APPENDICES

APPENDIX A

(See Section 5)

FAECAL COLIFORM CONCENTRATIONS MODEL AND SIMULATION RESULTS

1. Hydrodynamic Model Calibration and Validation

This was carried out by comparing computed versus measured values of:

- Current Speeds
- Current Directions
- Water Elevations

at different locations in the domain. The model was tuned by varying the coefficients of friction, the time step and boundary specification until good agreement was obtained between computed and measured values for the environmental conditions that prevailed when the measurements were recorded. The model was then validated by ensuring that good agreement existed between predicted and measured data for other events without changing the calibrated model parameters.

In order to calibrate and validate the hydrodynamic model, current measurements were taken over a complete tidal cycle at two sites, for both spring and neap tide conditions. Measurements of water elevations were also recorded at two separate sites for both spring and neap tide conditions.

The hydrodynamic model was calibrated against measured data for Spring tides and was validated against measured data for Neap tides at the two sites. Water elevation data for both Spring and Neap tides were used for further validation. Current measurements were taken at a number of depths below the surface (typically 1.0m below the surface, mid-depth and 1.0m above the bed), and at approximately half-hourly intervals over a tidal cycle. The current measurements were reduced to depth-integrated form using Abbott's equation in order to compare model predictions with measured results.

The calibration analyses were carried out by simulating the environmental conditions that prevailed during the measurement period and by comparing the predicted current speeds and directions over a full tidal cycle with the corresponding obcerved values for that period at the measured sites. A number of runs of the hydrodynamic model were necessary before good correlation was obtained between the predicted and measured current velocities and directions.

The bed roughness length (k) was adjusted along with a number of fine adjustments to the other empirical coefficients. River inflow and tidal boundary conditions were specified sufficiently distant to avoid influencing flow patterns in the study area. Information on tidal ranges at the southern boundary was provided by the measurements recorded at site T1.

The final calibrated values used in the model were:

Bed roughness length:	30mm
Eddy viscosity coefficient:	0.100

Air-water interfacial resistance coefficient: 0.001
Momentum correction factor: 1.016

2. Dispersion Model Calibration and Validation

Once the hydrodynamic model had been validated, the dispersion coefficient were fine tuned so that the dispersion could be accurately modelled. Dispersion coefficients were computed using results from discrete dye releases carried out by Hydrographic Surveys Ltd. Continuous dye releases were carried out in order to examine the movement of a plume released at the outfall locations. The discrete and continuous plumes were tracked. These were then simulated by the dispersion model using the environmental conditions which prevailed on the day, thereby serving as a means of validating the dispersion model.

3. The dispersion analyses modelled the two proposed outfall sites, as well as the existing regime and the proposed overflow from the pumping station at Denis' Quay. The modelled water quality parameter was faecal coliform (*E. Coli*) which is a recognised indicator of the presence of pathogenic organisms. A decay rate of T_{90} equal to 9 hours was specified in the model, which is regarded as conservative. The decay rate governs the build-up mechanism with the result that 90% of faecal coliform concentrations will have died off after 9 hours.

4. The dispersion analyses were carried out for a simulation period of 100 hours using a time step of 20 seconds. This simulation period was sufficient to ensure that steady state conditions were obtained for all analyses. At the start of each analysis, the study area is considered to be filled with clean water and as the simulation proceeds, a build-up of concentration levels develops throughout. Eventually, a steady state condition is reached whereby the rate of increase in concentration levels due to the effluent discharge is in equilibrium with the rate of decrease in concentration levels due to flushing, take-up and die-off.

5. The results from the dispersion analyses are presented in the form of time series at the outfall and observation sites and as colour tonal plots of solute concentration in the study area. The numerical model domain is very large, extending from Sandy Cove upstream to beyond Kilmacsimon Quay.

6. The E. Coli concentration of untreated sewage is taken to be 1 x 10^6 No./100ml. Secondary treatment will generally remove 90% of faecal coliform from raw sewage.

7. The discharge regime for the existing regime was simulated for untreated sewage for a summer population equivalent of 6,800 p.e.

8. The discharge regime for the proposed regime was simulated for the design population of 9,800 p.e. assuming 90% reduction in faecal coliforms following secondary treatment.

Figure	Description
A.1	Outfall 1, High Water, Spring Tide
A.2	Outfall 1, Mid-Ebb, Spring Tide
A.3	Outfall 1, Low Water, Spring Tide
A.4	Outfall 1, Mid-Flood, Spring Tide
A.5	Outfall 1, High Water, Neap Tide
A.6	Outfall 1, Mid-Ebb, Neap Tide
A.7	Outfall 1, Low Water, Neap Tide
A.8	Outfall 1, Mid-Flood, Neap Tide
A.9	Outfall 1, High Water, Mean Tide
A.10	Outfall 1, Mid-Ebb, Mean Tide
A.11	Outfall 1, Low Water, MeanTide
A.12	Outfall 1, Mid-Flood, Mean Tide
A.13	Outfall 2, High Water, Spring Tide
A.14	Outfall 2, Mid-Ebb, Spring Tide
A.15	Outfall 2, Low Water, Spring Tide
A.16	Outfall 2, Mid-Flood, Spring Tide
A.17	Outfall 2, High Water, Neap Tide
A.18	Outfall 2, Mid-Ebb, Neap Tide
A.19	Outfall 2, Low Water, Neap Tide
A.20	Outfall 2, Mid-Flood, Neap Tide
A.21	Outfall 2, High Water, Mean Tide
A.22	Outfall 2, Mid-Ebb, Mean Tide
A.23	Outfall 2, Low Water, Mean Tide
A.24	Outfall 2, Mid-Flood, Mean Tide
A.25	Existing Regime, High Water, Mean Tide
A.26	Existing Regime, Mid-Ebb, Mean Tide
A.27	Existing Regime, Low Water, Mean Tide
A.28	Existing Regime, Mid-Flood, Mean Tide
A.29	Proposed Overflow, High Water, Mean Tide
A.30	Proposed Overflow, Mid-Ebb, Mean Tide
A.31	Proposed Overflow, Low Water, Mean Tide
A.32	Proposed Overflow, Mid-Flood, Mean Tide

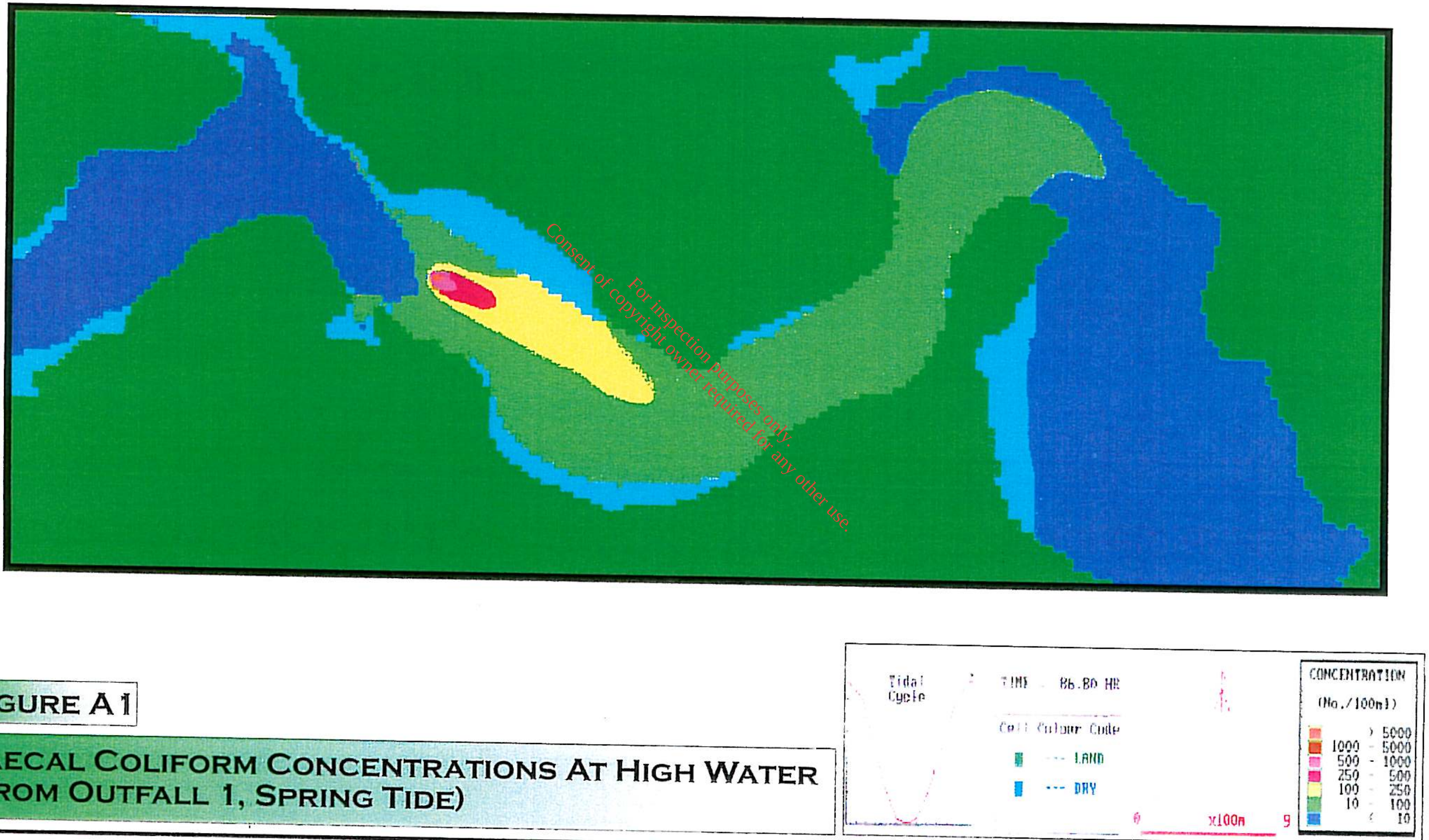


FIGURE A1

FAECAL COLIFORM CONCENTRATIONS AT HIGH WATER (FROM OUTFALL 1, SPRING TIDE)

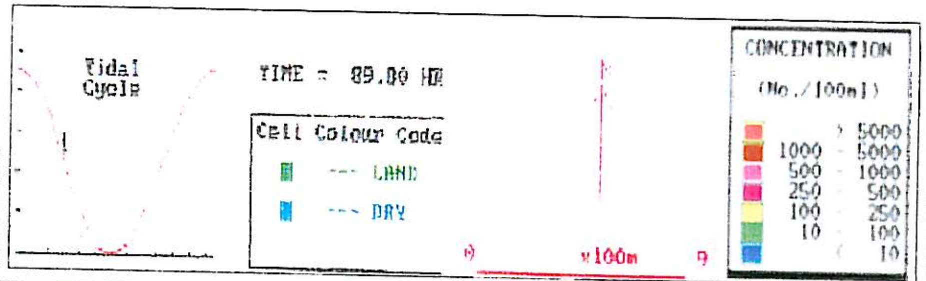
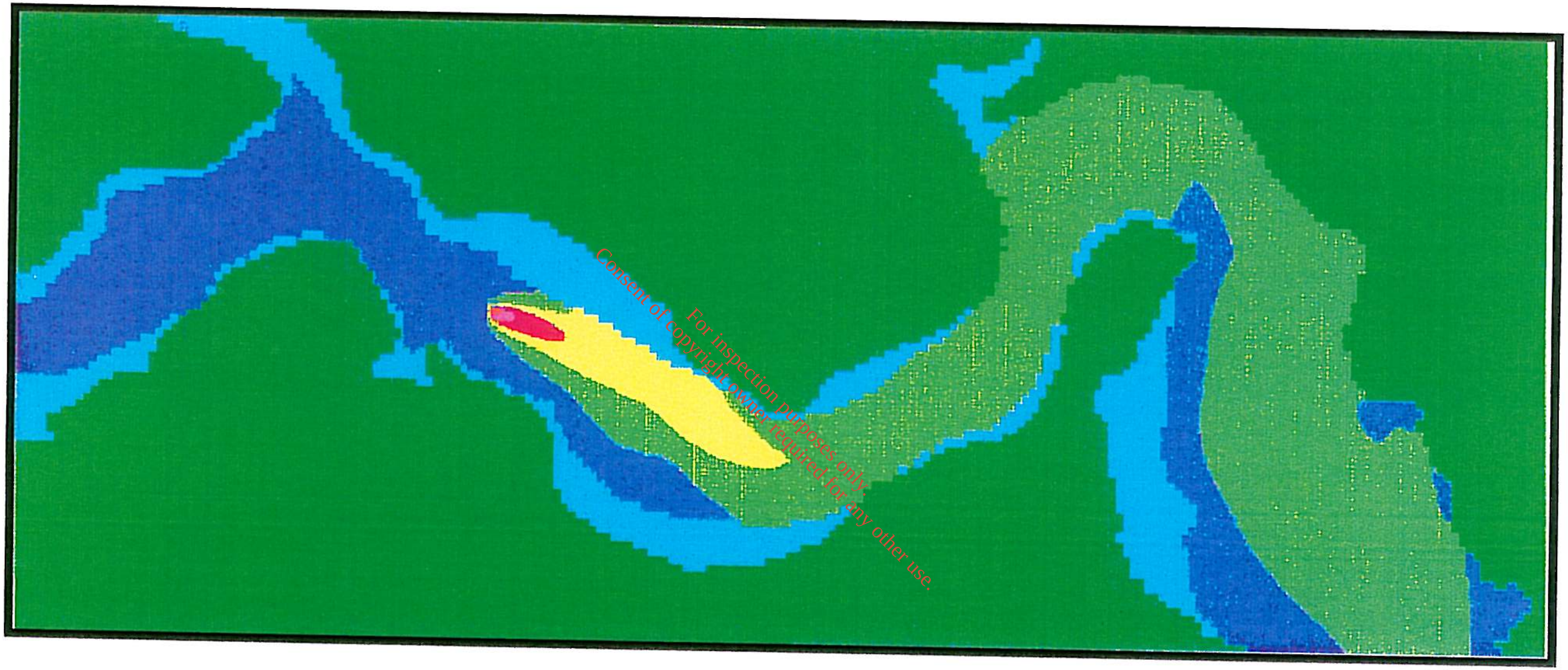


FIGURE A2

FAECAL COLIFORM CONCENTRATIONS AT MID-EBB (FROM OUTFALL 1, SPRING TIDE)



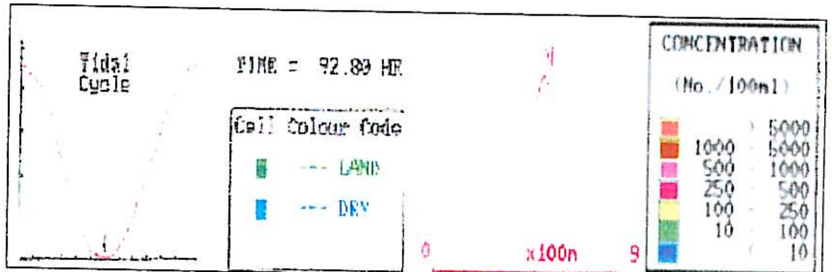


FIGURE A3

FAECAL COLIFORM CONCENTRATIONS AT LOW WATER (FROM OUTFALL 1, SPRING TIDE)

