RURAL RESIDENTIAL DEVELOPMENT IN THE WINNIPEG REGION: REMEDIATION OF EXISTING SITES TOWARDS STANDARDS OF SUSTAINABILITY

b y

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A Practicum
Submitted to the Faculty of Graduate Studies
in Partial Fulfillment of the Requirements
for the Degree of

MASTER OF LANDSCAPE ARCHITECTURE

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Winnipeg, Manitoba

April 1995

ISBN 0-612-13334-6

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Theology 0469

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History
- General 0578
- Ancient 0579
- Medieval 0581
- Modern 0582
- Black 0328
- African 0331
- Asia, Australia and Oceania 0332
- Canadian 0334
- European 0335
- Latin American 0336
- Middle Eastern 0333
- United States 0337

History of Science 0585
Law 0398
Political Science
- General 0615
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- Public Administration 0617

Recreation 0814
Social Work 0452
Sociology
- General 0626
- Criminology and Penology 0627
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Women's Studies 0453

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- Plant Physiology 0817
- Range Management 0777
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- General 0306
- Anatomy 0287
- Biostatistics 0308
- Botany 0309
- Cell 0379
- Ecology 0329
- Entomology 0353
- Genetics 0369
- Limnology 0793
- Microbiology 0410
- Molecular 0307
- Neuroscience 0317
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- Obstetrics and Gynecology 0380
- Occupational Health and Therapy 0354
- Ophthalmology 0381
- Pathology 0571
- Pharmacology 0419
- Pharmacy 0572
- Physical Therapy 0382
- Public Health 0573
- Radiology 0574
- Recreation 0575
- Speech Pathology 0460
- Toxicology 0383

Home Economics 0386

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- General 0485
- Agricultural 0749
- Analytical 0486
- Biochemistry 0487
- Inorganic 0488
- Nuclear 0738
- Organic 0490
- Pharmaceutical 0491
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- Radiation 0754

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Physics
- General 0605
- Acoustics 0986
- Astronomy and Astrophysics 0606
- Atmospheric Science 0608
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- Electronics and Electricity 0607
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- Mechanical 0548
- Metallurgy 0743
- Mining 0551
- Nuclear 0552
- Packaging 0549
- Petroleum 0765
- Sanitary and Municipal 0554
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Geotechnology 0428
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Plastics Technology 0795
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ABSTRACT

The intent of this study is to explore the possibility of improving the sustainability of existing rural residential sites in the context of the Winnipeg region.

The study includes a literature review and a study site analysis in order to identify issues and concerns associated with these sites. After identifying these areas of concern, a series of remediation guidelines is developed which, if applied to a rural residential site, are intended to increase the sustainability of that site.

Finally, the remediation guidelines are applied to the study site in order to demonstrate their application.

ACKNOWLEDGEMENTS

I would like to extend many thanks to my practicum committee of Professor Al Rattray (chairperson), Professor Alf Simon, and Professor Louis Lenz for their guidance and patience. Also many thanks are extended to Professor Charlie Thomsen for his help in evaluating the final report.

Very special thanks are extended to my parents for their constant support throughout my years of study.

TABLE OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

Residential development in the rural-urban fringe of cities has become an area of increased concern and study in recent years. Problems associated with these developments have been and are being identified, and planning policies are being formulated to deal with them. Most new policies are directed towards future developments, yet existing developments remain, as do their associated concerns and problems.

In order to remediate existing problems and concerns, the concept of sustainable development may be applied to existing developments.

1.1 DEFINITION OF SUSTAINABILITY

Sustainable developments do not damage potential uses by present or future generations. Wastes are dealt with at the site level as much as possible and resources such as drinking water, are not unnecessarily depleted. In Manitoba, the Provincial Land Use Policies (1993) are "intended to promote sustainable development" (Government of Manitoba 1993) while guiding future residential subdivision and development. Many existing rural residential developments may not conform to all of these policies, as in the example of development occurring on prime agricultural land. While it may not be possible for existing rural residential sites to meet all criteria set out in the Provincial Land Use Policies (1993), selected policies are applicable to develop remediation measures for these sites. The following are excerpts from the Provincial Land Use Policies (1993) which may be considered to be applicable to existing development.

Policy #1 - General Development
B.4. Development shall take place in an environmentally sound manner. Development should also complement or be in harmony with the general character of the area. As well, development should have regard for existing natural and other features in the area; for example, commercial or residential development should retain as many existing trees as possible.

B.17. Rural residential (large lot) development . . . are appropriate land uses in rural areas and shall be encouraged provided that they:
a) are planned so that they do not . . . require piped services from them; and
b) . . . require lots of sufficient size to accommodate sustainable on-site sewage disposal rather than piped services.

Policy #4 - Water and Shoreland
B.4. Development shall occur in a manner which sustains the yield and quality of water from significant aquifers.

Subdivision Policies
3. Subdivision design should take into account: . . . potential energy consumption and conservation (including orientation to the sun, wind velocity and direction), as well as the right of existing and future residents' to enjoy and use their property with consideration of view, harmony with environment, nuisance and safety.

4. Rural residential lots shall be planned to accommodate environmentally sound sewage disposal which protects aquifers and surface water and prevents soil salinization, nuisance and health problems. On-site sewage disposal shall be used rather than a common

pipe system in order to lessen demand for urban-size lots (and services) in rural areas. A minimum lot size of two (2) acres shall generally be maintained to assist in achieving effective on-site disposal and to help retain rural characteristics.

5. Subdivisions shall be planned so that an adequate supply of potable water may be provided.

To summarize these policies, in order to move towards increased sustainability, the rural residential sites must ensure on-site sewage disposal, conserve and preserve the quality of water resources, in particular potable water, and ensure that the sites reflect the environmental constraints and opportunities of their setting. This definition of increased sustainability will be used in the remainder of the report.

1.2 SCOPE OF REPORT

This practicum sets out to examine a specific type of rural residential development in the Winnipeg region. Many such developments may be seen as essentially “transplanted” suburban lots. These rural residences are not associated with activities such as hobby farming, but function in a similar manner to that of suburban lots, in that the residents work in the city and rely on the city for services, such as health care, markets and entertainment. However, these residences occur in the countryside and are much larger in size than a suburban lot, and are not serviced in an urban manner. The country location and the type of site services present both important environmental opportunities and problems for the residents.
Given the problems of the rural residential

sites, it is important to move towards increased sustainability of these sites. It must be noted that in order to move towards true sustainability, all aspects of both the built and natural environments and the interaction between these environments must be evaluated. Lack of specific data on many issues, including water consumption and aquifer recharge rates and sewage disposal problems, does not preclude the necessity of beginning remediation measures at the present time. The scope to this report is to deal with a specific part of the environment, the landscapes of existing rural residental sites, and by using existing information, to suggest how these landscapes and their functions may become more sustainable.

1.3 GOALS AND OBJECTIVES

The goal of this study is to develop a process to evaluate the landscapes of existing rural residential sites and then to suggest remediation measures for these landscapes that would result in an increase of their sustainability and ensure the quality of living sought after in the countryside.

The following objectives are intended to achieve this goal:

1. To gather information from a literature review and a study site analysis in order to identify problems associated with rural residential landscapes.
2. To develop a set of remediation guidelines to address these problems.
3. To demonstrate how the guidelines may be applied to the study site to increase its sustainability.

2. LITERATURE REVIEW

In order to better understand the nature of existing rural residential developments, it is necessary to identify the reasons for the attraction of the urban fringe, the reasons for the form of the existing developments, and the problems associated with these developments.

The literature identifies a number of reasons for the popularity of the urban fringe countryside as a living environment. The "major advantage of living in the city's countryside is the ability to be close to nature, open space and all that they stand for and to be able to have access to the facilities of the city" (Bryant, Russwurm, and McLellan 1982). Many people may prefer not to live in a city, but they do not want to live far from one (Lyon 1983). The various studies conducted show a definite consistency in the residents' reasons for their attraction to the countryside. Increased privacy, less crowding, and a better place to raise children are cited in most studies. In addition, the freedom to carry on various activities not usually permitted in higher density areas is important (Bryant, Russwurm, and McLellan 1982; Hogue 1992). These activities may include raising larger numbers of domestic animals than permitted within city limits or collecting various types of machinery for hobby purposes. Lower land prices and lower taxes in the countryside in comparison to the city are considerations for many rural residents (Lyon 1983; Municipal Planning Branch 1974). In a 1990 Canadian poll, almost seventy percent of urbanites, if given a choice, would live in the country (Scanlan 1993), and in a 1985 Gallup poll, almost half of American adults indicated a preference for living in a small town or rural area (Herbers 1986). The attraction to the rural environment is very strong in our culture, but this attraction may pose serious problems, as is pointed out by Bunce. "In general the attraction is to an idealized rather than a real environment: to a product of a mythology which has grown as genuine rural experience fades from our memories. Rural sentiment is, in fact, a manifestation of an underlying reverence for rural environment and culture" (Bunce 1981). Rees (1988) points out that farm life on the prairies was seldom as communal or as satisfying as it is now supposed to have been. Often the new residents regard the rural landscape "not as a productive system or a way of life but as a locational amenity" (Riley 1993). Many residents settle in the countryside seeking characteristics which may not exist in the modern urban fringe. Rees (1988) describes the new prairie landscape as "the pared down, energy-intensive landscape of agro-industry that bears little relation to popular notions of how a countryside ought to look."

Rural residential developments in urban fringe environments are generally characterized by random, scattered patterns, concentrated along major transportation routes, and are generally associated with prime agricultural land or high amenity areas (Lyon 1983). The dispersed nature of rural residential settlements is due to the increased mobility of the population brought on by the prevalence of the automobile in our society (Bryant, Russwurm and McLellan 1982). As well, the availability in the countryside of most urban technologies such as telephone and energy services, has added to further dispersion of the population.

Most land in the urban fringe is held in private ownership, a fact which is critical to the patterns formed in this area. Along with private ownership comes the attitude that owners may use their land for any desired purpose. "The view of land as a commodity has predominated over the concept of the land as a resource" (Lyon 1983). Landowners in the urban fringe may subdivide initially for financial gain. Farmers receive much higher prices for land subdivided for residential uses instead of agricultural uses (McRae 1980). Land may be purchased for speculative reasons, but often the land owners are "overly optimistic about the chances of selling. This alone would thus permit a much greater scattering of country residences than would otherwise occur" (Bryant, Russwurm and McLellan 1982).

Planning policies for development have long been in place and new ones are continually being developed and revised, but often these policies are not applied consistently at the local level where subdivision and development takes place (Government of Manitoba 1990). Public officials of smaller jurisdictions may not be inclined to enforce land use controls especially where open space is abundant and landowners object to controls deemed to be unnecessary (Herbers 1986).

While residents express a strong rural sentiment, this sentiment does not always manifest itself in the form of the settlements. Urbanites are "attracted by rural values in real estate advertising, but demand the convenience and conformity of suburban-style subdivision" (Bunce 1981). The homes built by rural residents are "frequently identical to those built in cities or suburbs, making them strikingly different from local, traditional farm buildings" (Healy and Short 1981).

In the study, Rural Residential Development in the Winnipeg Region (Government of Manitoba 1990), the problems associated with this development are summarized. Problems identified include:

the loss of agricultural land,
conflict with agricultural activities,
waste disposal,
drainage and flood control,
ground water pollution,
loss of aggregate resources,
degradation of recreational resources,
impacts on future city growth,
protection of transportation corridors and the cost/revenue balance of rural residential development.

For the purposes of this study, a number of these problems may be addressed at the individual site level. The loss of agricultural land is of concern not so much in terms of quantity, but rather the high quality of the land that is taken out of production for development purposes. Since development occurs close to cities and "over half of Canada's best agricultural land . . . is located within fifty miles of the centre of the twenty-three largest urban centres", (McRae 1980) the actual loss of productivity potential is quite high. Conflicts with existing farm operations arise when residents seeking the rural values of the past, must contend with modern, commercial agricultural methods. Problems of waste disposal arise mainly from private sewage disposal systems, such as septic fields, which are prevalent in rural residential developments. In a survey from 1974, 74.8%

of rural residents in the Winnipeg region used septic fields and of those, 12.5% experienced trouble with this method (Manitoba Municipal Planning Branch 1974). Due to increased development in recent years, problems of this nature may become more prevalent. Many municipal landfill sites are nearing capacity and cannot accomodate increasing wastes from development. Flood control is of importance to residences situated close to rivers and streams but drainage is of importance to most residences. The existing rural system of drainage is often not designed for the increased runoff from development and is intended for farmland, not residential development. Ground water is often the source of water for rural residents, and increased development can lead to depletion of this resource, as well as pollution. Many existing developments show signs of internal threats such as too many septic tanks, uncontrolled residential dumping, and overuse of scarce water (Herbers 1986).

Since the countryside has become such a popular and attainable residential location for many people, the problems associated with the development in the countryside must be addressed. Remediation measures must be encouraged to ensure that the existing rural residential developments "preserve rather than squander resources and the natural environment" (Herbers 1986).

3. SITE INVENTORY AND ANALYSIS

The study site was subdivided from agricultural land under cultivation (see Fig. 3.2). Prior to 1976, lots could be created in Manitoba using the 'metes and bounds' system which did not require approval from a municipal council or board. Sites required a legal description of the land but not an official survey. The study site was subdivided in this manner and the house was built in 1976. The site is located on NE 25 - 13 - 2E in the Rural Municipality of Rockwood and is approximately a 40 minute drive from downtown Winnipeg (see Fig. 3.1). Figure 3.3 illustrates the existing site conditions.

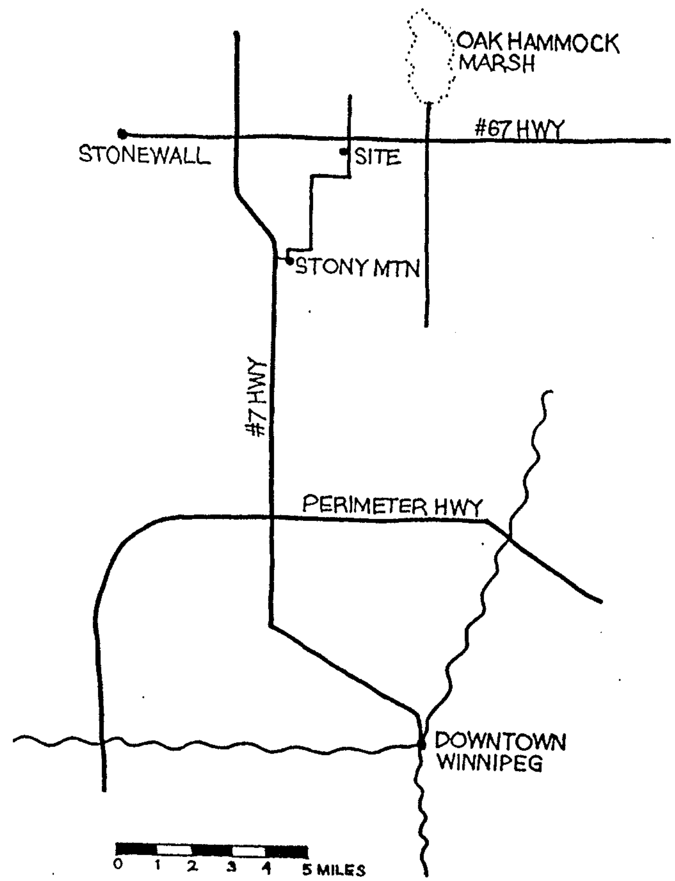
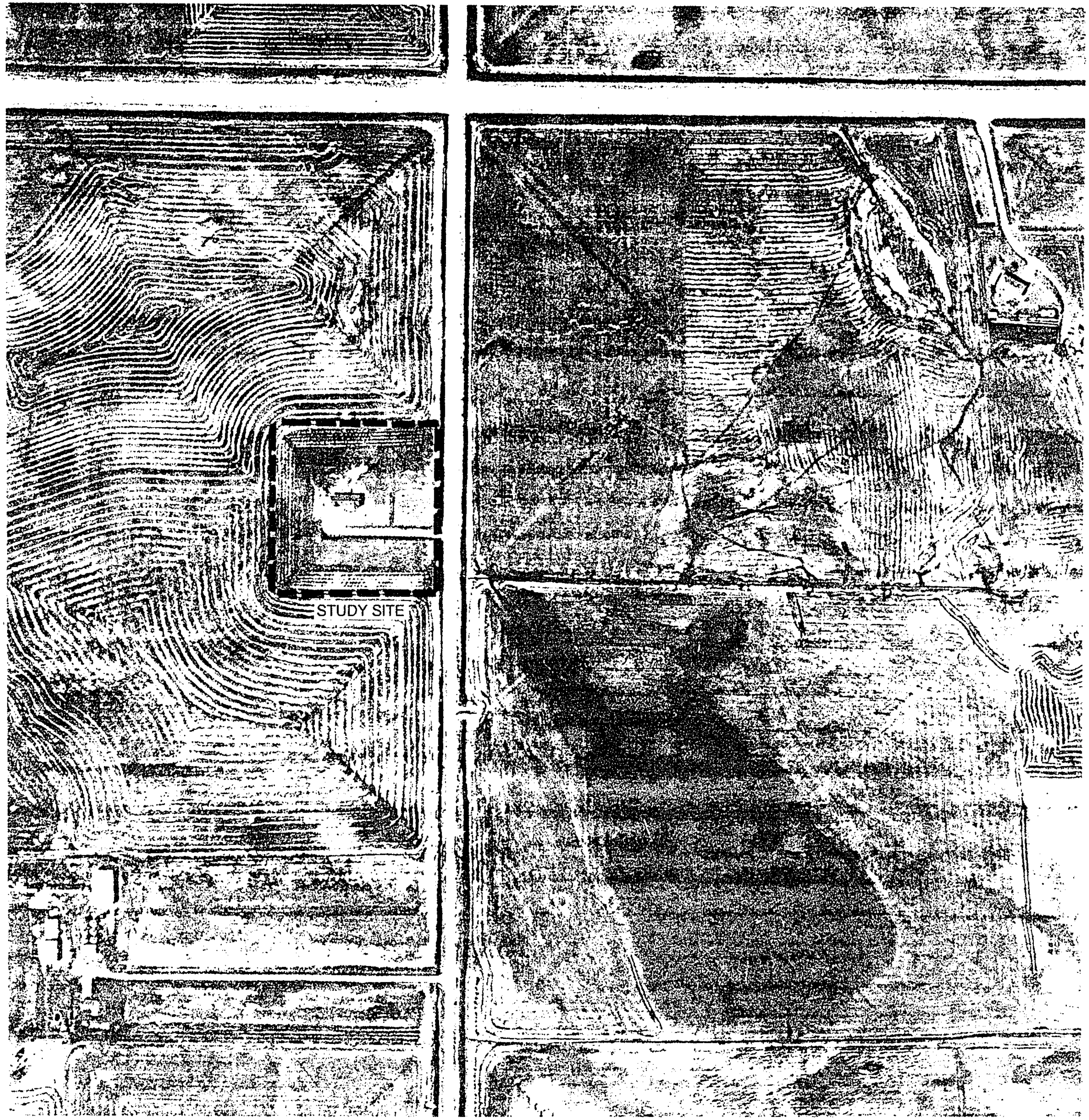


