Chalk	Lincolnshire Limestone	Sherwood Sandstone	Lower Greensand
If the following elements are present in high concentrations in the native water then			
General • fluoride is not likely to be involved in chemical reactions, therefore mixing might increase fluoride in the recovered water • sodium and chloride are not likely to be involved in chemical reactions, therefore mixing might increase both in the recovered water • high iron and manganese concentrations might decrease as a consequence of precipitation of iron and manganese oxide and hydroxide when the injection water has a high oxidative capacity	Older native water • fluoride is not likely to be involved in chemical reactions, therefore mixing might increase fluoride in the recovered water • sodium and chloride are not likely to be involved in chemical reactions, therefore mixing might increase both in the recovered water • high iron and manganese concentrations might decrease as a consequence of precipitation of iron and manganese oxides and hydroxides when the injection water has a high oxidative capacity Recent native water • nitrate is not likely to be involved in chemical reactions, therefore mixing might increase nitrate in the recovered water	Older native water • the concentration of sulphate is unlikely to be diminished by chemical reactions, therefore mixing might increase sulphate in the recovered water • high iron and manganese concentrations might only decrease as a consequence of precipitation of iron and manganese oxides and hydroxides if the injection water has a high oxidative capacity Recent native water • nitrate is not likely to be involved in chemical reactions, therefore mixing might increase nitrate in the recovered water	General • high iron and manganese concentrations might only decrease as a consequence of precipitation of iron and manganese oxides and hydroxides if the water has a high oxidative capacity and pyrite is not available for oxidation
If the elements mentioned are present in the injection water then			
General • high nitrate is only likely to be reduced significantly in the case of pyrite oxidation • high sulphate (surface or shallow groundwater) is not likely to decrease	General • nitrate is not likely to be involved in chemical reactions, therefore it might be present in higher concentrations in the recovered water	General • high nitrate concentrations are only likely to be reduced significantly in the case of pyrite oxidation	General • high nitrate concentrations are only likely to be reduced significantly in the case of pyrite oxidation
