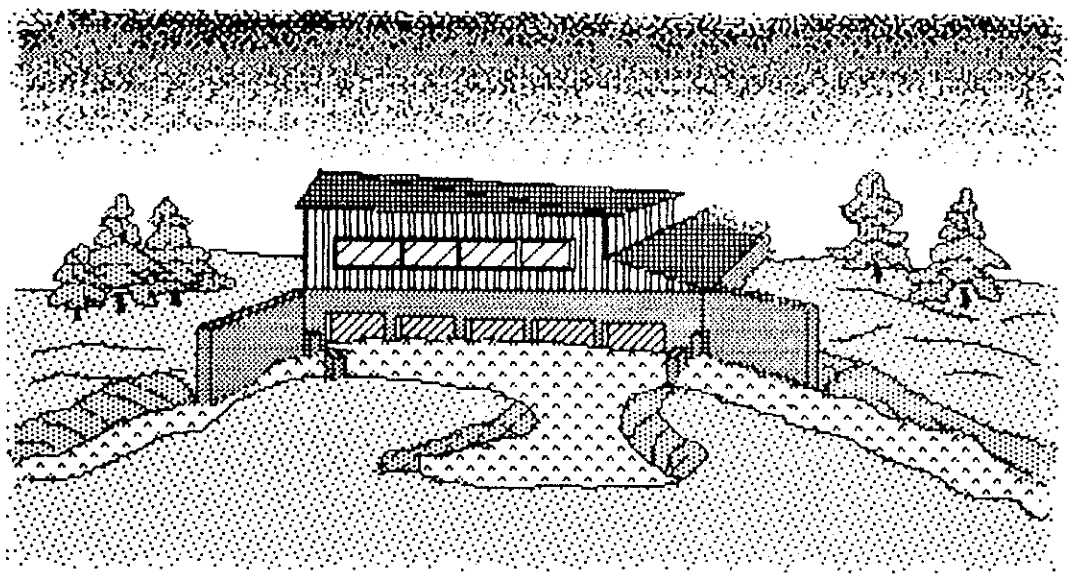
S.Bruneau Copy.

A
Fluvarium
for St. John's



Report By: Stephen Bruneau

April 11th/1986

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont;)

INTRODUCTION

A conceptual plan for an aquatic heritage project for St. John's has been developed. The project has been divided into two major components or areas of interest which will be administered by the Quidi Vidi Rennies River Development Foundation. These are: King George V Memorial Park development which deals with attractions and activities in the Quidi Vidi Lake Area, and the Rennies Mill River development which centres on the River and on Long Pond.

The project was initiated by those interested in the enhancement and interpretation of the aquatic heritage of St. John's for the benefit of the resident market and visitors. Furthermore, the project was intended to offer a unique link for existing recreation activities, tourist attractions and activities as well as an overall theme upon which to develop additional attractions and activities. This would provide city tourism planners and marketers with a heritage theme to support and guide future promotional and developmental efforts.[1]

The development Concept is now in it's final stages and preliminary facility designs have been prepared. Amongst these are designs for: a series of walkways, a boating lagoon, a museum, an amphitheatre, concession areas, and a fluvarium.

The fluvarium was conceived as an project independent from the development scheme until the masterplan prepared for the Foundation Committee drew in most of the recreational and educational projects planned for the district. A number of years ago, Dr. John Gibson of Federal

Fisheries and Oceans recognized the problem involving the destruction of valuable fish habitat inside the city limits. Today, through channelizing, improper culvert implementation, pollution and infill, much of the outstandingly fertile trout habitat has been lost and the remaining is endangered.

Presently he feels that what needs to be done is to reduce the inertia of destructive practices amongst developers and city planners thus decreasing the magnitude of the problem. Adapting stricter legislation and stiffer fines for offenders to the existing "Guidlines for Protection of Fish Habitat in Insular Newfoundland" may help to meet this need. But the overriding problem recognized by Dr. Gibson was that there is no facility available where city residents, tourists, planners, developers or researchers may go to view, learn about and appreciate the natural fish resource found in the city water bodies. The solution proposed was to build a fluvarium.

The fluvarium, hereinafter identified by its two main parts; the interpretation centre, and the streamtank, would be the only public facility of its kind in North America. Streamtanks have been built elsewhere but in most cases strictly for research. This streamtank has been given the mandate to simulate natural environment unlike an aquarium, and in doing so will demonstrate complete stream ecology to the public.[2]

The location of the fluvarium has been chosen. The site is to be on the North Bank of Long Pond alongside Nagle's Hill Brook. Preliminary work has also been done on the layout and size of both the streamtank and the interpretation cenre. Briefly, that which has been forwarded is as follows: The interpretation centre is a low aesthetically attractive building with its 425 sq. meter ground floor built flush with the higher portions of the bank while its lower 235 sq.meter basement exposes itself on the lower side of the slope. From the basement, a ramp, through a corridor, connects the interpretation centre to the streamtank located further down the bank, nearer to the stream. The streamtank's 600 sq. foot single story structure is located along a 120 meter stretch of diverted streambed of which appoximately 10 meters can be viewed from within (See appendix I).

This report has been written to recommend specific action in implementing the streamtank, to bring to light some of the problems associated with its construction and to prescribe solutions to some of those problems.

SECTION I

"The Site"

REVIEW OF SITE SELECTION

SITE CONDITIONS

SITE PREPARATIONS

REVIEW OF SITE SELECTION

In the early stages of conceptualization, the location of the fluvarium was chosen by a small group led by Dr. Gibson. This location was chosen with the following constraints in mind:

- The facility must be within the city limits, preferably within the jurisdictional area of Pippy Park.
- The streamtank must be on or near a body or channel of water attractive for aquatic life and large enough to support a streamtank.
- The area chosen must be accessible by a contractor and the public and must be an area suitable for recreational and educational development.

Four sites were discussed under these criteria. A site on Learys Brook near the Red Cross Centre raised questions about the extent of Pippy Park's land ownership. Expansion would be a problem and its urban surroundings would limit interest and accessiblity. Furthermore, the vulnerability of the stream to high levels of life-threatening pollutants was thought to be high in this area.

The drainage from Larrys Bog west of Higgins Line and from the slope in front of the Marine Institute meet and flow underground through culverts as far down as 100 meters from the head of Rennies River, where it then comes above ground. The remaining open stream is one of the richest spawning grounds for Brown Trout in the city. The second site considered would have called for the reopening of this brook further upstream and the placement of the streamtank there. Unfortunately, expansion to Higgins Line and subsequent development have made this proposition too expensive despite its excellent fish potential and accessibility.

Nagles Hill Brook which drains the Three Pond Barrens and flows west into Long Pond was considered in two locations, the first of which was near the bridge on Mt. Scio Road.. Here, the brook gurgles through relatively open heath in a location both accessible by all, and centrally located within Pippy Park owned land. At this point Nagles Hill Brook is a healthy trout stream with very low pollution levels but of questionable size. It was thought that there may not be enough water during the low flow months to provide for continuous operation of the streamtank. Furthermore, during high flow conditions, Nagles Hill Brook becomes a raging torrent capable of topping its banks and depositing tonnes of substrate along it's course. For these reasons this area was not chosen.

The last 150 meters of Nagles Hill Brook was channelized and does not have a record of topping its banks since this was done. This is in the area of Pippy Park which is actively used for recreation through its picnic, camping, meeting and playground facilities. Nagles Hill Place runs approximately parallel to the brook in this area and is open for easy access and parking year round. It was thought that the stream was just large enough for the purpose of supporting a streamtank in this area. Though the immediate groundwater conditions are not advantageous for construction in this area, it was thought that because of the central, accessible location, park land ownership, and the health of the stream, with the additional benefit of Long Pond's excellent wildlife characteristics that this would be the most desirable location for the streamtank.

SITE CONDITIONS

- Property

The slope of that area north of Long Pond, east of Nagles Hill Brook and South of Nagles Hill Place is approximately 10 degrees in the southern direction and 4 degrees in the east, south-east direction, along the brook (see figure 1). The ground is rounded and resembles a rolling moor. The plateau adjacent to the road and used for parking, overlooks the slope and trees and sees beyond the natural setting of Long Pond to take in part of the university campus. Tall grass is the predominant vegetation. Where water springs to the ground's surface, marshy weeds grow amongst the sparse balsam fir stands. A few alders grow along the stream's banks but where channelizing took place, a high course gravel levee provides bedding for only a few weeds and some grass. The soil in the area appears to be a fairly well graded till, typical of that which is built upon around the city, but this observation was made only where the soil was exposed. There may be some peat in the marshy areas but it is unlikely that it is very deep.

- Stream

Nagles Hill Brook drains the Three Pond Barrens and flows free of developed areas. It passes under one Bridge and through two culverts on its ascent into Long Pond. The preservation of this brook has resulted in its continued cleanliness and natural fertility. Unfortunately, the proposed Outer Ring Road is scheduled for construction within the next 10 years and will pass directy through this brook's watershed. The effects will be minimized, according to city officials, and will not be detrimental to the condition of the stream.

In a preliminary Environmental Impact Study by the city, water quality studies were carried out on several streams throughout the impacted area. Some of the findings were as follows: In the first week of November, 1985, Nagles Hill Brook recorded a temperature of 1 degree celcius, second highest amongst the eight streams tested. This may be attributed to its continous rapid state. The brook falls on a slope of approximately 5 degrees over its entire course, more than that of any other stream in the test. The flow volume was recorded at approximately 0.22 m^3/sec. November is the highest precipitation month of the year is St John's on average but according to Martin Lewis of the St. John's weather office, November of 1985 had a total precipitation of about half of what was normal. As a result this reading is probably best used as only a rough approximation of the flow for any year. Chloride concentrations were low at 14 mg/l and a pH value of 6 units (average for all streams) was found. Traces of oil and grease were found in one sample but not at problem levels. The total suspended sediment count was higher for Nagles Hill Brook than for any other. Again owing to the high flow velocity of this brook, erosion and carrying capacity is high. Lastly, the dissolved oxygen level, which is vitally important to the life of the stream was slightly above average at a healthy level of 13 mg/l.[3]

SITE PREPARATIONS

- A Survey

To help prepare the way for the final design and eventual construction of the facility, an accurate ground survey will be needed. The exact grades of the proposed streambed and elevations of the facility components may be derived from such a survey. The following may be used as a guide for this survey:

From observation, the area shown in figure 2 was outlined. The first step in a survey of this type is to run a traverse around the area and establish the corners. Then the bound area is broken into squares, rectangles or rhombuses of uniform size, as was done. The dimensions of these subparts should be such that the accuracy required for local contour drawing is achieved. Some of these parts may be broken down smaller to obtain local precision. The subdivisions chosen for the site in figure 4 are 20 meters long with further subdivisions of 10 and 5 meters possible.

Each of the grid points should be defined by a stake. This may be done by laying a line using a level or theodolite and measuring the distances of 20 m in progression away from the instrument. This is to be carried out at each point along parallel boundaries. One may check the accuracy of stake placement by cross sighting in the direction perpendicular to that just measured.

Elevations of each stake can be taken by sighting a point of known elevation and tying-in, ideally to an instrument site that can oversee the entire grid of stakes. Intermediate points may be measured out and level shots taken to point out local anomolies. The object is to move the level as few times as possible and to check off each point after its shot has been recorded.[4]

- Soils Tests and Coping with Drainage

Soils tests to determine soil strengths, ultimate bearing capacity and permeability will need to be carried out. A shallow test hole or pit would suffice here but a proper bore hole to determine the elevation of the water table and the depth at which bedrock lies may be necessary.

According to Prof. Waterhouse of Memorial University of Newfoundland's Faculty of Engineering and Applied Sciences, the water that feeds the marshy area of the slope in all likelihood originates above Nagles Hill Place in the trailer park area. If a porous overburden material overlies a relatively impermeable till or bedrock aquiclude then water will percolate along the interface until it reaches the surface at a lower elevation. At that point the water emerges and runs on the surface as seepage. This is called a contact spring [5](see figure 3). The condition existing along portions of the north bank of Long Pond may be similar to this. With the introduction of an underdrain along Nagles Hill Place, it is felt that the water may be intercepted and redirected down a ditch and disposed of in a controlled way. The successive changes to the water table would be as is indicated in figure 4(a). To be certain that this is the problem and to determine the nature and depth of the ditches necessary, some field work will be necessary. The watershed remaining below Nagles Hill Place and any residual underground flows may be taken care of in a similar way by using "Sinks" or underdrains . In the case of the streamtank a sink drain may constitute a deep sump dug near the building, filled with gravel or other coarse material and pumped to keep the local watertable low.[6] See figure 4(b) and 4(c) for ditch details.