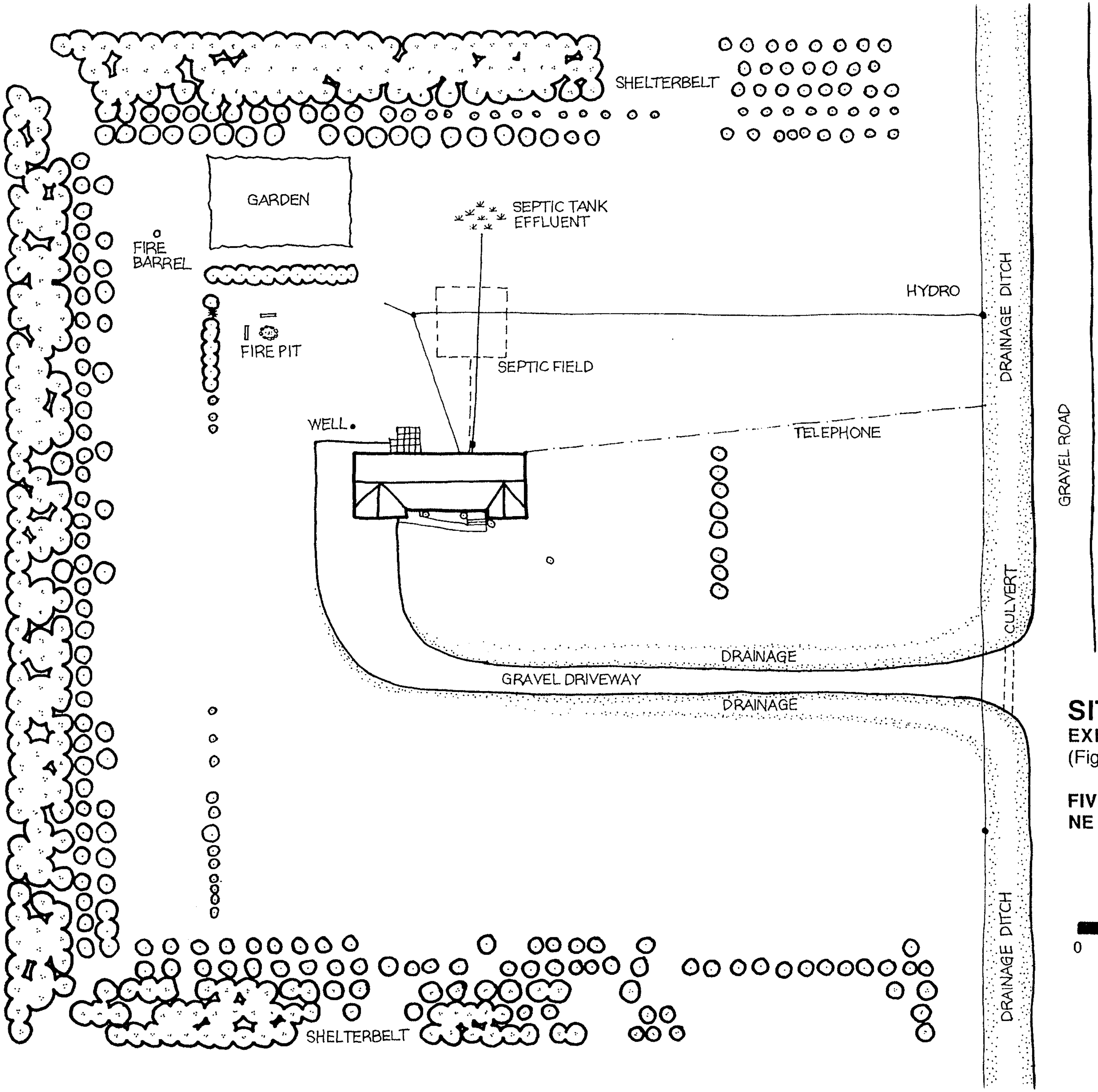
Figure 3.1 Study Site Location



CONTEXT

(Figure 3.2)

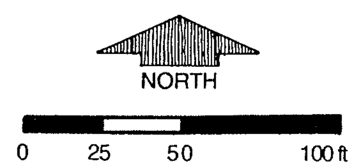
FIVE ACRE LOT
NE - 25 - 13 - 2E



SITE PLAN

EXISTING CONDITIONS
(Figure 3.3)

FIVE ACRE LOT
NE - 25 - 13 - 2E



3.1 CLIMATE

Located on the open prairie, the site is subject to all of the extremes of the prairie climate. The following data from the 1992 Annual Meteorological Summary, Winnipeg, Manitoba, by the Atmospheric Environment Service of Environment Canada provides information on the individual elements of the climate.

Wind is a very significant factor with a yearly average speed of 18.6 km/hr but wind gusts of over 80 km/hr can occur. Northwest winds often bring winter storm systems and lower temperatures, but the average prevailing wind direction is from the south, an often overlooked condition.

Temperatures are wide ranging with a normal average high of -14.3°C in January and +25.9°C in July and normal average lows ranging from -24.2°C in January to +13.3°C in July. Not only do the yearly temperatures have a wide range, but deviations from normals within each month can be quite common, giving even more diversity to the climate.

Average annual precipitation is 525.5mm (20.69") with an average total rainfall of 411mm (16.2") and average total snowfall of 125.5cm (49.4"). Ninety-seven percent of the rainfall occurs from April to October and eighty-five percent of the snowfall occurs from November to March. As with temperature these precipitation averages may vary greatly from year to year.

The average yearly number of hours of sunshine is 2321.4 with the sunniest month occurring in July with 315.6 hours of sunshine. Figure 3.4 illustrates the sun path patterns for the site and Figure 3.5 illustrates the shadows cast by the house throughout the year.

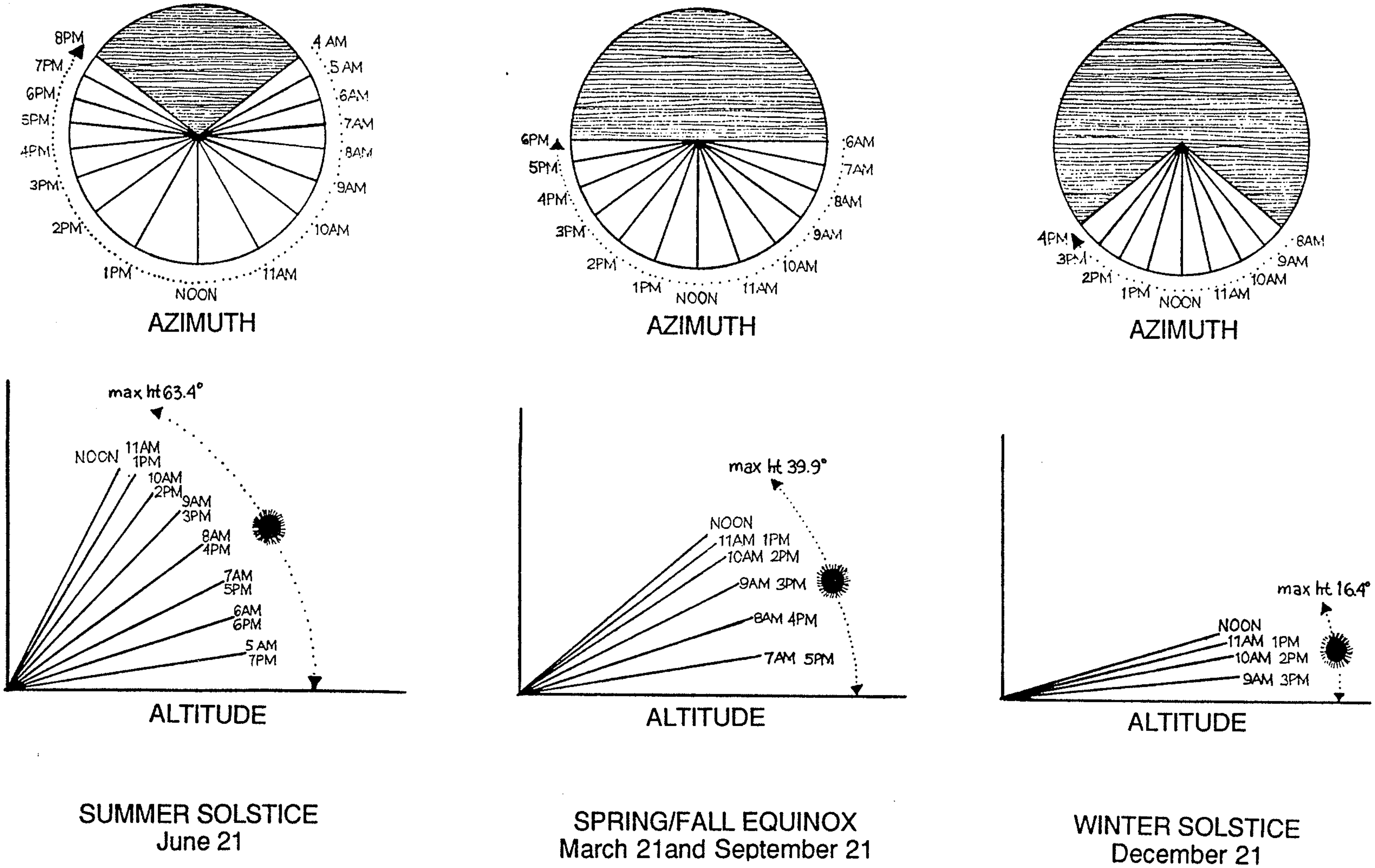


Figure 3.4 Sun Angles Latitude 50°8'

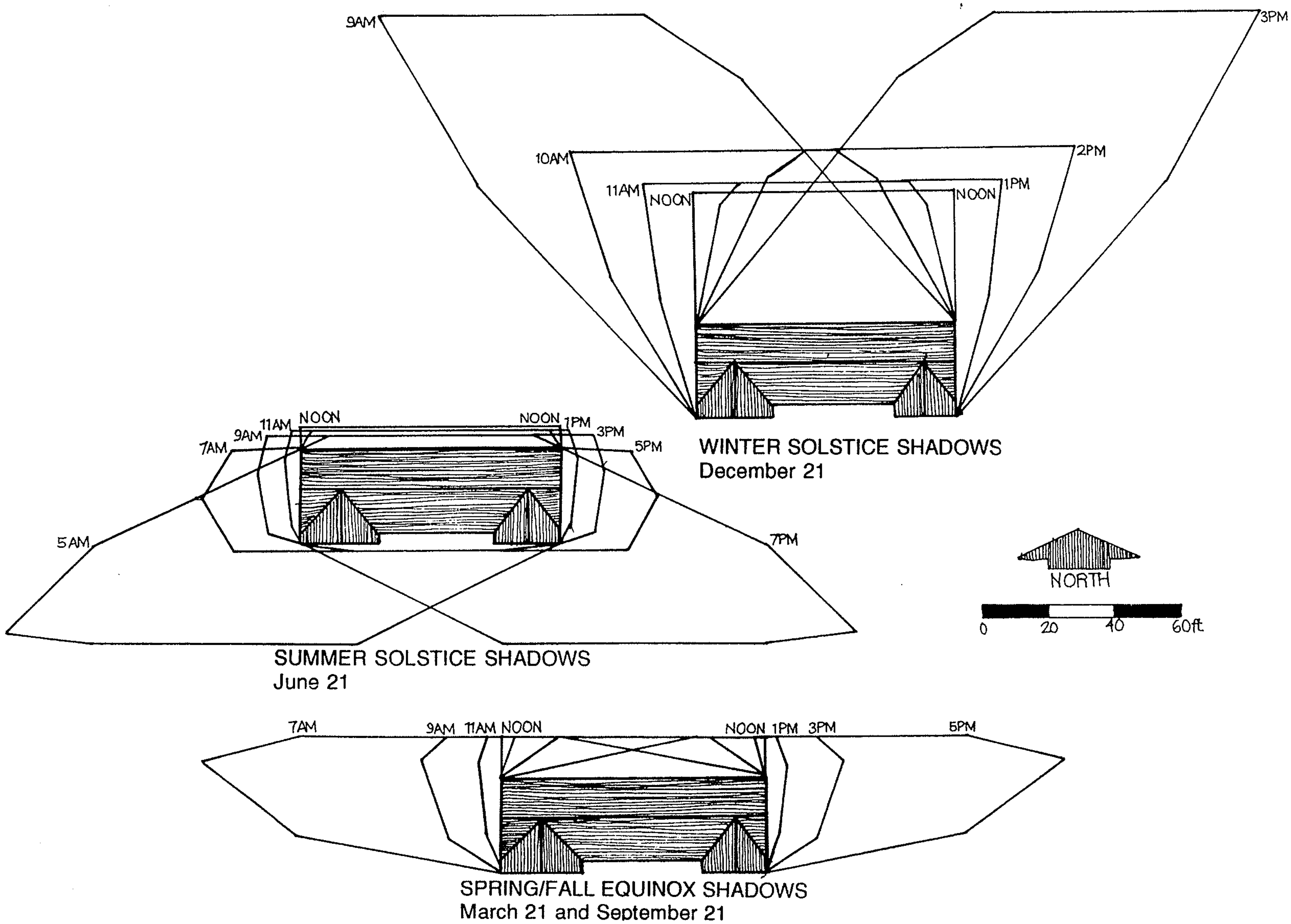
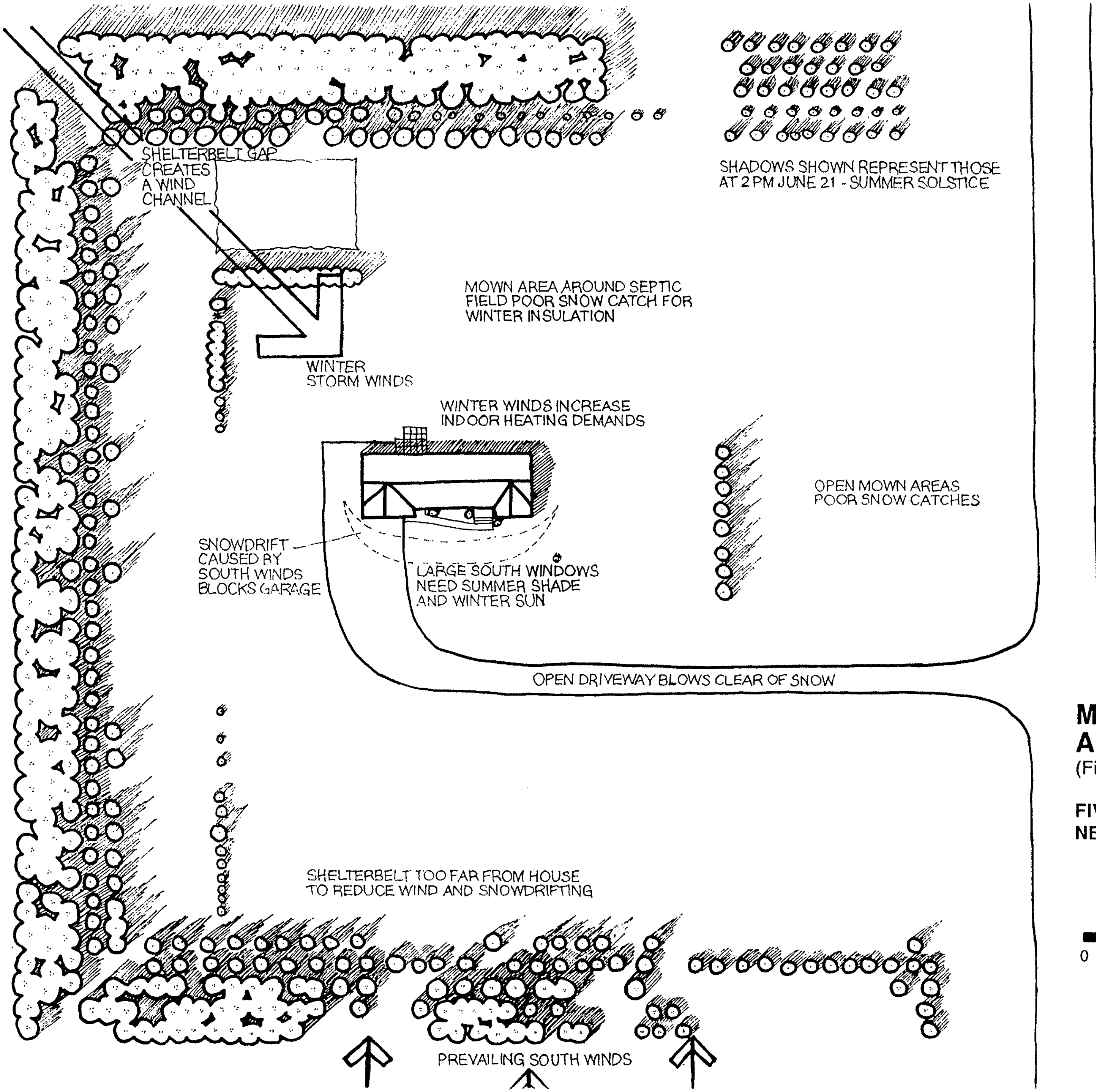


Figure 3.5 House Shadow Patterns



MICROCLIMATE ANALYSIS
(Figure 3.6)

FIVE ACRE LOT
NE - 25 - 13 - 2E

NORTH

0 25 50 100 ft

Figures 3.7 and 3.8 illustrate the lack of shelter around the house. The site is very open to the road. There are no small-scale sheltered locations which could provide varied microclimate conditions (see Figure 3.6).

