ADDENDUM TO REPORT ENTITLED

WATER QUALITY STUDY

SEPTEMBER, 2004

NEWPORT SEWAGE OUTFALL

NEWPORT BAY

CO. MAYO

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Introduction

In addition to the site investigation carried out in the main body of the report, an alternative site for the Newport sewage outfall was also considered. The two dimensional model DIVAST was again used to predict the solute transportation. This addendum presents a schematic of the modelled area, the exact location of the alternative site, and the various model inputs. The model results predicting concentrations of faecal coliforms, copper, cadmium, and ammonia throughout the modelled area as well as the current velocity vectors are also presented. These results are discussed in accordance with the same water quality standards used in the first site investigation. The conclusions regarding the suitability of the current site are drawn based on the possible impact which the proposed outfall will have on the surrounding marine environment.

Model details and hydrodynamic simulations

The extent of the model area and the site of the proposed outfall are shown in Figure A.1. The tidal boundary conditions are the same as those used in the model for the first site investigation, i.e. spring and neap tidal ranges are 4.0 m and 1.6 m respectively. The hydrodynamic model was run for a full spring-neap tidal cycle to examine the water circulation patterns and the variation of current velocities throughout the bay. The results from the hydrodynamic model simulations are presented in Figures A.2 to A.9 as snapshots in time of velocity vectors at model grid points. The output is presented at four different times during the course of a neap tidal cycle: mid-flood, high water, mid-ebb and low water, and also during a spring tidal cycle.

Current velocities near the proposed site range from practically zero at high water to maximum of 0.35m/s on the flooding spring tide. The current velocities calculated during the spring tidal cycle at mid-ebb and mid-flood are much greater than the corresponding flows during the neap tidal cycle, as expected. The current velocities are also greater on the flooding tide. The mean maximum neap tide velocity is 0.12m/s and the mean maximum spring tide velocity is 0.35m/s on the ebbing tide whereas the corresponding velocities are 0.1m/s and 0.26m/s on the flood tide.

Solute Transport results

Using the flow rate and effluent concentrations specified in Table A.1 the model was run for a full spring - neap tidal cycle (i.e. 350hrs). River discharge into the model area bay was not considered since it would only have a very small overall influence on the predicted solute concentrations. Snapshots of the faecal coliform, cadmium, copper, and ammonia plumes within the study area were output by the model at four different stages of the tide, namely, high water, mid-ebb, low water and mid-flood, for both neap and spring tide conditions. The simulations carried out for ammonia included the effects of diffusion due to a moderate southerly breeze, (i.e. 7.5m/s) and also for a zero wind condition. The neap solute plumes were output by the model at approximately 175 hours into the simulation while the spring plumes were output after approximately 350 hours of the simulation. These solute plumes are illustrated in Figures A.10 – A.49. A table of the maximum concentrations predicted at each stage of the tide is presented below (table A.2). These maximum values occurred within a 20m grid square surrounding the outfall pipe.

Rate of discharge (l/s)	Concentration of faecal coliforms in effluent (number/100ml)	Concentration of copper in effluent (mg/l)	Concentration of cadmium in effluent (mg/l)	Concentration of ammonia in effluent (mg/l)
12.3	2000	0.08	0.001	5.0

Table A.1: Characteristics and flow rate of effluent from outfall pipe

Tidal stage	Copper conc. [ng/litre]	Cadmium conc. [ng/litre]	FC conc. [number/100 ml]	Ammonia Conc. (mg/l) no wind	Ammonia Conc. (mg/l) wind
Neap mid flood	45.6	0.57	0.83	0.0050	0.0022
Neap high water	48.8	0.61	1.04	0.0178	0.0025
Neap mid ebb	43.2	0.54	0.73	0.0042	0.0020

Neap low water	53.6	0.67	1.09	0.0052	0.0025
Spring mid flood	26.4	0.33	0.42	0.0024	0.0011
Spring high water	32.1	0.40	0.77	0.0082	0.0017
Spring mid ebb	24.2	0.30	0.36	0.0015	0.0010
Spring low water	48.1	0.60	0.98	0.0052	0.0021

Table A.2: Maximum faecal coliform, cadmium ,copper and ammonia concentrations at different periods in the tidal cycle

Discussion of Results and Conclusions

Looking at the maximum values predicted at the outfall for the different stages of the tide examination it is evident that, in general, higher solute concentrations occur during the neap tidal cycle due to a smaller tidal range and hence lower current velocity values which tend to inhibit rapid dilution of the effluent during this period. Conversely, dilution of the effluent plumes is greatest on the spring tide at periods of relatively high current velocity i.e. at mid-ebb and mid-flood tide, when the volume of water entering or leaving the bay is at a maximum. The absolute highest concentrations for each substance occurred during the neap tidal cycle and are 1.09 number/100ml, 45.6ng/l, 0.57ng/l, 0.0025mg/l, and 0.0178 mg/l for faecal coliforms, copper, cadmium, and ammonia with and without wind respectively. These will now be compared with the relevant water quality standards outlined in chapter 5 of the main report. A summary of the standards presented in that chapter are as follows:

1. The Shellfish Water Directive (79/923/EEC) states that a mandatory value of <300 faecal coliforms/100ml be observed in the waters in which live shell fish directly edible by man
2. The most stringent requirement laid down by the EU permit a maximum of 5µg/l in the drinking water and surface water regulations
3. In fresh water the 24hr average values of cadmium permitted by the World Health Organisation are: 0.012µg/l, 0.025µg/l and 1.05µg/l, for hardness values of 50, 100, and 200mg/l $CaCO_3$
4. For salmonid waters the World Health Organisation specifies values which range from 0.4µg/l to 1.2µg/l.

5. The equivalent values for copper are; 0.5mg/l in the EU Drinking water Regulations, 0.05mg/l in the EU Surface water Regulations, 0.005mg/l in the Salmonid Waters Regulations, and a 24-hour average value of 5.6μg/l permitted by the World Health Organisation for fresh water.
6. The most stringent limits according to the OSPAR Ecotoxicological criteria are 0.01 - 0.1μg/l for cadmium, and 0.005 -0.05μg/l for copper.
7. The EU Directive on water quality associated with freshwater fisheries, 78/659/EEC, stipulates that the maximum permissible levels of total ammonia, as N, is 0.3 mg/litre, which is considered to be that which would contain the limiting amount of un-ionised ammonia which is most harmful to freshwater aquatic life.

The maximum faecal coliform and ammonia concentrations are well below the limits specified in the above standards and so will have no impact on the surrounding water quality.

Background levels of cadmium in Irish estuaries range from 0.034 – 0.096μg/l and background levels for copper on the west coast of Ireland are 0.31μg/l. Although the maximum predicted concentration of copper (53.6ng/l) is slightly above the range of values specified by OSPAR Ecotoxicological criteria, it is well below the background concentration level mentioned above and so will not have any adverse effects on the surrounding water quality. The maximum predicted value of cadmium falls well below the strictest requirements of the water quality legislation. In fact the maximum value of cadmium is 1-2 orders of magnitude less than the allowable values. The only precaution which should taken is to monitor the concentration of copper and cadmium in the sediment close to the outfall site to examine any possible build up over a long period of time. Given the minute quantities involved however, this is unlikely to present any problems.

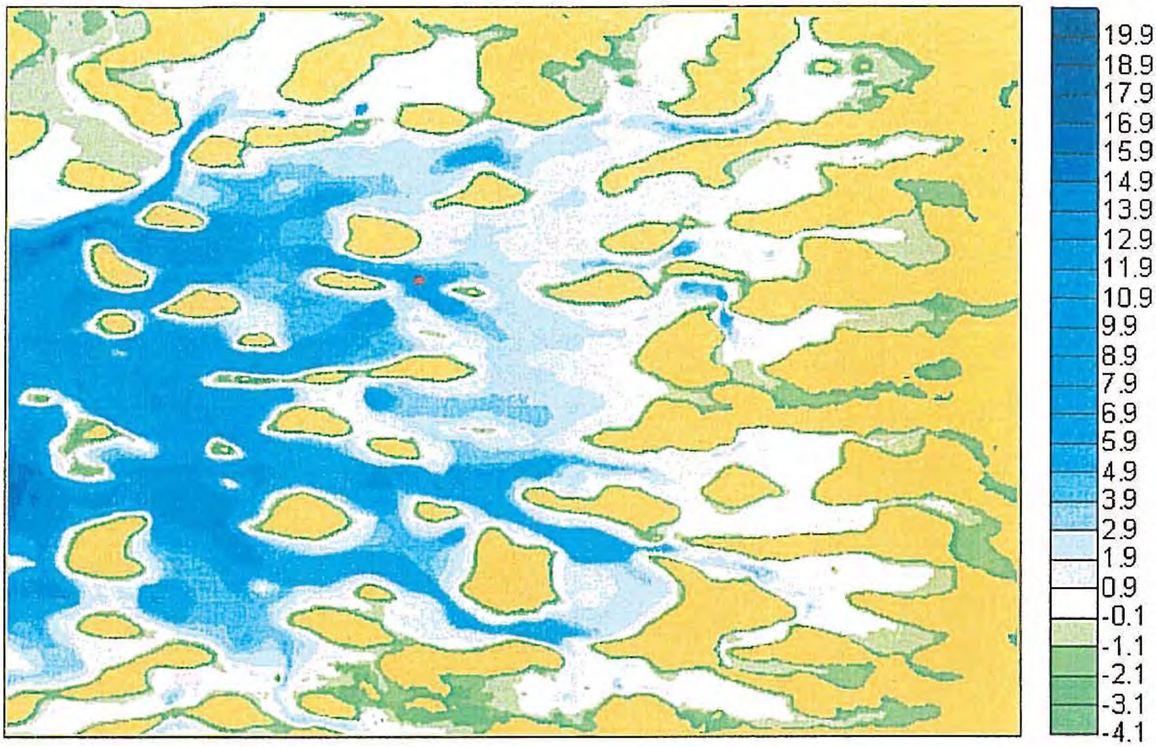

Figure A.1: Plan view of Newport Bay study area showing the location of the proposed outfall (E93503, N293116)

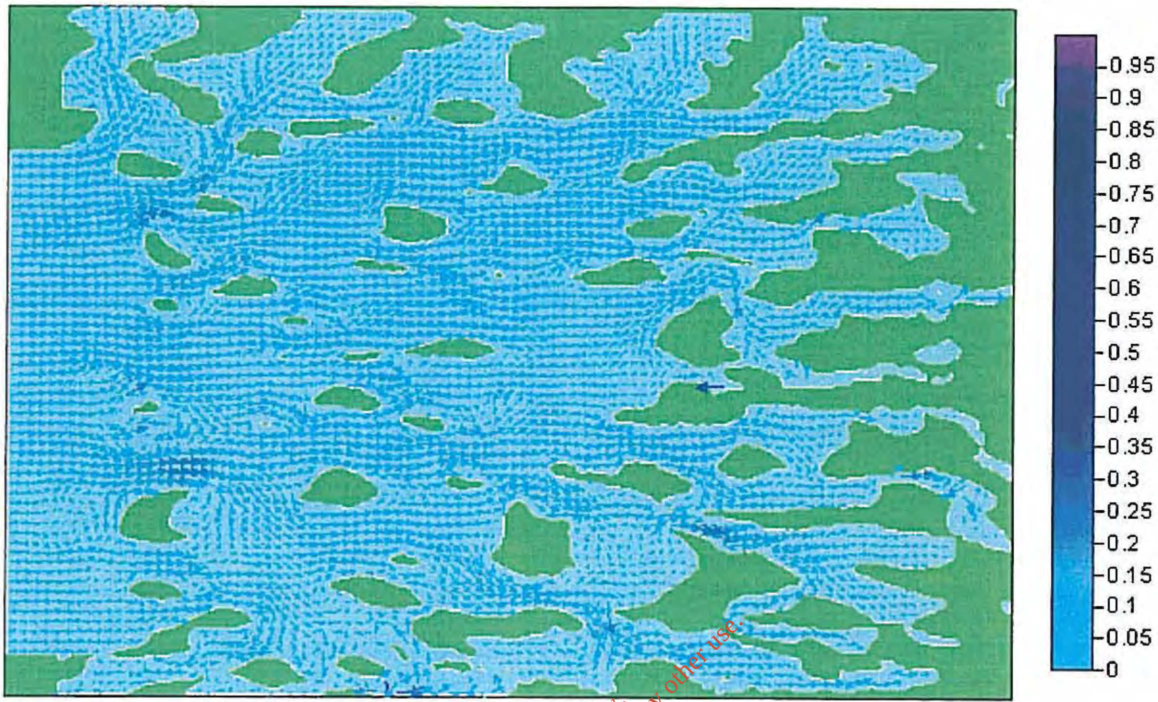

Figure A.2 – Current velocity vectors (m/sec) calculated at mid-flood on a neap tide.

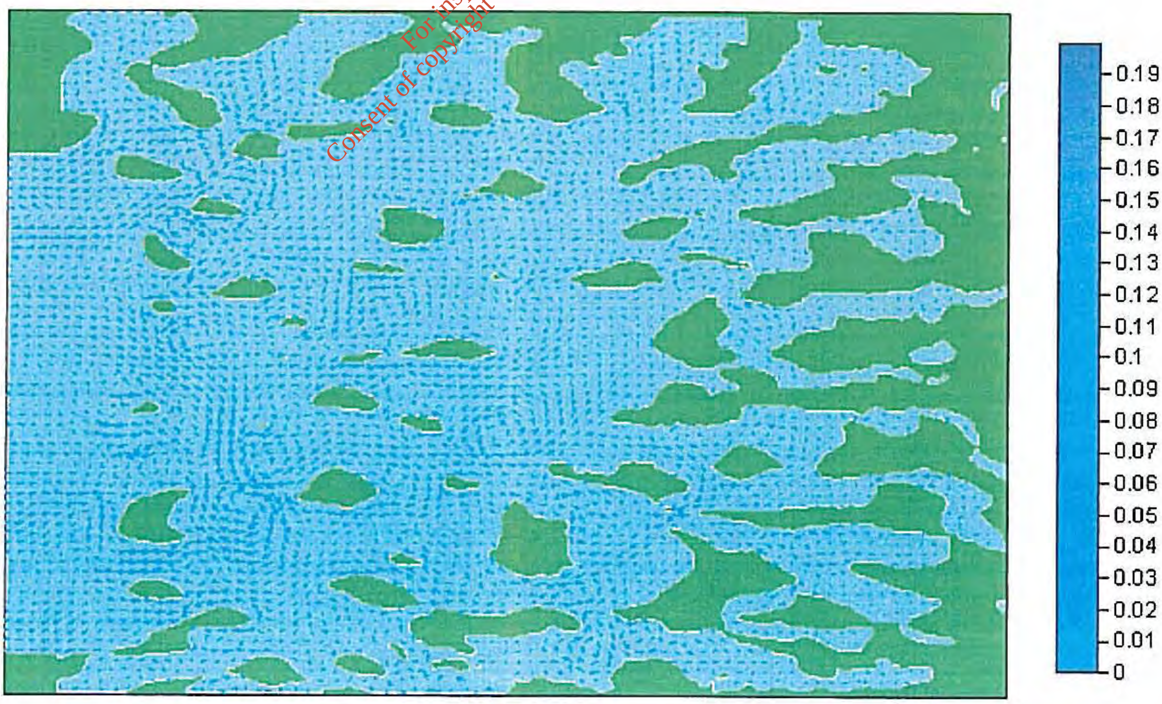

Figure A.3 – Current velocity vectors (m/sec) calculated at high water on a neap tide.

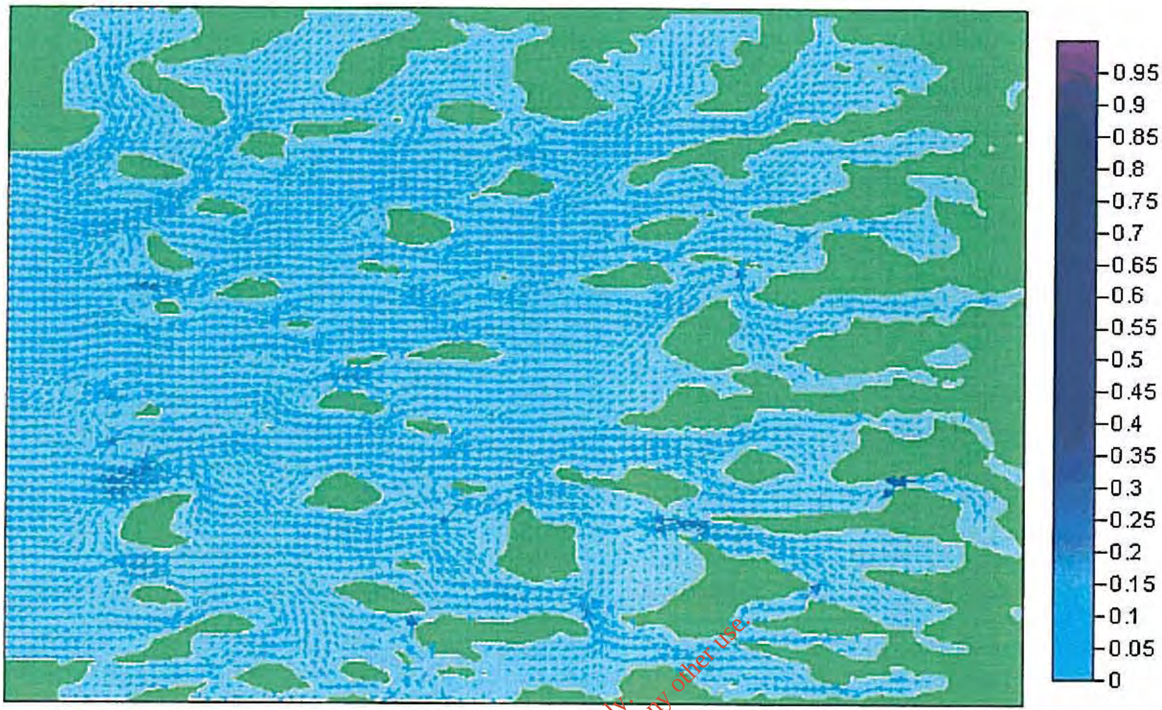

Figure A.4 – Current velocity vectors (m/sec) calculated at mid-ebb on a neap tide.

