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GABRIOLA

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1 INTRODUCTION

Gabriola Bar is a large intertidal area in False Narrows on the south side of Gabriola Island. During low tides and particularly during the very low spring tides much of the bar is exposed to and available for harvesting of clams. Over the years this area has been periodically closed to harvesting, generally during the summer months, due to the incidence of high fecal coliform levels detected in commercially harvested clams. Surveys have been conducted by the Department of Fisheries and Oceans and Environmental Protection to assess the bacteriological quality of the waters and shellfish harvested from the area. A summary of these surveys is presented in Appendix I.

Briefly, three surveys (June & August 1982, February 1983 & December 1984) evaluating marine, freshwater, sediment and manure samples in this area did not identify a source of contamination. A study in June 1984 attempted to determine if prolonged holding (3 days) of sacked clams at various locations in the intertidal area affects fecal coliform levels. Results indicated that 28% of total samples collected exceeded the shellfish meat standard, however results were inconclusive concerning prolonged holding of the clams. In 1985 studies by both Environmental Protection and Fisheries and Oceans found some contamination but no conclusive results indicating the source.

This report describes a bacteriological survey, conducted between May 26 and May 29, 1986, of groundwater, clam tissue and beach sediment from Gabriola Bar . This survey attempted to identify a source of contamination to the clam harvesting area at Gabriola Bar. Previous work speculated that the source of the contamination may be tile field effluents from homes onshore of the clam area.

2 METHODS FOR THE ANALYSES OF SHELLSTOCK AND SEDIMENT

2.1 Shellstock

1. Collect shellstock, label samples, and store at 4^{o} C until bacteriological analyses can be performed.

2. Prior to bacteriological analysis all shellstock will be scrubbed and washed under tap water. This will remove excess grit or dead algae, etc.

3. During the processing of shellfish, rubber gloves should be worn and periodically sterilized with an iodine solution or equivalent. Additionally, sterilize the shucking knife periodically with methanol and air dry. Using a shucking knife for oysters, or scalpel for clams, pry open the shell and put all contents, meat and fluid, into a sterilized tared waring blender jar.

4. When an adequate amount of shellfish sample is shucked, approximately 250 grams for oysters and 100 grams for clams, tare the blender jar and contents. After taring, add an equal amount (grams) of buffered sterilized dilution water which will result in a 1:1 dilution.

5. After blending for 90 seconds, aseptically pipette 20 grams of the contents into a tared 80 ml dilution blank of buffered sterile water. The net result will be a 1:10 dilution.

6. Shake contents for about one minute and the aseptically pipette aliquots of 10, 1 and 0.1 ml into a 5 tube dilution series for MPN using standard methods.

2.2 Sediment

1. Collect sediment with a sterile spoon to a depth of 2-3 cm and deposit in a sterile Whirl Pac or another suitable sterile container. Store at 4^{o} C until bacteriological analyses can be performed.

2. Aseptically add 50-100 grams of sediment into a tared sterile plastic sample bottle. Tare bottle and contents and add an equal amount (grams) of sterile buffered dilution water. This will result in a 1:1 dilution.

3. Aseptically pipette 20 grams of the supernatant into a tared 80 ml dilution blank of sterile buffered water. The net result will be 1:10 dilution.

4. Shake contents for about 30 seconds and aseptically pipette aliquots of 10, 1 and 0.1 into a 5 tube dilution series for MPN using standard methods.

3 DESCRIPTION OF THE AREA AND STUDY PROCEDURE

3.1 Topography and Precipitation

Gabriola Bar and the populated area inland from False Narrows rises in elevation from sea level to the highest elevations on the island (>160 meters). The principle bedrock in this area is a highly fractured Northumberland shale. Although shale is generally low in perosity, highly fracturd shale can be quite permeable (B. Moen, 1979).

Topography can play an important role in the movement of groundwater since hydrostatic pressure differences are responsible for groundwater flows and movement is from higher elevations to lower elevations. Groundwater recharge on Gabriola is predominately due to precipitation and generally occurs at higher elevations while discharge zones occur at lower elevations. The higher elevation directly behind the False Narrows area serves as a recharge area while Gabriola Bar serves as a discharge zone. Under such conditons, septic field effluent from homes along the Gabriola/False Narrows foreshore could leach to the groundwater flow and ultimately discharged to the clam beds (Figure 1).

Although rainfall did not occur during the week of the survey, 25.8 mm fell during the week prior to the survey. Rainfall for the entire month of May amounted to 87.7 mm (Rainfall data courtesy Atmospheric Environment Service).