Figure 1

Contour Map of Streamtank Site

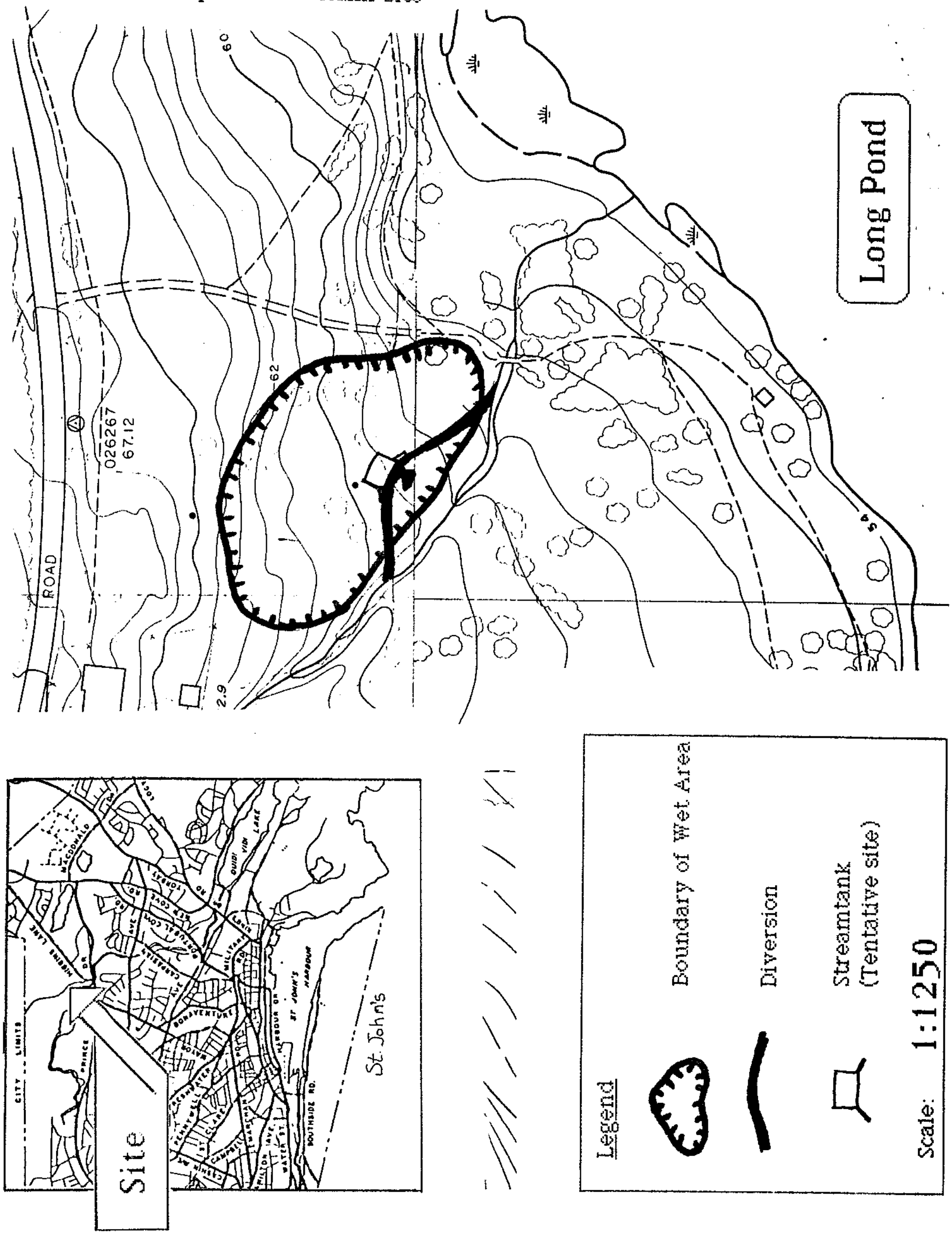


Figure 2

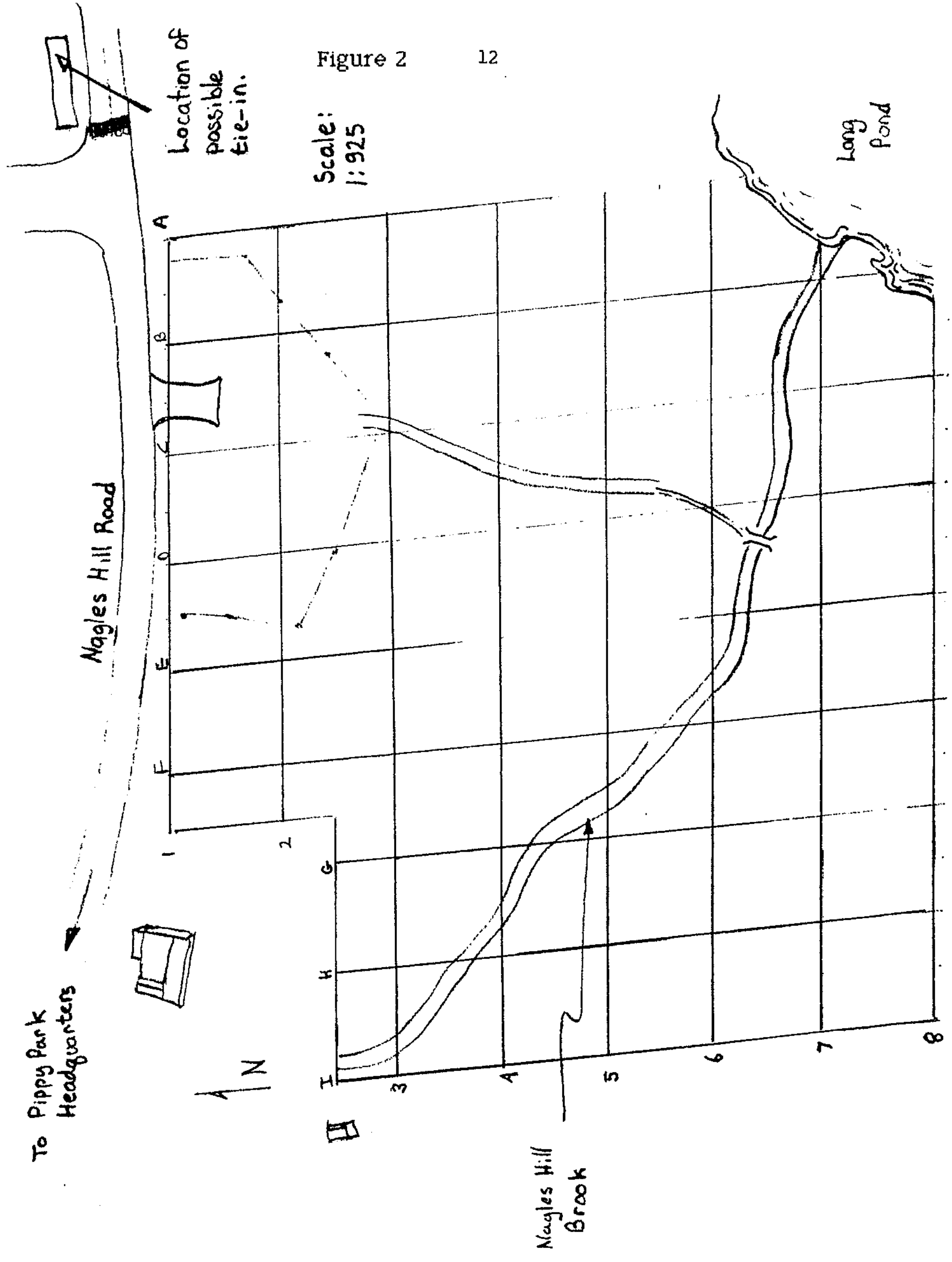

Location of possible tie-in.
Scale: 1:925
Long Pond
Nagles Hill Road
To Pippy Park Headquarters
N
Nagles Hill Brook
A
B
C
D
E
F
G
H
I
1
2
3
4
5
6
7
8

Figure 3

Contact (stratum) spring

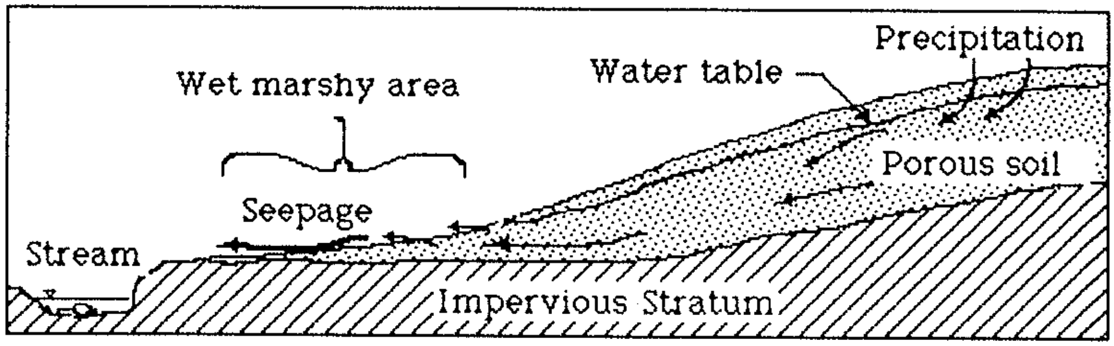
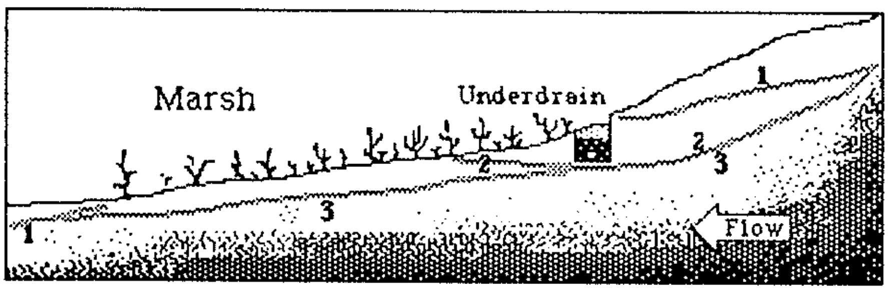


Figure 4 (a) Successive Water Table Changes



An Underdrain dug near the spring line would produce the successive changes 1, 2 and 3 in the water table.

Figure 4(b)

Underdrain

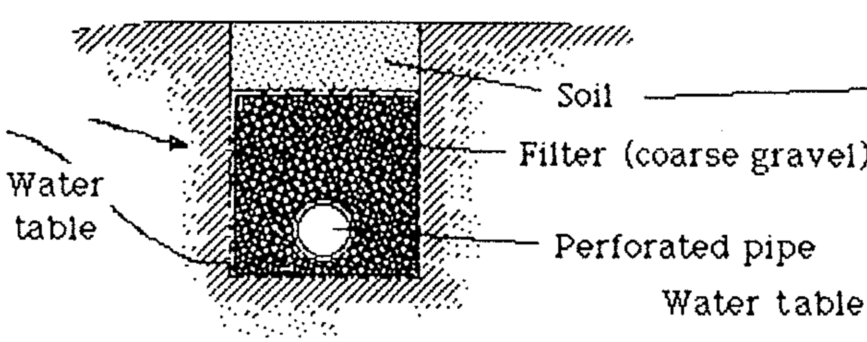
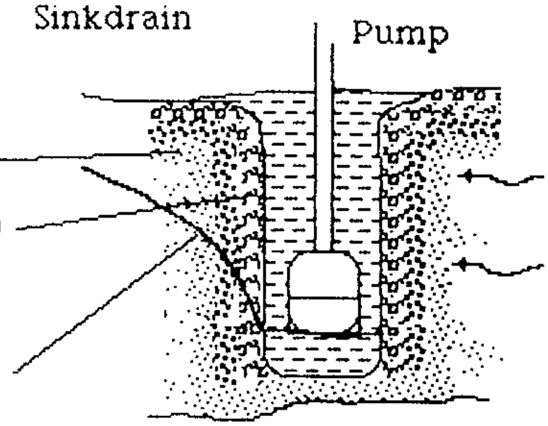


Figure 4(c)

Sinkdrain



SECTION II

"The Streamtank"

GENERAL

STRUCTURAL DETAILS

SERVICES

FIRE REGULATIONS

INTERIOR DESIGN

DISPLAY/INTERPRETATION

GENERAL

It is in the best interest of Pippy Park and the QVRRDF that the interpretaion centre and streamtank be attractive to look at and effective in capturing the interest of the people visiting it. The facility should be constructed in a uniform style and finish and be made to look complementary to the north bank of Long Pond. A compromise between structural integrity, cost and appearance will eventually dictate the final design of this building. With these constraints in mind and in the pupose of serving its primary function (to demonstrate stream ecology to the public) a preliminary structural design has been drafted (see figures 5(a)-(f)).

STRUCTURAL DESIGN

In keeping with the Dr. Gibson's suggestion that there be approximately 9.2 meters of viewing space inside the streamtank, and that it will need room for people to stand and walk about, the exterior dimensions of 6.2 by 9.5 meters have been chosen. The structure should be made with a poured reinforced concrete foundation and typical wooden truss, joists, cladding, etc. similar to todays house construction. In a previous design by Douglas Hawes and Richard Seypka the roof sloped in accordance to the natural slope of the land and the exterior was a finished wood strip design where the streamtank extended above ground level. This provided an esthetically pleasing design which should be adhered to.

The viewing chamber may have to provide any additional length of ramp that cannot be accommodated by the corridor connecting it with the interpretation centre. Inside there should be as few obstructions as possible allowing people to move about freely to observe any portion of the stream at any time. A protective railing must follow the ramp and the stairwell, and may also be used to display information while keeping people from directly contacting the glass. The chamber need not have any other windows besides those through which the stream will be observed. This is primarily due to the desired light control which will be discussed in the section under the heading 'SERVICES -Interior Lighting'. The walls of the viewing chamber will be slightly thicker than the foundation of a house, reinforced and carefully treated with waterproofing. Reinforcement will be needed on the front wall and to prevent heaving between the chamber walls and the proposed 'wing deflectors' on the streamside corners of the streamtank.[7] These deflectors will provide a guide for the brook past the front of the building and prevent erosion around its edges. To provide for the viewing glass, the front wall will have to be poured carefully around the forms and vibrated between the steel reinforcing (see figures 5(g)&(h) for details).

Some of the problems associated with designing a proper viewing window into a stream are as follows:

- Possible damage to glass or frame from the freezing and subsequent expansion of the ice
- Condensation on the glass inside the streamtank due to a differece in temperatures on either side of the glass
- Leakage around the glass or frame
- Possibility of damage to glass from vandalism, suspended objects in the stream, or simply lack of strength for the retention of pressure

- The difficulty of good quality control; this concerns the fitting of the frame, the fitting of the glass, and the ease of glass replacement
- and lastly, accommodating the change in elevation over the stretch of brook in which the substrate and stream would like to be seen at all times.

Some of solutions to these problems will now be reviewed.

To accomodate the expansion of ice in the brook, one may choose to do any number of the following:

- Place logs in the stream to absorb the crush of expanding ice.
- The placement of plastic foam strips or blocks at a distance from the glass or adjacent to it to absorb the expansion of the ice.
- The far bank may be gently sloped and bedded with sand and gravel to allow the ice to "ride up".
- Install glass and a frame that are simply strong enough to withstand the forces involved or flexible enough to accommodate them.
- As a last resort the ice may be manually broken or removed when it becomes a threat to the safety of the streamtank.

Note: The phenomena of ice building-up on the bottom of streams is called anchor ice. It has been observed in Nagles Hill Brook but does not pose a threat to the safety of the glass. This ice undergoes little change in temperature and subsequently very little change in size. The problems associated with it are that it kills young fish, incubating eggs and other benthic or bottom dwelling organisms in the winter time. It is believed that anchor ice is responsible for limiting the spawning of salmon in northern waters.

The problem with condensation may be combatted by placing a two pane system in the window frame so that it acts as a standard window box with an air, temperature barrier, or, by installing glass that is thick enough to accommodate different temperatures on both sides of the pane. Fans installed above or below the glass and blowing over it, similar to defoggers in an automobile, may also provide a solution. Less desirable solutions may involve changing the temperature inside the streamtank to better match the temperature outside, or simply to squeegee the condensation off the glass when it obstructs viewing.