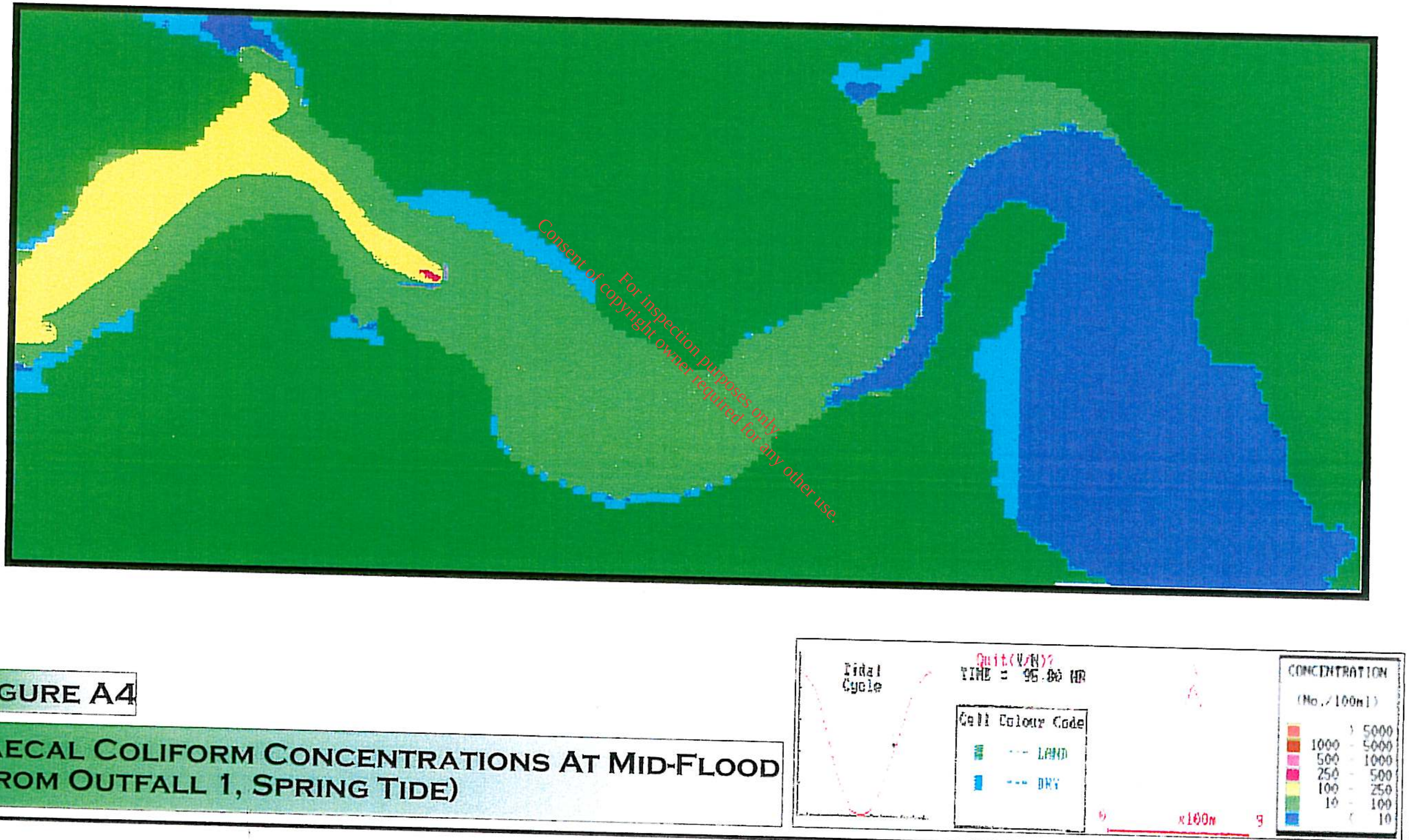


Figure A4

Faecal Coliform Concentrations At Mid-Flood (from Outfall 1, Spring Tide)

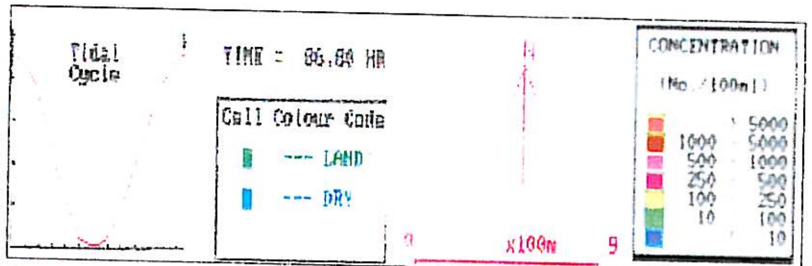


FIGURE A5

FAECAL COLIFORM CONCENTRATIONS AT HIGH WATER (FROM OUTFALL 1, NEAP TIDE)

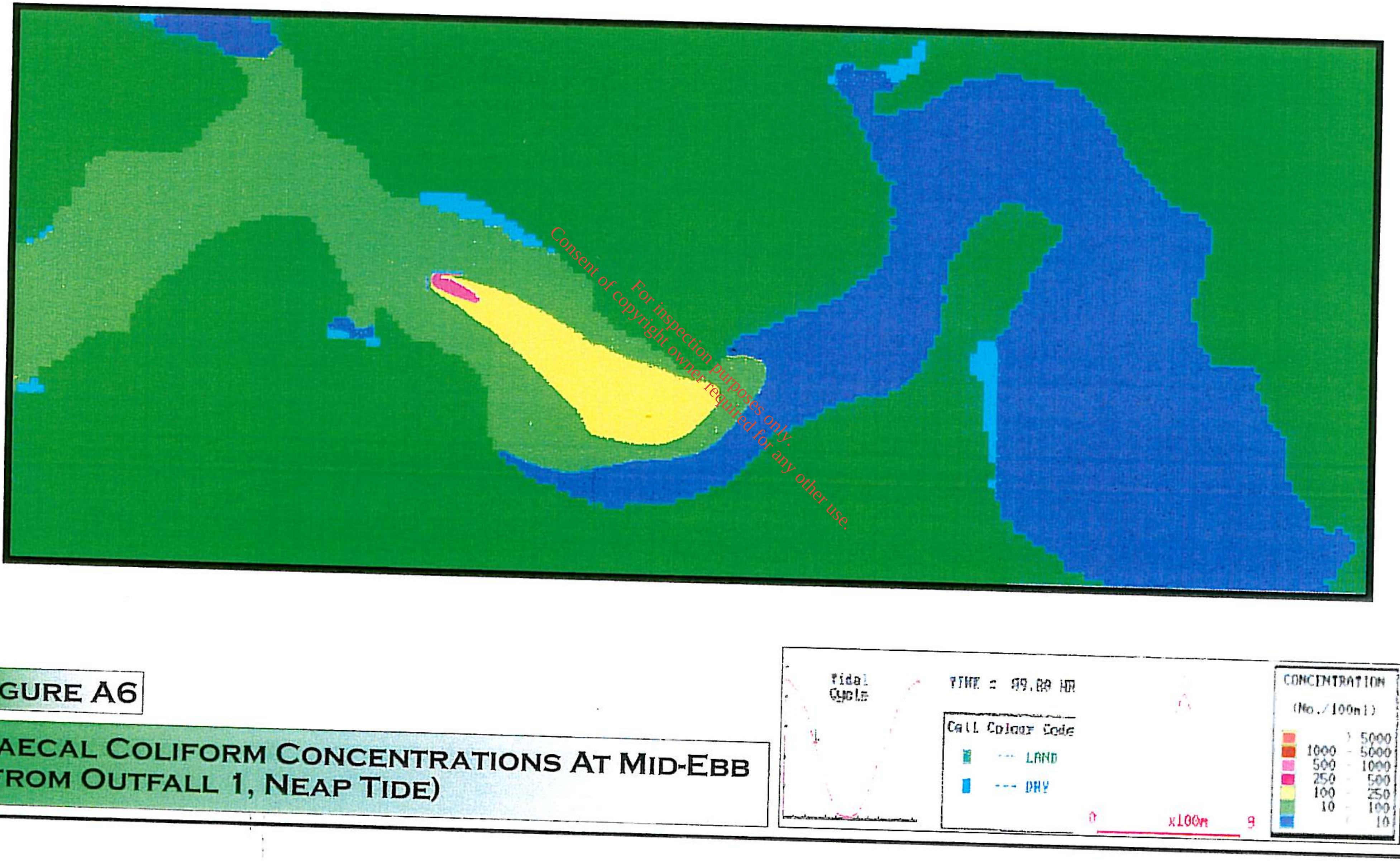
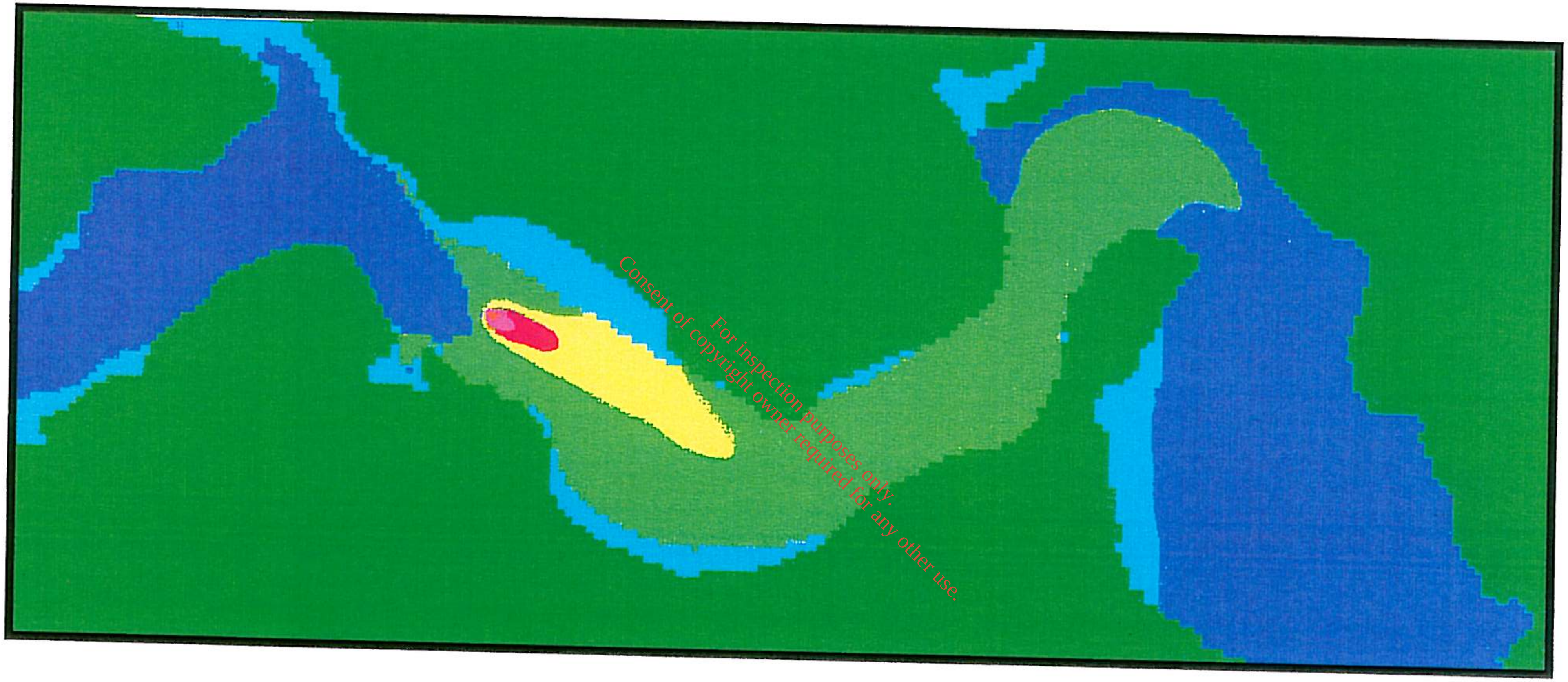


FIGURE A6

FAECAL COLIFORM CONCENTRATIONS AT MID-EBB (FROM OUTFALL 1, NEAP TIDE)



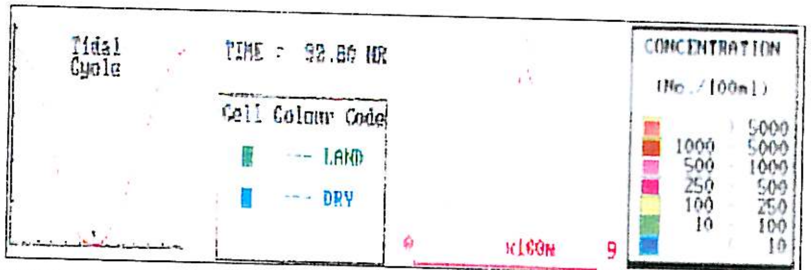
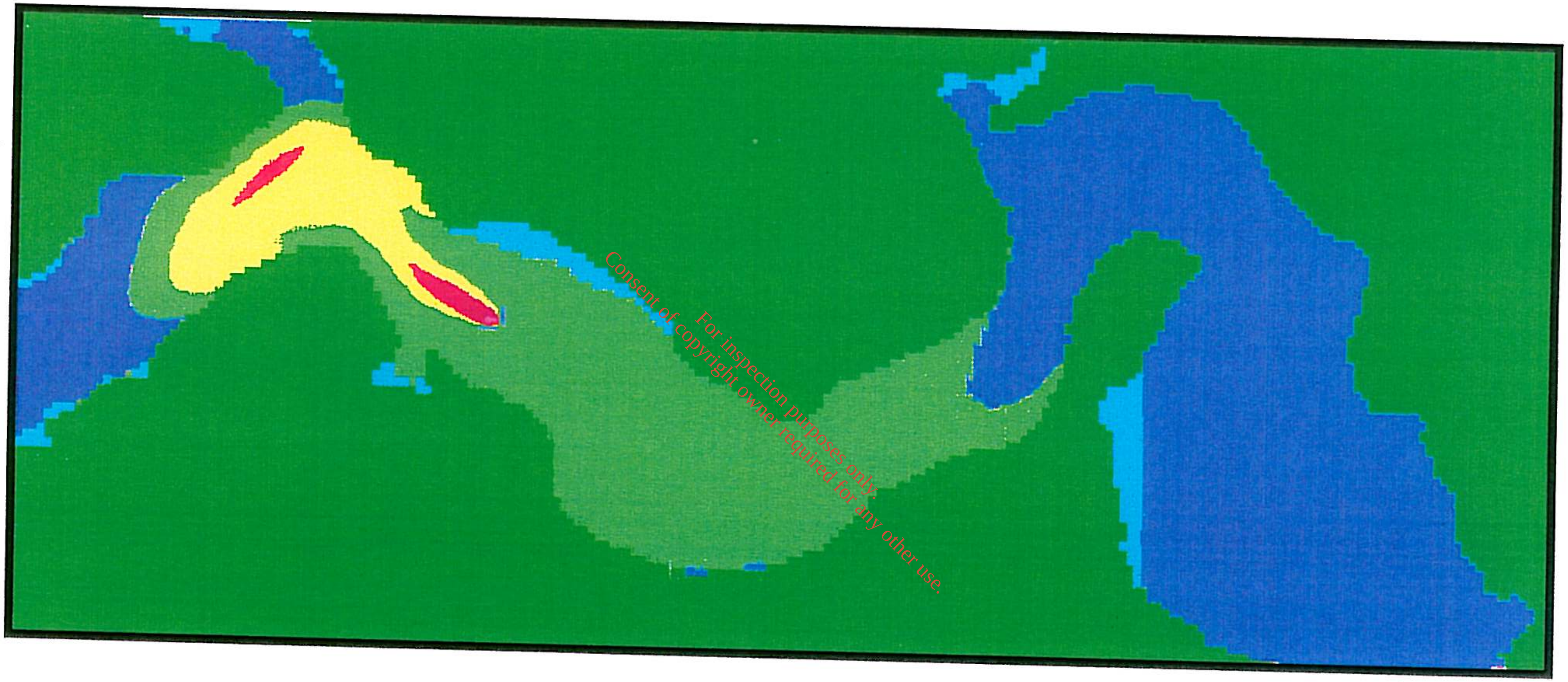


FIGURE A7

FAECAL COLIFORM CONCENTRATIONS AT LOW WATER (FROM OUTFALL 1, NEAP TIDE)