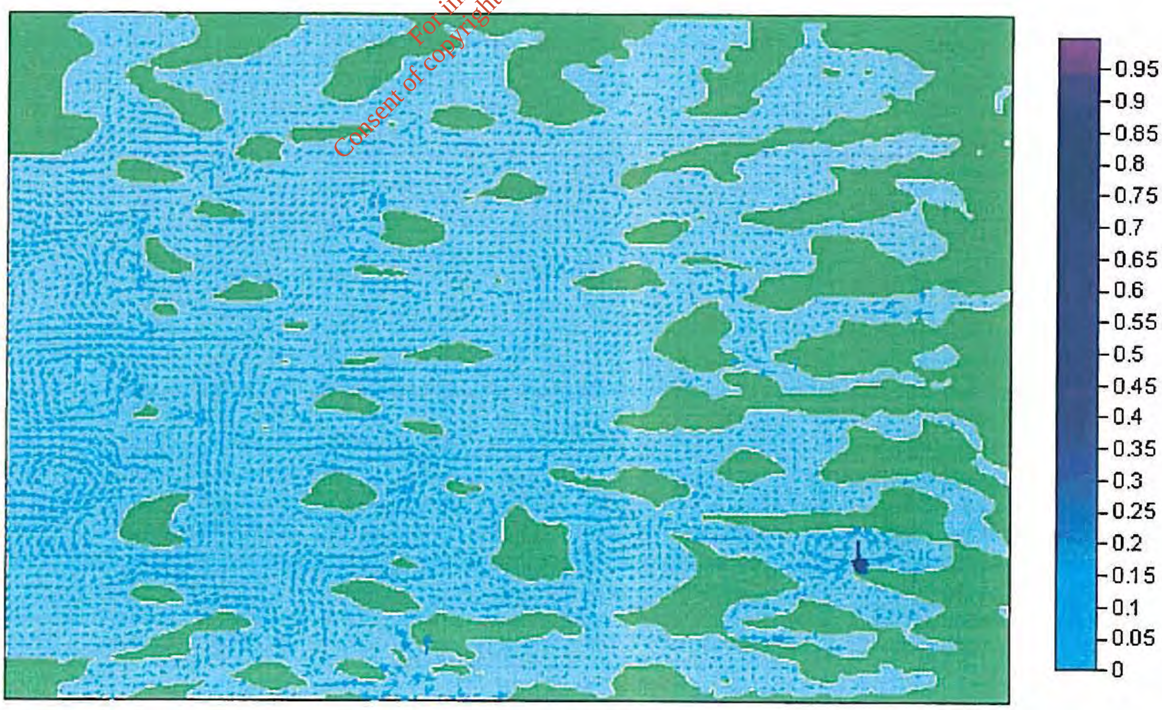

Figure A.5 – Current velocity vectors (m/sec) calculated at low water on a neap tide.

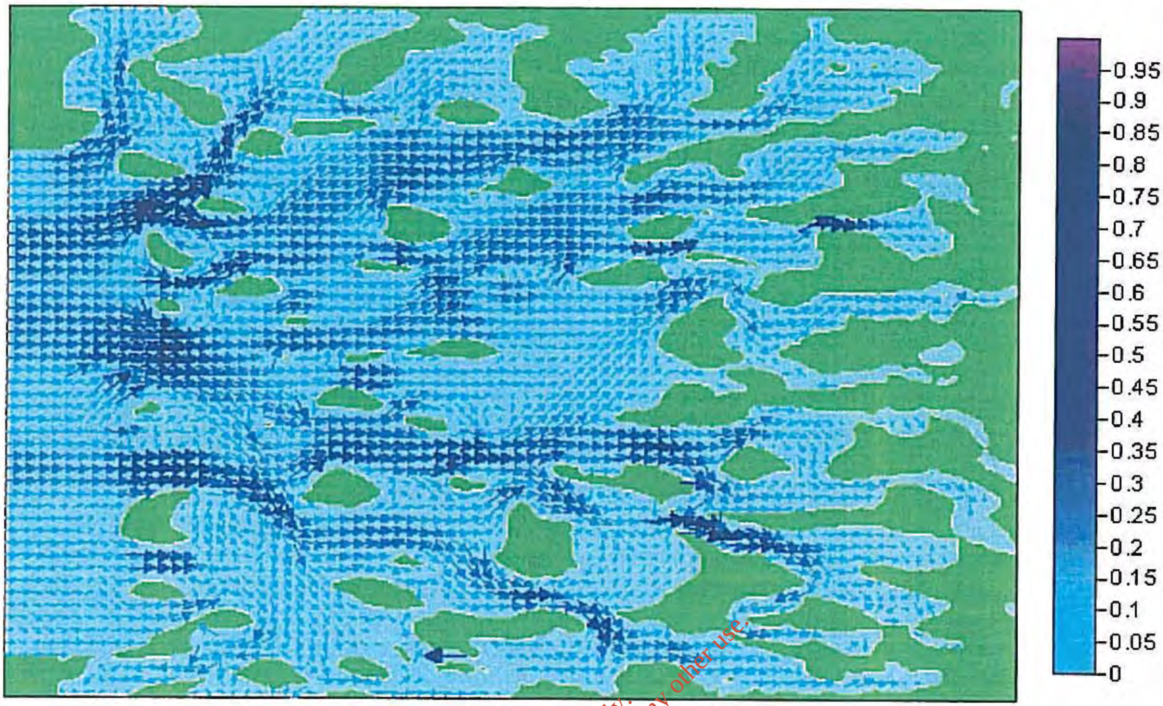

Figure A.6 – Current velocity vectors (m/sec) calculated at mid-flood on a spring tide.

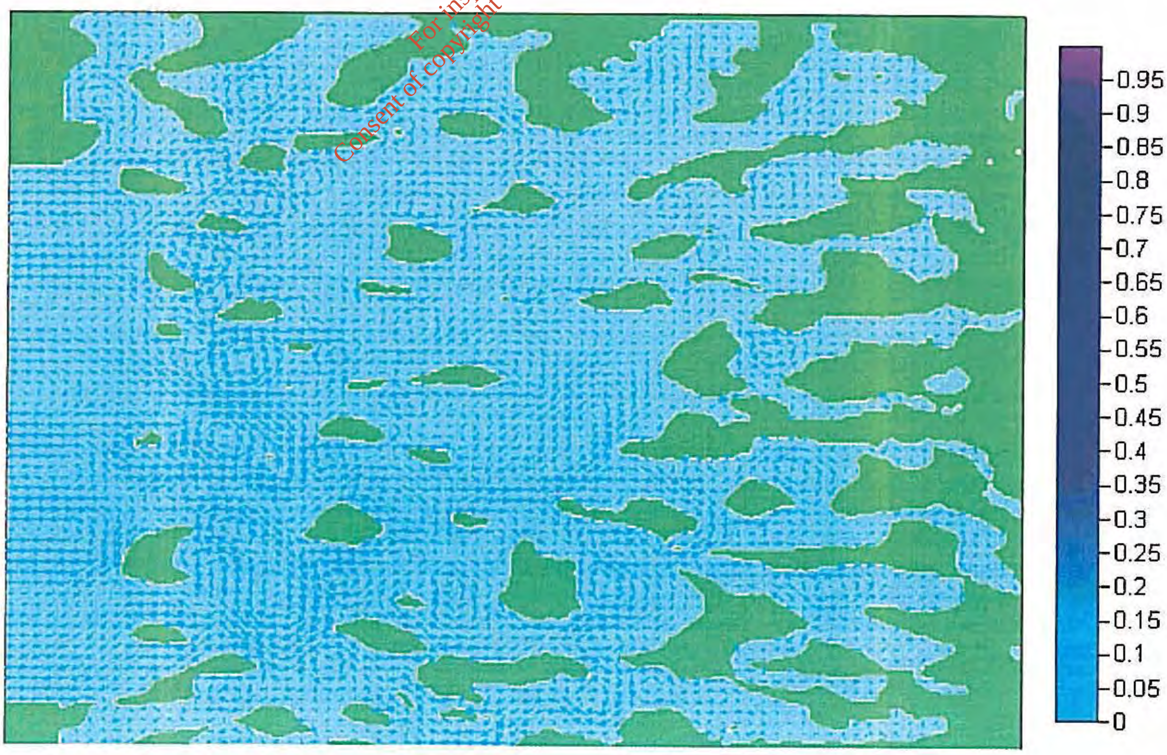

Figure A.7 – Current velocity vectors (m/sec) calculated at high water on a spring tide.

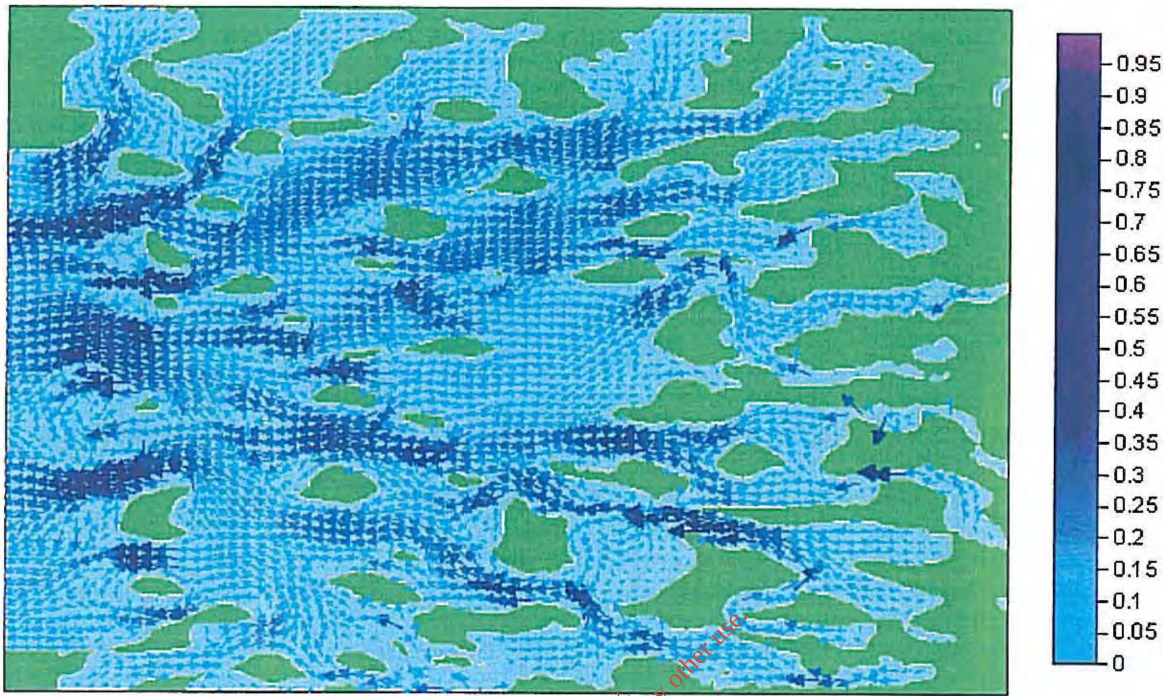

Figure A.8 – Current velocity vectors (m/sec) calculated at mid-ebb on a spring tide.

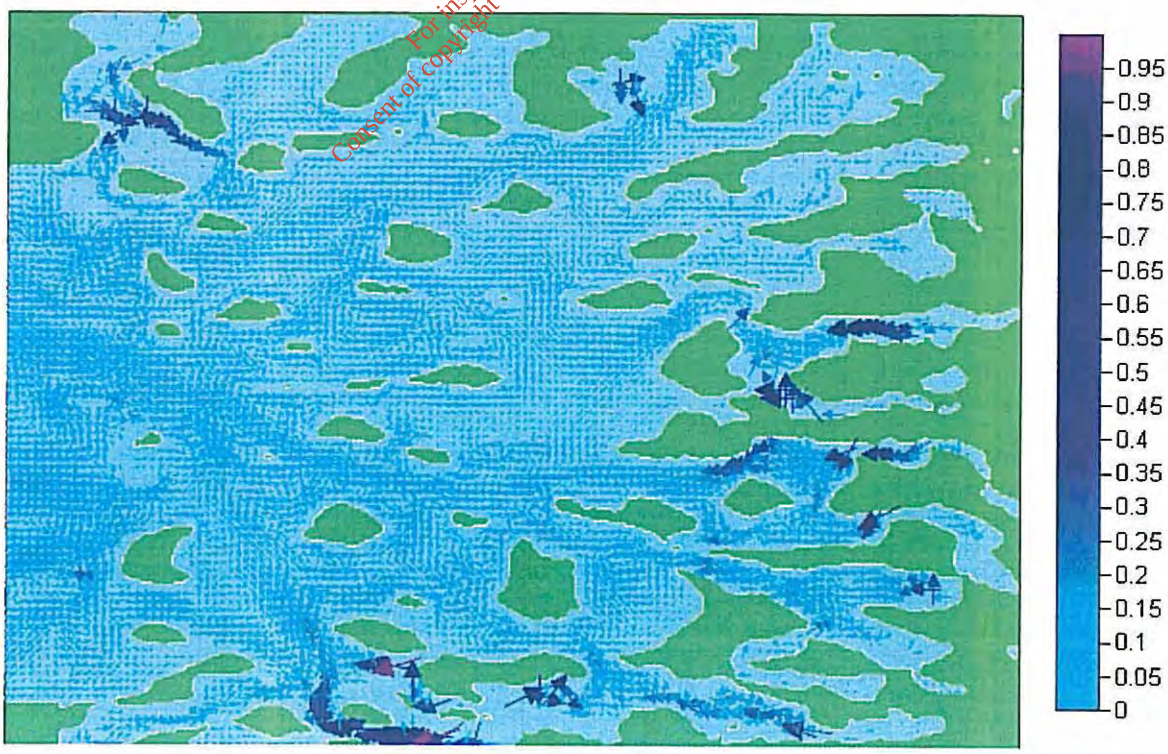

Figure A.9 – Current velocity vectors (m/sec) calculated at low water on a spring tide.

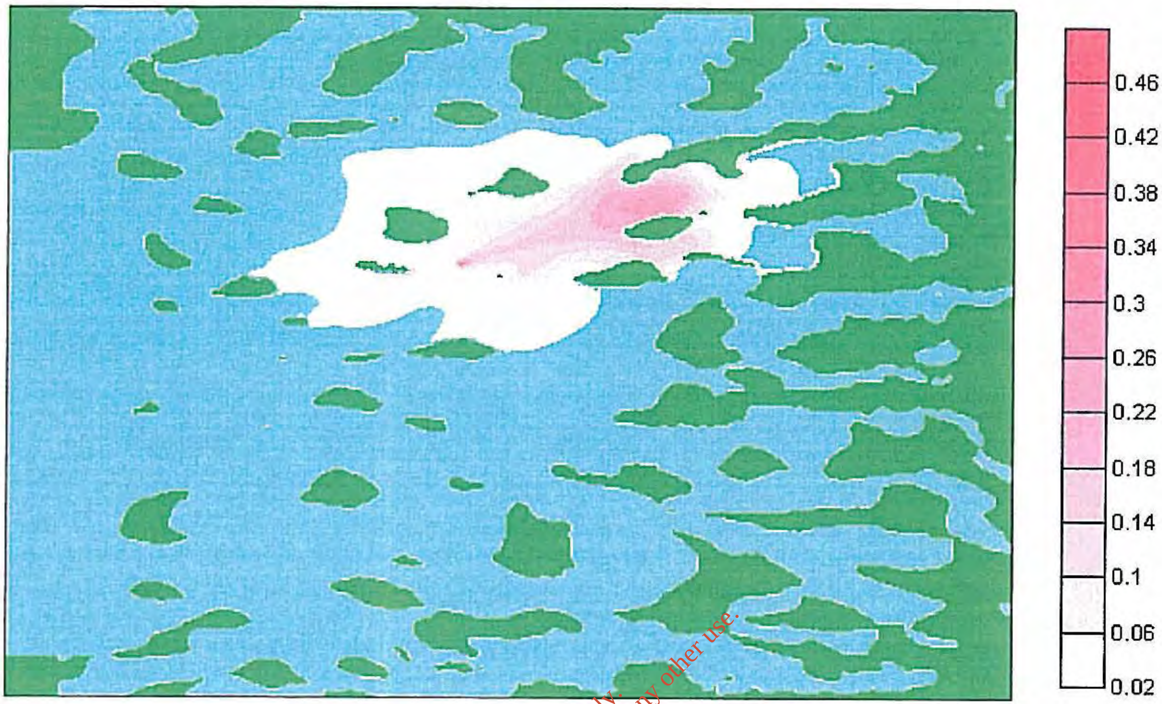

Figure A.10 : Faecal coliform concentrations at mid-flood on a spring tide (number/100 ml)

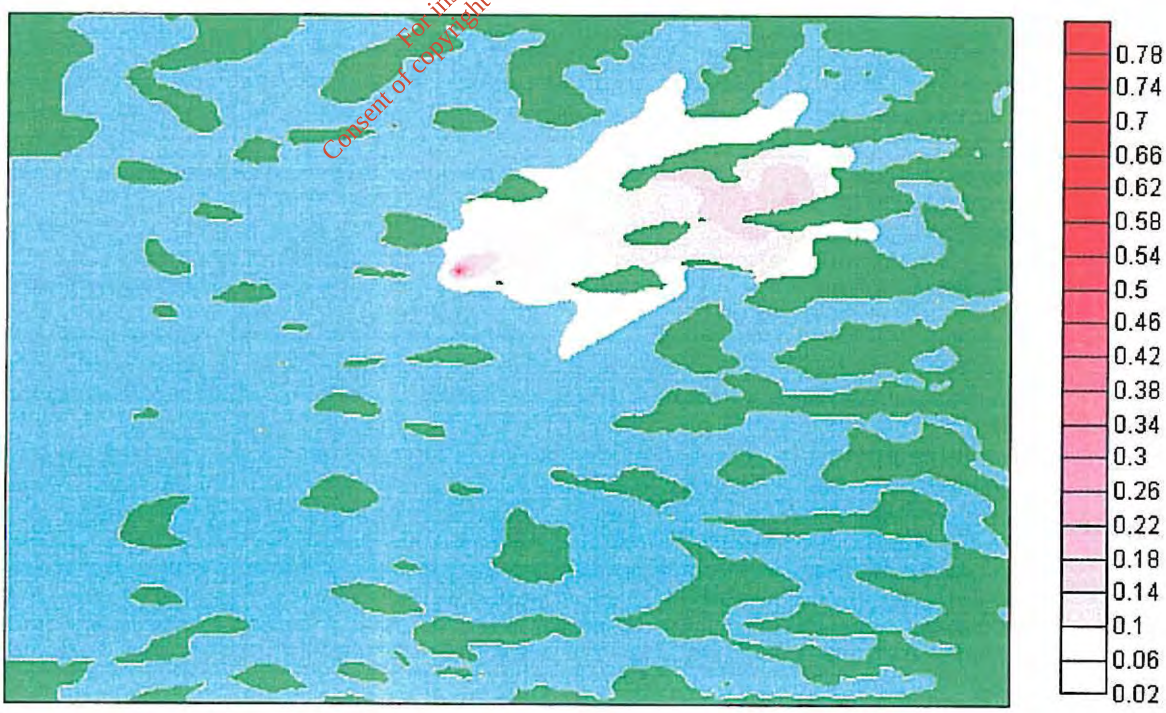

Figure A.11 : Faecal coliform concentrations at high water on a spring tide (number/100 ml)