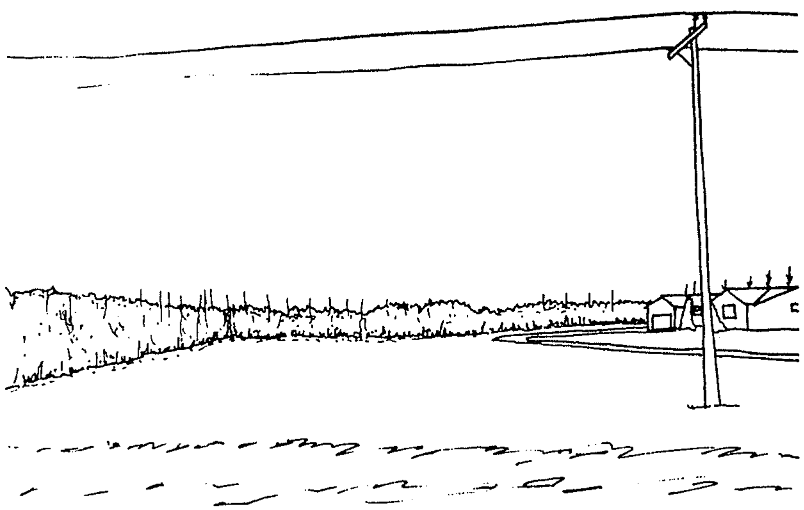


Figure 3.7 View to Front Yard of Site from the Adjacent Road

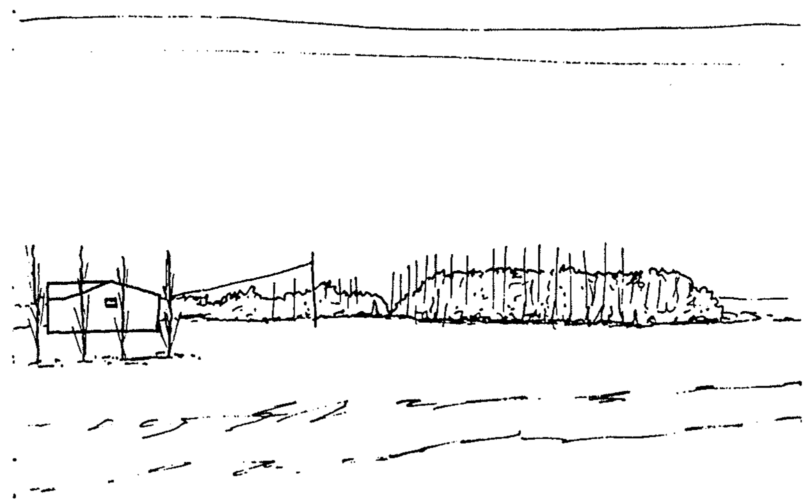


Figure 3.8 View to Back Yard of Site from the Adjacent Road

3.2 TOPOGRAPHY AND DRAINAGE

The general area of the site is poorly drained due to very little variation in surface topography but the original grade of the site was not significantly altered. Figure 3.10 illustrates the direction of flow of surrounding run-off and direction of flow of the drainage ditches. When the site was chosen for subdivision, a higher section of land was selected. The grade around the house was raised approximately 1-2 ft. when originally constructed. No drainage problems have occurred with the foundation of the house. The raised driveway with adjacent drainage channels does not experience problems and remains in good condition in wet weather. Figure 3.11 illustrates the site topography and direction of flow of run-off.

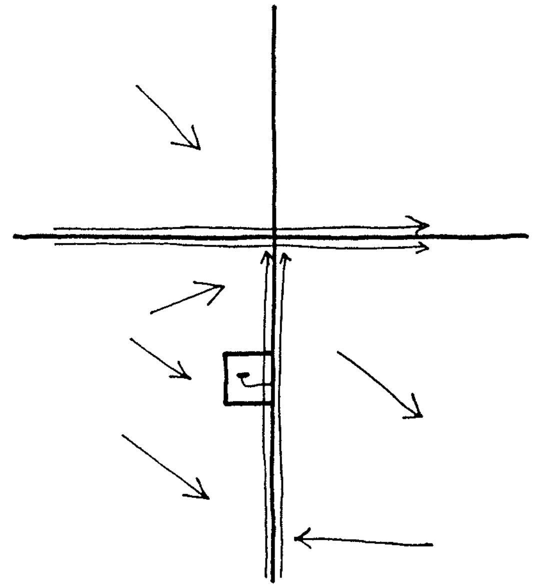
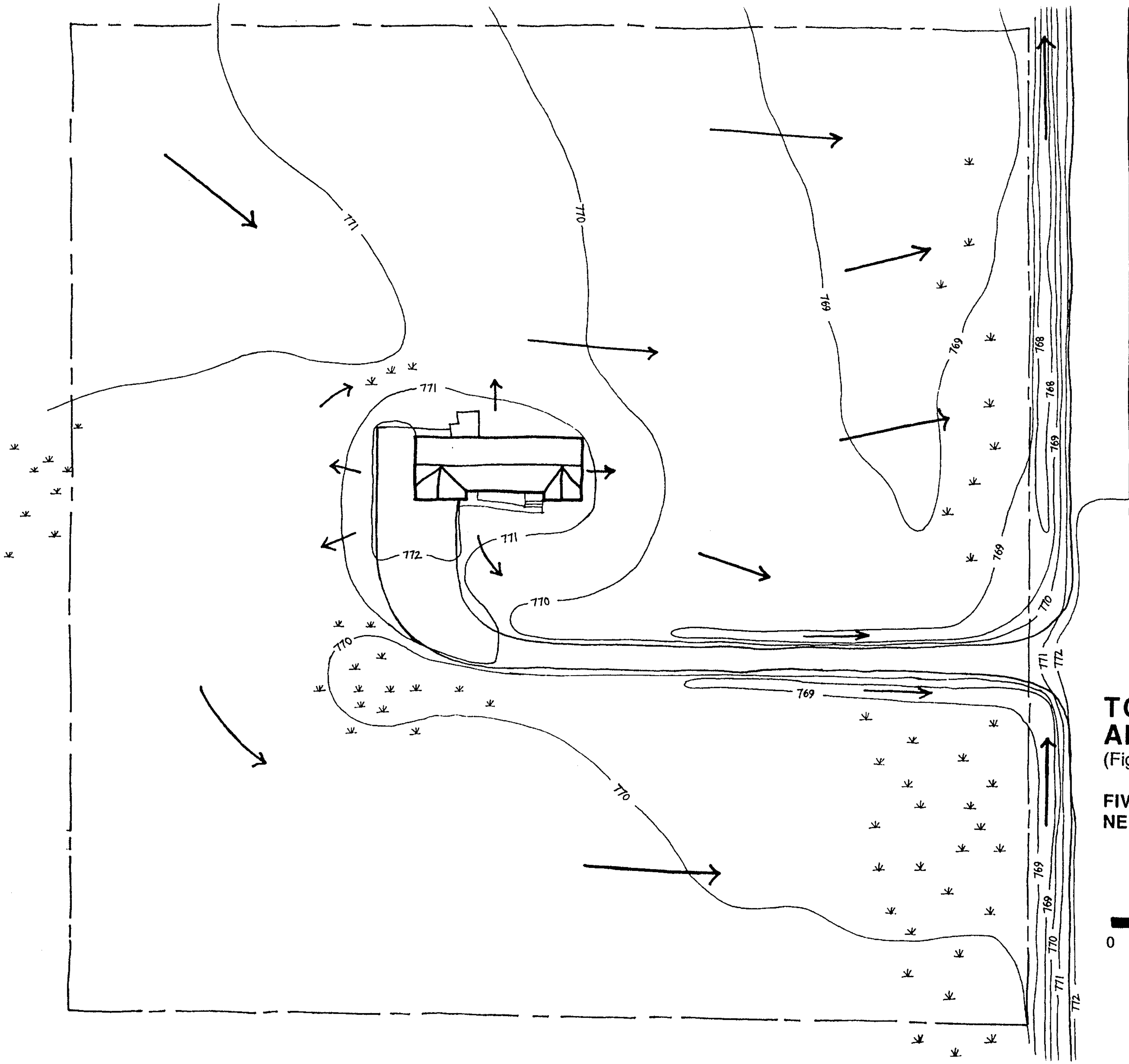


Figure 3.10 Regional Drainage



CONTOUR INTERVAL - 1 FT

AREAS INDICATING STANDING WATER IN SPRING AND AFTER HEAVY RAINS

TOPOGRAPHY AND DRAINAGE
(Figure 3.11)

FIVE ACRE LOT
NE - 25 - 13 - 2E

NORTH

0 25 50 100 ft

3.3 SOILS

The soil of the study site comes under the classification of the Lakeland Series (Hopkins 1980) which is a Gleyed Carbonated Rego Black soil. The term ‘gleyed’ indicates poor internal drainage of a soil and the term ‘rego’ indicates excessive salts in the parent material of the soil. Bedrock geology is dolomite and limestone of the Red River Formation and surficial geology is lacustrine deposits of clay and silt from glacial Lake Agassiz. Due to past disturbances from cultivation, the A horizon of the site soil is black soil about 8-9” in depth with a lower B horizon of grey soil. The average composition of the Lakeland soil is: sand 25%, silt 45%, clay 30%, making it a ‘clay loam’ soil (Manitoba Department of Agriculture n.d.). A clay loam soil has a good water holding capacity generally in the range of 32-48% (Harapiak 1986).

The soil is a Class III agricultural soil, indicating that it has moderately severe limitations that reduce the choice of crops or requires special soil conservation practises. These soils are medium to moderately high in productivity for a range of field crops (Manitoba Department of Agriculture n.d.). In the area of the study site, salinity and wetness would be limitations to agricultural productivity. Wheat and barley would produce good yields but beans and corn would not be appropriate crops for this land.

Three soil tests were taken of the study site (see Fig. 3.13) and were analyzed by Norwest Labs in Winnipeg (see Appendix for complete test results).

In the first test, at 0-6” depth, available nutrient analysis revealed that nitrogen (N) is deficient, phosphate (P) is marginal, and potassium (K) is optimum. Nitrogen is required for green growth, phosphorous for strong root development and potassium for strong roots and stems and ensuring the proper water balance in a plant. The pH reading is 8.1, making it an alkaline soil. The electrical conductivity (EC) reading, an indication of salinity, is 1.9 decimhos/m. In the lower portion of the same test (16-22"), the pH is 8.4. The deeper soil was tested for the presence of sodium, calcium, and magnesium and the results indicate excessive quantities of each. The calcium and magnesium contribute to the high pH of the soil. The excessive amount of sodium at 340 ppm causes severe limitations to plant growth. Any reading over 100 ppm is considered excessive.

In the second test, in the garden area, the nitrogen, phosphate, and potassium readings indicate excessive amounts of each nutrient. The high nutrient values of the garden soil are likely due to the fact that the garden soil was in summer fallow when tested and residual amounts of fertilizer may have been present from the previous year. The pH in this test is 8.0 and the EC reading is 1.2 decimhos/m.

In the third test, taken in the front grassed area, the nitrogen is deficient, phosphate marginal and potassium excessive. The pH is 8.2 and the EC reading is 1.0 decimhos/m.

The high pH values of the site soil must be considered when choosing appropriate plant selections for the site. The presence of excessive soluble salts - sodium, magnesium and calcium - poses serious limits to plant growth as is illustrated on the site. While not all areas were tested, areas contaminated with excessive salts are revealed by the growth of the trees on site (see Fig. 3.12 and 3.13).

Figure 3.12 Limits to Tree Growth Caused by Excessive Salts in the Soil

These salts in the soil can be very mobile through the soil profile depending on moisture conditions. Raising or lowering of the water table may move the salts through the soil profile. As soil moisture is lost at the surface or to plants, the salts remain in the soil and can accumulate to toxic levels. Excess salts may interfere with a plant's ability to obtain water from the soil, restrict root development or be directly toxic to the plant.

3.4 VEGETATION

The original vegetation in the area of the site was prairie and aspen groves or willow bluffs. The site was under cultivation for the production of cereal grains for over 50 years before subdivision. The trees, obtained from the Prairie Farm Rehabilitation Administration nursery located in Indian Head, Saskatchewan, were planted in 1976. The site was also seeded with a Kentucky Bluegrass seed mix in the same year. The shelterbelts were regularly cultivated until approximately 5-6 years ago and the mown lawn area was sprayed with herbicides. Since the shelterbelt areas were allowed to 'naturalize', the trees now have an opportunity to regenerate through seeding or suckering. This opportunity to regenerate is very significant since all trees on site are the same age and the vegetation lacks age diversity, an important ingredient in creating a plant community. The shelterbelt undergrowth reflects the conditions of the area (see Fig. 3.13 for vegetation list). Red and white Dutch clover, Canada thistle, wild mustard, and western dock are species indicative of good moisture conditions. White and yellow sweet clover and alfalfa are salt tolerant and are often some of the first species to establish on bare ground.

The mown lawn area has not been sprayed with herbicide for 2-3 years and the presence of forb species is again indicative of different conditions on the site. The red and white Dutch clover and mosses indicate the areas with higher moisture conditions. The presence of silverweed corresponds with the wet area caused by drainage off the driveway.

Dandelions become predominant in areas where grasses are not as vigorous. The common plantain is indicative of disturbed places.

The area where the septic effluent drains has become colonized by species indicative of wet places. The sedges and dock filter the effluent and help to purify the water (Salvatori 1990) and provide some amelioration to the present state of the septic system.

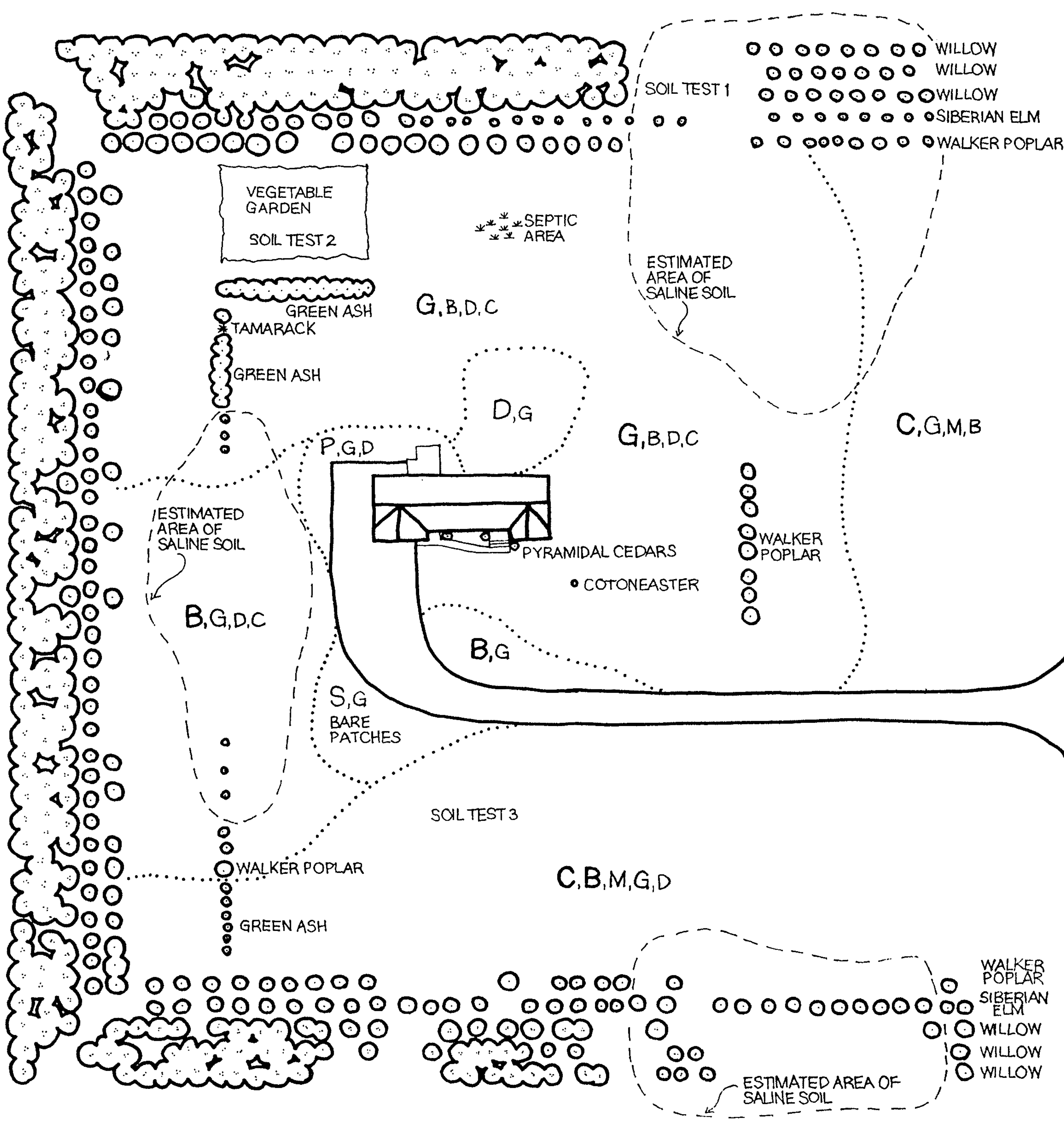
The shallow root systems of the willow, Siberian elm, and Walker poplar contribute to their success on the site. As mentioned earlier, the presence of toxic levels of soluble salts in the soil limits the growth of some vegetation. Since no area of the site is lacking some vegetative cover, except for a few very wet spots, the salts are not present in toxic levels at the surface of the soil. Since the tree roots penetrate deeper than the herbaceous vegetation layer, they may come in contact with salts lower in the soil profile.

The vegetable garden is located on soil of high nutrient value and the lowest pH of the soil tested, but is now experiencing competition from the tree roots of the shelterbelt and is not as productive as possible.

With some minor changes in site maintenance in recent years, the vegetation has a chance to diversify but still lacks significant age diversity and is almost totally lacking representation of a shrub vegetation layer.

3.5 WILDLIFE

The shelterbelts provide cover for mice, rabbits, deer, foxes and coyotes as well as a number of bird species. Mice, rabbits and deer forage on trees sometimes causing significant damage. Wildlife browsing may conflict with attempts to establish various types of introduced vegetation.



TREES

Willow	*Salix acutifolia*
Siberian Elm	*Ulmus pumilia*
Walker Poplar	*Populus sp. 'Walker'*
Green Ash	*Fraxinus pennsylvanica*
Tamarack	*Larix laricina*

ORNAMENTALS

Pyramidal Cedar	*Thuja occidentalis'Pyramidalis*
Cotoneaster	*Cotoneaster lucidus*

SHELTERBELT UNDERGROWTH

Various Grasses including	
Bromegrass	*Bromus sp.*
Quack grass	*Agropyron repens*
Kentucky Bluegrass	*Poa pratensis*
Creeping Red Fescue	*Festuca rubra*
White Sweet Clover	*Melilotis alba*
Yellow Sweet Clover	*Melilotis officinalis*
Sow Thistle	*Sonchus arvensis*
Canada Thistle	*Cirsium arvense*
Alfalfa	*Medicago sativa*
Wild Mustard	*Brassica kaber*
Dandelion	*Taraxacum officinale*
Red Clover	*Trifolium pratense*
White Dutch Clover	*Trifolium repens*
Goat's Beard	*Tragopogon dubius*
Goldenrod	*Solidago sp.*
Western Dock	*Rumex occidentalis*
Northern Bedstraw	*Galium boreale*

MOWN LAWN

G Various Grasses including	
Kentucky Bluegrass	*Poa pratensis*
Creeping Red Fescue	*Festuca rubra*
Quack grass	*Agropyron repens*
Bromegrass	*Bromus sp.*
D Dandelion	*Taraxacum officinale*
B Black Medick	*Medicago lupulina*
P Common Plantain	*Plantago major*
C Red Clover	*Trifolium pratense*
C White Dutch Clover	*Trifolium repens*
S Silverweed	*Potentilla anserina*
M Mosses	

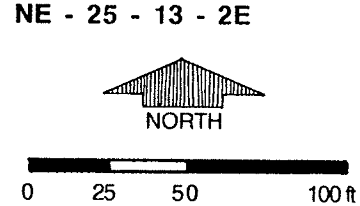
NOTE: Code letter size on drawing indicates relative dominance of groundcover.

