turbulence on the total protected area.[9]
7. Where possible, avoid openings in shelterbelts located on the west and north sides if the prevailing the wind comes from those directions. This is due to the chance of experiencing a wind tunnel effect. The other option, if the opening is on the west, is to make the crossing at an angle. If this is not possible, add a leg to the shelterbelt running perpendicular to it and at least.[10]

Conclusion

The lesson to be learned from this investigation of shelterbelts is that one size does not fit all. Before including a shelterbelt in a design, consideration must be given to its primary purpose: is it for aesthetics; controlling snow deposition or wind; creating a microclimate; or controlling odor?

Tindall & Colletti [2007 59 citing Khan and Abbasi 2001 and Ucar and Hall 2001] confirm the importance of understanding the purpose of a shelterbelt before establishing it.

> If a shelterbelt is planted without the consideration of ecological, biochemical, and engineering principles and knowledge, shelterbelts can be inefficiently utilized or worse they could be ineffective. [… Existing] shelterbelts and other vegetation may work quite well for their original purpose (i.e. erosion control, crop/animal protection, riparian buffer zones), but in establishing shelterbelts for other goals (such as odor mitigation) careful design is imperative.

[9] Ibid.
[10] Ibid. Poppy.

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Chapter 6

Exploration and informing the design

Genius loci or sense of place?

A standard first step in determining what will inform a design is to consider the genius loci of the place.

What does genius loci mean?

> "In classical times it means not so much the place itself as the guardian divinity of that place. It was believed that a locality – a space or a structure or a whole community – derived much of its unique quality from the presence or guardianship of a supernatural spirit … in the eighteenth century the Latin phrase was usually translated as 'the genius of a place', meaning its influence. […] We now use the current version to describe the atmosphere of a place …" [Jackson, 1994, pp. 157–158]

C. Norberg-Schulz describes genius loci as "representing the sense people have of a place, understood as the sum of all physical as well as symbolic values in nature and the human environment." [Jivan and Larkham 2003 70]

Jivan and Larkham [2003 74] comment:

> "It would appear, therefore, that planning and urban design in the post-war period have tended to use the terms 'sense of place', 'character', 'appearance' and genius loci indiscriminately and interchangeably. This, as Norberg-Schulz (1980) argues, is incorrect: the concepts of sense of place and genius loci are distinct and operate at different levels."

There appears to be a variety of interpretations of just what genius loci is and how it is arrived at. Jivan and Larkham relate various researchers' and authors' perspectives on genius loci. One says genius loci is best expressed by a visitor to the site because visitors are intent on searching out experience. On the other hand, others "see the experience and perception of genius loci as a facet of long-term familiarity with place" [Jivan & Larkham 2003 70) Another author believes the visual is particularly important in arriving at the genius loci, while others believe genius loci can only be perceived holistically through the senses, memory, intellect and imagination. One author "emphasizes the individual, subjective nature of place in his discussion of genius loci. … Others give more stress to the collective, rather than individual, view.” [Jivan and Larkham 2003 70]

I have always considered genius loci to relate to the spirituality of a place; it is the undercurrent in a place that has resulted from the passage of time and experience; a sense that there is something indefinable about the space, yet readily felt. Hallowed. When I think of genius loci, I tend to consider the more classical definition – the spirit imbuing the place, developed over time.

How can a site, such as the Glenlea Research Station, of relatively recent vintage where the space is a mix of rural and urban, living and work, academic and blue collar, wild and domesticated, public and private have a genius loci in the classical sense?

After all, it is not a battlefield imbued with the easily understood genius loci of heroism, grief, and soul searing memories. Nor is it a cathedral, with an easily recognized spirit of solemnity, pomp, circumstance, and spiritual renewal realized over the ages. Nor is it a raging river roiling through a forest canyon with an easily felt sense of wonder, mystery, awe, and soul-gripping danger.

The Glenlea Research Station is not a place easily thought of as having a spirit so to attach some generic or communal genius loci to the place would not do it justice. Consequently, I prefer to think of it in terms of its nature, character or sense of place rather than its genius loci.

How does a sense of place come about? Stedman [2003 671] indicates common to the evolving definitions of sense of place is a “three component view that weaves together the physical environment, human behavior and social and/or psychological processes.”

> “‘a place . . .takes in the meanings which people assign to that landscape through the process of living in it.’ ……. sense of place is not intrinsic to the physical setting itself, but resides in human interpretations of the setting, which are constructed through experience with it. Spaces become ‘places’ as they become imbued with meaning through lived experience…. it is possible for a single space to encompass multiple ‘places’, reflecting the uniqueness of human culture and variations in experiences people have had with the landscape.” [Stedman 2003 672/673]

What is the sense of the place that is the Glenlea Research Station in the sense of its nature – meaning its character?

I prefer to approach determining and defining the nature of this place as an individual experience – my experience. Different people will sense different things about this place. I can only express what the site means to me; how I view the nature of the place and, in so doing, extend to others insights on which they may build their own sense of the nature of the place if they so choose.

What, then, do I sense as the nature of the place that is the Glenlea Research Station?

There is a tug of war going on. It is a place of struggle and tension. It's about finding a balance. The tug of war is expressed in layers.

The land and river represent the base layer. The river encroaches on the land through its regular erosion of the bank; at irregular intervals, it engulfs the land. The dike rises up to hold back the water.

In the second layer is the public and private space. How can the place be open to inform the public while at the same time protecting the privacy of those living on the site and the integrity of the research?

The farming operation and the academic research represent the third layer. What takes precedence? Precedence is in the eye of the beholder. Can the farm exist without the research component? Can the research be accomplished without the farm?

Finally there is the layer that is the workers and the academics. Each has its own priorities. One does not necessarily understand the priorities of the other or the value of the other's work.

The nature of the site is intrusion. Outside forces are pushing in; inside forces are pushing back.

The site is in effect a microcosm of agriculture today.

There is the private/public struggle. The public wants to know about agriculture, but on its own terms. Whether that's an intrusion depends on your perspective. Where does public ownership "stop" and industry or the individual producer's ownership begin? Agriculture is veiled; how much should modern agriculture reveal; how much should it keep to itself?

Agriculture and nature struggle – each makes inroads into the other. A balance must be found between agriculture and nature.

The farmer tries to maintain a life, but must deal with outside forces that may or may not be within one's control.

Agriculture has no choice but to co-exist. A way to co-exist has to be found or nothing survives.

On the site, co-existence has to occur because the berm contains it. There is no escape.

In so many ways, the site is agriculture's story.

This informs my sense or nature of place that is the Glenlea Research Station, based on my experience and interpretation of the site. Others from different backgrounds and with different experiences will take different meaning from the site.

My sense of place is a starting place from which to interpret and consequently enhance a sense of place for the Glenlea Research Station.

Interpreting the nature of the place leads to consideration of the following as design elements:

- contrasting soft and hard forms;
- juxtaposition of expected and unexpected;
- materials that provide a sense of tension; and
- treatments that communicate a change of space.

Two elements

As mentioned earlier, there are two elements that affect the site profoundly, and, therefore, to overlook them in the site design would be disingenuous. Those elements are land and water – specifically, the dike and the river.

The dike isolates the site, while the dike itself is alone and isolated. It is set apart from the site yet it is integral to it. It is obvious from every location on the site, yet it contributes nothing aesthetically to the site. It is essentially unclothed and sometimes undressed. That is to say it has no adornment, being covered only with grass that browns as the summer progresses, and from time to time, depending on vehicular traffic, muddy tracks can be seen.

The dike offers opportunities to add visual interest while softening it and integrating it with the site so that it maintains its protective function without being overbearing.

The river is integral to the dike, without it there would be no need for the dike. The river is a powerful force eating away at the riverbank, pushing towards and into the site. This sense of "pushing" is reinforced by the geography of the river as it passes the site. The river bends in a northwesterly direction, quite literally appearing to push into the site. Once or twice in a decade the river swallows the land around the site, seeking to infiltrate where it can.

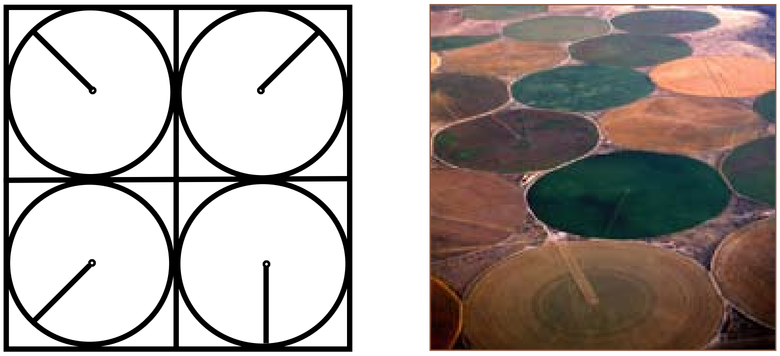
Language of nature/ language of agriculture

In interpreting the site, the languages of nature and agriculture cannot be overlooked. Generally speaking the language of agriculture, particularly on the Canadian Prairies, is linear and angular while the language of nature is curved and smooth.

A pictorial investigation of the language of agriculture and nature was undertaken followed by a graphic interpretation to explore how the language could be represented visually within landscape design. (See figures 65 to 67) A graphic exploration was also undertaken to determine ways the two languages intersect or co-exist.

The conclusion from this exploration was that the positioning of vegetation could reflect the linearity of agriculture while the shaping of land forms and water channels could reflect the softer form of nature.

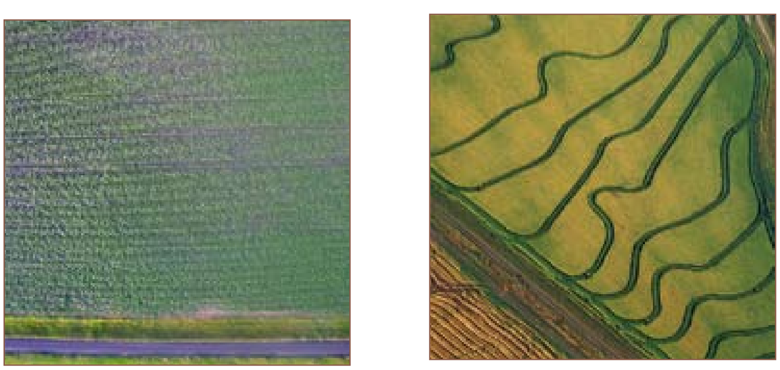
Figure 67: The language of agriculture: visual



Section: 1/4 section irrigation pattern

Horizon

Lines



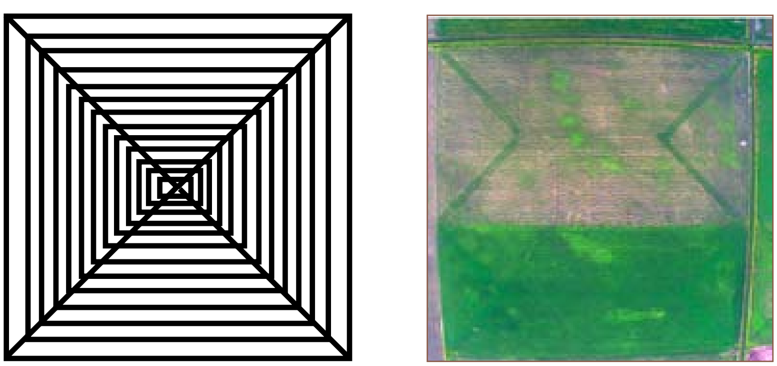
Pattern

Figure 67: The language of agriculture: visual

Row cropping

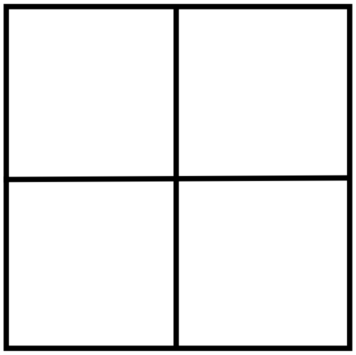
Sequence

Section with shelterbelt & yardsite

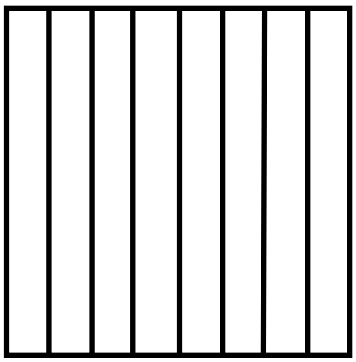


Section: harvest/seeding pattern

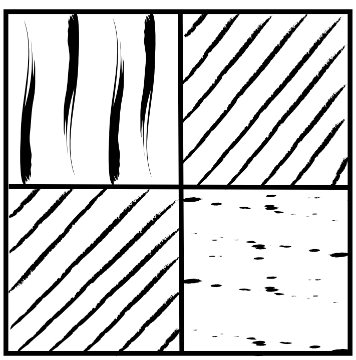
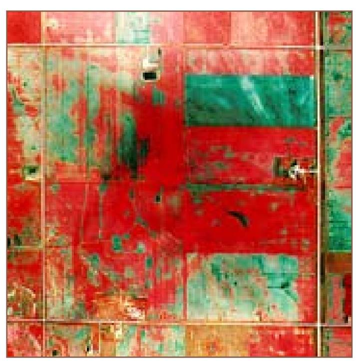
Figure 67: The language of agriculture: visual



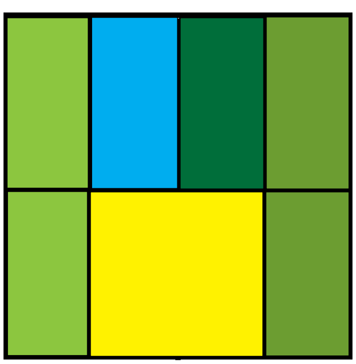

Square survey: section



Plots

Section cropped: half section

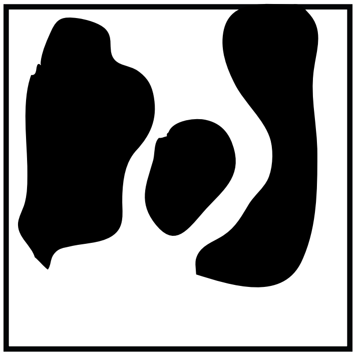


Agricultural language: verbal

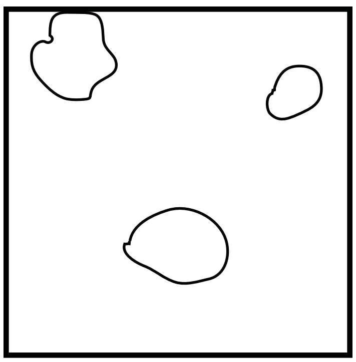
Square	Ditch	Straight	Patchwork
Rectangular	Order	Clean	Geometric
Row	Block	Belt	Segregated
Pattern	Grid Line	Hard	

Section cropped: 80 acres

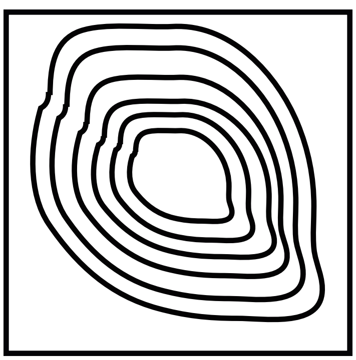
Figure 68: The language of nature: visual



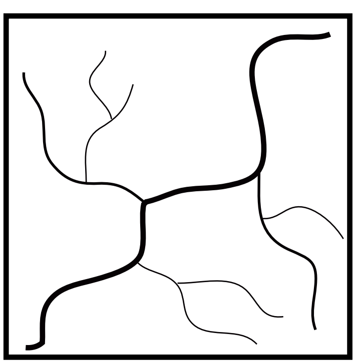
Patch



Potholes



Hill or valley

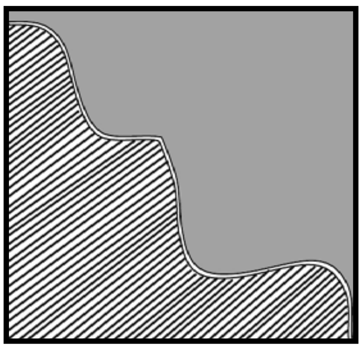


Watercourse

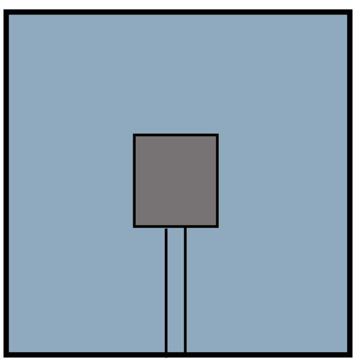
The language of nature: verbal

Curvilinear Circular Edge Cut Diverse Mixed Patch Random
Ebb & flow Ordered disorder Soft

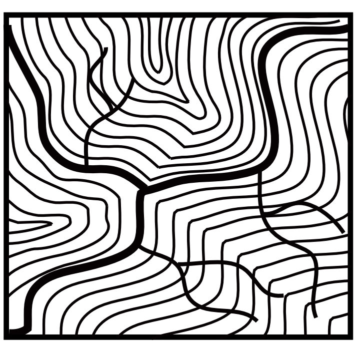
Figure 69: The language of agriculture and nature: visual




Cultivated edge

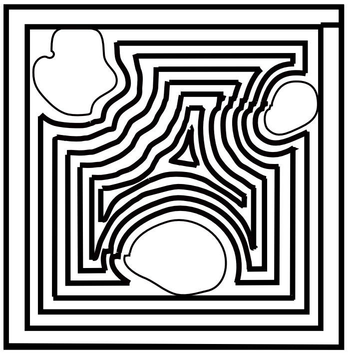


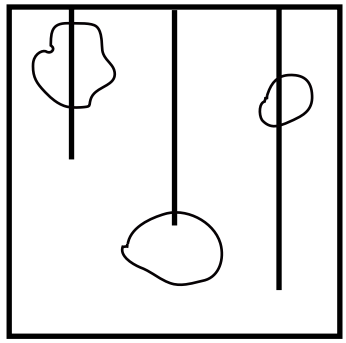

Flood



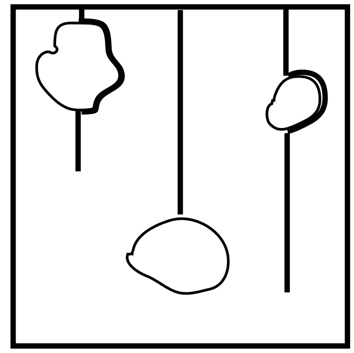

Cultivated water course

Figure 69: The language of agriculture and nature: visual

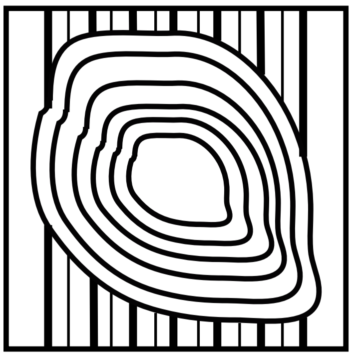


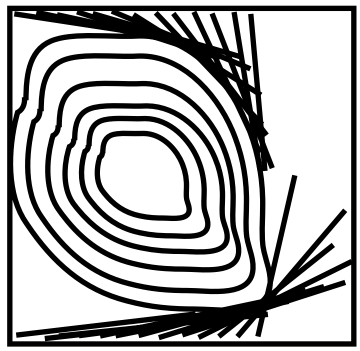


Ignoring the obvious

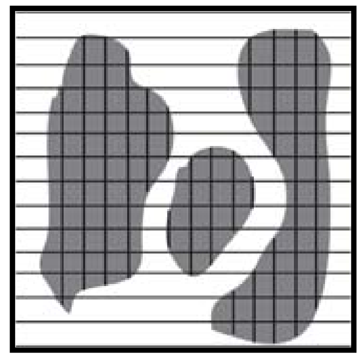


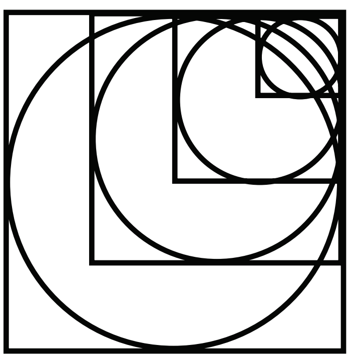
Skirting a problem

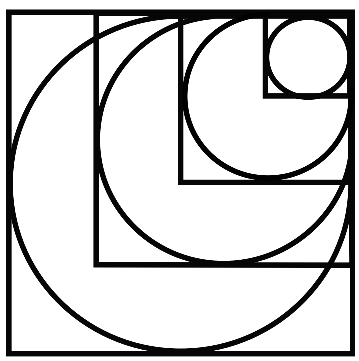




Nature run amok







Geometry and number symbolism

The use of geometry and numbers played a significant role in determining the design elements used in my regional studio: Yesterday's trail … a path for today - the Crow Wing Trail. Consequently, I had an interest in determining whether there were any applications that would assist in determining design direction for the GRS site.