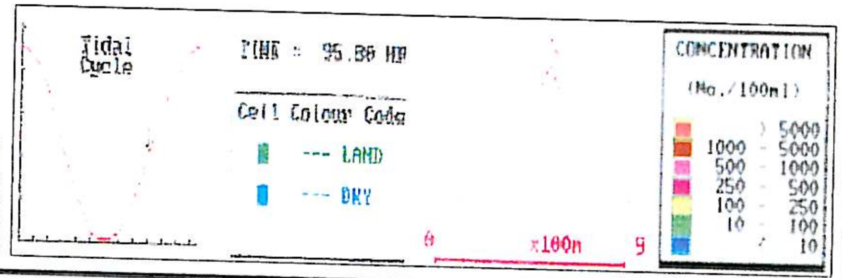
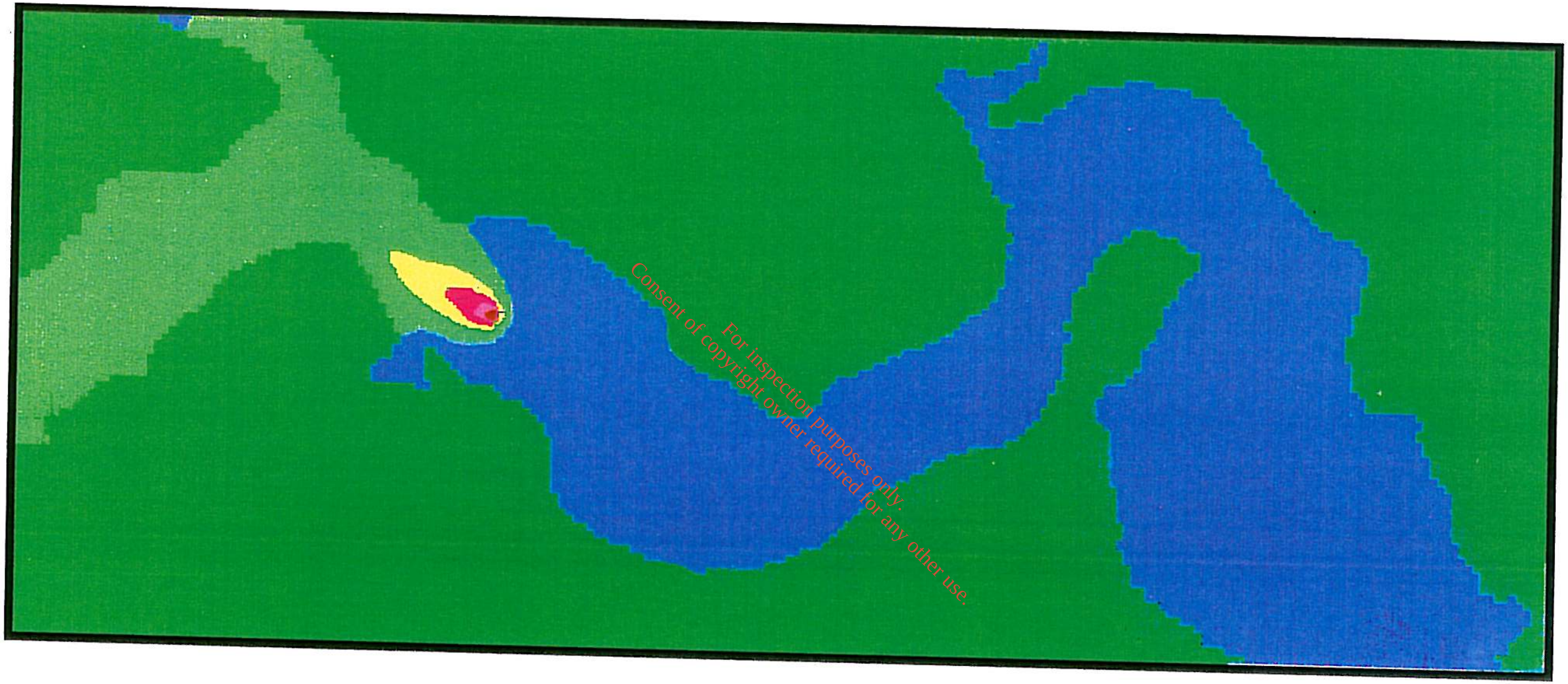


FIGURE A8

FAECAL COLIFORM CONCENTRATIONS AT MID-FLOOD (FROM OUTFALL 1, NEAP TIDE)



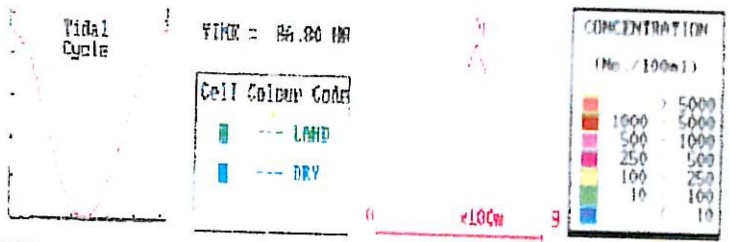


FIGURE A9

FAECAL COLIFORM CONCENTRATIONS AT HIGH WATER (FROM OUTFALL 1, MEAN TIDE)

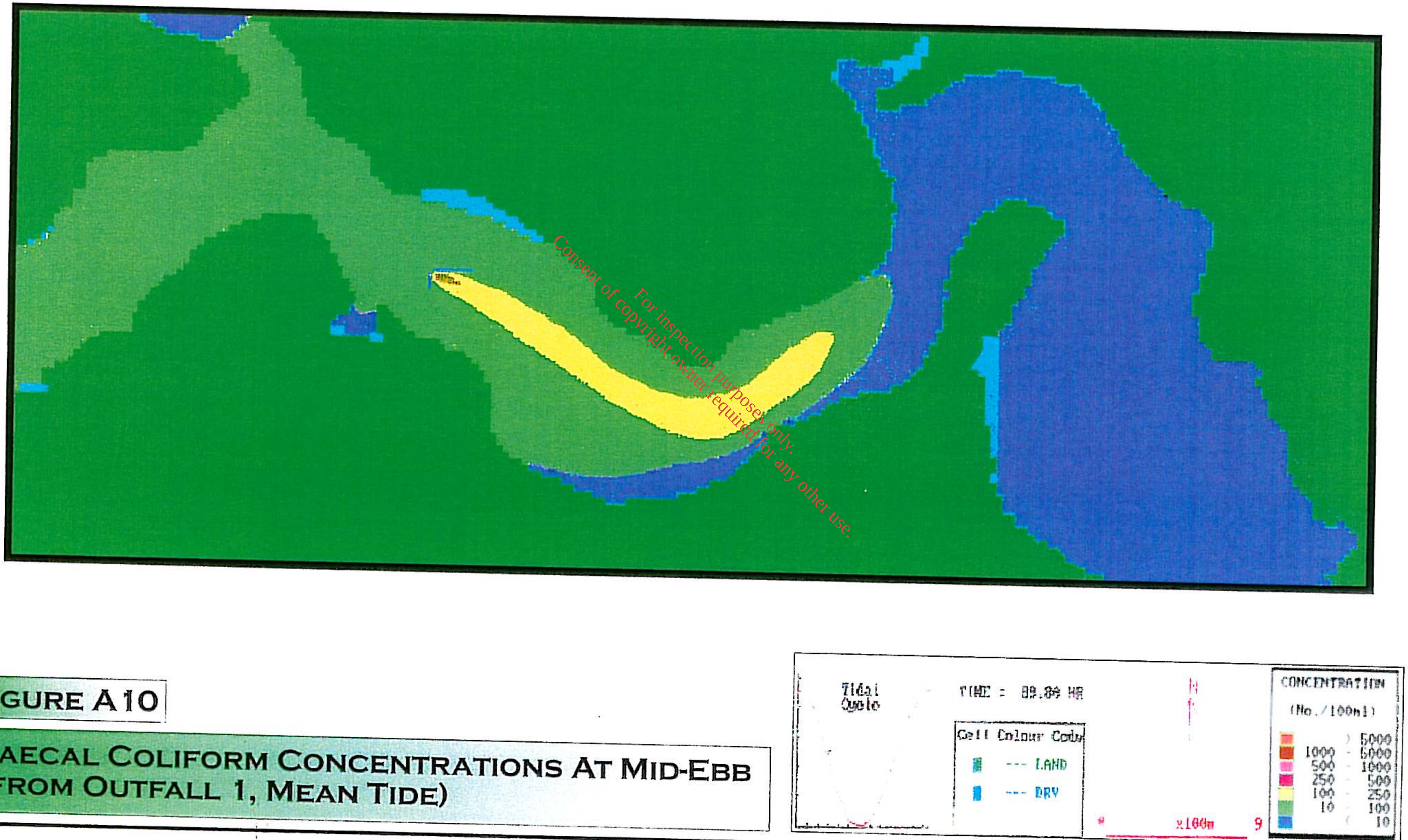
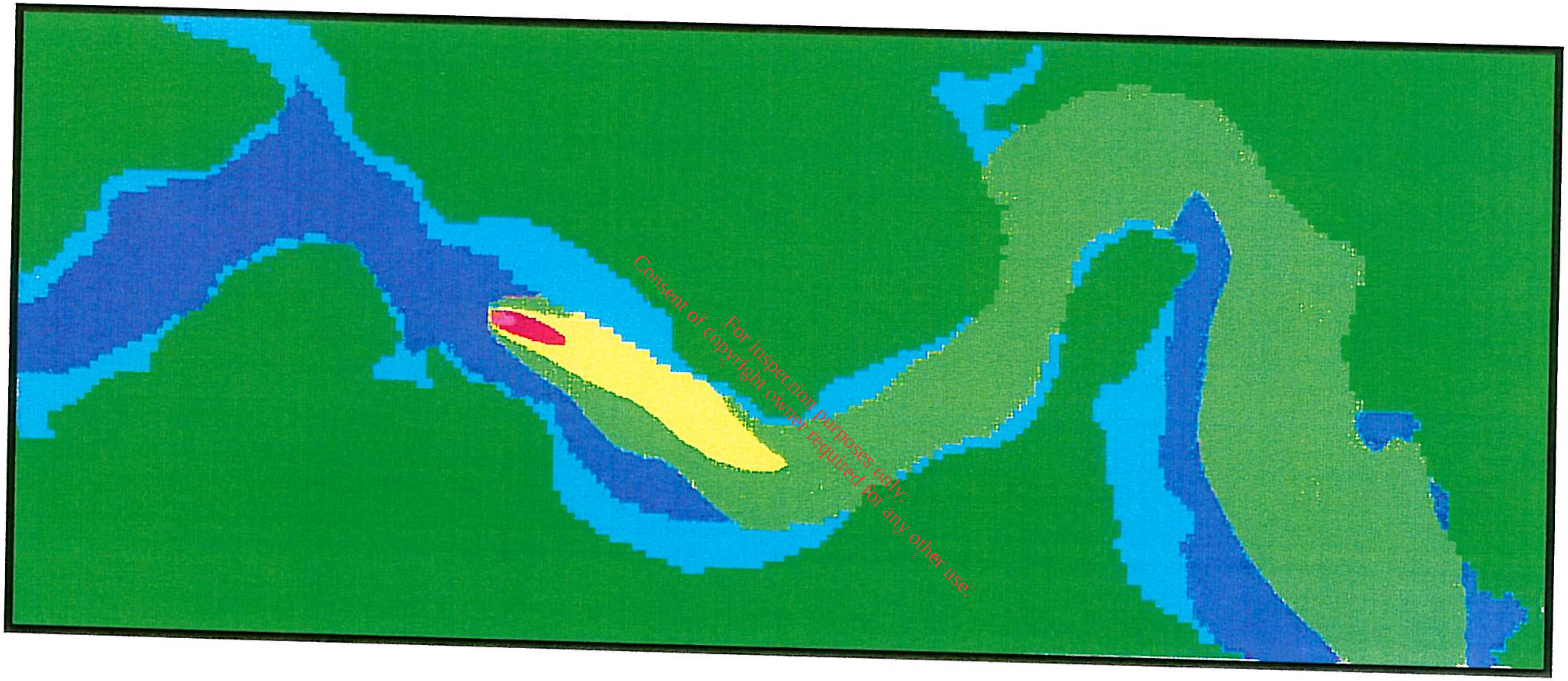


FIGURE A10

FAECAL COLIFORM CONCENTRATIONS AT MID-EBB (FROM OUTFALL 1, MEAN TIDE)



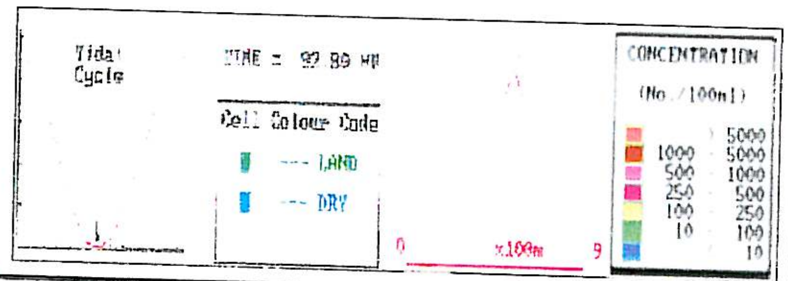


FIGURE A11

FAECAL COLIFORM CONCENTRATIONS AT LOW WATER (FROM OUTFALL 1, MEAN TIDE)

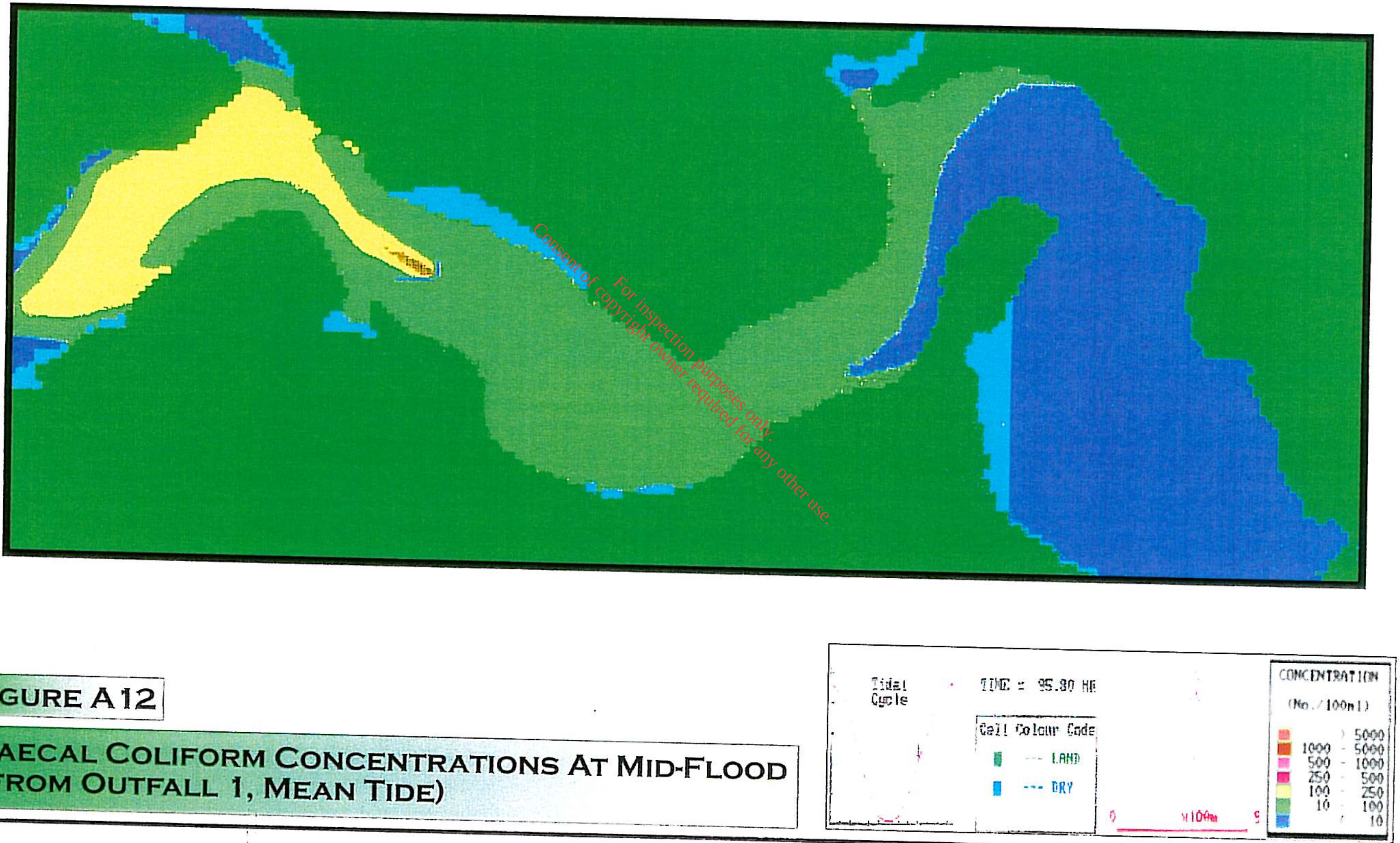


FIGURE A12

FAECAL COLIFORM CONCENTRATIONS AT MID-FLOOD (FROM OUTFALL 1, MEAN TIDE)