SEPTIC AREA

Sedges	*Carex sp.*
Western Dock	*Rumex occidentalis*
Aster	*Aster sp.*

EXISTING VEGETATION
(Figure 3.13)

FIVE ACRE LOT
NE - 25 - 13 - 2E



3.6 SITE SERVICES

WATER SUPPLY

The site is underlain by a carbonate rock aquifer capable of supplying sufficient quantity and quality of groundwater to satisfy domestic needs (0.3+ L/s with total dissolved solids less than 2000mg/L) (Betcher 1986). The flow of this aquifer is in an east-south-easterly direction of the site. In 1992, the aquifer was found to be contaminated with industrial chemical wastes from the Bristol Aerospace Propellant Plant, located approximately 2 miles southeast of the site. Due to the direction of flow of the aquifer, wells to the north and west of the Propellant Plant are not contaminated (see Fig. 3.14). Water use is not monitored or regulated from uncontaminated existing wells but new wells now require a permit from the Department of Environment.

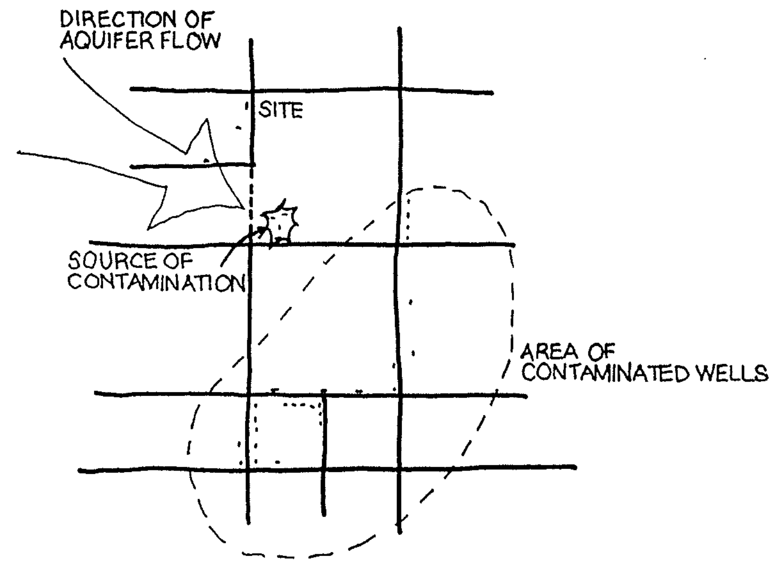


Figure 3.14 Aquifer Flow and Contamination

Water from the aquifer is particularly hard and is softened with the addition of salt for regular household use. Water from the site well has a high iron content which poses no health concerns only aesthetic considerations since staining can occur on laundry and other household items in regular contact with the water.

SEWAGE DISPOSAL

The site is serviced by a septic tank system consisting of a holding tank and dispersal field. At the present time, the field is not functioning and effluent from the holding tank is being released above ground (see Fig 3.3). The problem is due to poor installation of the underground pipes. A soil percolation test was conducted on site and the soil in the area of the field was found to have a percolation rate of 30 minutes per 25mm(1") which falls within acceptable rates for a septic field (CMHC 1978). Greywater released into the system has a high salt content from the softened water. The water table can range to seasonal highs of 1 1/2 to 3 ft below surface limiting the absorption of effluent into the ground.

WASTE DISPOSAL

Combustible wastes are burned in a fire barrel on site. Other wastes must be delivered to the municipal landfill site. Like many of the landfills in the rural areas, the Rockwood site is almost at capacity and alternative sites and options for garbage disposal are being explored by the municipality.

4. SUMMATION OF ISSUES, CONFLICTS AND OPPORTUNITIES

4.1 ISSUES AND CONFLICTS

A number of issues and conflicts relating to rural residential development may be identified from the literature review and the study site analysis. The following is a summary of these issues and conflicts which are pertinent to existing rural residential sites.

Issues Identified from the Literature Review

1. Residents seek open space, less crowding, increased privacy and the ability to be close to nature (Bryant, Russwurm and McLellan 1982).

2. The countryside is perceived to be a better place to raise children (Lyon 1983; Bryant, Russwurm and McLellan 1982).

3. The countryside is perceived to be a place where there is increased freedom to carry on activities not usually permitted in higher densities (Bryant, Russwurm and McLellan 1982; Hogue 1992).

4. Residents seek a rural setting but with suburban conveniences (Bunce 1981). The limits of the rural setting are not always recognized and demand for services may lead to serious environmental and economic costs (Herbers 1986).

5. A predominance of the view that the land is a commodity that may be used for any desired purpose conflicts with the view of land as a resource to be managed within its natural limitations (Lyon 1983). Land viewed as a commodity may suffer from exploitation and

degradation.

6. Conflicts may occur between residences and existing agricultural activities (Government of Manitoba). Noise, odour, dust and herbicide use from nearby farms may cause problems for rural residential developments.

7. Drainage problems occur in areas where rural drainage systems cannot accommodate higher density development (Government of Manitoba 1990).

8. Waste disposal problems occur due to malfunctioning septic fields and overcrowded municipal landfill sites (Government of Manitoba 1990; Herbers 1986).

9. Unmonitored, excessive use of groundwater resources leads to depletion and contamination of those resources (Government of Manitoba 1990; Herbers 1986).

The following issues have been identified in the literature review including: the loss of agricultural land, the loss of aggregate resources, degradation of recreational resources, impacts on future city growth, and impacts on transportation corridors are important issues but are not directly applicable to remediation of existing rural residential sites and are therefore, beyond the scope of this report.

Issues Identified from the Study Site

1. The shelterbelt design and location does not provide maximum benefit to the house and lawn areas.

2. The energy efficiency of the house is reduced by winds in winter and additional solar heating in summer.

3. The septic field is not functioning due to poor installation.

4. The aquifer supplying potable water has industrial chemical contaminants though not at the study site.

5. Potable water is used to irrigate the landscape of the site.

6. The uniformly mown lawn does not correlate with the varying soil and moisture conditions on the site.

7. The site has minimal vegetation diversity in terms of species and age.

8. There is lack of private human-scale spaces on the site and very little privacy from the adjacent road.

4.2 OPPORTUNITIES

With respect to the study site, opportunities exist to remediate the conflicts and issues identified previously. These opportunities are identified here and will be further explored in the following sections of the report.

1. Existing shelterbelt areas may be increased to provide greater protection.

2. The energy efficiency of the house may be increased with appropriate planting.

3. An appropriate on-site sewage disposal

system may be provided.

4. Measures can be taken to protect and conserve the groundwater source.

5. Vegetation may be chosen to more closely match soil and moisture conditions and increase plant species diversity.

6. Human-scale outdoor private spaces as well as the more visible open spaces may be developed on the site.

5. REMEDIATION GUIDELINES

In order to address the conflicts and issues identified in the literature review and the study site analysis, a series of remediation guidelines can be developed in order to address these issues and propose remediation measures with the goal of increasing the sustainability of existing rural residential sites.

5.1 WATER ISSUES

Guideline: The use of potable water in the landscape should be eliminated in rural residential sites.

Rationale: A potable water supply is an essential resource for any home. Groundwater is generally the main source of potable water for residents of rural residential sites. While groundwater issues are site specific, a number of concerns have risen in recent years as to the quality and quantity of this resource. Depletion of groundwater can lead to the intrusion of saline water or polluted surface water into a freshwater aquifer. Unmonitored overuse of water can jeopardize supply when use exceeds the rate of aquifer recharge. The trend for water use is on the rise, thereby causing reason for concern. City of Winnipeg figures show that for 1960-1964, water consumption averages were 30.24 gal/day/person. The predicted consumption rate for 1986 was 52.78 gal/day/person (Underwood, McLellan and Associates 1973). 1993 water consumption figures were 300L (65.99 gal)/day/person. While water use is generally unmonitored in rural areas, the trends may be expected to be the same and in some cases, water use averages may be even higher, especially in areas where new landscapes are being established. Because little is known about many aquifers with respect to use and recharge rates, conservation of this resource must become a priority.

Strategies: In addition to the rain and snow of a site, other sources of water are available for use in the landscape.

Rainwater: Rain, of course, falls on the ground and is used by plants. Rainwater falling on hard surface areas, as in the roof of a home, may not be utilized if it drains away quickly or seeps into areas where it is not needed. Rainwater can be collected for use during dry spells for plants needing a more regular watering schedule. Figure 5.1 illustrates the amount of rainwater that is available annually from a given catchment area.

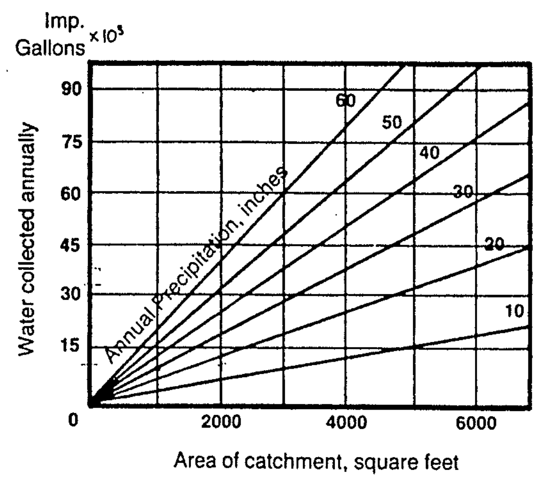
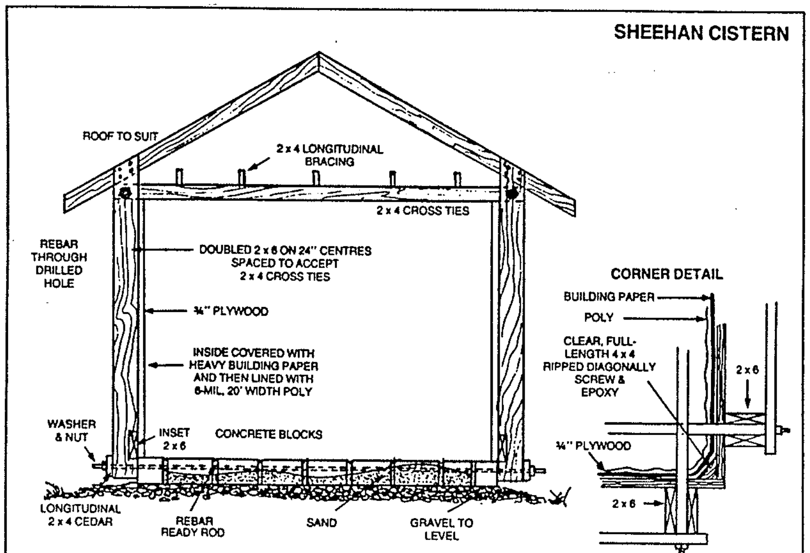


Figure 5.1 Rainwater Availability
Source: (Swanson 1988, 56)

Depending on the intended use, a cistern may be constructed in order to store all available water or simply a few 45-gal. drums or other containers may be placed at the base of the eavestrough downspouts to catch water for smaller uses. The amount of water collected and the amount of water available should correlate with the intended use of the water.



An inexpensive aboveground cistern can be made with 2-by-6 and 2-by-4 lumber. A sand bottom and building paper over plywood on the sides protect the 6-mil polyethylene liner from abrasion. In most of Canada, this model is restricted to summer use and will have to be drained each fall to prevent damage from freezing.

Fig. 5.2 A Simple Cistern for Outdoor Use

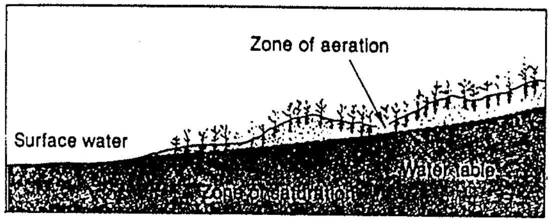
Source: (Swanson 1988, 54)

Greywater: Greywater is the discharge from washing machines, showers and bathtubs and does not include discharge from toilets, kitchen sinks or dishwashers. Greywater may be used effectively in the landscape if it is applied properly. Kourik (1988) outlines the following criteria for greywater use in the landscape. Greywater must be distributed into the landscape immediately after it is discharged and must be applied beneath mulch via drip irrigation tubing or into very shallow gravel leach fields just below the soil surface. Greywater must be distributed in different areas around the yard and should not be applied to acid-loving plants or root vegetables. Phosphates and other nutrients in the greywater are beneficial to plants but high salt content from powdered laundry detergents and especially water softeners will limit the application of the water into the landscape.

Greywater must only be distributed to plants when they are actively growing and therefore, must be discharged into the septic system in the winter months.

Surface Water: Water from rain and snowmelt, called run-off, may be directed to areas of a site in order to increase the amount of moisture in a specific locality. Manipulation of the surface topography can distribute water to desired areas.

Water Table: The water table is the upper limit of the part of the soil or underlying bedrock that is wholly saturated by water (see Fig. 5.3). Areas with a low water table would be suited to plants with deep root systems and areas with a high water table would be suitable for more moisture-loving plants and ones which can withstand saturation of their roots for periods of time.



(A) Water seeps into the ground through pore spaces in the rock and soil. It passes first through the zone of aeration, in which the pore spaces are occupied by both air and water, and then into the zone of saturation, in which all of the pore spaces are filled with water. The depth of the water table varies with the climate and amount of precipitation. In most areas, it is near the surface (or at the surface, in lakes and swamps), but it can be hundreds of meters deep in desert regions.

Fig. 5.3 The Water Table
Source: (Gorrie 1992)

As well as utilizing the various sources of water for use in the landscape as previously outlined, the following strategies may be incorporated to increase water conservation.

Native Vegetation: The native vegetation of a region is naturally adapted to the water availability of the area. The native prairie grasses have extensive root systems which allow the plants to survive fluctuating moisture conditions. This ultimately leads to the success of these species of plants in the prairie environment.

Given the large size of rural residential lots, the incorporation of extensive areas of native plant communities may eliminate the need for additional water supplies to a good portion of the landscape (see Fig. 5.4). Native vegetation may be present on some rural residential sites, in which case it would be desirable to manage the site in order to preserve this vegetation. When incorporating native vegetation into a disturbed site, it may not be possible to recreate the same communities as were originally there. Many rural residential sites, especially in the Winnipeg region, have been twice removed from their original condition, first by agriculture and then by the rural residential development. These sites may also be lacking the original soil organisms and wildlife which are integral parts of the native plant communities. An important lesson of native vegetation is that plant communities may have general similarities but each individual locality has a unique community of plants particularly suited to the conditions of that locality.

In order to eliminate the use of any source of water other than rainfall in the landscape, the Greenhome project in Waterloo, Ontario used native vegetation in the landscape of its suburban lot (Fig. 5.5). Priority was given to species native to the Waterloo area first, then to southwestern Ontario and then to Ontario. Because of the high water requirements of a traditional lawn, more drought tolerant native groundcovers were chosen instead.

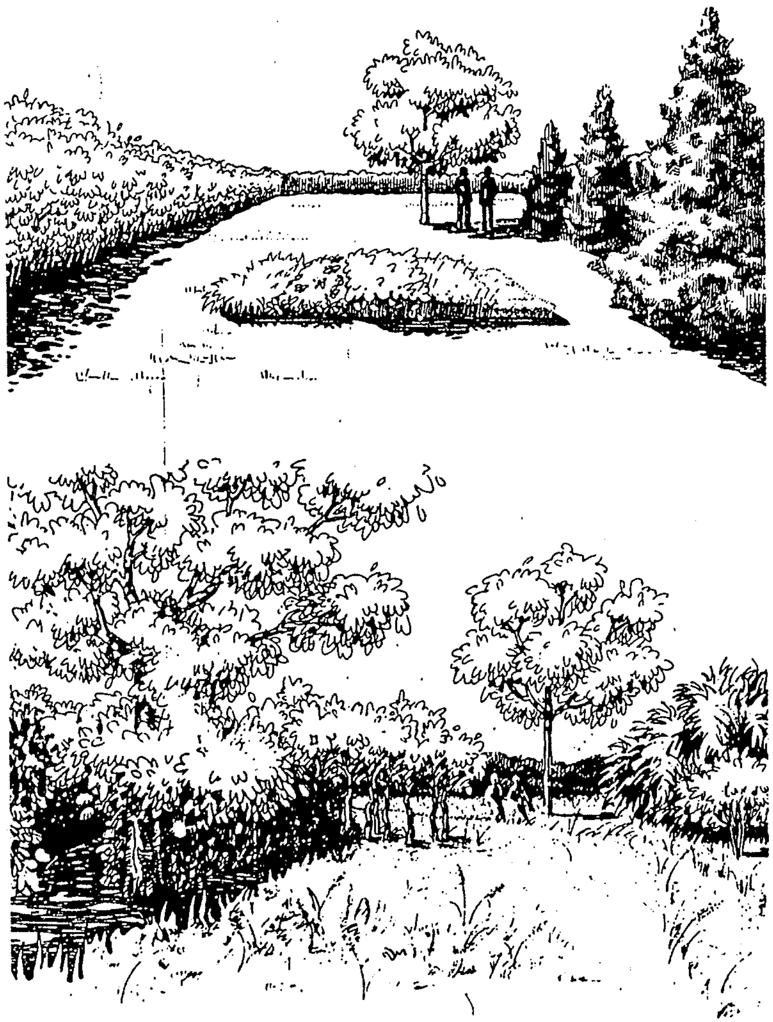


Fig. 5.4 A Landscape Illustrated in a Traditional Style (top) and using Native Vegetation (bottom).
Source: (Dieklemann and Schuster 1982, 12)

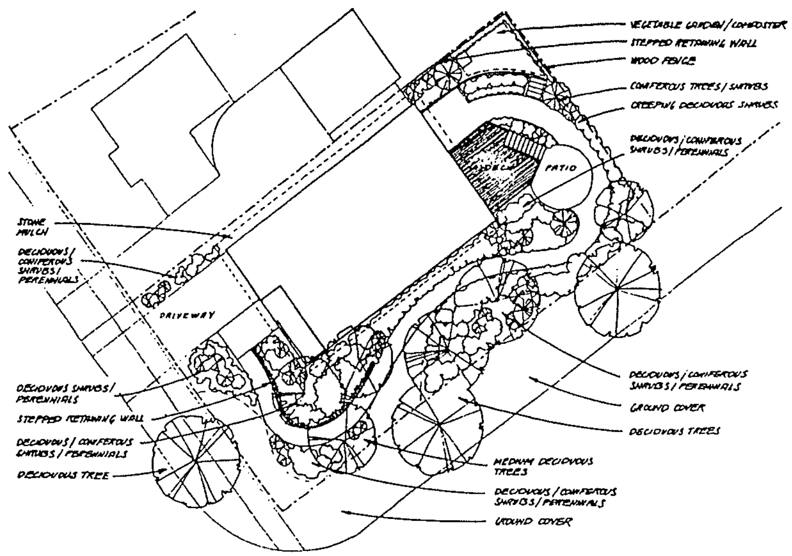


Fig. 5.5 The Greenhome Landscape Plan
Source: (Grady 1993, 190)

Xeriscaping: Xeriscaping involves the conservation of water through creative landscaping and incorporates seven principles as outlined by Williams (1994).