Concentration changes due to interaction with the sediment			
General • if the injection water is saturated with oxygen and therefore has a strong oxidising capacity, oxidation of pyrite within the sediment might occur ; this might increase iron and sulphate concentrations • no major pH changes are expected	General • no major pH changes are expected	General • no major pH changes are expected Older native water • if dolomite dissolves an important increase in both magnesium and sulphate (from gypsum) concentrations can be expected • if pyrite oxidation occurs due to the injection of oxidizing water, both iron and sulphate concentrations are expected to increase • due to the rare occurrence of pyrite in the sediment, the chances for pyrite oxidation to occur are small	General • no major pH changes are expected, however, due to large differences in buffering capacity between native waters, lowering of pH cannot be excluded in extremely poorly buffered native water when oxidising water is injected • if pyrite oxidation occurs due to the injection of oxidizing water, both iron and sulphate concentrations are expected to increase • due to the high pyrite concentration in the sediment, pyrite oxidation is likely to occur

⟵ INCREASING DUAL POROSITY CHARACTER OF THE AQUIFER
more diffusive exchange between native water in the matrix and injected water in the fractures
larger mixing area (in the fractures and the matrix)
larger component of the native water in the recovered water quality
stronger chemical interaction between the native and the injected water

INCREASING SINGLE POROSITY CHARACTER OF THE AQUIFER ⟶
a "bubble" of injected water will be created
smaller mixing zone at the edges of the injected water
more intensive chemical interaction between injected water and the sediment
less chemical interaction with the native water

Table 11.   Influences on the recovered water quality for each of the four aquifers as can be concluded from the PHREEQC2 modelled examples.
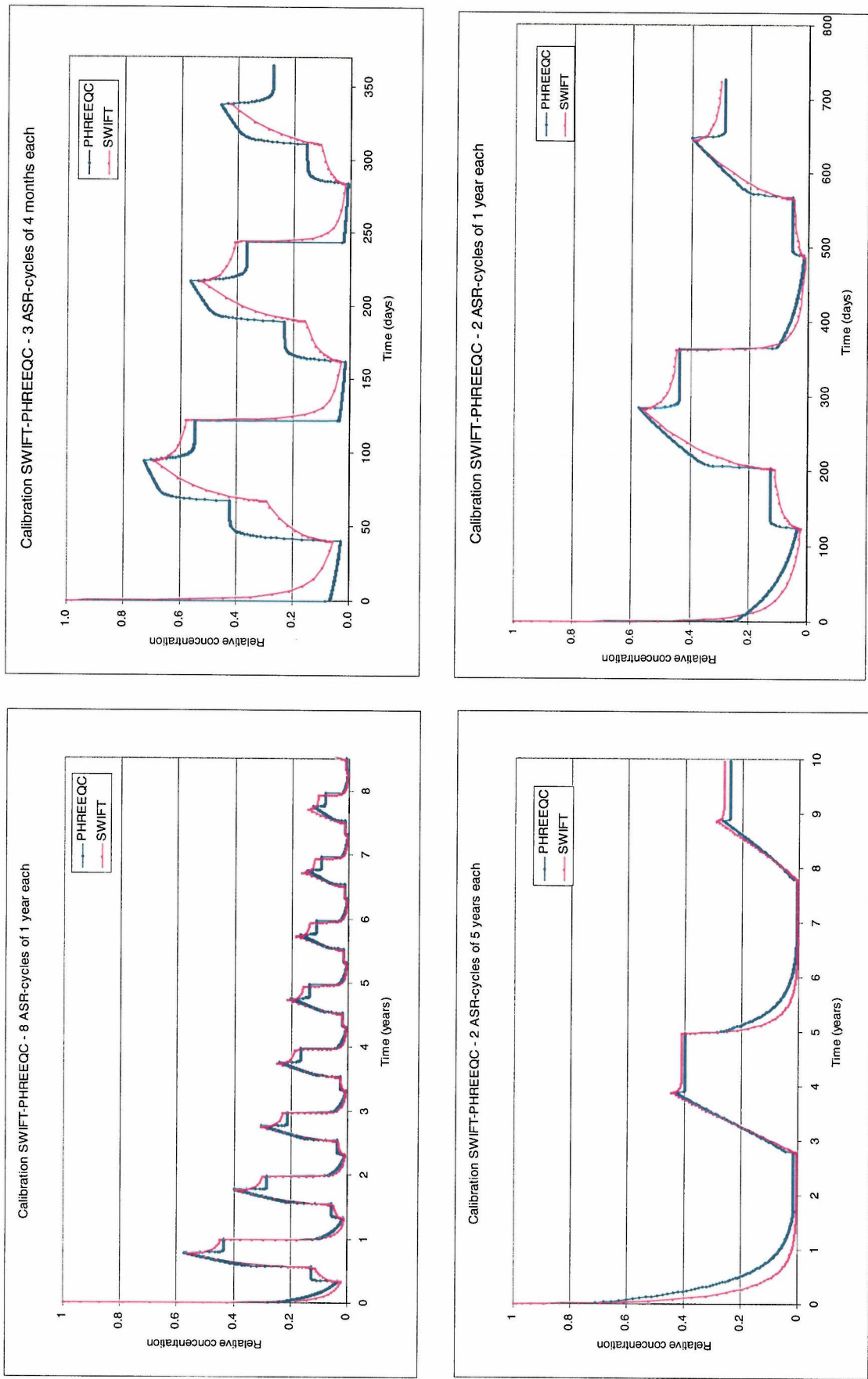
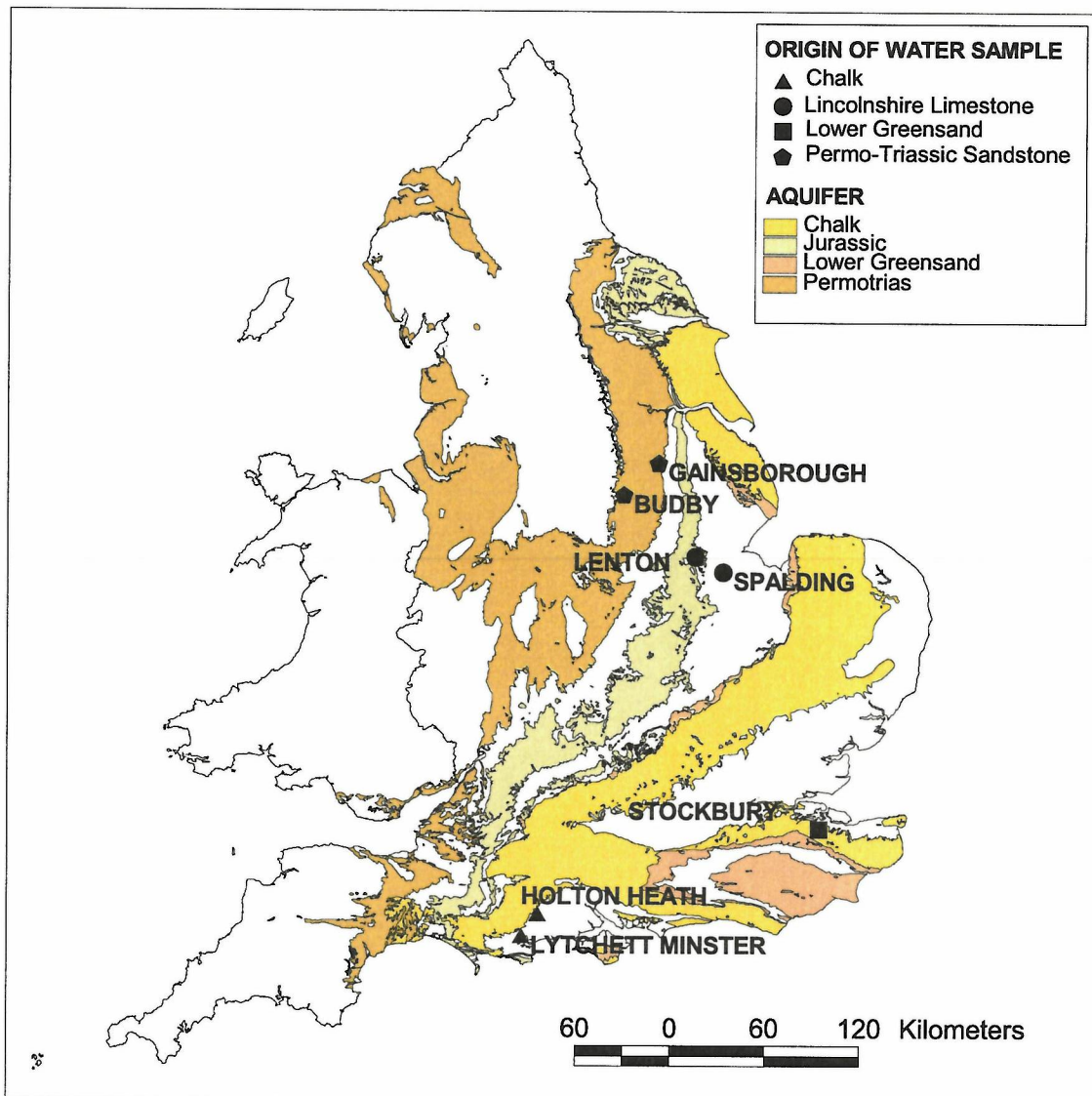Fig. 1   Comparison of PHREEQC and SWIFT results for ASR-cycles with different timescales.