Initially, a modified figure ground study was done to determine whether there were any patterns on which a design could be based. Vertical and horizontal lines were drawn along the boundaries of existing permanent buildings keeping in mind the linear orientation of Prairie agriculture.

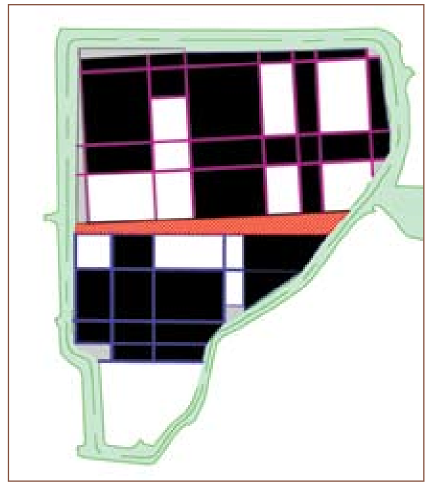


Figure 70: Figure ground study.

What was revealed is that not all the buildings have been built along parallel lines. The original livestock buildings, north of what is called the dirt path or dirt road and built in the 1960s, were constructed on a north-south orientation. The office/shop building, also built in the 1960s, is oriented to the east, three degrees off north. The feed mill and new conventional swine barn built in the early 2000s are oriented the same way. A hay shed, concrete manure pad and covered manure compost shed all built between 2005 and 2009 are also oriented in the same direction.

The most interesting feature to arise out of this analysis is the "strip" indentified in red hatching between the north and south built areas of the semi-private region because it shows how off- square one portion of the site is from the other emphasizing the disconnectedness of the site.

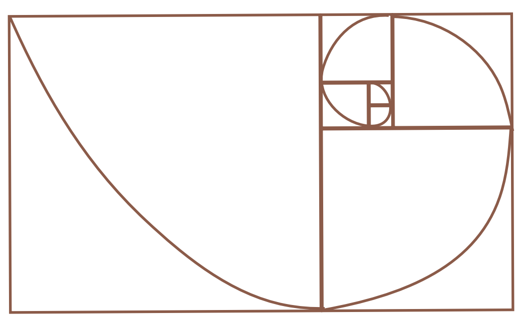


Figure 71: Golden Spiral from a Fibonacci series of squares.

An exploration of the Fibonacci series was undertaken along with the Golden Proportion, both of which had been used with great success in Studio 5: Yesterday's trail … a path for today - the Crow Wing Trail.

There was another compelling reason to explore these geometries – the Fibonacci series[11] is expressed widely in nature, and by extension in agriculture, (ex. pine cones and sunflower heads). "The ubiquity of the sequence in nature has led many to conclude that patterns based on the Fibonacci sequence are intrinsically aesthetic and, therefore, worthy of consideration in design." [Lidwell et al 2003 78]

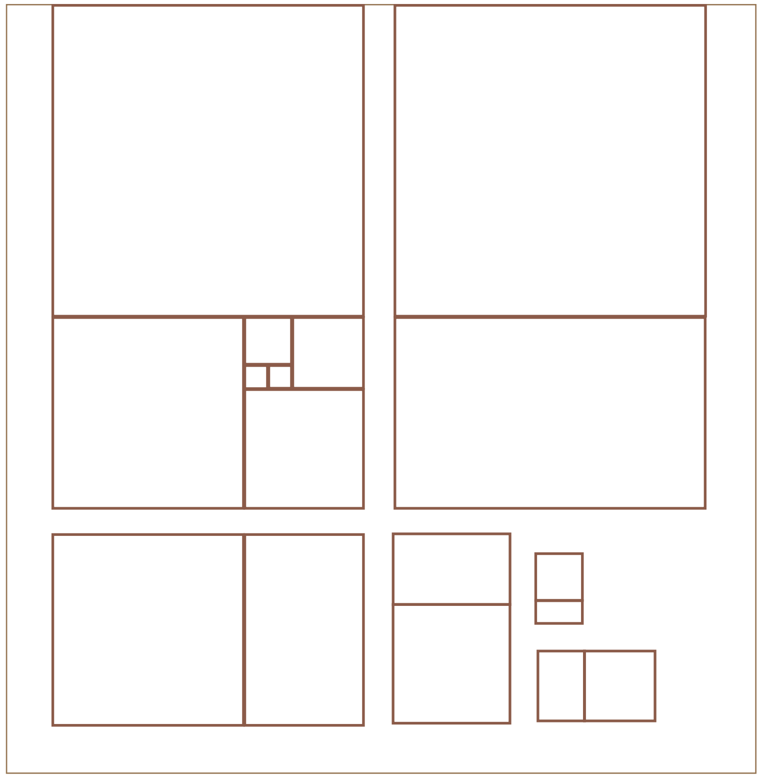


Figure 72: Deconstructing Fibonacci to yield Golden rectangles.

The Golden Mean, Golden Section or Golden ratio are the basis for the Golden Rectangle purported to be the most aesthetically pleasing of all the proportions of a rectangle. Building increasingly larger Golden Rectangles one on another results in a Golden Spiral.

In a design exploration, the areas north and south of the dirt road were divided into a series of smaller and smaller Golden Rectangles. An arbitrary decision was made to draw lines from corner to corner; circles were placed where the lines crossed the Golden Rectangles. The space was observed for any patterns with and without the building footprints being visible. The purpose was to determine whether there were any patterns that might inspire ideas on how to proceed with design interventions. Unfortunately, none came to mind.

Lidwell's advice had to be heeded.

> "Do not contrive designs to incorporate Fibonacci sequences, but also do not forego opportunities to explore Fibonacci relationships when other aspects of the design are not compromised." [2003 78]

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[11] Each number in the Fibonacci series is the sum of the two preceding numbers (e.g., 1, 1, 2, 3, 5, 8, 13).

> and "Consider the golden ratio when it is not at the expense of other design objectives. Geometries of a design should not be contrived to create golden ratios, but golden ratios should be explored when other aspects of the design are not compromised." [2003 96]

There was one place where use of the golden rectangle proved initially to be an elegant solution. It was decided to develop a fountain waterscape for the foyer area. For details on the design, please see pages 103 to 106. In designing the "steps" of the waterscape, a series of Golden rectangles were used to move the water from one level of the waterscape to the next. This design was later abandoned in order to better integrate the waterscape with the form of the design that was eventually pursued.

Looking to numbers for inspiration and explanation is not new.

> "The pre-occupation with numbers, which has persisted to our own day, arose from two independent sources, the astrological lore of ancient Babylon and the Pythagoreanism of ancient Greece. The two currents of thought fused as they made their entry into Christianity, and though number symbolism appealed particularly to the Gnostics, it was frequently resorted to by the Fathers …The Middle Ages elaborated further the earlier views, which were in turn transmitted to the Renaissance. But it is not to be thought that obsession with numbers distinguished only the theologians and the literati of the Renaissance. On the contrary, scientists of the first order often turned to numerology;" [Partrides 1958 394]

In Yesterday's trail … a path for today - the Crow Wing Trail, the number five underpinned the design with interventions based on combinations of five elements. The success of that basis for design led to the exploration of the potential use of numbers in designing the GRS site. Four was selected as a logical number to explore based on the nature/agriculture relationship – four seasons, four elements, four corners of the earth, four winds, four directions, four quarters in a section of land in the square survey method of the Prairies, four corners of a square in a section.

The meaning or definition of four, as with other numbers, is varied and can be found in a variety of popular books and websites on mythology, astrology and mysticism. One website[12] ascribes the following characteristics to the number four.

> Positive Traits: Strong sense of order and values, struggle against limits, steady growth, highly practical, scientific mind, attention to detail, foundation for achievement, a genius for organization, fine management skills.

[12] http://www.astrology-numerology.com/num-keywords.html. Accessed November 22, 2010.

Negative Traits: Lack of imagination, caught up in detail, stubborn fixed opinions, argumentative, slow to act, too serious, confused.

Certainly many of those characteristics can be related to the site: scientific mind, attention to detail, foundation for achievement relates to the scientific undertakings on the site and its role in future discoveries; highly practical relates to the farming component of GRS and the hoped for outcome of the research; struggle against limits depicts the constraint represented by the river, dike and inadequate funding. The negative characteristics are traits that are sometimes ascribed to the structure and outlook of the academic and research environment.

Regardless of the apparent appropriateness of design based on the number four or incorporating the number into design elements, various design explorations came to naught. Even numbers have an aesthetic downside in that "features that are grouped in threes, or in other groups of odd numbers, such as in groups of five or seven, feel more balanced to the eye and give a stronger sense of unity. Odd numbers are often seen or perceived as a group and are not as easily split or visually divided as even numbers." [Hansen 2010] Using a square as the basis for design based on the square survey proved unworkable and uninteresting.

Pursuing the use of the number four would have resulted in a "forced" design based on "pre-design" rationalization.

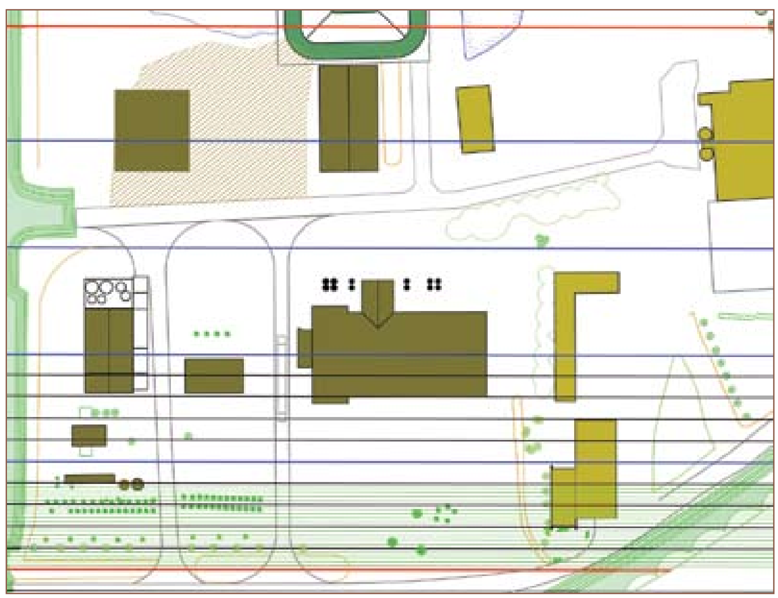


Figure 73: Riverlot boundaries as place holders.
Red signifies an actual riverlot boundary. Blue is a second order line, achieved by dividing a riverlot into five equal spaces. Black is a third order line, while green is fifth order.

Lidwell's advice to avoid contrivance when incorporating Fibonacci sequences or geometries holds equally for numerology.

Ironically, in the end, the design became based on the number five. After many attempts to find linkages and connections between the disparate areas and facilities of the site, a decision was made to step back and look beyond the immediate within dike site. To this point it had been a case of seeing only the trees, not the forest.

What had been overlooked or forgotten from the outset is that the research station, unlike the majority of Manitoba farmland, is comprised of river lots established under the parish system transplanted with the francophone community from Quebec. Five of the GRS's nine riverlots run full length from the Red River to west of Highway 75. It was decided to take a closer look at whether the riverlot concept could assist in clarifying the design.

Actual riverlot boundaries for the five riverlots were demarcated on the plan and observed where they intersected the site. They were subsequently divided into five, followed by second and third subdivisions of five, creating first, second, third and fourth order riverlot lines

The lines formed by these subdivisions were then used for siting and aligning interventions, giving a raison d'être for the placement of many of the elements that had been arbitrarily positioned earlier in the design process.

The river lot lines provide structure – the bones; water provides continuity – the blood.

Water

"Water by its very nature of being different from land, and in that sense contrasting to land, is seen as continuous and as a whole. … Whether the oneness of moving continuity, the wholeness of surface, or the singleness of one material, the expression still lies with its unity." [Litton et al 15].

The role of water in the GRS site is so obvious in light of this quotation, but the epiphanous moment did not come until late in the design process. Water is the connecting force on the site.

From the outset, it was obvious the water on and around the site needed to be better handled. If the site was to realize a holistic approach, the purported underpinnings of the National Centre for Livestock and the Environment, then better use needed to be made of the water – less waste. The numerous borrow pits were simply holes for collecting and holding water. Could they be used as sources for irrigation water for the landscape vegetation? Could the external borrow pits be turned into active wetlands and contribute to, at least, surface water treatment. Could the treated water from the wastewater treatment facility be used for aesthetic or irrigation purposes instead of being released into the Red River? Could the ditches and channels play more of a role than just a trench to move water?

The initial approach to the design and master plan was to approach these possibilities in isolation. In other words, address each one on its own terms. The external borrow pits could become a wetland so that was the focus rather than how can they integrate with the whole site.

Too often the "whole" is obscured, because the focus is on one piece of the landscape. One too often sees only the piece of the landscape one is in at any point in time. That is how I initially saw the water on the site – as fragments, here and there, not as continuous or as linkages or connections. I didn't recognize it as coming and going as one continuous "stream."

"For all its contributions to aesthetic quality, water in its basic unification, its capacity to provide connection in the landscape should be recognized as its one most significant visual role." [Litten 107]

That is the key – the water on the site connects the various disparate pieces. While it is treated and used differently in different areas, it remains the thread that ties the site together. Logically the design can be held together by its water elements.

With that realization, the site can then be viewed as a basin, which it is topographically, with areas of the site treated as watersheds.

Nature and agriculture interacting

Given that the site is the embodiment of the juxtaposition of agriculture and nature, the impact of each on the other has to be reflected in the design. There is push and pull – each exerts force on each other. One infiltrates or fends off the other. There is constraint and release. How could these contrasts be achieved?

Constraint could be achieved by "caging" the water in some way, and then releasing it through waterfalls or into wetlands, signifying the contrast between a controlled agriculture and a free or wild nature. Use of materials such as concrete and metal reflect control and regimentation found in modern agriculture. Banks of vegetation – wafting floral mounds or waving grasses – imply unfettered nature.

Infiltration could be depicted by one element appearing to intersect another element – for example concrete emerging from a landform or one element disappearing into another or arising from another.

Push or pull could be relayed by one mass appearing to shape another or force change by altering the direction of an element.

A sense of tension

In defining its sense of place, the GRS was described as having a sense of tension. Exploration was undertaken to consider ways in which tension could be depicted or expressed. Certainly, this can be achieved through the treatment of the landscape – contradictions, unexpected installations, tears and rifts; however, I wanted something more subtle, something that isn't obvious at first as that is my sense of the site and agriculture. Agriculture is pictured as bucolic, yet under the surface, it is anything but. Similarly, the GRS appears uncomplicated to the uninitiated; it is quite something else when one comes to understand the dynamics of the place.

Figure 74: Metal grating serves as bridge.

Figure 75: Metal grating serves as a covering for fragile groundcover allowing it to be used in a walkway.

Metal grating was chosen as the vehicle to express tension. It is used to cover waterways and bridge openings. While it is secure, metal grating imparts a sense of insecurity for many people when used as a walkway. That translates into psychological tension. One is never quite sure of one's step. It's not "normal" to be able to look through a path to space below, particularly when that space is some distance below.

Chapter 7

The master plan

Background

Redesigning an existing site, while keeping cost in mind and trying to meet the expectations of the design component of the Department of Landscape Architecture, proved to be a significant challenge in this practicum. The original intent was to treat the site as a real life situation. A Master Plan would be developed to provide a "road map" for future development on the site, identifying key components for redevelopment.

It was suggested by the client that it would be useful to have a Master Plan that identified the order in which changes could be made to the site.

Early discussions with the chair of my practicum committee, Professor Jean Trottier, resulted in the suggestion to consider the site as a *tabula rasa* so that my design ideas and interventions would not be constrained. While that would have been the easier road, and in the end probably a smarter choice, I could not bring myself at that time to follow that route because of the wish to remain reality-based, given that four of the site's major buildings and two minor ones had been put in place since 2003.

Working around the existing buildings, though, took longer than anticipated.

Two elements drove the master plan – improving circulation within the site and moving buildings to more functional locations on the site, underpinned by the need to reduce the potential for mishaps among pedestrians, farm equipment and service vehicles.

Circulation

The key to most of the circulation shortcomings is that there was only one road on the site, despite the significant changes that have occurred over the last ten years. Compounding the problem was a dangerous bottleneck created at the office/shop where traffic is hemmed in on one side by the dike and the other by the building. In addition, the road begins to curve at that point, creating a dangerous blind spot.