1. Design of the landscape. A xeriscape develops hydrozones in the landscape which are areas containing plants which require the same amount and frequency of water (Cox 1991). Figure 5.6 lists the four different hydrozones and the criteria used to define them. The principal and secondary hydrozones should be limited in size to what is absolutely necessary for the needs of the design.

	Human contact	**Visual importance**	**Water & energy needs**
Principal hydrozone	Direct, intense, active.	Conspicuous	Greatest
Secondary hydrozone	Less direct, less intense, more passive.	Conspicuous	Reduced
Minimal hydrozone	Little	Less conspicuous	Slight
Elemental hydrozone	None	Inconspicuous	None

Figure 5.6 Matrix of Hydrozone Values
Source: (McPherson 1984, 199)

Figure 5.7 illustrates how the hydrozone concept may be applied to a suburban lot and how the components of the landscape fit into the different hydrozones.

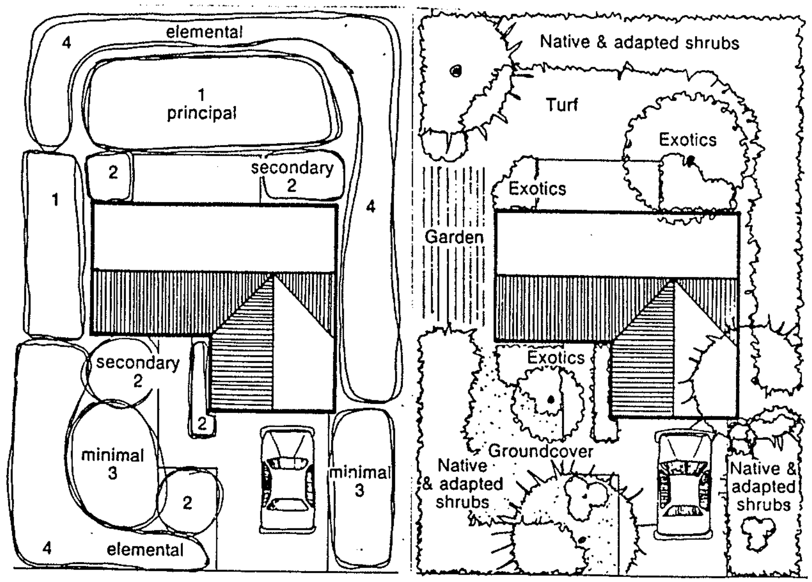


Figure 5.7 The Hydrozone Concept Applied to a Suburban Lot
Source: (McPherson 1984, 200)

2. Soil amendments. The addition of organic matter such as compost, peat moss, or manure to clay or sandy soils improves the water

percolation rates and the water holding capacity of the soil. The organic matter must be thoroughly mixed into the soil up to 12-18 inches for maximum benefit.

3. Efficient irrigation. Deep, less frequent watering of plants during establishment promotes stronger plant development and may use less water than daily shallow waterings. Drip irrigation reduces the amount of water applied to the landscape. Watering early in the day when winds are calmer and temperatures cooler reduces water loss from evaporation.

4. Practical turf areas. A lawn area which is intensively used may require a traditional Kentucky bluegrass lawn mix but other areas which are not as intensively used may incorporate drought-tolerant groundcovers or native grasses and wildflowers which require no additional irrigation.

5. Appropriate plant selection. Plants should be chosen to correlate with natural conditions of the site. For example, drought-tolerant plants should be used in dry, open areas, and more tender species used in sheltered areas only.

6. Mulches. Mulching the soil surface with organic material such as wood chips or bark, grass clippings and straw can reduce moisture loss from surface evaporation, prevent germination of annual weed seeds, and insulate the soil from temperature fluctuations. In clay soils, compaction of the soil may be reduced from the cushioning effect of a mulch. As organic mulches decay, they improve the soil structure and fertility, although with some mulches, such as wood chips or straw, the addition of nitrogen may be necessary as the decomposition process may remove it from the soil.

7. Appropriate maintenance. An irrigation

system must be properly maintained and used only when the landscape has not received adequate moisture from natural sources. Organic mulches must be replenished as necessary. Weeding is very important since removing all undesirable plants ensures that all available water resources may be used by the desired plants. Maintaining mown turf areas at a height of 2 or more inches makes a lawn more resistant to drought stress.

Conservation during Plant Establishment: Many plants survive on the natural available moisture of a site but only when they are established. Water conservation during periods of plant establishment is very important in rural residential sites since these sites often use increased amounts of water to establish large amounts of new vegetation. Measures can be taken to reduce water consumption during the period of plant establishment. Conditioning the soil first by adding organic matter or planting a soil conditioning crop such as clover for a year will enhance the available moisture in the soil. Early spring planting takes advantage of moisture from snowmelt. Minimizing planting in very dry years reduces the need for excess water. Planting when soil moisture conditions are adequate ensures a higher rate of survival.

A major factor in determining the amount of water absorbed by a plant is the depth and concentration of its root system. Plants with underdeveloped, shallow root systems are more prone to rapid drying and drought stress. During the establishment period of plant growth, a strong root system should be encouraged rather than significant top growth of the plant in order to reduce chances of drought stress in later years. Planting stock should be chosen according to the size of its root system, not just the size of its top growth. Fertilizers high in phosphorus to encourage strong root development should be used during the establishment period rather than high nitrogen fertilizers which encourage strong green or top growth.

Guideline: Rural residential sites should accommodate surface drainage on site.

Rationale: Rural drainage systems are generally designed for agricultural purposes. Drains are designed to accommodate increased summer rainfall amounts but not always increased spring flooding. Agricultural drains may not meet the year-round needs of residential development. Increased residential development leads to increased run-off and the potential for overloading rural drains. Maintaining and expanding the rural drainage system creates additional costs for a municipality.

Strategies: A site must accommodate all the drainage needs of its various components. Drainage must be directed away from the house, the driveway and the septic field. Areas intended for temporary retention of run-off must have appropriate surfacing. For example, a neatly trimmed grass surface can repel almost half as much rainwater as a shingled roof (Grady 1993), thereby permitting a high rate of run-off rather than percolation into the soil. Retention areas must have a permeable surface and groundcover which reduces surface movement to allow for percolation into the soil to recharge groundwater and replenish aquifers. These retention areas act like a sponge to absorb water on the site and filter sediment and impurities in the run-off water. Vegetation in these areas must be able to withstand the moisture conditions. Areas which are intended to retain water for short periods of time during high run-off periods as in the spring or after heavy rainfall may incorporate species appropriate to a wet meadow or trees such as willows which can withstand periods of flooding but will not grow in continually saturated soil.

Areas of very high moisture may be developed into small marshes which would be continually saturated and which would take on the distinct visual characteristics of a marsh with species such as cattails and sedges predominant. Marshes are very effective in purifying water flowing through them.

Retention areas should be located away from high use areas of the site since during periods of saturation the use of these areas may be limited. Retention areas should be situated to intercept run-off from the site before it reaches the drainage system in order to filter and purify the run-off.

Run-off water may be directed to provide additional moisture to areas such as shelterbelts to reduce the need for irrigation especially during establishment periods.

5.2 SEWAGE DISPOSAL

Guideline: Proper selection, siting and functioning of an on-site sewage disposal system should be ensured on existing rural residential sites. The conventional septic tank and disposal field system should be utilized wherever possible.

Rationale: Emphasis is placed on the septic tank and disposal field method because it is "the simplest and most convenient method of sewage disposal within the confines of a small individual lot, and when constructed and maintained properly, performs satisfactorily, at least for the limited effective life of the disposal field." (CMHC 1978). As well, this system is widely recognized as an acceptable and accessible method of sewage disposal both in terms of cost and construction technology. Site soil conditions, topography, and groundwater conditions may pose limits on the use of this system.

Strategies: While it is not the intention here to provide detailed technical information on the workings of the septic tank system, the criteria for construction and measures for the prevention of the failure of the system will be outlined (CMHC 1978; Laak 1978; Underwood, McLellan and Associates 1973).

The criteria for the construction of a septic tank system include:

- surface topography of less than 5% requires a minimum lot size of 0.5 acres, 5% to 10% requires 0.75 acres and 10% to 20% requires 1 acre in size
- a minimum depth of 3 ft. must be provided between the maximum high water table level and the bottom of the absorption trenches of the disposal field
- discharge amount based on the number of bedrooms in a home with the occupancy

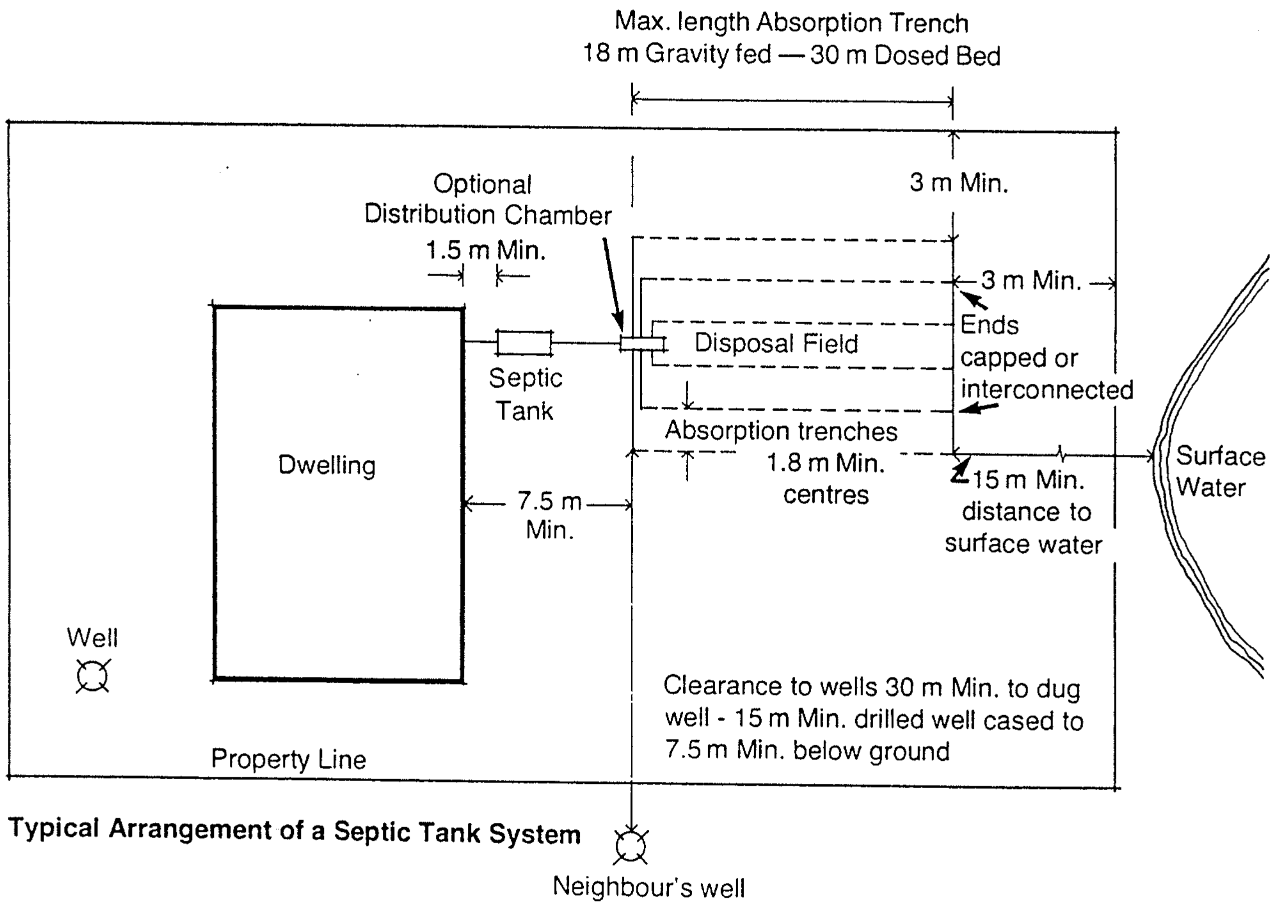


Figure 5.8 Septic Tank System Layout

Source: (CMHC 1978, 15)

Notes:

1. The above layout is suitable for a disposal field using normal construction methods.

2. Location of tank and disposal field to be on lower ground than adjacent wells or springs, if possible.

3. Internal plumbing and main drainage outlet should be designed with a view to connecting to possible future sanitary sewers.

4. Roof water, surface water, discharge from footing drains, etc. must be excluded from entry to septic tank.

5. Disposal fields NOT to be located in swampy ground or in ground liable to flooding.

considered to be 1.5 people per bedroom in 3-4 bedroom homes and 2.0 people per bedroom in a 1-2 bedroom home and the standard figure of effluent discharge of 50 gal/day/person.

The size and design of the septic tank system must be appropriate to all these conditions. Figure 5.8 outlines the layout of a septic tank system with some of the minimum distances required for functions within and adjacent to the system. In addition, the recommended ground cover for the disposal field is grass kept at a minimum of 2" in height. Gardens and shrubs should be kept a minimum of 10' from the outside edge of the field. Trees should be placed an adequate distance from the disposal field to avoid clogging of the distribution pipes by the root systems and driveways and walkways must not be located over the field. The field should be covered with straw, preferably flax, to a depth of 2' in the winter to prevent freezing of the distribution pipes. A standby area equal to the original size of the disposal field must be provided for the future development of a second disposal field and incompatible land uses avoided on this site. The maximum area for a septic tank system including the standby area in the Winnipeg region is 1.54 acres.

The causes of failure of septic tank systems are not always properly identified and therefore, the failure of a particular system may not preclude the installation of another septic tank system on a particular site. In the Winnipeg region, limits to the success of septic tank systems are often caused by heavy clay soils with limited percolation rates and seasonal high water tables preventing absorption of effluent. Owners' lack of understanding of the operation and maintenance of a system may reduce its efficiency or cause failure.

Problems caused by the failure of septic tank systems include the ponding and run-off of wastewater into natural and built drains and waterways, odour and pollution problems and groundwater contamination. Groundwater contamination may occur from excess nitrates from effluent seeping into the water. Septic tanks are not specifically designed to remove nitrogen from the sewage. Cleaners, solvents and other chemicals being disposed of into the septic system may also leach into groundwater. A number of measures can be taken to prevent the failure of a septic tank system.

1. Ensure proper design. The septic tank system must be designed to be appropriate for all the conditions of a particular site and the use of the system. As discussed earlier, water use is on the increase and the discharge estimate of 50 gal/day/person may be too low for some present systems. However, in this case, it would be both environmentally and economically wise to reduce water use to at the very most 50 gal/day/person rather than increase the size of a disposal field.

2. Ensure proper installation. Construction practises and materials used must be suitable for each site. For example, in areas more readily subject to deeper frost penetration, piping that is subject to frost damage should not be used. The septic tank must be of sufficient quality so the no cracking occurs which would allow groundwater to seep into the tank.

3. Ensure proper maintenance and operation. The septic tank should be cleaned and pumped out annually. Water use should be maintained at the level that the system was designed for. Inappropriate materials such as garbage, grease, large amounts of paper products and cleaners and solvents which destroy sewage-

digesting bacteria should not be discharged into the system. These items must be disposed of in the household garbage or at proper hazardous waste collection depots.

4. If a dwelling is expanded, the septic tank system should be expanded accordingly.

5. During occasional periods of a seasonal high water table, rigorous water conservation measures may be taken to reduce effluent discharge. This solution would only be appropriate for short periods of time on an occasional basis. Regular periods of a seasonally high water table would require a redesigning of the septic tank system.

6. Using greywater in the landscape reduces the load on the septic system and reduces the liquid-to-solid ratio in septic tanks allowing for increased digestion of solid materials. Reduced greywater in the septic system produces cleaner effluent with less chance of clogging drainage holes in the distribution pipe (Kourik 1992). Greywater must be discharged into the septic system in the winter months.

7. Owners should be educated on the workings and maintenance of a septic tank system to avoid failure and inappropriate operation such as disconnecting part of the discharge line to the disposal field and discharging effluent to other areas.

Given the choice of present accessible technology, the septic tank system best meets the needs for on-site sewage disposal on existing rural residential sites.

Septic tank systems do have limits to their use especially in areas where soil conditions prevent adequate percolation of effluent and where hazards are placed on groundwater. A new method to deal with nitrate contamination of groundwater is being developed at the Waterloo Center for Groundwater Research.

The possibility of laying the tile bed of the disposal field in an organic material such as peat instead of gravel may be a possible solution to prevent the infiltration of nitrates into the groundwater (Gorrie 1992). Updating the technology of the septic tank system is definitely needed as well as more information on the workings of the present systems and water consumption figures.

Alternative Systems: Where conditions prevent the use of a septic tank system, alternative methods of sewage disposal must be used. The methods outlined are intended for on-site disposal but it is necessary to point out that in some instances collective systems of sewage disposal must be installed in areas where on-site disposal is no longer an option. ***Built-up Disposal Fields:*** A raised disposal field maybe constructed on sites where there is not a minimum of 3' between the trench bottom and the maximum seasonal high water table, bedrock, or impervious soil (see fig. 5.9). Raised disposal fields are more susceptible to frost penetration and require adequate winter protection.