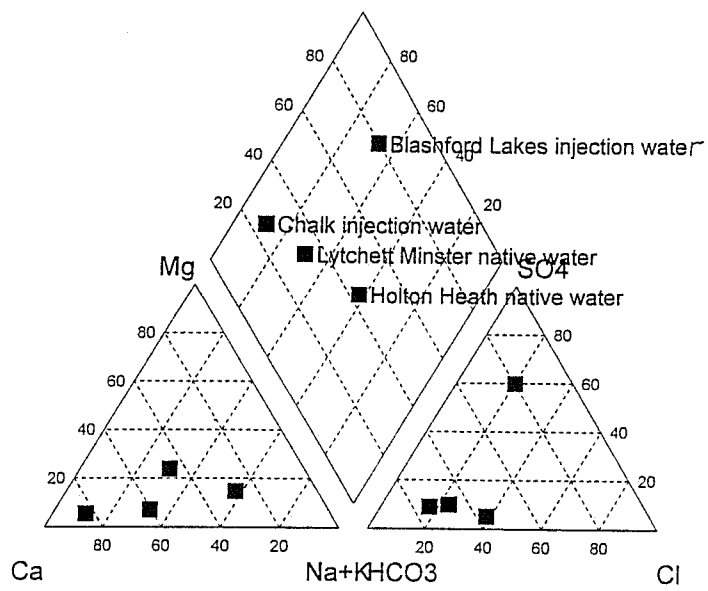Fig. 2   Overview of the aquifers and sample locations.

Fig. 3 Piper diagram of the injection and native waters used for the Chalk.
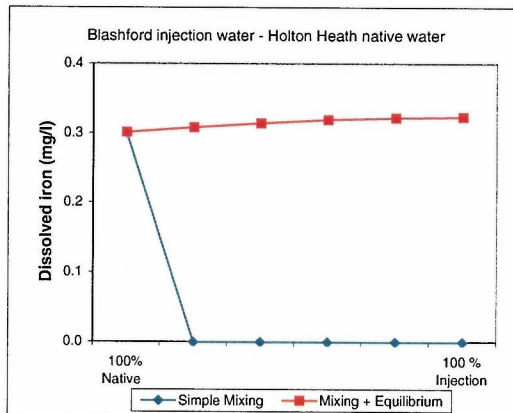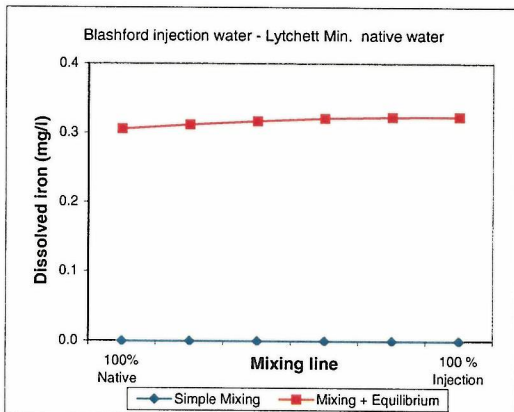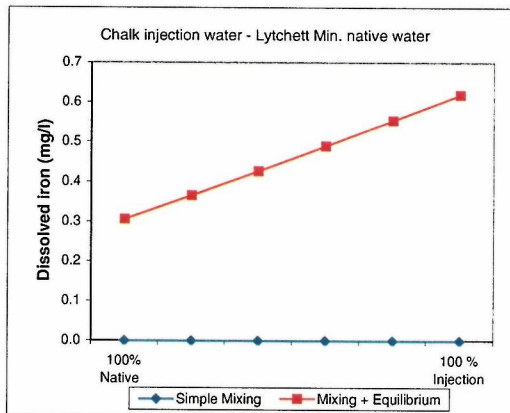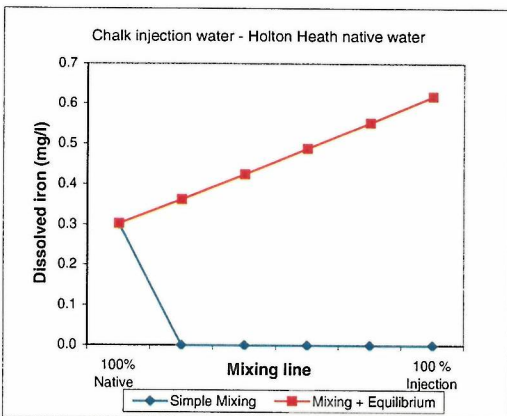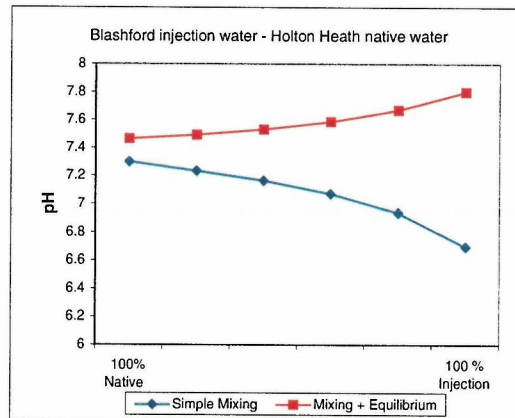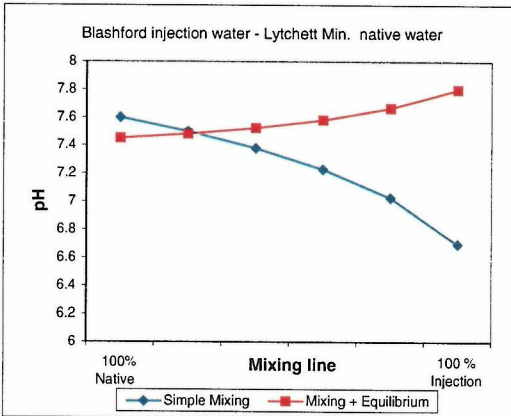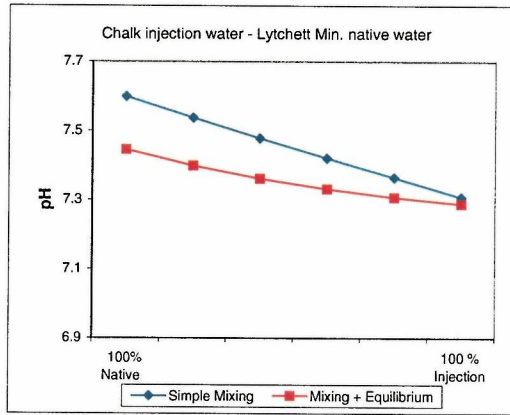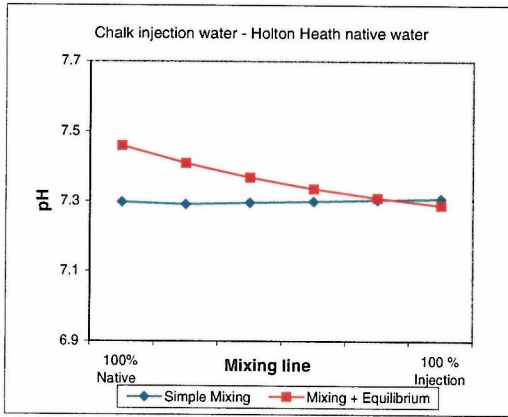
Fig. 4   Mixing modelling results for pH (upper) and iron (lower) for different injection and native waters in the Chalk.
