Modelling the hydrology of wetlands for ecological management – considerations of scale.

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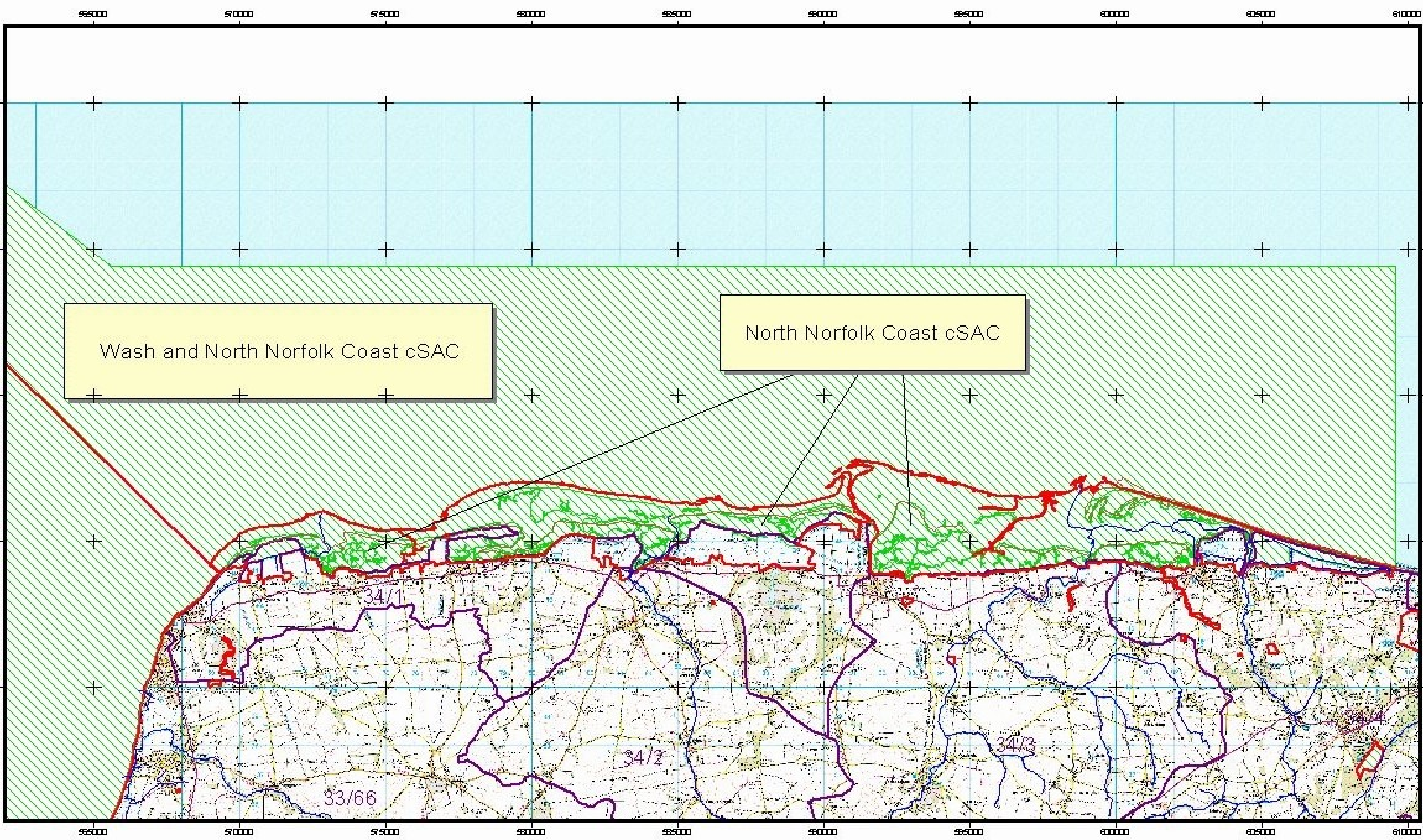
Modelling at different scales requires different sorts of models

Regional scale	Water budget Regional Ground water flows
Local Scale	Catchment models
micro-environment (plant) studies	Within field process models 2 or 3 dimensional modelling

Three Case studies

- North Norfolk Coast coastal reed beds
- River Ray – river enhancement
- Somerset Levels – prescription reviews