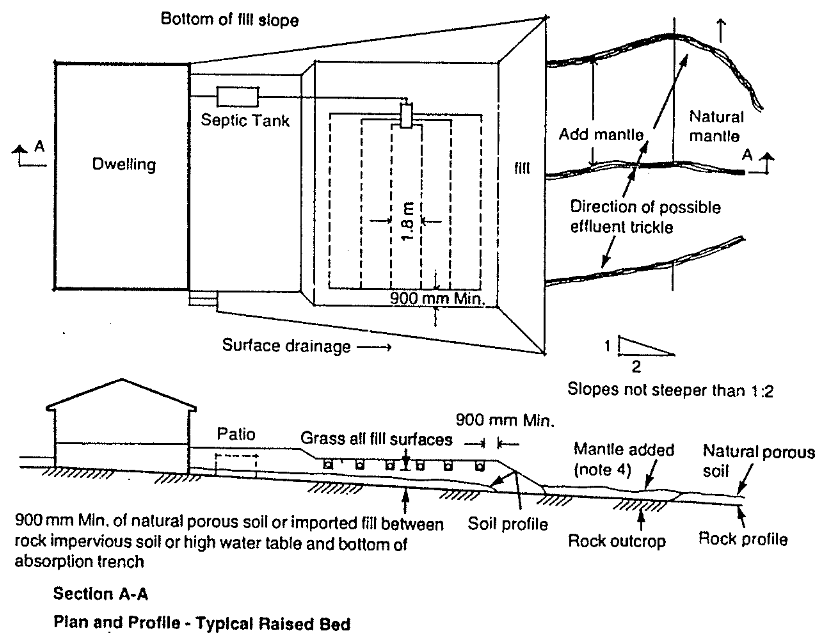


Figure 5.9 Built-up Disposal Septic Field
Source: (CMHC 1978, 24)

Holding Tanks: In areas where soil conditions or density of development prevent the use of a disposal field, a holding tank is often used for all septic discharge and must be regularly pumped out. In order to avoid some of the pump-out costs, residents sometimes illegally discharge sewage onto the ground or into ditches or waterways. More acceptable ways to reduce pump-out costs would be to utilize greywater in the landscape using correct methods of application and to use water conservation practises in the household.

There is a need for new or improved technology with respect to on-site sewage disposal systems. Aerobic systems, which use oxygen for sewage treatment, release more nutrient energy than conventional anaerobic systems and incorporate the use of plants into the process (Salvatori 1990). These systems show promise of becoming important for sewage disposal and the recycling of nutrients is in keeping with the concept of sustainability. Aerobic systems presently have limits to their use in cold winter months but new developments in the technology may solve this problem. Any new systems proposed for use in existing rural residential sites must be acceptable environmentally, socially and economically if they are to become accepted standard practise.

5.3 WASTE DISPOSAL

Guideline: Rural residential sites should utilize or recycle as much domestic waste as possible on site.

Rationale: Rural municipal landfill sites are often nearing capacity and costs related to garbage management are rapidly increasing. Managing wastes at their source increases the sustainability of a site.

Strategies: While every person, no matter where they live, can practise the 'three R's" - reduce, reuse and recycle - with respect to waste management, some strategies can be particularly applicable to rural residential sites.

Composting: Approximately one-third of all garbage consists of organic wastes such as food and yard refuse (Buchanan 1988). These organic wastes may be composted on site and then applied to the soil. Composting, through a heat fermentation process, converts wastes into a valuable resource which can be used to enrich the soil of a site and improve its water holding capacity, thereby making it an important component in water conservation practises. Rural residential sites provide virtually limitless opportunity to incorporate the compost produced on site since the large size of the lots is capable of absorbing all the compost produced by the residents.

Recycling: Sorting of recyclable materials such as glass, plastics and aluminum can be carried out by rural residents in the rural-urban fringe even if a particular municipality does not have collection depots set up. Being close to the city, the rural residents can deliver recyclables to private recycling companies or collection depots generally more commonly located in cities.

Burning: Burning garbage is a common method of waste disposal in the countryside, however, modern day refuse is not often safe to burn. The presence of certain plastics and metals in many products makes them unsafe to burn since the potential for releasing dioxins harmful to human health is quite high (Mohr 1988). Burning would be acceptable for certain items, in particular, organic wastes such as meat scraps and diseased plant material not suitable for the compost pile.

5.4 CLIMATE

Guideline: Rural residential sites should address climatic problems and benefits.

Rationale: Rural residential sites are located away from the warming and sheltering effects of the city. In the Winnipeg region, exposure to the extremes of the prairie climate reduces both the energy efficiency of a home and human comfort levels in the landscape. "Physically the prairie in some ways is more threatening than it was in the past. Technology has made us careless . . . and when our machines break down we are more than ever at the mercy of the elements." (Rees 1988). The landscape itself may be altered to defend against the extremes of the climate and to create microclimates suited to particular needs. As well, working within the limits of the climate will create a more sustainable landscape.

Strategies:

Wind Control: Wind is generally considered to be one of the most problematic features of the prairie climate. Wind increases the cold in winter with the windchill factor and increases evaporation and drying in summer. Reducing windspeeds in winter with the use of shelterbelts can reduce household heating costs by 20-40% per year (White 1984). Energy savings are most dramatic when an open, exposed site becomes well sheltered from the wind. Figure 5.10 illustrates the degree of wind protection from shelterbelts.

The design of a shelterbelt varies depending on the site and its use. For the most effective wind control, the shelterbelt should be located perpendicular to prevailing winds. The degree

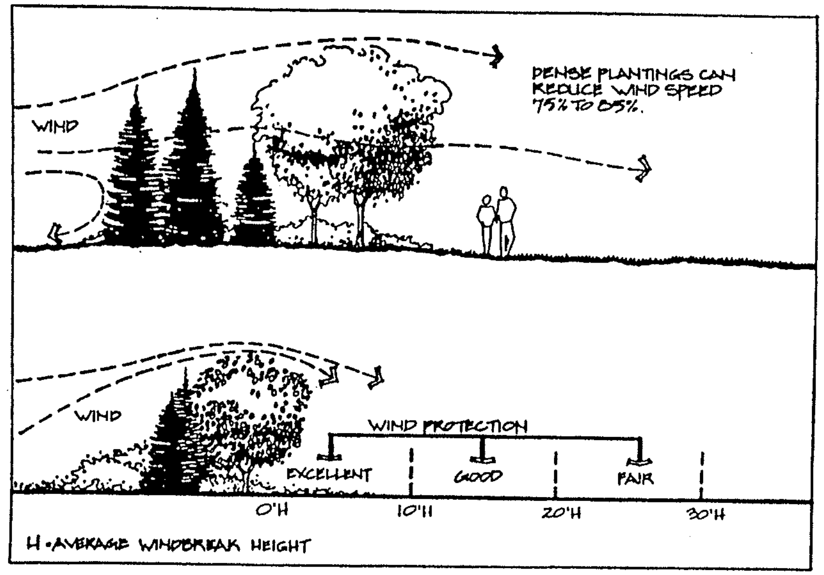


Figure 5.10 Effects of Shelterbelts for Wind Protection

Source: (Walker 1990, 105)

of protection provided by a shelterbelt is dependent on the height of the vegetation, the width of the belt and the penetrability of the plants used. A shelterbelt with a density of 50 to 60% (White 1984) is considered optimum since less suction is created on the leeward side of the belt and wind speeds are reduced for a longer area on the leeward side and acceleration of wind back to original speed is more gradual.

Buildings should generally be located 100 ft. from the main shelterbelt to avoid the accumulation of snow which forms behind the belt (White 1984). Trees and shrubs may be still be planted within this area for ornamental value and to provide shelter on a smaller scale for areas such as gardens and childrens' play areas (see Fig. 5.11).

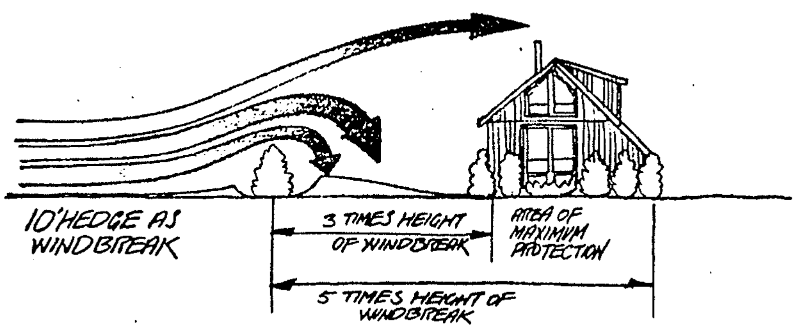


Figure 5.11 Areas of Snow Accumulation and Wind Protection from a Windbreak
Source: (Gaudet 1985, 27)

Generally the shelterbelt should contain a mix of deciduous and coniferous plant material. For best winter protection, trees should be densely branched and have no openings in the shelterbelt to prevent windtunneling. Trees and shrubs which are branched to the ground level are important to prevent wind from tunneling under the shelterbelt. Plants used in a shelterbelt should be those that are most appropriate for the natural conditions of the site. Moisture availability and soil conditions must be assessed in order to choose plants which will provide the most vigorous growth and to ensure the longterm health of the plants. Native vegetation may also be used for shelter. The aspen bluffs are generally in the shape of a dome which gradually lifts winds up and over the stand of trees and protects the inside areas (Cohlmeyer 1977). Often a young stand of aspen has a much greater density of trees than would normally be planted in a shelterbelt, thereby providing better protection in earlier stages of development (see Fig. 5.12). Native vegetation can be used in conjunction with introduced species to increase wind protection. The native trees provide shelter for the trees such as the slower growing evergreens.

Figure 5.12 Young Stand of Native Aspen

Rural residential sites do not always optimize the use of shelterbelts on site since most often a planting of trees or shrubs is located around the edges at the property line. This way of locating plantings on the site often results in inadequate shelter for the house and landscape of the site.

Snowdrift Control: Snowdrifting can be manipulated on a site to prevent inconvenient snow accumulations and to distribute snow cover to areas where it is desired. Winds can be directed to scour snow from areas such as driveways and roads. Shelterbelts can be designed to develop certain patterns of snowdrifts (see Fig. 5.13).

may be continually used to distribute snow cover over a large area.

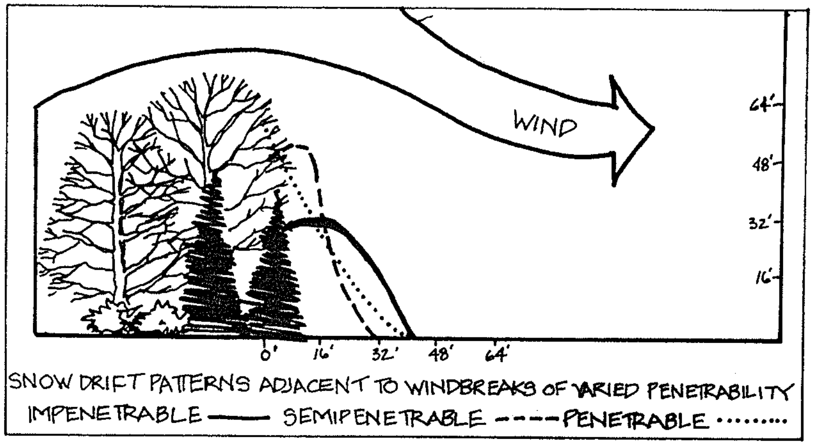


Figure 5.13 Snowdrift Patterns Formed by Different Shelterbelts
Source: (adapted from Walker 1990, 107)

Shelterbelts are not the only method available to control snow. A variety of methods for snowcatching is important on open rural residential sites since shelterbelts can take many years before they are fully effective. Snow can be distributed on a site by using varying heights of ground cover (see Fig. 5.14). This method is particularly important during the establishment stage of shelterbelts and may be continually used to distribute snow cover over a large area.

Figure 5.14 Varying Heights of Groundcover helps to Distribute Snow

Leaving the stalks of annual plants such as sunflowers or corn standing over winter can provide snow catches, as can a variety of other elements such as fences and haybales.

Solar Radiation: Bright sunlight is a welcome feature in cold winter months but can cause overheating in hot summers. Deciduous trees planted on the south and west sides of a home can lower the indoor temperatures up to 10 to 15 degrees Fahrenheit (White 1984) and reduce cooling costs in summer. Deciduous vines on a south wall can also reduce solar radiation reaching the house. Deciduous plants which provide shade in summer and allow sunlight to penetrate in winter are most appropriate for use in controlling solar radiation since the goal is to minimize the amount in summer and maximize the amount in winter (see Fig. 5.15).

By plotting sun path diagrams of a site and determining the seasonal shadow patterns formed by buildings, vegetation and landforms, the location of different elements on a site may be more closely related to their specific requirements. For example, a deck located on the south side of a home and shaded by deciduous trees would generally be comfortable for use for a longer season than a deck located on the north side shaded by the home. Sunshine in the spring and fall would provide a warming effect not possible on the north side of the home.

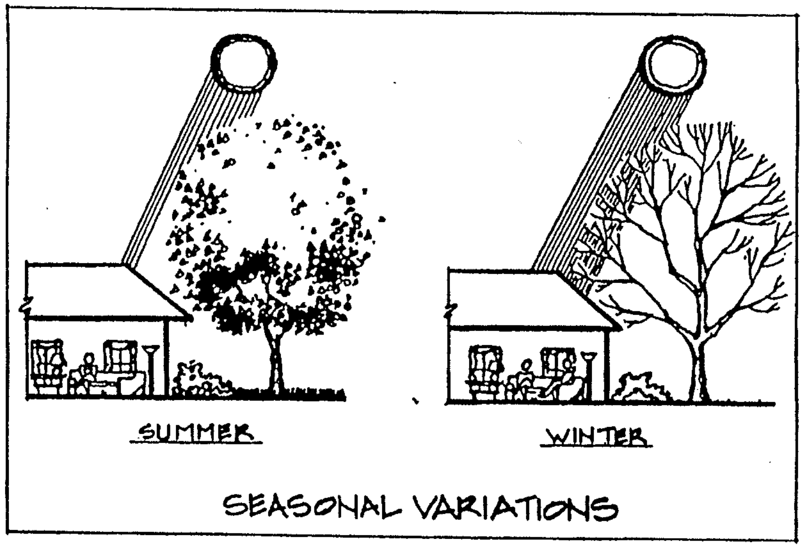


Figure 5.15 Deciduous Trees Shade Summer Sun but allow Winter Penetration
Source: (Walker 1990, 106)

Microclimate: A microclimate is influenced by the land contour, vegetation, ponds, lakes, or streams, soil conditions, and sitings of buildings. These factors combine to affect the temperature, humidity, windchill, wind, snowdrifting and run-off (Gaudet 1985). Site conditions can be manipulated to create areas of varying microclimates to increase comfort for humans and wildlife, and to create a diversity of different environments. Microclimates can be created to suit varying plant requirements. The exposed nature of many rural residential sites limits the use of some introduced plant species of warmer hardiness zones which may survive in sheltered city lots but not in rural areas. By providing sheltered areas, a wider range of species may be incorporated into the site. For example, to maximize the productivity of a vegetable garden located on a prairie site, a location which provides shelter from the wind but maximizes available sunlight is desirable. The normally low humidity of the climate should be maintained but without allowing strong winds to increase evapotranspiration rates and the garden should not be located in a low lying area more susceptible to frost.

Diversity: Species richness ensures the presence of organisms to perform nutrient recycling and retention under all experienced conditions of a fluctuating environment. Variety "endows a system with robust qualities" to ensure "the probability of the system persisting" (Main 1993). The prairie landscape is subject to an extremely fluctuating climate. The native prairie plant communities respond to this fluctuating climate by ensuring a diversity of species within the community. The numbers of individual plants of each species may vary greatly from year to year depending on changes in the moisture conditions and temperature ranges. The presence of a wide variety of species creates a robust system since species prevalence can vary and ensure a strong plant community under any climatic conditions. A community of plants with varying species, whether native or introduced, varying forms and ages is most likely to be a successful sustainable system.

5.5 CONTEXTUAL ISSUES

Guideline: Rural residential sites should develop measures to minimize conflicts with agricultural activities.

Rationale: Problems of noise, odours, dust and herbicide use from agricultural activities in the rural-urban fringe often cause conflicts with existing rural residential sites.

Strategies: Shelterbelts can reduce noise, odour and dust problems. Noises may be reduced by vegetation but the effect is not often significant, however screening the views to problem causing sources can provide some relief by minimizing the exposure to the problem. Dust problems can be reduced by planting that blocks areas which are the source of dust, including cultivated fields and gravel roads. Vegetation removes dust by slowing windspeed which causes suspended particles to fall and impacting with the plants themselves causes the dust particles to be removed from the air. Avoiding using shelterbelt species such as Manitoba maple, Acer negundo and Siberian elm, Ulmus pumila, which are susceptible to herbicide damage, on the outside row or leaving a buffer area between a cultivated field and a shelterbelt can reduce damage to trees caused by herbicide use on the farmland.

Guideline: Rural residential sites should include a diversity of spaces appropriate to the various functions of the site.

Rationale: Residents of rural residential developments express the desire for open space, privacy and the presence of nature. In addition, pursuing activities not generally permitted in higher densities is sometimes desired.

Strategies: Rural residential sites are often managed in a similar manner to suburban lots. The large size of the rural lots present more opportunity to diversify the space. Privacy is not generally a result of increased space on the prairie landscape. Privacy can be achieved through the development of human-scale enclosed spaces. The feeling of open space can be enhanced by directing views to open areas outside the site. Habitat for wildlife can be provided in areas of the site where it will not conflict with human activity and will have minimal human interference. Using rural residential sites for activities not generally permitted in higher densities involves site specific issues but generally these activities should be suitable to the site conditions and context. A rural location alone is not sufficient in determining the appropriateness of a certain activity.

Guideline: Rural residential sites should incorporate measures to increase the sustainability of the landscape of the site in order to create a setting in harmony with the rural context and character.