3.2 Seepage Flux Meters and Mini-Piezometers

Seepage flux meters and mini-piezometers are two relatively inexpensive instruments used to measure and collect groundwater flowing into an estuarine zone (Lee, 1977). Seepage meters are constructed by cutting a 15 cm section from the top and the bottom of a 208 liter drum. The open end is turned into the sediment of the area to be sampled leaving the vent hole slightly elevated to allow gas to escape. A rubber stopper with a plastic tube in the stopper center is inserted into the vent hole and a sterilized plastic bag is attached to the tube with an elastic band. Upward seepage will then be collected in the plastic bag (Figure 2 & 3).

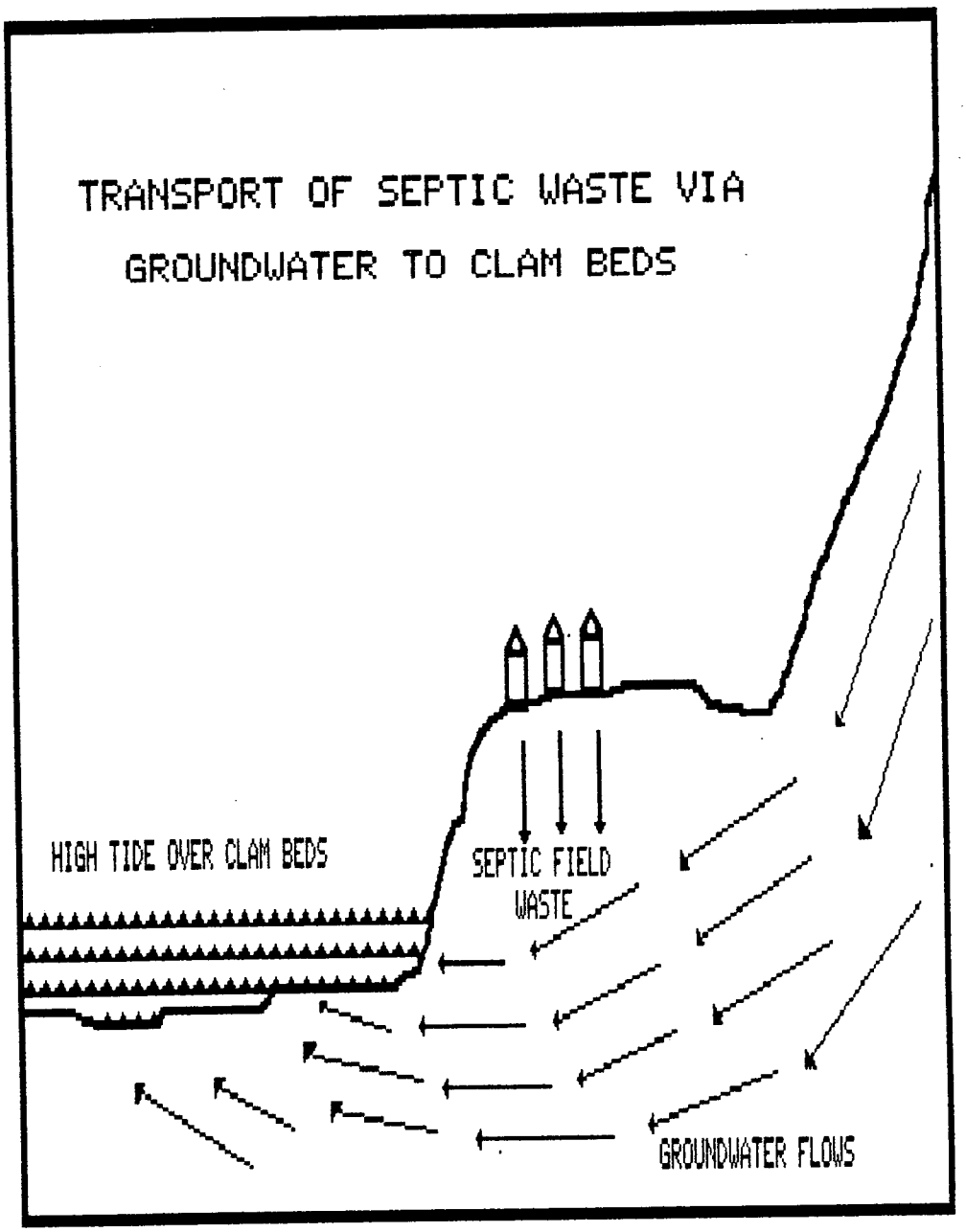

FIGURE 1 CONTAMINATION OF GROUNDWATER BY SEPTIC FIELDS

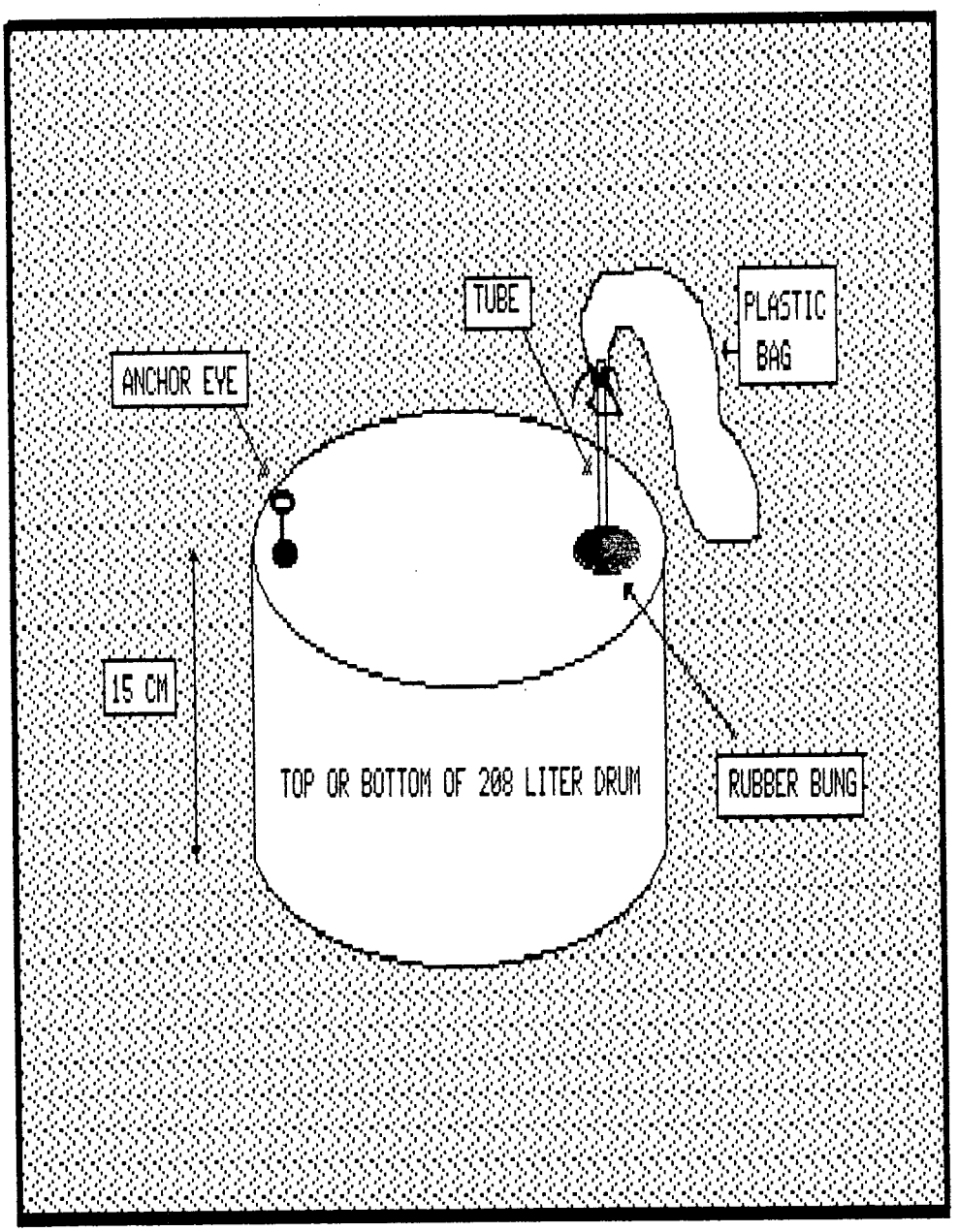

FIGURE 2 GROUNDWATER SEEPAGE FLUX METER

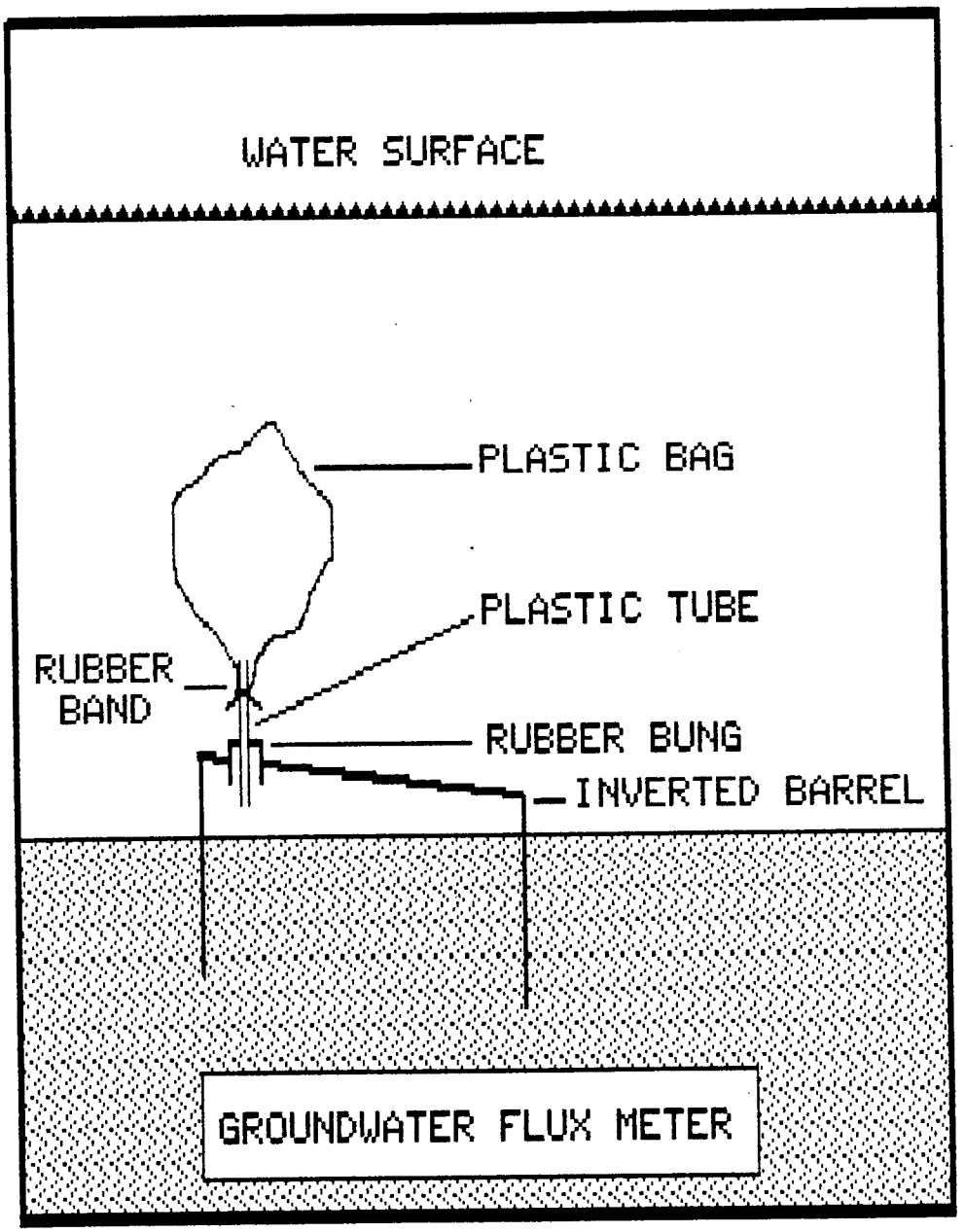

FIGURE 3 SEEPAGE METER IN PLACE HIGH TIDE

Mini-piezometers were installed by driving a 2.5 cm steel pipe one meter into the sediment. The pipe is loosely fitted with steel lag bolts at both ends. Once the desired depth is reached a plastic hose with mesh secured to the end is inserted into the pipe and held in place while the pipe is removed. The lag bolt remains at the bottom of the bore with the nylon mesh tubing positioned just above the bolt. Samples from piezometer wells were taken during low tides by pumping liquid for varying periods up to 75 minutes in duration (Figure 4).

Seepage meters and piezometer wells were set into the intertidal zone during low tide and sampled for three days after the completion of one tidal cycle (Figure 5). Bacteriological results for the sampling period are presented in Table 3.

3.3 Shellstock and Sediment Samples

Shellstock samples were taken from 12 locations in the False Narrows area and sediment samples were duplicated in ten of these locations. Figure 6 shows station locations for these samples while Table 2 gives the bacteriological results for the samples taken during the survey.