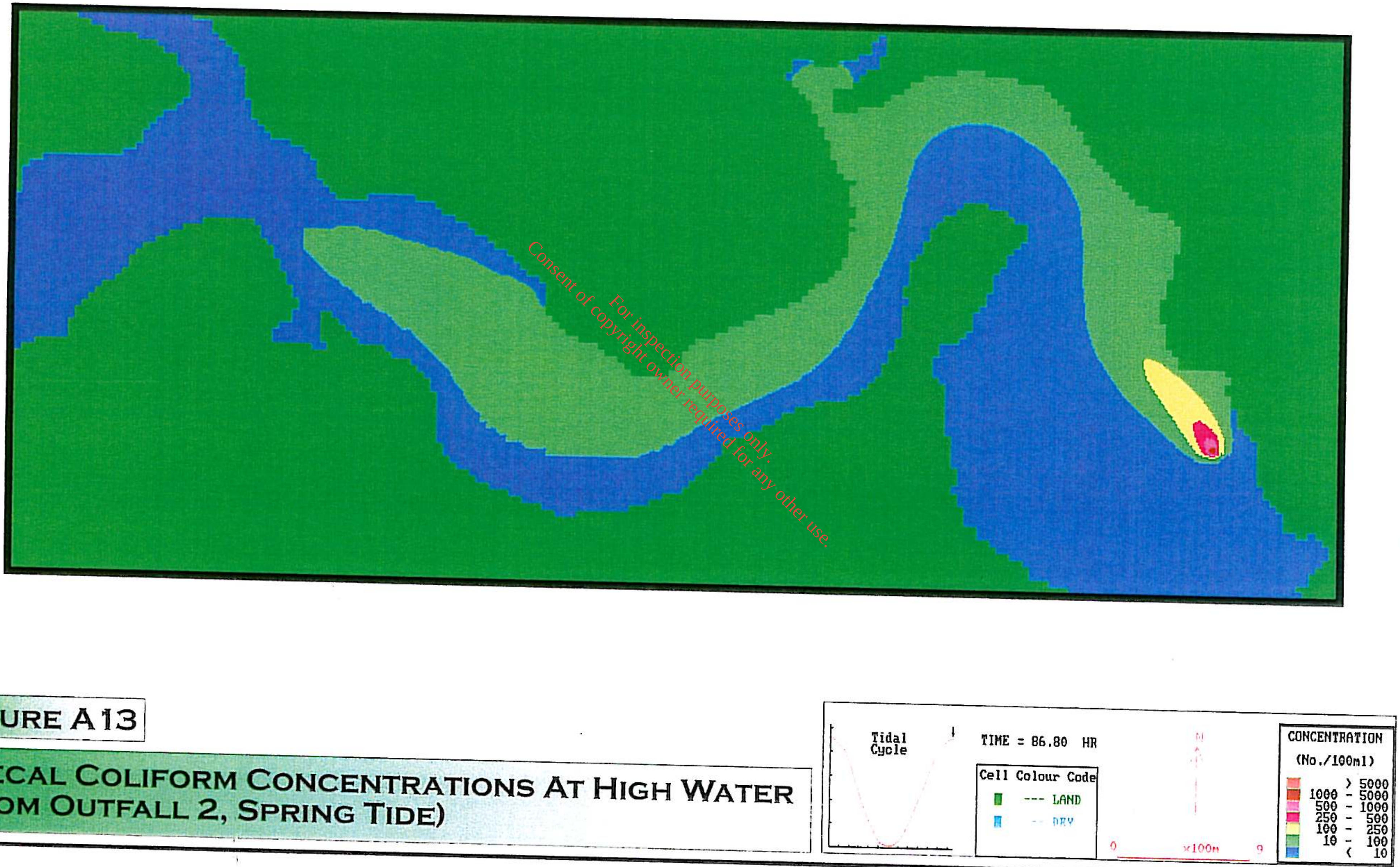


FIGURE A13

FAECAL COLIFORM CONCENTRATIONS AT HIGH WATER (FROM OUTFALL 2, SPRING TIDE)

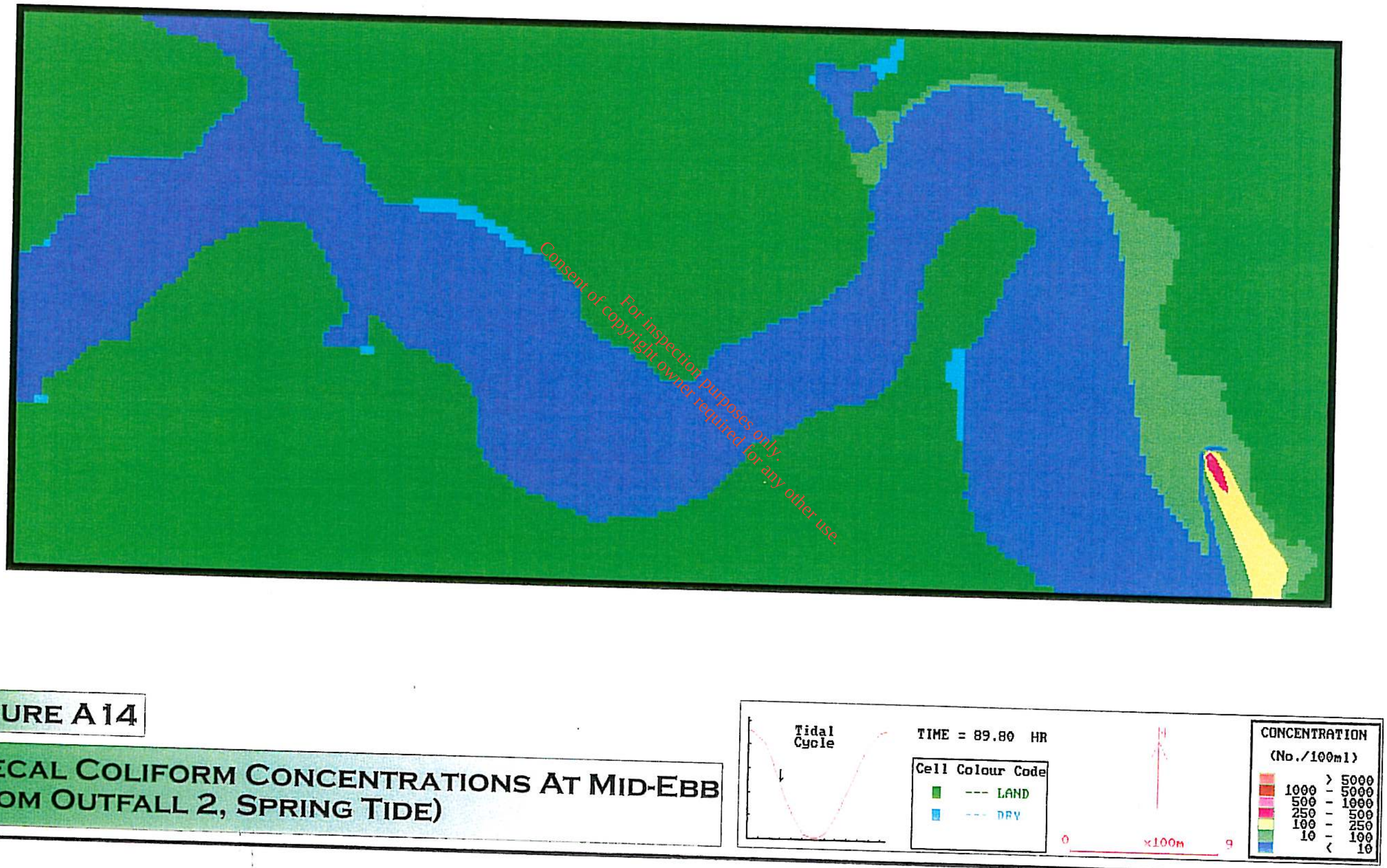


FIGURE A14

FAECAL COLIFORM CONCENTRATIONS AT MID-EBB (FROM OUTFALL 2, SPRING TIDE)

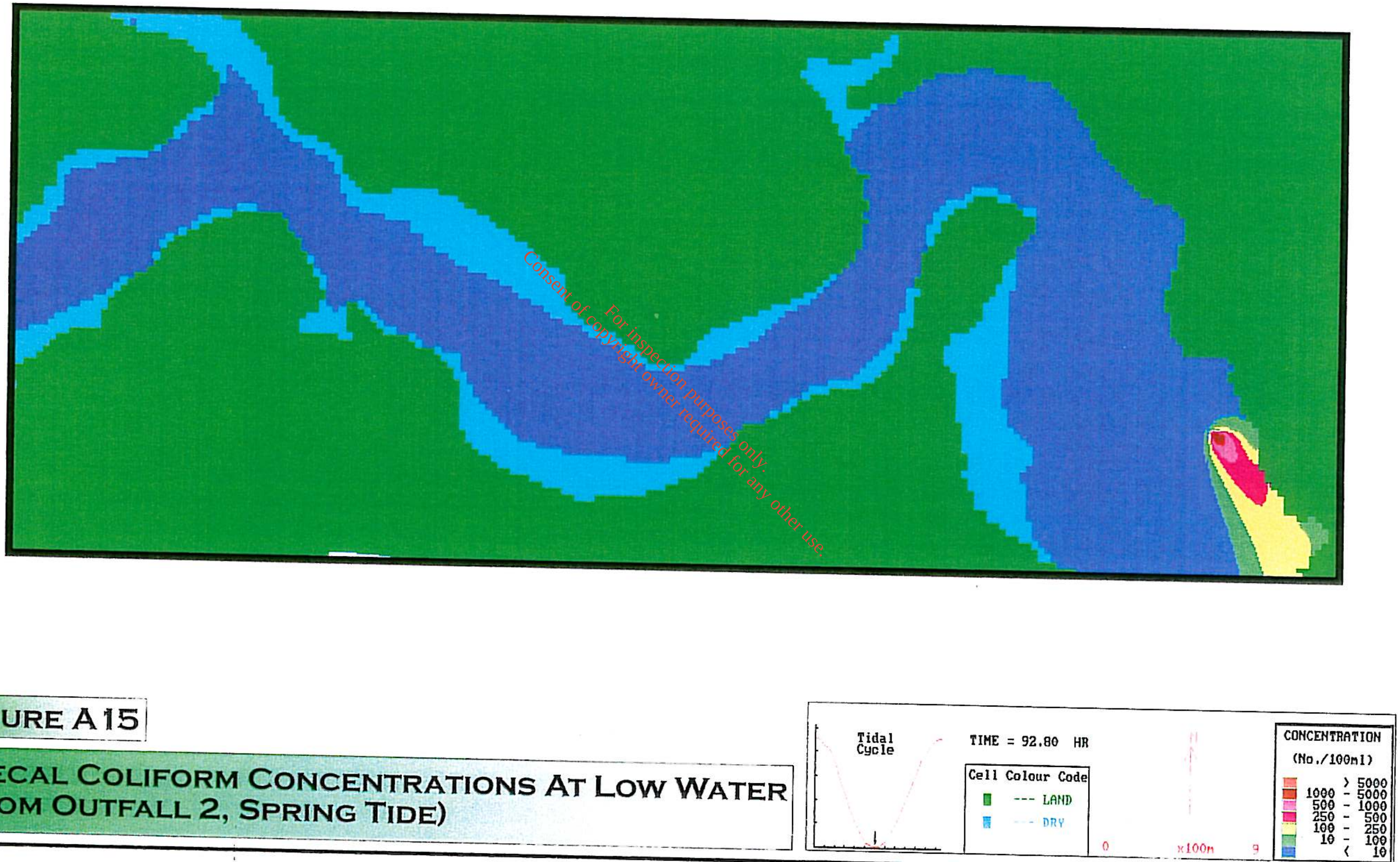
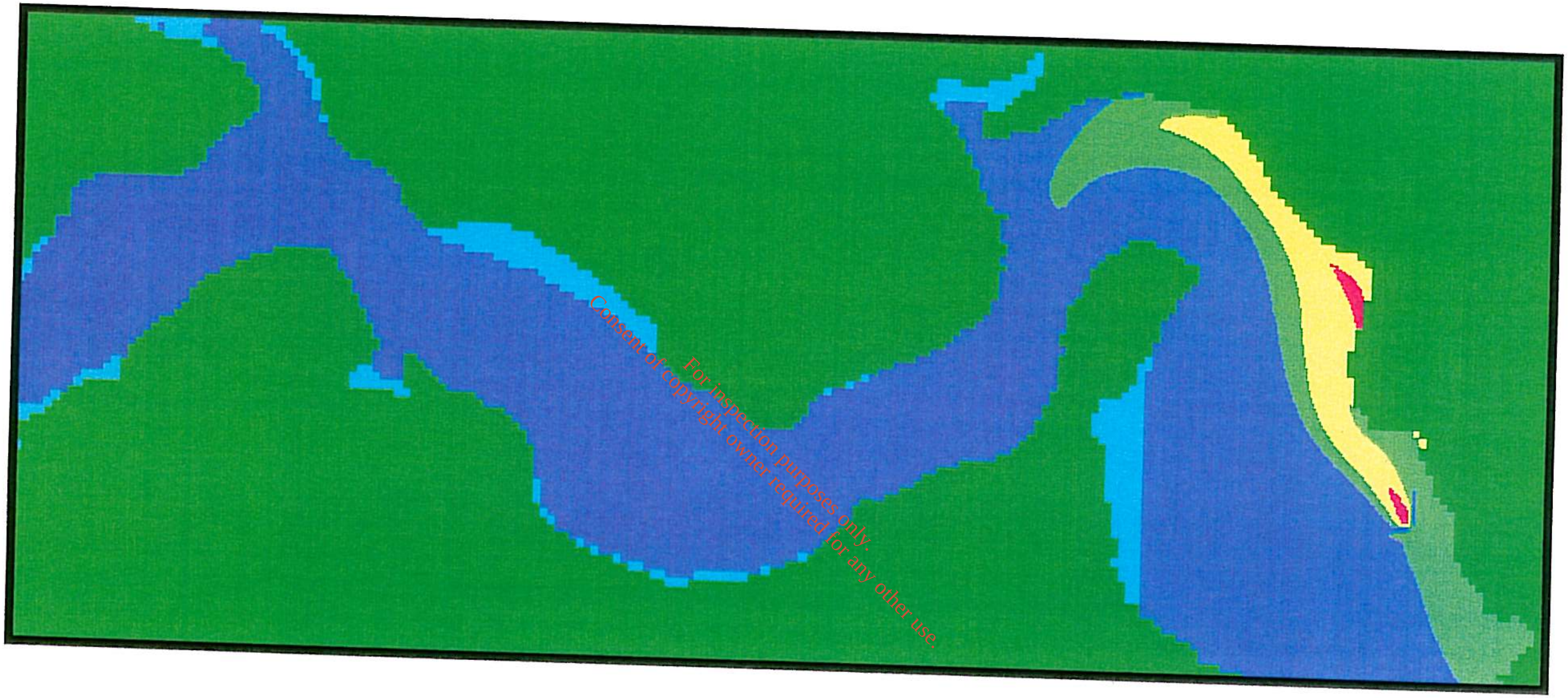


FIGURE A15

FAECAL COLIFORM CONCENTRATIONS AT LOW WATER (FROM OUTFALL 2, SPRING TIDE)



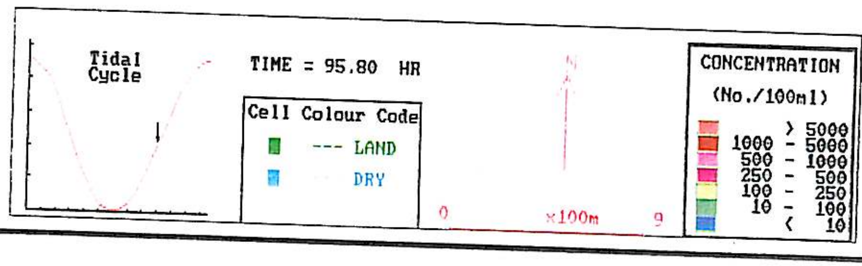


FIGURE A16

FAECAL COLIFORM CONCENTRATIONS AT MID-FLOOD (FROM OUTFALL 2, SPRING TIDE)

