British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL
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The 'Great Spring': updating a source protection zone in a complex karst aquifer

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1. Introduction

Source Protection Zones (SPZs) have been delineated around public water supply abstractions in England and Wales since the late 1980s. They are used to help manage risks and reduce qualitative and quantitative pressures on valuable groundwater resources. The Great Spring SPZ was first delineated in the late 1980s and there was an operational need to update this using a more modern approach and incorporating new information.

2. The Great Spring

- Principally a large dewatering scheme in operation since the 1870s
- Prevents groundwater flooding the Severn Tunnel carrying the Cardiff-London train line
- 60-120 ML/day is abstracted
- A small proportion goes to public water supply the remainder flows into the Severn Estuary
- Carboniferous Limestone with some Triassic cover and extensive superficial deposits
- Limited (visible) karst features such as sinks suitable for tracer tests
- Losing and gaining water course and a large groundwater dependent wetland
- Rural, peri-urban and industrial land use

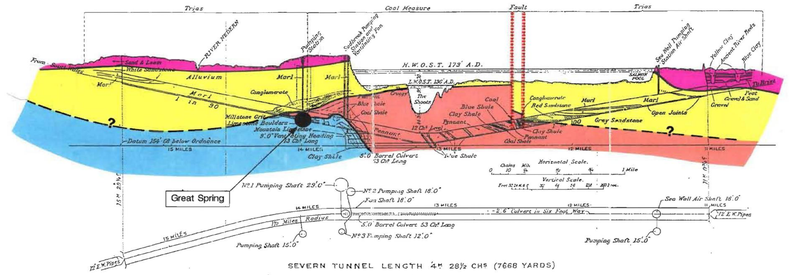

Fig. 1. The Severn Tunnel with the Great Spring and pumping station (Walker, 1888)

Fig. 2. Looking upwards in the pumping station

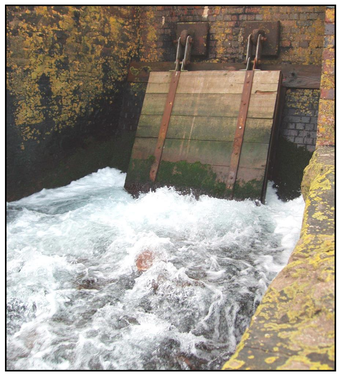

Fig. 3. Outflow of the Great Spring

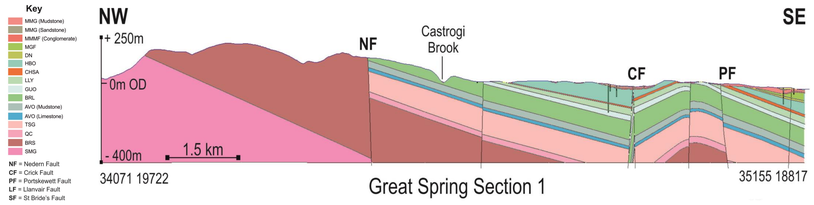

Fig. 4. Geology of the Great Spring catchment

3. Karst Vulnerability Methodology

We used a vulnerability mapping method specially designed for the delineation of SPZs in karst aquifers (EA, 2004). The methodology defines two factors termed 'Protective Cover' and 'Bypass Flow' which are combined at the end to create the final SPZ that has both a high and low vulnerability ranking.

PROTECTIVE COVER includes reassessment of the geological mapping allowing bedrock or superficial geology >3m in thickness to be identified. We calculate travel time of pollutants through unsaturated zone

BYPASS FLOW involves applying a 50m radius applied to all bypass features including: sinks, quarries and surface waters known to loose to ground . HOST Soil types including BFI and SPR assessed with slope to see where bypass flow is likely to be generated.

Expert knowledge is used to review the output and to make any adjustments necessary.