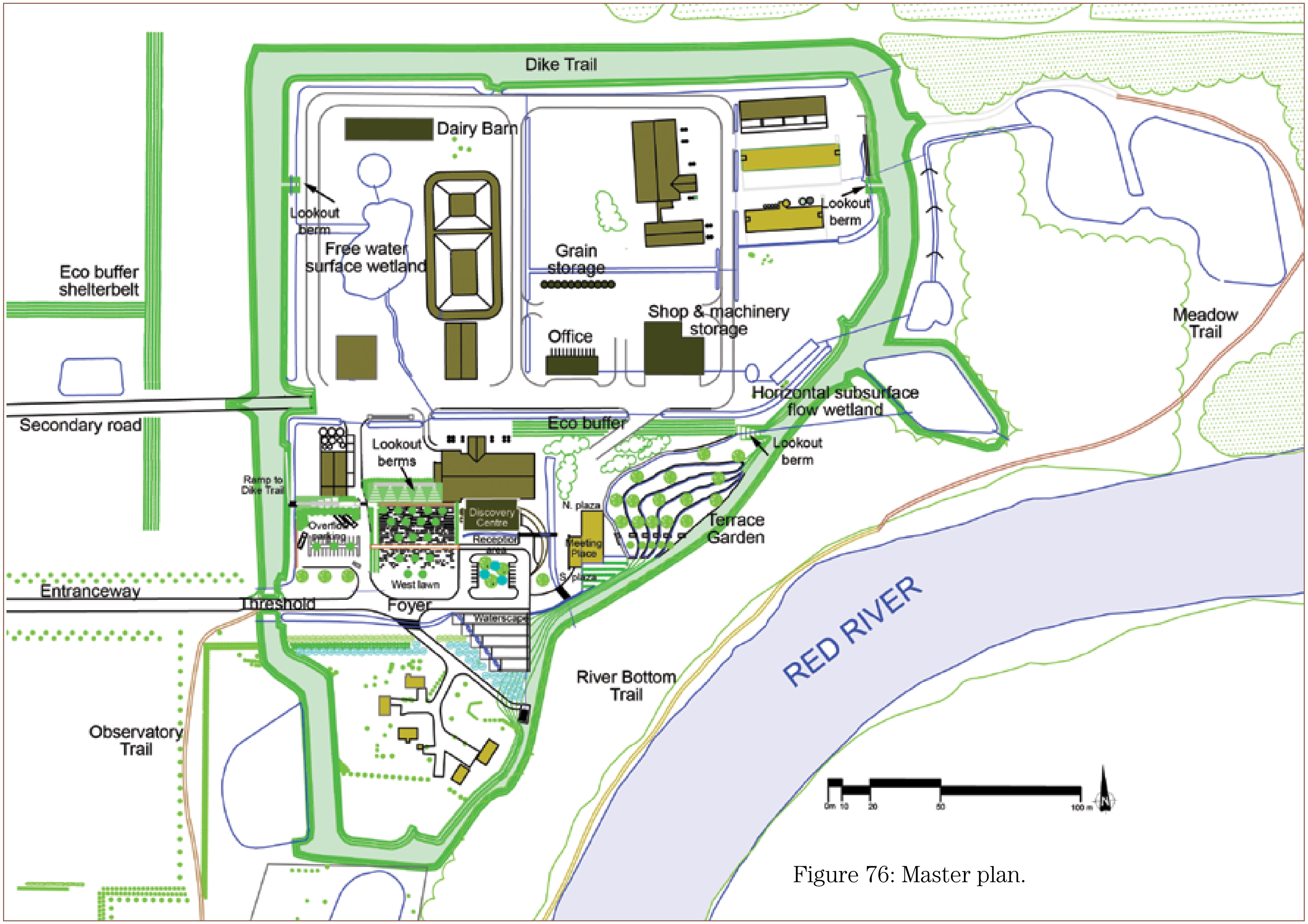
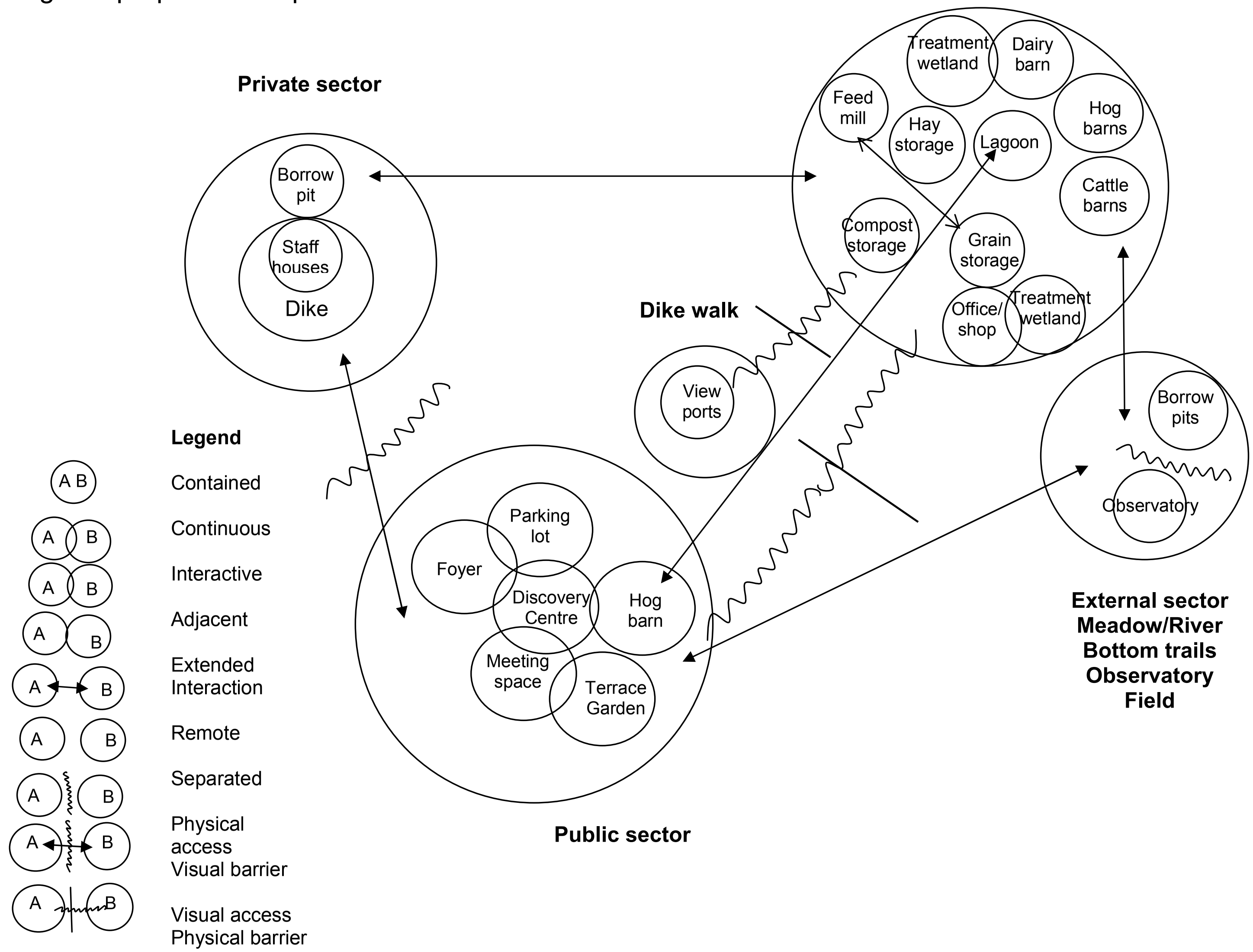


Figure 76: Master plan.

Figure 77:

Functional diagram

Existing and proposed components



Given that there was already a separation between the Public and Semi-public sectors as a result of erecting new structures – the new conventional hog barn and manure composting and hay storage structures – it was logical to introduce a service road in that area. That would take the traffic pressure away from the office/shop area. The dilemma then became where would the service road join the main entrance road given the cost of road building? The feed mill road presented a possibility, but that would mean equipment and large vehicles would join the main road within 45 m of the opening in the dike, only slightly less dangerous than its current location.

The east-west dirt trail offered possibilities. The initial master plan considered upgrading the dirt road and curving it to meet the main road about 200 m west of the dike entrance, saving the cost of building 400 m of roadbed and a new approach to the municipal service road.

At the time that this intervention was being considered, funding proposals were being prepared by the Faculty of Agricultural and Food Sciences (FAFS) for what would become the Bruce D. Campbell Farm & Food Discovery Centre and related amenities. The NCLE management committee agreed that a new service road made sense; however, committee members preferred a road completely separate from the existing one.

An independent service road would avoid any visitor/farm equipment or large vehicle interaction. Of particular concern was isolating the public from the experience of meeting loaded manure spreading equipment on the main road, and the material that is inevitably left behind as it heads to the fields.

The decision was made to construct the new road fully to the municipal service road, providing the funding could be sourced.

Planning work then turned to assessing the area related to the site for the Discovery Centre. Immediately west of the construction zone were two short north/south roads – one for access to the feed mill and the other for access to the truck scale. Obviously, two roads that would be travelled by heavy vehicles between 40 m and 90 m from the front entrance of the Discovery Centre presented safety issues. In addition, the truck scale was essentially suspended over what amounts to a pit, a place where a small visitor could become entrapped. The scale needed to be moved – logic would suggest it be moved to the westerly of the two roads and put in proximity to the feed mill.

Figure 78: Site circulation.
Upper left, the dirt path which provided the foundation for the secondary road in 2010. Lower left, point of entry into the site. Lower right, the new road has not been completed fully to the east. Lower centre, fork for north-south road to lagoon.

The scale serves to weigh grain, loads of livestock, and manure. For phytosanitary reasons, the manure cannot be weighed adjacent to the feed mill, so another location had to be found. The first choice was between the two roads at their north end. Whether there was enough turning radius for semis appeared questionable, based on the arrangement of the space at the time.

The next consideration was to move the scale further north and east, incorporating a turnabout in the roadway which would allow vehicles that did not need to go further into the site to be weighed and unloaded at the feed mill or grain storage area.

While this was being considered FAFS accessed money to build a new service road and it was determined that the scale could eventually be located at the north end of and perpendicular to the two service roads.

In addition to a new service road, the Master Plan proposes a smaller north south service road to allow access to the lagoon when it needs to be emptied. It will also serve as a road to the location proposed for the new dairy barn. As future buildings are added, the road can be extended to provide a perimeter road on the north and west of the site.

Buildings

Figure 79: Interior of the equipment storage building.
In the redevelopment, the side walls would be removed.

The office and the shop were destined to be relocated for a number of reasons. The office should be situated within the semi-private region in the "middle" of the activity for which the GRS manager is responsible. The machine shop is antiquated and the doorway too small to accommodate some of the larger farm equipment, meaning that the mechanic must work on it outside. During spring snowmelt and heavy rains, water seeps into the shop because, with 30 years of re-gravelling the driveway and natural settling, the building is now slightly below grade.

The question remained: what to do with the existing building? Given that NCLE is about sustainability and recycling, it was decided that the building should be retained and reused. The master plan proposes that the office and meeting rooms would be renovated to provide classrooms, while the shop would have its two exterior walls replaced with glass to view the exterior and provide a meeting or eating space for visitors to the Discovery Centre and for tours for NCLE events. The equipment storage area would be stripped of its exterior walls except for structural support and serve as a covered display area for large equipment or other activities.

By retaining the building, a piece of the original architecture from the period when the GRS was opened – the mid-sixties – can be maintained.

The first plan was to locate the new office almost directly north of its current site on the south side of the new service road, with the machine shop and equipment storage located in the area of the decommissioned hog barn.

This was dictated by the initial intention to maintain the dairy at its current site. The existing barn is the original one, making it over 40 years old. It is a tie-stall barn, when most barns today are free stall with milking parlors. The planning decision to leave the dairy where it is was based on the relatively new research laboratory attached to the barn.

That decision was revisited for a number of reasons - all of which outweighed the cost savings of not having to build a new lab. The new service road makes it difficult to move cattle to grass west of the dike. Having a livestock facility in the centre of a non-livestock area is not the best use of space. Finally, the easterly borrow pit to the rear of the non-traditional hog barn was filled in 2008. Initial plans had called for turning it into an operational wetland that could be used to treat the dairy's barn's liquid effluent. With the pond filled, there was one less reason to keep the dairy barn where it is.

Consequently, the dairy barn has been relocated to the north-west of the site, which is currently open land. The cattle can easily be moved to the pasture west of the dike. Access to the outdoors for the cattle is important so that visitors can view the cattle and because of the growing public belief that access to the outdoors is part of humane treatment. There is outdoor space to put up display pens so that visitors who choose to take the dike walk will be able to see the dairy cattle, something that is not possible at the current location.

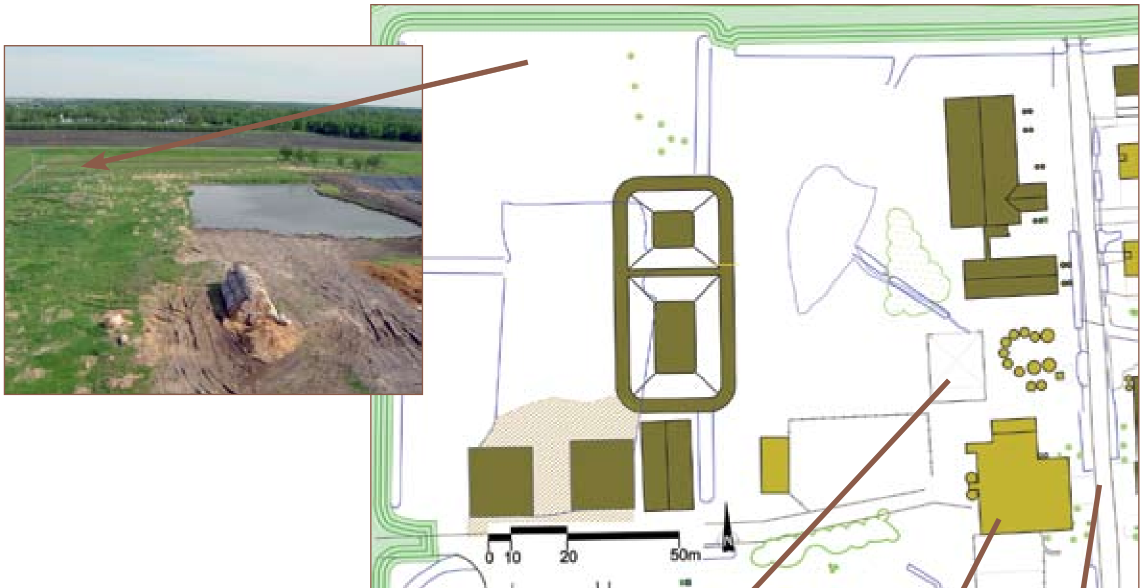
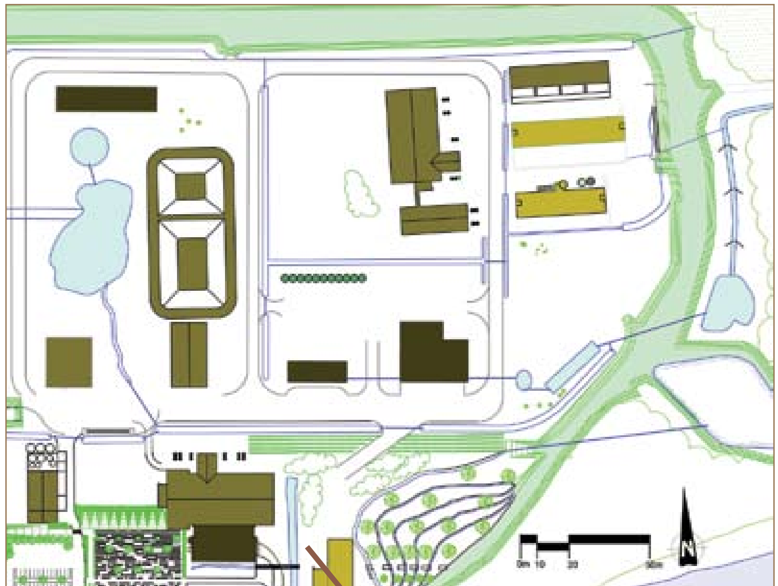


Figure 80: Dairy barn.
On the leading edge when it was built in the 1960s, the dairy barn is now antiquated and will need replacing.
Upper left shows the proposed new location for the barn. By relocating the barn, the unsightly molehill (manure storage) will be removed from the centre of the site and milk pick-up will require less manoeuvring.
Bottom, the curent dairy barn.

Moving the dairy barn freed up space for the office and shop/storage facilities. Moving the office to the north side of the service road allows more space in the Public sector and makes a clean separation between the two sectors. The machine shop and storage building are positioned adjacent to the office on the corner. This allows both parts of the building to be accessed from two directions with minimal disturbance of adjacent land.

The unused conventional hog barn is to be demolished providing space for a treatment wetland discussed in the next section. Its removal will increase the land inventory available for new facilities. The other land inventory area is between the lagoon and non-traditional hog barns. As most of this area was only filled in 2008 and 2009, settling will be required before facilities can be built.

Water



Location of treatment wetlands

There are three places on the site where wetlands are proposed: a surface flow wastewater treatment wetland south of the new dairy barn; a horizontal subsurface flow wastewater treatment wetland east of the new office and workshop; and an ephemeral wetland channel running north-south along the east side of the Discovery Centre site

Figure 81 & 82: Wetland locations. Photo shows how drainage channel (ephemeral wetland) was left after cosntruction of the Discovery Centre.

Dairy treatment wetland

The area south of the new dairy barn location and west of the existing hog lagoon provides at least 2.5 acres on which a surface flow treatment wetland could be sited. Actual dimensions of the wetland and number of cells required would be based on the combined outflow of animal waste and wash water. A holding tank for solids would precede the treatment wetland. Treated water would be released into a vegetated channel for further polishing.

The location of this wetland provides an interesting contrast between a natural way to handle wastewater and a standard agricultural method. To the east of the wetland is the covered lagoon which collects hog manure from the conventional hog barn. Once the holding capacity of the lagoon is reached, the manure slurry is pumped out of the lagoon and applied to the surrounding crop land as fertilizer.

Office/ workshop treatment wetland

A horizontal subsurface flow treatment wetland is to be sited east of the north-south main service road on the decommissioned hog barn site. The location allows for visitors to easily view the site from view points on the dike. The wetland vegetation would offer a point of interest and improve the aesthetics in this area of the site.

Ephemeral wetland

This wetland is so named because significant amounts of water will be present only after snowmelt or rain events. The wetland acts as a drainage channel for water from the Discovery Centre's building and surrounding area. Rather than create a grassed runway, the channel would be planted to wetland species adapted to a range of moisture regimes.

This wetland would offer visitors to the centre an opportunity for a closer look at plants they might not ordinarily see.

The watershed concept

What is a watershed?

A watershed is a hierarchy of water channels – creeks, streams, rivers – that drain into a larger body of water. Watersheds are separated from each other by a topographical feature, such as a ridge or hill, that causes the water of each watershed to flow in different directions. A watershed can have many sub-watersheds – smaller networks of channels that drain into a larger channel.

The terms watershed and basin are used interchangeably by some, while others define a basin as the highest drainage level before water reaches its final destination in a large lake or the ocean. In other words, several large watersheds comprise a basin. For the purposes of this practicum, watershed and basin are differentiated. For discussion purposes, the site surrounded by the dike is considered to be the basin while specific drainage areas within it will be discussed in terms of watersheds.

Watersheds and the site

Once it was recognized that water was the underlying connection that binds the areas of the site together and links it with is external space, it was natural to think of drainage areas within the site as watersheds.

The ability to think in terms of watersheds was facilitated by the assumption that drainage in the site would not necessarily follow current site patterns and that drainage systems could be redefined in a logical pattern. This is a reasonable approach to take because the current drainage pattern has been confounded by the lack of maintenance of existing ditches and the addition of structures and access routes without consideration of existing drainage patterns.

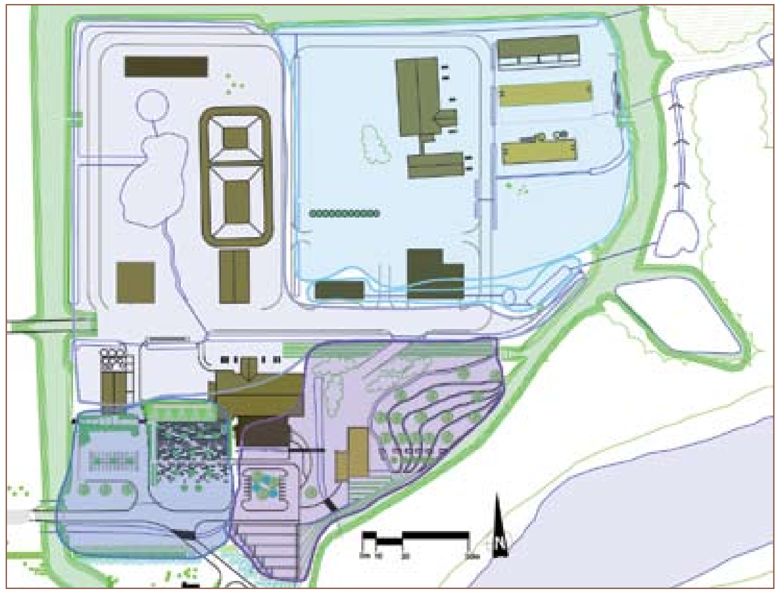


Figure 83: Four watersheds.

The first approach to assigning areas of the site to watersheds was to look at logical water flow patterns. That resulted in four watersheds, roughly approximating four quadrants on the site – northwest, northeast, southeast and southwest. All would flow towards outlets through the dike on the northeast of the site, with the exception of the southwest quadrant which would continue to flow west through existing culverts in the dike. It should be noted that this flow is counter to the natural flow, which is towards the river. A reason provided by a site staff person for the contrary flow is that at some point in time the culvert that would have allowed the water to drain eastwards and through the dike became compromised and was never repaired.

The northwest watershed was to drain water from the dairy treatment wetland as well as surface water through a vegetated channel to a main drain (ditch) carrying water east to a culvert through the dike that would eventually empty into the river. The northeast watershed was to be comprised of two sub-water sheds. One would drain surface water eastward through an existing dike culvert to a vegetated waterway leading to two external borrow pits currently used as evaporative ponds. The second would involve a subsurface treatment wetland for the wastewater coming from the new office and shop buildings.