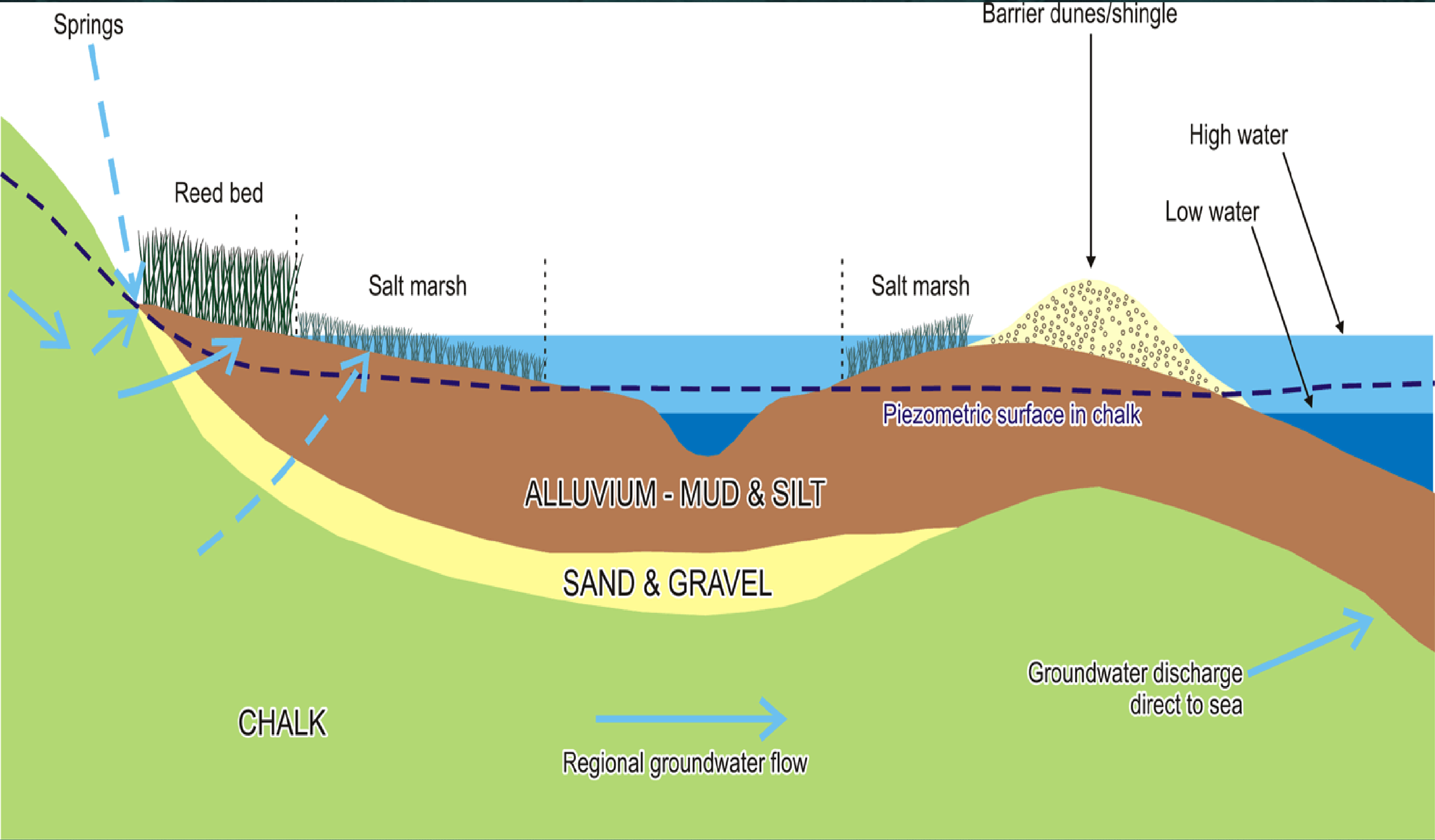

Wash and North Norfolk Coast cSAC
North Norfolk Coast cSAC
34/1
34/2
34/3
33/66

Wells-next-the-sea, Norfolk

Brancaster

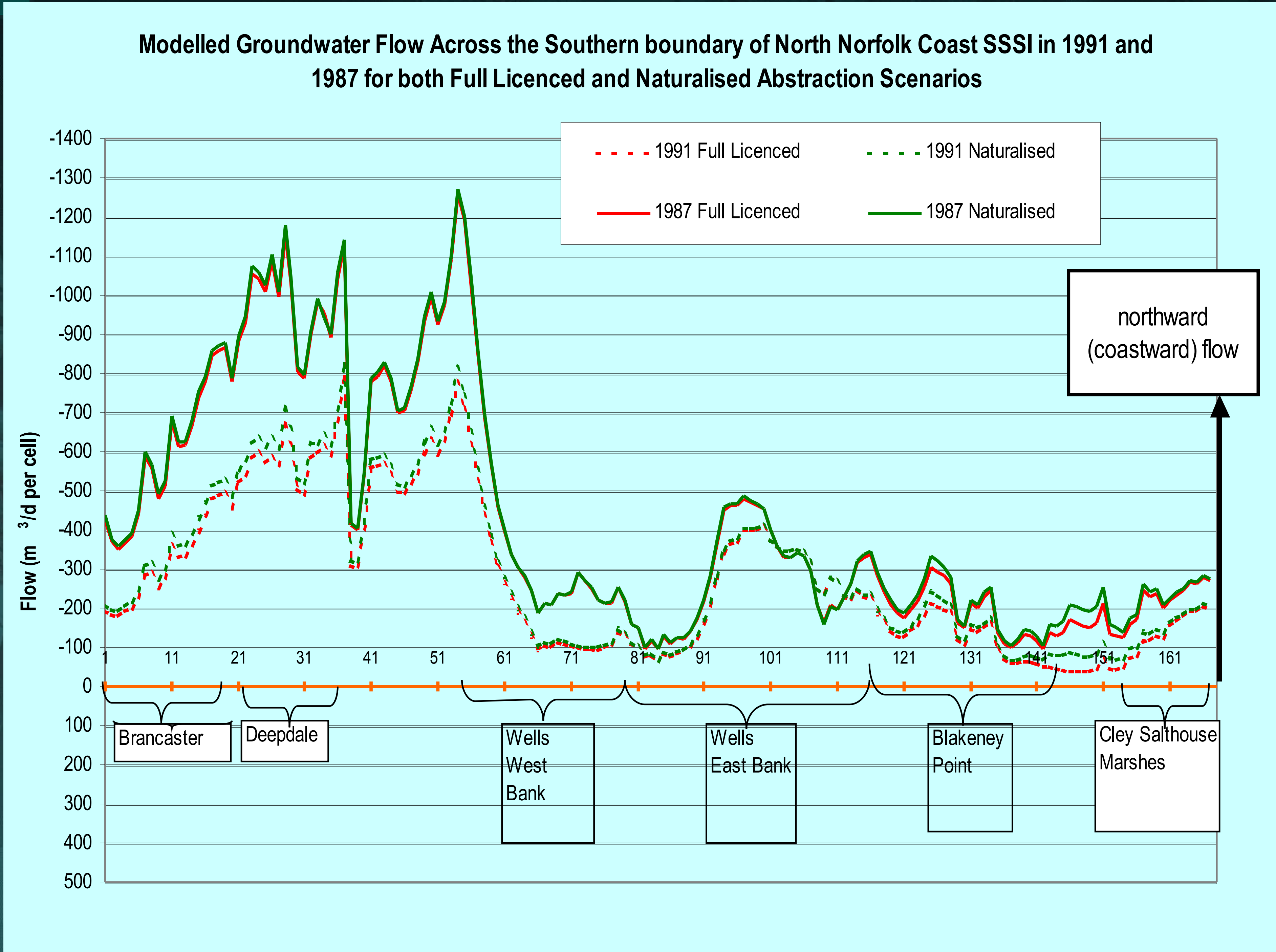
Norfolk: Cley-next-the-sea Reed beds

North Norfolk Conceptual Diagram



North Norfolk: Models required

- **Define the freshwater flux into the marsh zone**
  (all Groundwater flow)
- **Regional water balance**
- **Regional ground water model**
  - (MODFLOW)
  - Requires analysis of abstraction for PWS etc
  - Requires detailed hydrogeological work to define aquifer properties