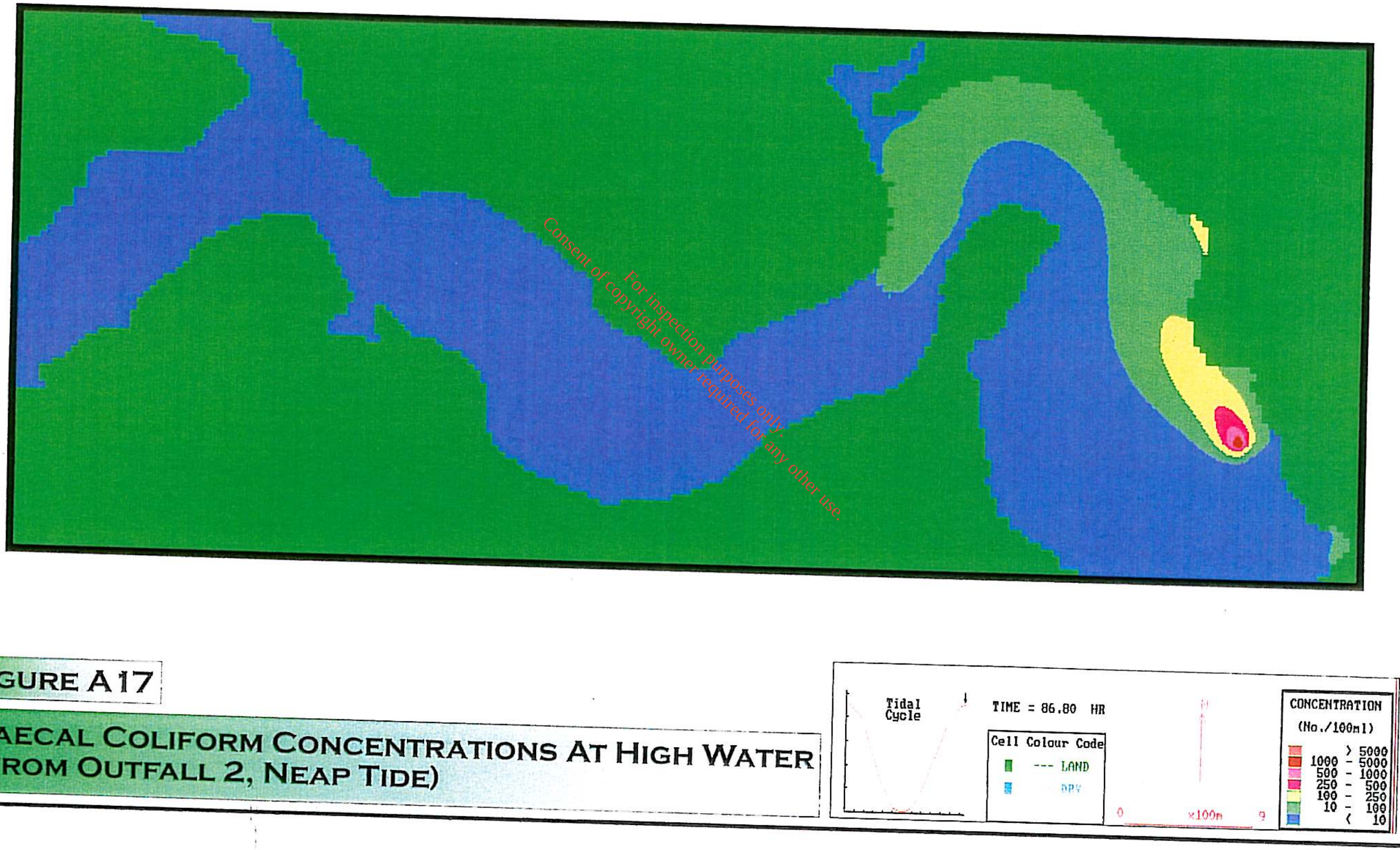
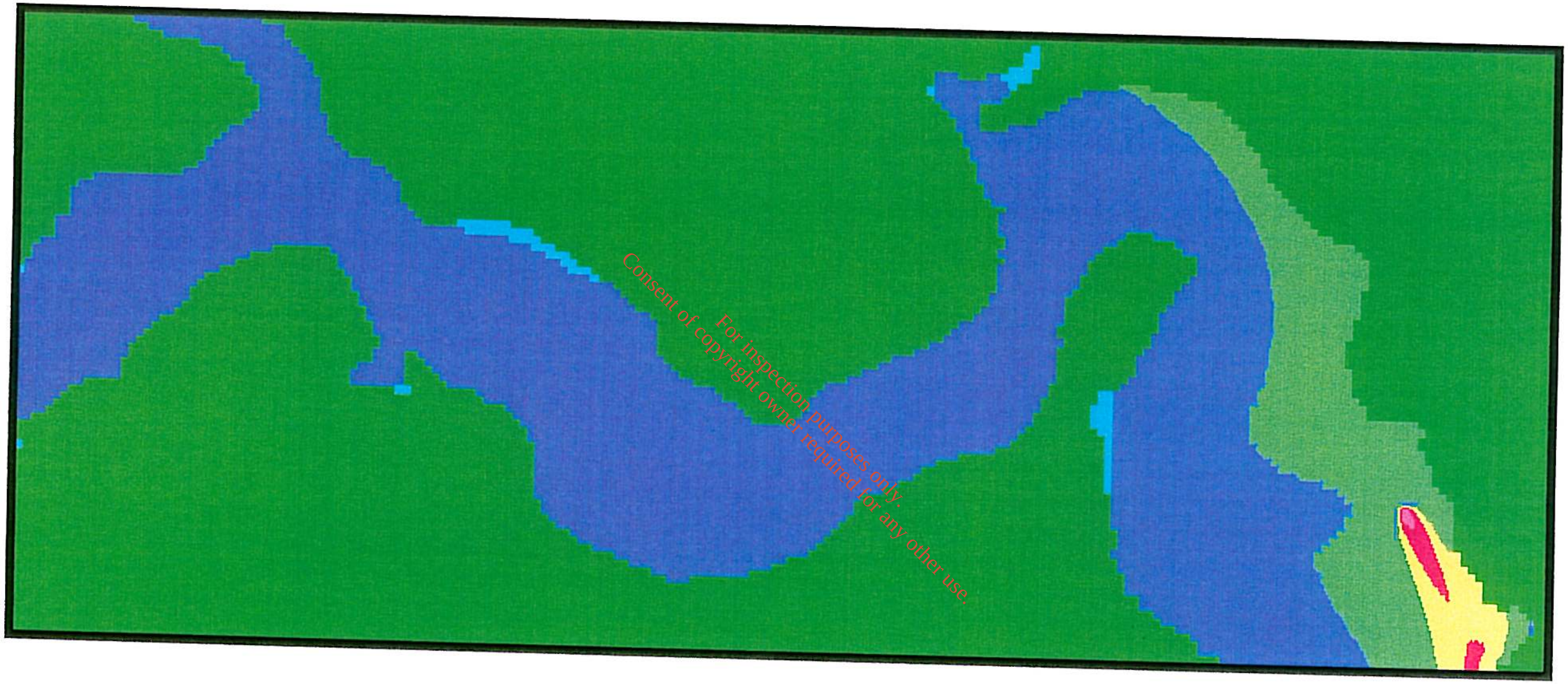


FIGURE A17

FAECAL COLIFORM CONCENTRATIONS AT HIGH WATER (FROM OUTFALL 2, NEAP TIDE)



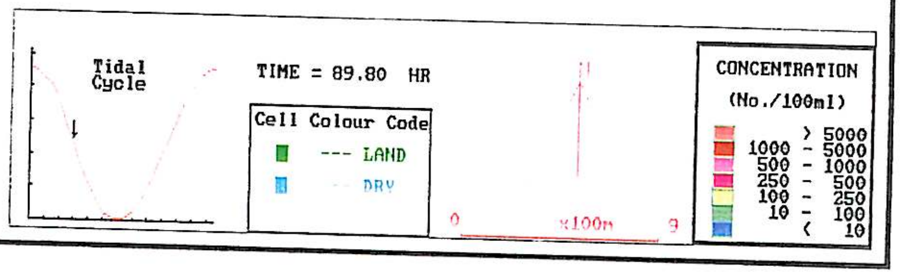
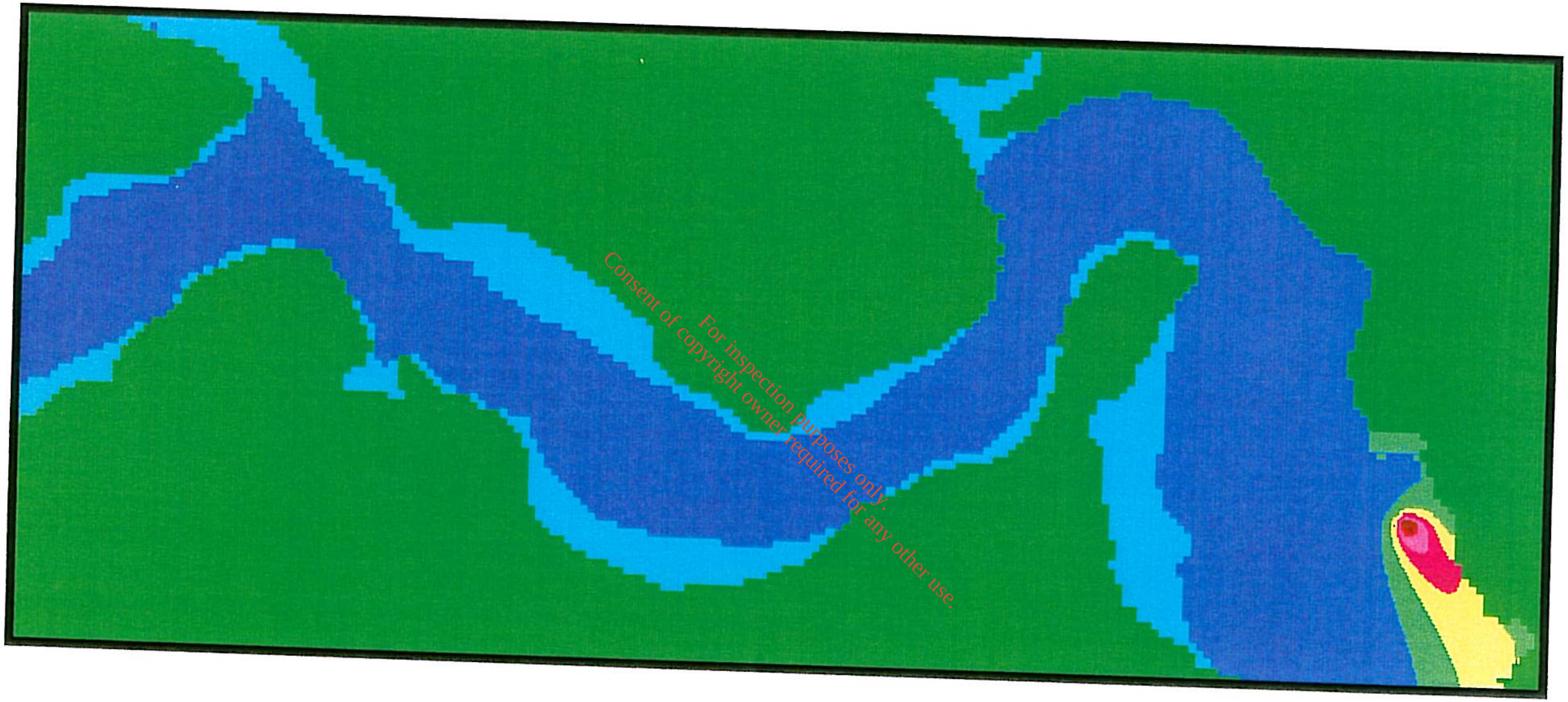


FIGURE A18

FAECAL COLIFORM CONCENTRATIONS AT MID-EBB (FROM OUTFALL 2, NEAP TIDE)



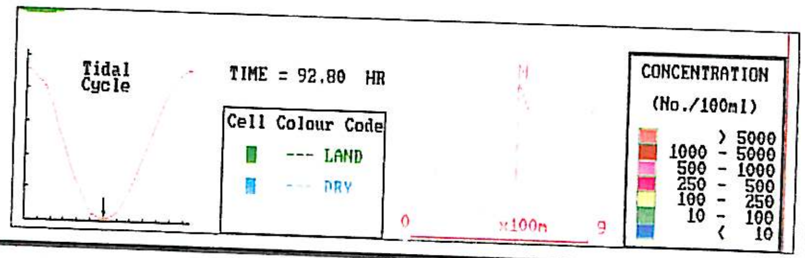
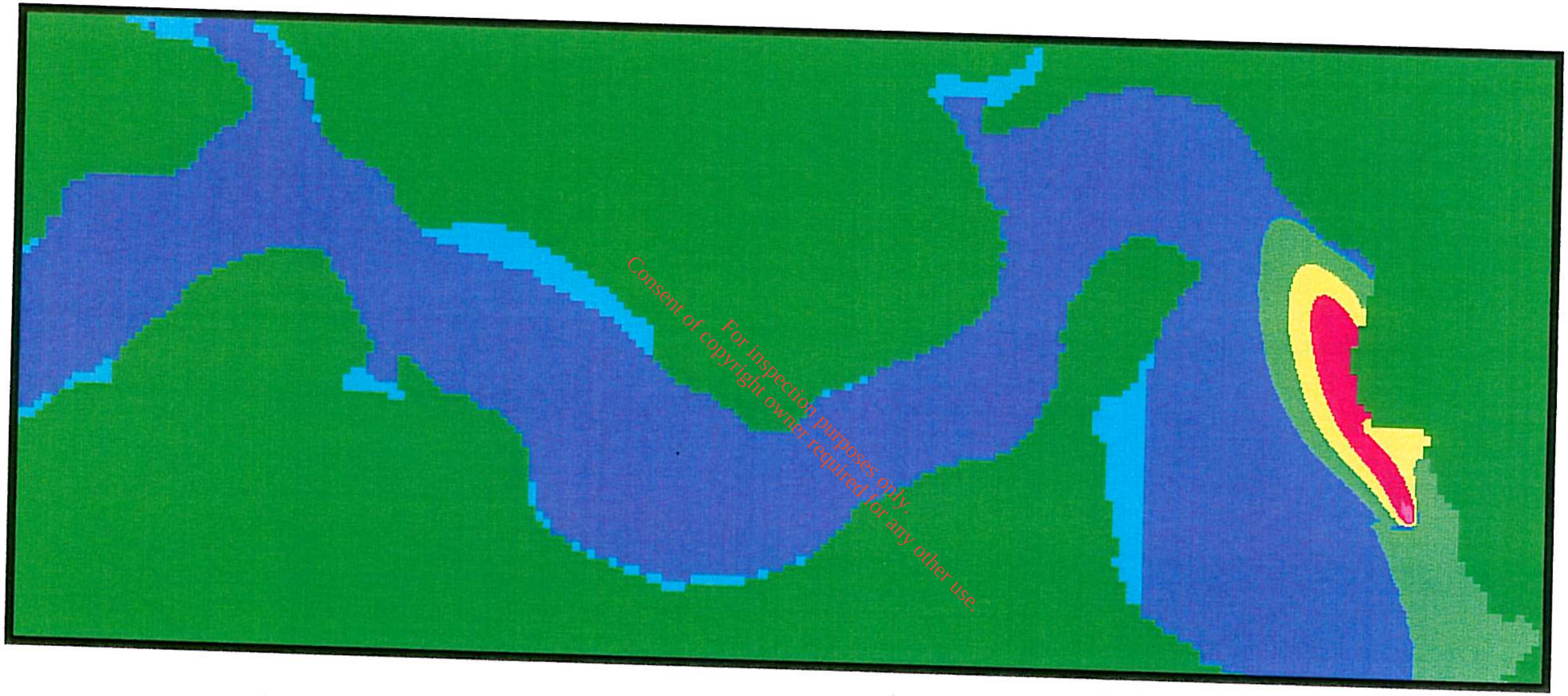


FIGURE A19

FAECAL COLIFORM CONCENTRATIONS AT LOW WATER (FROM OUTFALL 2, NEAP TIDE)