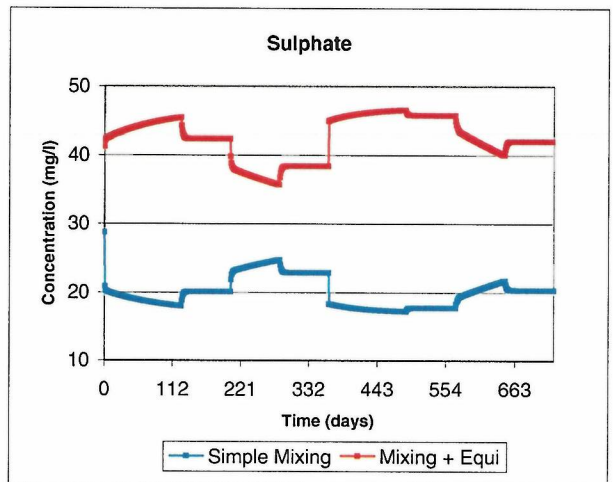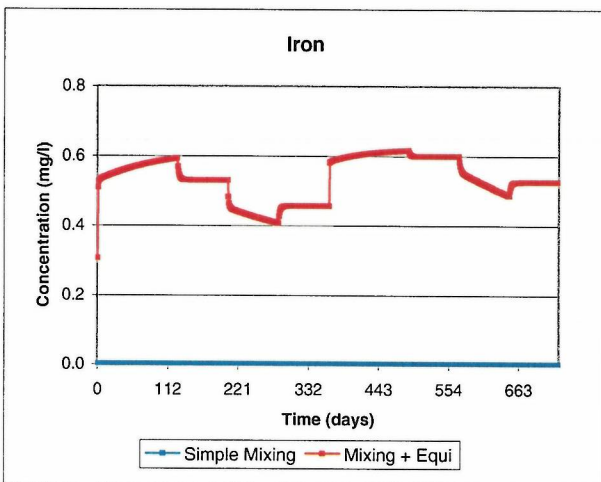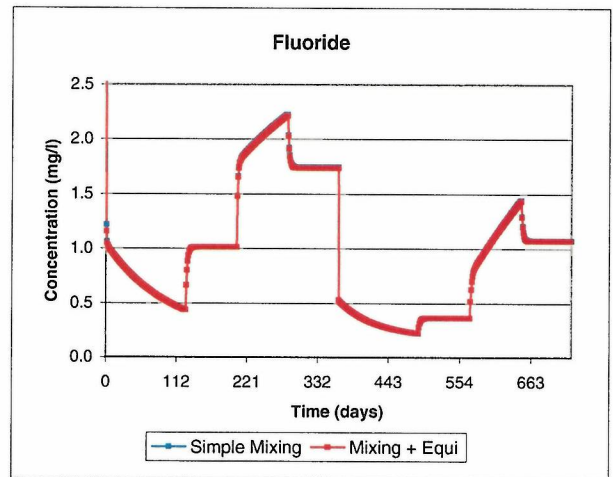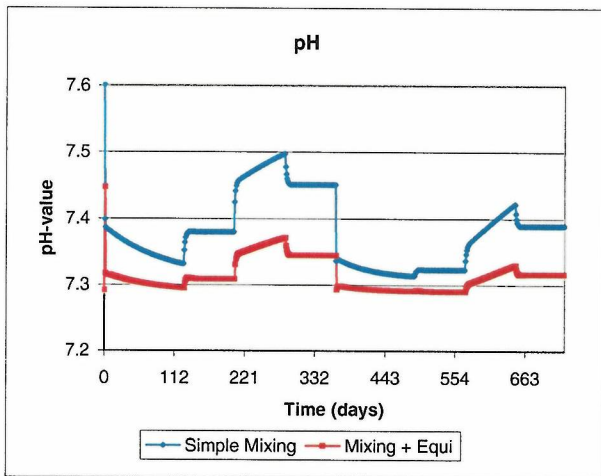
Fig. 5 Cycle modelling example pH, fluoride, iron and sulphate in the Chalk (injection of Chalk groundwater in the Chalk aquifer at Lytchett Minster).
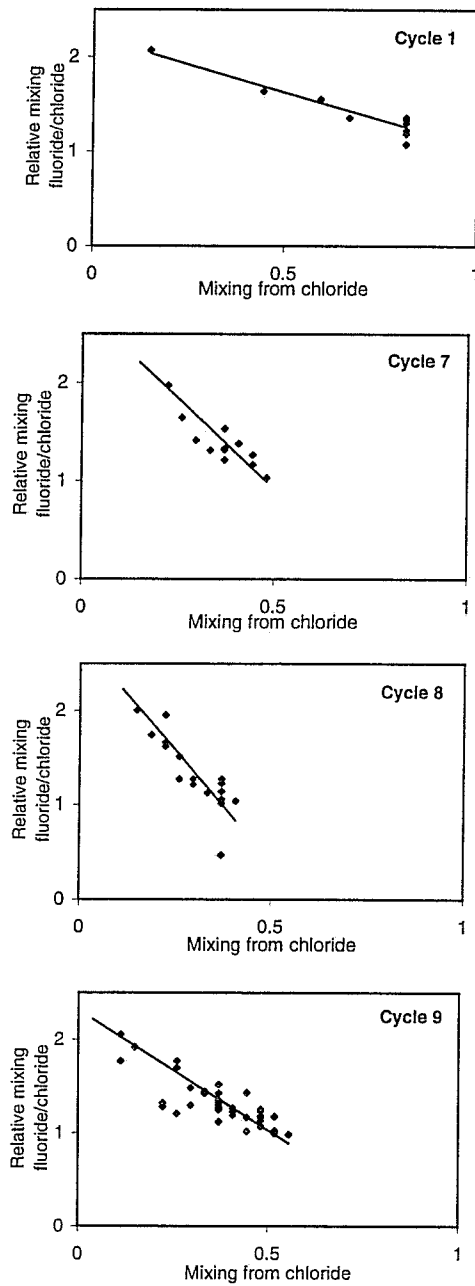
Fig. 6   Excess of apparent mixing based on fluoride/chloride mixing ratio
for observations during cycles 1 (upper), 7, 8 and 9 (lower) of the Chalk ASR-trial.