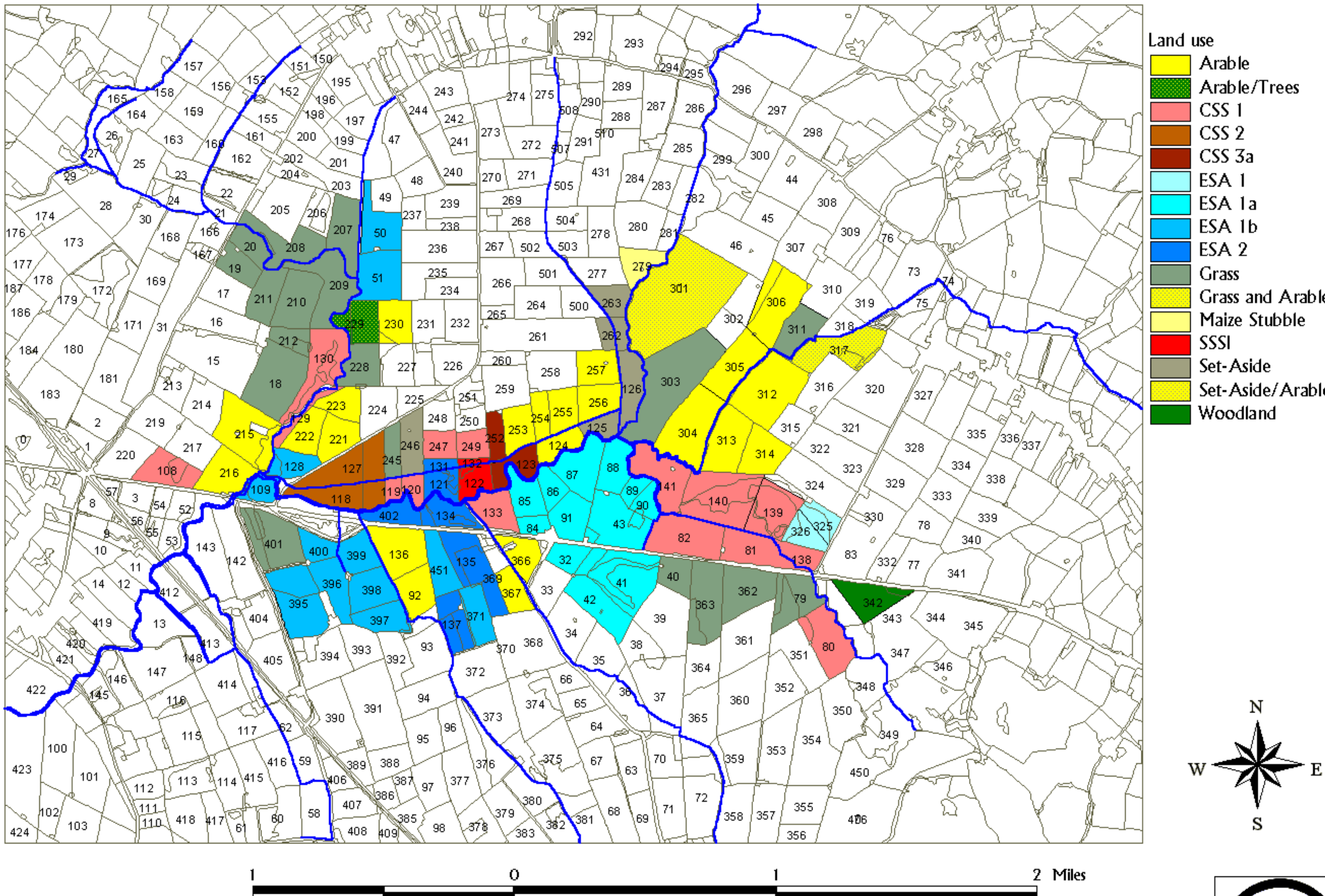

Modelled Groundwater Flow Across the Southern boundary of North Norfolk Coast SSSI in 1991 and 1987 for both Full Licenced and Naturalised Abstraction Scenarios
1991 Full Licenced
1991 Naturalised
1987 Full Licenced
1987 Naturalised
northward (coastward) flow
Flow (m 3/d per cell)
-1400
-1300
-1200
-1100
-1000
-900
-800
-700
-600
-500
-400
-300
-200
-100
0
100
200
300
400
500
1
11
21
31
41
51
61
71
81
91
101
111
121
131
141
151
161
Brancaster
Deepdale
Wells West Bank
Wells East Bank
Blakeney Point
Cley Salthouse Marshes

North Norfolk - conclusions

- Major variations in the ground water flux along the coast, reflecting hydro-geological conditions
- Coastal reed beds not necessarily located where the ground water fluxes are greatest
- Coastal zone is sensitive to extraction of regional groundwater in the inland catchments

River Ray at Marsh Gibbon, Oxfordshire

- **Flood plain wetland**
- **Tributary of the upper Thames**
- **Underlain by clay**
- **Looking to identify field most suitable for recreation of wet meadow**
- **Looking to implement channel improvement works**
  - Bunds,
  - riffles
  - restoration of palaeochannel



Plan title
River Ray Catchment
Figure (2)