To provide a waterproof seal silicon or vulkam, 116 sealant may be used at interior and exterior joints. Ample amounts of sealant should be used but care should be taken to hide it from view because of its messy appearance. Accommodation for exterior joints to be out of view from inside the tank may be made for this reason.

To avoid breakage, the frame could be made from heavy wood sections, structural steel sections, prefabricated for better quality control and strength, or simply formed in the concrete. The glass should be shock resistant and laminated. The lamination would avoid a catastrophic failure by shattering without collapsing and thus retaining the stream even after breakage. A 2.5 cm(1 inch) laminated tempered glass with approximately 8 to 10 cm of its edges imbedded in the frame would be adequate. (Note: According to a number of glass salesmen in the city, the edges of tempered glass are brittle, possessing no more strength than ordinary glass.) In a run-of-the-river aquarium in St. Andrews, N.B., designed by Neill and Gunter Limited, the glass used was a 1 1/16" triple plate glass from PPG Canada.[8] The glass was laid into a notch formed in the concrete and glued and sealed in place with vulkam 116 sealant (see figure 5(i)). This system has proven successful in other applications and is the one recommended for this facility. The replacement of glass is not easy with this arrangement but is not anticipated to be a frequent task.

To get the greatest appreciation of the stream ecology, the glass sections should show substrate and stream at all sections. To accommodate this, five, 1 meter high by 1.5 meter long (3' x 5') panes should be used. They may be stepped by regular height intervals so that they can accommodate the change in elevation of the stream across the viewing wall.

According to Greg Gof, a behavior specialist at the Federal Department of Fisheries and Oceans, a maintenance room present in the streamtank would be in the best interest of the operating party. A facility of this nature whose well being is dependent upon fish and other aquatic organisms, should be prepared to provide adequate care for them. A place to store fish food, screen and glass scrubbers, fertilizer, etc. is needed. A room for this would also allow any maintenance or research personnel to carry out basic work in a private room. Accommodation for a freshwater supply to a wetbench (a stainless steel sink and countertop) and outlets for a microscope or a balance should also be made. A room for this purpose should have easy access to an exit leading to the ground level immediately outside the streamtank. To accomodate this room and the exit, a second level would be most convenient.

The second level would not cast a shadow over the stream since it is on its north bank, therefore, its affect on the fish is minimal. Its presence may make the building stand out more, esthetically taking away from the facility, but only minimally since the first level would be sunk deep into the ground anyway. The second exit that would be placed on this level is a necessity by fire regulation and must be made to open outward. The potential for this room to be used in part as a viewing room for wildlife or to display information and exhibits in the future, are high.

The final irregular design problem associated with the streamtank to be dealt with is its drainage.

The streamtank's foundation lies below the level of the brook. This coupled with the presence of wet ground in the immediate area, dictates that a scheme to control drainage will be necessary.

The installation of weeping tile and crushed stone would make the water accessible beneath the foundation of the building. In the absence of nearby storm drainage and the presence of the water table above the ground floor level, either a pump or a gravity based drainage system must be installed. The pump would be set in a compartment located at the lowest point on the floor of the streamtank. It would extend down past the level of the floor concrete and into the crushed stone. A float mechanism by which the pump may be activated automatically when water levels in the compartment rise, may be used. A clay tile would provide the strength and porosity needed to retain the crushed stone and allow the water to pass into the sump chamber. Note that the pump needn't drain the foundation any lower than a couple of cm below the floor level. A possible design for one would be as is shown in fig. 5(i)9 and an estimate of seepage rate is outlined in figure 5(k). If seepage were to be close to 1800 imperial gallons per hour then a standard 1/3 hp Canadian Tire sump pump would be sufficient. The discharge from the pump may be hooked up to the sink drain and carried off to a disposal field located a few meters down the bank. A gravity based system would include a pipe leading from the bottom of the foundation down the streambed to a lower elevation where it may be discharged.

SERVICES*

Wastewater Disposal and Water Services

There is no sewage disposal system planned for the streamtank since facilities requiring such are not planned for this portion of the facility. If a wet bench (stainless steel tabletop and sink) is installed and water services are necessary then a conduit may be placed in the corridor connecting the streamtank with the interpretation centre in which the water may be carried. The first level will require plumbing to carry the sump discharge up to and to connect with the sink drain. See figure 6 (a)&(b) for plumbing details.

As previously mentioned to dispose of this brown water and the brownwater from beneath the floor of the streamtank, a disposal field may be used. The size of the disposal field needed is a function of the percolation rate of the soil, the required drainage and the type of field utilized. Since the percolation rate of the soil is presently unknown and the rate of drainage required is now uncertain, only the type of field to be used may be recommended. The continuous bed drainage field with a grade of less than 3% would provide the means with which to dispose of the water in an area smaller than all of the other disposal field options. See figure 6 (c) for details.

*Note: See review of Brad Sheppard's term 3 work report entitled "C. A. Pippy Park Commission, FLUVARIUM: SITE OPTIMISATION" (Fall 1985), for the study of services to the Interpretation Centre site.

- Electrical

The electricity lines may be carried to the tank in a conduit through the connecting corridor similar in fashion to the one for the water line. Accommodation for at least three wall sockets should be made so that any audio-visual equipment, alternate or emergency light appliances or research equipment may be used in the viewing chamber. Similarly, at least two should be present on the second level. For complete electrical plans see figure 6 (d)&(e).

- Lighting

During observation periods little or no artificial light will be needed in the viewing chamber. To accomodate the varying degrees of light entering the tank on different days and at different times of the day, a dimming switch would be recommended. For two reasons it should be darker in the tank than outside. They are; one, to highlight the viewing of the stream and substrate which would appear to be the brightest things in the room, and two, the dark interior would tend to attract fish to the glass. Note that light shining in the tank from the sky should be blocked out with either removable sheets of opaque material or by building valence boxes on the inside of the windows. The light from the sky lights up faces and the streamtank interior scaring the fish away from the glass. The lights should be the overhead incandescent porch type that are sunken so that they are flush with the ceiling. These may be used to highlight displays and walkways or illuminate the entire tank so that maintenance can be performed at any time of the day or night.

The second level maintenance room may be lit by standard fluorescent fixtures. Four, double bulb fixtures located symmetrically overhead will do.

- Exterior lighting

Two ideas discussed for illuminating the stream in front of the streamtank are:

1 Overhead flood lamps on poles on the opposite side of the brook from the streamtank, directed down toward the stream.

2 Adjustable (tilting) fluorescent lights on exterior of streamtank shining down into the stream.

Either of the two methods of artificially illuminating the brook would be beneficial by extending the viewing hours of the stream and by protecting it from vandals. Interestingly, a prolonged day does not seem to affect the fish. Fish "sleep" or substantially slow down their metabolism in the night and often stop feeding after dusk. But according to Dr. Gibson they don't really need to. Fish have been known to feed 24 hours a day in northern regions during summer months. Extending viewing hours would be good idea. Note also that the lights in the evening would attract insects providing a greater food input to the stream.

Corner spot lights on the Building would be advised to eliminate dark spots and to keep the stream in view of security personnel.

- Heat

Electrical heat would be the best means to regulate temperature in the streamtank. It is easy to adjust and to control accurately. It may be installed without special accommodation to the building and is inconspicuous once put in place. Estimates by Keans Pro Hardware and by Squires Mechanical Ltd. averaged 106 watts per square meter (10 watts per square foot) for electric heat requirements in a room like the viewing chamber So at 57 sq. meters and a subsequent 6000 watt requirement, four, 2 meter (6 foot) 1500 watt radiators placed along the back and side walls would do. In a similar estimate for the second level three of these radiators would be a conservative heat supply. Commonly, electric heating dries out the air and provides an uncomfortable atmosphere in poorly ventilated buildings. It is unlikely that in the streamtank, lack of moisture and low humidity will be a problem.

- Ventilation

Proper ventilation ducts and the installation of a fresh air fan would dehumidify the streamtank and rectify some problems with the decay and corrosion of building materials or with the desired atmosphere in the viewing chamber. Initially though the implementation of air ducts to the outdoors and space where a fan may be installed would be all that is necessary until the humidity levels in the building can be monitored.

FIRE REGULATIONS

If the streamtank is used primarily as a standing chamber, without chairs or tables then regulation allows approximately .66 sq. meters (7 ft^2) per person. This would translate to 85 people in the proposed 57 sq. meter (600 ft^2) area. According to the Provincial Fire Commissioner's Office, the streamtank will have to provide two exits since it can house over fifty people. The proposed connecting corridor and the upstrairs utility exit will be adequate. Note that any outside door must be made to swing outwards.

Emergency lighting should be of the form of a double spotlight fixture with a continually recharging power pack (always plugged in). Each spots should be turned to illuminate an exit. This can be accommodated on the back wall of the first and second levels (see figure 6(e)). Fire extinguishers will have to be provided for both levels. One, ten pound, ABC dry chemical extinguisher located near the chamber entrance on the back wall in the viewing chamber and a similar five pound extinguisher on the rear wall on the second level, will be sufficient.

INTERIOR DESIGN

- Viewing Chamber

The interior of the streamtank should procure safety and add to the viewing of the brook. If colorful, bright finishes are used and if lots of wall displays are present, too much will be taken away from the stream. A smooth finished concrete, painted to a dark glossy finish and a modest amount of display area would be suitable for the walls. A slightly raised wooden floor allowing a sloped concrete floor underneath would be attractive but practically, a rubber tile floor with slip resistant raised rubber discs would be best. This too may be placed on a raised, level floor. The ceiling can be constructed similar to that of a house, ie no ductwork, sprinklers, etc., but should also be kept dark. Keeping in mind the high humidity that may be present, a water resistant building material, tile or finish should be used inside the streamtank on any surface at all times if it practical to do so.

The hand rail to be placed around the viewing glass and the ramp should be a galvanized steel tubing finished with a low gloss corrosion resistant paint. The same railing may be used around any display that may warrant protection.

- Second Level Room

The interior of this room may be painted an institutional light color. Shelving on open walls would provide the storage space needed for supplies. A tough linoleum floor that would be waterproof and scuff resistant is recommended. The room will be for private use primarily, and as a result public appeal is a low priority.

DISPLAY/INTERPRETATION

Inside the streamtank there will be space available for displaying information. A number of techniques have been proposed. Some of these are:

A central display area with glass cases holding interpretive data would be kept out of touch by railings. It would have to be made small enough and in a certain shape so that mobility to a crowd of visitors is maintained.

Interpretation panels located on a sloped display case beneath the windows and kept out of reach by railings would provide an excellent means of displaying information. Typically, it may show illustrative pictures of many organisms that may be seen in the stream or bed and provide a key whereby each may be identified and explained in any amount of detail.

On the walls of the streamtank, panels, posters or leaflet dispensers may provide interesting information.

In any case, the information supplied must be easy to read and accurate. Varying degrees of detailed information should be available since school children and scientists will be visiting and should find it an informative experience.

No display space has been planned for the second level since it is primarily a private room.