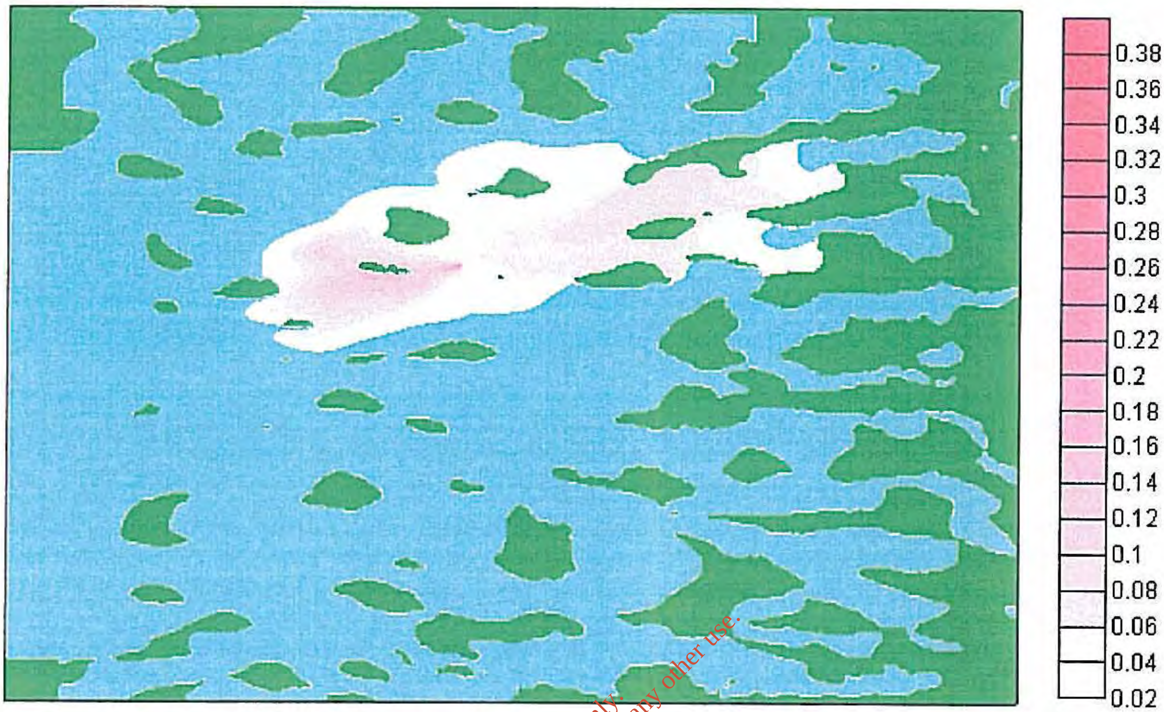

Figure A.12 : Faecal coliform concentrations at mid-ebb on a spring tide (number/100 ml)

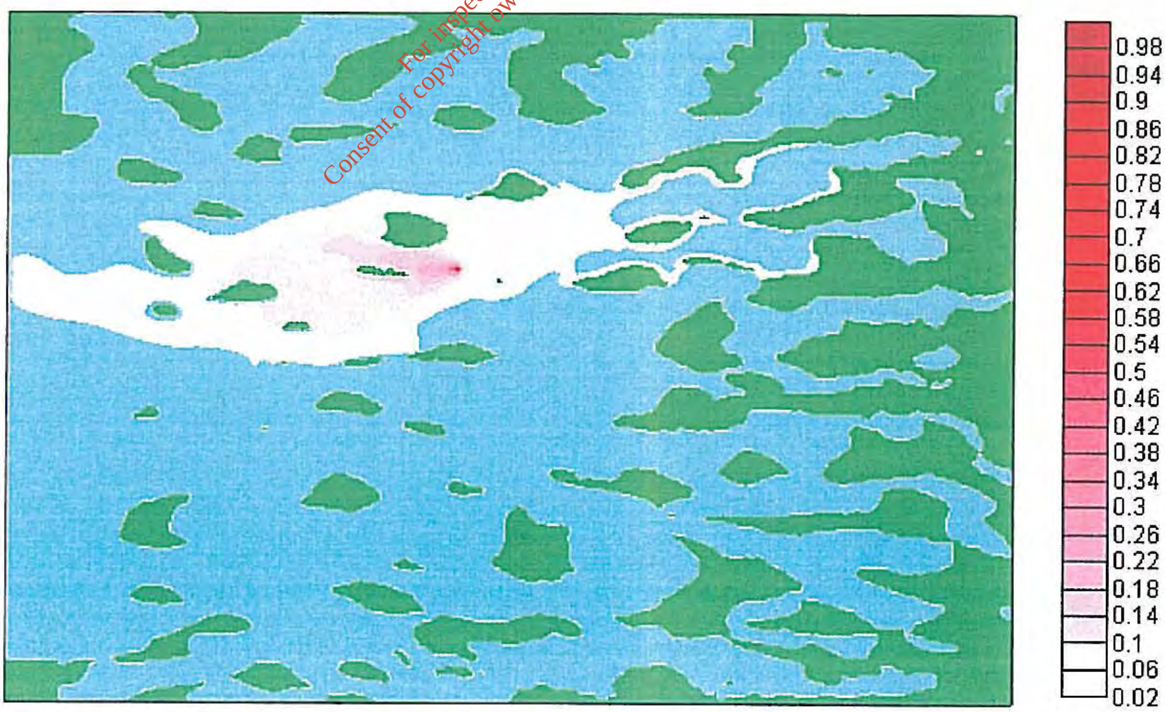

Figure A.13 : Faecal coliform concentrations at low water on a spring tide (number/100 ml)

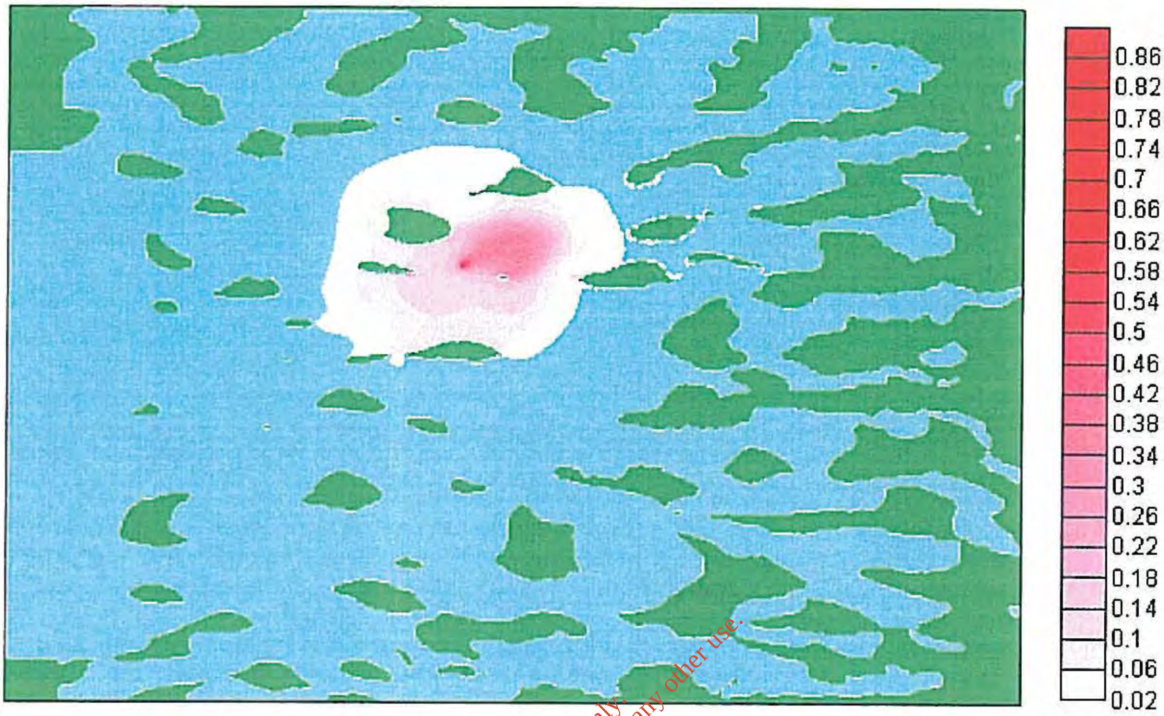

Figure A.14 : Faecal coliform concentrations at mid-flood on a neap tide (number/100 ml)

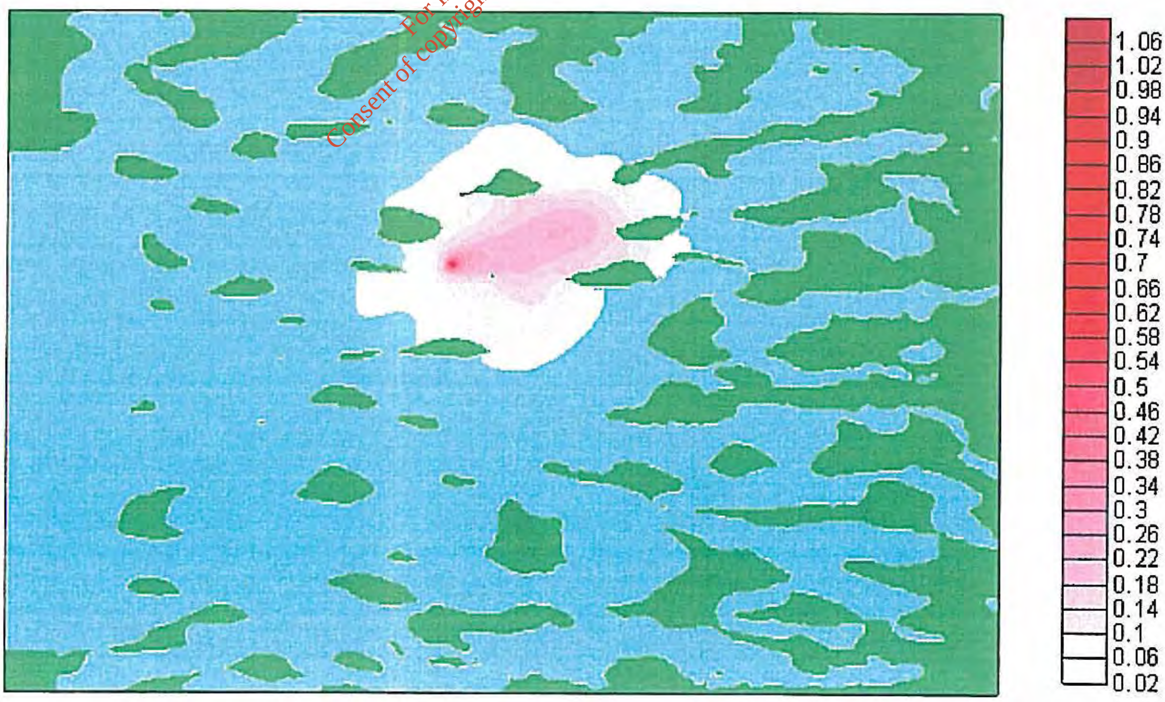

Figure A.15 : Faecal coliform concentrations at high water on a neap tide (number/100 ml)

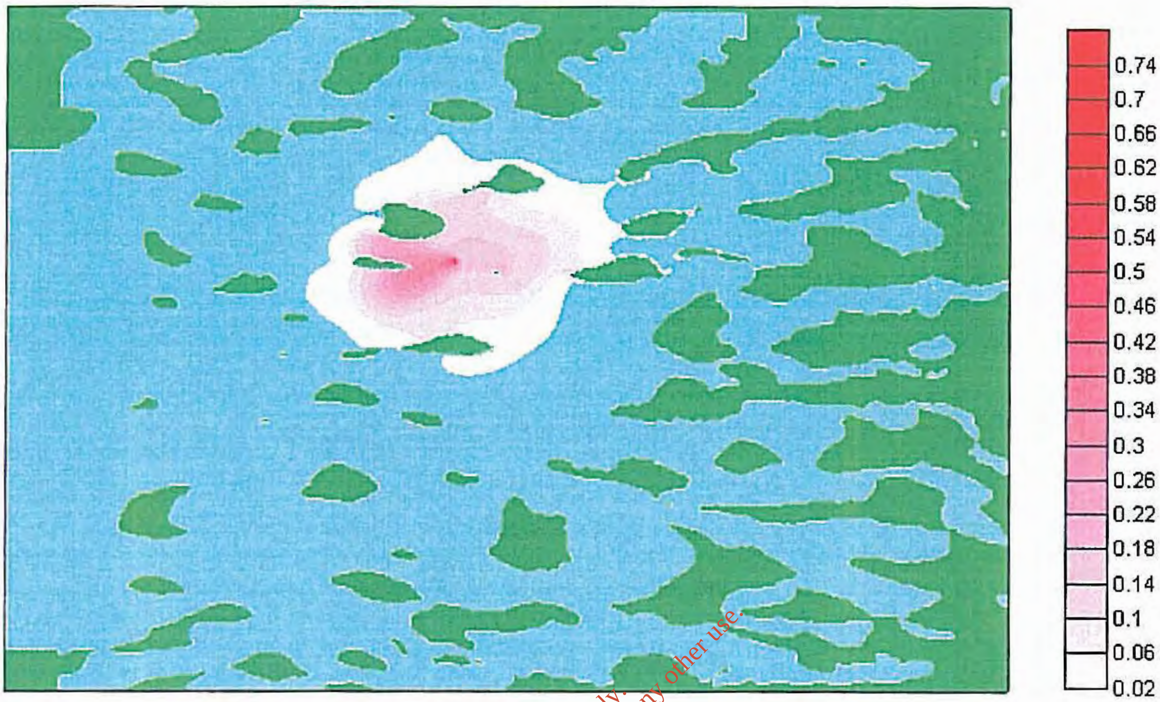

Figure A.16 : Faecal coliform concentrations at mid-ebb on a neap tide (number/100 ml)

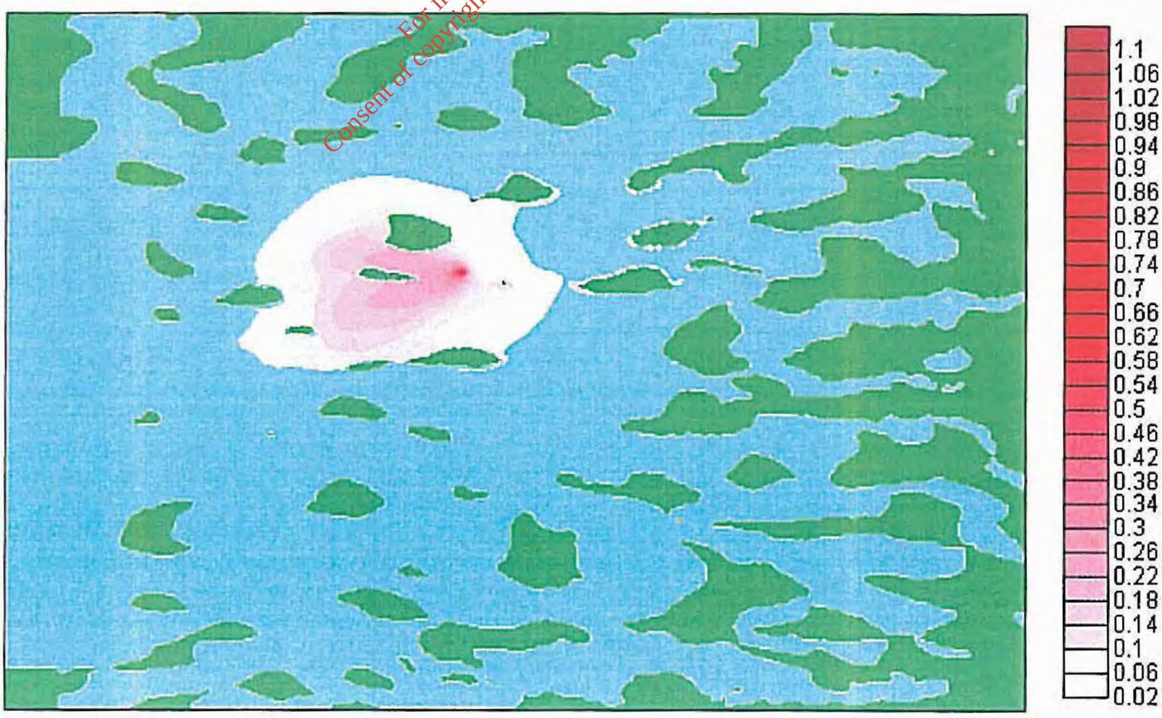

Figure A.17 : Faecal coliform concentrations at low water on a neap tide (number/100 ml)