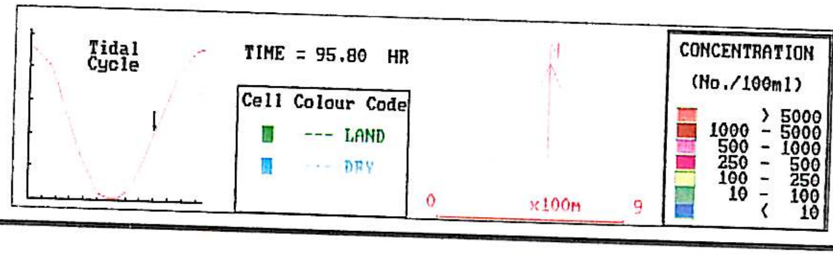


FIGURE A20

FAECAL COLIFORM CONCENTRATIONS AT MID-FLOOD (FROM OUTFALL 2, NEAP TIDE)

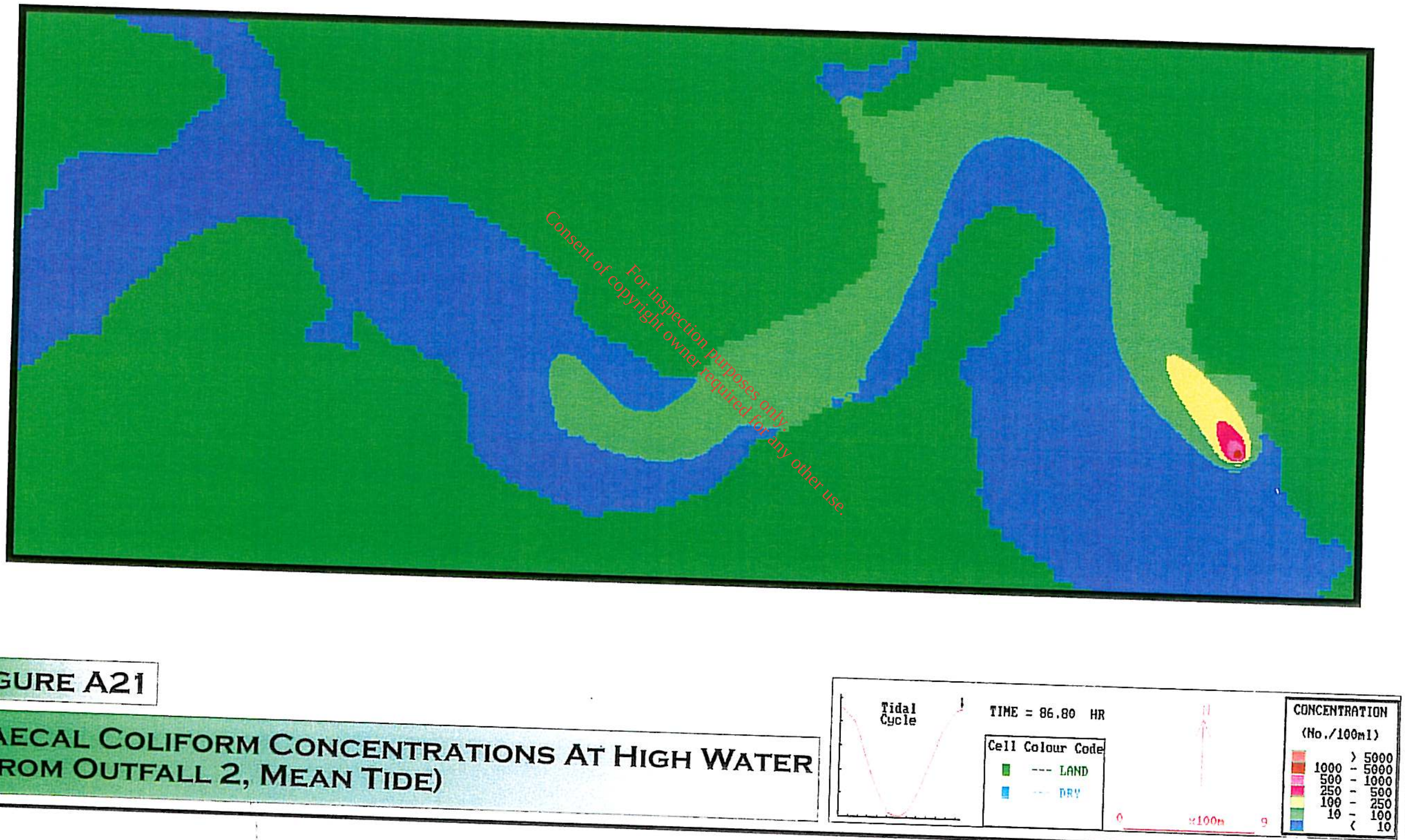
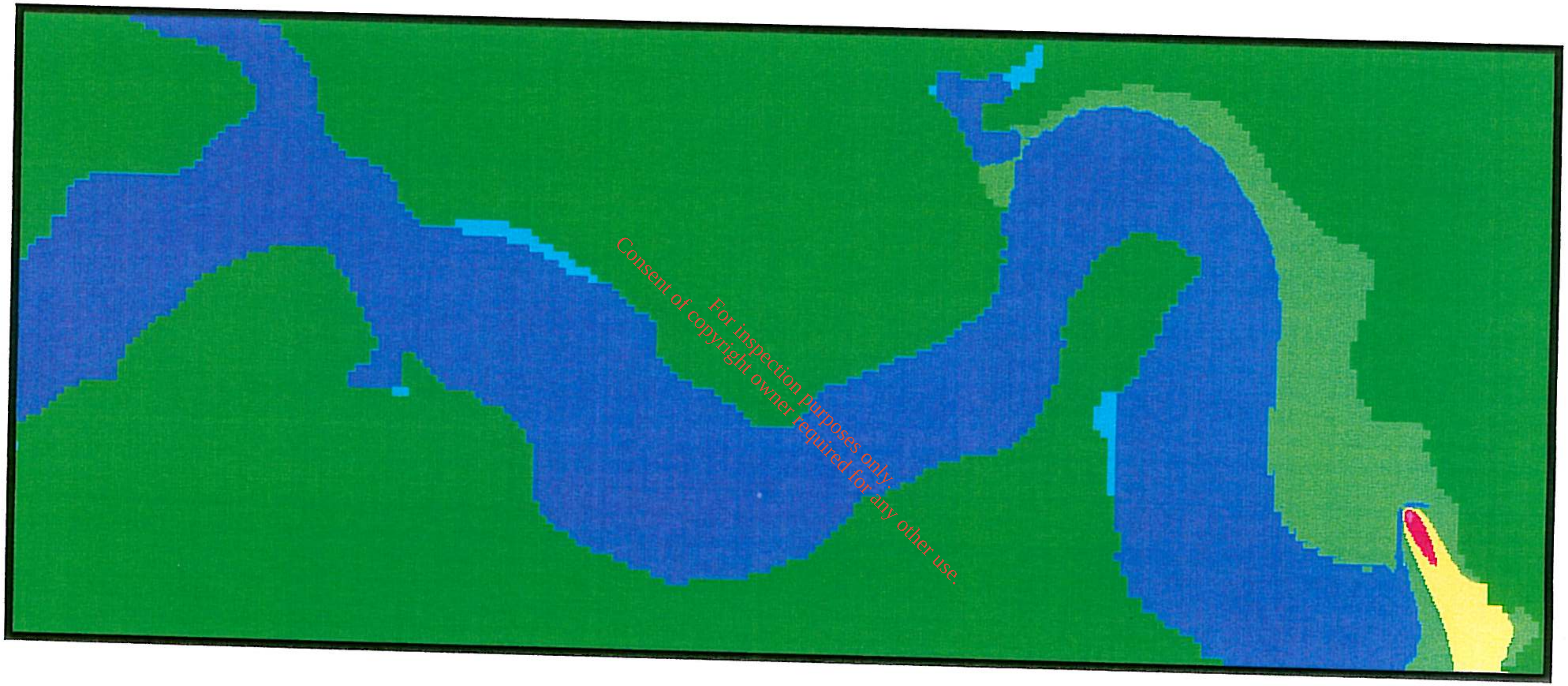


Figure A21

Faecal Coliform Concentrations At High Water (from Outfall 2, Mean Tide)



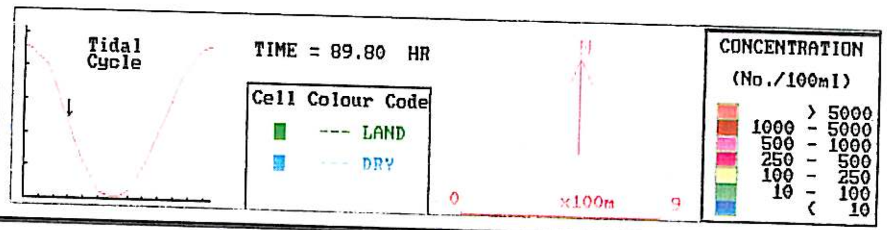


FIGURE A22

FAECAL COLIFORM CONCENTRATIONS AT MID-EBB (FROM OUTFALL 2, MEAN TIDE)

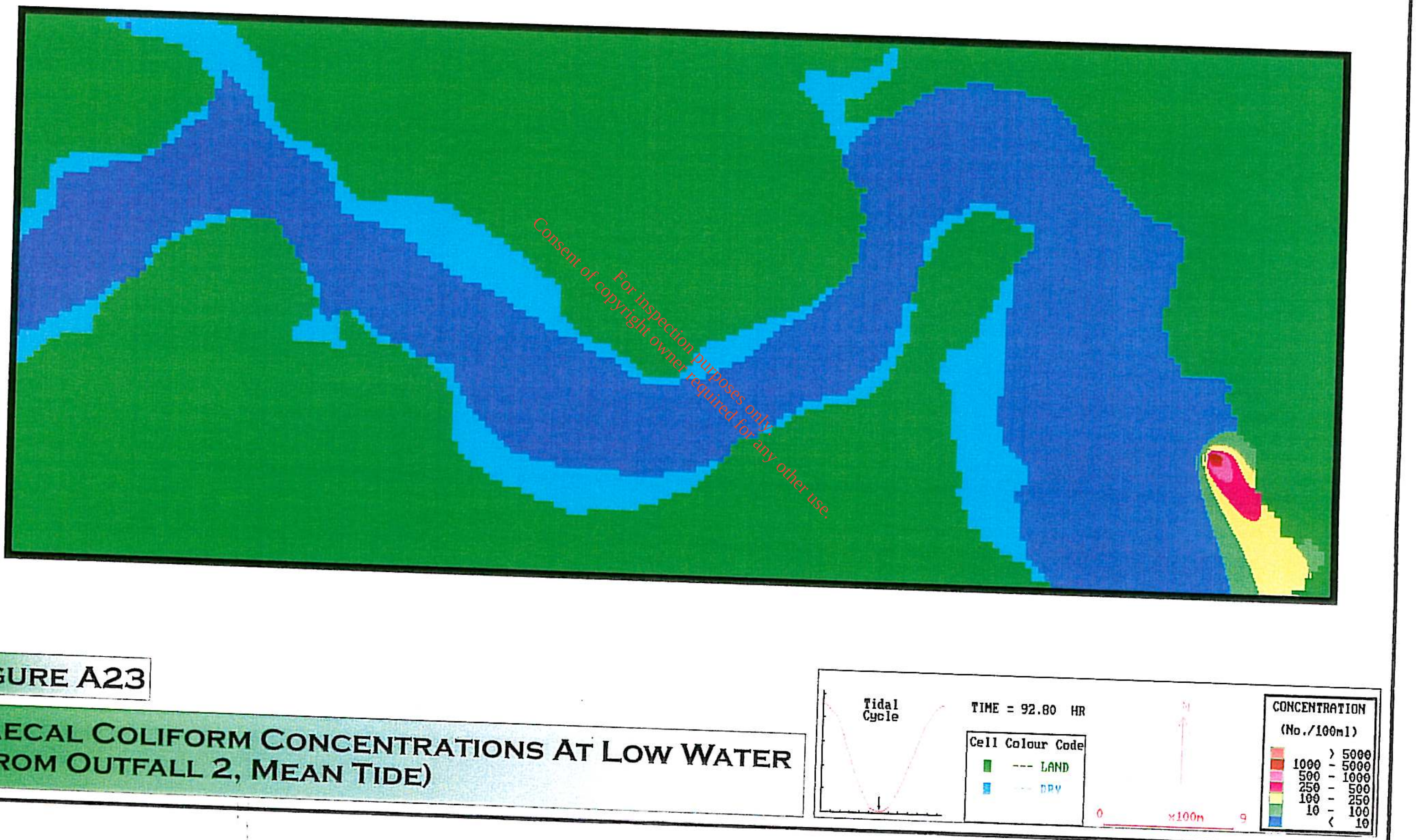


FIGURE A23

FAECAL COLIFORM CONCENTRATIONS AT LOW WATER (FROM OUTFALL 2, MEAN TIDE)

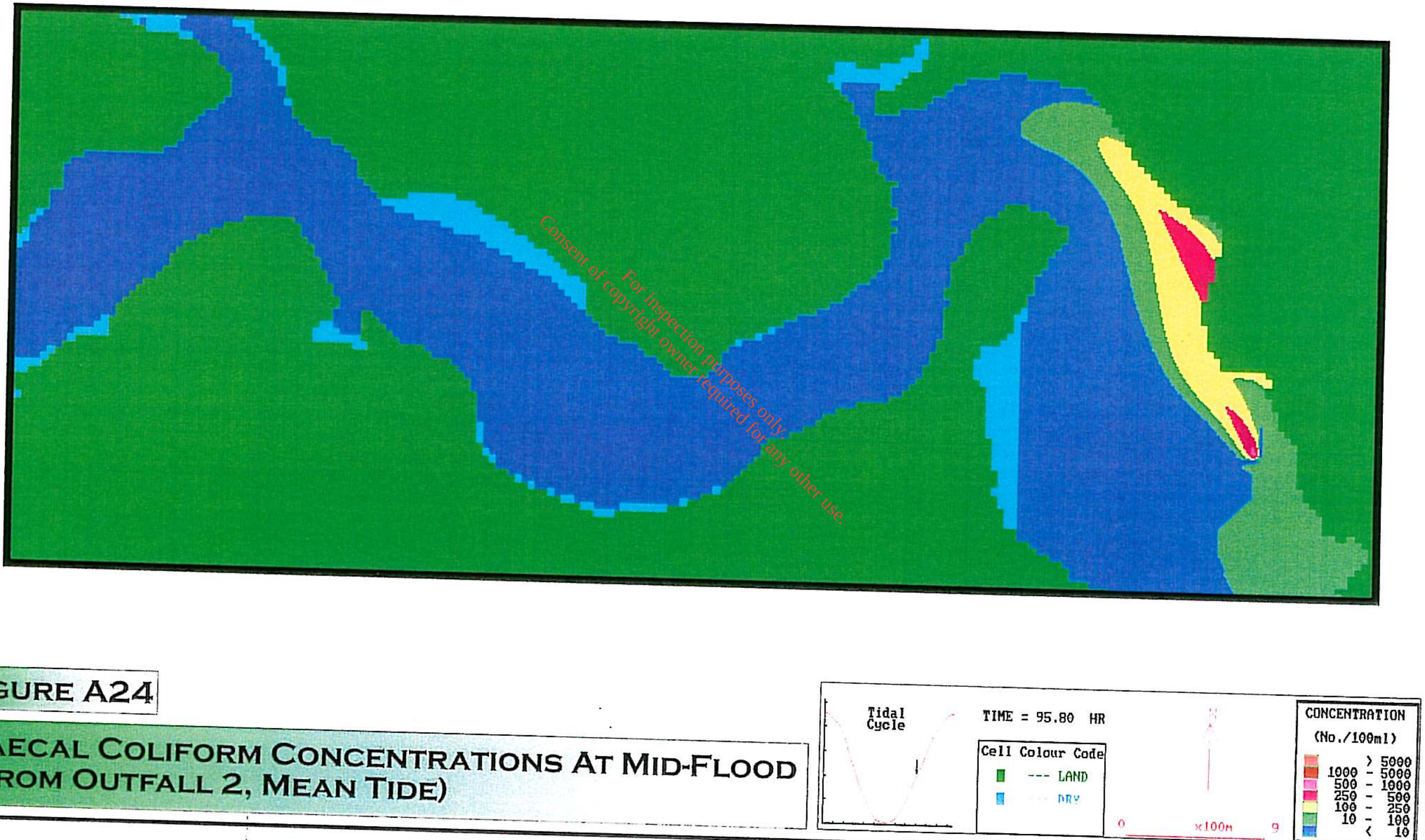


Figure A24

Faecal Coliform Concentrations At Mid-Flood (From Outfall 2, Mean Tide)