Figure 5 (a)
Roof Plan

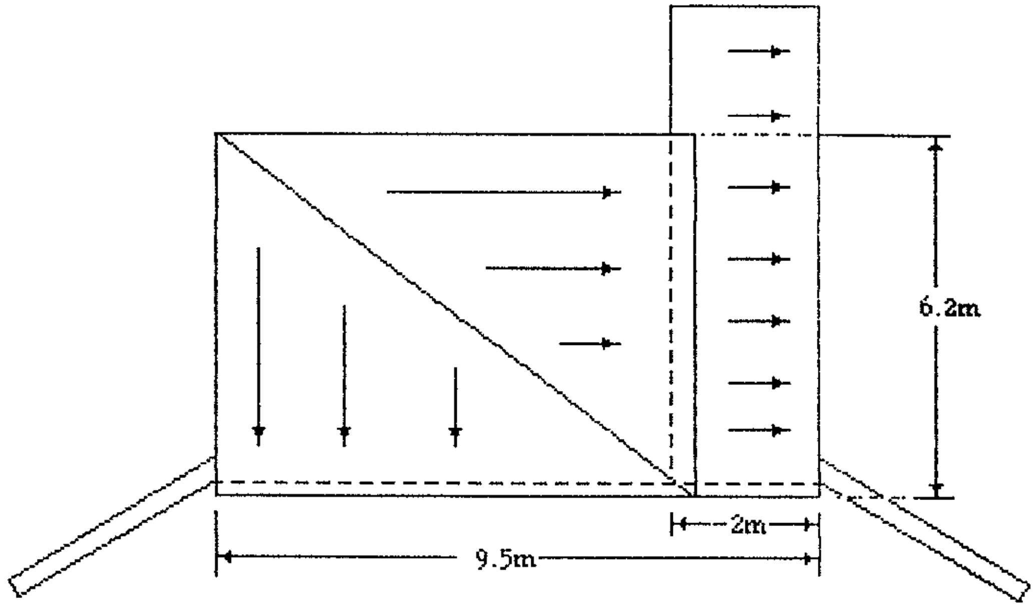


Figure 5 (b)
2nd Level Plan

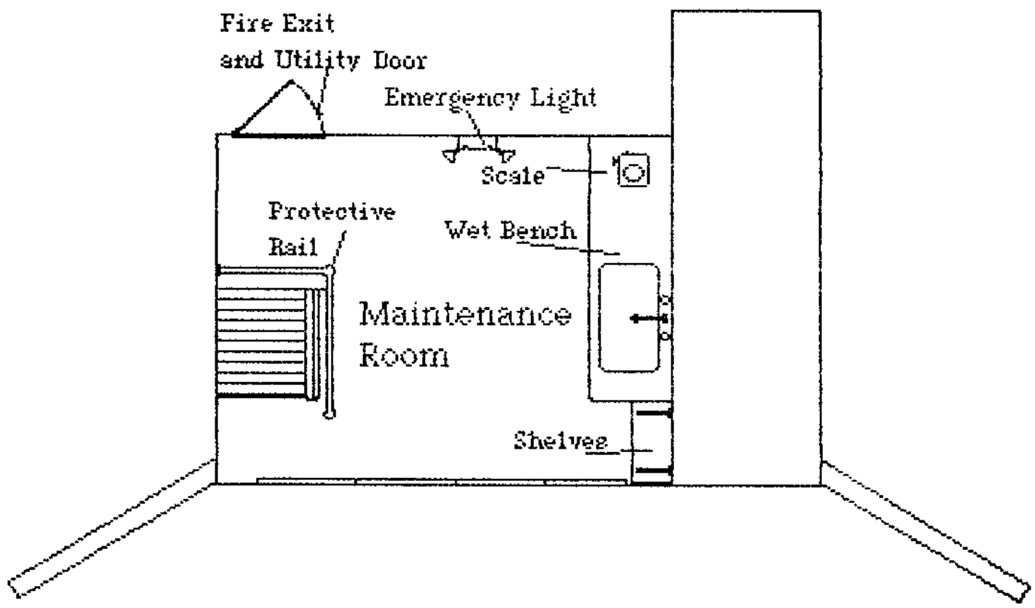


Figure 5 (c)
1st Level Plan

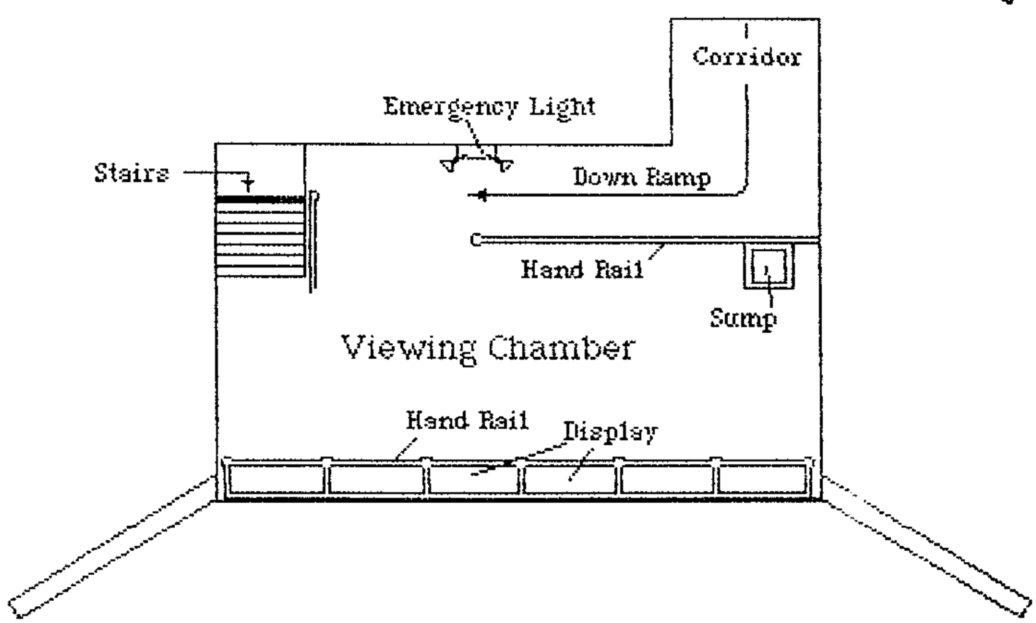


Figure 5 (d)
South Elevation

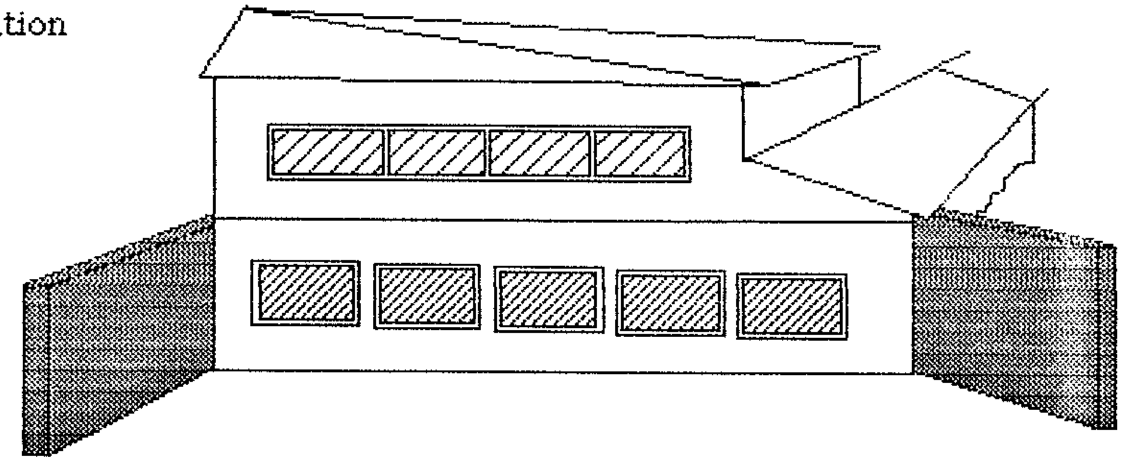


Figure 5 (e)
West Elevation

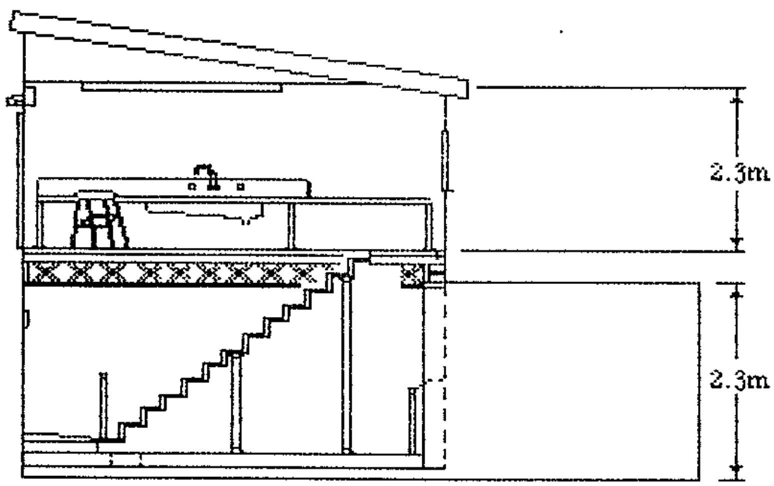


Figure 5 (f)
East Elevation

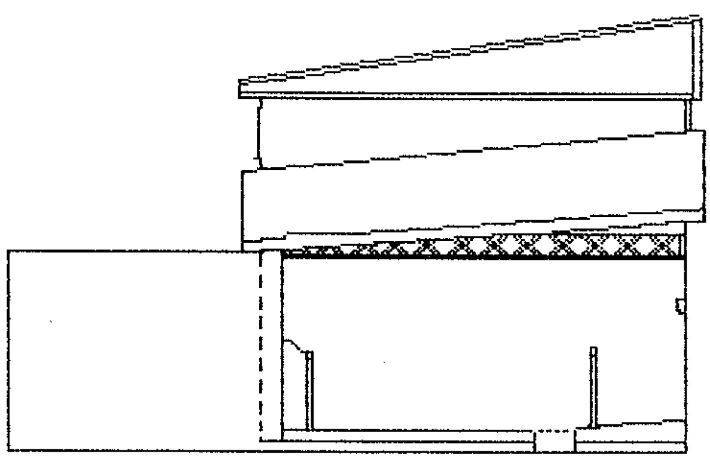


Figure 5(g)
Wing Deflector

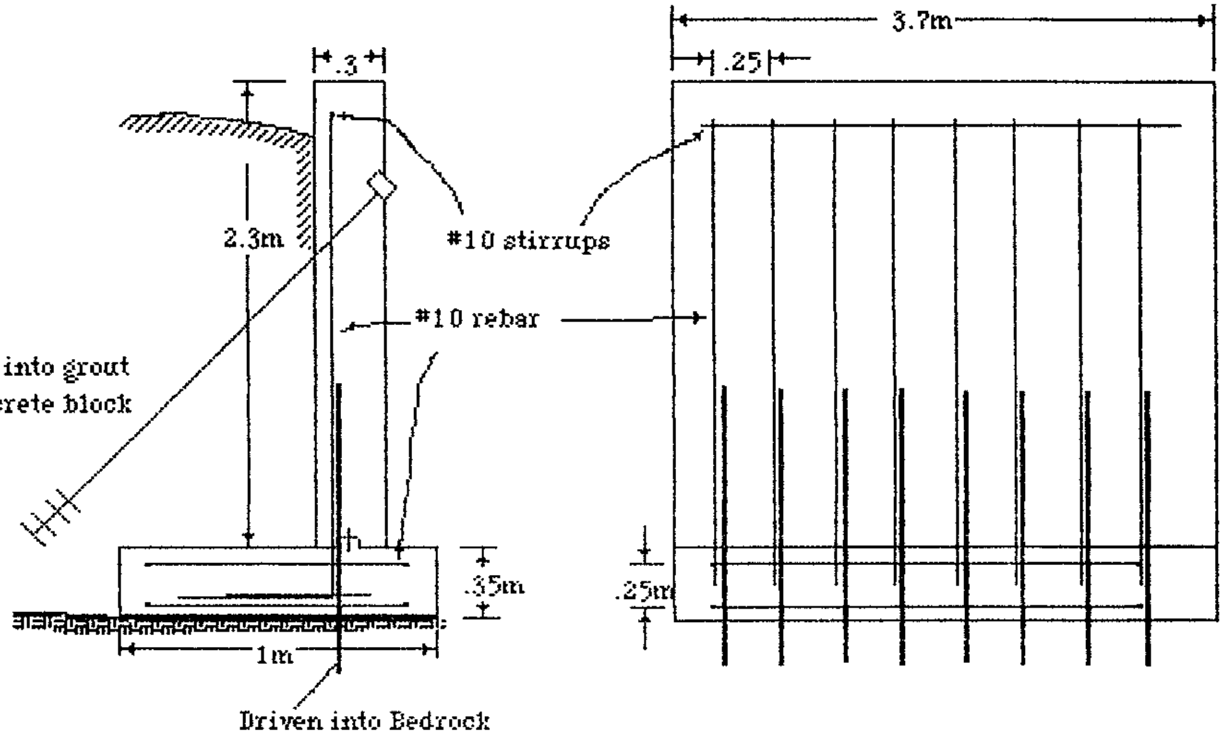


Figure 5(h)
Wing Deflector
and Wall Joint Detail

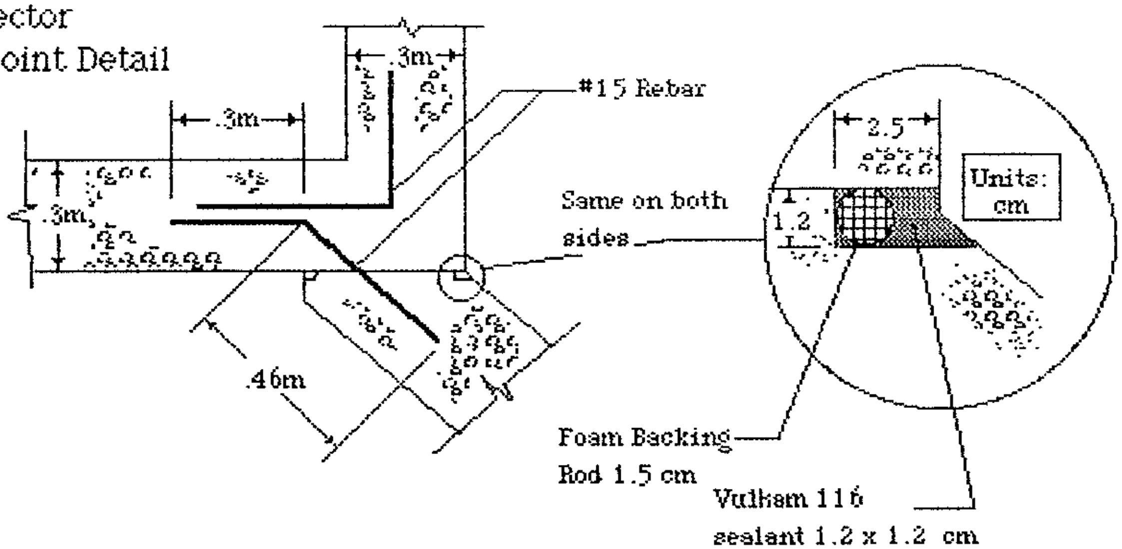


Figure 5(i)
Glass and Frames Detail

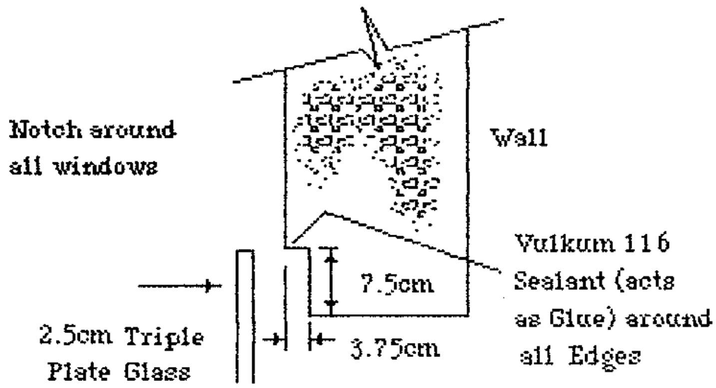


Figure 5(j)
Sump Detail

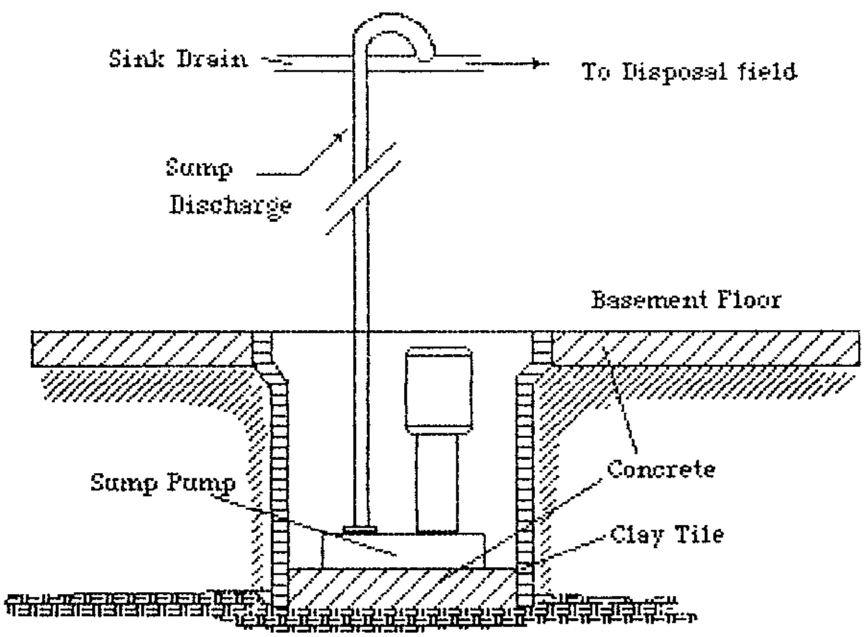
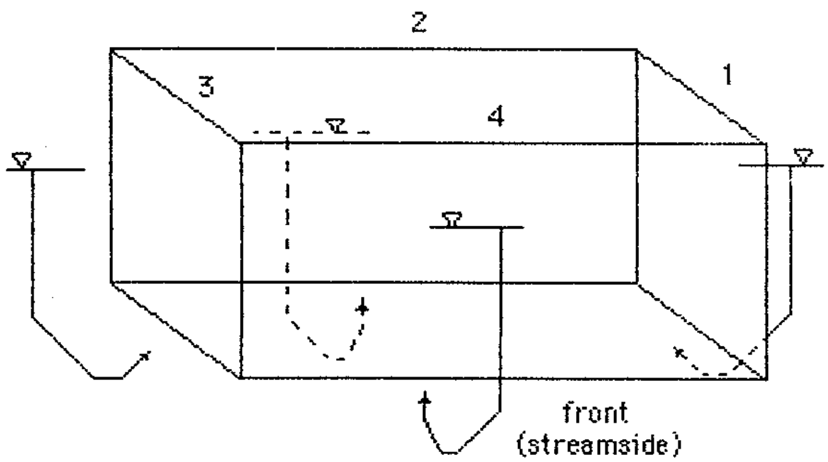