Project Name
Marsh Gibbon Enhancement
Scheme Feasibility Study

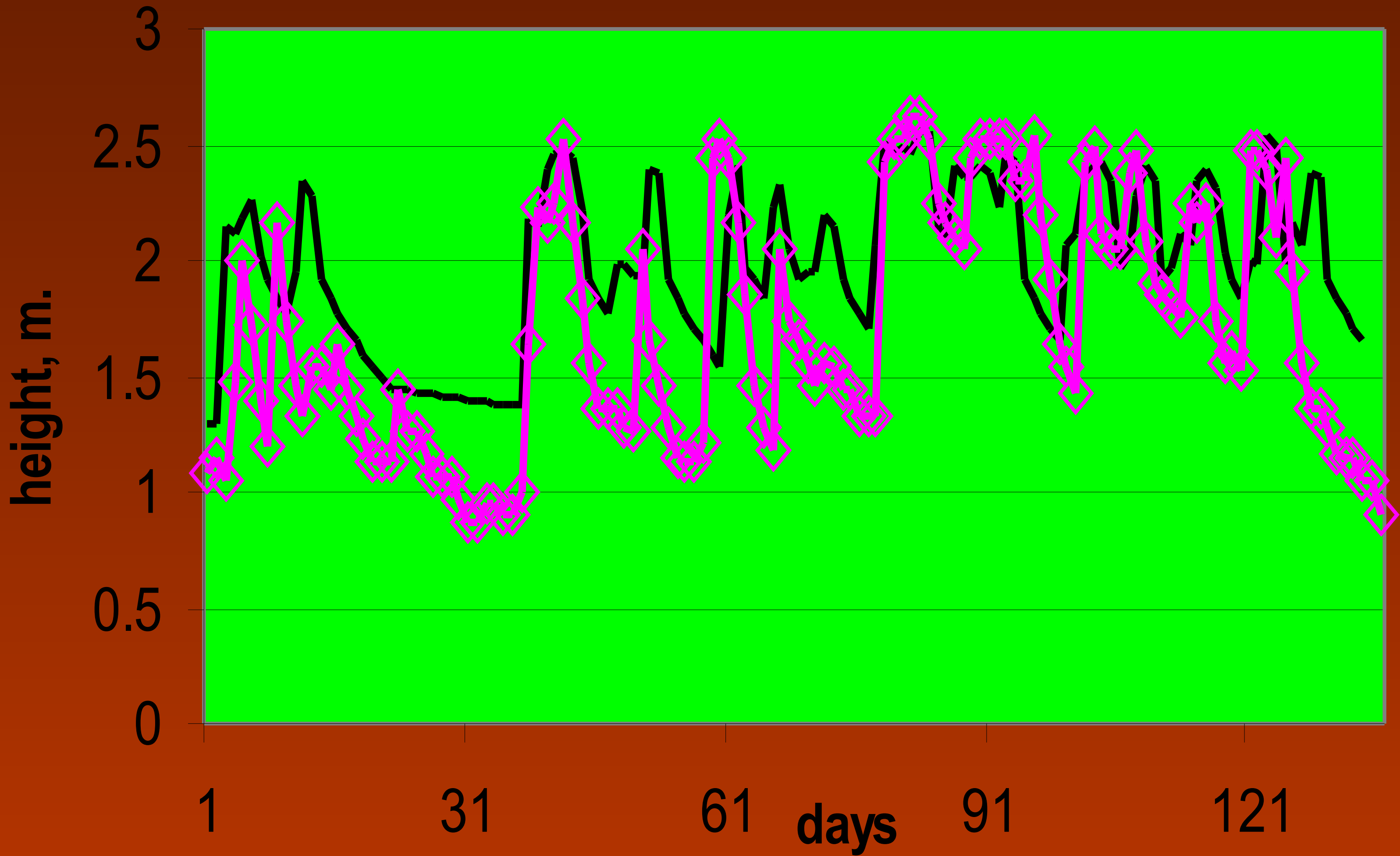
ADAS

River Ray - Models required

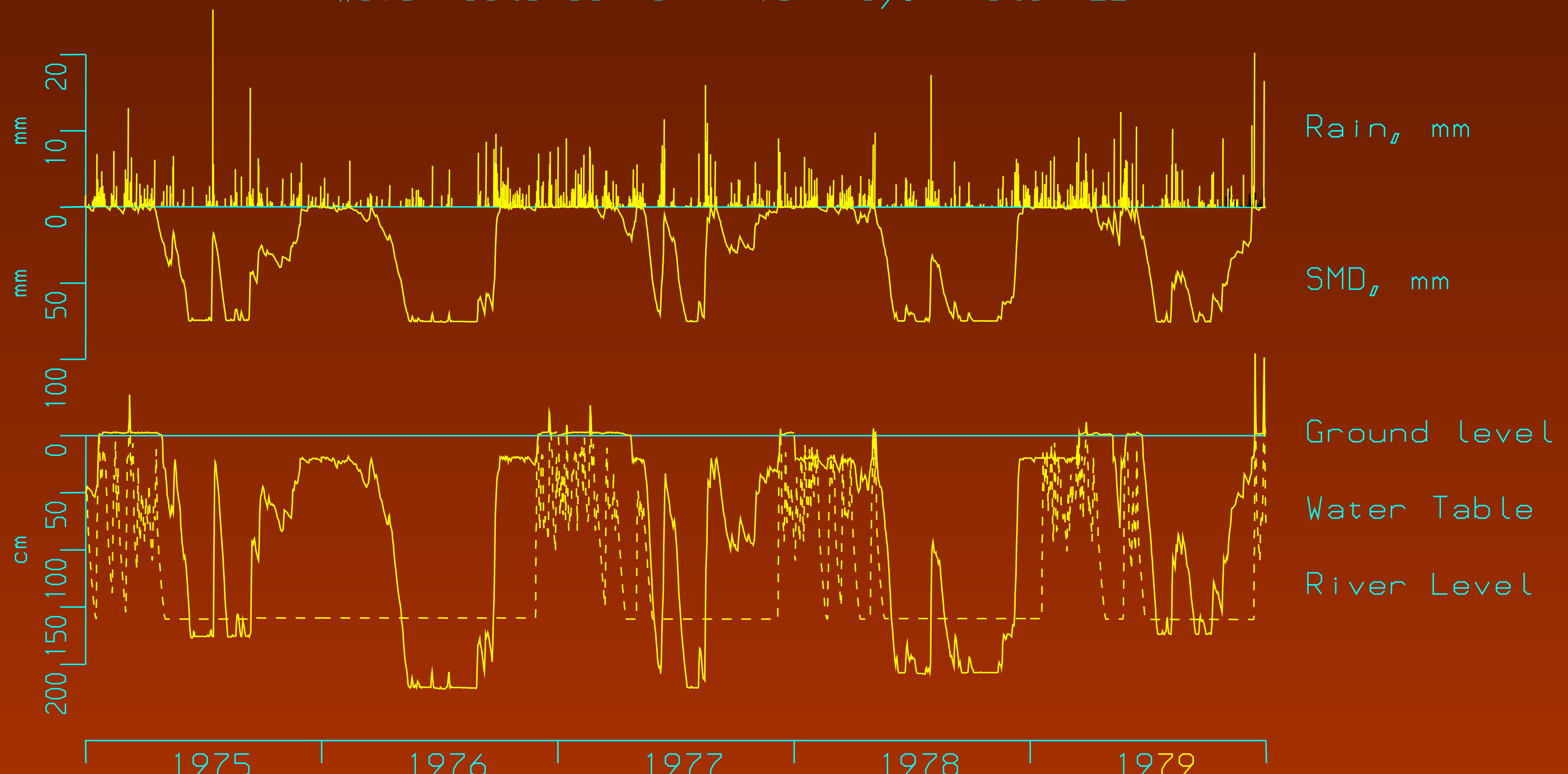
- **Rainfall runoff model for gauging station**
- **Flow transfer model to study reaches**
- **cross-correlation to define levels in tributary streams and ditches**
- **Ditch/field interaction model to define water tables**
- **GIS to integrate & manage catchment scale data**

- **Flood routing model to define channel flooding levels (HECRAS)**
  – required DTM data