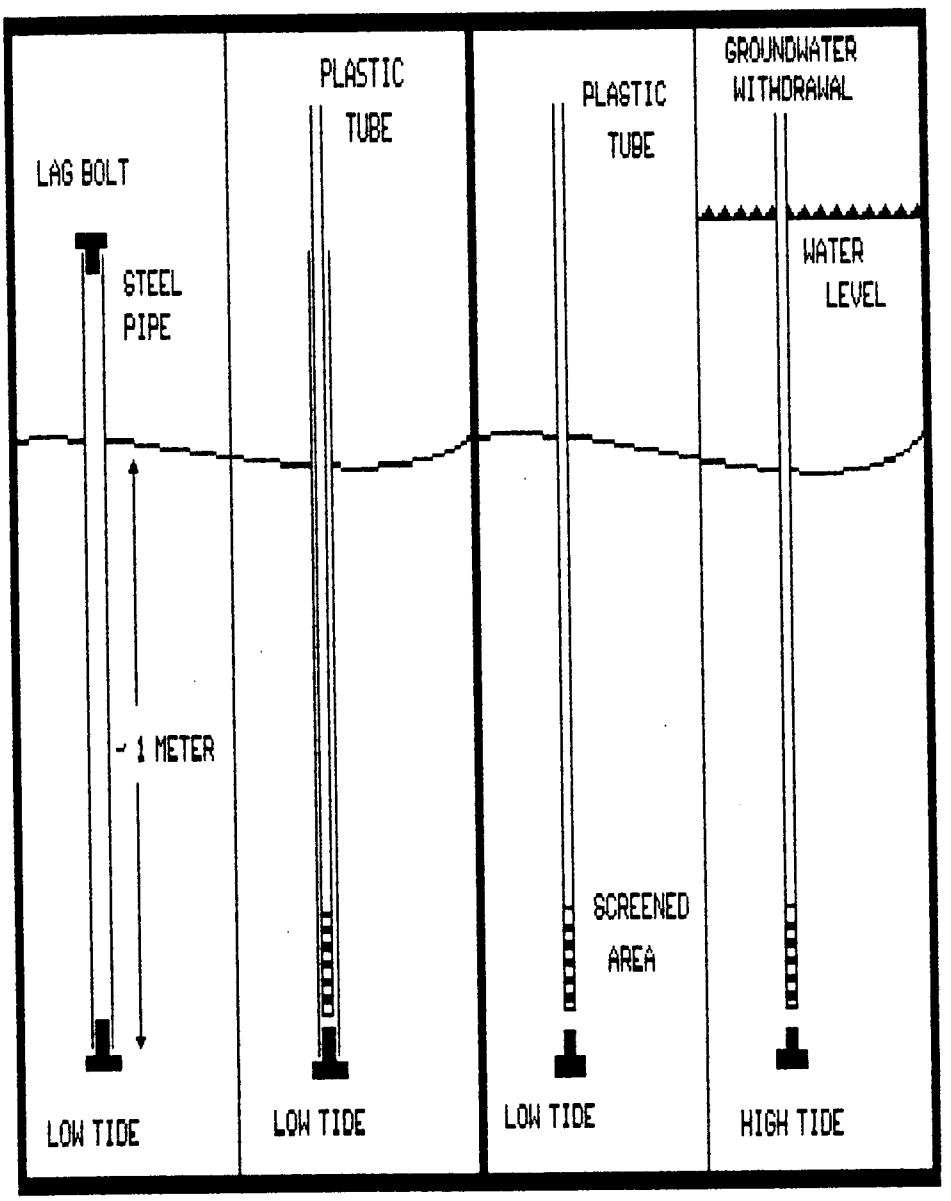

FIGURE 4 MINI-PIEZOMETER OPERATION

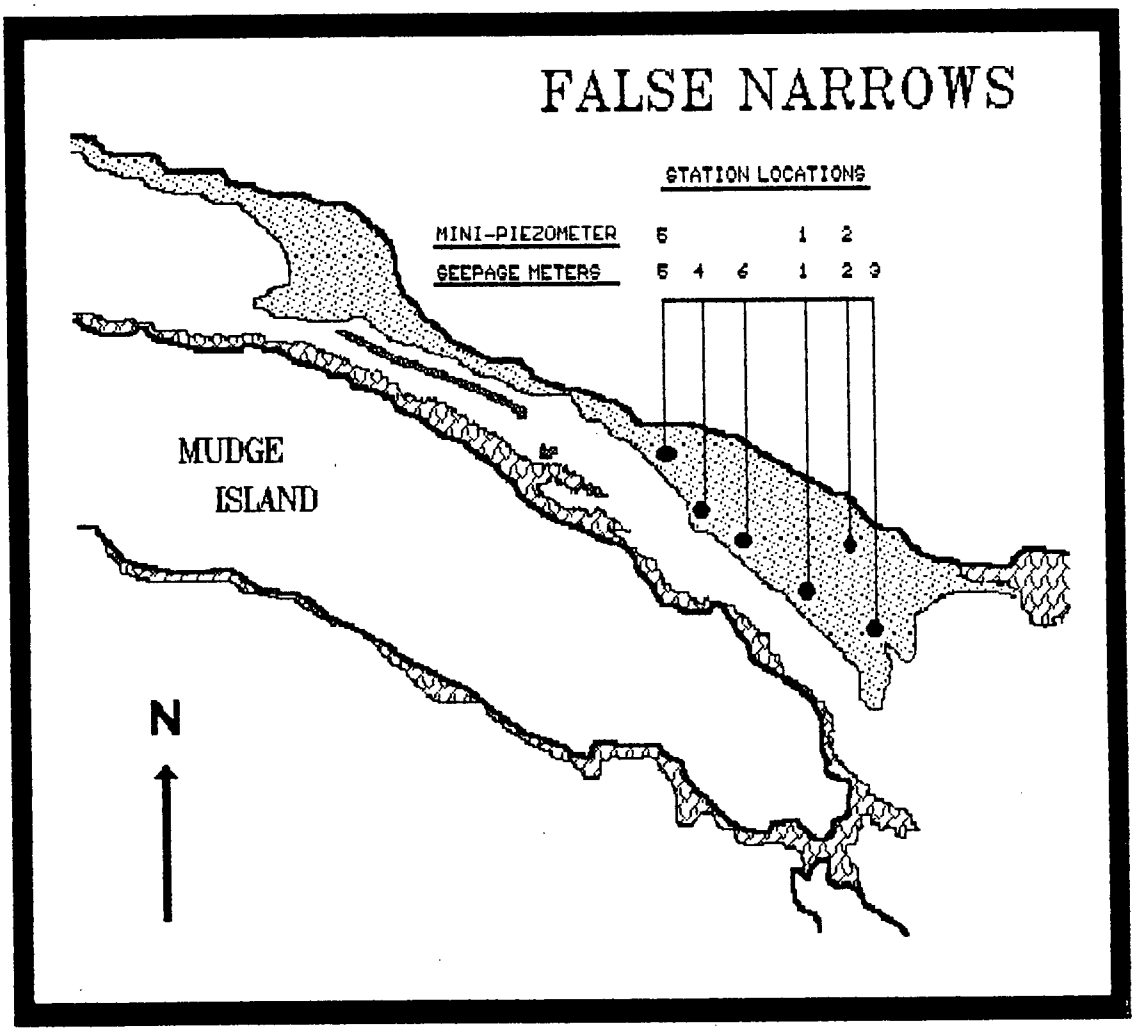

FIGURE 5 SEEPAGE WELL AND PIEZOMETER LOCATIONS

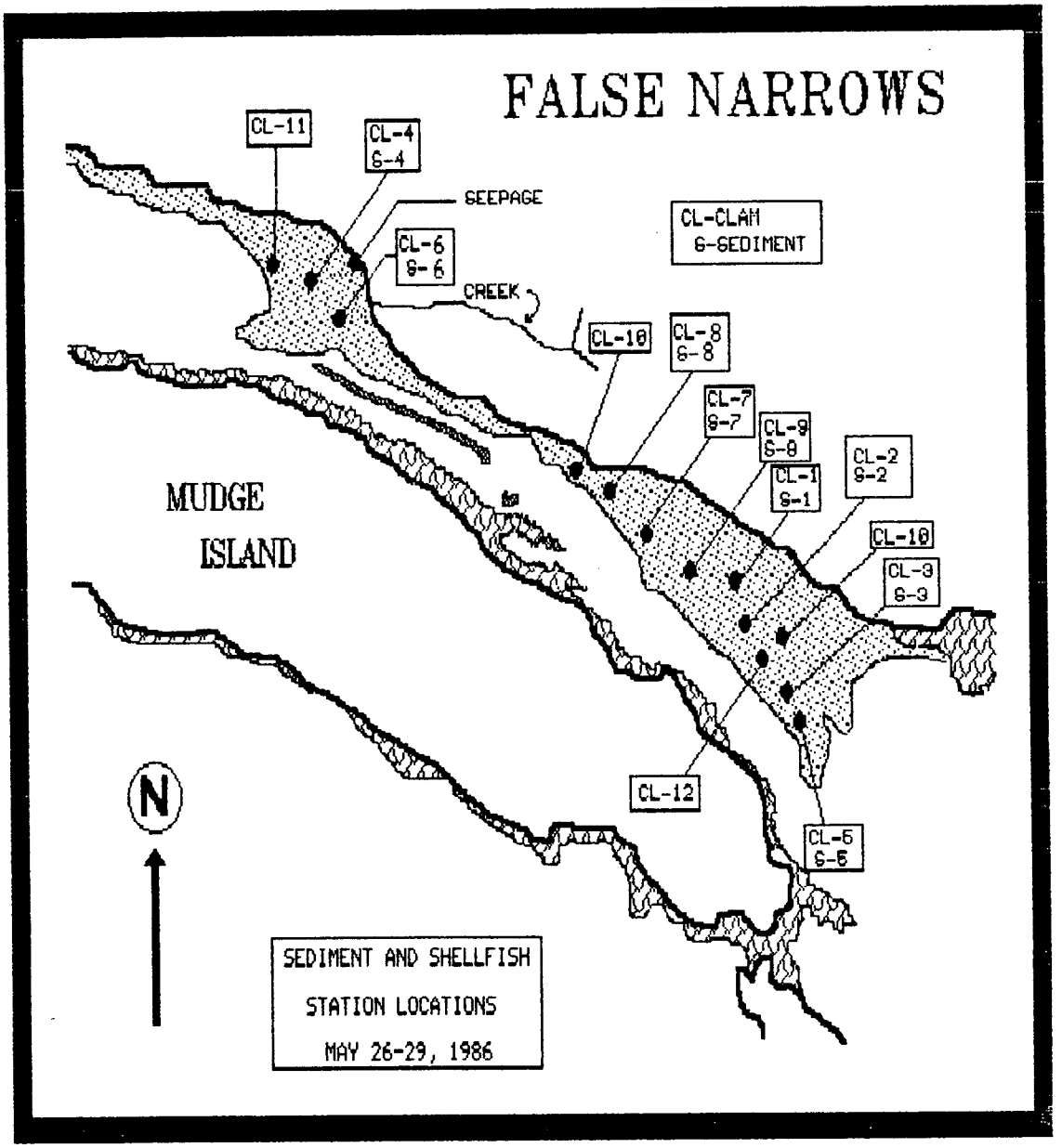

FIGURE 6 STATION LOCATIONS SEDIMENT AND SHELLSTOCK

4 DISCUSSION OF RESULTS

4.1 Groundwater Seepage Flux Meters and Mini-Piezometers

Fecal coliform bacteria were not found in any of the samples from either the seepage meters or the piezometers wells. Salinity values on all seepage meter samples indicated that saline waters were being sampled rather than the intended groundwater flux (Table 3). On May 27, salinity readings on two of the piezometers wells indicated that some fresh water was present at one meter below the surface. Wells 1G and 2G recorded readings of 16 and 17 ppt salinity.

4.2 Sediment, Shellstock and Freshwater

Samples of sediment and shellstock indicated that contamination was present throughout the bar, with one shellstock sample exceeding the shellfish sanitation program guidelines of 230 FC/100g. This occured at station 0601-10 which is located in the area referred to as the "Brick Yard". Fresh water station 0601-10 flows into this area but was not running during this survey.