The southeast watershed was to involve the water from the foyer's waterscape through to the terrace garden. That water would leave that area and enter into the east-west drain flowing east to exit the site through the dike culvert and find its way to the river.

Finally the southwest watershed would drain the west lawn of the Discovery Centre and the ditch south of the main road to the west through culverts in the west dike and external channels that flow south and then east to the river.

Nearing completion of the design process, it was decided to take another look at the functionality of the drainage patterns proposed for the site through the four watersheds. This was done particularity in light of the fact that the long-term goal is to have a self-sustaining, largely closed-loop, holistic approach to water management.

Three areas of concern were identified.

1. By having water from Watershed 3 drain into the river, an opportunity is being missed to continue to find alternate uses for the water on the site for such things as irrigating the gardens and beds.

2. Research opportunities might be missed by combining the water from Watershed 1 and 3 and then draining it into the river. For example, might there be benefit to having the option to regulate and mix the treated water from the treatment plant with naturally treated water?

3. Should the water from the public area be mixed with water from the farm/livestock areas – by separating the two, would opportunities for research emerge or might there be fewer regulatory barriers in the initial stages of implementing the proposed drainage system?

4. It was concluded that the watersheds should be reconfigured to two: Watershed 1 north of the secondary road and the eco-buffer demarcating the public space from the semi-public space; and Watershed 2 incorporating all the public space.

Initially Watershed 2 would be completely isolated from Watershed 1 and would drain into an existing pond outside the dike. A new culvert would be constructed to run from the lowest terrace channel through the dike to the pond. The pond's level would be regulated by a controlled outlet to the river on its southeast side. To the southwest of the watershed, the existing ditch would flow towards the waterscape, entering the lowest concrete channel. A filter system would be incorporated to reduce the amount of sediment entering the waterscape.

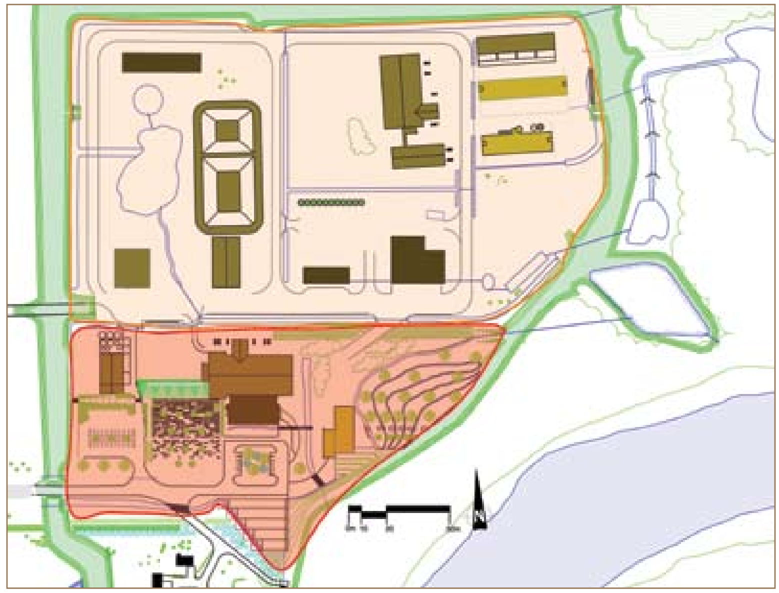


Figure 84: Two watersheds

Watershed 1 would collect water from the dairy treatment wetland, the subsurface treatment wetland and surface runoff. The naturally treated wastewater would exit the site through a new culvert in the dike to a small vegetated .wetland, not much more than a pothole, and then through a series of weirs across the vegetated channel. This external system is to allow the wastewater more residence time for further purification before entering the external borrow pits. It needs to be noted, though, that if the treatment wetlands are built properly and maintained, the water should be clean by the time it exits through the dike. The secondary retention system will allow for testing in the early years, post-construction, to establish compliance with whatever water quality regulations may be in place. Surface water would continue to exit through the two existing dike culverts and flow to the external borrow pits.

The proximity of the retention pond for Watershed 2 to the vegetated channel for Watershed 1 would allow the two to be connected in the future, discontinuing the flow of Watershed 2 water into the river.

It is hypothesized that by the end of the useful life of the wastewater treatment plant, sufficient testing of the natural wastewater system could have been done so that a replacement mechanical system would not be needed. The water system could go to a closed loop, with an outside water source only as backup.

Wherever mechanical pumping is needed on the site, solar powered pumps would be used.

Shelterbelts

There are numerous reasons for including shelterbelts on the site: to control snow deposition; to reduce the effects of wind; to create a microclimate; to test and demonstrate a new shelterbelt configuration; and to create physical barriers to pedestrian traffic.

Outside of the dike to the west, an eco-buffer is to be planted running parallel to the dike from the north end of the property to the main road. Perpendicular to it a second eco-buffer is to be planted to the municipal service road on the west side of the property. The parallel belt is positioned so that snow will be deposited between it and the dike, rather than just inside the dike and at the threshold of the site as it now is. The perpendicular belt is to reduce the potential for a wind tunnel effect due to the opening in the parallel shelterbelt created by the secondary road into the site.

From a design perspective the east-west eco-buffer is aligned along a primary riverlot line rather that parallel to the secondary road. This is to reinforce the riverlot concept. It also reflects the remnants of shelterbelts further south on the GRS property that were planted along the original river lot property lines. (Note: As the exact location of the new secondary entrance was not available at the time of writing, it is assumed it follows the original dirt path.)

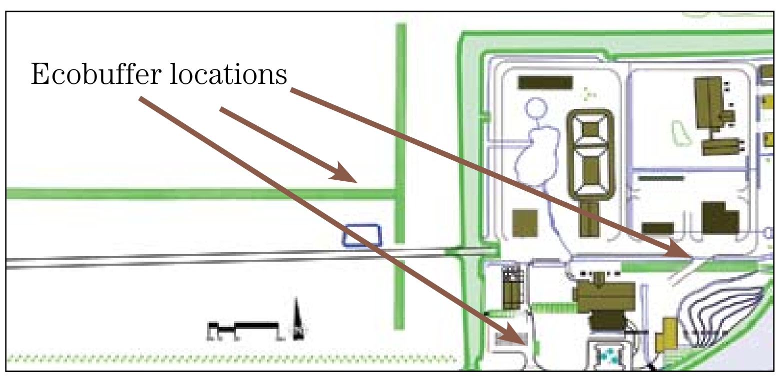


Figure 85: Ecobuffer locations.

Additionally the positioning introduces a hint of tension because the line appears to be out of “kilter” and not aligned as would be expected.

Inside the site there are two locations for the eco-buffer. The intent of the first, located on the west lawn of the Discovery Centre, is to provide visitors with an opportunity to see the new configuration and to add visual interest. This eco-buffer is a hedgerow of only three rows.

The second location is between the public area and the semi-public area. Its main purpose is to serve as a physical barrier to keep the public from the working/research area of the site. It also serves to create a microclimate in the north east of the public area. In this area, visitors can get a look at a full eco-buffer.

It was also intended that this shelter belt could contribute to a reduction in odor on the site

Work done by Lin, Barrington et al [2006] was considered when confirming the location of the eco-shelterbelt inside the dike. Graphic work done by Lin visually characterized the effect of windbreaks on the quantity and extent of odor deposition. After a cursory review of the research, it appeared that the public area could become a catch basin for odor immediately south of the eco-buffer.

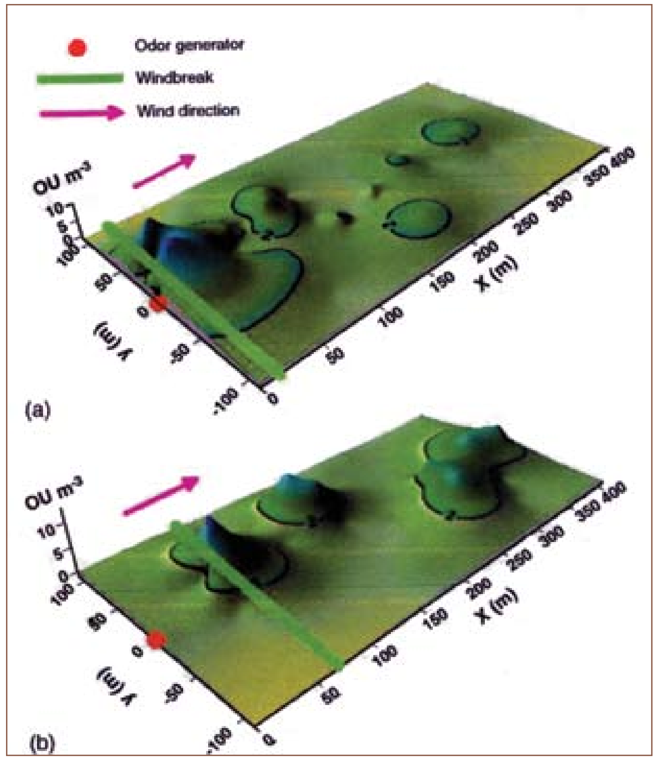


Figure 86: Odor visualized.
These three-dimensional graphs provide a visual representation of how an odor plume is distributed when the odor source is 15 and 60 metres from the shelterbelt.

Personal communication with Dr. Barrington, however, confirmed that the distance from the alternative barns to the eco-buffer was too great for any concentration of odor to occur in the public area, in fact by the time the wind plume reached the eco-buffer, some 120 m to the south of the barns, much of the odor would have dissipated. Dr. Barrington indicated that the preferred distance from source to shelterbelt for odor control is 15 m for a mechanically ventilated barn and 30 m for one that is naturally ventilated.

In reassessing the GRS site, it was concluded that there is no space for a downwind shelterbelt to filter hog barn odor, given the location of livestock buildings; their proximity to buildings occupied by people; the predominant direction of the wind, north and north-west; and the dike, from the perspective of restricting planting locations.

Trails

The Dike Trail

Almost immediately after embarking on this practicum, the dike was identified as a form that could be used to view the site. Initially, a driving route was considered along the dike; however, that presented logistical and maintenance problems and it subverted the intention of the experience – to feel the relationship between agriculture by looking at and being in an agricultural setting juxtaposed with nature.

A circle walking trail was decided upon having several viewpoints along the way, with signage explaining points of interest both internal and external. There are to be two access points to the trail: one in the southeast from the terraces; the second from the West Lawn on the west. Where vehicular access points are located, Texas gates would be located across the roadways to prevent pedestrian access into the farm/research area.

The Dike Trail would provide access in the northeast to the Meadow Trail.

Beyond the dike

There are several areas outside the dike, which could be developed for public access. Three areas could easily be developed: The Meadow Trail, The River Bottom Trail, and the Observatory Field.

The Meadow Trail

This trail would start at the existing vehicular access point from the dike to the evaporative borrow pits. It moves from a narrow meadow through a deciduous mixed wood to a meadow clearing surrounded by riparian forest. The majority of the clearing is covered by two shallow ponds.

This spot offers an excellent opportunity for visitors to experience a naturalized wetland. A number of ducks can be seen on the ponds at different times of the year, and there is ample evidence of deer via their droppings and paths through the grass down to the water's edge.

The clearing is interesting because it has the feel of an isolated space, yet all the noises from the site – pigs squealing, cattle bellowing and equipment, particularly the compressor

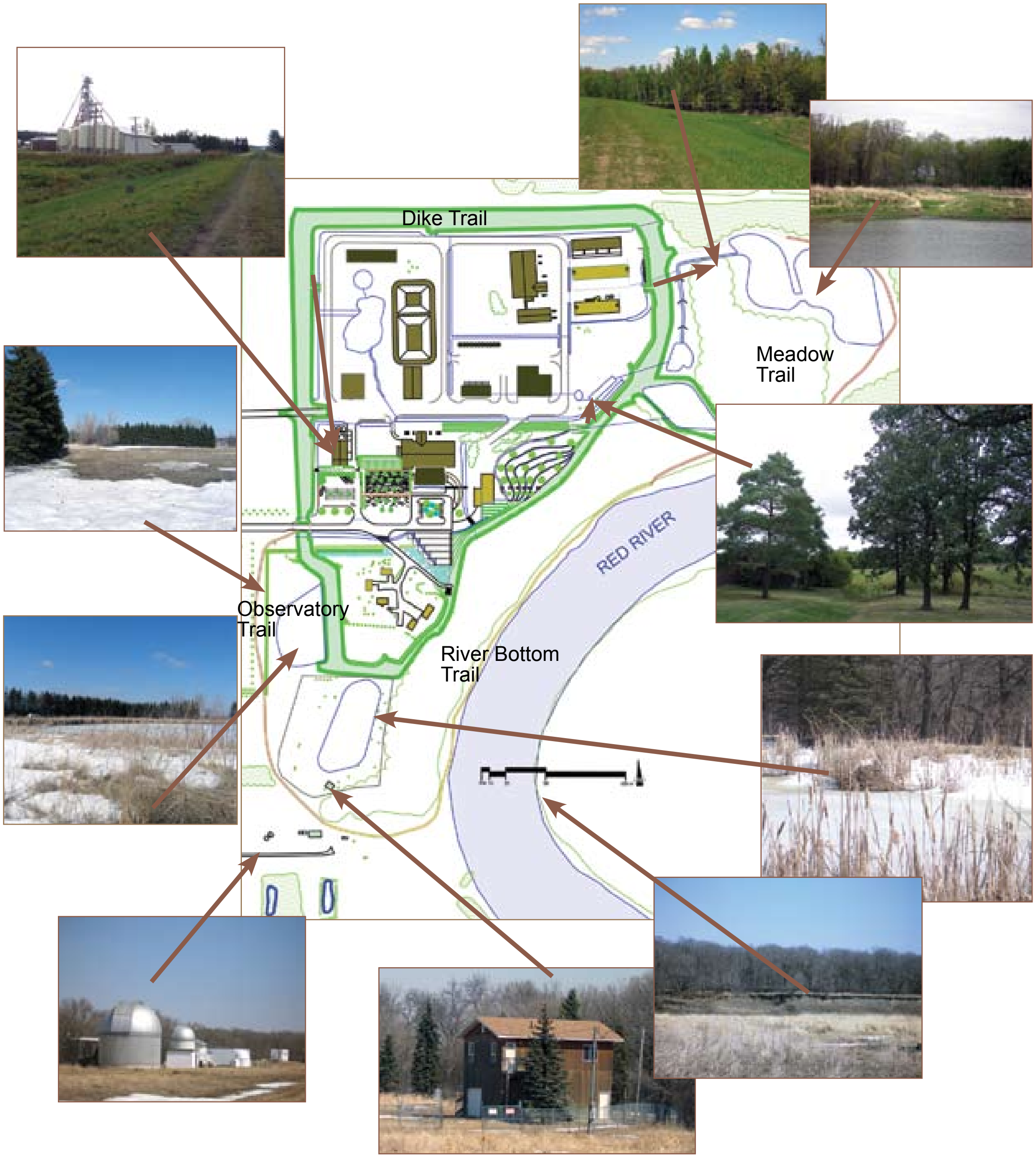


Figure 87: Views along the trails.

at milking time, can be heard. It provides the audio component of the agriculture/nature interface. The trail would circle the ponds to the east and then head back southwest at the bottom of the second pond following the escarpment of the bank and re-entering the site where the dike extends to the terraces.

The River Bottom Trail

At some point east of the dike, between the terraces and the main road, the dike begins to follow the edge of the escarpment. It is at this point that the River Bottom Trail would begin and extend some 500 metres south adjacent to the river.

Preparation of this trail would take considerable work as there was significant tree fall and tree damage resulting from the 2009 flood. Ground-truthing was done on only a very small portion of the northern end of this potential trail, so it is not known what the distance is between the escarpment/dike and the water's edge or whether there is sufficient space to build a pathway the full extent of the proposed trail.

Vegetation in this area is typical of that found in shaded, moist river bottom spaces. This space provides a completely different experience from the meadow and escarpment woods where there is more light and a more open feeling.

The Observatory Trail

This space is completely open. The bank is denuded of trees, so the erosion on the opposite riverbank can be clearly seen. It offers a teachable moment about the power of water as well as soil horizons.

Signage would be appropriate to talk about Ewen Remote observatory and equipment located here and the projects and programs undertaken. Just north of the Observatory Field is a large pond built for experimentation with geese by the psychology department of the university. It has apparently been abandoned for a number of years. There may be opportunity to develop the pond into a wetland, although the depth is unknown so it may not be suitable.

There is also a relatively new building in this space that could be used for overnight accommodation if an experiential tour package were developed that allowed visitors a 24 or 48 hour visit to the GRS site.

A trail from the Observatory Field could be extended west and northward through an existing grove of deciduous trees and spruce shelterbelt and back to the main road. Currently there is an unfenced borrow pit of undetermined depth that would present a safety hazard. If the dike is to be considered for a portion of the northern leg of the trail, it must be kept in mind that is the backyard boundary of three of the homes and appropriate privacy interventions would need to be considered. Finally, to re-enter the site as it is currently designed, pedestrians would cross paths with vehicles on the main roadway. Such a trial would provide visitors the opportunity to get a close look at crops during different stages of development, as the trail would be adjacent to cropland.

Sequence of site redevelopment

Sequence of building, relocating or renovating site components:

1. new secondary road – partially completed
2. relocation of scale
3. closure of scale road
4. build overflow parking
5. redirection of road to housing
6. relocation of dairy barn and development of north/south access road
7. relocation of office and workshop
8. complete east end of secondary access road
9. conversion of 1960s office and workshop building to public facility
10. development of grain storage area
11. close road east of existing office/shop

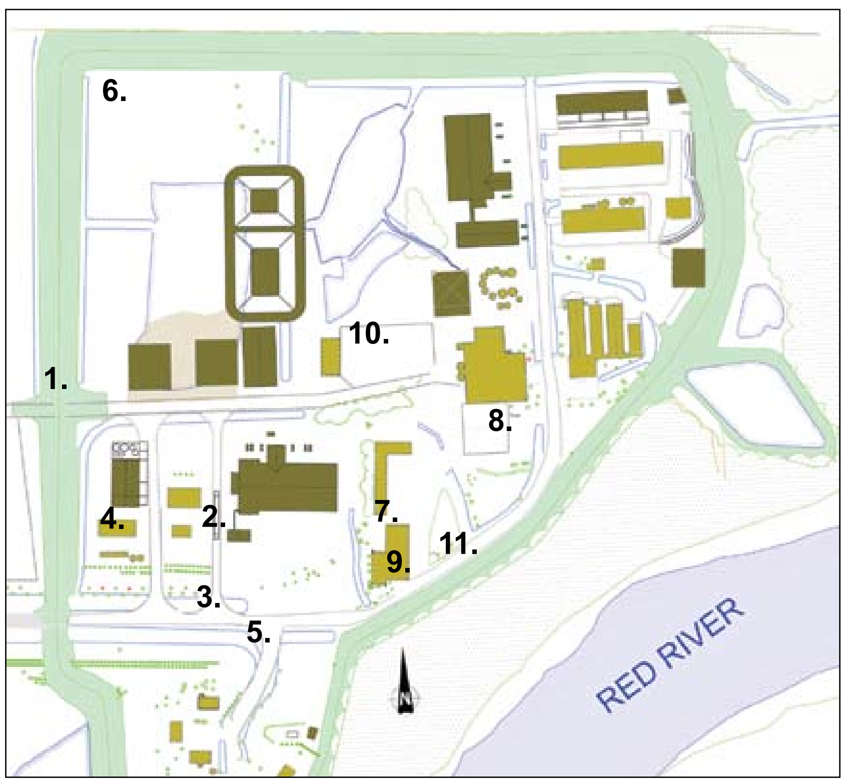


Figure 88: Sequence of site redevelopment.

Intentionally blank

Chapter 8

Design interventions

It was the intention from the outset to design interventions that could be realized by the client at some point, which meant inexpensive and spare, given the financial constraint under which the university finds itself. It became increasingly obvious that to follow that route would short change the site and the client. Consequently, design interventions are proposed that are interesting, exciting and engaging to the site.