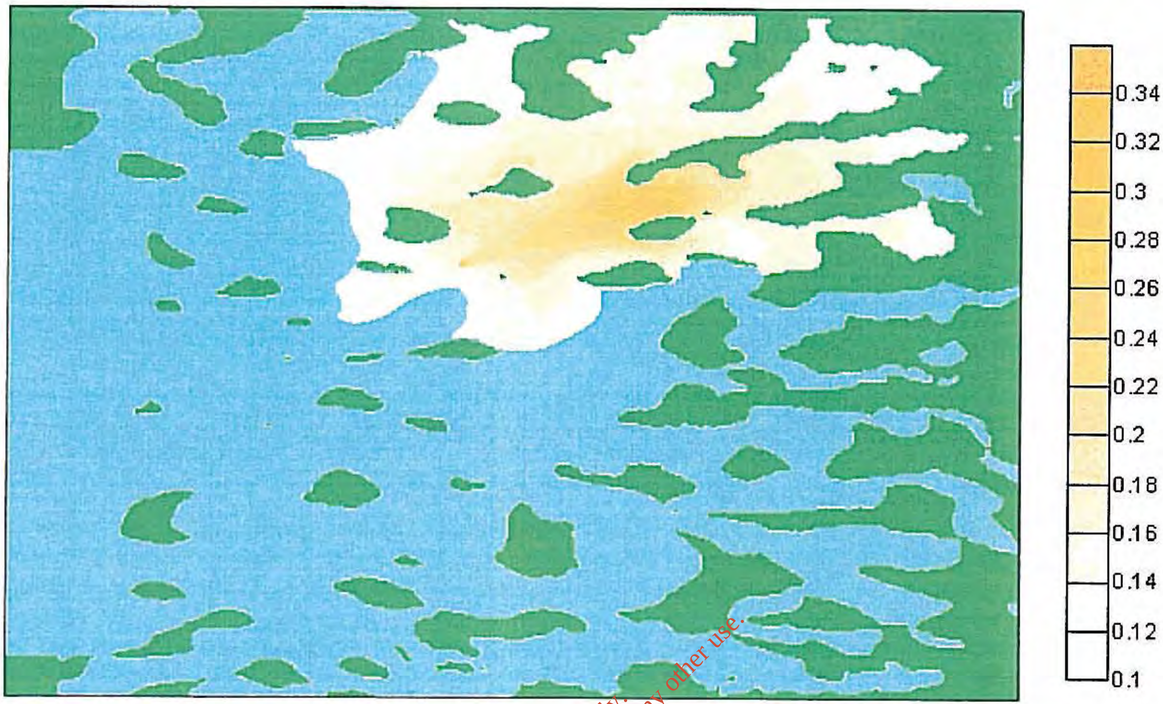

Figure A.18 : Cadmium concentrations (ng/l) at mid-flood on a spring tide

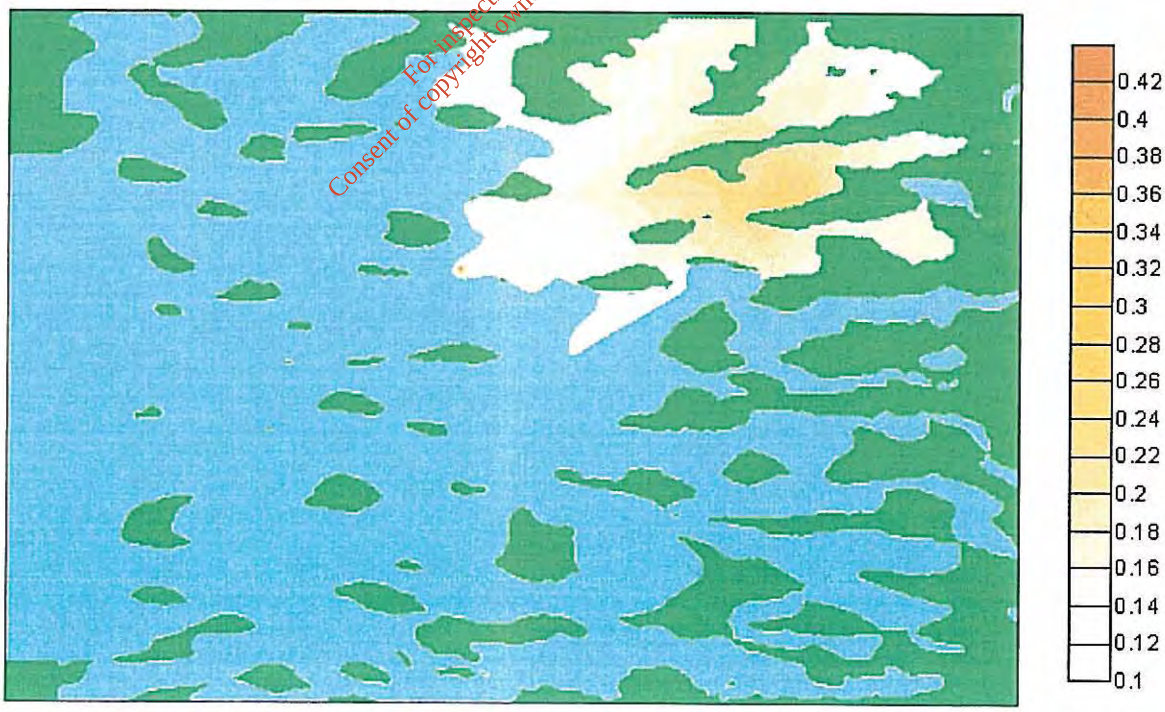

Figure A.19 : Cadmium concentrations (ng/l) at high water on a spring tide

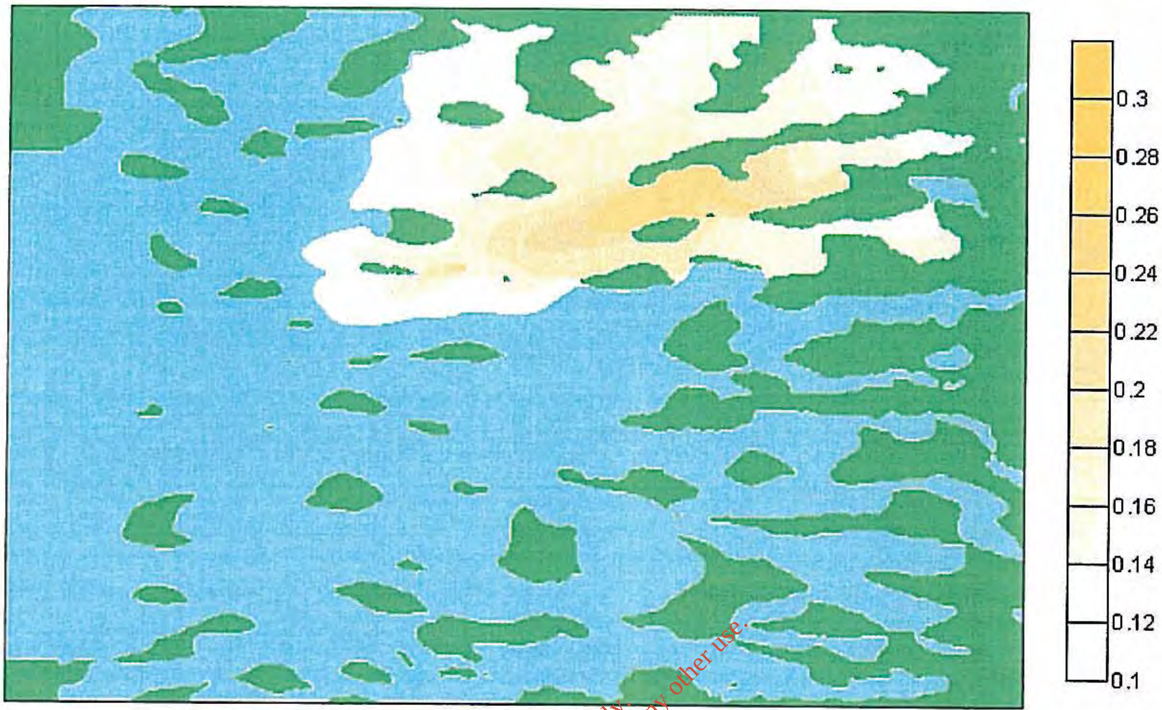

Figure A.20 : Cadmium concentrations (ng/l) at mid-ebb on a spring tide

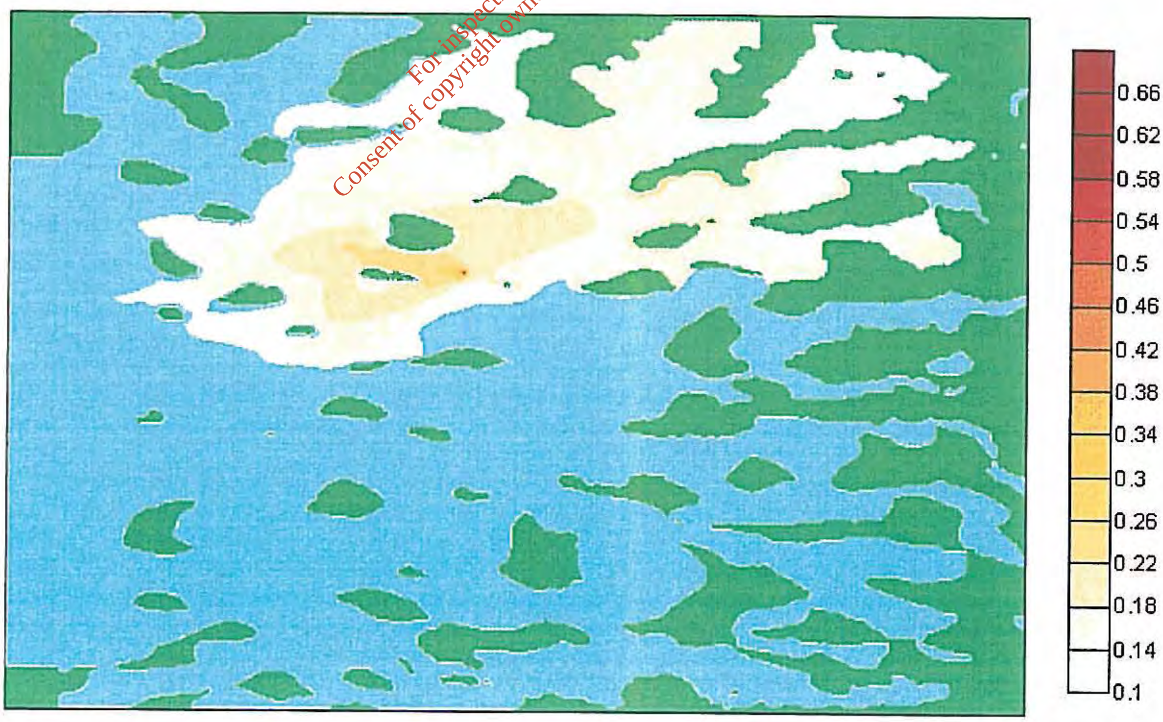

Figure A.21 : Cadmium concentrations (ng/l) at low water on a spring tide

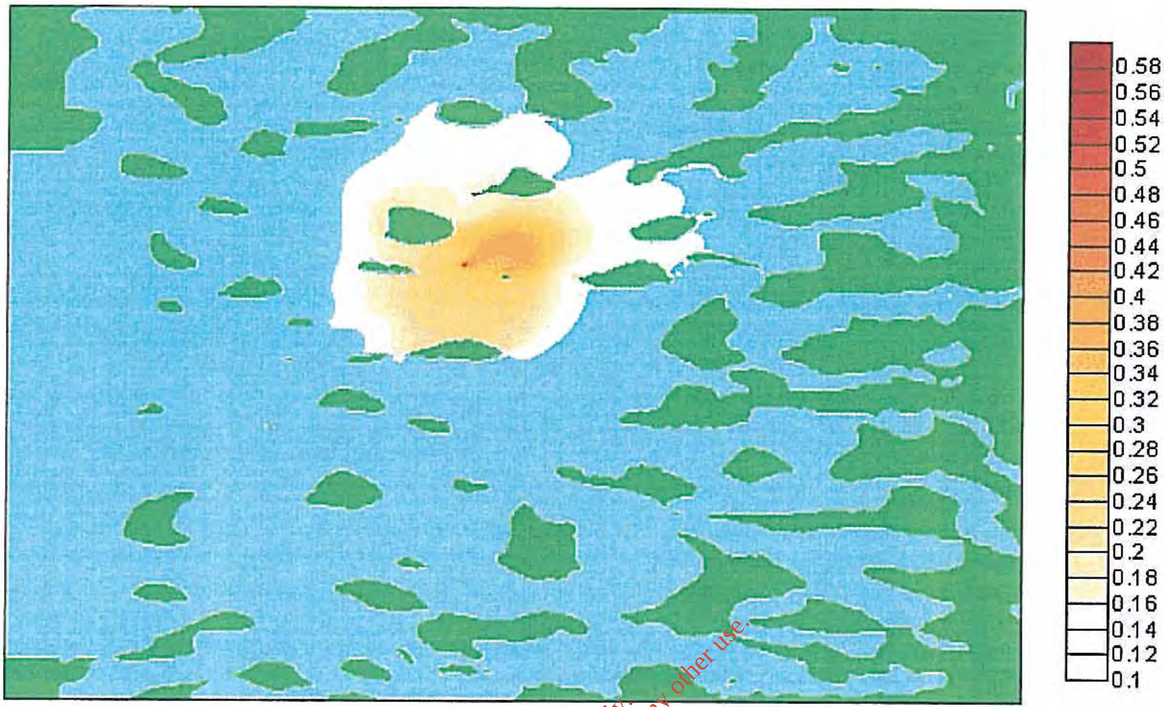

Figure A.22 : Cadmium concentrations (ng/l) at mid-flood on a neap tide

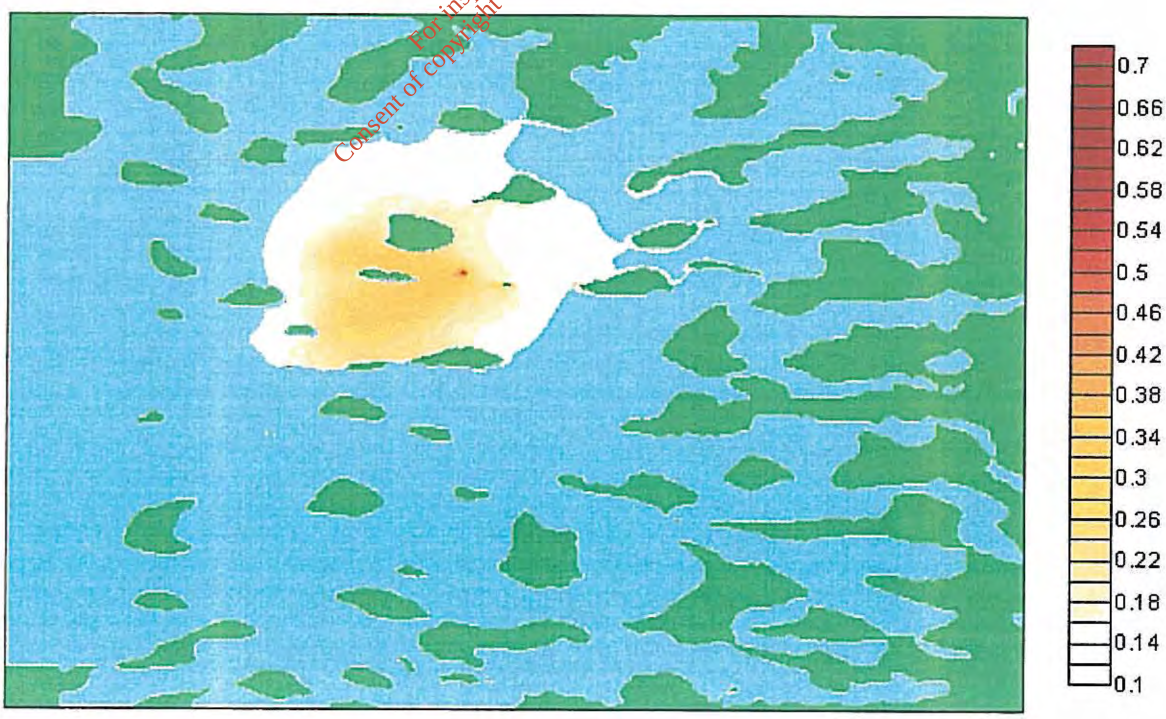

Figure A.23 : Cadmium concentrations (ng/l) at high water on a neap tide