Figure 5(k)

Since all four walls of the viewing chamber are subject to seepage, the following assumptions have been made so that an estimate of total seepage may be made for the streamtank:

Streamtank walls subject to seepage



Assumptions:

Permeability of soil(k) = 10^-4 m/s

Soil is homogeneous throughout

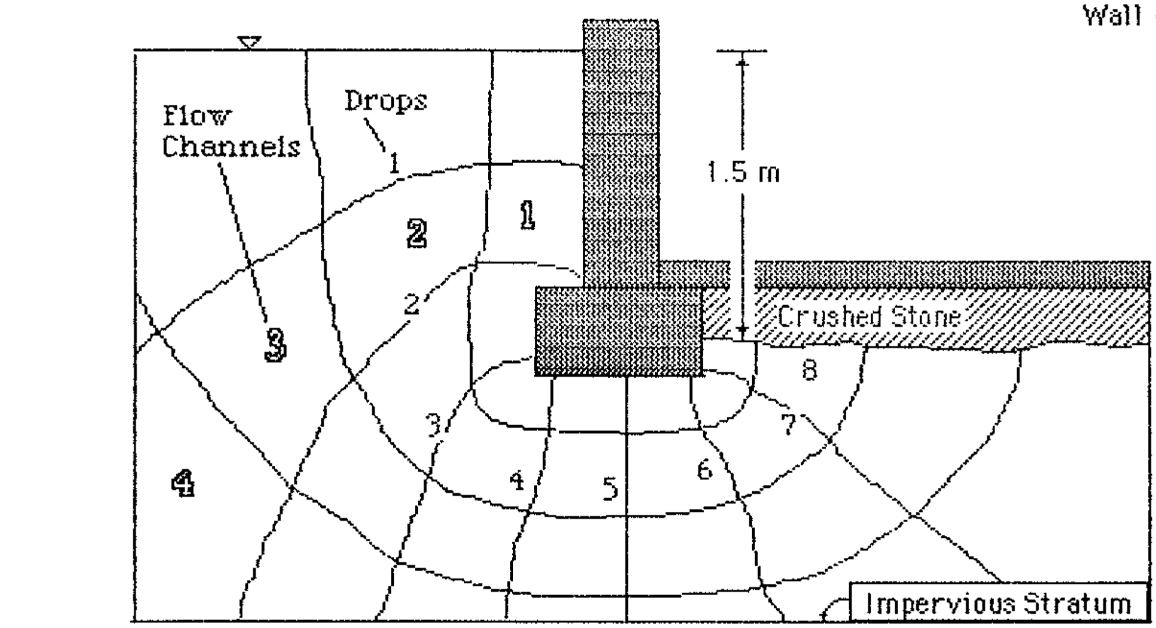
Impervious stratum is approx 2 m below the footings

$$\text{Seepage} = \frac{k*h1-h2\ n}{N}$$

where n = # flow channels
N = # drops in potential

Wall 1 h1-h2 = 2m
Wall 2 h1-h2 = 2.4 m
Wall 3 h1-h2 = 3.3m
Wall 4 h1-h2 = 2m

An approximation of the flow net for wall #1



SEEPAGE: (note that the ration of n/N is assumed approx. const at 4/8 = 0.5)

Wall #1 & #4 $\frac{(10^{-4})*2*4}{8}$ = 10^-4 m^3/sec = .36 m^3/hr

" #2 $\frac{(10^{-4})*2.4*4}{8}$ = .00012 m^3/sec = .43 m^3/hr

" #3 $\frac{(10^{-4})*3.3*4}{8}$ = .00165 m^3/sec = .59 m^3/hr

Total seepage = 1.38 m^3/hr

(1 gallon = 4.546*10^-3 m^3)

= 1800 g/h

Figure 6 (a)

2nd Level Plan for Plumbing

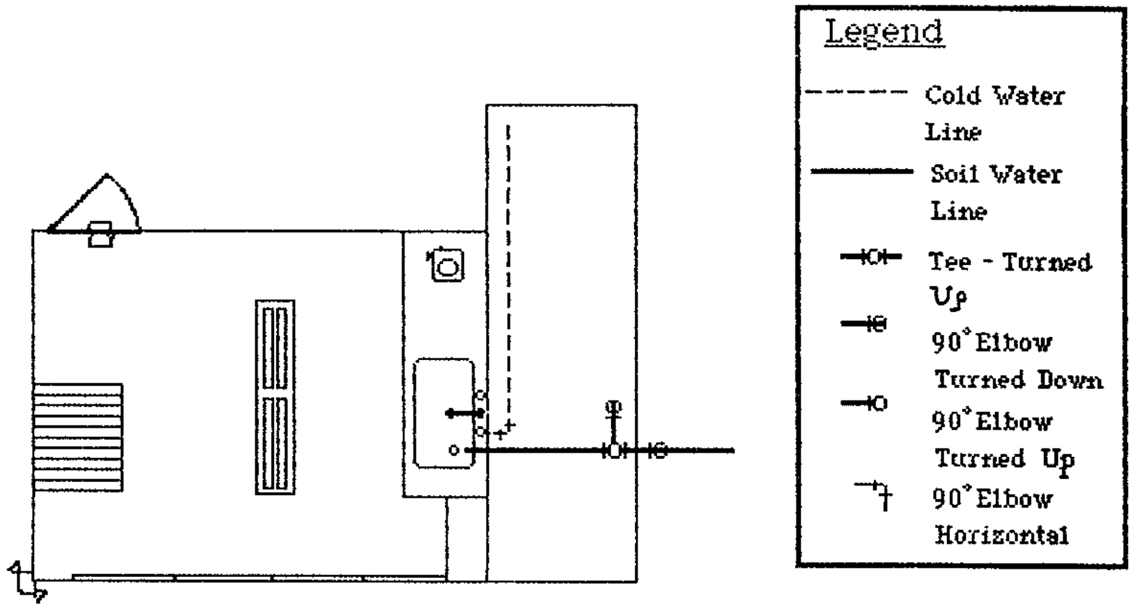


Figure 6 (b)

1st Level Plan for Plumbing

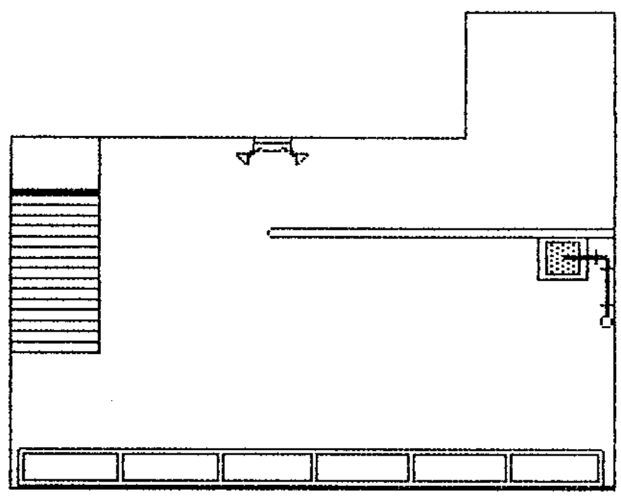


Figure 6(c)

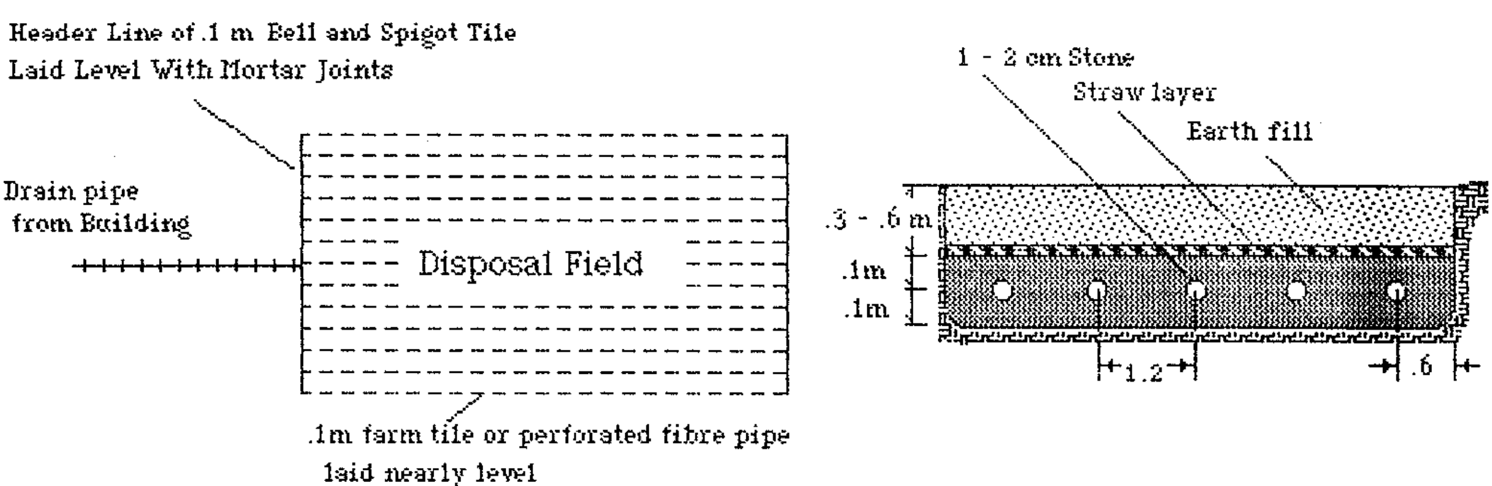
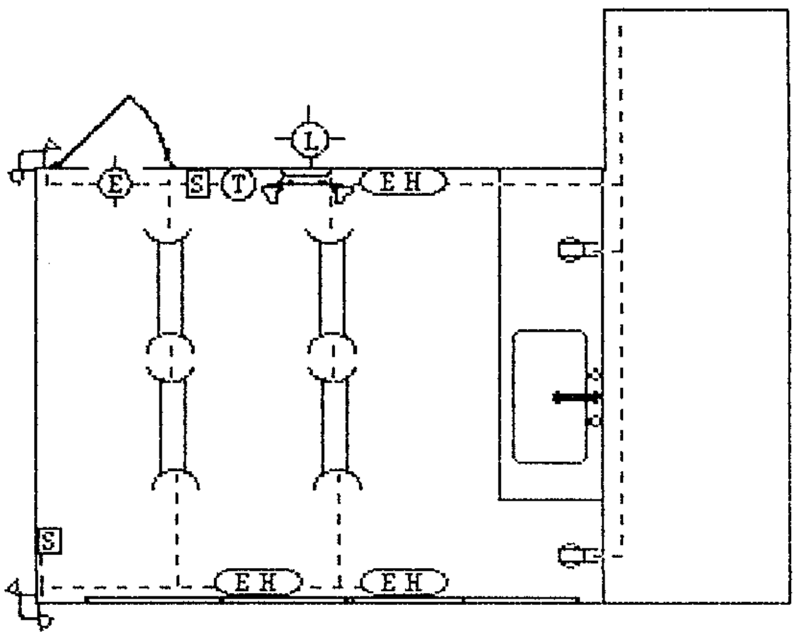


Figure 6(d)

2nd Level Electrical Plan



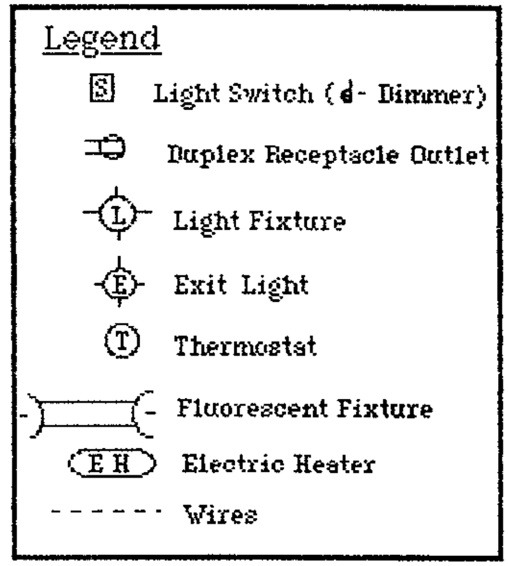
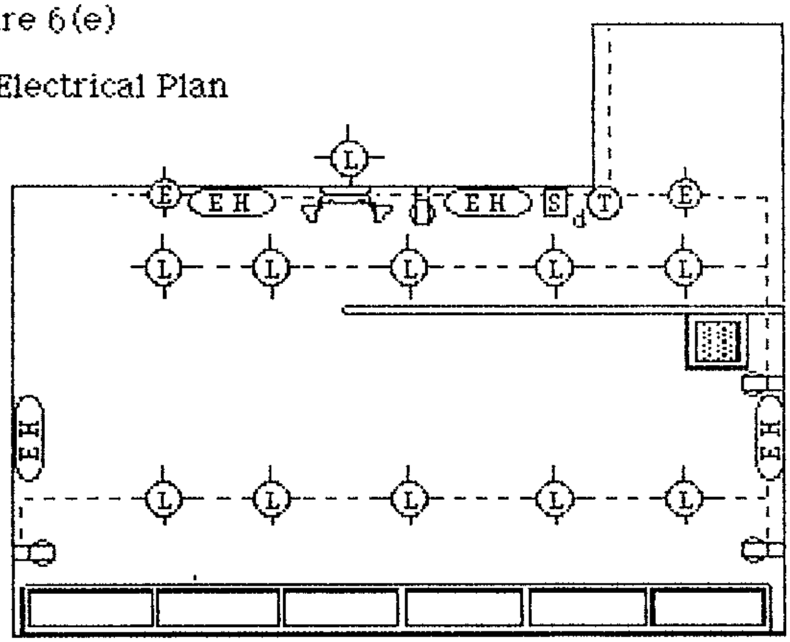


Figure 6(e)

1st Level Electrical Plan



SECTION III

"The Stream"

CONTROL STRUCTURES

SUBSTRATE AND CHANNEL DESIGN

FISH

VEGETATION

CONTROL STRUCTURES

The size of flow, the retention of fish and the rate of erosion should all be controlled by structures placed alongside or in the new stream channel. The following are descriptions of structures that may be used for these puposes.