Provost as precedent

What is a precedent? In the process of design, where students are admonished by their professors to consider precedents when contemplating their interventions, it essentially refers to what has been done in order to do. For the longest time, I could not grasp the concept because, to me, it was appropriating another's intellectual property. Referring again to my regional studio, it was during that period that I came to realize what precedent is. Precedent is not copying; it is recombination in new and interesting ways. It is meant to inspire.

Alain Provost, French paysagiste/landscape architect, has been the inspiration for many of the interventions for GRS. His works are recognized for the incorporation of water as connector and tempter of the senses through sight, sound and feel. Visitors to his works walk over, through and around water. Water is hidden and revealed, disappears and reappears. Much of his work is linear, revealing lines

Figure 89: Provost water features from Parc Citroen, Paris, France.

through vegetation, hardscape, and water. And finally, his work regularly incorporates changes in grade: mounds, waterfalls and steps.

Figure 90: Provost's Parc Citroen, Paris, France.

Not only are his works applicable to GRS, but so are his words.

> The fourth nature[15] is the recomposed nature. … the issue to be addressed is not the rebirth of the art of gardens, something impossible to contemplate in our contemporary societies, but the re-composition of agrarian landscapes. … Our roots of the Art of Gardens are set in these agrarian landscapes, extraordinary geometries, serene or tense, adjusted to the lie of the land. …
>
> This fourth nature shall not be the preserve of the landscape architect alone but also that of the scientists who will have finally taken into account and assimilated the poetry, sensibility and emotion to their concepts and proposals. One may dream! ... Fallow lands endured, controlled or uncontrollable: new forms of maintenance will have to be found, a dynamic form of conservation based on technical, economic, typological, planned and, why not? even utopian projections; there is great scope. The necessary transformation into an art will ensure that the recomposed landscape stands apart from the second nature and that it constitutes a fourth. [Provost 2004 17]

These words I find compelling.

Figure 91: Linearity in Provost's Parc Citroen, Paris, France.

Figure 92: Mounds from Provost's Citis. Inspiration for the berms used as lookout places in the GRS designs.

Figure 93: Hill's from Provost's Parc de la Courneuve, north of Paris.

[15] The first nature: the natural landscapes. The second nature: the cultural landscape. The third nature: the invented landscape, gardens. [Provost 2004 16]

The public space

The public space naturally divides itself into a series of spaces.

Entrance way

This area constitutes the driveway from Highway 75 to the dike entrance. It is often forgotten because it is disconnected from the site by the west dike.

The importance of this area, other than as an entrance to the site, is its potential as the figurative connection to the University of Manitoba.

Two things are viewed as critical in maintaining and enhancing this connection: maintenance of the rows of trees on either side of the roadway and a “folly” at the end of the road within the site. Additionally gates incorporating signage similar to that used to identify Faculties on campus and at the junction of Chancellor Drive and Pembina Highway could be erected. Materials to be considered would be limestone and red brick, similar to that used in the original buildings on campus from the Manitoba Agricultural College period.

The main row of trees are *Ulmus americana* (American elm), planted in the late 60s, undoubtedly to reflect the Avenue of the Elms leading to the university’s main campus. Within the last 20 years, they have been back planted to *Fraxinus pennsylvanica* (green ash), most likely due to concerns about Dutch Elm disease. Unfortunately, *Agrilus planipennis* (emerald ash borer) poses a significant potential threat to these trees within the next five to ten years.

None of the trees have been well maintained. Pruning has been inadequate, while too little or too much water (flooding) has stressed both tree species. In order to improve the health and, therefore, resistance of this significant landscape component, maintenance of the trees must be improved.

The focal point of the main drive to the university is the cupola of the Administration Building. To enhance the connectivity of GRS to the university, it was determined that a relevant focal point should be developed for the GRS main road.

Initially the use of a silo was explored, as two concrete silos have been part of the site since its early years and are now slated for demolition. While technologically advanced at the time of construction, the concrete silos are now essentially dinosaurs, having been first replaced in the industry by metal/fibreglass, air-tight Harvestores, and more recently horizontal concrete bunkers.

Figure 94: GRS silos.

The GRS silos presented interesting visual and textural aspects due to the combination of metal ridges, rims and concrete "panels." While the silos themselves could not be moved to act as follies, the idea was to replicate a silo. It could be used not only as the entrance focal point, but also as an interactive element that could be used to move people from ground level to the top of the dyke via an interior spiral staircase around the walls and as a viewport for the site. It was soon recognized this would be impractical from a cost/benefit and safety perspective.

Figure 95: Windmill.

In reviewing possible elements, a windmill held the most potential. The metal material reinforced the metal used in the siding of the Discovery Centre. It would add the third, wind / air, of the four elements to the site while making visitors aware that wind energy is a reality and lets them "see" the air in action. Finally it could serve a very practical purpose of pumping water between the waterscape and terrace garden.

Threshold

The dike serves as the threshold to the foyer. The design intent here is to enhance the visitor experience of what it means to be within a dike and the power/influence of the river.

Currently the threshold is elevated and sits about one metre below the top of the dike. During floods, the road is "topped off" with fill to close the dike. The non-flood elevation of the road provides no entry experience.

Initially raising the road to the elevation of the top of the dike was explored. Raising the road would have provided a visual and physical experience through the process of cresting the hill (dike), viewing the foyer, and then descending into the site. Unfortunately this posed a safety hazard from three perspectives. Blind spots are created for drivers where approaching vehicles cannot be seen. Ditch sides would be very steep in proximity to the entrance, making maintenance difficult and presenting hazards to pedestrians. Large vehicles leaving the feed mill road would have a steep grade to manoeuvre to exit the site.

Figure 96: Threshold.
Arrow indicates main road over dike.

The other alternative was to cut the dike by dropping the threshold about 1.5 metres to the elevation of the main road. While the visual experience would not be as significant, the physical experience created would provide visitors with a real sense of the depth of water that can surround the site. This option was initially considered impractical because it would involve significant cost for earth moving whenever the river came into flood.

The option became plausible with the discovery of a "mobile" dike product, Geocell System's Rapid Deployment Flood Wall. The system is a series of panel-like grids that are filled with sand by a front-end loader to the width and height needed to hold back flood water. The resulting wall is rectangular rather than trapezoid as a sandbag wall would be, consequently less sand is used. The grids snap into place and are then filled by a front-end loader. Each Rapid Deployment Flood Wall unit stands 1.22 m iwide and 20.3 cm tall.

Figure 97: Geocell Rapid Deployment Flood Wall.

The units interlock horizontally and overlap to give a deployed width of 1.05 m per unit. At the time of writing each unit cost about $87 US. The grids are reusable up to three times.[16]

Given these specifications, the cost to protect the dike entrance at an approximate width 10 m to an approximate height of 2.4 m would be about $10,500 US.

Figure 98: Geocell grids ready for filling.

Figure 99: Geocell grids being filled.

The Foyer

Public/ private space

The foyer is one of two places on the site where it is important to create boundaries for the general public. Here is found the access to the private homes.

The entrance road to the homes has been redirected to the northwest both to accommodate the waterscape and to sever the direct alignment of the private entry road from the entrance to the Discovery Centre's parking lot. The separation is further enhanced by the use of metal grating for the bridge over the ditch/water channel. The grating provides a warning that a change of space is occurring.

A visual and physical barrier is initiated by the existing shelterbelt of mature *Picea glauca* (white spruce). To enhance the barrier, a row of native *Thuja occidentalis* (eastern

[16] Personal communication with Al Arellanes, president, Geocell Systems Inc., November 8, 2010 and http://www.geocellsystems.com accessed November 25, 2010

white cedar) is to be planted to the north of the spruce belt to hide its dead lower branches. The lines of trees are extended to the entrance road and across it. The planting pattern is reminiscent of how land is cropped around a pothole – straight rows approach the wetland and are then diverted. Here the spruce and cedar rows move up to the waterscape and then are diverted south and east around it.

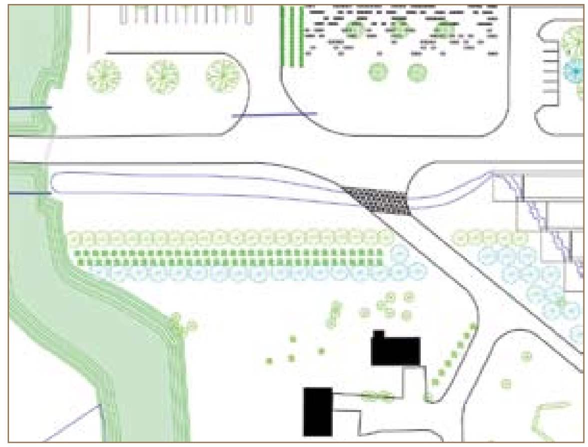


Figure 100: Plan of the foyer.

Waterscape

Early in the design process, it was determined that a visual barrier was needed to block the view of the wastewater treatment facility. At the same time, a physical barrier was needed to prevent the public from entering the private area.

Figure 101: The wastewater treatment plant dominates the foyer.

From a design perspective, the southeast side of the foyer offered an opportunity to integrate the dike with the site by "pulling" it into the foyer space. The first design investigated extending the earthwork of the dike westward and incorporating into it a series of wetland terraces and waterfalls. The water, at its upper end, was to appear as if it were coming through the dike. From a symbolic perspective, this design portrayed the meeting of agriculture and nature.

Figure 102: Preliminary waterscape design. Arrow shows location of waterfall and flow direction.

After working through a partial design, it became apparent that this space was too small to accommodate the design without grading and drainage issues. The area south of the berm in the private space would essentially become a bowl. Aesthetically, the wetlands and waterfalls would have little visual impact as they would only been seen when entering the foyer or if people were to walk up the berm. What resulted was really a landmass for the sake of a landmass with few other redeeming features.

A reading of An Introduction to Landscape Design [Motloch 2001] on water in design inspired a new approach. Two references: "hard edge convey[s] feeling of nature under control" and "archtectonic line extending the architecture into the landscape" caused a rethinking of the material and form of the waterscape.

Is not nature under control in the agricultural landscape? Is it not just as relevant a concept to extend architecture into nature, particularly in the case of the foyer of the GRS?

The first iteration of the waterscape was a series of long, rectilinear concrete forms arranged in 0.3 m steps running east and west from an elevation of 236.8 to 234.8 metres. On the west side of these forms were a series of Golden Rectangles, stepping down at 0.15 m intervals, with a portion of each planted to wetland species. Treated water from the wastewater treatment facility was split into two streams, one to run down the concrete steps in a sheet, the second to meander through the Golden Rectangles.

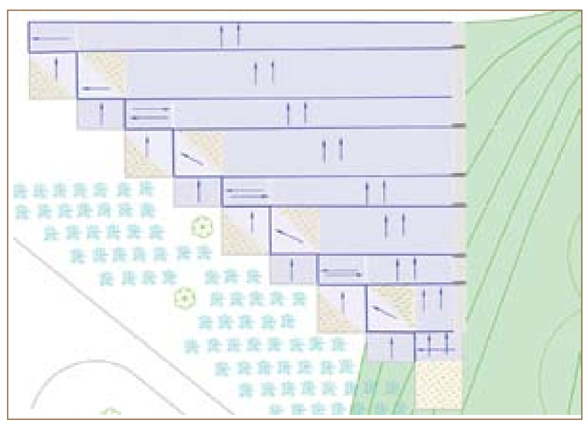


Figure 103: First waterscape iteration.

This design posed two problems. The mass of concrete was out of context with the reminder of the site – nature, and indeed agriculture, would be overwhelmed. This form of the waterscape was better suited to an urban setting. The second problem related to whether the water treatment facility could supply the quantity of water required to have a continuous flow through the waterscape.

The second iteration replaced the horizontal concrete plane of the rectilinear boxes with grass, tying the intervention more effectively with the dike. Narrow concrete channels, covered with metal grillwork, run along the step edge of each level and "disappear" into the dike.

Figure 104: Final waterscape design.

The wetland section was modified into a square form, discarding the Golden Rectangle as it no longer tied into any other design work on the site. The number of steps was also changed from nine to five to reflect the five river lots.

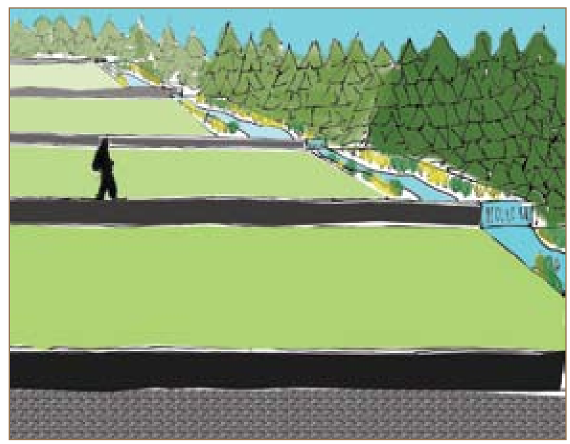


Figure 105: Waterscape perspective.

Water flows from the wastewater treatment facility to the first wetland "box" where it meanders to the water channel at the edge of the "step" and drops into it. The channel fills until the water level reaches the height of an outlet that allows the water to flow into a square chamber. When the chamber is full, the water falls to the next level of the waterscape. At the bottom of the waterscape water flows eastward, feeding the Wetland Pool.

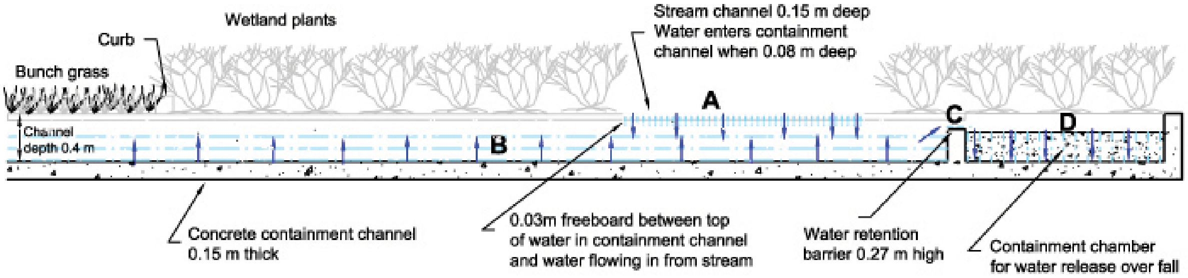
Figure 106: Waterfall, Sprint Headquarters, Kansas City, Missouri. The square chamber is similar to what is envisioned for the waterscape waterfall.

Figure 107: Garden waterfall, Akureyri, Iceland.

The water from the treatment plant is fully treated and is currently released to the Red River by pipe on the bottom of the river. The plant treats between 15,000 and 19,000 l per day. Using the volume of water available, based on an 18 hour operation period, calculations indicate that it would take seven to eight days to fill the waterscape and the channels in the Terrace Garden. Between late fall and spring thaw, the treated water would be redirected to the river.

Figure 108:

Waterscape channel and waterfall section



Water flow pattern: A. water flows from the stream channel through openings the barrier and falls to the containment channel. B. The channel fills to a level of 0.28 m high, then flows over the water retention barrier, C. It fills the containment chamber until it surpasses a depth of 0.24 m and falls over the chamber wall to the next stream 0.24 m below.

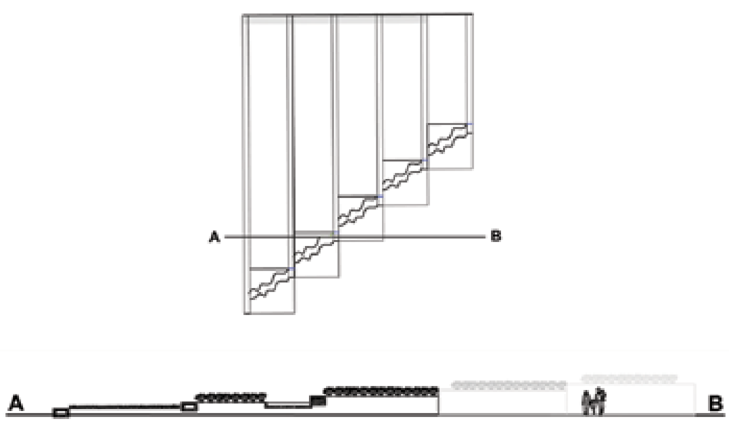


Figure 109: Waterscape section.

West lawn

This area is more enclosed that any of the other spaces on the site – one reason is for safety, the other to create a sense of mystery. The west lawn is primarily a place to engage children, but it also serves as a conduit to move people from the Dike Trail to the Discovery Centre and vice versa and to the overflow parking lot.

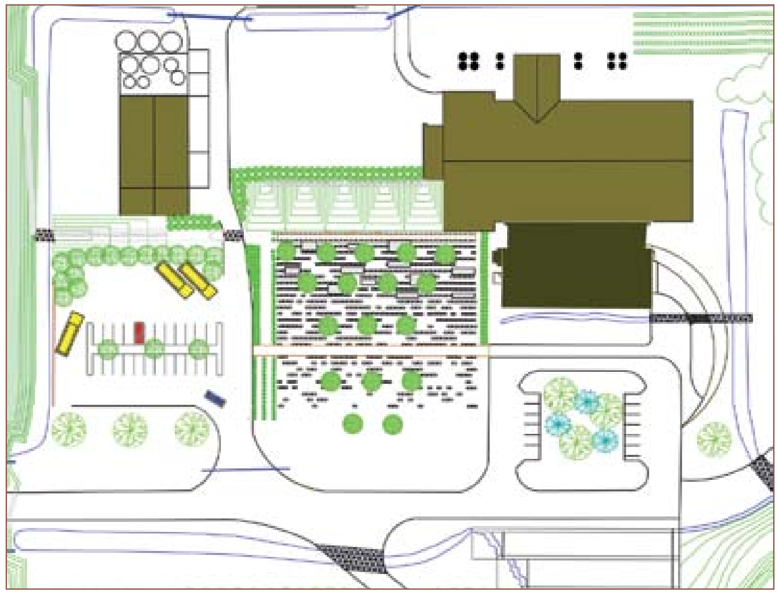


Figure 110: West lawn plan.

The lawn on the north is bounded by "Provost" berms, five earth masses rising 2.4 metres from grade, with a 20 percent slope from north to south and an 50 percent slope on the east and west sides. The vertical north face is held in place by a corrugated, metal-faced retaining wall. *Pinsepia sinensis* (cherry prinsepia) is planted along the north and west faces of the berms to discourage visitors from migrating into the semi-public space.

Figure 111: "Provost berms" Citis, France.

The top terraces are connected by metal grating bridges that allow visitors to walk the approximately 50 metres of space taken up by the berms. The bridgework acts as viewing points into the feedmill area of the semi-public space.

It is in the west lawn where the linearity of agriculture is reinforced through placement of vegetation and hardscape. The memory of the river lots and a past way of life are brought to mind by rectangular pavers running east-west through a portion of the lawn, appearing or disappearing into the grass, whichever is the viewer's perspective, in a north/south

Figure 112: Remembering agriculture.
Linear plantings and paver placement is to recall ploughing the land and the agricultural nature of the site. Sprint Headquarters, Kansas City, Missouri.

Figure 113: Sprint Headquarters, Kansas City, Missouri.

direction. This signifies the transition between nature and agriculture.

Caragana species, often found on the shelterbelts and yards of early prairie farm homes, demarcate the north west and north east boundaries of the space *Quercus macrocarpa* (bur oak), a river bottom species, is planted along river lot lines, aligned north and south with the lines between the Provost berms. A short hedgerow eco-buffer is positioned in the southeast corner of the lawn, bridging the old and new – representing the traditional shelterbelt that protected prairie yards but with species and placement reflecting a new way of doing things.

This is the one space on the site that has no actual water running through it, yet the presence of water has not been forgotten. In the north section of the lawn, culverts of varying sizes and lengths are randomly spaced along riverlot lines. The culvert signifies surface water management, which for some in rural communities is a bane and for others a boon.

