presentation

• SGS role in strategic water resource planning & operations – River Severn regulation

• Development of the scheme to date

• Environmental management

• System management
LYNN CLYWEDOG OPERATIONS 2006

Flooding
Flood Drawdown
Release or Overflow
Shropshire Groundwater
Seek Drought
Order Drought Order
In Force
Temporary Flood Drawdown
Clywedog: Proposed Control Curves 2006 - scenario from 21st Aug

- Flood Draw Down Zone
- Hydropower Release Zone
- SGS Zone 1 - up to 75 Ml/d Net
- SGS Zone 2 - up to 150 Ml/d Net
- SGS Zone 3 - up to 225 Ml/d Net
- Automatic Drought Order Zone
- % Storage 2006

Forecast Profile:
- 250 Ml/d
- 300 Ml/d
- 350 Ml/d
- 400 Ml/d
- 450 Ml/d
- 500 Ml/d

Map derived from 1:250,000 scale BGS mapping under licence 2003/012.
## Shropshire Groundwater Scheme – Gross Deployable Yields and Operational Years

<table>
<thead>
<tr>
<th>Phase</th>
<th>Gross Yield</th>
<th>Regulation Seasons Requiring SGS Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 3 (commissioned 1998)</td>
<td>50Ml/d</td>
<td>2006</td>
</tr>
<tr>
<td>Phase 4 (commissioned 2001)</td>
<td>45-50Ml/d</td>
<td>2006</td>
</tr>
<tr>
<td>Phase 5</td>
<td>60-65Ml/d est.</td>
<td>Under development</td>
</tr>
<tr>
<td>Phase 6</td>
<td>20-25Ml/d est.</td>
<td>Not developed</td>
</tr>
<tr>
<td>Phase 7</td>
<td>35-40Ml/d est.</td>
<td>Not developed</td>
</tr>
<tr>
<td>Phase 8</td>
<td>40-45Ml/d est.</td>
<td>Not developed</td>
</tr>
<tr>
<td>TOTAL SCHEME</td>
<td>(max. 330Ml/d)</td>
<td></td>
</tr>
</tbody>
</table>

### Environmental Management

- Groundwater level monitoring & resources assessment
- Crop vulnerability mapping
- Ecological monitoring
- Hydro-chemical monitoring & assessment
Legislative Drivers

- 1979 SGS Public Inquiry
- Model Terms & Conditions Agreement
- 1981 SGS Abstraction Licence
- Water Resources Act 2003
- CAMS - Catchment Abstraction Management Strategies
Figure 6.1 Monitoring Network

Phase 4 Group Test

Predicted Drawdown
in the Sandstone Aquifer
& in Relation to Known
Private Sources

Predicted well field generated from
East Grinstead Groundwater model.

Key

Phase 4 Abstraction Boreholes
Phase 1 & 4 Private Sources

This map is reproduced with the permission of Defra on
behalf of the Environment Agency.

GD-99/TTG, 2002
Midlands Region Shropshire Groundwater Scheme Phase 4 Test II

Soil Moisture Vulnerability

Soil Moisture Vulnerability Depth Classification

- Class 1: Water table shallower than 1.5 m NGF
  - Possible brackish or salty habitats and significant loss due to evaporation

- Class 2: Water table between 1.5 and 2.5 m NGF
  - Some evaporation and recharge

- Class 3: Water table between 2.5 and 4 m NGF
  - Minimal recharge

- Class 4: Water table deeper than 4 m NGF
  - No recharge

Area underlain by non-aquifer material.

Phase 4 Groundwater Scheme pumping station

- Simulated area affected by pumping

NEUTRON PROBE INSTALLATION

- A neutron probe is used to measure soil moisture content.

The Principle of the Neutron Soil Moisture Probe

Fig A.5.1

Sand/gravel/soil view of probe in use
Graphs to show the growth of brown trout in River Tern compared to the standard growth of brown trout in rivers (National Fisheries Laboratory, unpublished data).

Graphs to show the growth of chub in River Tern compared to the standard growth of chub in other rivers (National Fisheries Laboratory, unpublished data).

**Brown Trout**

**Club**
Hydro-chemical Monitoring

• Baseline (non-operational) & Operational sampling regimes

• Early analysis - nutrients, metals, & major ion chemistry

• Organic chemistry - Pesticides, Herbicides & Hydrocarbons

• Gas Chromatography Mass Spectrometry (GCMS)
Borehole Yield - MSc Study

- Comparison of operational yields and repeat step test v baseline specific capacity
- Hydro-chemical modelling showed water to be supersaturated with iron species haematite, magnetite, goethite & ferrhydrite
- Microbial testing confirmed presence of iron & sulphur reducing bacteria and slime forming bacteria
  - Iron reducing bacteria (greater mobility)
  - Slime forming bacteria (catalyst to encourage Fe & Mn precipitation)
- 6 out 42 boreholes proven to have >5% yield loss. Coincide with areas of localised confined aquifer (thick drift) giving rise to reducing conditions (Phase 2 & 5) low DO & elevated Fe & Mn

System Management

- Asset management plans
- Routine turnover of pumps & scheduled maintenance
- Telemetry monitoring, interrogation & operation
- System performance
Energy Consumption 2006

- Combination of up to 4 Phases
- Target Daily Yield 100ML/d
- Total Vol Pumped 4,752 ML
- Total Energy units 1,211,012 kWh
- Electricity Cost £66,989
Energy Performance Evaluation

- Hodnet Abstraction Pump
- Operating Flow 6.02 Ml/d
- Head 44m
- Energy & Carbon Emission Savings
  Annual kWh Savings = 7,230.65 (£557.12)
  kWh/Ml Savings = 9.872
  kgCO$_2$/kWhr = 0.43
  Estimated Annual CO$_2$ Savings (tonne) = 3.11
Concluding points

• Shropshire Groundwater Scheme - Role in Strategic Water Resource Planning & Operations

• Environmental Management

• System Management