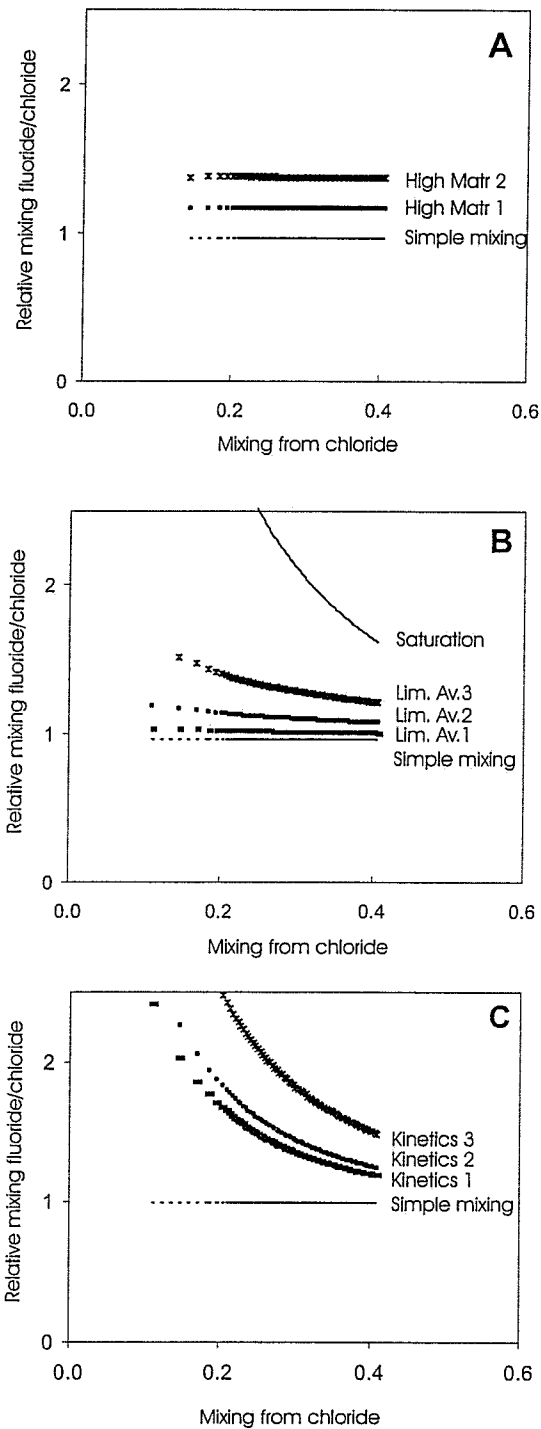
Fig. 7 Modelled excess of apparent mixing based on fluoride/chloride mixing ratio assuming
that the excess of fluoride is caused by: (A) a difference in fluoride concentration
between the matrix and the fractures; (B) dissolution of fluorite while fluorite has a
limited availability in the Chalk aquifer; (C) dissolution of fluorite controlled by slow
reaction kinetics.
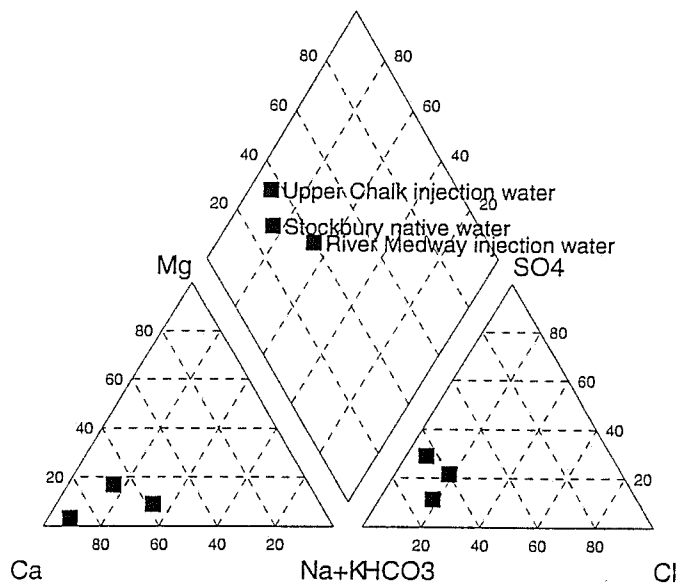
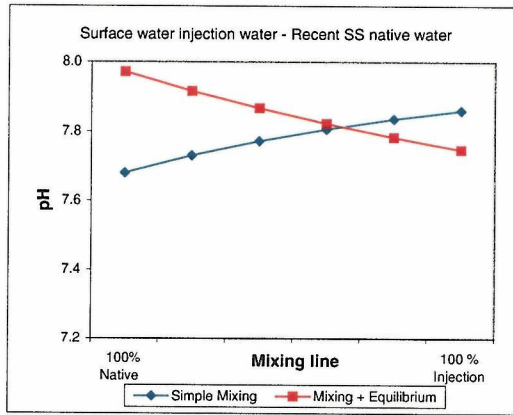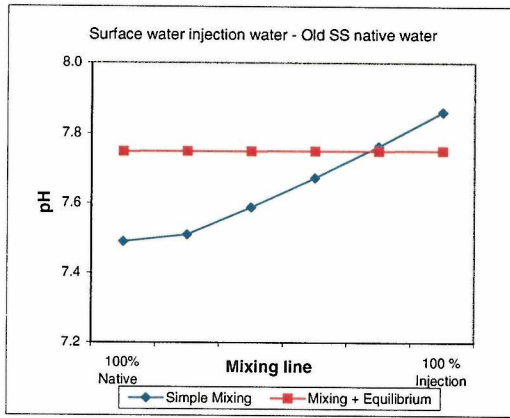Fig. 8   Piper diagram of the injection and native waters used for the Lower Greensand.