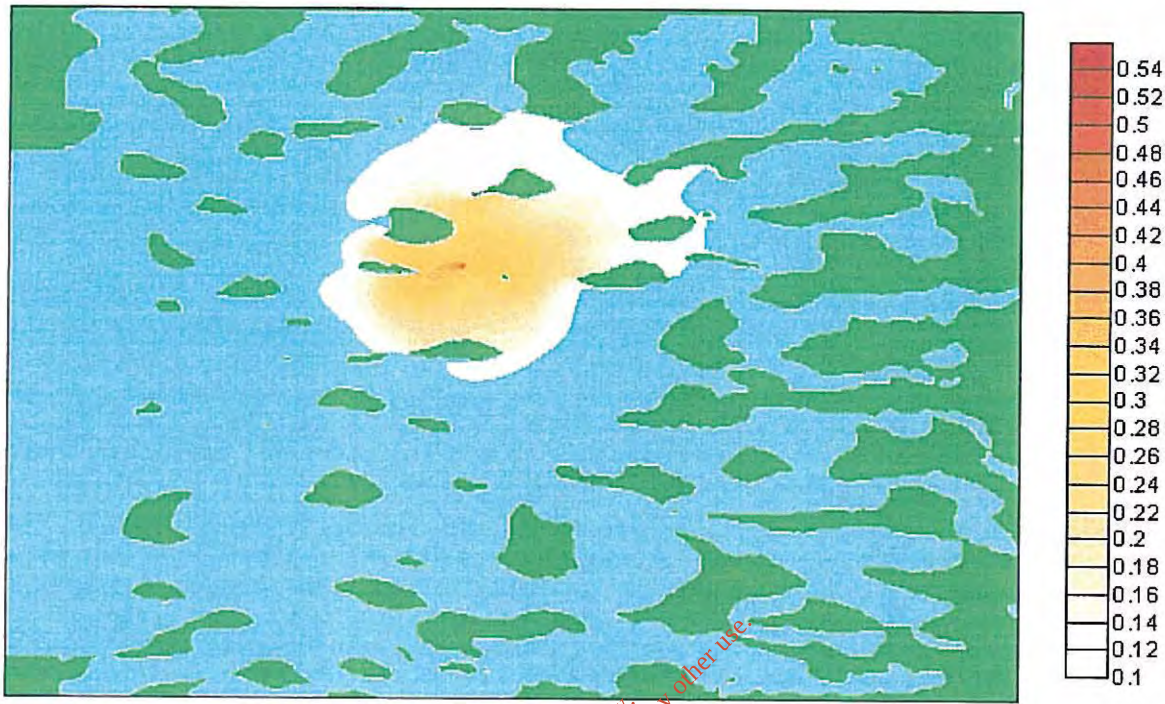

Figure A.24 : Cadmium concentrations (ng/l) at mid-ebb on a neap tide

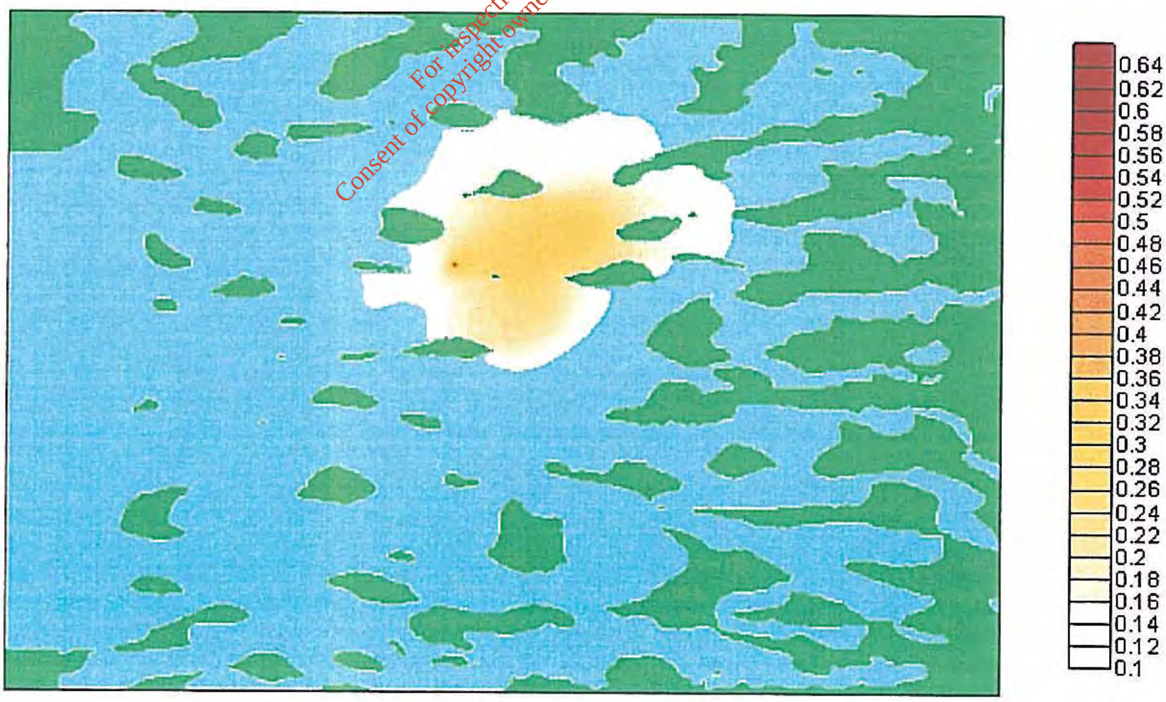

Figure A.25 : Cadmium concentrations (ng/l) at low water on a neap tide

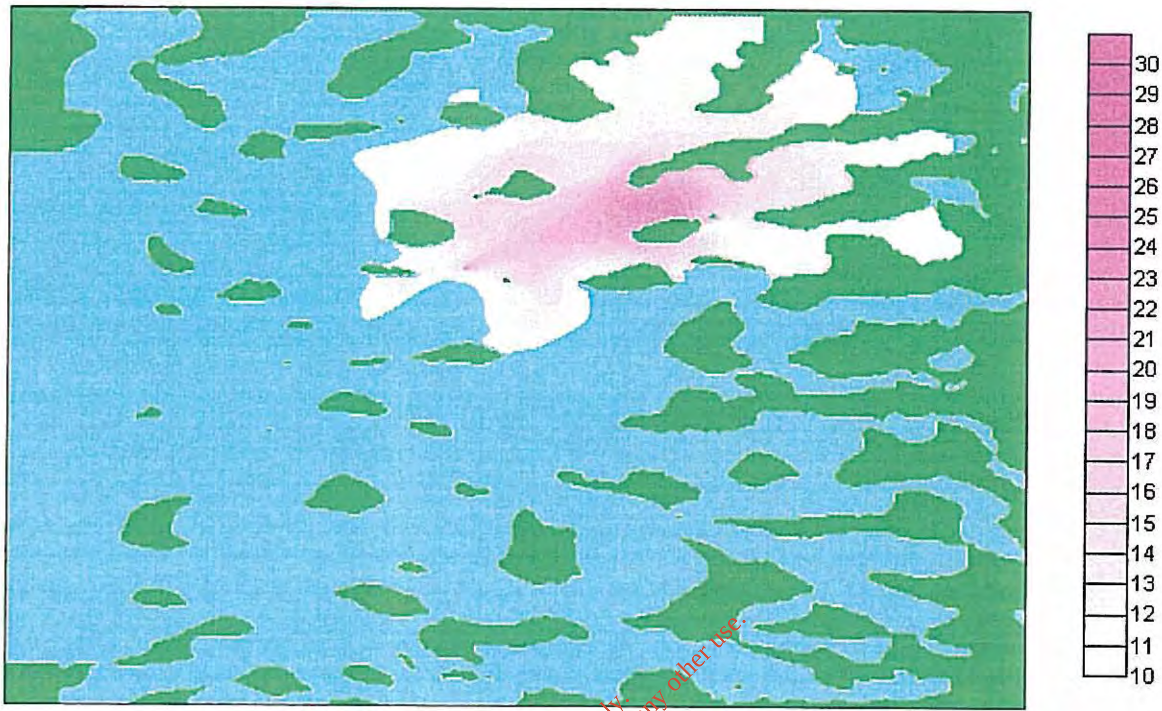

Figure A.26 : Copper concentrations (ng/l) at mid-flood on a spring tide

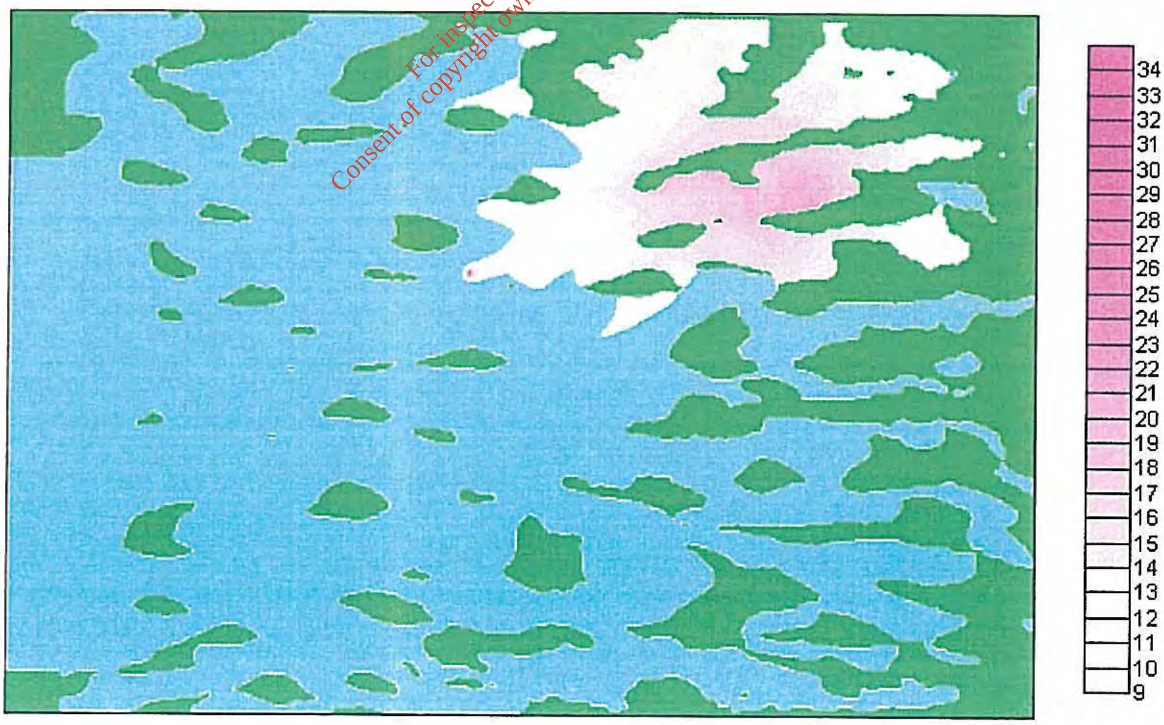

Figure A.27 : Copper concentrations (ng/l) at high water on a spring tide

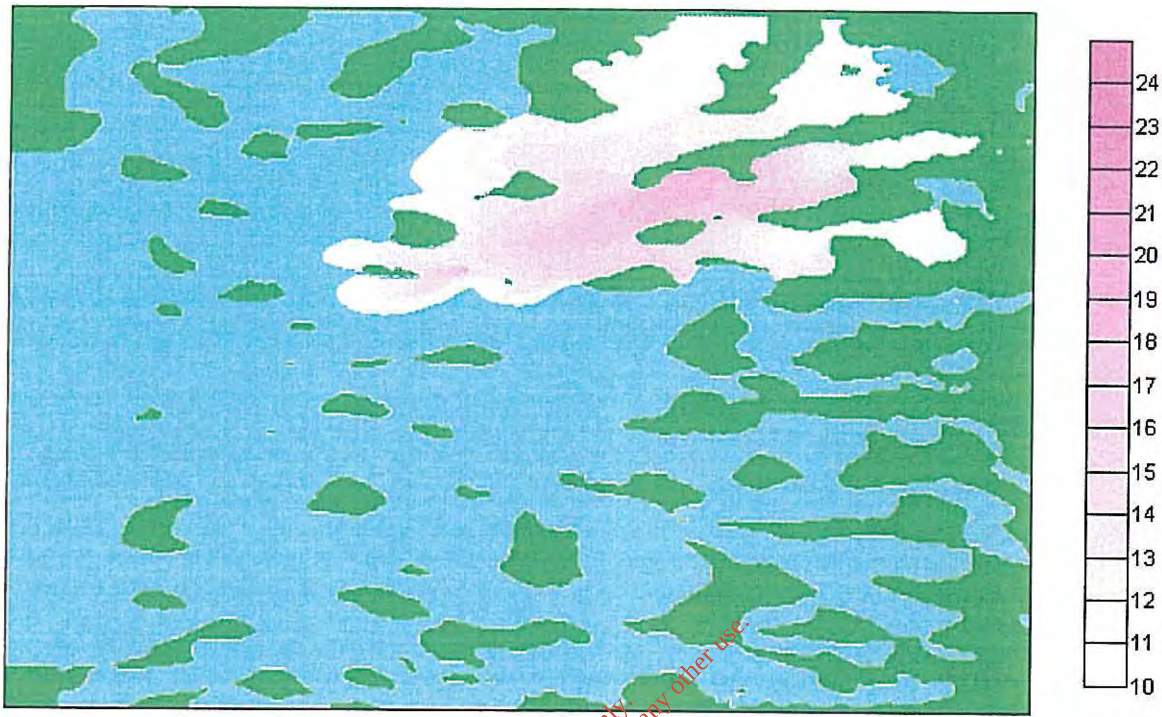

Figure A.28 : Copper concentrations (ng/l) at mid-ebb on a spring tide

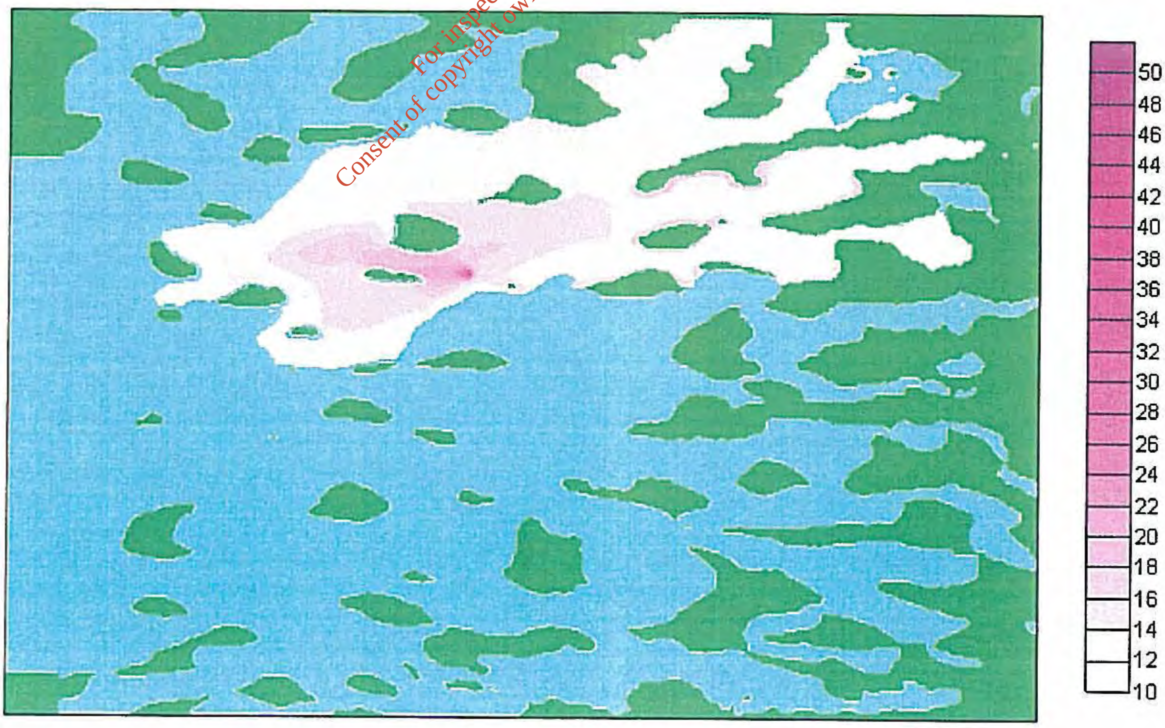

Figure A.29 : Copper concentrations (ng/l) at low water on a spring tide

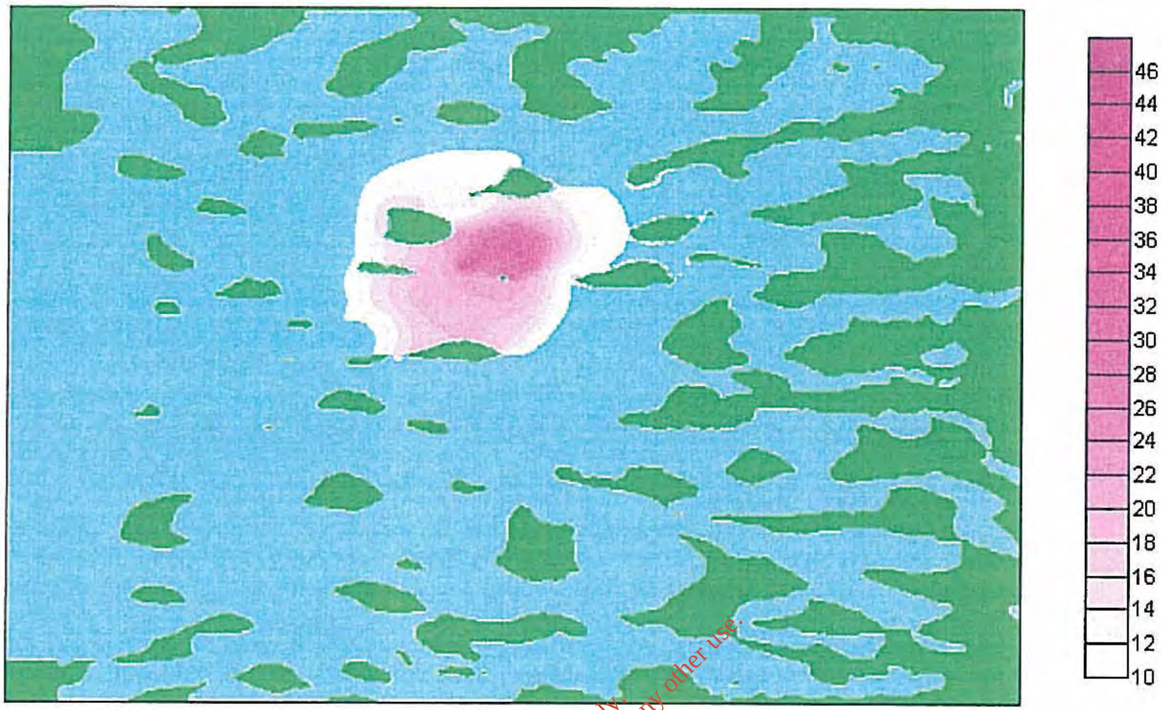