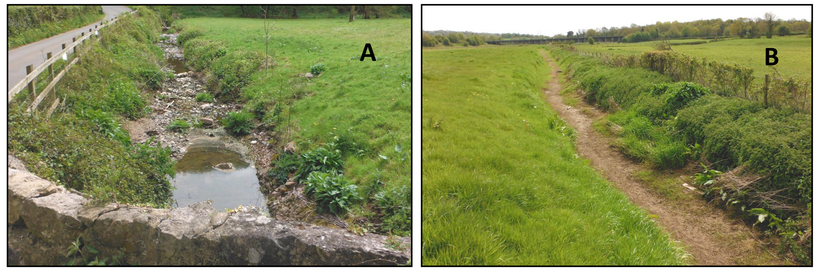

Fig. 5.A & 5B. Bypass Flow. The Nedern Brook is seen sinking (left) and dry (right)

4. Stream Geometry

The stream geometry of the main water courses, derived from 29 measurements of channel width and depth, was used to estimate discharge and ground water recharge within the main limestone gorge along the Castrogi Brook. Upstream from the main limestone gorge, channel cross-section area increases with catchment size (Figure 6A), reflecting a downstream increase in discharge (Figure 6B). However, the scaling of channel geometry breaks down within the limestone gorge, with a smaller channel reflecting an estimated loss of up to 95% of the discharge under low to base flow conditions (dry weather).

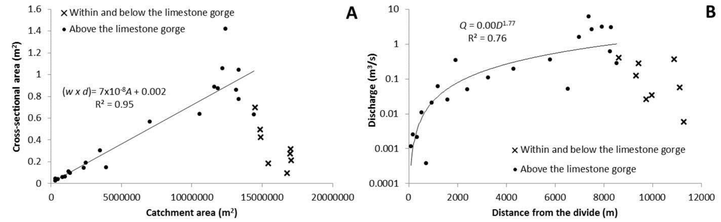

Fig. 6A & 6B Stream geometry and relationship to losing reaches

5. Results

The SPZ was improved by;

- inclusion of the surface water courses (bypass features)
- Revisiting the geological mapping providing confidence on the type of protective cover
- Use of GIS system to create accurate geological boundaries
- Stream geometry to estimate recharge to groundwater
- Total catchment increased to ~50km2
- High and Low vulnerability areas now included (old SPZ only had high vulnerability rating) allowing for a more risk based approach to regulation

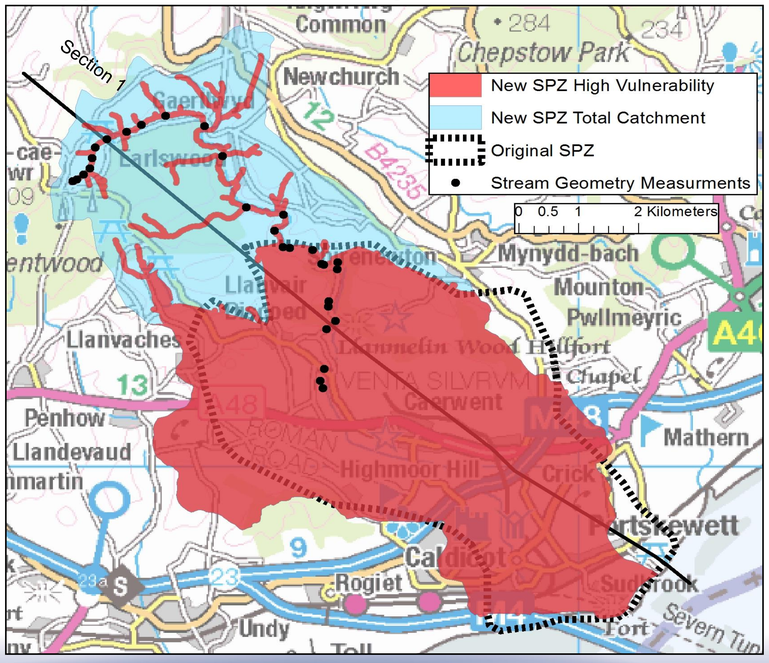

Fig. 7. The Great Spring Source Protection Zone . Contains Ordnance Survey data © Crown Copyright & database rights 2015

Reference: Lawrence D.J.D, Farr, G, Whitbread, K & Kendall R. 2013. The Geology, hydrogeology and vulnerability of the Great Spring Source Protection Zone. Confidential.

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