Historical data for this station suggest that although the creek does not provide a constant source of contamination, periodic high fecal levels have occured (Table 1).

A sample of seepage in the area produced a count <2FC/100 ml (Figure 6).

TABLE 1 HISTORICAL BACTERIOLOGICAL DATA - STREAM. 0601-10

Station	Agency	Date	Fecal coliform/100 ml
S6	EPS	85 12 07	56
	EPS	12 08	20
	EPS	12 09	7
	EPS	12 10	5
	EPS	12 11	3
	DFO	85 06 03	49
	DFO	06 04	13
	DFO	06 06	280
	DFO	06 07	22
	DFO	07 02	5
	DFO	07 03	<2
	DFO	07 04	33
	DFO	07 05	130
	EPS	84 12 03	<10
	EPS	12 04	30
	EPS	12 05	<10
	EPS	83 02 15	<10
	EPS	02 16	10
	EPS	02 17	160
	EPS	02 18	10

TABLE 2 RESULTS FOR SHELLSTOCK AND SEDIMENT ANALYSIS

STATION	DATE SAMPLED	FECAL COLIFORM/100g		
		SEDIMENT	BUTTER	LITTLE NECK (MIXED)
1	May 26/86	92	80	230
2	May 26/86	26	70	80
3	May 26/86	14	70	80
4	May 26/86	26		80
5	May 27/86	22	20	20
6	May 27/86	34		330
7	May 27/86	10	20	80
8	May 28/86	4	130	80
9	May 28/86	26	<20	<20
10	May 28/86	14	70	80
11	May 29/86		<20	<20
12	May 29/86		20	<20
13	May 19/86			<20

TABLE 3 BACTERIOLOGICAL RESULTS FOR FLUX METER SAMPLES AND PIEZOMETER WELLS MEMBRANE FILTRATION DATA

SAMPLE #	DATE SAMPLED					
	SEEPAGE METER			MINI PIEZOMETER		
	FC /100ml					
	May 26	May 27	May 28	May 26	May 27	May 28
1	0(28)*		<10(27)	0(16)	0(28)	0(28)
2		0(28)	0(27.5)	0(17)	0(25)	0(28)
3	0(28)	0(28)	0(28)			
4	0(27)		<10(27.5)			
5	0(27)	0(27)	<10(26)	0(26)	0(28)	0(28)
6	1(28)	0(28)	0(28)			

* (brackets) are salinity values in parts per thousand
MEMBRANE FILTRATION METHOD

5 CONCLUSIONS

1. The marine waters of the Gabriola Bar area did not show fecal contamination in the samples taken from the seepage meters.

2. Samples taken from the mini-piezometers wells did not show fecal contamination.

3. Samples taken from the seepage meters and the mini-piezometers were not representative of groundwater flux. This was most likely due to one or a combination of the following;

    i) groundwater was not being discharged to the area because there had been no precipitation,
    ii) the sample stations were not correctly located and therefore missed the main flow,
    iii) the seepage meters were not installed properly and the piezometers were not deep enough,
    iv) this area is not a discharge zone for groundwater.