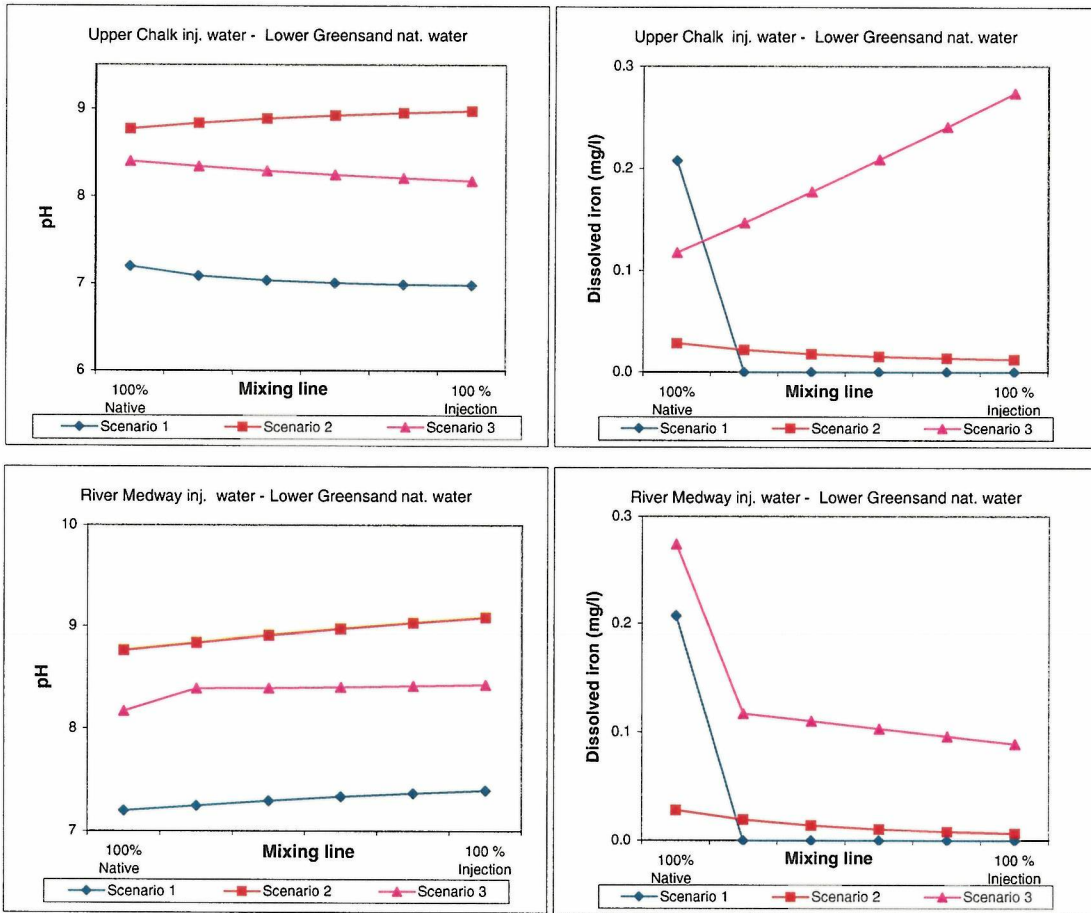
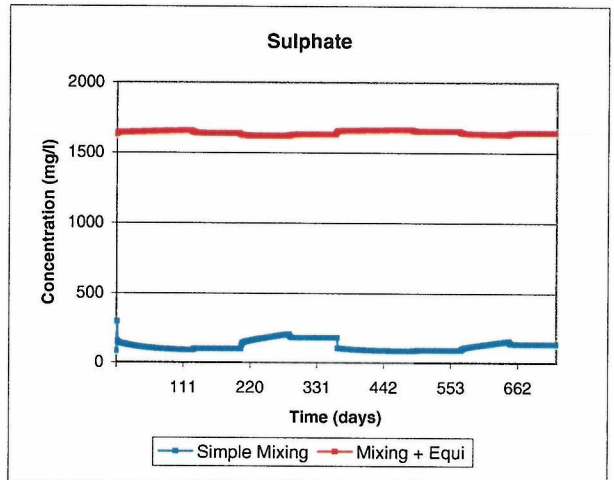Fig. 9   Mixing modelling results for pH (upper) and iron (lower) for different injection and native waters in the Lower Greensand.