- Sluice Gates

At the upstream site where the stream diversion occurs, a sluice gate arrangement will be needed for stream control (see figure 7(a)).

During regular flow conditions all the water of Nagles Hill Brook should be utilized and carried through the new channel. During flood conditions access water must pass by the diversion and spill down the old channel with little disruption or change in direction. To accommodate this, two reinforced concrete sluice gates, each with a concrete toe, may be used (see figure 7(b)). The two may be poured monolithically since they are adjacent. The larger of the two (in the old streambed) would have a gate whose bottom level is the same as the top level of the smaller (in the new streambed) ie. when water fills the opening of the smaller and attempts to build up, it naturally starts flowing over the bottom level of the larger. The approximate size of each opening is shown in figure 7(c).

- Back-Up Stream Pump

Since it is uncertain whether the flow during the winter months will be sufficient to maintain the aquatic environment desired, water may be pumped from Long Pond into the brook upstream of the streamtank.

Until it is certain as to whether this is necessary, a pumping system should not be installed, but accommodation for one may be made. This may include as little as knowing what kind of equipment to get and where to get it in the time of need. If, for example, it is known that an extra 0.05 m^3/sec of water were needed in the brook then it can be shown that approximately one 4 kW gas run pump with a flexible cloth hose may be utilized to move the water 130 meters upstream. Such a system would require no special accommodation on site since the pump can be placed on the shore of Long Pond and the hose can run along the streambed and bank up as far as the viewing section. Additional security precautions, fuel and maintainence would increase the operating costs of the fluvarium.

- Screens

The screens to be used in the stream to hold the fish in the viewing area should be made of a corrosion resistant, non-toxic, durable material. This may be stainless steel, vexar or vinyl . Copper is toxic to fish in small quantities so it is out of the question. The size of the mesh should be approximately .65 cm (1/4 in.) during the presence of small par and fry in the spring and 1.3 cm (1/2 inch) for later in the summer and fall when fish are larger and the leaves start falling. Frequent cleaning at this time will be needed to prevent clogging by fallen leaves and branches.

These screens may be placed into slotted concrete walls placed in cross section on the new stream just up and downstream from the viewing chamber windows. These would be built in such a way as to provide easy removal for cleaning or replacement of the screens (see figure 8). The same concrete walls may be used house fence posts for a security fence.

- Wing Deflectors

Wing Deflectors located along the side of the streamtank were discussed and illustrated in detail in SECTION II under 'STRUCTURAL DESIGN'.

CHANNEL DESIGN AND SUBSTRATE

Originally, the total length of the new watercourse was planned to be approximately 120 meters. After having investigated the site a revised estimate of approximately 65 m of diversion is recommended. The present streambed would remain as a spillway for access water and diversion in the case of emergencies (see figure 9). It was channelized a number of years ago and would not constitute a great loss to the natural environment if it were to become inactive. A footbridge to span the new channel adjacent to the streamtank will be necessary to access both sides of the stream in the immediate area.

It would be advantageous to step the streambed over the entire length of the new watercourse. The total head over the length of the diversion is approximatly 2.5 meters and the grade is close to 4 percent on average. If the stream were stepped, the energy of the falling water could be dissipated at regular intervals. This would control the rate of erosion and in the case of an emergency diversion away from the new stream, water would be retained in pools that could sustain aquatic life. The size of each drop and the nature of its associated riffle or rapids can be determined by the conditions in situ. Figure 10 illustrates one way in which this may be done. The viewing area of the streamtank would oversee a drop in stream elevation of approximately 0.4 m if the grade of the brook is kept constant but this is negotiable and should be made so that little inconvenience is made to those viewing the stream from inside the tank.

The substrate of the new watercourse should be chosen carefully to ensure that proper living and spawning conditions for the species of fish present in the brook can be produced. Fish must have both winter and summer substrate. Substrate is classified as follows:

Boulders	(>26 cm);
Rubble	(15-26 cm);
Cobble	(6-15 cm);
Pebble	(3-6 cm);
Gravel	(2-30 mm);
Sand	(0.06-2 mm);
Silt	(0.004-0.06 mm);
Clay	(< 0.0039 mm)
Organic detritus	(Incl. leaves and sticks but not tree debris)
Bedrock	(Differentiating between convoluted bedrock and smooth bedrock)

According to the publication "Stream Enhancement Guide"[11] and from discussion with Dr Gibson, it appears that the best stream bed for winter and summer habitat would be made up of the following percentages of substrate sizes:

Boulder	10%
Rubble	60%
Gravel	30%
Pools	More boulders
Riffles	More Cobbles

From discussion with Dr. J. Gibson, it was decided that the area of stream observed through the streamtank should include two pools and one fast flowing (riffle) area. Typically, the pool to riffle ratio is >1 in streams similar to Nagles Hill Brook . Figure 11 is a sketch of the stream as seen from within the streamtank. A secondary holding area or small pond may be necessary to provide a more sizable habitat for fish retained in the viewing area or simply for the live storage of fish. It too is illustrated in cross section in figure 12.

To provide a realistic habitat conducive to fish spawning, some stumps or toppled trees lying in the brook but not blocking passage would be recommended. Some low barrier dams built from boulders, logs or gabions may be utilized to step the stream and get the desired change in elevation and number of pools or riffles into the limited space of the viewing area. For further information on stream alterations, see the 'Stream Enhancement Guide' (reference 11).

FISH

It is very important that the streamtank display fish that are natural to our streams, and in a way that simulates the natural condition. Even though the streamtank is designated to demonstrate complete stream ecology including all of its natural inhabitants, the fish in the brook will be the most sought after organism by viewers. People are always trying to catch fish but know little of what they look like in their natural habitat. For many Newfoundlanders, fishing represents a livelihood and a source of recreation. The potential of our freshwater fish to be utilized as an industry and to grow in recreational value is enormous.

By screening off the ends of the stream, and with the addition of an auxiliary pond opposite the streamtank, the area may be stocked with several species and sizes of fish. The species of fish now in consideration vary in living and spawning habits and may be utilized to enhance viewing over a greater portion of the tank and to provide a longer viewing season.

Fish compatibility and disease control are problems that may arise if fish are stocked in numbers greater than that which would naturally occur. A committee formed in the federal Fisheries and Oceans department and headed by John Pippy oversees the movement of any live fish in the province to protect against the spread of disease and the introduction of unique strains of species that may prove to be detrimental to the environment or unable to survive. This committee will have to be involved in the selection of fish for this facility.

Generally speaking, fish from the same watershed are of the same strain and fish from nearby watersheds are likely to be the closest match. Therefore, when obtaining fish for the streamtank, this should be considered.

To catch the fish, alive, for stocking the viewing area a few techniques are recommended. These are: Electro-shocking, which is a technique whereby fish in a netted off area of a stream are stunned by an induced electrical impulse so that they may be picked from the water; The use of a seine net, which spans two people with floats on the top and sinkers on the bottom so that when a portion of the brook is circled the fish in that area are retained; and lastly, the use of a Fyke net, which on principle works similar to a lobster trap by luring fish into a small hole at the end of a conical section of net, which they have difficulty recognizing as an escape route once inside. This equipment for catching fish is available from Dr. Gibson at the Federal Fisheries and Oceans Building.

Every year new fish will have to be placed in the viewing area. Some fish may be retained for any number of reasons but the par and fry should be released and restocked in spring. The fish population can be changed at any time. For example if, in the fall, it is desired to replace Brook and Brown trout every two weeks so that new spawning couples can be seen then this can be done. It is important though that at all times the total fish biomass does not exceed 100 g/m^2 so that the stream may retain its natural state and not become an aquarium.

The following is a table showing potential fish species to be placed in the viewing area, the location where they may be found, the technique by which they may be caught, and a scenario for their population distribution.

Species	Location	Tech.	Scenario Weight	#	Total
Sticklebacks- 3 spine Sticklebacks Nine Spine (9)	Anywhere in the system Kelly's Pond	Electro-shocking	≈ 15 g	≈ 6	90 g
Brook Trout	Three Pond Barrens - Left Pond	Electro-shocking	≈ 5-50 g	≈ 5	125 g
Brown Trout	Anywhere in the system	Electro-shocking	≈ 5-50 g	≈ 5	125 g
Rainbow Trout	Picco's Brook - Flatrock	Electro-shocking	≈ 5-50 g	≈ 3	75 g
Atlantic Salmon small big	North Arm River Salmon Ass. of Nf. North Harbor River	Seine	≈ 20 g	≈ 20	400 g
Wananish	Fourth Pond, Goulds	Fyke	≈ 5-50 g	≈ 2	50 g
Eels	Anywhere in the system	Electro-shocking	≈ 10-100 g	≈ 1	50 g

With the addition of one or two big trout and salmon at approximately 1/2 kg each and the same with salmon the total fish biomass for the screened off area would be:

3 x 0.5 + Sum of Totals in table = 1.5 kg + .915 kg = <u>2.5 kg</u>

for the scenario proposed.

Noting that the natural condition found by Dr. Gibson in these parts was close to 60 g/m^2 of fish biomass to streambed area, the condition that would be produced in the viewing area would be:

2500g/ (10m x 2m(stream) + 3m x 4m(side pool)) = <u>80 g/m^2</u>.

Since 80 g/m^2 represents a higher biomass than is typical the fish may have to be fed. This may be carried out on a voluntary basis once or twice a week by throwing fish food pellets into the stream.

VEGATATION

The banks of the new stream will need to be vegatated. The vegatation provides resistance to erosion and stability to the banks. Also, streamside vegatation in combination with streambed vegitation is responsible for the primary food production in the aquatic environment. Without it, microorganisms, invertébrates, and all other aquatic organisms cannot survive. Furthermore, cover provided by overhang is needed for proper trout habitat by providing dark shade and keeping the temperature of the water down. For this reason, it would be best to investigate the naturally occurring vegatation of productive brooks and rivers nearby, to find the species of plants and trees most likely to take hold and provide a healthy aquatic environment.

According to Dr. Gibson and Martin Goebelles of the Provincial Dept. of the Environment, only one or two days after a new channel is opened, it will start to come alive. Invertébrates will move in immediately and weeds will begin to grow. Other more substantial plants should be planted to help attain a healthy equilibrium.

Trees that would be suitable to place along the bank opposite the streamtank are as follows: alders, whose deep roots, thickness for shade, and nitrogen fixing ability make it a wise but unattractive choice; willows, whose roots prevent erosion and can be seen shining bright red along the banks may be planted. Dogwood trees are also fine. Conifers are less desirable, they have shallow roots, provide little food and keep falling into the brook after which they are slow to break down. Trees may also be placed along portions of the diverted stream not in the viewing section in sparser numbers.

Other vegatation that may be placed along the banks to provide a healthy, attractive environment include the following: cinqafoil, the shrub, which has a bright yellow flower and appears along the banks of streams in the Holyrood area; wild mint, which grows fast and provides good cover, now found in and around Long Pond, watercress the aquatic plant that is edible and grows well just down stream in Rennies River, fontenalius, another valuable aquatic plant but slow to catch on, should be added to the brook, and any of a variety of tall grasses available locally would do well as streamside vegatation. Mr C. M. Manning, general manager of Pippy Park, and Dr. Gibson may be contacted to provide further information in this area.