4. Shellstock and sediment samples indicate a persistent source of fecal contamination to the area. This is supported by data from pervious surveys.

5. Freshwater 0601-10 was not flowing at the time of this survey, however previous data have estabished a low level of contamination in the creek waters. The creek drains a pasture area where cows have direct access to creek waters.

6 RECOMMENDATIONS

DATA REVIEW

This survey and previous surveys have not identified a point source of contamination, however data indicates a source of contamination exists. Future work should review all past survey and harvesting data in an effort to correlate contaminated lots with such events as rainfall, summer cottage activities, bird and waterfowl activity and non-point source activity that may effect the creek and ultimately the area of the brickyard.

SOURCE IDENTIFICATION

Review of data should take into consideration that the two harvesting areas (Gabriola Bar and the Brickyard) are most likely experiencing contamination that may be from different sources and transported by different means.

MANAGEMENT PLAN

Conclusions from this review should be used with information on the commercial value of the harvest toward assessing the need for further work in the area or the development of a management plan that will satisfy the requirements of the Shellfish Sanitation Program.

FUTURE SURVEY WORK

Should further sanitary work be required it is recommended that a groundwater specialist be involved in the development of a field program.

REFERENCES

1. Moen, B. An Investigation Into Groundwater Availability and Quality On Gabriola Island, British Columbia. Report to the Island Trust (April 1979).

2. Lee, David R. and John R. Cherry. A Field Exercise on Groundwater Flow Using Seepage Meters and Mini-Piezometers. Journal Of Geological Education Vol. 27, pp. 6-10 (1978).

APPENDIX I

DATE	REPORT	AUTHOR	PURPOSE	CONCLUSIONS	RECOMMENDATIONS
July '75 Aug '75	RPT. 75-12	Environmental Protection	Sanitary Shellfish Survey	All stations met the approved growing water standard.	No Closure
June '82 Aug '82 Feb '83	RPT. 83-12	Environmental Protection	Sanitary Shellfish Survey	All stations met the approved growing water standard. Two separate stations in False Narrows exceeded the standard on different days on one occasion only. Shellstock samples showed low level contamination. Observed pollution was not considered significant. Brookswood Poultry Farm was not considered to be an impact on False Narrows.	No closure. However, it was noted that there has been an increase in the numbers of contaminated lots coming from this area.
June '84	File Rpt.	Environmental Protection	FC study of sacked clams placed at various tide levels and the effects of holding through a 48-hour period. Sediments were sampled at the same time.	Fecal coliform levels in the sacked clams increased over time at the high intertidal and above tide line stations in mixed species. Pollution sources have not been identified.	Butter clams and littleneck clams should not be mixed but sampled separately. Dye testing of sewage systems in private homes in the area should be done. Samples should be taken on a flood tide.
Dec '84	File Rpt.	Environmental Protection	Survey of marine waters, fresh waters, sediment and potential pollution problems from the Brookswood Poultry Farm.	Marine waters showed low levels of contamination. Sediment stations showed higher levels of fecal contamination. FC:FS rations were not conclusive as to origin. Creek water samples were low in FC levels. Large numbers of birds were noticed in the Brick Yard area and the west end of the sand bar.	Contaminated lots still coming from this area. Seasonal closure action results from commercial lot sampling.

DATE	REPORT	AUTHOR	PURPOSE	CONCLUSIONS	RECOMMENDATIONS
June '85 July '85 Aug '85	File Rpt.	Dept. of Fisheries and Oceans	Study to determine the bacteriological quality of marine waters and butter clams.	Fecal coliform levels in butter clams and marine waters were low. Creek waters were contaminated but were not flowing to marine waters due to the absence of rain.	Both butter and littleneck clams should be analysed. Worst case hydrographic conditions should apply to clam sampling (rain). Sampling on high tides to determine if tidal action is responsible.
Dec '85	File Rpt.	Environmental Protection	Survey of marine and sediment stations in the bar and narrows area.	Fecal coliform levels were elevated around the brickyard area but not above standard. Sediment station in this area also indicated a high fecal coliform level. Well waters were not contaminated nor were freshwater stations. No direct source of contamination was found.	Possible contamination of shellfish in this area due to contaminated groundwater or bird feces. Further survey work required on water, sediment, shellstock during low tide to assess potential groundwater contamination of stocks.
May '86	File Rpt.	Environmental Protection	Survey of groundwater, sediment, and shellstock to determine if the area is contaminated by groundwater transporting septic wastes to the clam beds.	Groundwater sampling was not successful with the flux meters however, mini piezometers indicated fresh water in some stations; FC contamination was not evident. Sediment samples did not show significant amounts of contamination. Only one shellstock sample was above standard. Low level contamination was evident in 9 out of 13 stations sampled.	