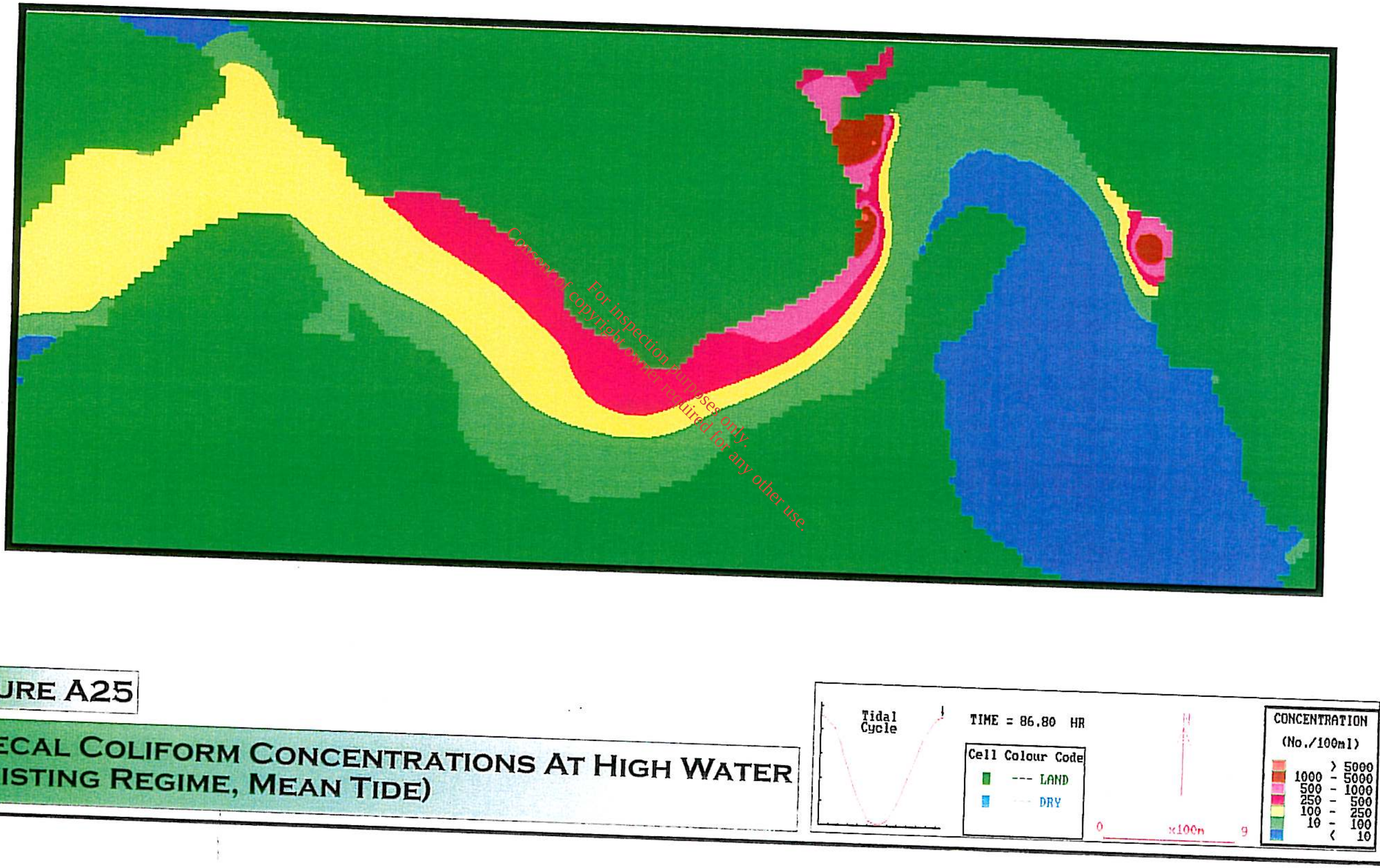


FIGURE A25

FAECAL COLIFORM CONCENTRATIONS AT HIGH WATER (EXISTING REGIME, MEAN TIDE)

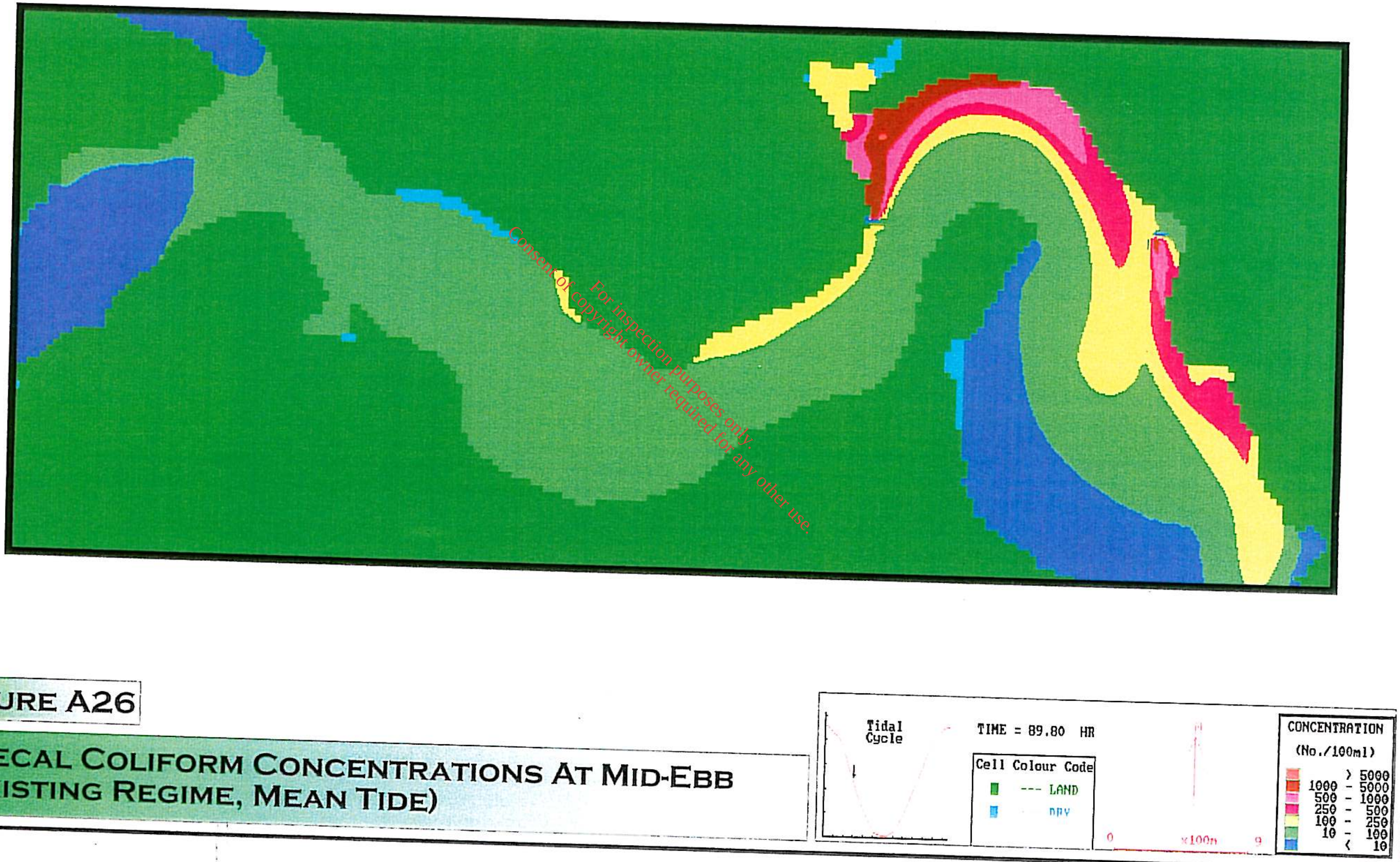
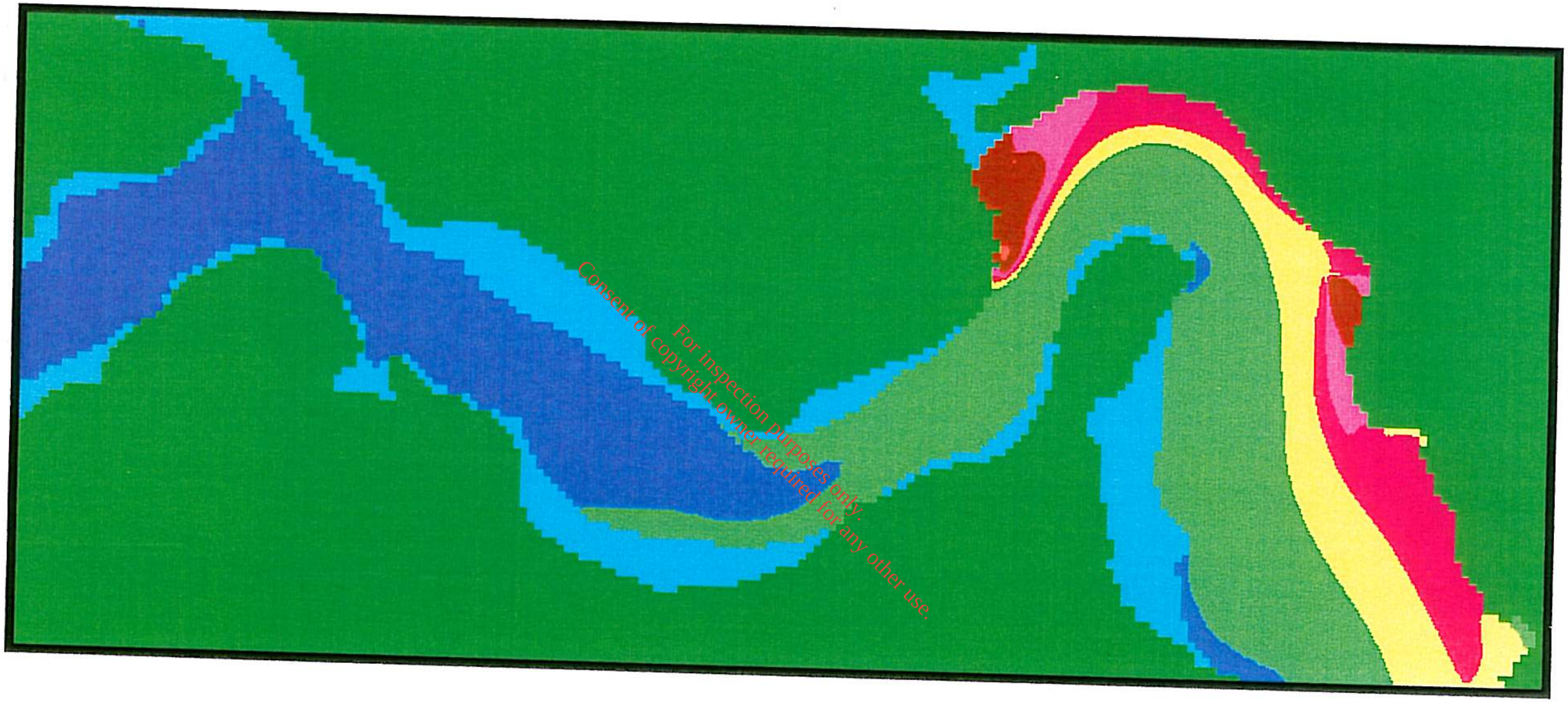


FIGURE A26

FAECAL COLIFORM CONCENTRATIONS AT MID-EBB (EXISTING REGIME, MEAN TIDE)



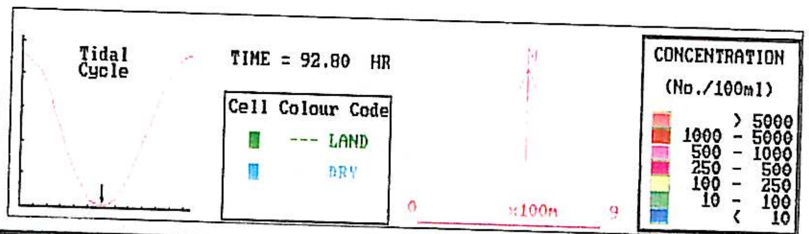


FIGURE A27

FAECAL COLIFORM CONCENTRATIONS AT LOW WATER (EXISTING REGIME, MEAN TIDE)

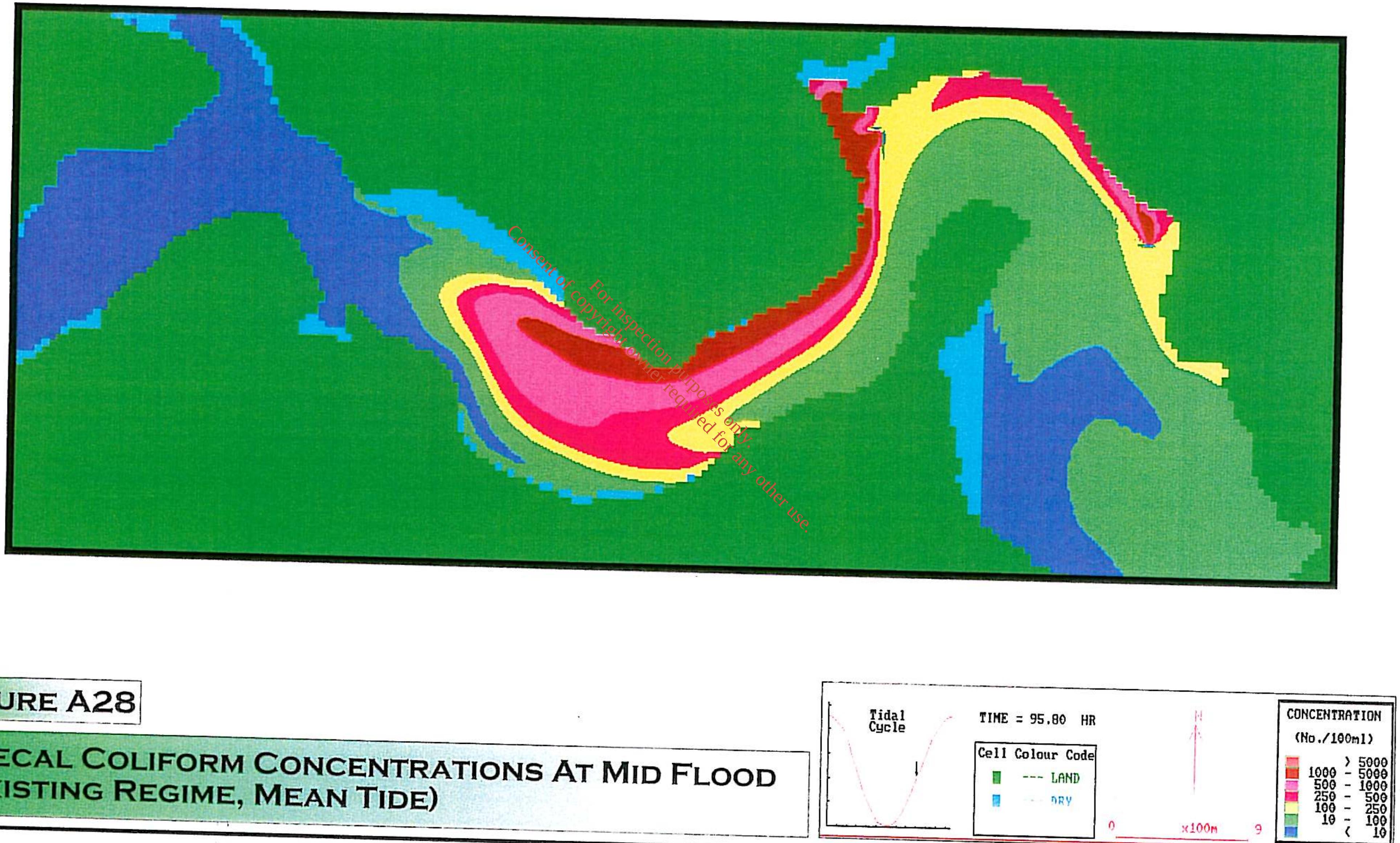


FIGURE A28

FAECAL COLIFORM CONCENTRATIONS AT MID FLOOD (EXISTING REGIME, MEAN TIDE)