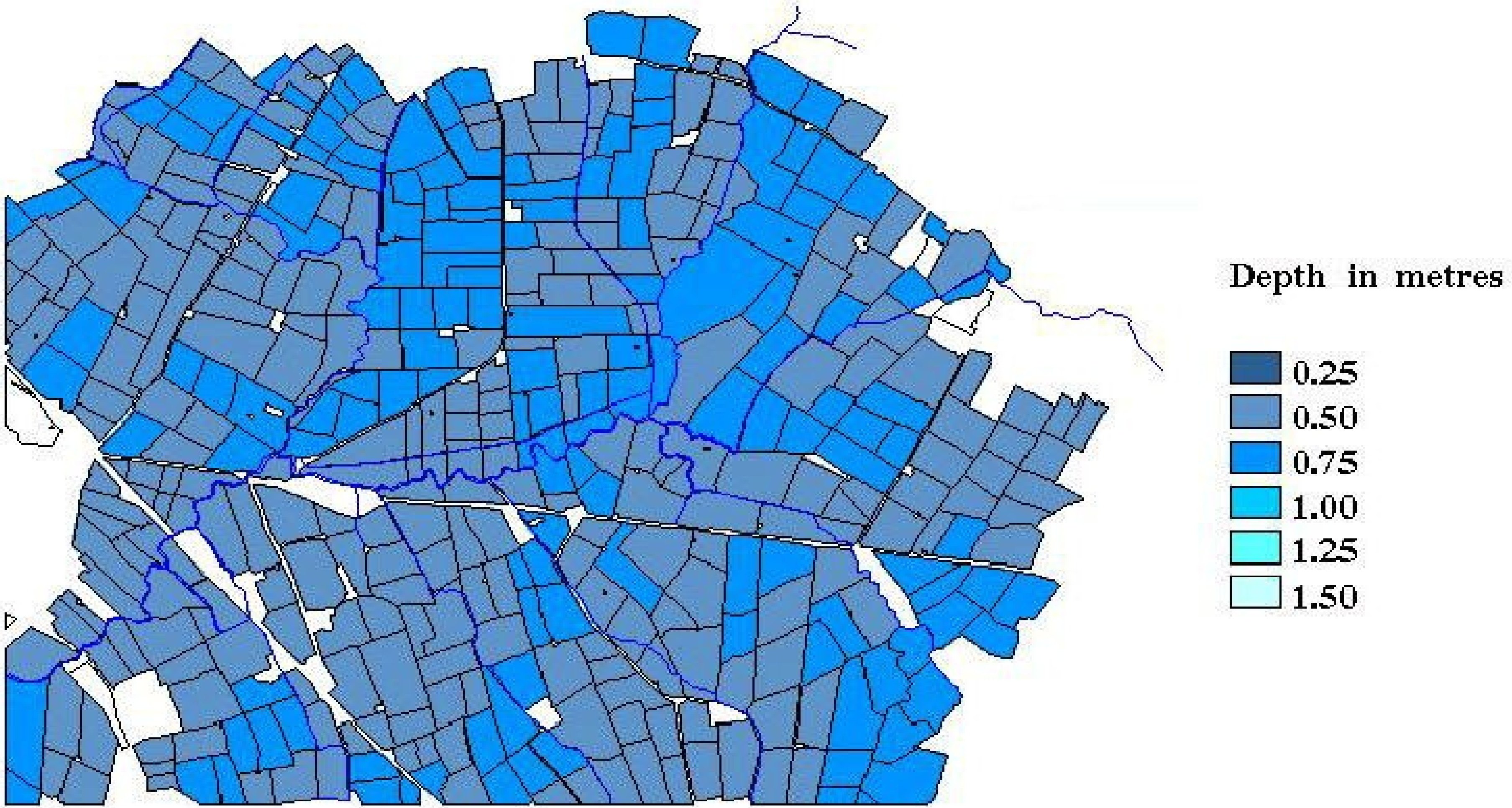
River Ray: Rainfall Runoff Modelling



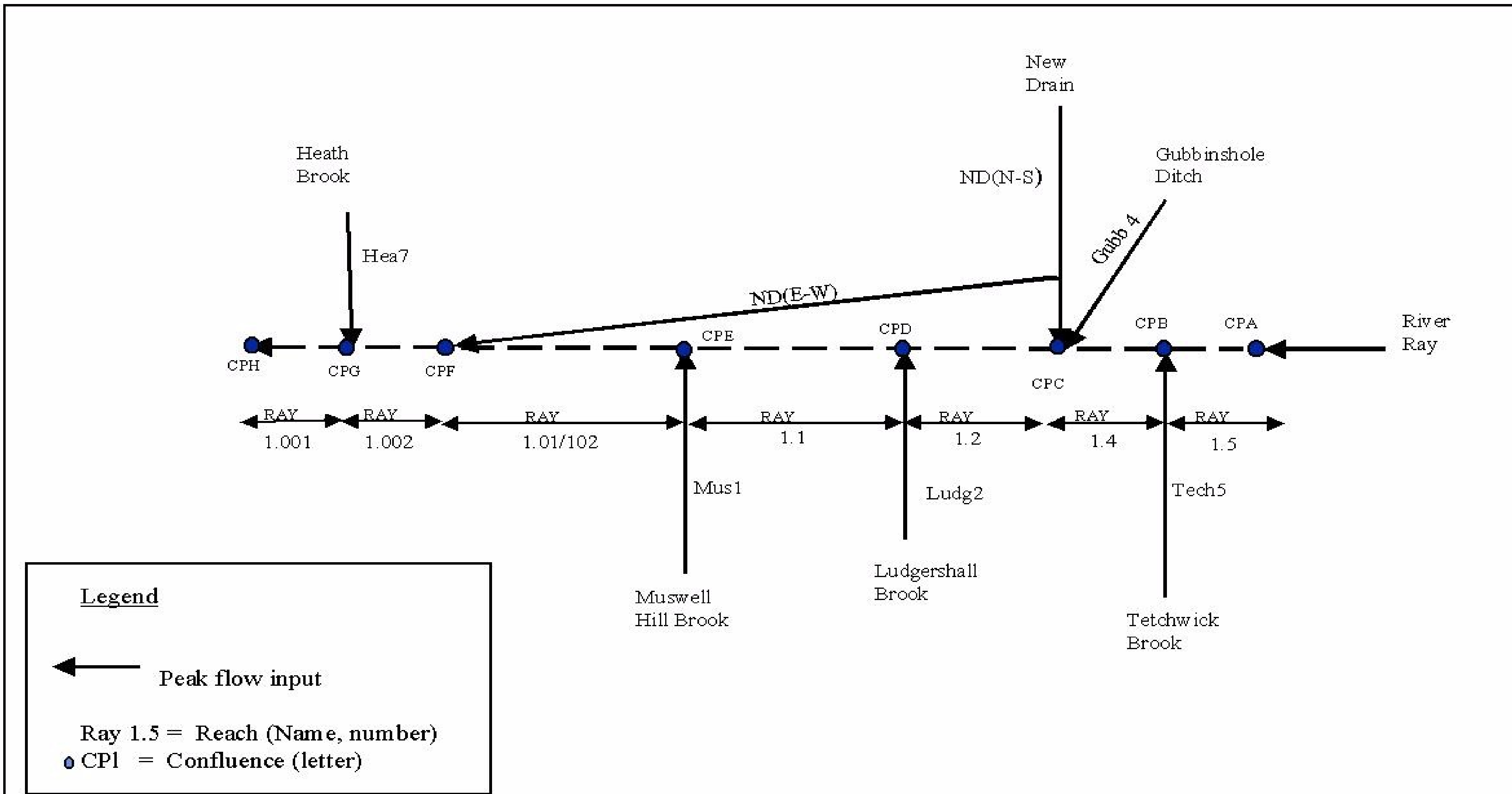
Water balance for River Ray: field 122



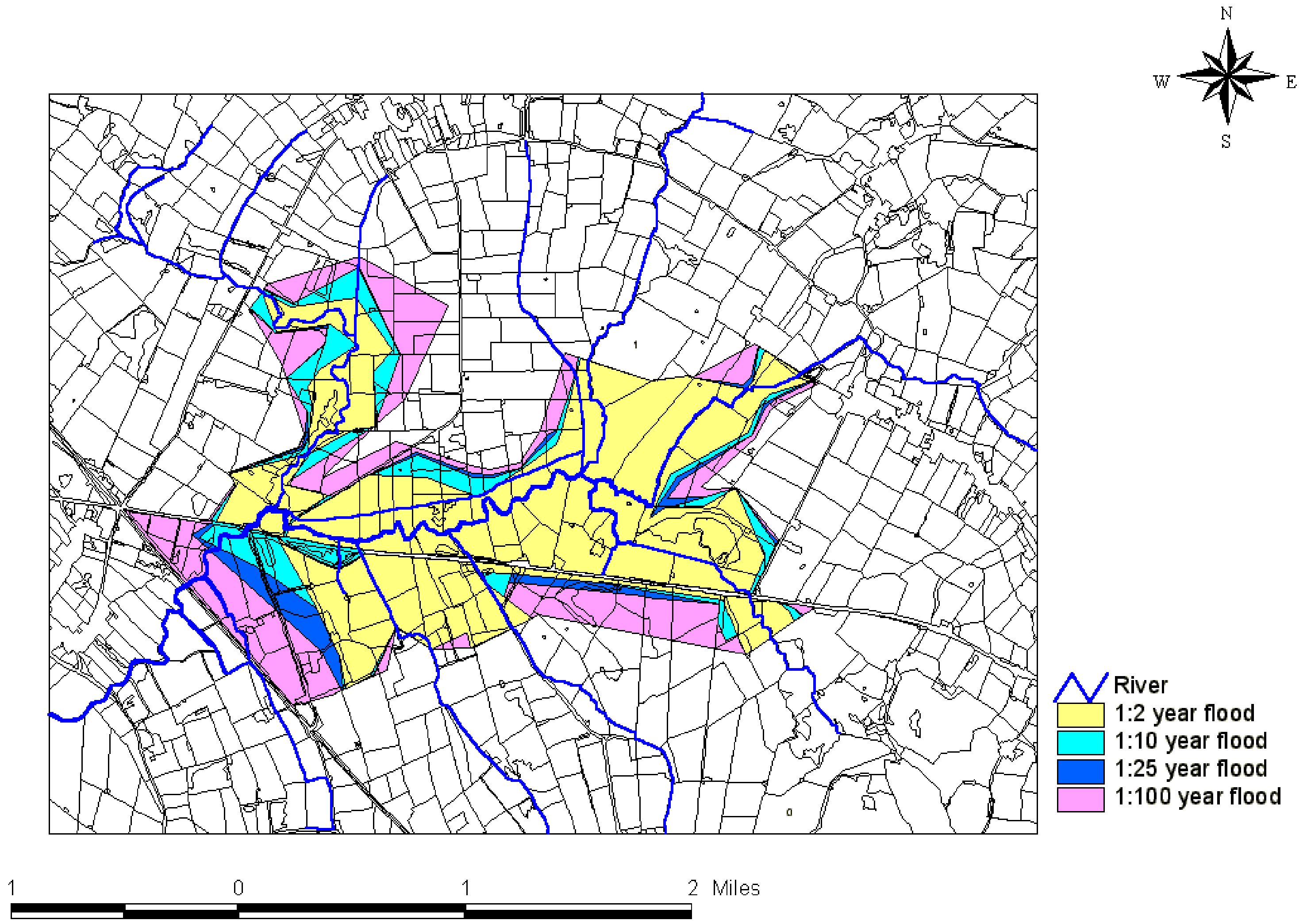
mean in-field depth to water table



River Ray - HECRAS Conceptualisation



River Ray Predicted Flood Levels



River Ray conclusions