Figure 7 (a)

Sluice Gates

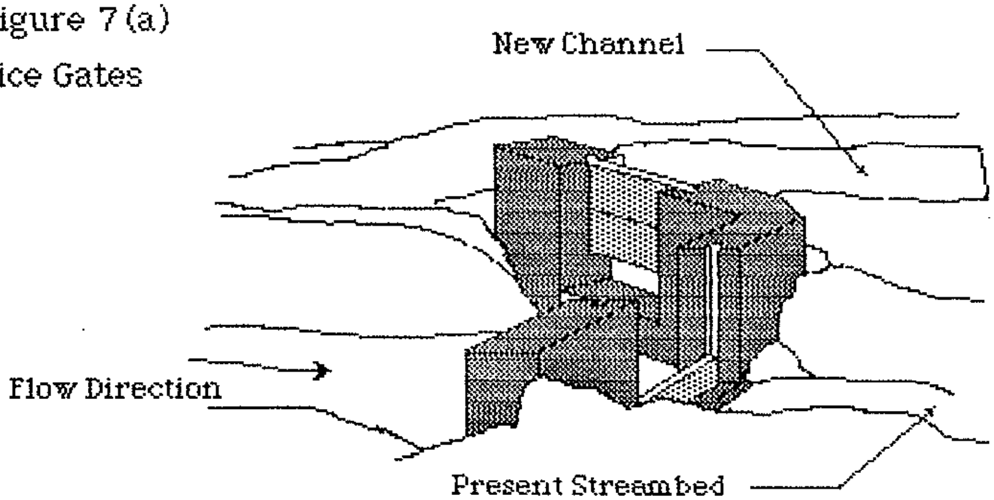


Figure 7 (b)

Structural Draft

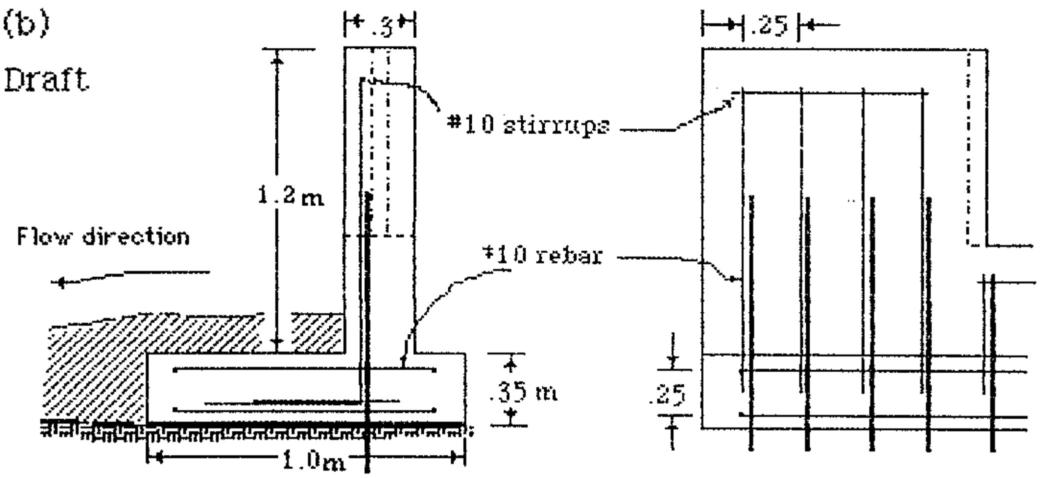
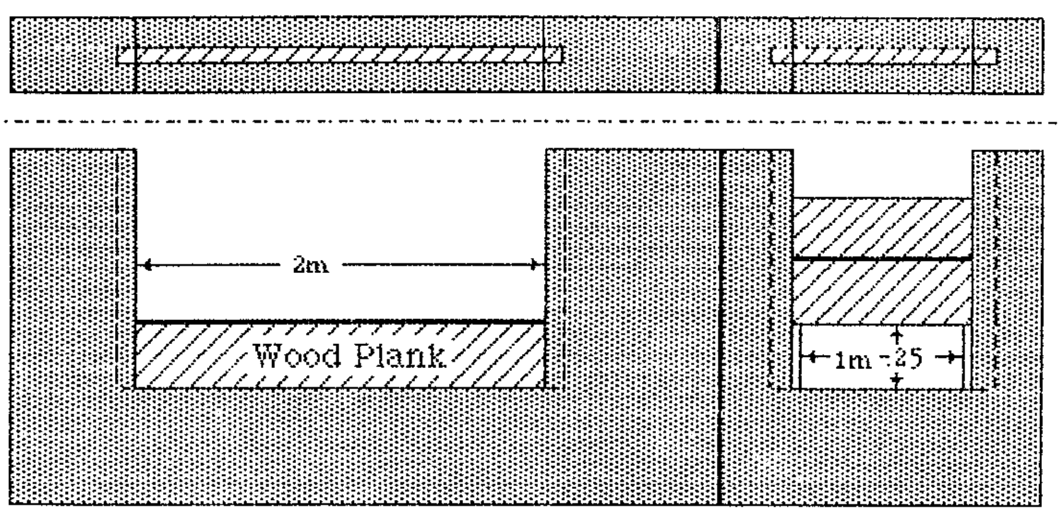


Figure 7 (c)

Sluice Gate Elevation



Note:
The dimensions and design shown above are intended to present the idea, to finalize the design or present detail would be premature at this time.

Figure 8(a)

Screen System

The two screen system is recommended since it provides a back-up screen in case one breaks, it permits one screen to be removed at any time for replacement or cleaning and it allows a better working system for screen sizes.

Note: A screen must be placed over the top of the structure to keep fish from jumping out over the upstream side.

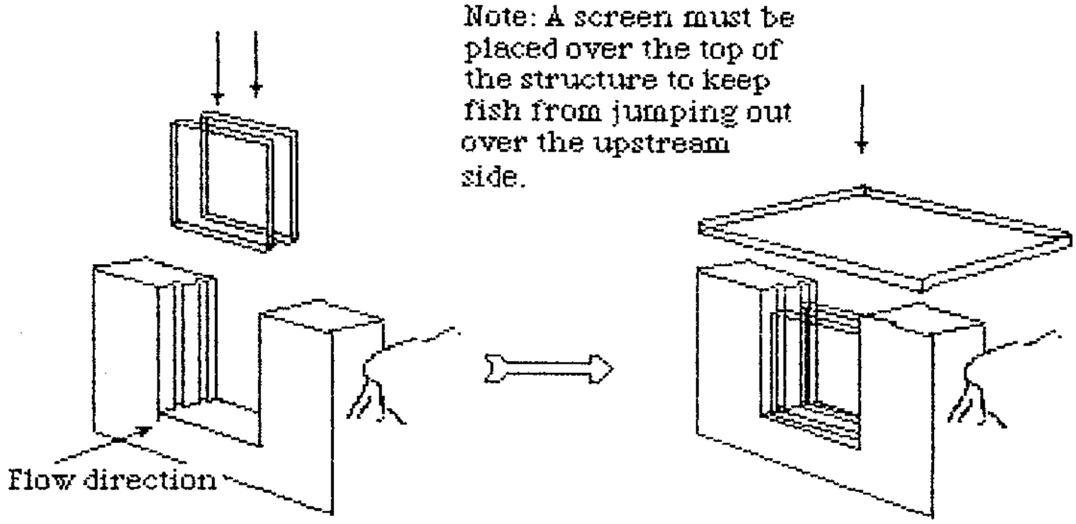
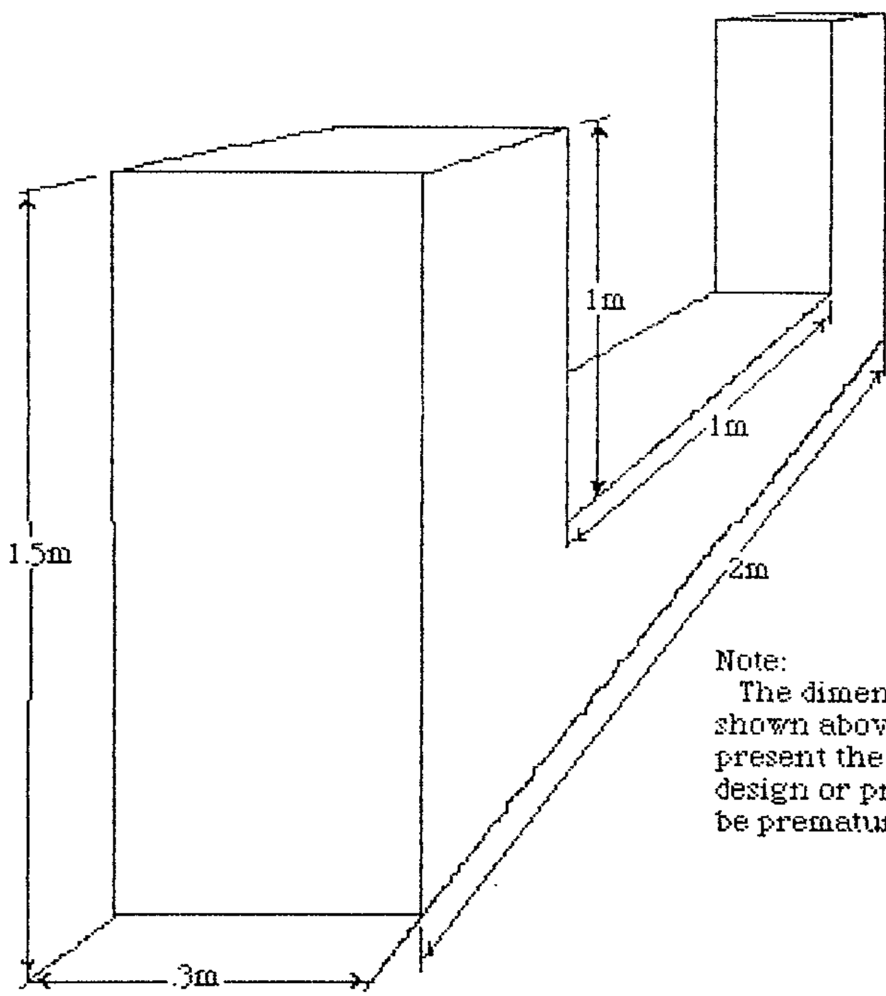


Figure 8(b)

Dimensions

Note that a footing similar to that under the wing deflectors may be used here.



Note:

The dimensions and design shown above are intended to present the idea, to finalize the design or present detail would be premature at this stage.

Figure 9

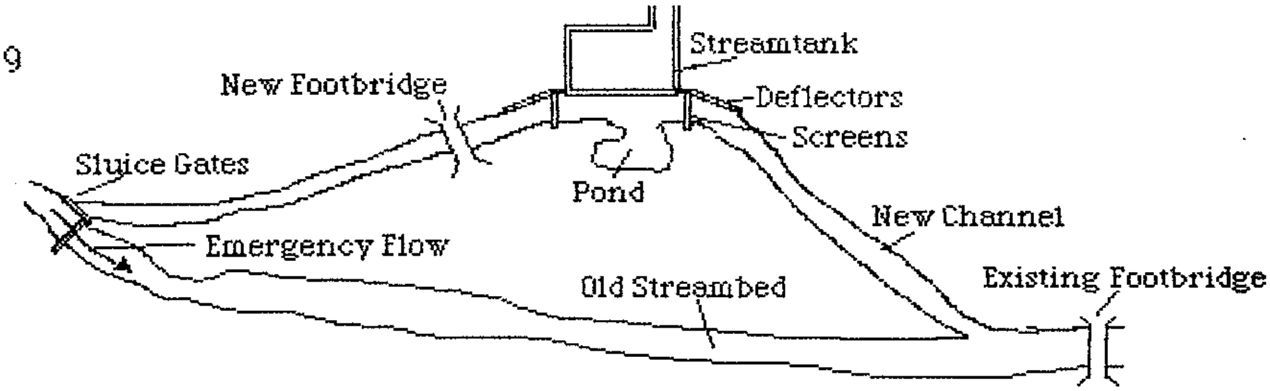


Figure 10 Low Barrier Boulder Dams

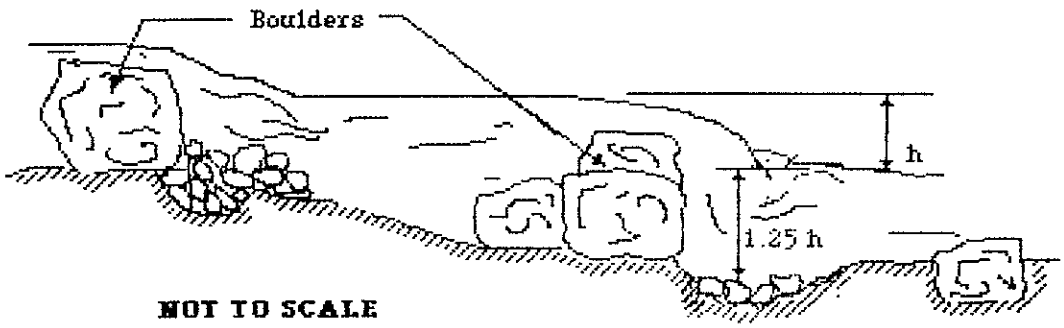


Figure 11 View Through the Streamtank

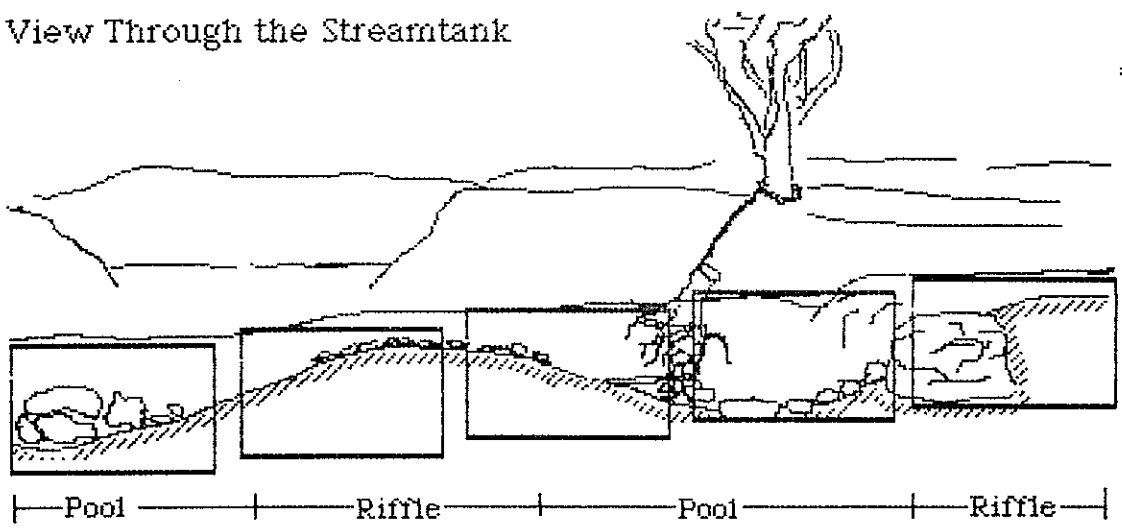
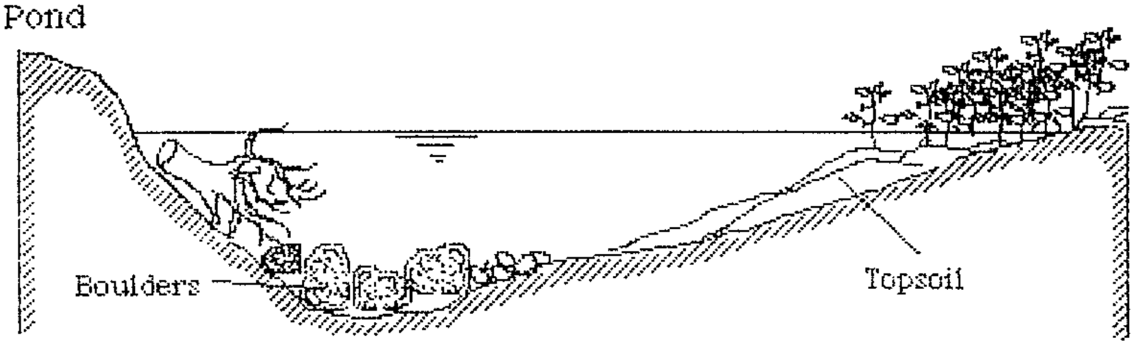


Figure 12 Pond



SECURITY AND MAINTENANCE OF FACILITY

SECURITY

As protection against vandals and poachers, a fence should be built to surround the streamtank and the immediate area. Fences of various forms are available from manufacturers of security items and hardware. In Pippy Park the intention would be to make the fence look as unobtrusive as possible. The color and design, as well as the extent of the fence will be subject to expense, availability of materials, availability of good soil, asthetics and other factors. An example of a design may involve a green plastic coated chain link fence with small shrub and tree growth along both sides. Each fence post should be put in a meter deep hole and set in concrete. Note that the concrete screen holders may be used as post footings where the fence passes over the stream.