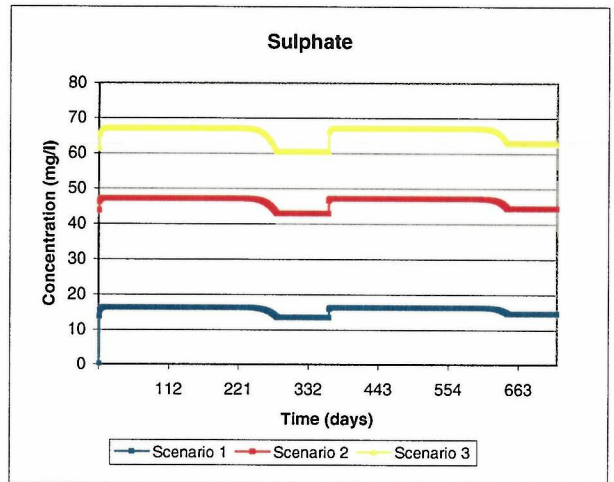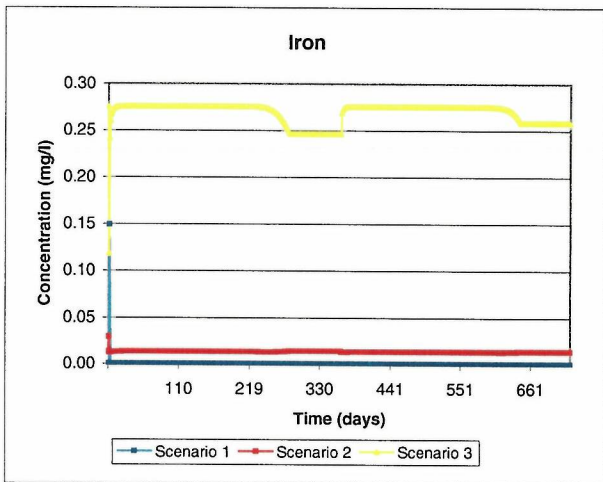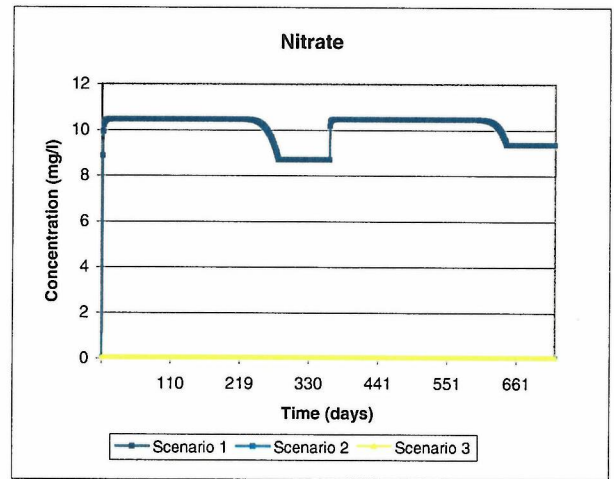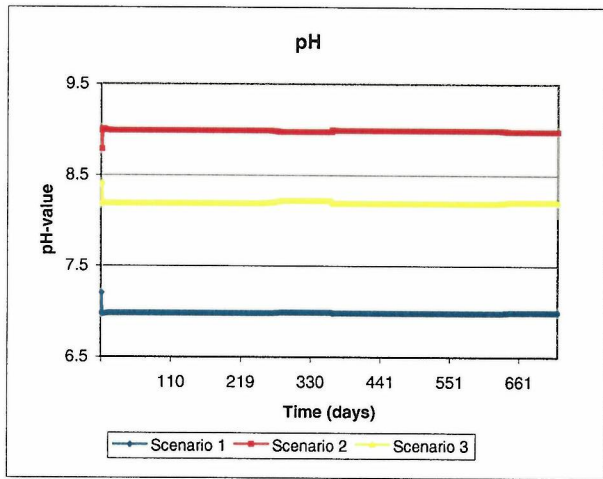
Fig. 10 Cycle modelling for pH, nitrate, iron and sulphate in the Lower Greensand (injection of treated Upper Chalk water into the Lower Greensand at Stockbury).
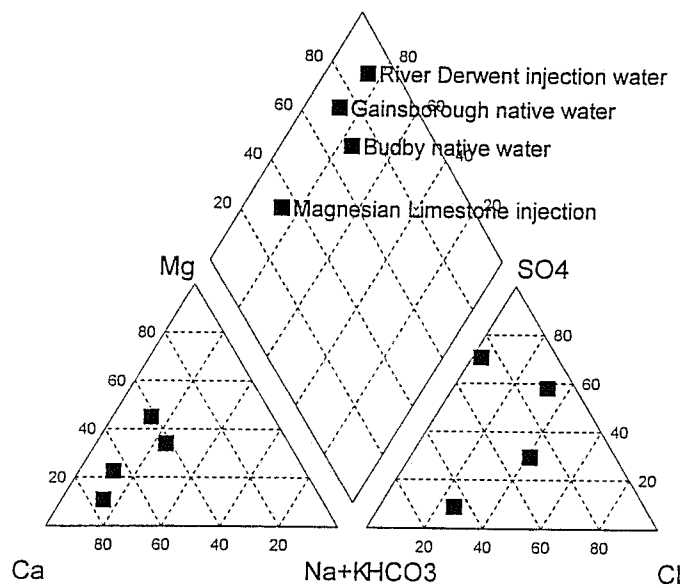
Fig. 11 Piper diagram of the injection and native waters used for the Sherwood Sandstone.