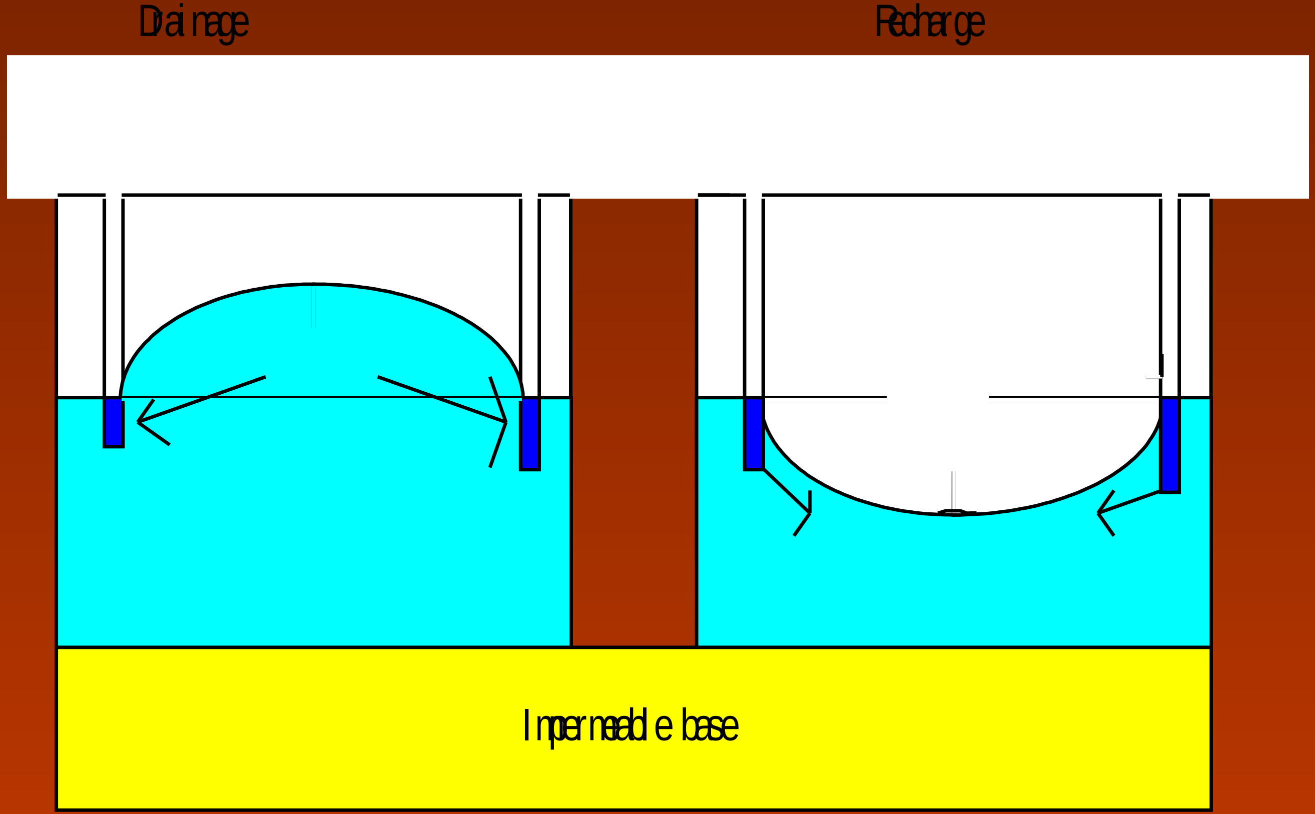
- Water tables not very variable over the site - mainly determined by clay sub-soils, not by interaction with ditches
- Flood generation dominated by constricting effect of major bridge - minor channel works had no impact
- As a result work is under way to restore the palaeo-channel

Interaction between ditch and in-field water table:

$$M(t) = M(t\text{-}1) + [R(t)\text{-}E(t) - Q(t)]/\ f$$

Drainage

Recharge



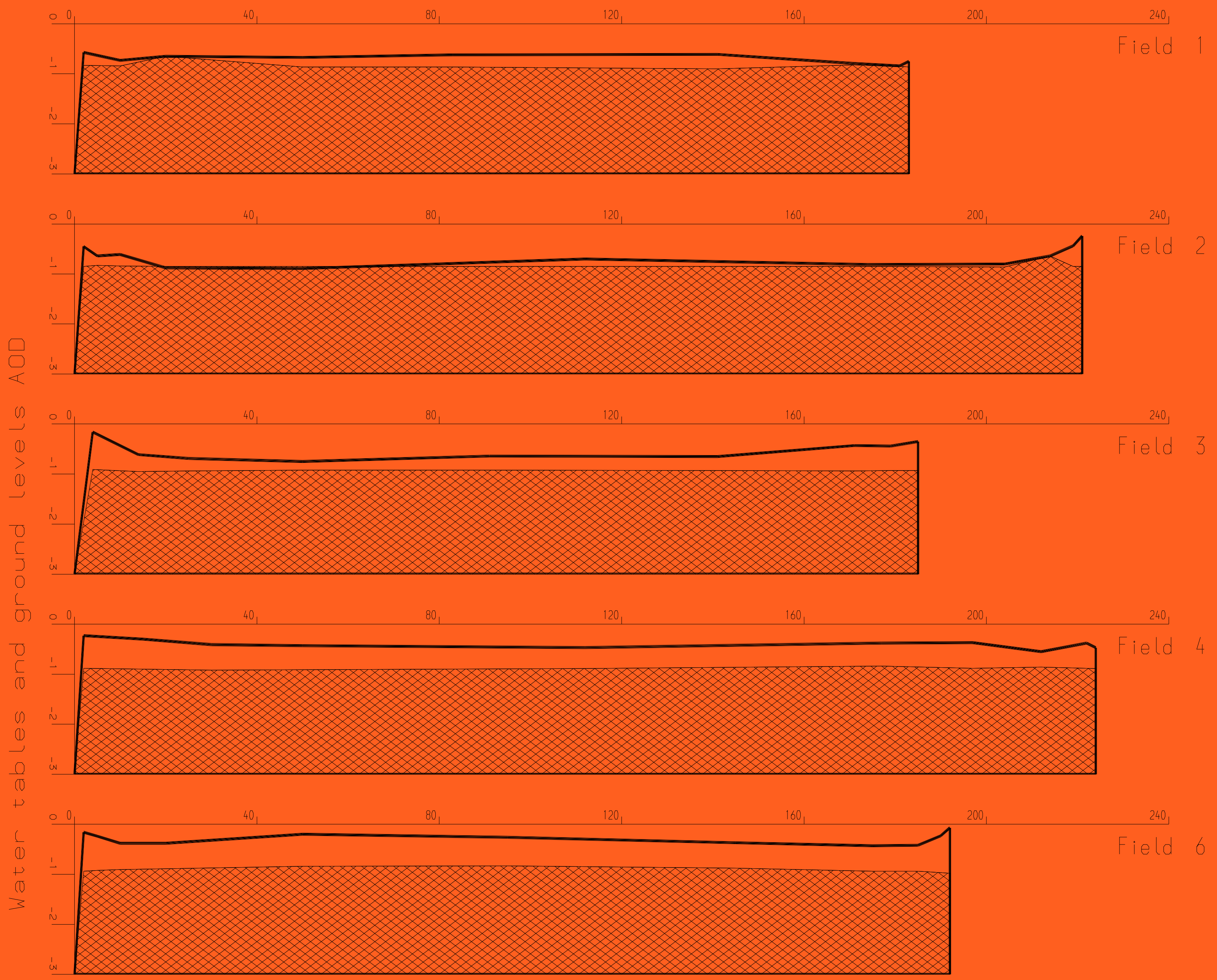
Water Table in an eliptical field (after Childs & Youngs)