The combination of the pavers and the culverts on the northerly portion of the lawn becomes a playground for children, allowing them to play hide-and-seek, tag, or whatever their imagination lets them do, moving from paver to paver and culvert to culvert.

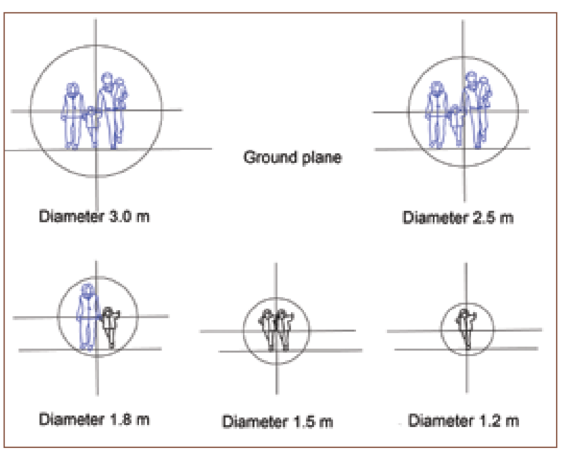


Figure 114: Culvert sections.

Link to the Dike Trail and overflow parking

This space provides either the ending or starting point of travel along the dike and around the site. The symbolism of the culvert is carried into this space in that the large culvert, which acts as a passageway, is "collecting" from the small culverts on the lawn. A 3.25 m culvert serves as a walkway, at the west-end of which is a bridge and ramp leading up to the Dike Trail. The culvert enters a modified Provost berm about halfway to the bridge. To allow light into the culvert, a longitudinal opening is cut in the top of the culvert and closed with plexiglass, starting where the culvert meets the berm.

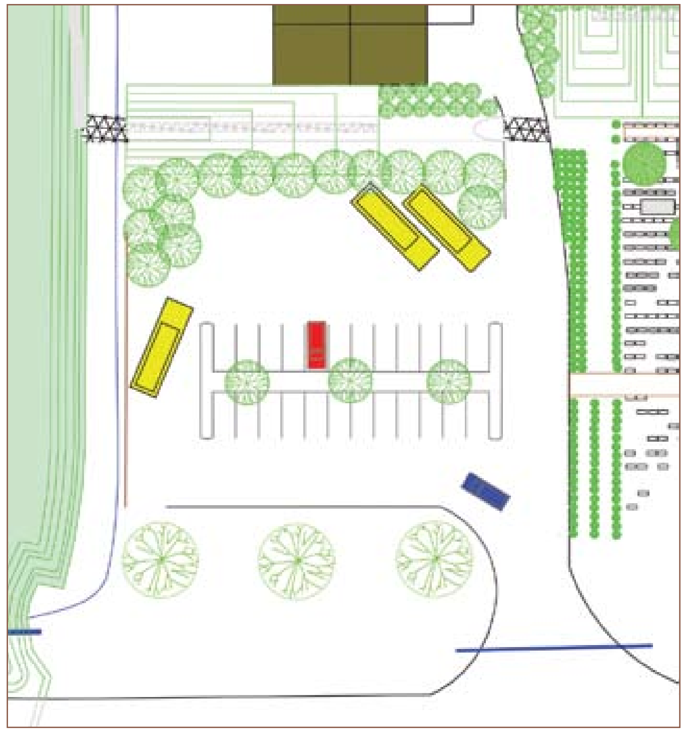


Figure 115: Overflow parking plan.

The transition from the west lawn to the culvert is across the road to the site's feed mill. The path is a continuation of the material used in the pathways in the west lawn. A modified Texas gate, metal grating in place of piping, is used just north of the pedestrian crossing to signify a change of space is occurring, and that it is not open to the public.

Tagged onto this space is the parking area to the southwest. This space provides parking for up to four school busses and 24 cars. Plantings of *Tilia americana* (American basswood) in the northwest corner provide a screen between the Dike Trail and the parking lot. A row of *Ulmus americana* are planted on the parking island.

Reception area

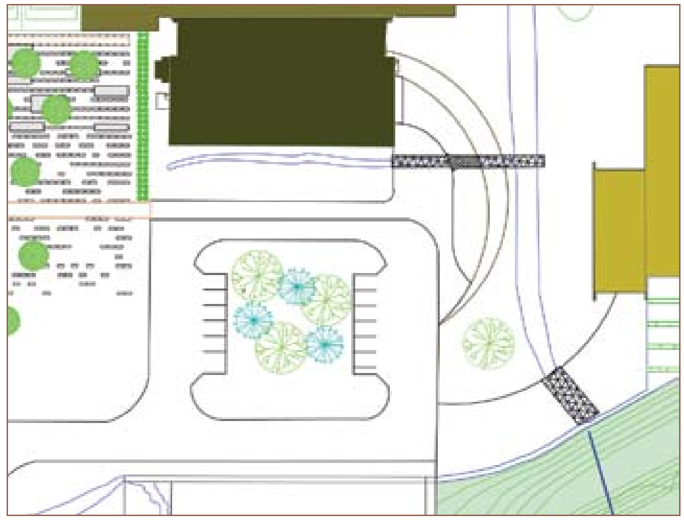


Figure 116: Reception area plan.

The reception area was designed by a landscape architectural firm hired through the Discovery Centre building process. The hardscaping was incorporated into the design for this practicum for the most part because it was installed in the fall of 2010, and it made no sense to ignore its presence. The hardscaping consists of a parking lot; a crescent-shaped concrete intervention demarcating the east side of the reception area; sidewalks running along the north and west sides of the reception area; and boulders along a portion of the base of the buildings south wall. A drainage swale to catch roof run-off was designed to run from east to west along the front of the building then south to the main drainage ditch along the roadway

Figure 117: The Bruce D. Campbell Farm and Food Discovery Centre nearing completion, November 2010.

My preference was to locate the parking lot to the west of the activity area, leaving the front lawn for softscaping. At the time the plans were prepared for the building, this was not an option. Early site plans for this area, show the parking lot taking the entire front lawn. Located within that space were five specimen spruce and several young *Ulmus davidiana* var japonica cv Discovery. The client was in agreement that the trees should be saved where practicable so that there was maturity to some of the plant material around the building.

Figure 118: The foreground spruce needed to be removed due to root damage that occurred in 2008.

The result was that three of the spruce were retained. One had to be removed in 2008 due to disease, while a second was marked to be removed by the contractor in 2010, again due to disease and damage caused when burying water and waste lines to the wastewater treatment facility. Two elms were retained while a third was relocated to the southeast of the parking lot.

Figure 119: Drainage swale in front of the Discovery Centre designed to drain west.

For the purposes of this practicum, several adjustments have been made to the original plans for the reception area.

Water has been incorporated as an active part of the design rather than as a passive element limited to removing roof run-off. The swale has been redesigned to flow from west to east creating a channel running under the sidewalk, through the “crescent” garden and out into the north-south drainage swale. The sidewalk material over the channel is metal grating. The grating continues east, bridging the wetland swale to the north entry plaza for the retrofitted office/workshop building. The line created by the bridgework continues through the open-air display space to the Terrace Garden. The alignment of the elements is along a second order river lot line.

Figure 120: Perspective - walking east from the Discovery Centre.

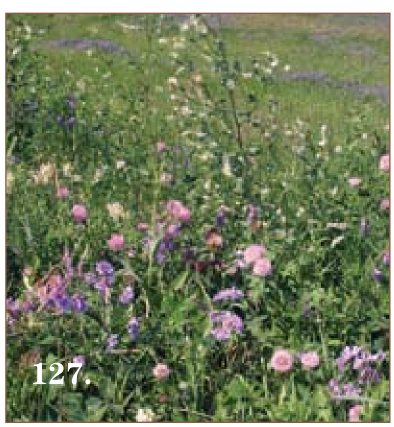
Figure 121: Office and shop complex viewed from the sidewalk of the Discovery Centre.

An east-west sidewalk that links with the path to the overflow parking has been added in front of the Discovery Centre. The north-west corner of the parking area has been reshaped to two right angle lines to provide cohesiveness with the linearity of the west lawn, while the northeast corner has been left curved as in the original design to mesh with the curved lines in this area of the reception space.

Figure 122: Concrete crescent.

Plant material in the "garden space" has also been altered from the original design to make maintenance easier and better reflect some of the components of the space.

It is proposed that the crescent garden be planted with species and varieties of perennial forage crops, eliminating the need to replant annually, allowing visitors a close-up view of plants that are often not displayed, allowing a "teacheable" moment about the nitrogen fixing capability of legumes, and last but not least, adding a sequential bank of colour in mid-June and, if cut



Figures 121 to 126: White clover; Big bluestem; Red clover; Little bluestem; mix of clovers; Prairie dropseed.

after flowering, again in mid-August. The display would also mimic what is often seen in meadows as one species comes into flower and then gives way to the next. The planting would be in bands following the curve of the concrete edge. Planting order from bottom to top: *Trifolium pretense* (red clover); *Medicago sativa* (alfalfa); *Onobtychis viciifolia* (sainfoin); *Melilotus officinalis* (yellow clover); and *Melilotus alba* (white clover).

Viburnum trilobum var. Compactum is planted at the base of the building. A native North American species suited to damp areas, it was chosen for its red fall colour to complement the red strip at the top of the building. To the front of the space, on the south side of the drainage channel, decorative native grass species are planted in rows to contrast with the forage mass-planting garden. The rows of grasses interacting with the swale mimic on a smaller scale the intervention south of the main road where the conifers move around the waterscape.

Beyond the concrete curb, bounding the east side of the reception area is a drainage channel planted to water tolerant species to create a faux wetland. Water from the channel drains south under the south plaza sidewalk covered by a grating to the water channel from the waterscape.

Meeting space

The meeting space has five components to it: the north and south entry plazas, the classroom space, the open-air display space, and the observation space.

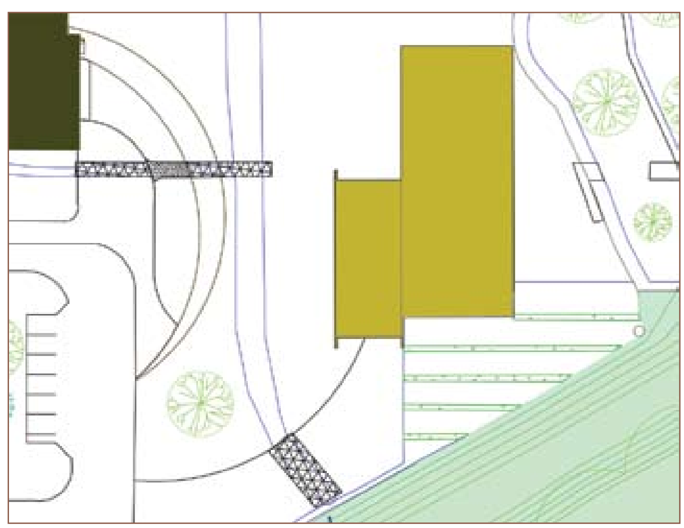


Figure 129: Meeting space plan.

The main road ends at the south plaza. This space serves a number of functions. The water from the waterscape flows through to the plaza in a channel that feeds into the wetland pool. The pool serves an aesthetic purpose while acting as a reservoir for water to feed the Terrace Garden. The pool abuts the refurbished office building/work shop. Five concrete planters filled with wetland species run east to west along fourth order river lot lines. The pool is the inverse of the waterscape – there the vegetation surrounds water channels, here water surrounds vegetated channels. The pool acts as a barrier, yet indicates there is something beyond. It can't be determined what – hide, reveal – water reflects, windows reflect, windows reveal. What lies "hidden" beyond the building? Reflect, reveal, reflect, reveal.

Figure 130: Wetland pond perspective.

The dike is planted with masses of flowering plants á la Prevost's planted berms in Parc Citroen. The treatment adds color to the site and provides a transition between the controlled waterscape and the naturalized Terrace Garden berms.

Figure 131: Chadhars, Technocentre Renault, Guyancourt, France. Provost's chadars resemble the planters in the wetland pool.

Access to the Terrace Garden is through the original office building, the interior of which is to be renovated to provide meeting space for groups visiting NCLE or the Discovery Centre. The western wall panels are replaced with glass to provide a view to the exterior and be more in keeping with the old storage space, which has its walls removed. The former shop, with ceiling to ground glass walls, serves as an eating area and observation place for the Terrace Garden and the wetland pool. The equipment storage space serves to accommodate large crowds and display large equipment or livestock. Visitors can access the Terrace Garden through the observation space.

Figure 132: Inspiration for dike plantings. Vertical gardens at Parc Citroen.

The north plaza is a continuation from, and connection with, the bridge from the reception area. The plaza provides a space for antique horse-drawn farm equipment – rakes, ploughs etc. – to provide scale and contrast with the modern farm equipment that would be on display in the open air-display space. The historic farm equipment will also act as a pull to attract people from the Discovery Centre to the meeting space area and the Terrace Garden.

Figure 133: Drifts of wildflowers. Inspiration for the crescent garden in the reception area and the dike.

The Terrace Garden

This is a space for reflection and quiet contemplation. Initially this space was to be an arboretum – a nursery space to nurture young trees for future planting around the site and to display native Manitoba plant material and material developed at the University of Manitoba or by other organizations or individuals in Manitoba. The space is currently an open lawn bounded by a dying lilac hedgerow on the north, unhealthy Siberian elm on the west and a lone silver maple on the east. The main road to the livestock facilities bounds the south and east of the space.

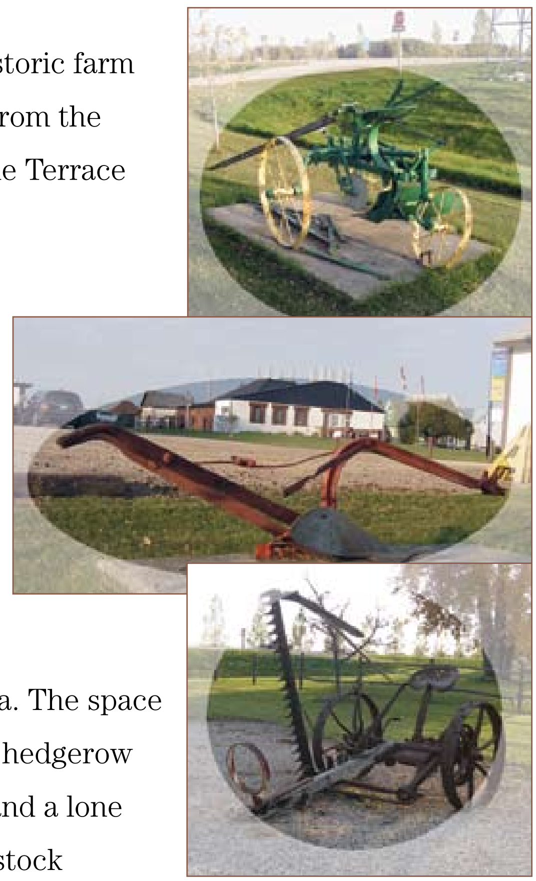


Figure 134: Antique farm equipment.

From the outset, it was the intention to close the road, thereby fully separating the public area from the semi-public area. First impressions of the space indicated a need to address the dike by replacing the grass with vegetation – ground cover or bushes – that would reduce or eliminate the mowing requirement, saving time, money and fossil fuel, while enhancing the aesthetics of the space.

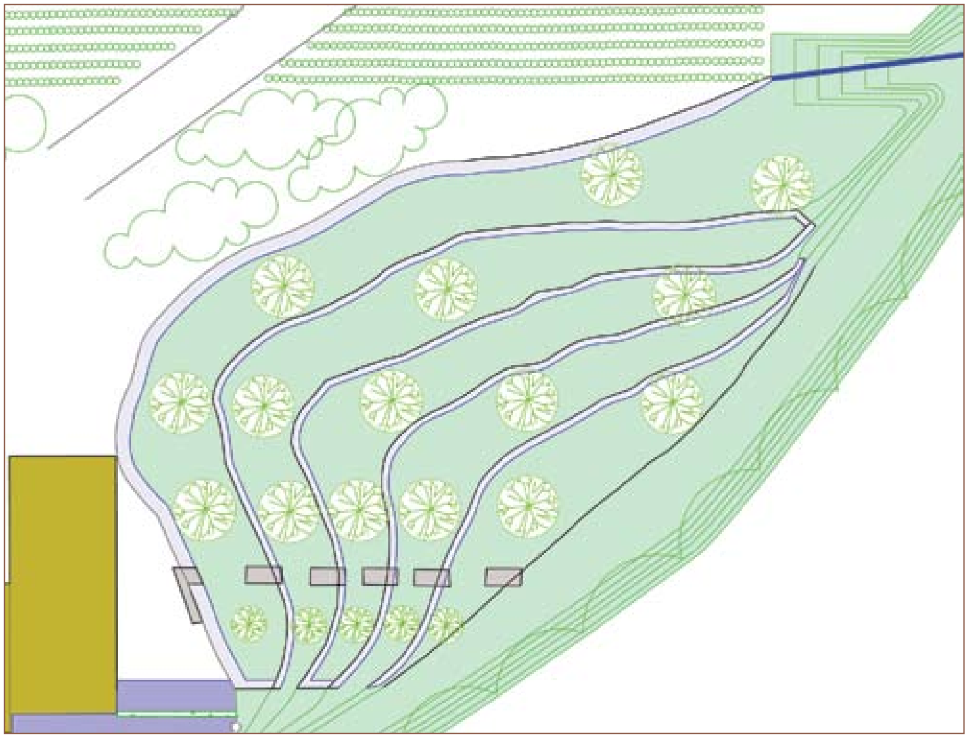


Figure 135: Terrace garden plan.

A caution raised by a structural engineer consulted with respect to placing shrubs or small trees on the dike was the potential risk to dike integrity. Plants with woody root systems were fine as long as they remain alive. Should they die, however, the decay of the woody roots could result in voids in the dike, potentially destabilizing it. The advice was to go no higher than the bottom This was a space where the dike could be brought into the site and better integrated with the space. An initial design concept extended the dike into the north side of the space in an arm or branchlike form. Access to the Dike Trail was to be by a ramp along the south side of this form. After consideration and analysis, it was realized that this was really a tentative gesture, and that far more substantive intervention was necessary.

Consequently, a step back was taken to look at the site and its surroundings more broadly. Two concepts were considered: humanizing the dike by addressing its scale and integrating it with the space; and addressing the agriculture/nature interface and the struggle between the two. In looking at the geography of the area, the river makes a bend at this point that gives the appearance of pushing north-westward into the space. Different interventions were tried with these concepts in mind. What revealed itself in the end was a series of terraces resembling the shape of the Red River. While the shape of each terrace is curvilinear, the edge of each is demarcated by a concrete channel, reflecting that the inroads of nature are still constrained.

The concrete channel is a conduit for moving the water from the waterscape in the foyer through the space. The water is moved from level to level by waterfalls at alternate ends of the terraces. Metal grating that covers the channels serves as a walkway along the terraces. There are opportunities to design a trickle irrigation system for the terraces, sourcing water from the concrete channels.

Visitors can also wander onto the terraces where space permits. A ramp/walkway from terrace to terrace is located along a second order river lot line and aligns with the bridge from the Discovery Centre's reception area. Native and Manitoba-developed tree species/varieties are also planted on each terrace along second order river lot lines.

Both by design and through good fortune, five terraces fit the space, stepping down from the dike.

The north end of the space is bounded by an eco-buffer. To the east of the eco-buffer extending from the dike is a Provost berm, tying this space with the west lawn of the Discovery Centre. The berm serves as a viewpoint into the semi-public space, which will offer a view of the subsurface treatment wetland as well as the shop area, alternative hog barns and cattle housing. The Provost berm also serves as a conduit through which water is moved out to the holding pond outside the dike.

To the southwest of the eco-buffer are random plantings of the riparian species *Acer nigra* (Manitoba maple); *Quercus macrocarpa* (bur oak); *Tilia americana* (American Basswood): and *Populus tremuloides* (trembling aspen), underplanted to *Cornus sericea* (red-osier dogwood); *Viburnum trilobum* (highbush cranberry) and *Corylus americana (*American hazelnut) to provide a vegetative screen for the road that enters from the service road to the open-air display facility.