Figure A.30 : Copper concentrations (ng/l) at mid-flood on a neap tide

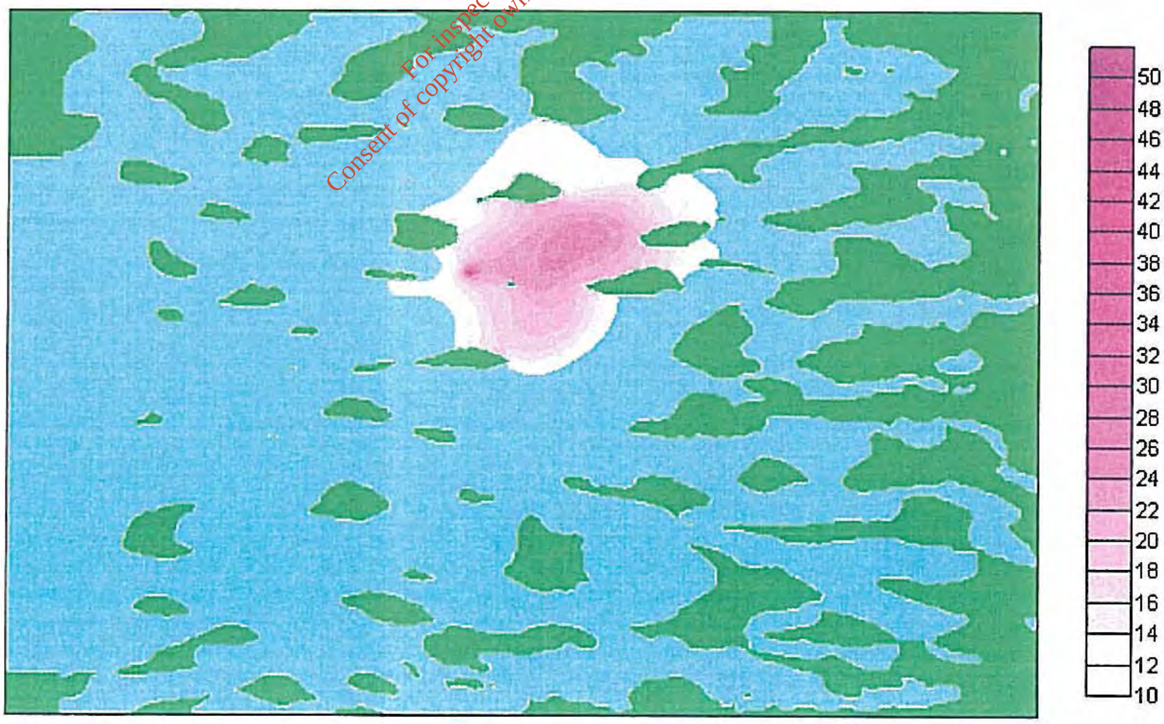

Figure A.31 : Copper concentrations (ng/l) at high water on a neap tide

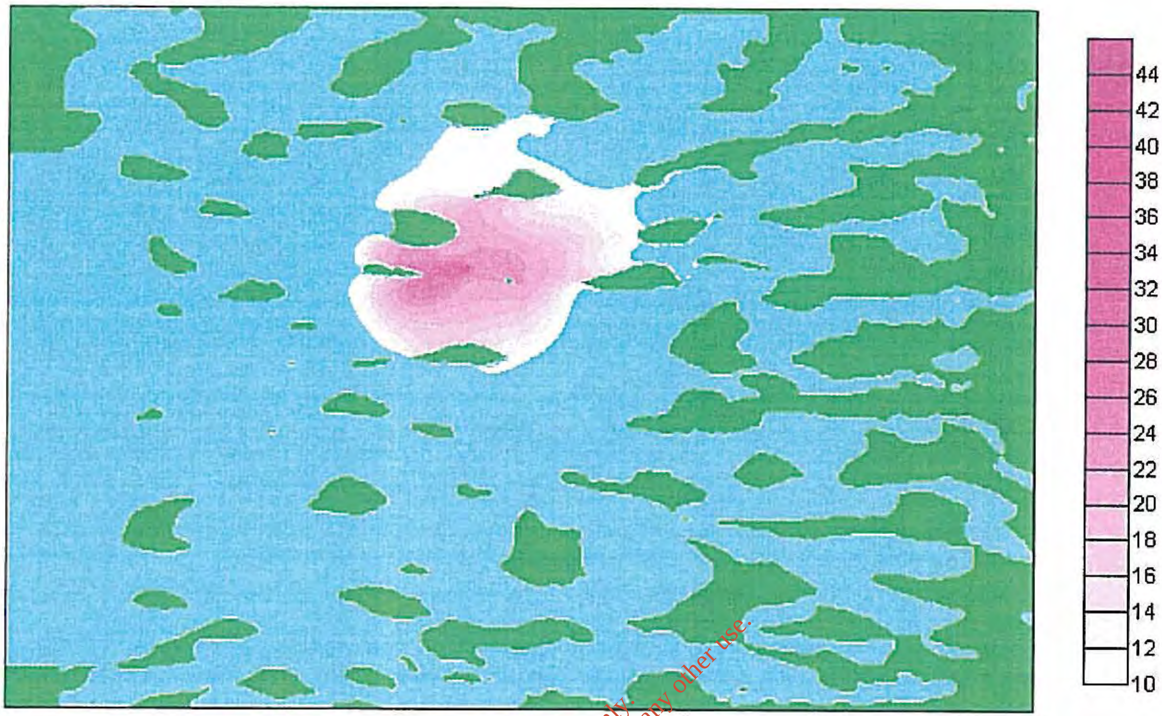

Figure A.32 : Copper concentrations (ng/l) at mid-ebb on a neap tide

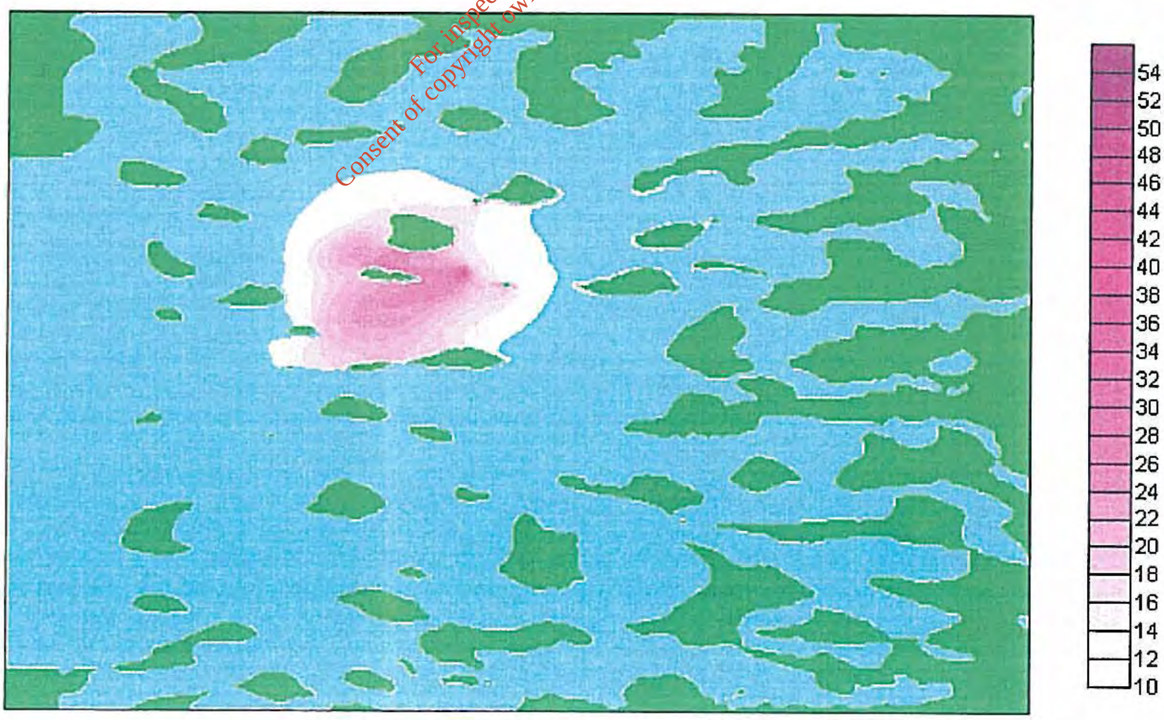

Figure A.33 : Copper concentrations (ng/l) at low water on a neap tide

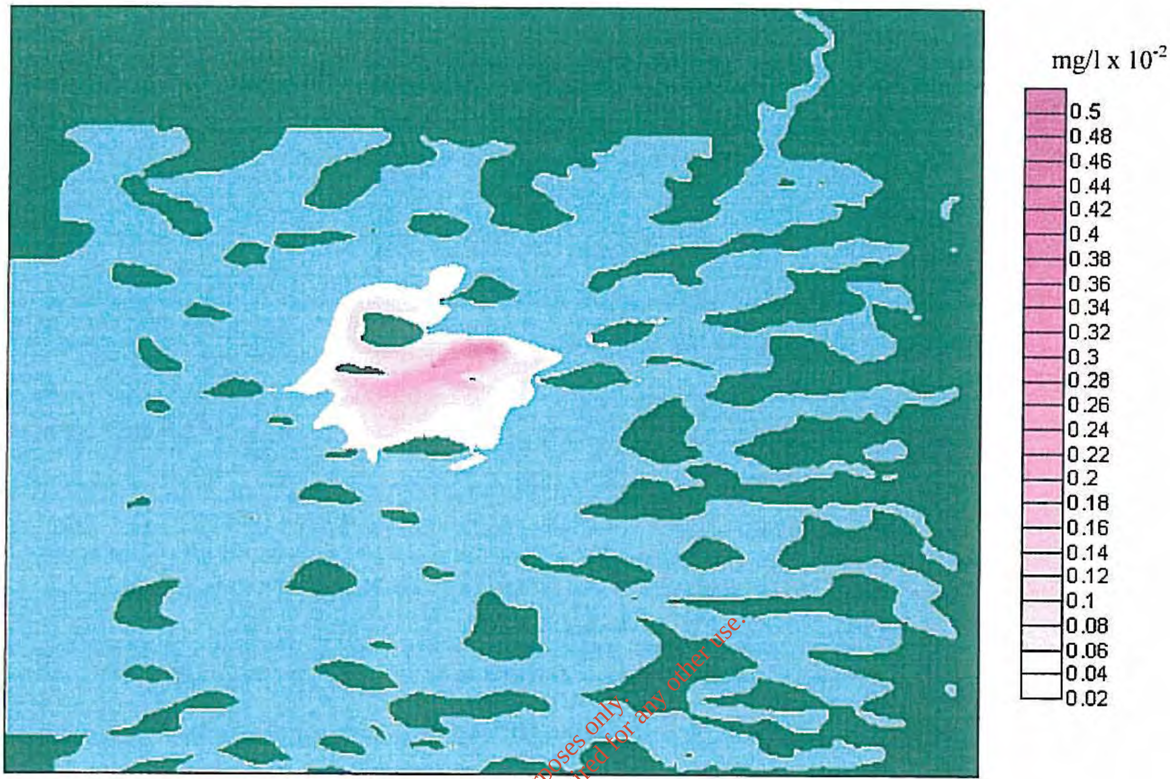

Figure A.34 : Ammonia concentrations at mid-flood on a neap tide

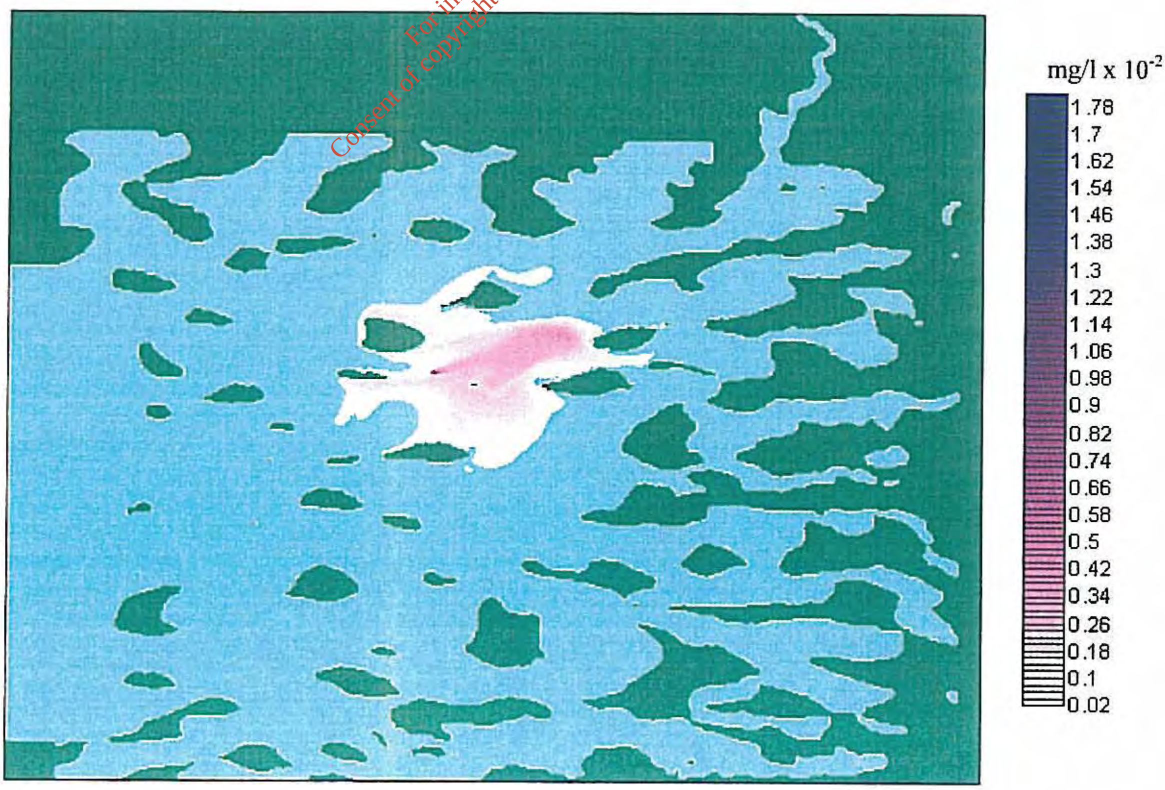

Figure A.35 : Ammonia concentrations at high water on a neap tide

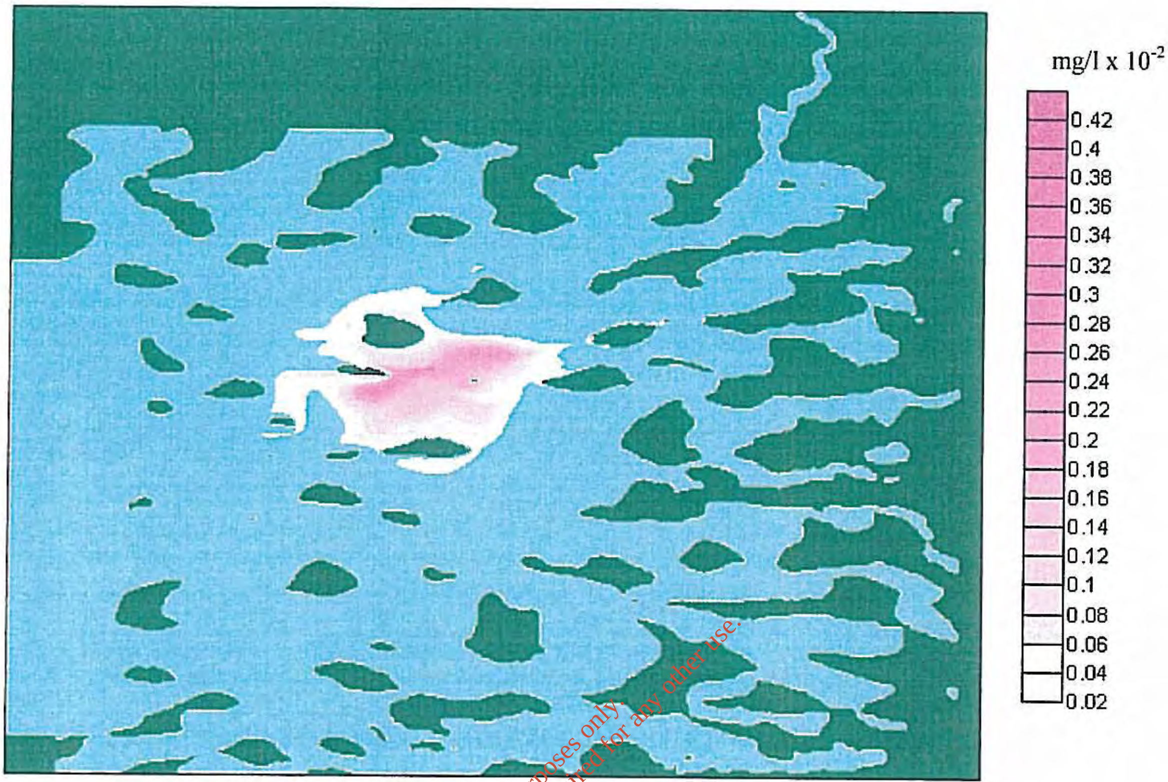

Figure A.36 : Ammonia concentrations at mid-ebb on a neap tide