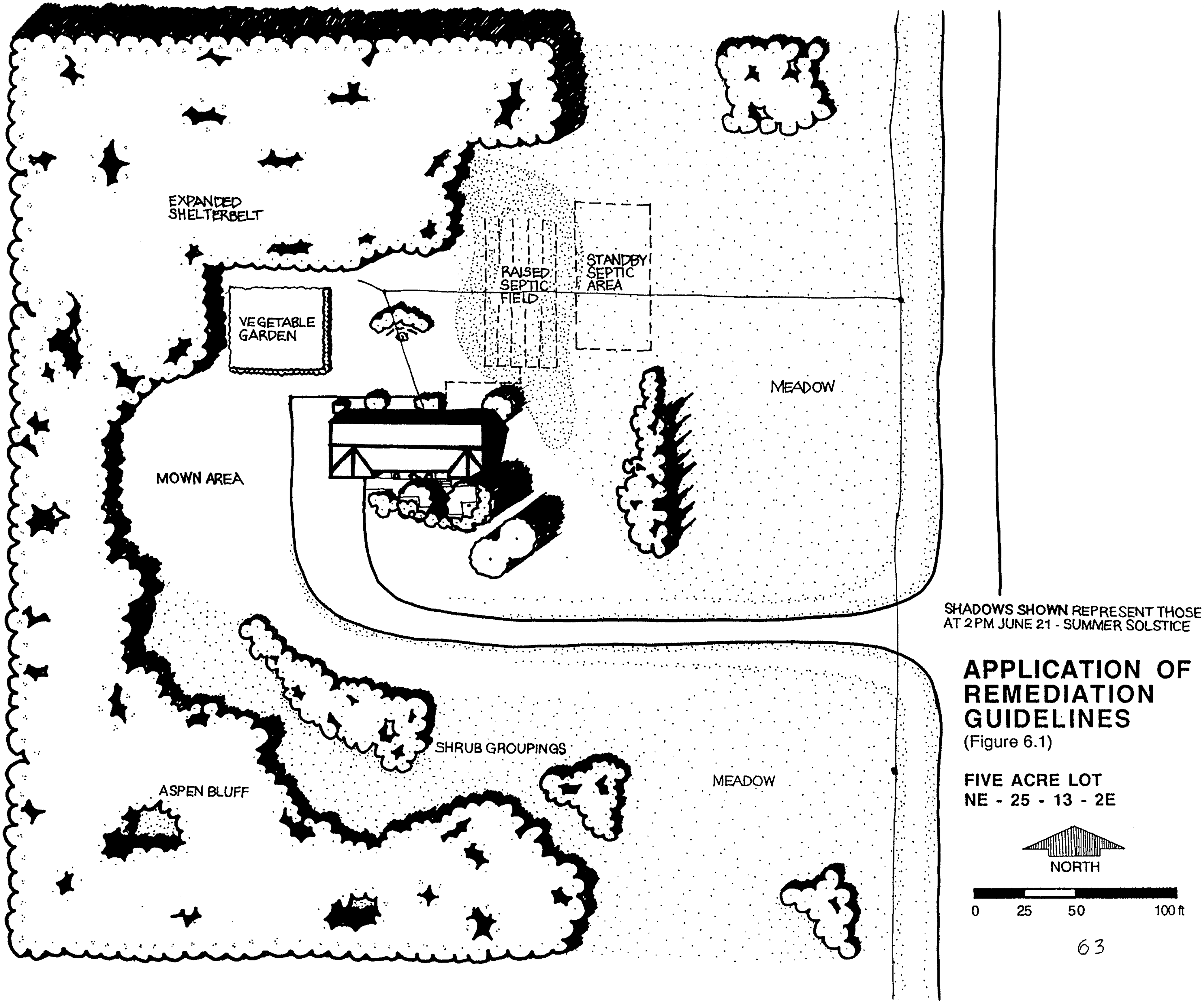
Rationale: The rural character of the countryside is determined by a number of factors and the interaction of those factors. Rural character is a product of nature, the tastes and designs of rural landowners, the economics and technology of rural land uses, the natural constraints of topography and rainfall, the type of crops grown, the proportion of cropland, pasture and forest, the density and type of non-agricultural activity, the highway and road network and the architectural styles of homes, farm buildings and fences (Healy and Short 1981).

Rural residential development often invokes the attitude that “the countryside just doesn’t look like countryside is supposed to look, anymore” (Riley 1993). Yet, being a combination of all the previous elements, the countryside is a constantly evolving and changing place. New patterns in the rural landscape do not necessarily have to be based on the patterns of the past. The answer to finding an appropriate form for rural residential sites may be found in the effort to increase the sustainability of the sites. A sustainable landscape may take on many forms and patterns but each is appropriate to, and respectful of, the inherent characteristics of that landscape.

6. APPLICATION OF REMEDIATION GUIDELINES

There are several opportunities to apply the remediation guidelines to the study site in order to increase the sustainability of the site. The site is still intended to function as a residential site and measures suggested are intended to increase sustainability by addressing the natural and existing features of the site without proposing costly and extensive changes to the site.

The septic field is sited first in order to provide as appropriate a location as possible. Due to the seasonally high water table, a raised disposal field is recommended for the septic tank system. Using fill with a percolation rate of 10 minutes/1" as opposed to the site soil percolation rate of 30 minutes/1", reduces the size of the field area needed. The soil with the lower percolation rate is a fine sand with some medium sand and an average particle size of 0.3mm. Using this type of soil, the amount of distribution pipe needed for the 4 bedroom home is 446 feet. The pipes are installed in 18" wide gravel trenches and spaced 6 feet apart. The maximum height of the raised berm is 3 feet. The area adjacent to the disposal field is set aside for the required standby septic area and is recommended to be planted with sweet clover and alfalfa. These plants are salt tolerant and have high water requirements which aid in lowering the water table. The disposal field is generally planted with grass but incorporating other groundcover species, especially alfalfa and various clovers, could aid summer evapotranspiration rates which increases moisture loss of the system through evaporation of the soil surface and plant



APPLICATION OF REMEDIATION GUIDELINES

(Figure 6.1)

FIVE ACRE LOT
NE - 25 - 13 - 2E

transpiration. These groundcovers would also increase snowcatching for winter insulation but should be supplemented with flax straw bales especially on the top of the berm.

The location of the bermed septic field also provides some privacy to the backyard area of the site and helps to define different spaces in the site. The recommended mixed groundcover which includes plants of varying heights and textures helps to blend the berm into the existing topography of the site without creating as an intrusive a feature as would a closely mown berm.

The vegetable garden is relocated away from the competition of the shallow rooted willows and is not shaded by trees or the house.

Located in the lee of the expanded shelterbelt, the area would receive good snow cover in winter, therefore ensuring good spring soil moisture availability. A low hedge, which could include raspberry, Rubus sp., currants, Ribes spp. and gooseberry, Ribes sp. planted on the south and east side provides wind protection without blocking sunlight. Organic wastes produced on site can be composted to reduce wastes destined for the municipal landfill site. This compost can be incorporated into the soil to provide additional nutrients and to improve soil percolation rates. Straw mulch can be used to conserve soil moisture.

For optimum growth, a vegetable garden needs an average of about 1" of water per week (Hole 1993). Average rainfall for the growing season is: May - 2.5", June - 3.2", July - 3", and August - 3". Rainfall averages would need to be approximately 4" per month for optimum growth of the vegetable garden. For the 2000 square foot vegetable garden, 1" of water equals 1000 gallons. Since the entire month of

May is not part of the vegetable growing season, the average rainfall and the soil moisture would generally be sufficient. For the month of June, the deficit would be about 800 gallons, and for July and August, 1000 gallons per month. In order to meet this deficit, rainwater could be collected from the roof of the house for use in the vegetable garden. A simple outdoor cistern (see Figure 5.2, p.34) could store the collected water until needed. Using only the back roof of the house and taking into account evaporation losses, the amount of water that could be collected in the summer months alone would approach about 1100 gallons per month. This amount would be sufficient to meet the water deficit of the vegetable garden. The distribution of precipitation may vary greatly from the averages cited which may create problems of water availability. By using a cistern which has a capacity of about 2000 gallons, water may collected and stored for longer periods of time in order to alleviate possible distribution problems.

Rainwater collected from the front roof of the house could be used to irrigate the front landscaped area to enhance this visible, ornamental area.

Greywater is not suitable for use in the landscape due to a high salt content in both the water and soil.

The areas of saline contaminated soil (see Figure 3.13, p.25) pose limits on the location of tree and shrub plantings. The water table is seasonally high, generally peaking in spring, but the site may also experience dry conditions as the water table drops in late summer.

The gaps in the existing shelterbelt are infilled with the same species since these species have a generally successful growth rate. Efforts to replant areas with contaminated soil would be futile and even though gaps are left in the shelterbelt, these areas are left devoid of trees or shrubs. The shelterbelt located on the northwest corner of the site is expanded to increase the energy efficiency of the house and reduce the impact of winter winds. Presently windtunneling occurs in this corner (see Figure 3.6, p.16). No conifers are recommended for use due to the high water table and the alkalinity of the soil. Although Black spruce may survive in this area, this particular conifer would not provide the desired density of the shelterbelt. Recommended species for this area include: hybrid poplars, Populus sp., Manitoba maple, Acer negundo, for fast growth and chokecherry, Prunus virginiana var. melanocarpa whose suckering habit provides good density for winter shelter. Introducing more variety in the shelterbelt provides increased diversity of forms and species. The expanded shelterbelt provides sufficient distance (80-100ft.) between this main belt and the house to allow for snow accumulation in the lee of the belt.

The shrub shelterbelt to the south of the driveway is intended to reduce snowdrifting in the front of the garage. This area receives drainage from the driveway but is not in a constantly saturated state. Species appropriate for this moist area would include: , Redosier dogwood, Cornus stolonifera, and pussy willow Salix discolor. These species are found in the surrounding region of the site and are located in generally moist areas.

The addition of shrubs to the existing row of Walker poplar to the east of the house would increase privacy from the road and filter some of the dust coming into the site from the adjacent gravel road. The extent of this shelterbelt is limited by the saline contaminated soil on site. Appropriate species would include: wolfwillow, Elaeagnus commutata, Saskatoon, Amelanchier alnifolia, and Redosier dogwood, Cornus stolonifera. Again, these species are found in the general region of the site.

During establishment of the shelterbelt areas, shredded wood chips could be used as mulch around the plants to conserve moisture and reduce some weed problems. Nitrogen fertilizer should be added as the wood chips decompose since this decomposition process may remove nitrogen from the soil. As well, these areas should be kept free of weeds which compete with the other vegetation for moisture.

An aspen bluff can be developed in the south west corner of the site. Presently the green ash in that location are doing poorly due to the salt content of the soil. The area has good moisture being located in a lower spot on site which would be appropriate to the aspen. The shallow, spreading root system would not be as subject to the salt contamination. The introduction of the aspen poplar, Populus tremuloides, as well as shrub species such as Redosier dogwood, Cornus stolonifera, highbush cranberry, Viburnum trilobum, and pussy willow Salix discolor would develop an aspen bluff appropriate to the site conditions. The native bluff would provide increased diversity and wildlife habitat on the site.

As the shadow patterns of the house show (see Figure 3.5, p.15) the house receives all incoming solar radiation on the south side. In order to reduce solar radiation and overheating on the south side of the house, a Manitoba maple Acer negundo, is planted to filter

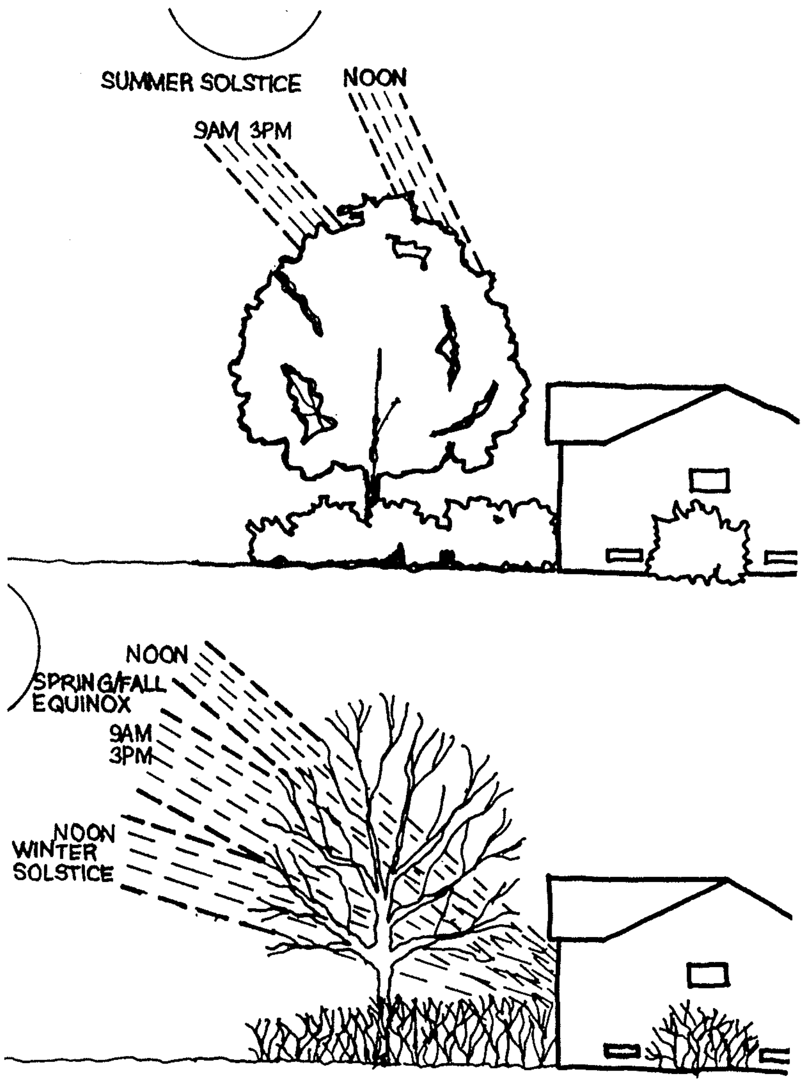


Figure 6.2 Sunlight Penetration through the Manitoba Maple.

incoming sun rays in the summer months (see Fig. 6.2). The Manitoba maple allows sunlight to penetrate into the house in winter and the form of the tree does not restrict activity under the canopy. An ornamental low hedge (4-6ft.) of various lilacs, Syringa spp., shrub roses, Rosa spp. and Spirea spp. planted around the trees in the front area provides a private enclosed space. Figure 6.3 illustrates the detail plan around the house. The enclosed area includes a low wood deck at ground level. Since this area has a high profile in terms of visibility and human use, species of high ornamental value are important whether these species are native or adapted to the region. The trees are underplanted with perennials and low shrubs appropriate to the location. While the maple is becoming established, the location would still be quite sunny and would be appropriate for

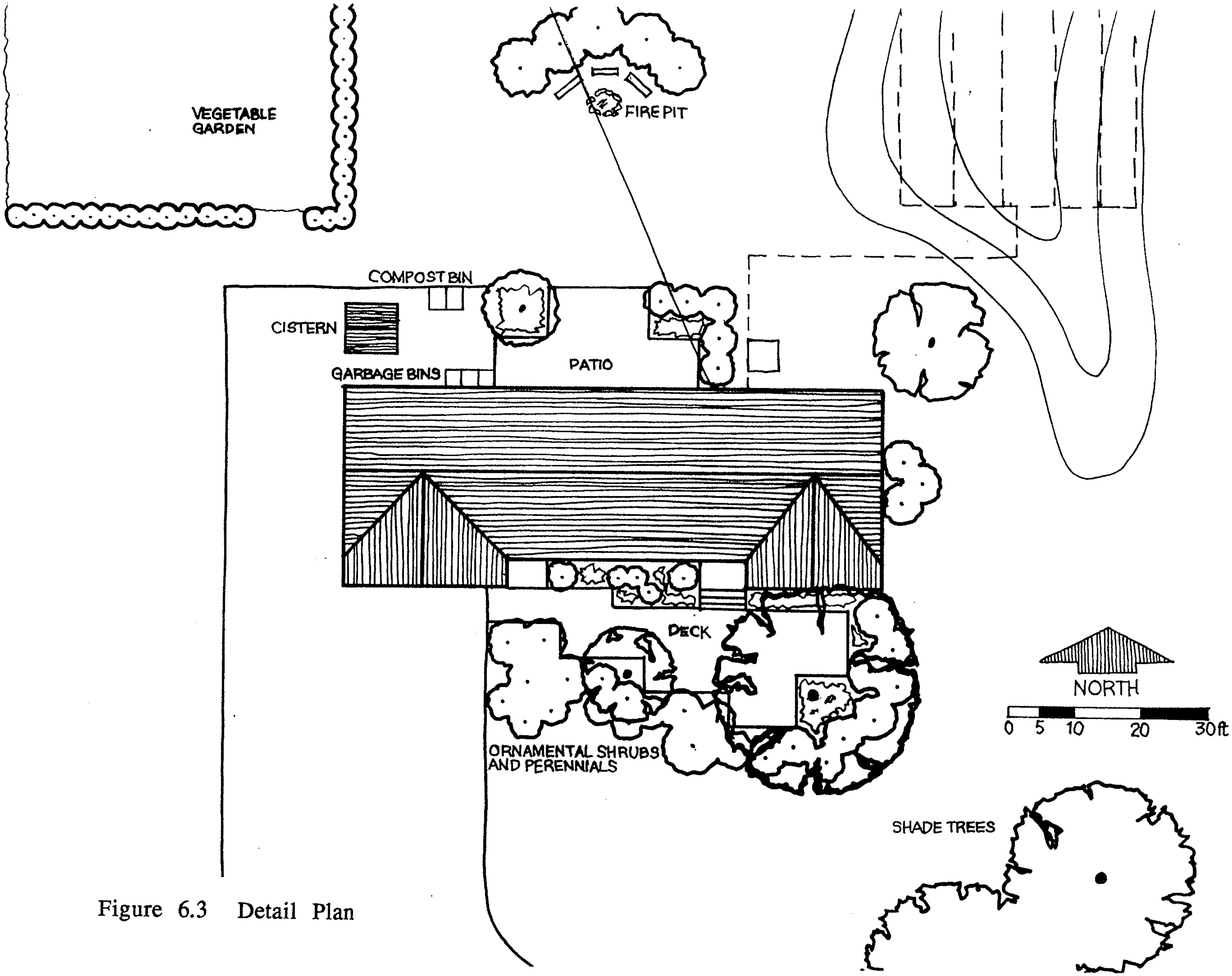


Figure 6.3 Detail Plan

such ornamental shrub species as various junipers, Juniperus spp. and potentilla cultivars, Potentilla fruticosa. Perennial species could include various sedums, Sedum spp., daylilies, Hemerocallis spp. and yarrows, Achillea spp., which are appropriate to exposed, sunny locations. As the tree matures and the area becomes more shaded, sun-loving plants may be replaced by ones more appropriate to shaded locations as well as using decorative mulch if root competition becomes a problem. Perennials appropriate to shaded locations such as hostas, Hosta spp., and lily-of-the-valley, Convallaria majalis, could be introduced.