Light sensitive outdoor lights should be utilized as a security system, illuminating the grounds in a way that prevents the formation of dark spots. A security alarm may be installed to react to any door jarring or window smashing. Lastly, the building should be checked by the night watchman on a regular basis.

MAINTENANCE OF STREAMTANK

The following are some of the tasks that will need to be carried out to upkeep the streamtank and stream:

Regular cleaning of the interior of the streamtank and daily light and heat control will have to be carried out.

The viewing glass may need to be scrubbed clean of algae on one side and fingerprints on the other. The exterior cleaning will be required, at most, once every two weeks.

The replenishment of any leaflets or other public freebees available in the viewing area, is required.

The walls of the streamtank will need to be regularly checked for cracks and any leaks found anywhere should be sealed immediately.

The sump pump should be checked regularly, especially if it or a spare pump have been inactive for any period of time.

MAINTENANCE OF STREAM

The fish in the viewing area may need to be fed two or three times a week.

The health of the fish and other aquatic life will need to be monitored and cared for if found unacceptable.

The screens need to be scrubbed and kept clean of sticks and leaves that pile up and block the passage of water. Similarly, the sluice gates should be kept clear of junk and checked for vandalism.

Deposits of sediments that build up in the viewing, sluice gate or screen areas will need to be moved and erosion around any of the control structures, kept in check.

REFERENCES

1 Exerts from "Aquatic Heritage Master Planning Process Proposal", Research Associates, May 23/1985.

2 Exerts from "Aquatic Heritage Master Planning Process Proposal", Research Associates, May 23/1985.

3 Preliminary Environmental Impact Statement for the Outer Ring Road. City of St. John's, 1986.

4 Moffitt F.H., Bouchard H. "Surveying" seventh edition. (Harper and Row Publishers, New York, 1982) PP 608-610.

5 McLean A.C., Gribble C.D., "Geology for Civil Engineers". (George Allen and Unwin, 1982) PP157-156.

6 Herubin C.A., Maratta T.W., "Basic Construction Materials" second edition. (Reston Publishing Co. Inc., 1981) PP51-54.

7 Neill and Gunter Limited, Fredricton, N.B,. and Halifax, N.S., "Atlantic Salmon Federation, St. Andrews, N.B., Artificial Salmon Pool". July 1985 (partial set of structural drawings).

8 Neill and Gunter Limited, Fredricton, N.B., and Halifax, N.S., "Atlantic Salmon Federation, St. Andrews N.B., Artificial Salmon Pool". July 1985 (partial set of structural drawings).

REFERENCES (Cont;)

9 Kicklighter C.E., "Architecture, Residential Drawing and Design". (The Goodheart- Willcox Co. Ltd. Incorporated, 1979) PP 335.

10 Kicklighter C.E., "Architecture, Residential Drawing and Design". (The Goodheart- Willcox Co. Ltd. Incorporated, 1979) PP 335-337.

11 "Stream Enhancement Guide", Ministry of the Environment, Province of B.C. & Fisheries and Oceans, Government of Canada, Vancouver, B.C., March 1980. Various readings.

BIBLIOGRAPHY

Further readings outside of those stated specifically in the reference include:

Gibson R.J. "The Potential of The City Rivers in St. John's". Fisheries Research Branch, Department af Fisheries and Oceans St. John's Newfoundland, 1985.

Gibson R.J. "The Rivers in St. John's a Precious Heritage" From The Osprey, Vol. 16, No.1, March 1985. PP. 54-58.

Gibson R.J. "The Interrelationships of Brook Trout, Salvelinus Fontinalis (Mitchill) and Juvenile Atlantic Salmon, Salmo Salar L'" University of Waterloo 1973.

Green J.M. & Cunjak R.A. "Habitat Utilization by Brook Char and Rainbow Trout in Newfoundland Rivers". Department of Biology and MSRL, Memarial University of Newfoundland. St. John's Nf. Sept29 1982.

Kendig L.H. "Why Consider Fishing in Urban-Suburban Planning" Session I Planning for Urban Development. Urban Symposium Proceedings, Bethesda, Maryland 1984.

Lindrath A. "A Streamtank at the Holle Labratory" Institute of Freshwater Research, Drottingholm, Report#35, Annual Report for the year 1953 & Short Papers, PP 113-117.

BIBLIOGRAPHY (Cont;)

Jones J.W. "The New Naturalist - The Salmon-" NMN Publishers 1959 London, PP 97-147.

Spangler M.G. & Handy R.L. "Soil Engineering 4th Edition" Harper and Row Publishers Ltd. New York, 1982.

ACKNOWLEDGEMENTS

I would like to acknowledge the generous assistance received from the following people to whom I am grateful.

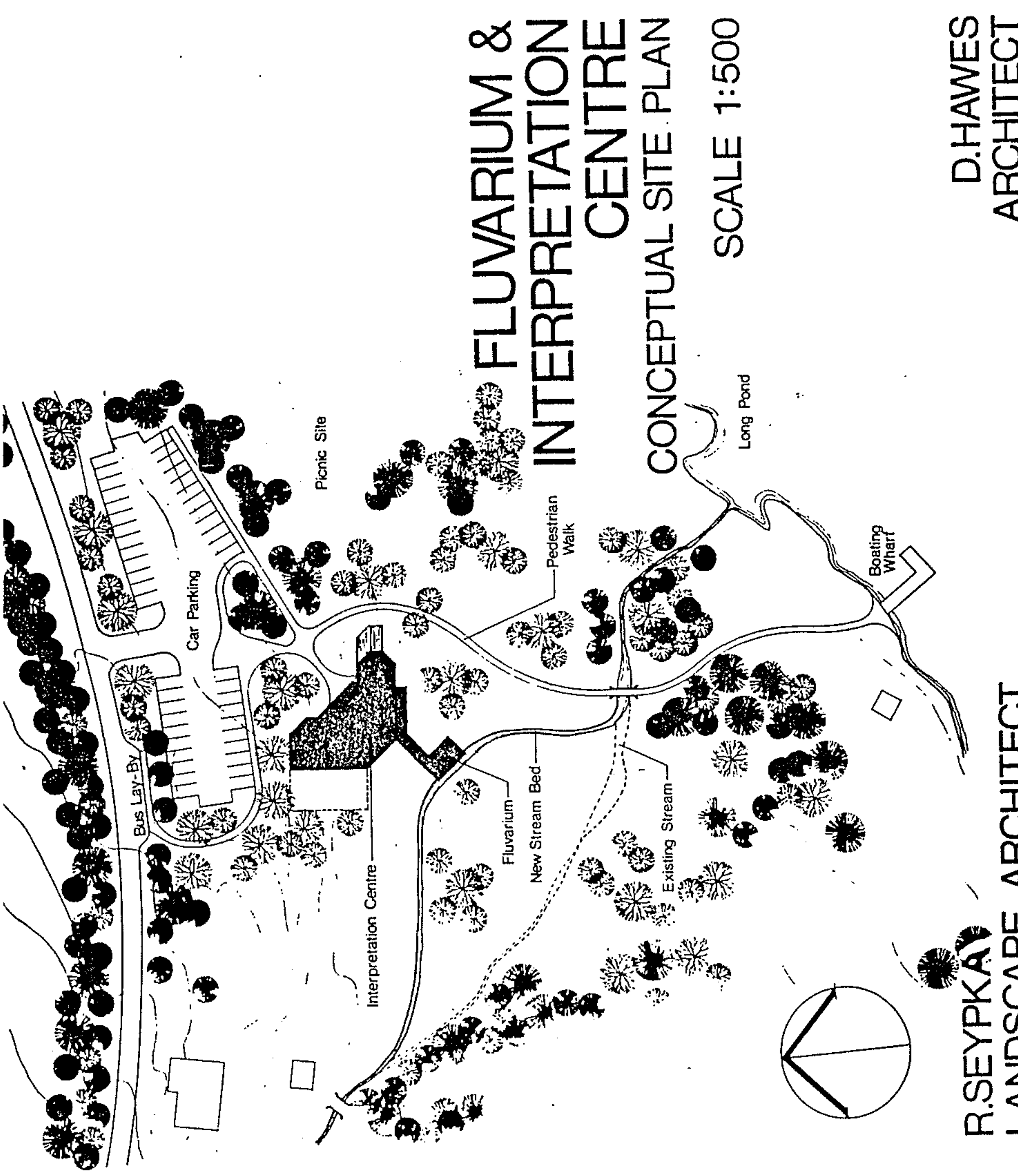
Dr. John Gibson	Stream Biologist, Federal Fisheries and Oceans
Mr C. M. Manning	General Manager of Pippy Park

Also appreciated was the assistance of the following groups and individuals:

Prof. J. Waterhouse	Prof. of Engineering, Memorial Univ.
Doug Hawes & Richard Seypka	Architects and Concept Developers
The QVRRD Foundation	
The Staff at Pippy Park Headquarters	
Greg Gof	Behavior Specialist, Federal Fisheries and Oceans
Murray Colbo	Biologist, Memorial Univ.
Dr. John Green	Biologist, Memorial Univ.
Ian MaCallum	Geographer, Memorial Univ.

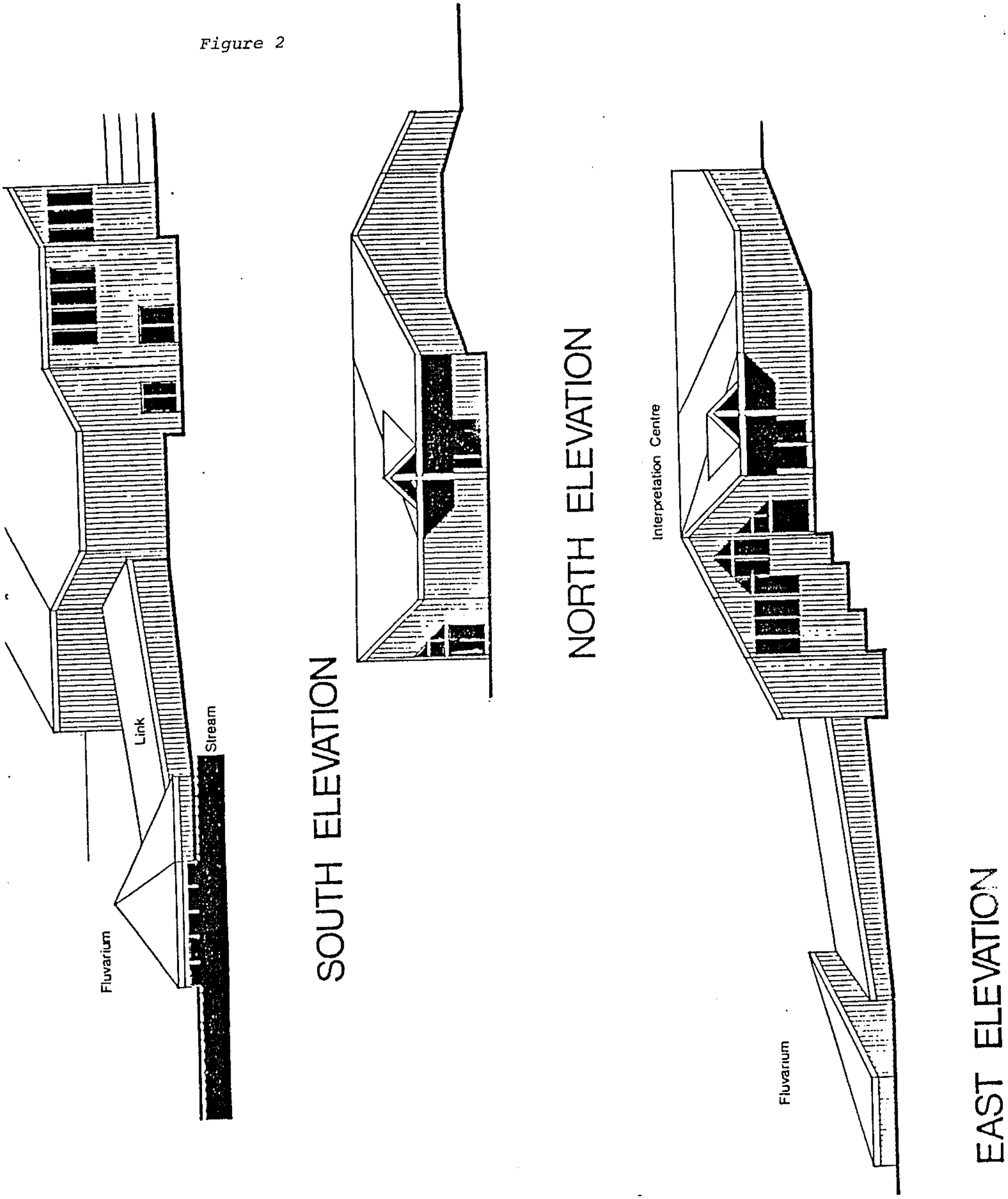
Appendix 1

Figure I



FLUVARIUM &
INTERPRETATION
CENTRE
CONCEPTUAL SITE PLAN
SCALE 1:500
D.HAWES
ARCHITECT
R.SEYPKA
LANDSCAPE ARCHITECT
Picnic Site
Car Parking
Bus Lay-By
Pedestrian Walk
Long Pond
Boating Wharf
Interpretation Centre
Fluvarium
New Stream Bed
Existing Stream

Figure 2


SOUTH ELEVATION
Fluvarium
Link
Stream
NORTH ELEVATION
EAST ELEVATION
Interpretation Centre
Fluvarium