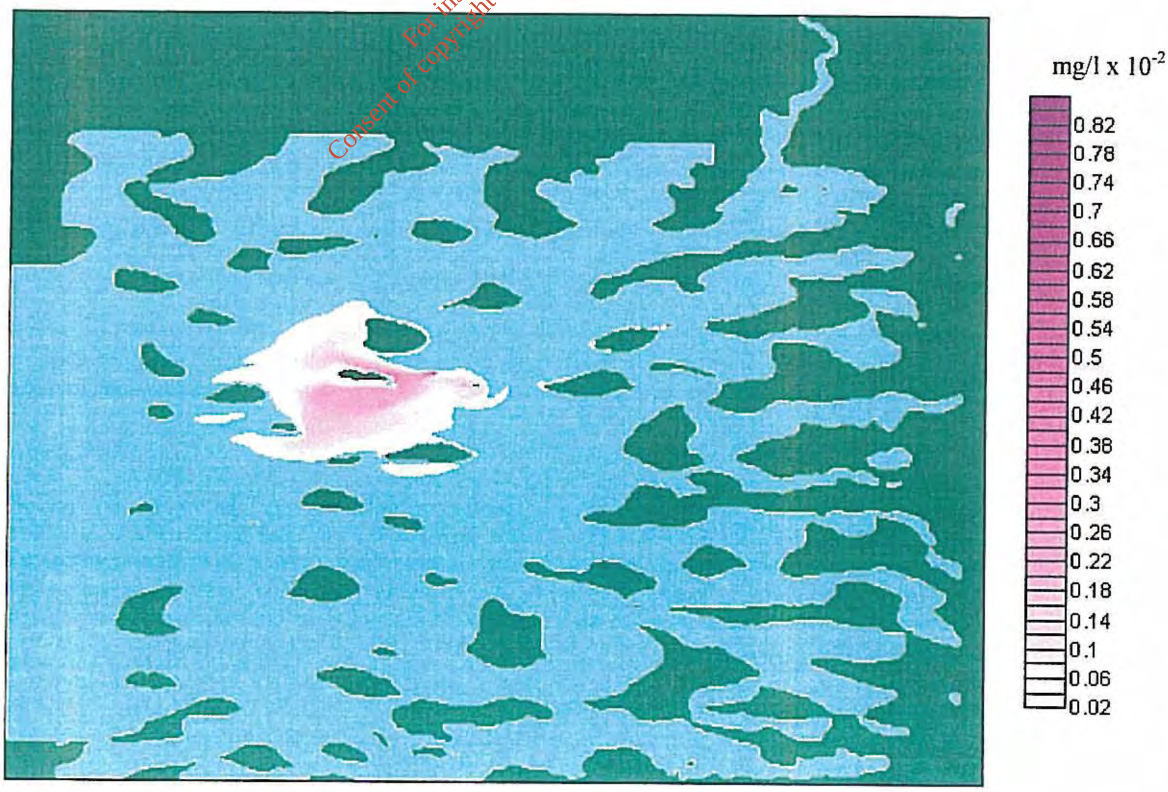

Figure A.37 : Ammonia concentrations at low water on a neap tide

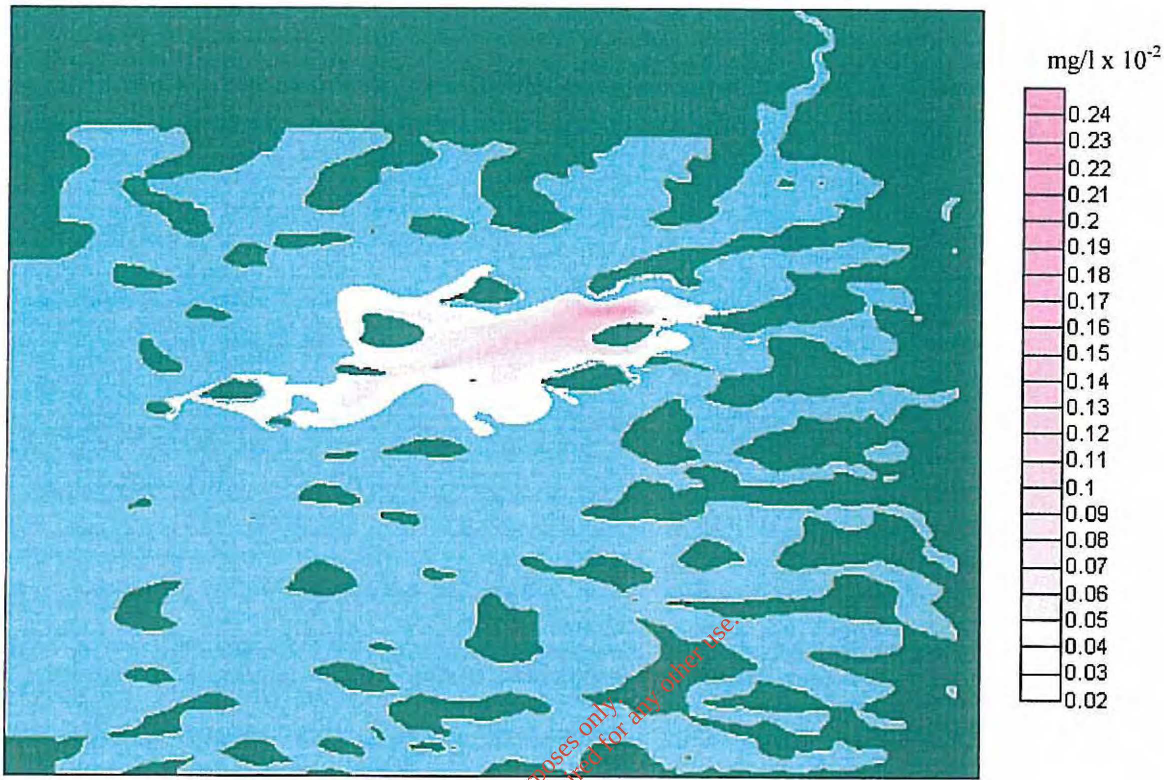

Figure A.38 : Ammonia concentrations at mid-flood on a spring tide

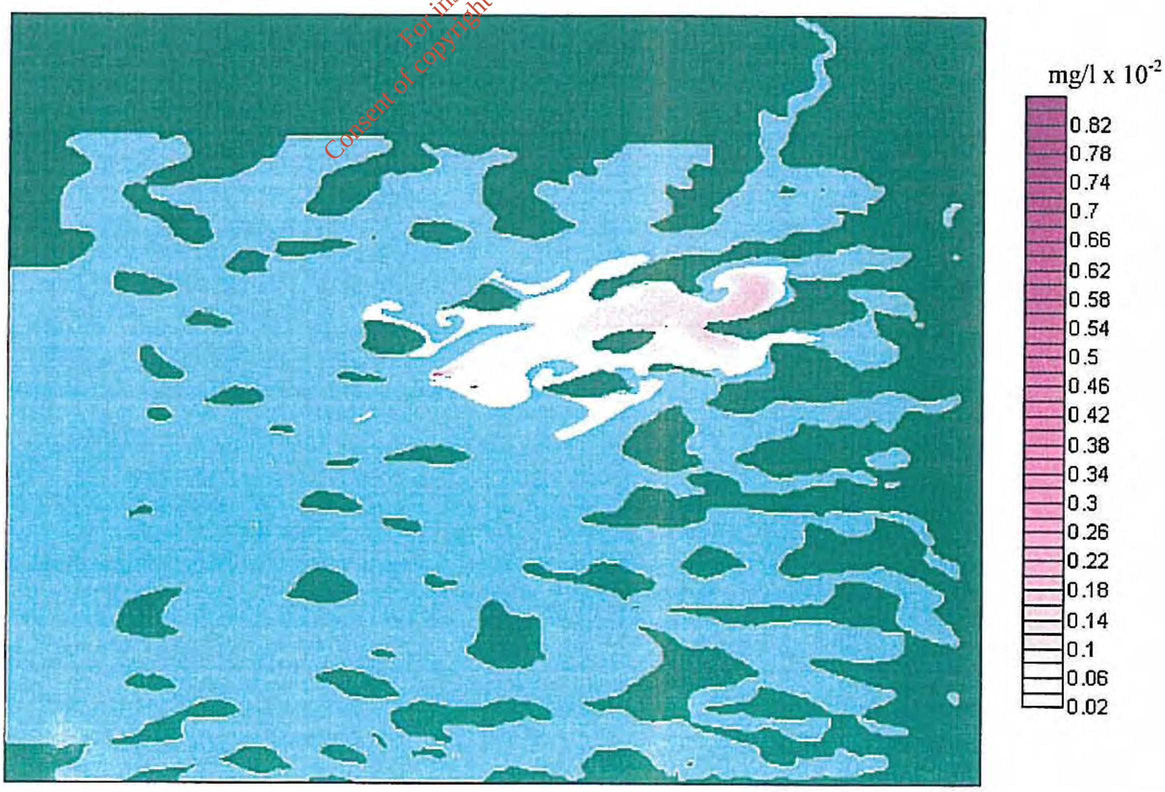

Figure A.39 : Ammonia concentrations at high water on a spring tide

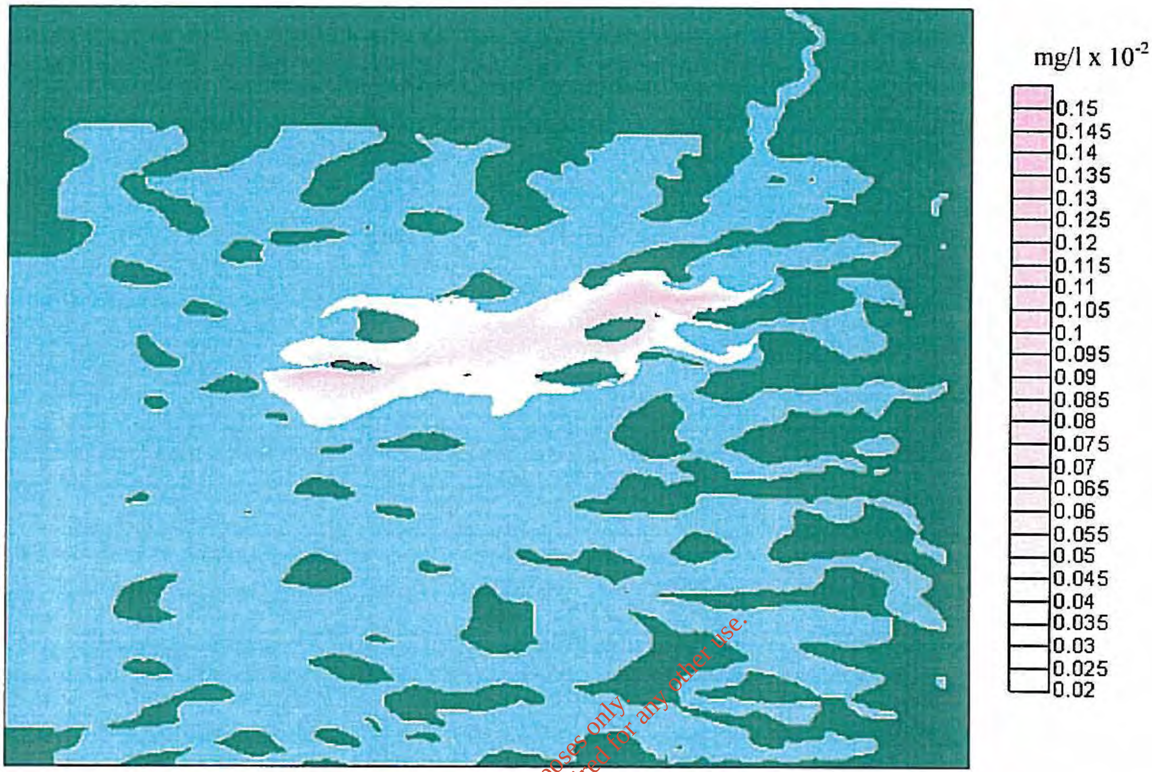

Figure A.40 : Ammonia concentrations at mid-ebb on a spring tide

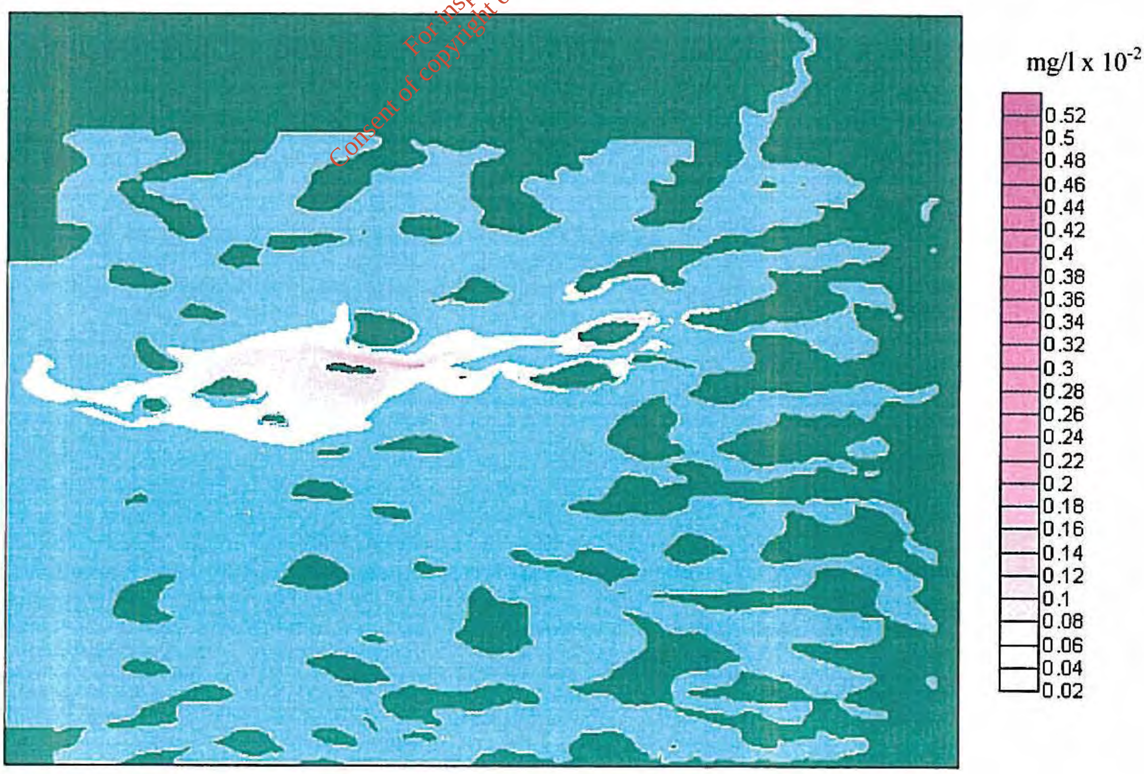

Figure A.41 : Ammonia concentrations at low water on a spring tide

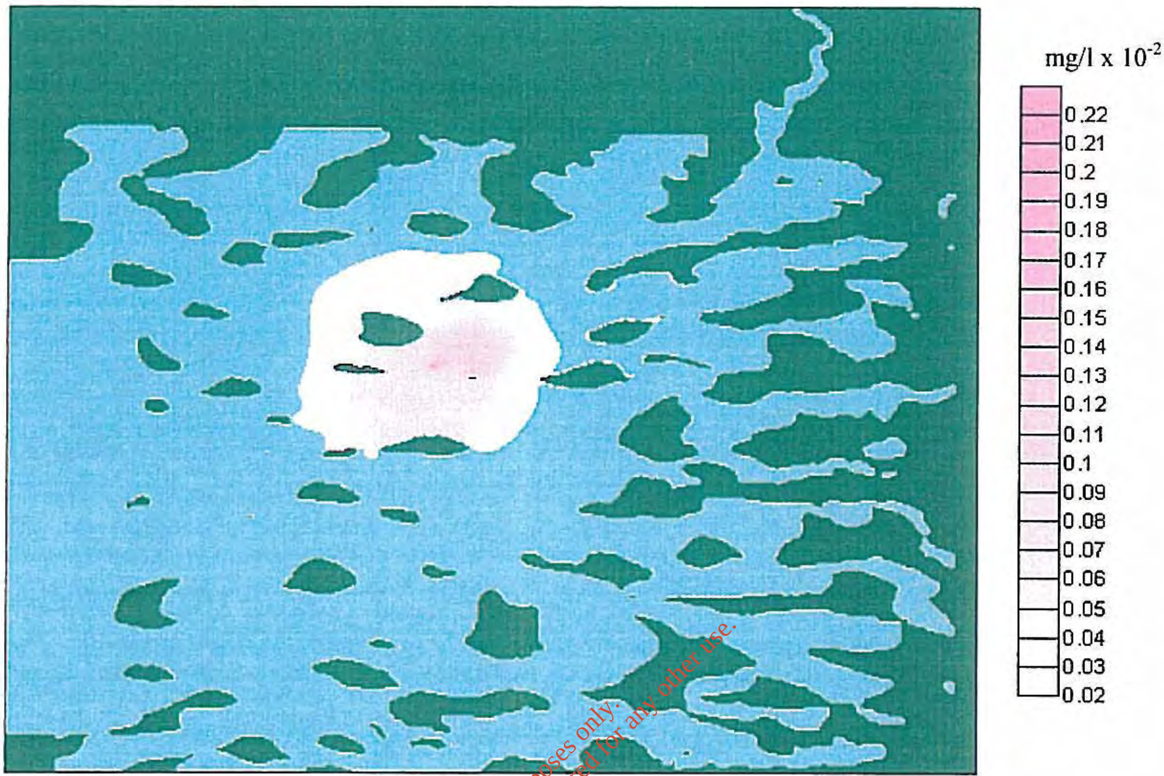

Figure A.42 : Ammonia concentrations at mid-flood on a neap tide

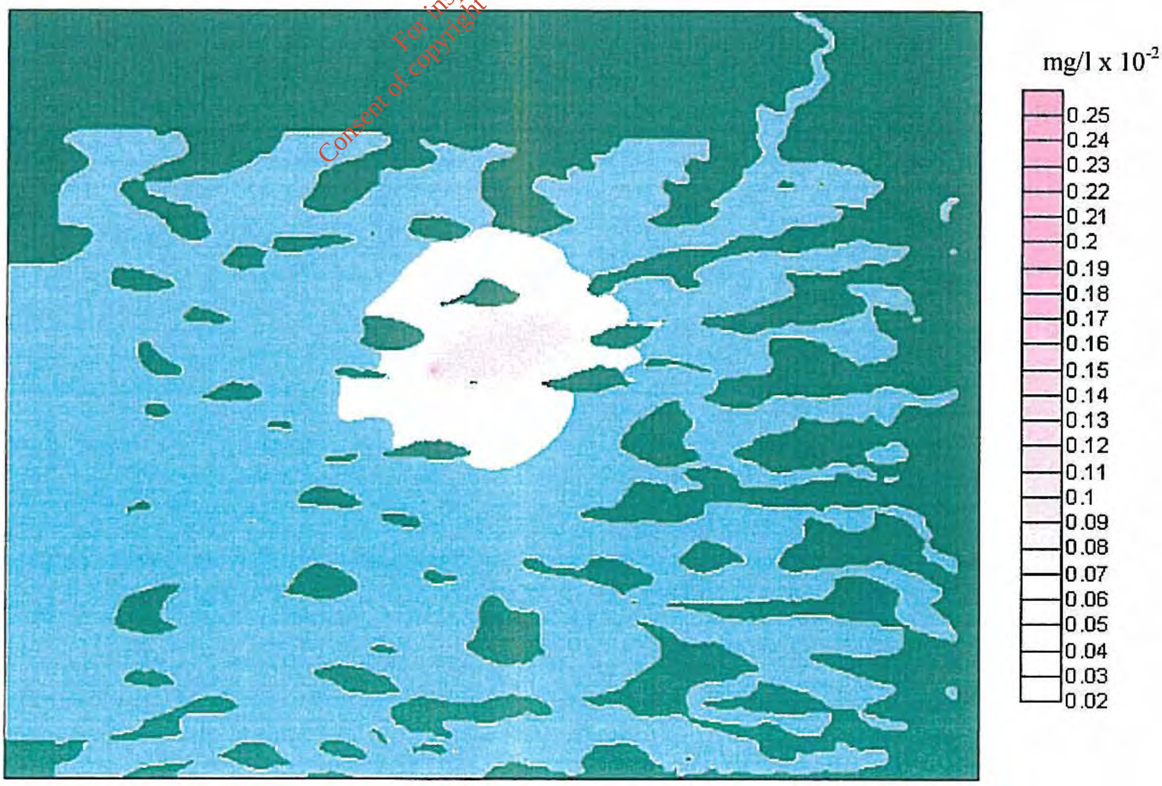