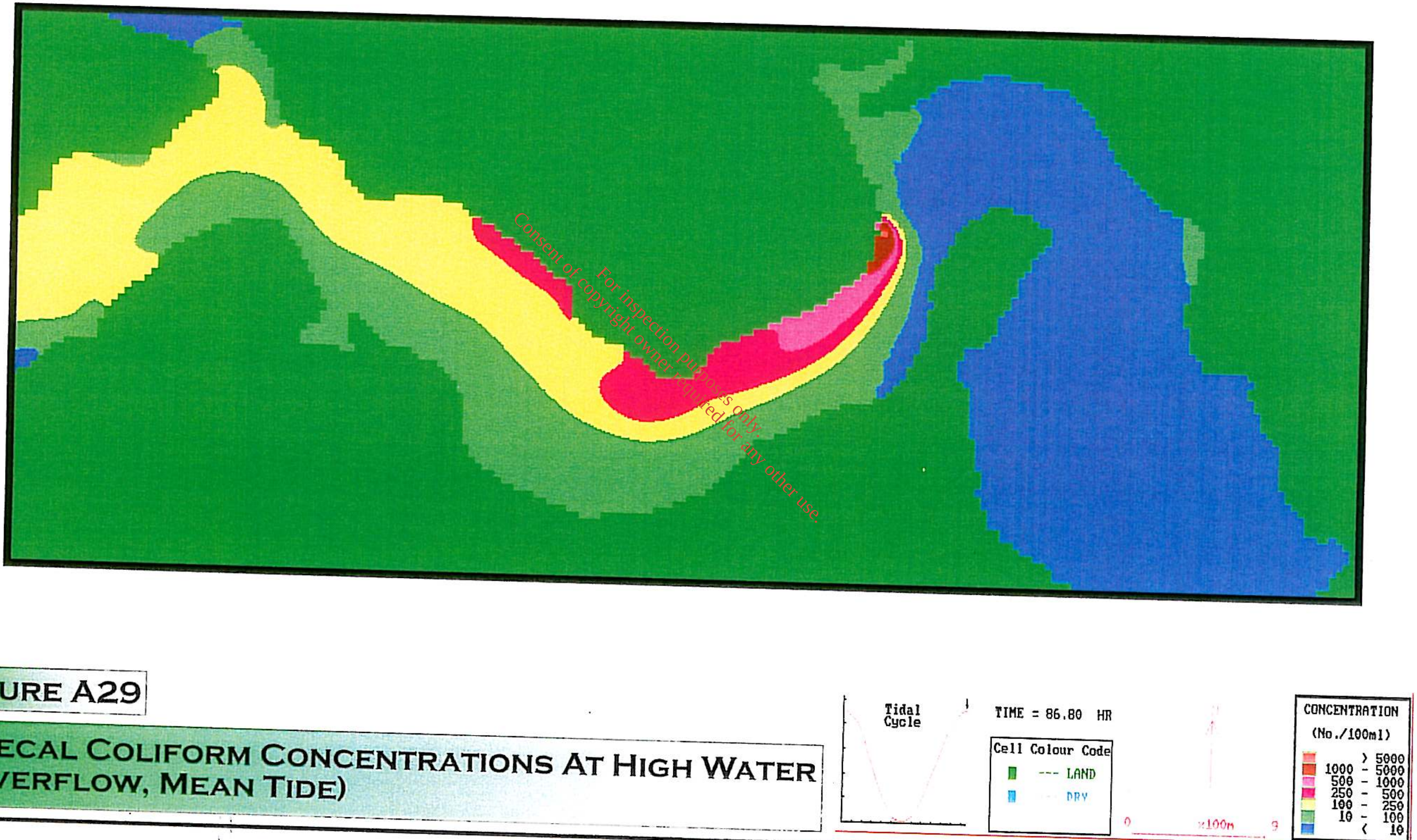


FIGURE A29

FAECAL COLIFORM CONCENTRATIONS AT HIGH WATER (OVERFLOW, MEAN TIDE)

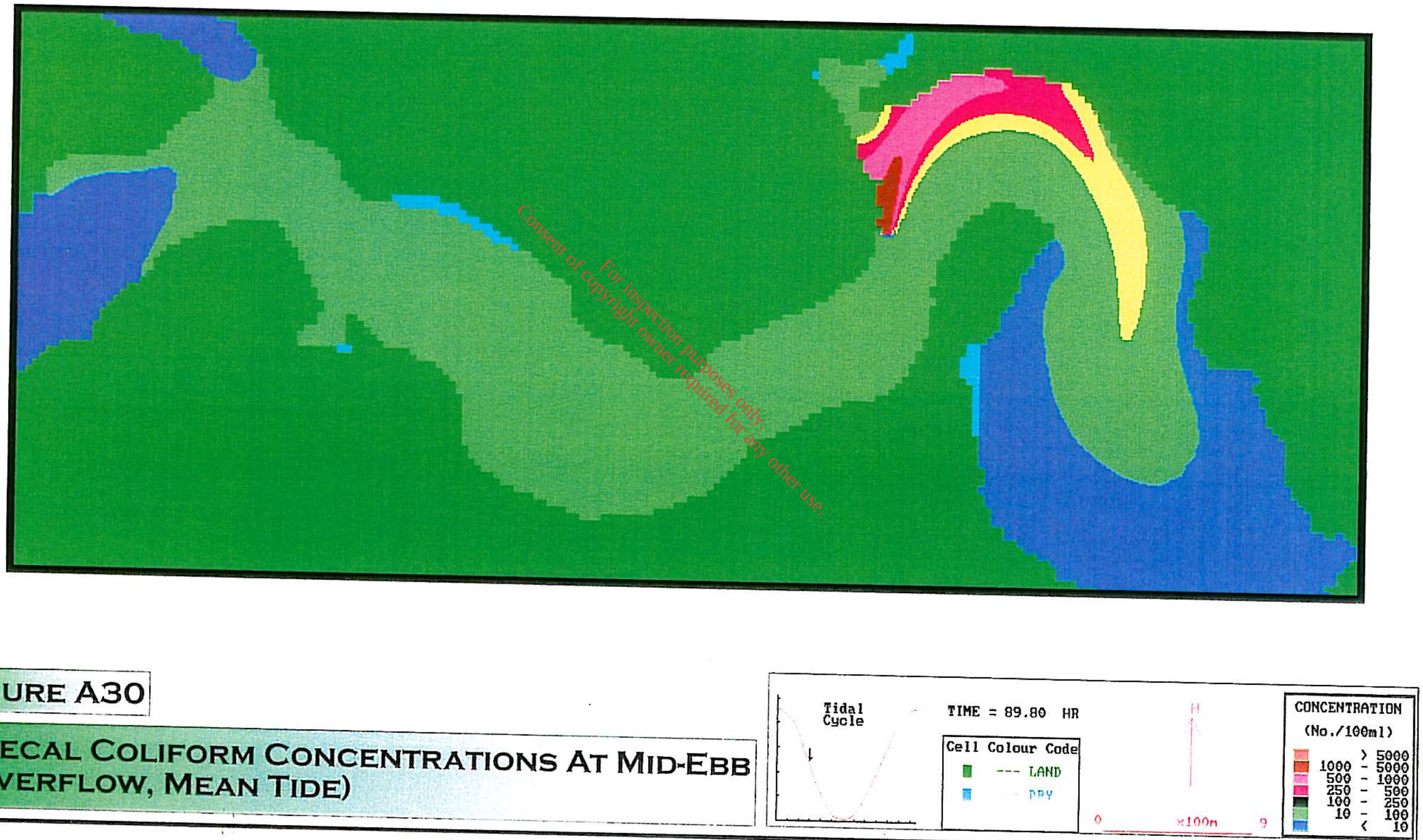
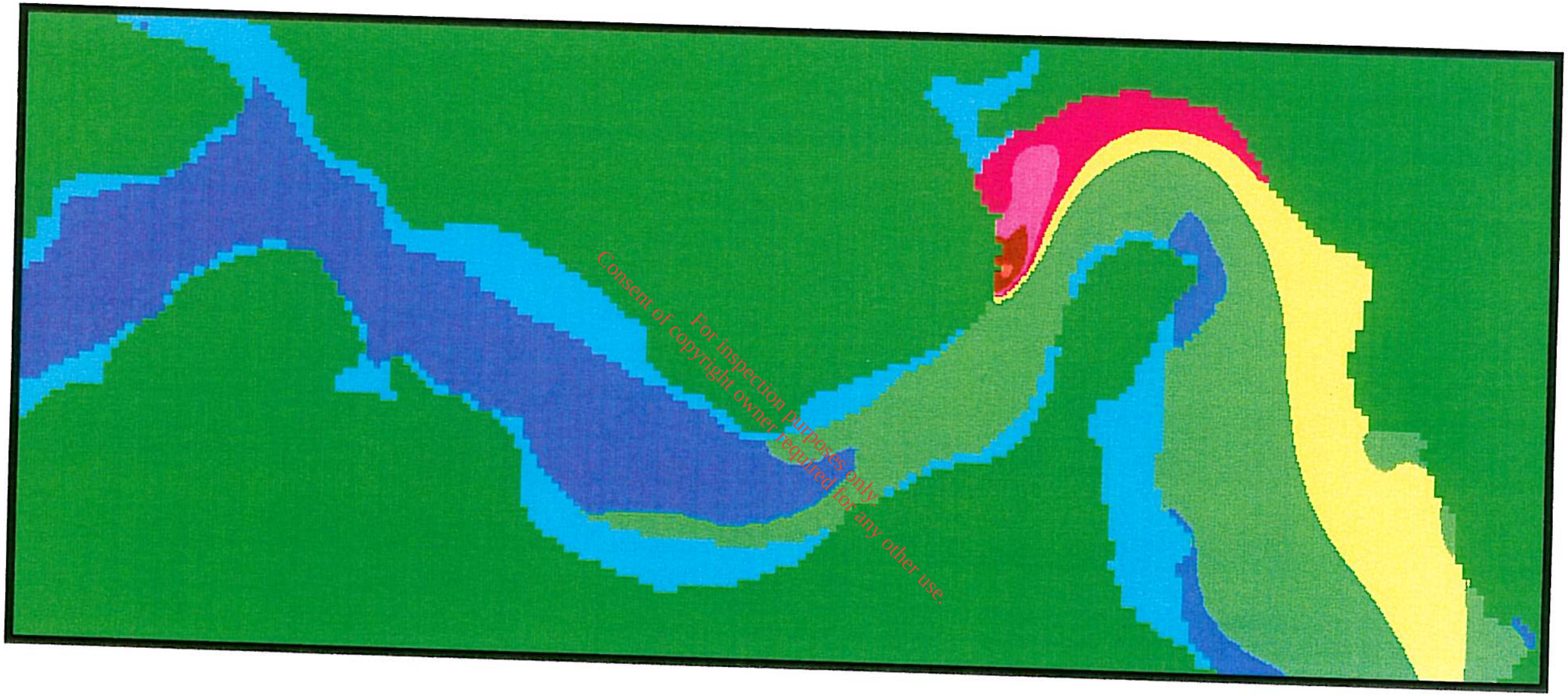


FIGURE A30

FAECAL COLIFORM CONCENTRATIONS AT MID-EBB (OVERFLOW, MEAN TIDE)



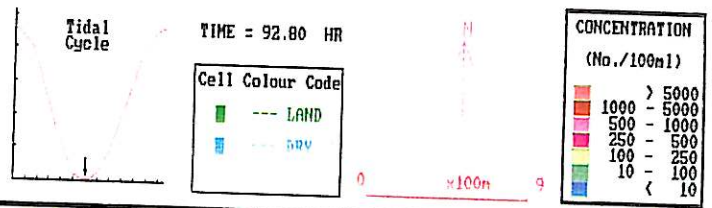


FIGURE A31

FAECAL COLIFORM CONCENTRATIONS AT LOW WATER (OVERFLOW, MEAN TIDE)

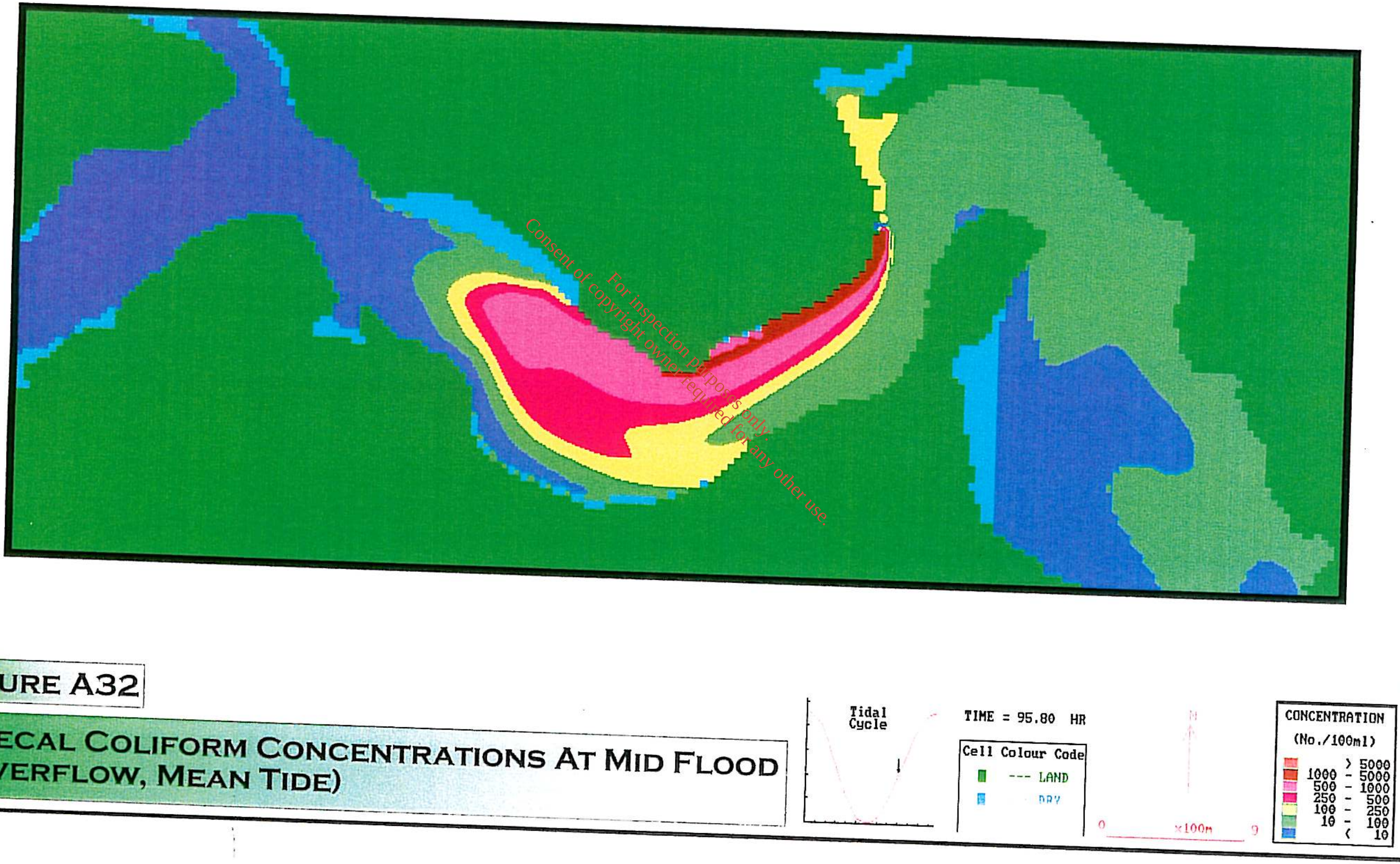


Figure A32

Faecal Coliform Concentrations At Mid Flood (Overflow, Mean Tide)