$(K/q)z^2=[1(1/a^{2+1/b}2)][1-(x^2/a^2 + y^2/b^2)]$

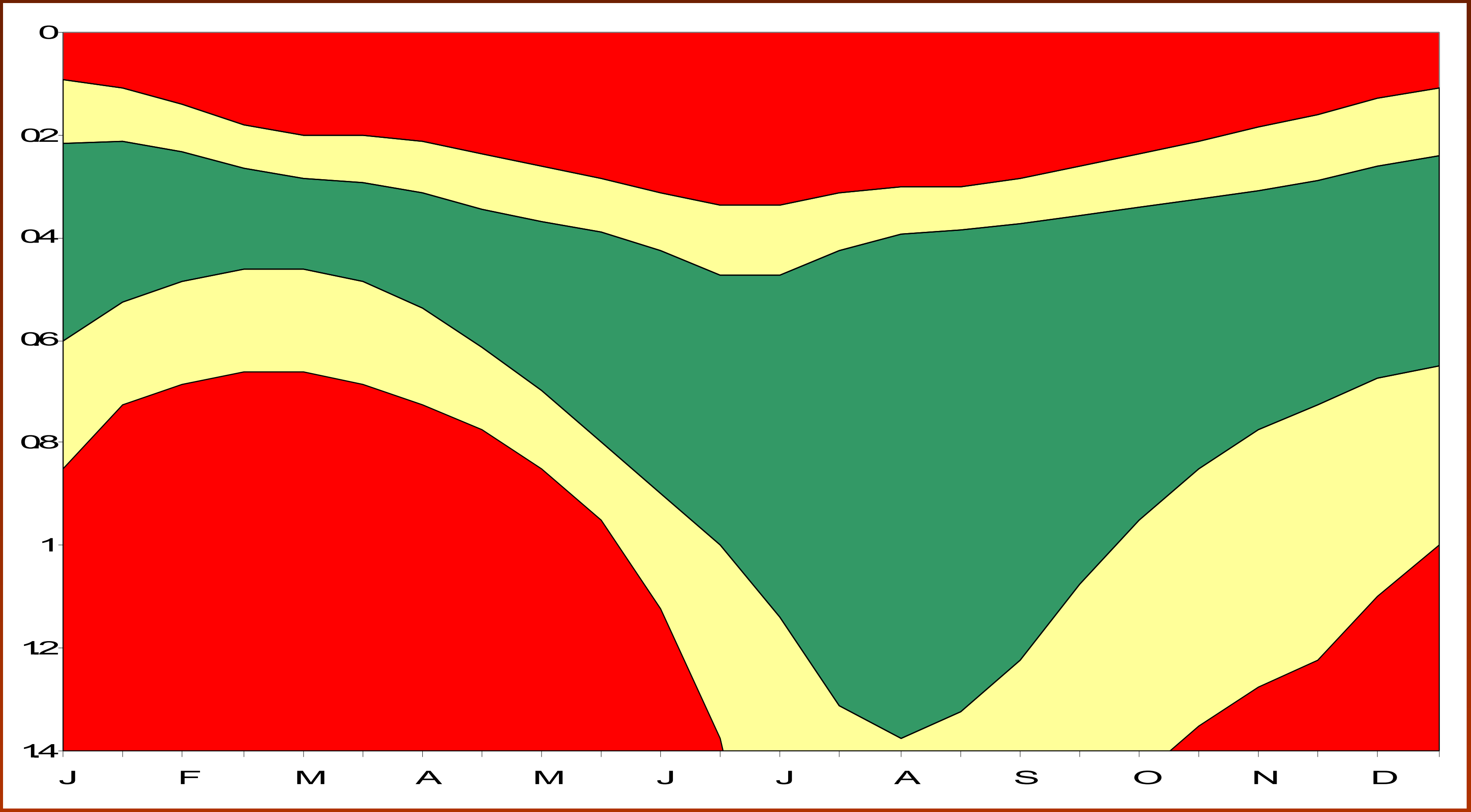
for an ellipse

$z^2/a^2 + y^2/b^2 = 1$

Broads ESA: water table shapes 11/ 5/ 92

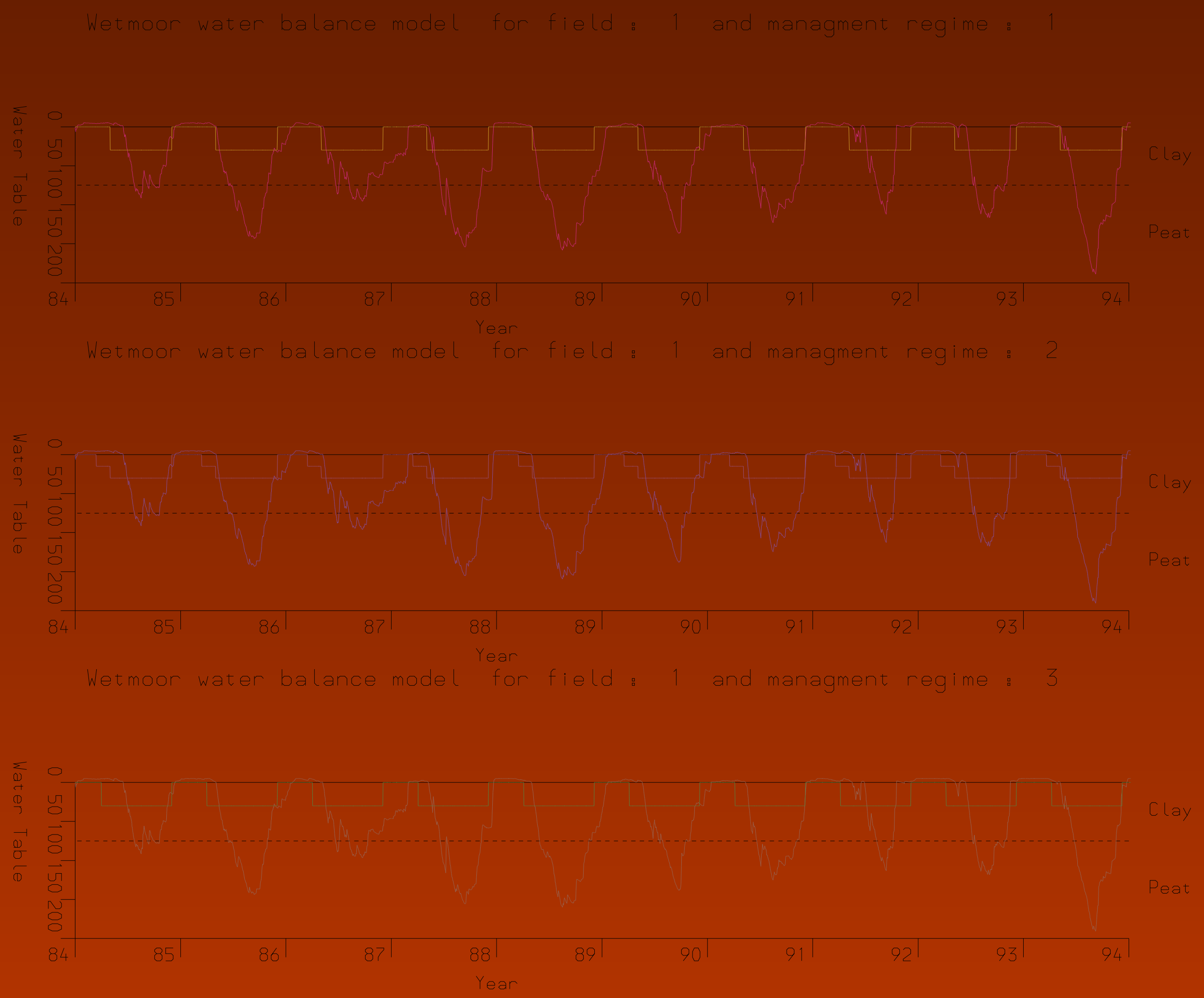


Target Water regime diagram for specific species.

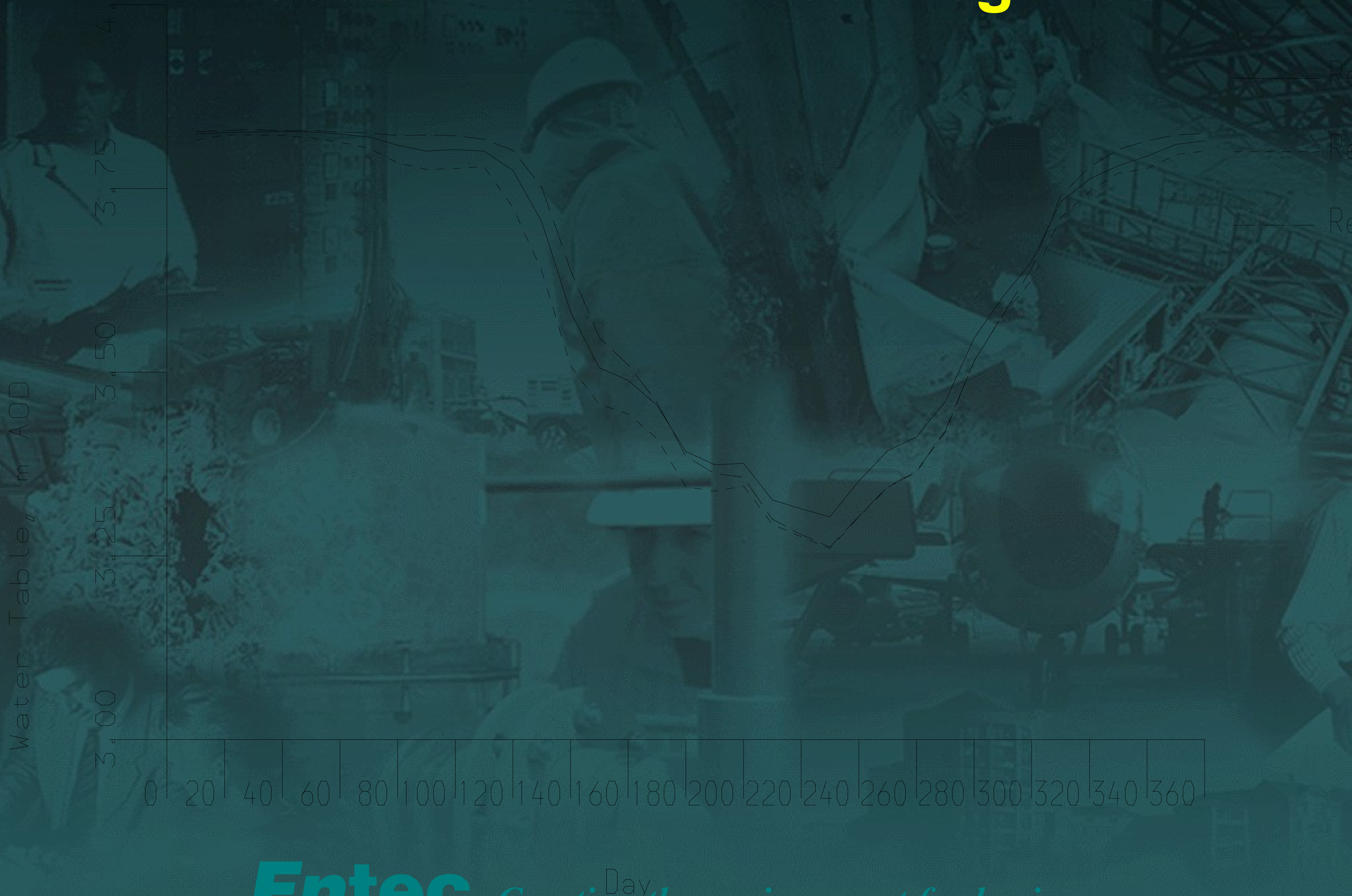


Water Balance Model - Wetmore

Effects of different ESA regimes



Effect of different Ditch regimes



Somerset Levels Conclusion

- Clay Marshes not sensitive to Water management options
- (But peat marshes are sensitive)

- Local microtopography critical in defining water regime and hence site suitability
  (We recognise this in the field with vegetation mapping)

Conclusions

- Different scales of study impose different modelling requirements
- There is no “one size fits all” modelling solution - no matter how good