Terrace vegetation

The tree species proposed for planting on the terraces are native or developed in Manitoba: *Ostrya virginiana* (hophornbeam or ironwood); *Juglans cinera* (butternut); *Acer saccharum* var Jetcan (Jetcan sugar maple); *Celtis occidentalis* (hackberry); and *Crataegus x mordenensis* var Snowbird (Snowbird hawthorn). They are species that are not commonly used, or are at the edge of their zone of adaptability, or in one case is a new introduction.

The trees are described as planted from north to south in the space.

- Eastern Manitoba is the western edge of the adaptability zone for hophornbeam. It is found along the Winnipeg River near Whiteshell Provincial Park, often growing on slopes and prefers moist well-drained soils. Given that it is borderline for hardiness, it is planted on this site where it will receive shelter from the eco-buffer and tree screen.
- Butternut is a visually interesting tree with a horizontal, spreading architecture and ridged and furrowed bark. Although it is outside its hardiness zone in southern Manitoba, it can be grown in protected areas (micro-climates) and several trees are present on the grounds of the Manitoba Legislature.
- The sugar maple is the envy of many Manitoba horticulturalists for its vibrant fall colors. Jeffries Nurseries, Portage La Prairie, has recently introduced a hardy sugar maple, Unity.
- Snowbird hawthorn was developed at the Morden Research Station of Agriculture Canada and introduced in 1967 as a hardier version of its predecessor Toba.
- The hackberry or bois inconnu has interesting historical roots in Manitoba. The name "bois inconnu" was given to the hackberry in eastern North America by early French settlers. The name was carried west by voyageurs. For a period of time, the tree was literally lost in translation. Early English-speaking historians reviewing notes taken by French observers of the tree in Manitoba made a literal translation of the the words to unknown wood or unknown tree, assuming the French did not know the specis of tree they were observing.

Sequence of landscape design elements

1. prepare foyer dike entrance for use with removable dike
2. install external western eco-buffer
3. install east-west eco-buffer between public and semi public areas providing it can be protected during completion of the secondary road

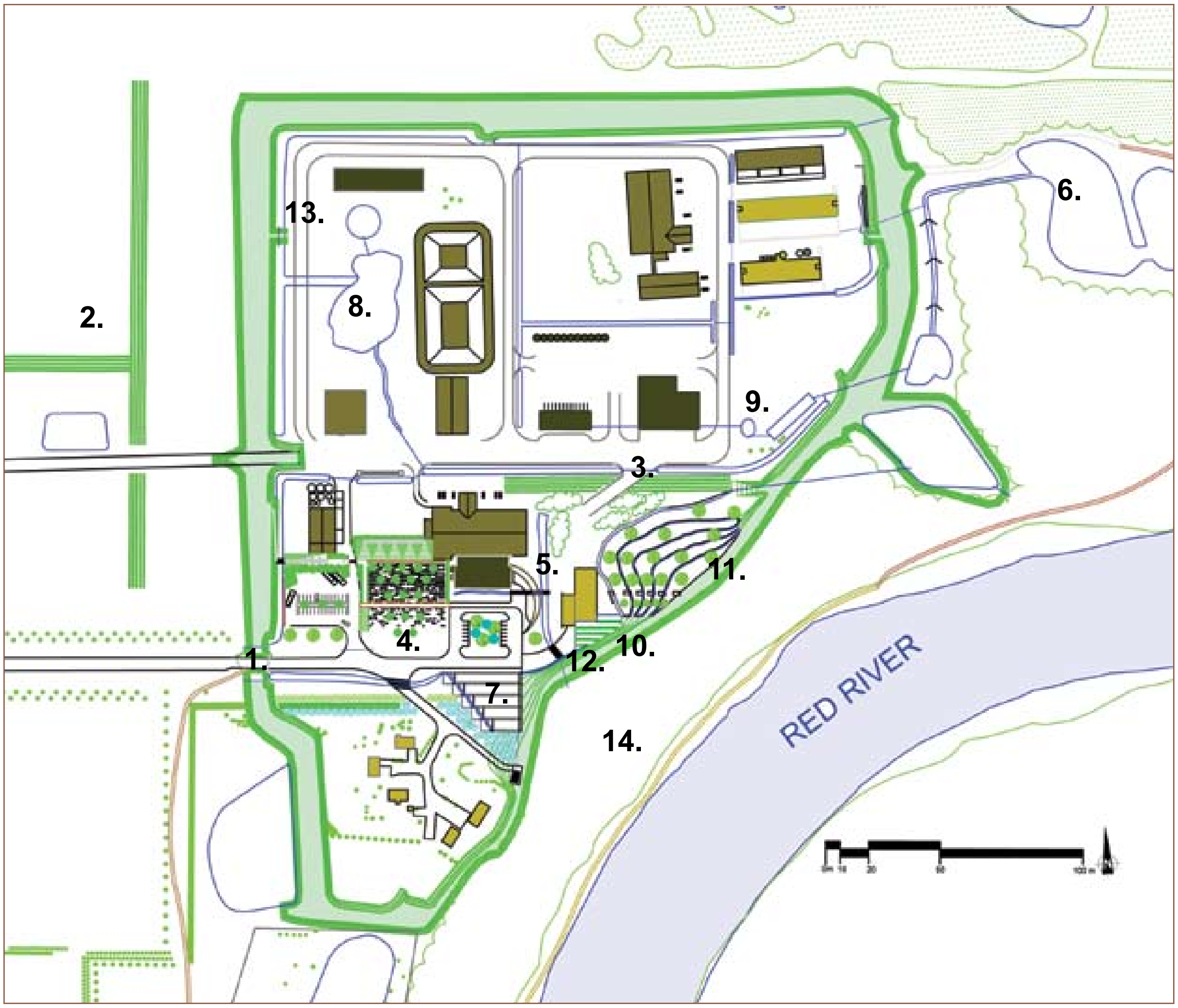


Figure 136: Design implementation sequence.

4. develop landscaping of the Discovery Centre's west lawn

5. develop north/south water channel east of the Discovery Centre

6. renovate borrow ponds north east of the dike and develop wetland/natural area

7. build foyer waterscape and related wetland south of the main road

8. build surface treatment wetland in conjunction with new dairy barn

9. build subsurface treatment wetland in conjunction with new office and work shop

10. build plaza around office/workshop in conjunction with retrofitting the building

11. develop east terraced berm

12. install/activate water circulation from waterscape to plaza to terraced berm
13. develop dike outlook points and dike trail
14. develop external trail routes from north-east wetland, south through riparian forest to astronomy viewing area and to the north through fields

Chapter 9

The practical practicum

Tree protection

One of the initial actions taken was to recommend and then lobby for appropriate protection for trees within construction zones on the site.

Figure 137: Tree protection is mandated by bylaw in Oakville, Ontario.

The initial site of concern was around the new wastewater treatment facility. Directly in the path of construction equipment was one of two remaining Scotch pines on the site, and within close proximity to the construction area was a row of healthy elm trees. GRS has been fortunate in maintaining its elms trees in a healthy state, considering that many elms in the area are showing signs of Dutch elm disease, particularly east of the river. It was essential then to ensure that the row of elms suffered no damage during construction.

Initial discussion with staff at Physical Plant revealed that 2x4s or 2x6s strapped around the trunks was sufficeint to protect treesin construction zones.

Figure 138: Proximity of excavated soil from wastewater treatment facility construction before tree protection was put in place.

It took some time after construction had begun to get fencing up. It was apparent from where excavation dirt was piled that it would have been right on top of the elms without fencing in place. The site foreman had to be reminded to stop placing heavy material around the base of the Scotch pine.

Obviously feeling constrained as to where excavation material could be placed, the construction crew began dumping fill north of the main lawn on what to them appeared to be "empty" space. In fact there were several young trees in the space, one of which was substantially buried for several months. In conjunction with the wastewater treatment plant construction, water lines were dug to several barns and tree roots disrupted. Of greatest concern was root damage to the specimen spruce on the front lawn. There was no reason why grading equipment had to come as close as it did to the trees. Damage to the roots of one subsequently led to visible decline of the tree over the succeeding two years, to the point that it had to be removed.

Figure 139: Excavated soil dumped on elm.

Figure 140: Damaged spruce roots.

The final interaction was regarding the young elms and mature spruce on the site of the Discovery Centre. By working with Physical Plant and its architect in charge, tree protection was written into the construction contract and included in the construction plans. The fencing went up; however it was not maintained, and by the end of the construction period, one fence had completely disappeared and construction material was being piled within the supposed protected space.

Figure 141: Construction material piled inside protective barrier. The contract required that the barrier be retained thorughout construction.

These experiences indicate there is a disconnect between Physical Plant and construction companies and a systemic lack of respect for plant material. This is ironic given the university has a faculty which teaches the proper way to secure trees on construction sites.

The lack of concern about plant material is further ironic in a university setting where, in many other areas of endeavor, every effort is being made to follow sustainable practices.

Figure 142: Mistreated elm. This elm was covered to mid-trunk level with dirt in 2008. In 2010, requirements to protect it during construction were ignored. It remains to be seen how long it will survive.

Figure 143: Misdirected care. Following land grading, these three green ash were covered with soil well above the root flare. They were dead within two years.

Vegetation inventory

Figure 144: Siberian elm, caragana and lilac. Nearing the end of their life expectancy and suffering from lack of maintenance.

Early on it became apparent that an inventory had to be done of the site's vegetation for very practical reasons – many of the trees were in desperate need of remedial pruning to slow the pace of disease and/or insect damage. A secondary reason was to determine what plants had surpassed their life expectancy or were not suited to their location and should be removed as a quick improvement to aesthetics.

A remnant caragana planting of five shrubs from the 1960s were no longer of any aesthetic value. An adjacent lilac hedge had been left to its own devices for too long and was inter-grown with self-seeded trees.

Weigela florida (weigela) planted in row in a bed in front of the office building was a poor choice because the plant is marginally hardy in Manitoba and needs special care if it is to be as showy as it has the potential to be. Because it blooms on previous year's wood, the shrubs often had only a "straggly" floral exhibition. Weigela needs winter protection to perform well, something the GRS staff has little time or inclination to do in the late fall.

By the dairy barn, a mature grouping of silver leaf willow of what could have been specimen quality suffered from errant limbs that posed a safety hazard and trunks that no longer had structural integrity.

Figure 145: Silver leaf willows in need of pruning. Weak and decaying branches pose a risk to passing vehicles.

A private arborist was consulted In September 2007 to confirm that the decision was correct about which trees were to be pruned or removed.

In June 2009 an arborist from Physical Plant examined two Dutch elms near the dike entry because they had been showing some distress for several years. It was important to discount Dutch elm disease. He concluded that the trees were suffering from "construction disease," the outcome of disturbance to their roots when the dike and roadway to the new feedmill were built. The conclusion was to eventually remove them. He also indicated that the row of elms along the entranceway road were in need of maintenance pruning to improve their form and overall health by removing dead and dying branches. Sound maintenance is one of the defences against Dutch elm disease.

See Appendix 1 for the inventory list and condition ranking and Appendix 2 for the report of the Physical Plant arborist

Tree pruning/ tree removal

Funding provided for this practicum had a component that allowed for plant material. The original intention was to use it to buy trees and shrubs for the site but, given the condition of many of the trees, a portion was diverted to pruning and removal. Early in 2008 competitive bids were sought from two experienced tree pruning companies. Green Drop

Figure 146: Pruning crew.

was contracted to prune 13 trees and remove 19 others, including one of the five specimen spruce from the front lawn as well as four Siberian elms east of the office/shop building.

Figure 147: Removing one of group of five spruce.

A lesson learned from this experience is that for any trees that are to be removed, stump grinding should also be contracted for. Due to cost constraints, it was decided to have the tress removed to ground level only. Given that there was considerable snow on the ground at the time, several stumps were left 20 to 30 cm above the ground. It had been anticipated that the stumps could be removed using a chemical to "rot" them or have them pulled out by a bulldozer. The chemical proved more expensive that anticipated, and the process more complicated. While there was, from time to time, a bulldozer on the site in the summer and fall of 2008, communication was such on the site that stump removal was never accomplished.

In August of 2009, a local landscaper was contracted to remove the remnant spruce and pine shelterbelt north of the main road at the dike entrance for aesthetic reasons.

Tree maintenance

A number of trees were identified by a consulting arborist as needing fertilizer. During mid-summer 2008, the four specimen spruce on the front lawn and two elms were fertilized using a single, manual drill to drill 2.5 cm diameter holes 15 to 20 cm deep, 45 cm apart in concentric circles staring at the drip line of the spruce and extending outwards to a distance equivalent to half the height of the trees. The deciduous trees were treated in the same way except the fertilizer application began about a metre from the tree trunk. Dry fertilizer, 25-10-10-5, was used. The timing of application was on the late side, given that there is concern that trees have adequate time to "harden off" between fertilizer application and frost.

The fertilizing was done in an effort to improve the vigor of the spruce that were being affected by Cytospora canker, spider mites, tip blight, needle miners and some bud

Figure 148: The difference fertilizer makes. The two circled elms received fertilizer in the summer of 2008, while the trees to their right did not. By late September, the benefits were obvious.

scale. Limited Hort Crew time and the frustration of the task limited further trees being fertilized.

Dry fertilizer was chosen, rather than the liquid application offered by many commercial companies, to avoid the grass being the major beneficiary and to provide a longer feeding period due to the slow release nature of the prills.

The benefits were evident by fall when the fertilized elms retained their leaves and fall color two to three weeks longer than unfertilized, adjacent elms of the same age.

Tree and shrub selection

Midway through the summer of 2009, rose bushes and Potentilla fruticosa shrubs were purchased from local nurseries. Potentilla was purchased to replace the *Weigela florida,* which was unsuitable for its location. Potentilla was chosen for its hardiness and ability to grow under almost any conditions. Varieties chosen were Pink Beauty and Snowbird, developed by Louis Lenz in the Faculty's Department of Plant Science.

Figure 149: Snowbird potentilla.

The potentilla shrubs proved to be an unexpected challenge, sequentially wilting or dropping their leaves for no apparent reason and then rejuvenating themselves. Soil moisture seemed adequate. The nurseries from where the shrubs were purchased could not provide a reason for the unthriftiness. Some weeks later in a chance conversation with a nursery wholesaler, it was indicated that this is not an uncommon problem in the year of establishment of potentilla, depending how root bound they are. The advice given was to make sure they were well-soaked with each watering and to water frequently.

The roses chosen were varieties developed at the Morden Research Station of Agriculture and Agrifood Canada – Snow Beauty, Morden Belle, and Winnipeg Parks. While the rose garden was initiated to add color and perennials to the front of the office, the dominant reason for the garden was to cover a portion of the lawn that would not grow grass. It was subsequently discovered that, during the winter , staff used a skid-steer loader to clean the short footpath, which is narrower than the width of the machine. Consequently the soil along the edge of the path had become compacted to the extent that it would not grow anything. As an extra incentive to turn to hand-shoveling, large boulders were placed in the corner to prevent passage of the skid-steer and keep other equipment out of the garden during the winter.

Figure 150: The rose garden.

While the staff co-operated in positioning the rocks, there was an indication that the staff were not pleased with the rocks' arrival. By the following spring the rocks were no longer in the garden, a useful lesson to avoid putting landscape elements where they aren't appreciated.

Figure 151: Selecting a Black Hills white spruce.

Towards the end of the practicum period, working with a Manitoba nursery wholesaler, trees and shrubs were selected for the Discovery Centre. Selection was based on suitability for the proposed location; novelty, and/or native to or developed in Manitoba.

Figure 152: Leaves of the Starlite crabapple.

With the architectural plans for the centre came a proposed landscape planting plan. As money for the project was limited, the plant material recommended in the plan was not followed. Money available through this practicum purchased a limited number of trees and shrubs for the site.

Seven, 1.8 m *Picea glauca* 'Densata' (Black Hills White Spruce) were purchased for a screen at the southeast corner of the hog barn attached to the Discovery Centre. It was recommended that they be planted on at least 5 m centres. The original planting plan called for a dense planting of 15 Colorado spruce on 3.5 m centres and much too close to the hog barn's fans for the health of the trees. My recommendation for the lighter planting was to allow the spruce trees space to maximize their adult architecture without the need for thinning. The native white spruce is also better adapted to Manitoba conditions than is the Colorado spruce.

Figure 153: Starlite crabapple.

Twenty potted *Viburnum trilobum* 'Compactum' (Compact American Cranberry) were selected for their fall color (deep red) to compliment the red siding on the upper portion of the Discovery Centre. The species is native to Manitoba, but the variety was selected from a native Minnesota population. The original planting plan had called for *Physocarpus opulifolius* 'Dart's Gold' (ninebark), a yellowy green-leaved shrub. The client is not fond of yellow-leaved plants.

Three, 6 cm caliper crabapple trees of the recently released variety Starlite (*Malus x Jefstar*), developed by Jeffries Nurseries in Portage la Prairie, were purchased for their unique leaf appearance (glossy and dark green). From a maintenance point of view the fruit is small and not readily dropped in the fall. The original planting plan called for five Kelsey Rosybloom crabapple trees. While a lovely pink-flowering tree,

> "[i]t is not a low maintenance plant, though, as the fallen fruit will need to be cleaned up in spring. … This tree should have only one use in a landscape – as a solitary accent for its showy spring bloom. It is a large tree which starts out upright but really spreads with age, ultimately requiring lots of room to grow for maximum effect." [Northscaping.com]

Three, 6 cm caliper *Ulmus americana* were selected that have shown increased resistance to Dutch elm disease. Two as-yet unnamed varieties were available, one from University of Manitoba material and the other from a North Dakota source. The choice was left to the nursery. The purpose of this selection is to put on display potentially new plant stock.

Figure 154: Preparing to move a Discovery elm.

The last tree species selected was *Cornus alternifolia* (Pagoda Dogwood). Its range is Eastern Canada; however here is a small native population on the Pembina Escarpment and around Riding Mountain National Park. It was chosen for this reason together with its horizontal form that resembles a pagoda. Three trees were purchased

Tree moving

In preparation for construction on the Discovery Centre site, it was decided that, if possible, the elms should be relocated. It was determined that construction would start in the late summer or

Figure 155: Beginning the lift.

early fall of 2009. Unfortunately, the summer was extremely hot and not conducive to moving a 22 cm caliper tree.

It was finally determined that two of the trees could be left in place and (hypothetically) accommodated with tree fencing, two would be destroyed, and the largest one moved to the edge of the centre's site. Before moving the tree, it was necessary to have an engineer locate electrical, potable water and waste lines because only approximate locations were available on maps of the site.

Figure 156: Preparing to place.

It was a logistical challenge to find a tree mover that could move a large tree and one who was agreeable to work to an unknown moving date. Adding to the challenge was balancing cost against tree survivability. If the weather turned hot after transplanting, a 90" spade increased survivability. A smaller spade would cost less and was acceptable if the weather remained cool after transplanting. Given the unusual weather pattern that summer it was decided to go with the large spade. The tree was moved at the end of September without mishap. In replanting it, the mover was able to tilt the tree slightly so that it is now stands upright; it had been growing at a slight angle in its previous location. The tree overwintered well, leafing out with smaller leaves as would be expected after being moved. The summer of 2010 provided more than adequate moisture. It will need to be monitored in the coming year to determine whether it requires fertilizer.

Figure 157: In place.

Figure 158: Protected.

The roots left behind demosntrate why it is so important to keep heavy material and equipment away from the root zone to avoid soil compaction and root damage. Given how close theselarge root are to the surface, it shouldn't be hard to understand the degree of risk to the fine feeder roots.

Figure 159: Roots left behind.