Figure A.43 : Ammonia concentrations at high water on a neap tide

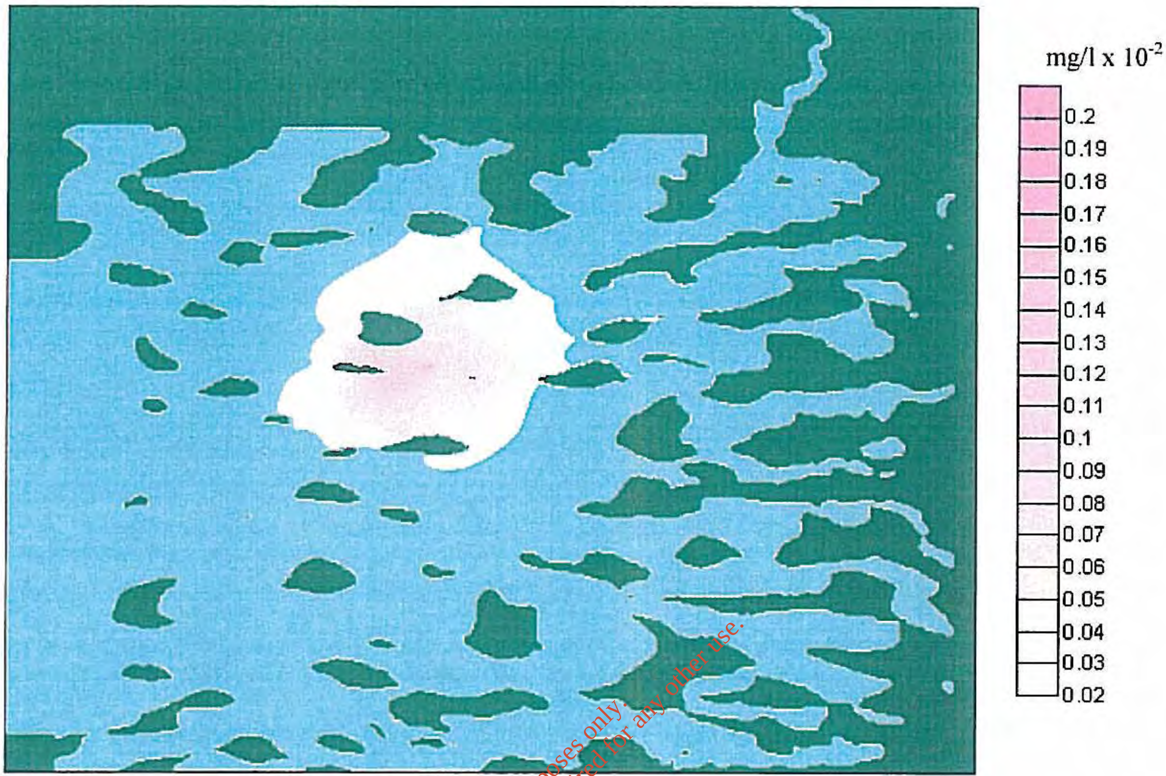

Figure A.44 : Ammonia concentrations at mid-ebb on a neap tide

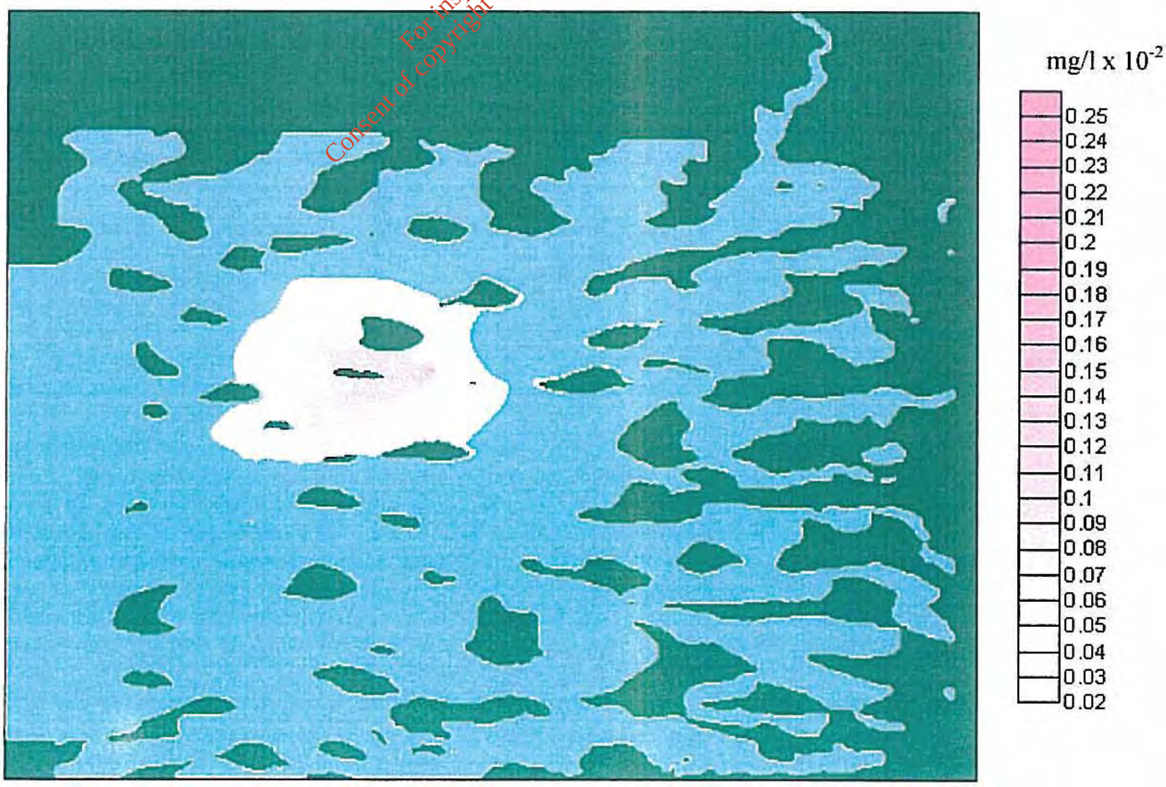

Figure A.45 : Ammonia concentrations at low water on a neap tide

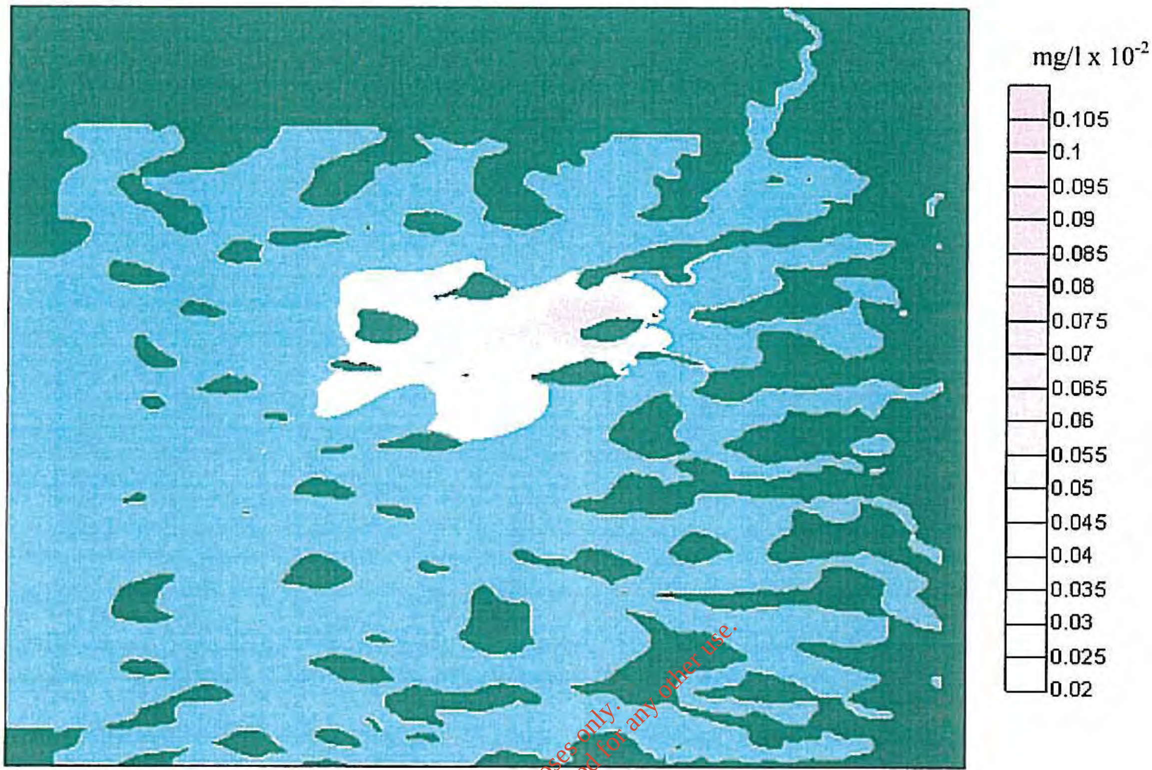

Figure A.46 : Ammonia concentrations at mid-flood on a spring tide

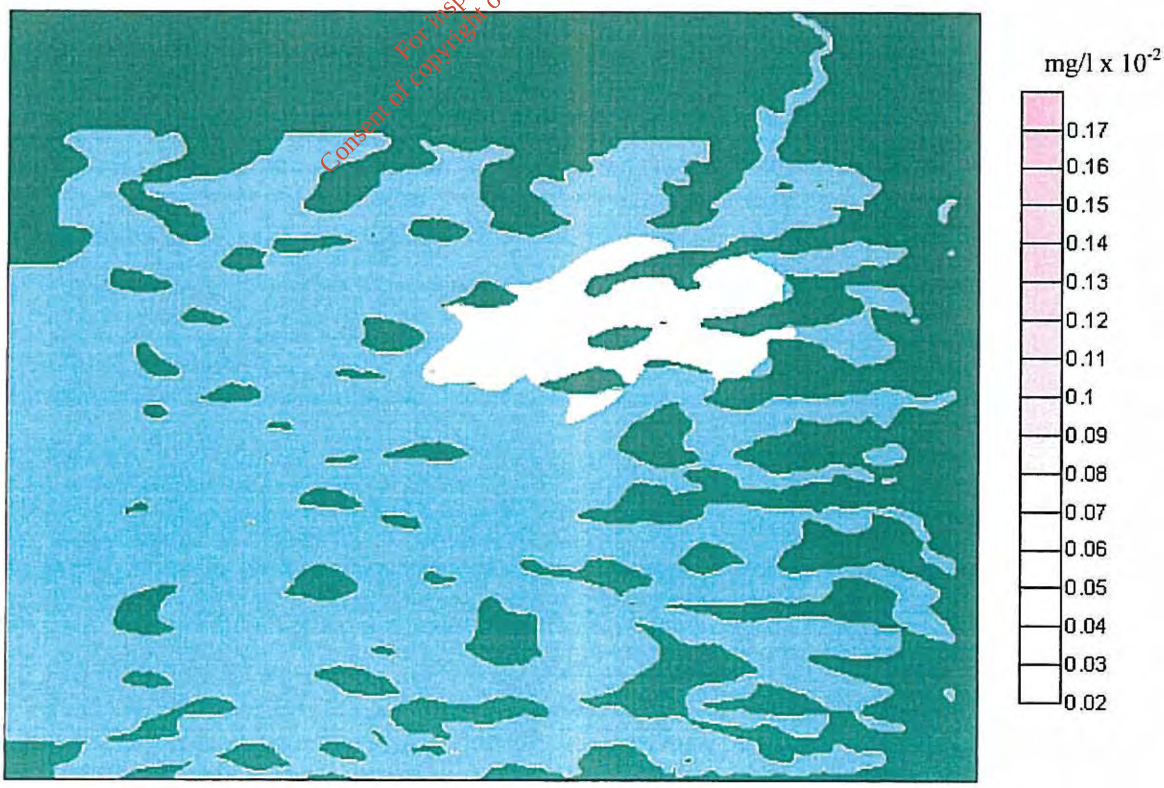

Figure A.47 : Ammonia concentrations at high water on a spring tide

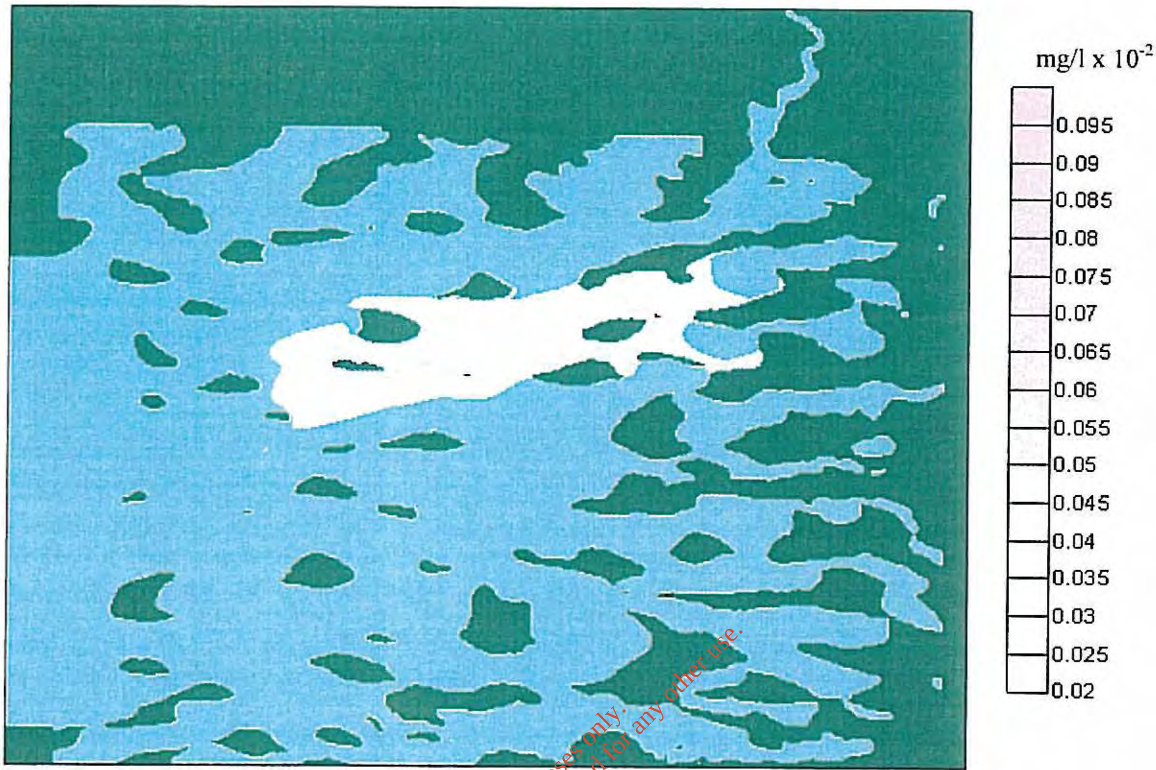

Figure A.48 : Ammonia concentrations at mid-ebb on a spring tide

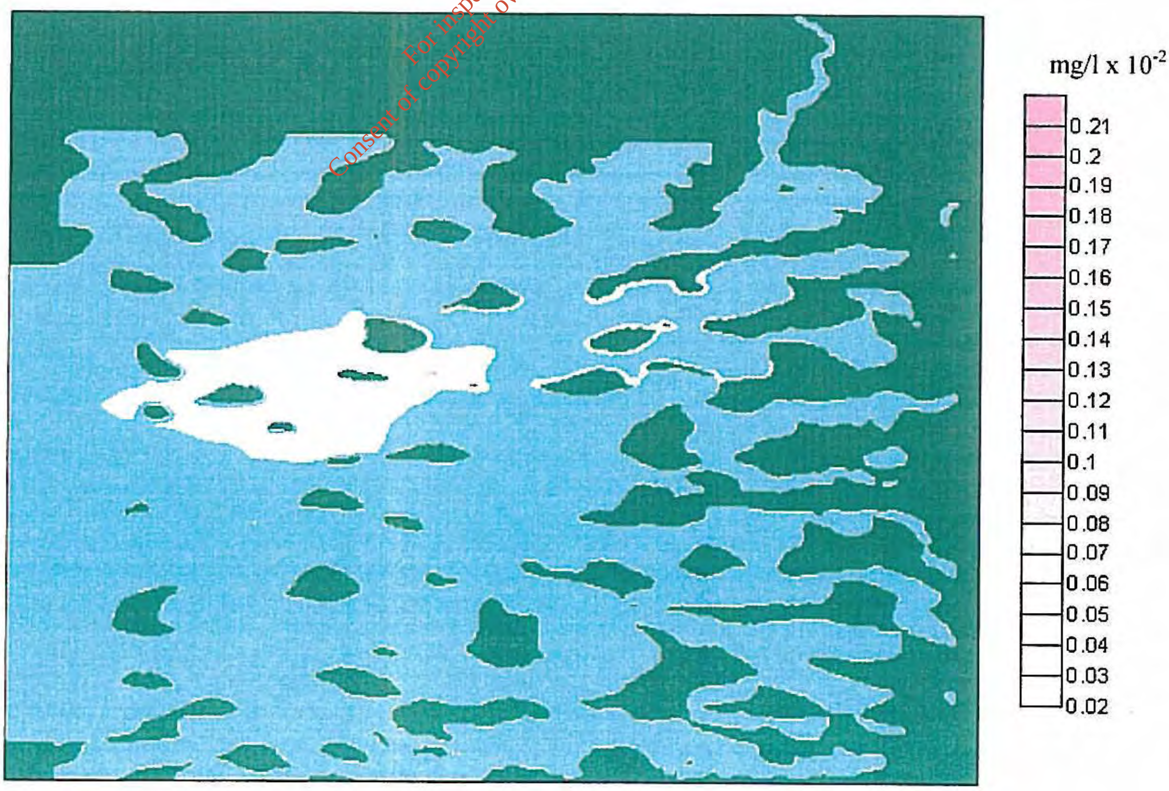

Figure A.49 : Ammonia concentrations at low water on a spring tide