The meadow areas are intended to be a mixture of both native and non-native species. A good deal of surface water is presently retained in these areas but allowing the areas to naturalize would increase percolation of surface water to help replenish groundwater sources and would reduce loss of soil moisture to evaporation. By matching species to site conditions more closely, the need for expensive regrading for drainage is eliminated. The location of the meadow areas ensures that site drainage is intercepted and filtered before it reaches the drainage system. The meadow areas would provide increased snow catch in winter since mowing or burning could be carried out once a year in the spring. A number of appropriate species, such as the clovers and medick, are already present in these areas but diversity could be increased with the inclusion of other species such as smooth camas, Zygadenus elegans, blue-eyed grass, Sisyrinchium mucronatum, and saltgrass, Distichlis stricta, which are moisture and salt tolerant. Canada anemone, Anemone

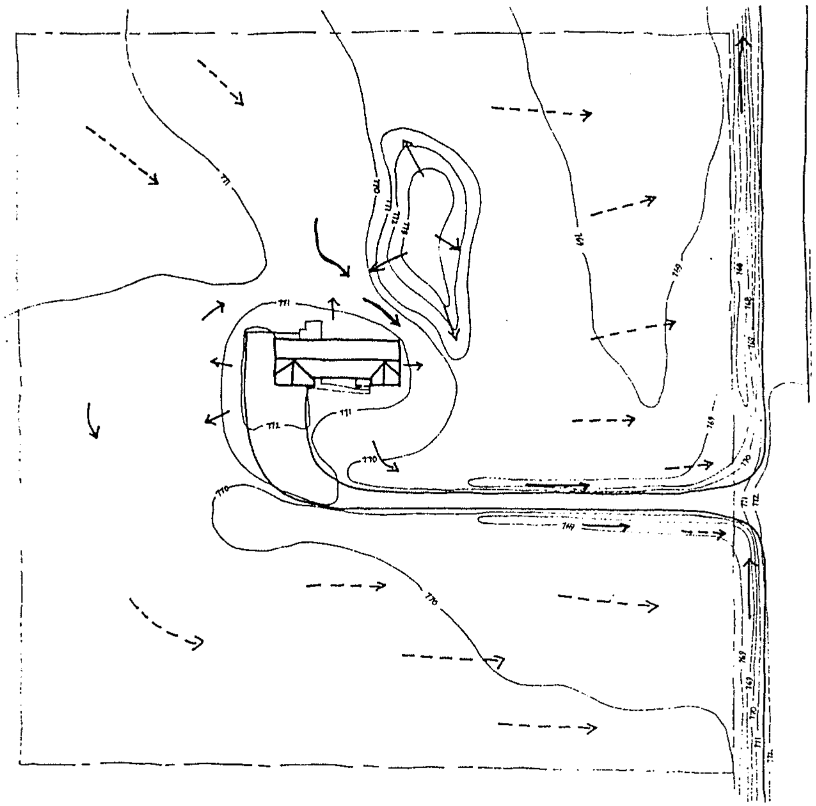


Figure 6.4 Revised Site Drainage

canadensis, wild vetch, Vicia americana, bog violet, Viola nephrophylla, and bergamot, Monarda fistulosa would be other species which could be introduced into the meadow areas.

The mown areas around the house provide recreational opportunities and ensure the presently successful drainage away from the house and along the driveway. The mown areas kept at a minimum of 2 inches in height make the lawn areas more resistant to drought stress in dry periods and are intended to be mixed grasses and groundcover as they are at present and would not receive additional watering or the use of herbicide. To reduce weed problems in the back lawn area, grass species such as creeping red fescue Festuca rubra which is more appropriate to a shaded location could be included to provide more vigorous growth to help reduce the number of weeds.

7. CONCLUSIONS

This report illustrates that there are many opportunities to remediate problems and conditions of existing rural residential sites. While a truly sustainable environment may not necessarily be achieved in these existing developments, increasing the sustainability of the sites is still a very valid goal, since sustainable development is an integration of ecological, economic, and social concerns. While the report deals with only the landscapes of existing rural residential sites, remediation must take place in the surrounding rural landscape and with respect to resource use and waste management within the homes in order to move towards sustainability. By recommending remediation measures that may be easily implemented by the residents themselves, a closer understanding of the landscape is achieved and the protection of that landscape is more likely to become a priority. It is important to apply the goals of sustainable development to rural residential development since ultimately they share a common goal. Sustainable developments are intended to preserve resources for future generations and a main attraction of residential development is the perception that it provides a better place to raise children. This perception begins to become a reality when the concept of sustainability is applied to rural residential development.

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9. APPENDIX

203, 545 University Cr.
Winnipeg,MB
R3T 5S6

NORWEST LABS
(204)982-8630
(204)275-6019fax

Robyn Magas
Box 82
Stoney Mountain, MB
R0C 3A0

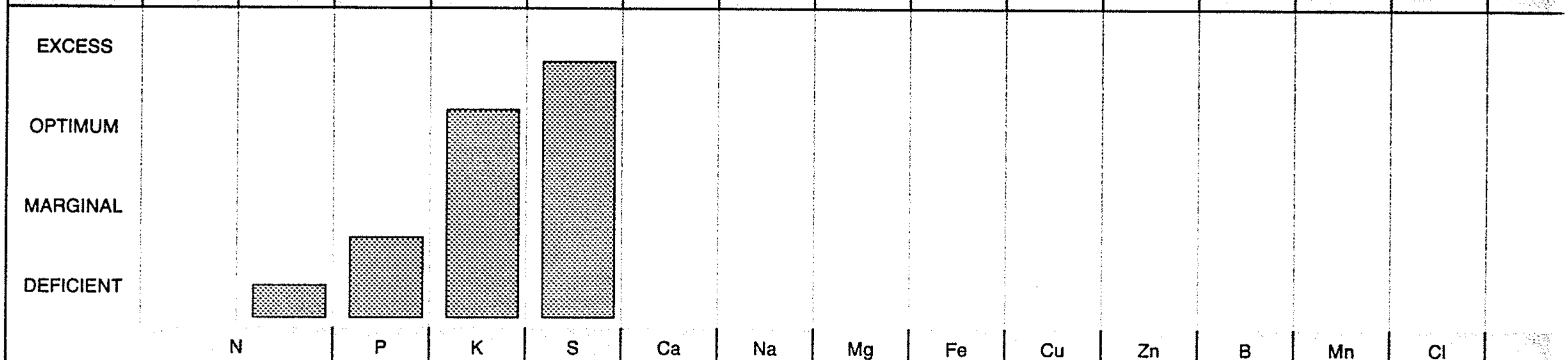
ROBYN MAGAS
SAMPLE: SITE 1A
NE25 T 13 R 2 W1

SAMPLE RECEIVED: 19 OCT 94
ANALYSIS COMPLETED: 21 OCT 94 08:54
SAMPLE RETAINED UNTIL: 21 NOV 94
FOR INFORMATION CALL: Jim Hicks
AT: (204)982-8630

client number: 71116 fax:Call To Pickup phone:344-5385

NUTRIENT ANALYSIS (P.P.M.)

SAMPLE DEPTH	AMMONIUM-N	NITRATE-N	PHOSPHATE	POTASSIUM	SULPHATE-S	CALCIUM	SODIUM	MAGNESIUM	IRON	COPPER	ZINC	BORON	MANGANESE	CHLORIDE
0- 6"		1	11	325	>20									
TOTAL LBS./ACRE		2	22	650	>40									
ESTIMATED AVAILABLE LBS./ACRE		**4**	**22**	**650**	**80**									



SOIL QUALITY

SAMPLE DEPTH	pH (ACIDITY)	E.C.(SALINITY)	ORGANIC MATTER %	Sand %	Silt %	Clay %	TEXTURE
0- 6"	8.1 (Alkaline)	1.9					

MICRONUTRIENTS

No micronutrient analysis requested.

RECOMMENDATIONS

Turf Est.

	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)	Sulphur (S)
Pounds/acre	170	41	0	0
Pounds/1000 sq.ft.	3.9	0.9	0	0

Nitrogen recommendation is for one year. This amount should put on with 2 to 3 applications; the first application should be in early spring.
The maximum amount of potassium applied at any one time should not exceed 1.5 lbs. per 1000 sq. ft.
Use a fertilizer blend that most closely matches the proportion of nutrients recommended.
Check with your garden centre or fertilizer supplier for available products.
Apply enough fertilizer to supply the required amount of the nutrient you need most.

NOTE: 1000 sq.ft. is equivalent to an area 20 feet wide by 50 feet long.

COMMENTS

These recommendations are given as a management tool based on general research consensus. They should not replace prudent and responsible judgment.

203, 545 University Cr.
Winnipeg,MB
R3T 5S6

NORWEST LABS
(204)982-8630
(204)275-6019fax

W.O. NUMBER: 9 83713

LAB NUMBER: 10843

Robyn Magas
Box 82
Stoney Mountain, MB
R0C 3A0

ROBYN MAGAS
SAMPLE: SITE 1B
NE25 T 13 R 2 W1

SAMPLE RECEIVED: 19 OCT 94
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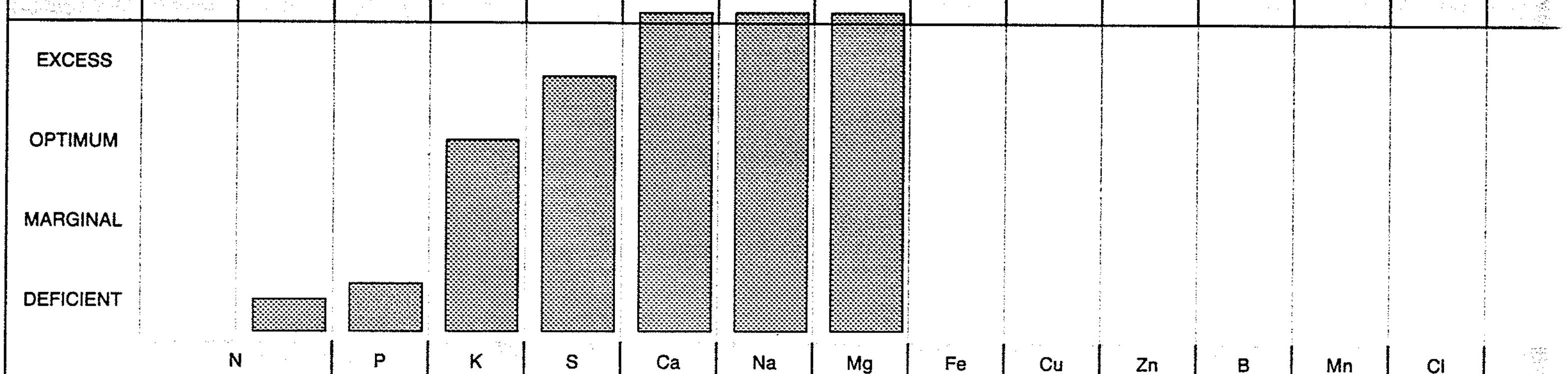
AT: (204)982-8630

client number: 71116 fax:Call To Pickup phone:344-5385

NUTRIENT ANALYSIS (P.P.M.)

SAMPLE DEPTH	AMMONIUM-N	NITRATE-N	PHOSPHATE	POTASSIUM	SULPHATE-S	CALCIUM	SODIUM	MAGNESIUM	IRON	COPPER	ZINC	BORON	MANGANESE	CHLORIDE
0- 6"		<1	2	248	>20	11800	340	3700						
TOTAL LBS./ACRE		<2	4	496	>40									
ESTIMATED AVAILABLE LBS./ACRE		4	4	496	80									



SOIL QUALITY

SAMPLE DEPTH	pH (ACIDITY)	E.C.(SALINITY)	ORGANIC MATTER %	Sand %	Silt %	Clay %	TEXTURE
0- 6"	8.4 (Alkaline)	1.9	3.7				

MICRONUTRIENTS

No micronutrient analysis requested.

RECOMMENDATIONS

Turf Est.

	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)	Sulphur (S)
Pounds/acre	170	57	0	0
Pounds/1000 sq.ft.	3.9	1.3	0	0

Nitrogen recommendation is for one year. This amount should put on with 2 to 3 applications; the first application should be in early spring.
The maximum amount of potassium applied at any one time should not exceed 1.5 lbs. per 1000 sq. ft.
Use a fertilizer blend that most closely matches the proportion of nutrients recommended.
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Apply enough fertilizer to supply the required amount of the nutrient you need most.

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W.O. NUMBER: 9 83713

LAB NUMBER: 10844

Robyn Magas
Box 82
Stoney Mountain, MB
R0C 3A0

ROBYN MAGAS
SAMPLE: SITE 2
NE25 T 13 R 2 W1

SAMPLE RECEIVED: 19 OCT 94
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SAMPLE RETAINED UNTIL:21 NOV 94
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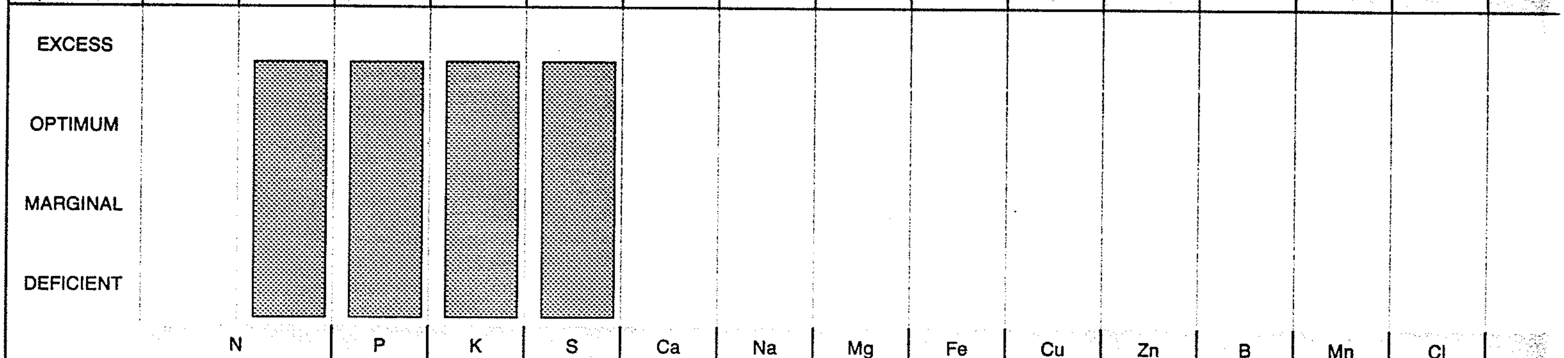
client number: 71116 fax:Call To Pickup phone:344-5385

NUTRIENT ANALYSIS (P.P.M.)

SAMPLE DEPTH	AMMONIUM-N	NITRATE-N	PHOSPHATE	POTASSIUM	SULPHATE-S	CALCIUM	SODIUM	MAGNESIUM	IRON	COPPER	ZINC	BORON	MANGANESE	CHLORIDE
0- 6"		58	>60	>600	>20									
TOTAL LBS./ACRE		116	>120	>999	>40									
ESTIMATED AVAILABLE LBS./ACRE		**232**	**120**	**1200**	**80**									



SOIL QUALITY

SAMPLE DEPTH	pH (ACIDITY)		E.C.(SALINITY)	ORGANIC MATTER %	Sand %	Silt %	Clay %	TEXTURE
0- 6"	8.0	(Alkaline)	1.2					

MICRONUTRIENTS

No micronutrient analysis requested.

RECOMMENDATIONS

Turf Est.

	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)	Sulphur (S)
Pounds/acre	0	0	0	0
Pounds/1000 sq.ft.	0	0	0	0

Nitrogen recommendation is for one year. This amount should put on with 2 to 3 applications; the first application should be in early spring.
The maximum amount of potassium applied at any one time should not exceed 1.5 lbs. per 1000 sq. ft.
Use a fertilizer blend that most closely matches the proportion of nutrients recommended.
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ROBYN MAGAS
SAMPLE: SITE 3
NE25 T 13 R 2 W1

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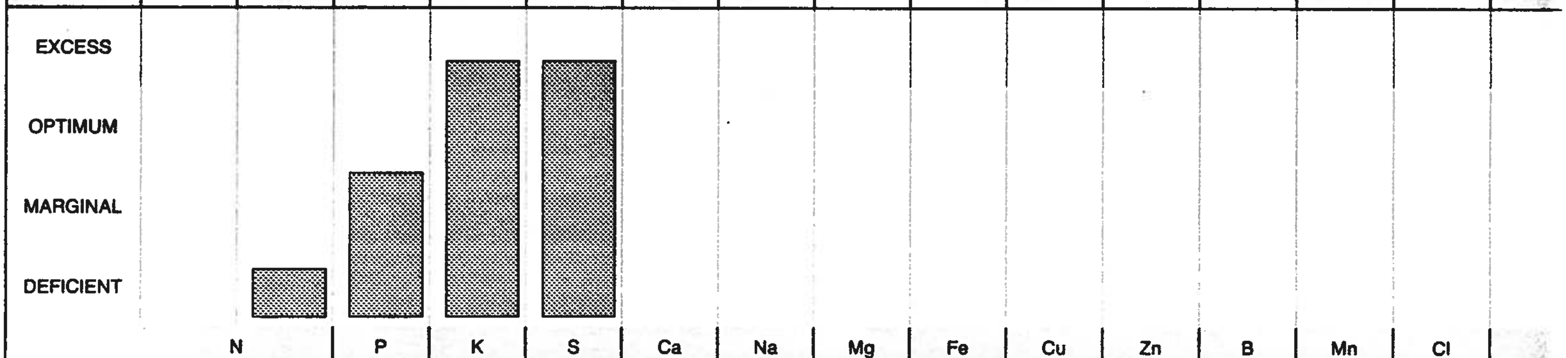
NUTRIENT ANALYSIS (P.P.M.)

SAMPLE DEPTH	AMMONIUM-N	NITRATE-N	PHOSPHATE	POTASSIUM	SULPHATE-S	CALCIUM	SODIUM	MAGNESIUM	IRON	COPPER	ZINC	BORON	MANGANESE	CHLORIDE
0- 6"		7	19	>600	>20									
TOTAL LBS./ACRE		14	38	>999	>40									
ESTIMATED AVAILABLE LBS./ACRE		**28**	**38**	**1200**	**80**									



SOIL QUALITY

SAMPLE DEPTH	pH (ACIDITY)	E.C.(SALINITY)	ORGANIC MATTER %	Sand %	Silt %	Clay %	TEXTURE
0- 6"	8.2 (Alkaline)	1.0					

MICRONUTRIENTS

No micronutrient analysis requested.

RECOMMENDATIONS

Turf Est.

	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)	Sulphur (S)
Pounds/acre	146	27	0	0
Pounds/1000 sq.ft.	3.4	0.6	0	0

Nitrogen recommendation is for one year. This amount should put on with 2 to 3 applications;
the first application should be in early spring.
The maximum amount of potassium applied at any one time should not exceed 1.5 lbs. per 1000 sq. ft.
Use a fertilizer blend that most closely matches the proportion of nutrients recommended.
Check with your garden centre or fertilizer supplier for available products.
Apply enough fertilizer to supply the required amount of the nutrient you need most.

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