Northeast external borrow pits

There are two ponds external to the dike located to the north east of the property. Their genesis and purpose are not particularly clear. It appears they may have been the result of fill mining for the dike after the 1997 flood. The design gives the appearance of a two-cell settling pond, and, in fact, they have been referred to as evaporative ponds. They were not established as treatment wetlands as initial visits to the site in 2007 indicated very little macrophytic wetland plants. By late 2009, a few patches of cattails were in evidence. It should be noted that duckweed, a floating water plant and indicator of high nutrient-laden water, was in evidence on the west pond at different times of the year.

The ponds are connected to the site by a narrow vegetated channel fed by a culvert through the dike that receives surface run-off water from the northeast portion of the site. During spring run-off it is surmised that surface water from this area will have high nutrient levels as it passes through the loose housing cattle sheds where small numbers of cattle are overwintered or maintained for research trials. No sampling of the water from teh concrete channel was done to determine nutrient levels.

What was initially intriguing about the ponds is that the second or easterly pond has a channel from it to the river. Given current concerns about nutrient levels in water entering water bodies, it is reasonable to question the purpose of this channel and the quality of water in the two ponds. Several people familiar with the site were questioned about the channel, but no one could provide a reason for its existence.

Three sets of water samples were taken in an attempt to quantify the impact of the ponds on their surroundings.

Once in 2007, in November and twice in 2008, in late June and late October, two water samples were taken from each pond to determine standard indicators of water quality such as nitrogen, phosphorus and BOD (biological oxygen demand) levels. In 2008, the water was also sampled for E. coli and coliform. Analysis was done by an accredited laboratory.

Table 2: Water analysis November 2007.

Analysis	West 1 Nov 2/07	West 2 Nov 2/07	Average	East 1 Nov 2/07	East 2 Nov 2/07	Average
Ammonium mg/l	3.87	3.72	**3.795**	1.78	1.79	**1.785**
Phosphorus dissolved mg/l	1.32	1.81	**1.565**	0.9	0.59	**0.745**
Kjeldahl N total mg/l	9.85	6.11	**7.98**	3.48	3.45	**3.465**
Phosphorus total mg/l	4.39	2.19	**3.29**	1.25	1.24	**1.245**
Organic carbon total mg/l	26.2	27.4	**26.8**	24	24.4	**24.2**
Electrical conductivity µS/cm	808	800	**804**	758	766	**24.2**
Nitrate/nitrite dissolved mg/l	0.74	0.19	**0.465**	.45	0.45	**762**
Biological oxygen demand	**44**				5	**0.45**

Table 3: Water analysis June 2008.

Analysis	West 1 June 23/08	West 2 June 23/08	Average	East 1 June 23/08	East 2 June 23/08	Average
Ammonium mg/l	1.15	0.93	**1.04**	<0.05	<0.05	**<0.05**
Phosphorus dissolved mg/l	2.91	2.71	**2.81**	0.24	0.41	**0.325**
Kjeldahl N total mg/l	9.18	10.4	**9.79**	2.56	2.58	**2.57**
Phosphorus total mg/l	2.97	3.1	**3.035**	0.31	0.47	**0.39**
Organic carbon total mg/l	49	55.9	**52.45**	21.4	21.5	**21.45**
Electrical conductivity µS/cm	945	946	**945.5**	580	586	**583**
Nitrate/nitrite dissolved mg/l	0.08	0.08	**0.08**	0.06	0.06	**0.06**
Biological oxygen demand	**<4**			**2**		
Total coliform MPN/100 ml	**130**			**49**		
Fecal coliform MPN/100 ml	**33**			**2**		
E. coli MPN/100 ml	**23**			**2**		

Table 4: Water analysis October 2008

Analysis	West 1 October 2008	West 2 Oct. 2008	Average	East 1 Oct. 2008	East 2 Oct. 2008	Average
Ammonium mg/l	3.01	2.59	**2.8**	0.06	0.07	**0.065**
Phosphorus dissolved mg/l	2.32	2.45	**2.385**	1.39	1.4	**1.395**
Kjeldahl N total mg/l	10	9.19	**9.595**	1.97	1.85	**1.905**
Phosphorus total mg/l	6.52	4.4	**5.46**	1.44	1.45	**1.445**
Organic carbon total mg/l	45	40	**42.5**	19.8	19.4	**19.6**
Electrical conductivity μS/cm	709	706	**707.5**	569	565	**567**
Nitrate/nitrite dissolved mg/l	0.08	0.1	**0.09**	<0.05	<0.05	**<0.05**
Biological oxygen demand	**<420**			**<42**		
Total coliform MPN/100 ml	**43000**			**2300**		
Fecal coliform MPN/100 ml	**2300**			**36**		
E. coli MPN/100 ml	**2300**			**36**		

June 23/08 samples taken @ 8 -8:30 a.m.
Oct. 22/08 samples taken @ 3:30-4:00 pm

The results show that, in all cases, water quality of the east ponds was superior to that in the west pond as would be expected given the west pond is the first cell to receive surface water from the site. In the case of the east pond, the one concern raised by the analysis is the level of total phosphorus. In all three test periods it is well above the provincial guideline for water entering rivers and streams (0.05 mg/L). This is not a concern provided the east pond water remains where it is.

Several times since the 1997 flood, river water has been observed in the meadow surrounding the ponds; however there was no consensus on when this occurred or how much water was in the area because observations were anecdotal, that is to say, someone remembered seeing water in the area but made no note of the time period or the amount of water.

Data on river levels were requested from Manitoba Water Stewardship. High water levels were compared to the elevations of the channel bank and bottom and the bank of the east pond from 1997 to 2007.

Table 5: Flood levels, 1997 to 2007.

Red River peak levels compared to borrow pit bank and channel bottom & bank elevations at the Glenlea Research Station (metres)				
Year	**River level at St. Adolphe Bridge**	**In excess of channel bottom elev. (231.63)**	**In excess of channel bank elev. (232.99)**	**In excess of pond bank elev. (232.38)**
1997	235.46	3.83	2.47	3.08
1998	230.79			
1999	232.17	.54		
2000	229.33 S			
2001	232.68	1.05		0.30
2002	230.73 S			
2003*	n/a			
2004	232.50	0.87		0.12
2005	233.26 S	1.63	0.27	0.88
2006	233.63	2.00	0.84	1.25
2007	230.79			

Peak water levels on the Red River at the St. Adolphe Bridge, about 3 km downstream from the GRS.
Source: Alf Warkentin, Manitoba Water Stewardship, March 4, 2008
*Data for 2003 were unavailable; however, Mr. Warkentin indicated that weather conditions were similar to 2000. S indicates a summer rather than spring peak.

The spring peak levels for 2000, 2002 and 2005 were considerably lower than the peaks generated by summer rainfall generated. For example the peak in March 2000 was 225.9 m and the highest level reached in the April-May period was only 224.3 m. Yet the peak for the year was 229.33 m.

Pond bank elevations and ground elevations are based on a survey done by Manitoba Land Surveyors conducted between April 22 and June 3, 2002. As noted on the survey: Geodetic Elevations are referred from Bench Mark Station No. 85M416 as provided by Manitoba Conservation (Survey Services Branch) - Elevation 234.394.

The elevation of the bottom of the channel at is north end is 231.63 m, while the elevation of the top of its bank is 232.99 m. Several spot elevations were surveyed around the two ponds, the lowest of which is 232.38 m to the northwest of the east pond. There is no indication on the survey whether this is the lowest point on the bank. For the purposes of this analysis, it is assumed that it is.

In years 1997, 2005 & 2006, the area of the ponds would have been inundated by flood water from the Red River. Period of inundation, supplied by A. Warkentin: For 2005, river

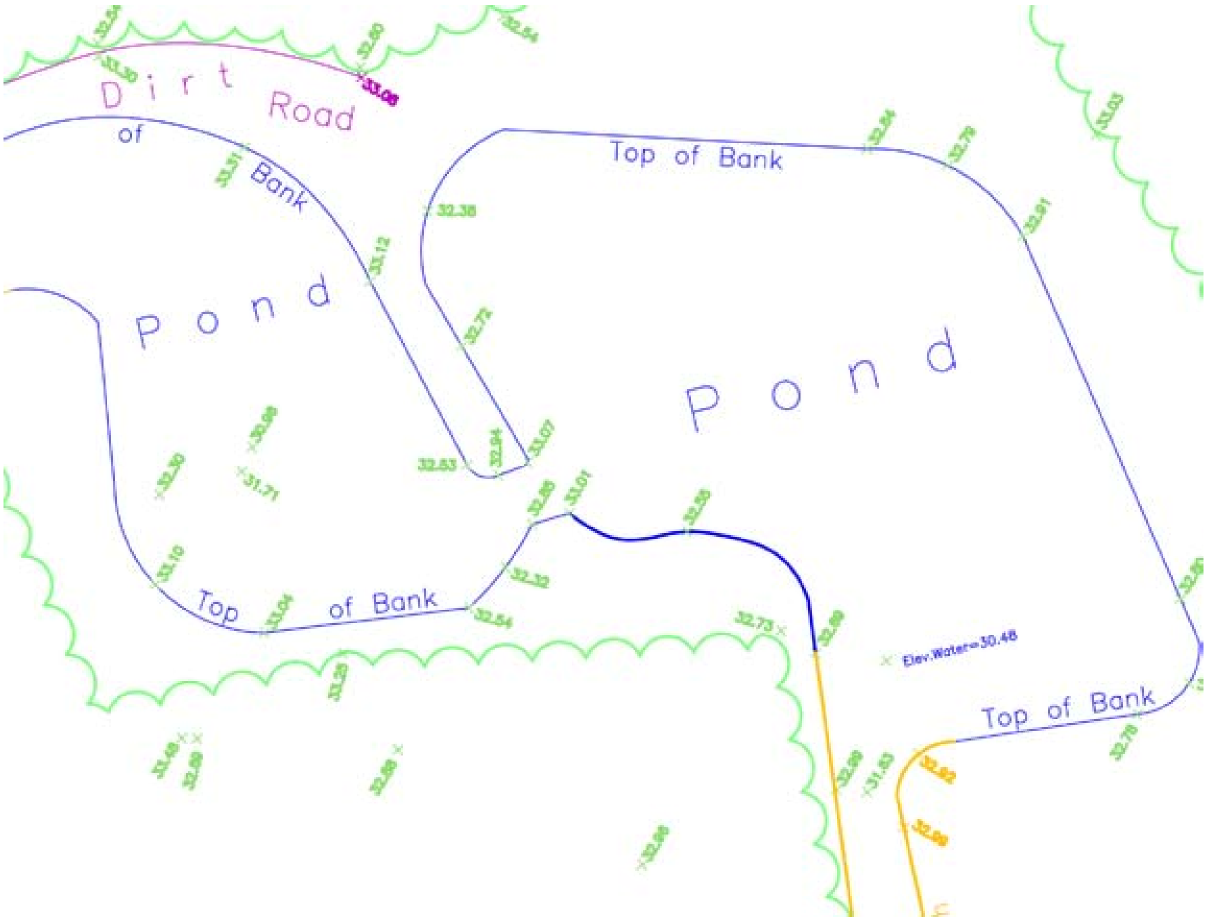


Figure 160: External pond elevations.

water was above 232.38 m from June 30 to July 10, with the peak on July 4. For 2006, it was above 232.38 m from April 8 to April 29, with the peak on April 20.

Excluding the general flood year, river water would have entered the east pond via the channel in 1999, 2001, and 2004, causing mixing of run-off from the site with river water.

In 2001 and 2004, flood water would have breached the bank of the east pond, after entering the pond through the channel and filling the pond to the lowest elevation of its bank.

What is unknown is the level that the water reaches in the two ponds during run-off events from the site inside the dyke. If the drainage/run-off water exceeds 231.63 m (the elevation of the channel opening) under “normal” conditions, then it will flow into the river. At the time of the elevation survey, April 22 to June 3, 2002, the elevation at the water’s surface in the east pond was noted as 230.48 m. Random observations over the period of this practicum indicated that water levels in the east pond were generally low, below the level of the channel opening.

Several alterations should be considered to the east pond. If the channel is to remain open, the ponds' banks should be raised to at least 233m. That would prevent the river water from breaching the banks from the pond side. The elevation of the channel opening should be raised, if not closed entirely. The channel opening could be raised to about 232.8 without potentially interfering with internal site drainage. The culvert through the dike that feeds water into the ponds has an elevation of 232.96 m at the intake end and 232.18 m at the outflow.

The simplest solution would be to close the channel opening entirely, provided this can be done without affecting the sites internal drainage, which should be possible. Regardless of whether outflow from the ponds or mixing of river water with pond water has any real implications for water quality and human health, as long as the channel is open, there is the potential for the public to perceive that the GRS is not following appropriate water quality guidelines.

In fact, during municipal rezoning hearings for the new NCLE facilities, a local activist and opponent to the rezoning claimed that effluent was being released directly into the river. This was a patently false accusation, but it demonstrates the public relations risk if anything can be construed to be outside generally accepted practices.

Chapter 10

Conclusions and recommendations

It is imperative that the management of the GRS adopt a master plan strategy for the site in order to make best use of limited financial resources and public funds. Being proactive in taking a long-term view rather than reactive in response to currently available or limited-term funding will result in an efficient use of space, avoidance of duplication, and reduced costs.

It is rewarding to see that the initial recommendation of this practicum to build a second access road for the site has been undertaken. In order to be fully functional and achieve its purpose of reducing traffic on the main road to the Discovery Centre, the road must be completed at its east end.

The site offers many possibilities for expanded research, demonstrations and learning opportunities. Interest in natural methods to treat wastewater is high at the current time. Partnerships and funding may be available to explore the creation of constructed treatment wetlands at the GRS. Testing the use of this treatment method could have future benefits to the farm and rural communities by developing protocols for the use of constructed wastewater wetlands in Manitoba's climate.

Incorporating an eco-buffer on GRS property would serve as a useful demonstration of a more practical style of shelterbelt. Currently, test and demonstration sites are located in Alberta and Saskatchewan. The first site in Manitoba is planned for the spring of 2011 by Whitemud Watershed Conservation District in partnership with the Agri-Environmental Services Branch (AESB). It will be located near Carberry along the Trans Canada Highway.

There are many opportunities to introduce landscape interventions that will make a visit to the site memorable and in keeping with the stature of a national research centre. It is recognized that the interventions explored in this practicum are outside the budget of the GRS without significant fundraising. They have been put forward to demonstrate the possibilities if the landscape component were adequately funded. Regardless of whether or not the interventions are incorporated, the site's greatest need is for the people who manage it, work on it, and live in it to recognize the important role that a sense of place plays in people's response to a site. A positive, welcoming, and inspiring sense of place cannot be achieved without care for the landscape.

Applying the findings of this practicum to livestock operations

1. Aesthetics

Improving and maintaining the appearance of the yard site has significant, but too often unrecognized, value in building relationships with neighbors and the general public. With the growing availability of information about native plants and plant material beginning to become available at nurseries, plants can be grown that are hardy, perennial and suited to specific environments. They offer alternatives to the often work-intensive, domesticated garden plants.

2. Odor mitigation

The science related to reducing odors through the use of plant material is still young, but there are guidelines and information available to assist in establishing plant material in and around a yard site that will contribute to a reduction in odor. The key is to recognize that "one size does not fit all" when it comes to shelterbelts. Design, location and plant species will determine whether the shelterbelt is effective for the job it is to do.

3. Establishment of eco-buffers

Eco buffers have the potential to improve the longevity of a shelterbelt while reducing the work associated with maintaining one, particularly in the early years of establishment.

4. Site design

Take the time to prepare a site master plan, even if the yard site is already established. When there is an opportunity to make changes to the operation, the implications of those changes can be reviewed in the context of the whole site, not just one small portion of it. A well thought-out site plan will facilitate future site changes in order to comply with environmental regulations, livestock handling guidelines and farm safety requirements.

5. Treatment wetlands

Constructed wetlands for wastewater treatment, both domestic and livestock, hold potential as natural methods of purifying black and grey water in rural areas. This is increasingly attractive due to ever more restrictive enivronmental regulations related to meachnical treatment methods.

Recommendations regarding design implementation

While the majority of design interventions are beyond the financial capability of the Faculty of Agricultural and Food Sciences at the current time, there are a few components that can be undertaken with modification.

1. Faux wetland

The drainage channel between the Discovery Centre and the office/shop can be reintroduced to the site by appropriate grading. It can be planted to native species that will survive a variety of soil moisture conditions. Signage can then be developed indicating the names of the various plants and explaining how a wetland functions.

2. Redirecting traffic and improving safety

By completing the east end of the new secondary road, staff, service, academic, and tour vehicles can be removed from the main road so that it services primarily the Discovery Centre and staff housing. Demolition of the sheds behind the office/shop would allow parking to be moved to that area from the east side of the shop. This would provide a route from the secondary road to the office/shop for equipment that needs servicing and vehicles that need access to the office. This reconfiguration would allow the portion of the main road east of the shop to be closed which would eliminate the current risks related to the blind corner at the shop.

High on the list of funding priorities should be the relocation of the scale, so that it is completely removed from the public area. Not only would this enhance safety, but it would allow for creating overflow parking and improving the aesthetics of the Discovery Centre.

3. Separating the public from the semi private

Strategic positioning of plant material can provide visual cues and physical barriers to the public regarding prohibited access. To reinforce the separation east of the shop after road closure, an eco buffer can be established in place of the existing row of lilac bushes and poplars located just south of the east end of the secondary road.

On the west side of the Discovery Centre, with the scale relocated, a second eco buffer could be established between the centre and the feed mill road and the road and the dike. This would act as an aesthetic link to the east side of the public area, while indicating to the public that they should not move any further north than the eco buffer.

4. Climate mitigation

A shelterbelt should be established west of the dike as indicated on the master plan. This will reduce the need for snow clearing while improving site environment by reducing wind speed from the north and wast.

5. Redevelopment of the area east of the shop

With the road closed and the eco buffer in place, the gravel and fill of the old road bed could be removed and the area worked to break up the hard pan which would have developed after nearly 50 years of traffic. The road bed could be rejuvenated over a number of years by planting forages and/or working in green manure crops to improve soil structure and tilth. Whether topsoil will eventually have to be brought in will depend on the material in the roadbed. The other alternative is to do some earth sculpting if soil becomes available from construction of other buildings on the site.

Recommendations regarding site aesthetics

Based on experience gained through this practicum with the site and the "corporate culture" of the university, in my opinion there is considerable downside risk regarding maintenance of the site to a standard required of a national visitor and research centre. The following are recommendations to mitigate that risk.

1. Enhance the level of respect and importance given to grounds maintenance and the crew responsible for it. There needs to be a paradigm shift in the attitude on the part of

management and staff with respect to the role aesthetics play in the atmosphere of the site.

2. Hire a consultant or part-time staff to make plans for each year, to ensure maintenance of site amenities occurs and to oversee the grounds crew.
3. Provide summer grounds staff (the Hort Crew) with training in plant identification, plant care and equipment use prior to allowing them to work on the site.
4. Establish a chain of responsibility for the care and maintenance of the horticulturally-related equipment and stock.
5. Require that a work journal be maintained including notes on such things as pruning schedule, watering and fertility schedule, suitable plant material and location, and where things are stored at the end of each season.
6. Increase the amount of plant material that is perennial in nature.
7. Return to the original practice of starting the site's bedding plants in the Department of Plant Science's greenhouses. This will allow for better control of the quality of the bedding plant material and insurance that there is the quantity of material needed for each year. Summer students could be hired on an occasional basis in March and April to plant and care for the seedlings.
8. Establish a pruning plan for the elms on the site. Provincial legislation prohibits the pruning of live elms from April 1 to July 31 to reduce the spread of Dutch Elm Disease. Elm bark beetles are attracted to living trees that have fresh cuts. As they are also attracted to dead and dying elms, it is important to regularly prune dead material from elm trees.
9. Establish a maintenance plan for the trees and a fund to prune and replace them.
10. Establish a better working relationship with the people in Physical Plant responsible for grounds maintenance. While Physical Plant does not have sufficient staff to assist with grounds maintenance, there are staff arborists who can provide advice on maintenance of plant material.

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