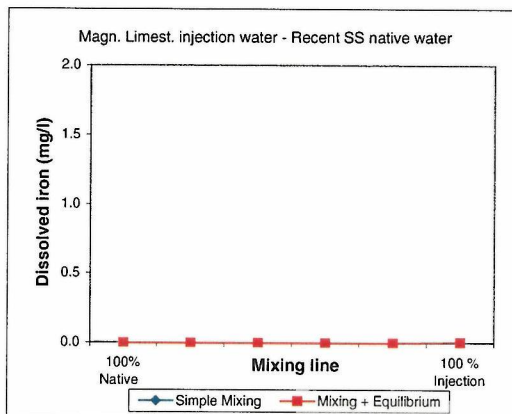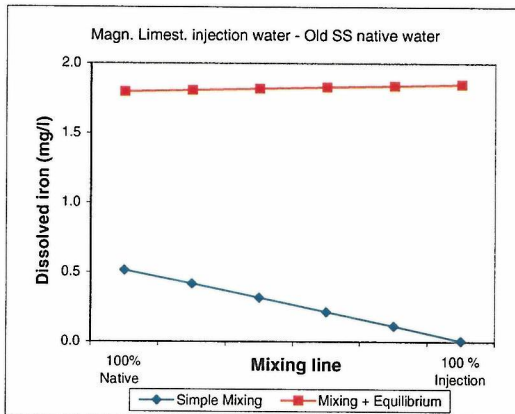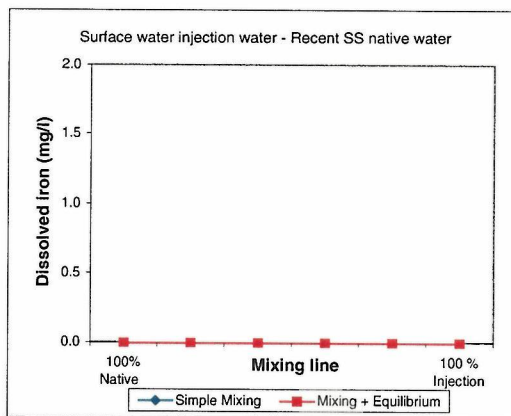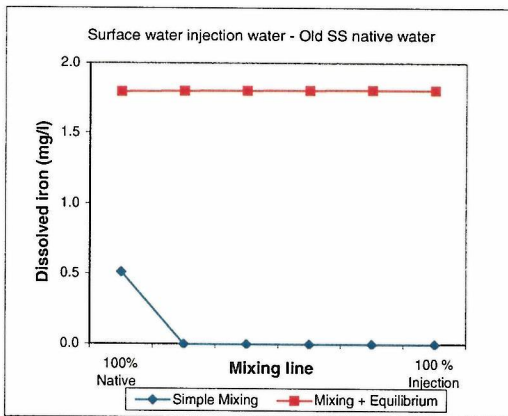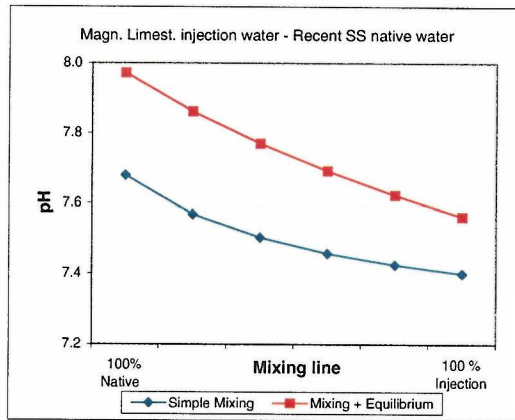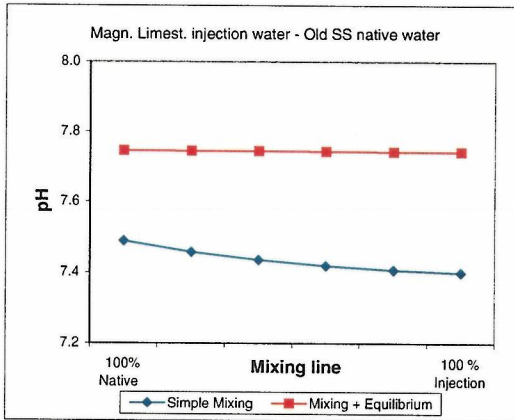
Fig. 12 Mixing modelling for pH (upper) and iron (lower) for different injection and native waters in the Sherwood Sandstone.
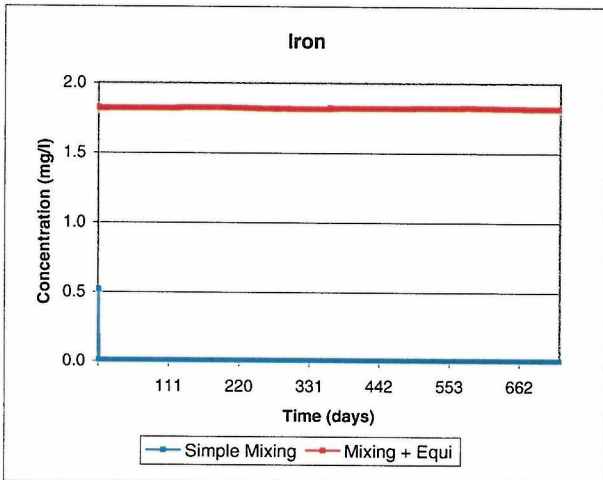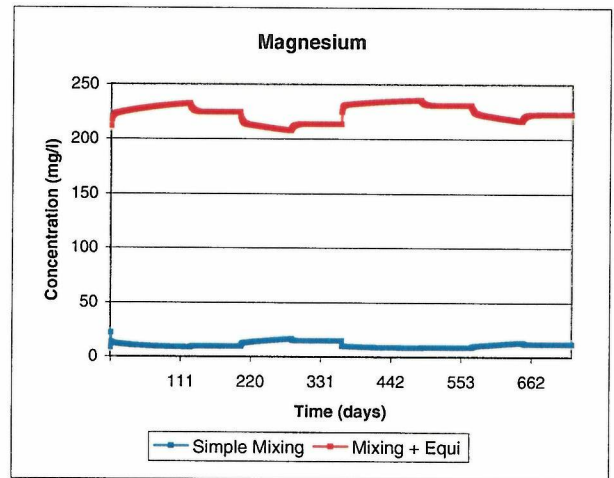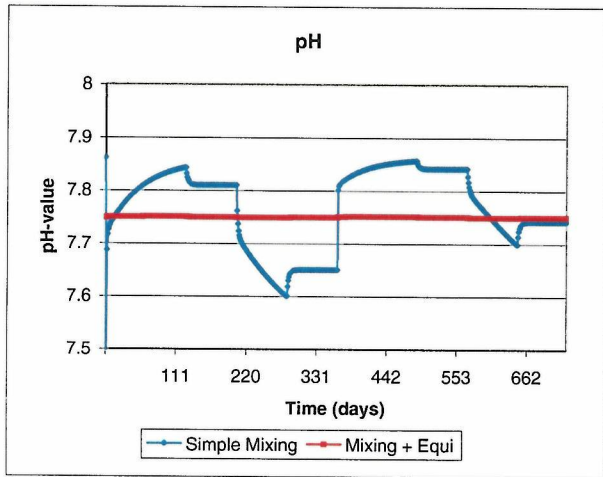
Fig. 13 Cycle modelling for pH, magnesium, iron and sulphate in the Sherwood Sandstone (injection of river Derwent water into the Sherwood Sandstone at Gainsborough)
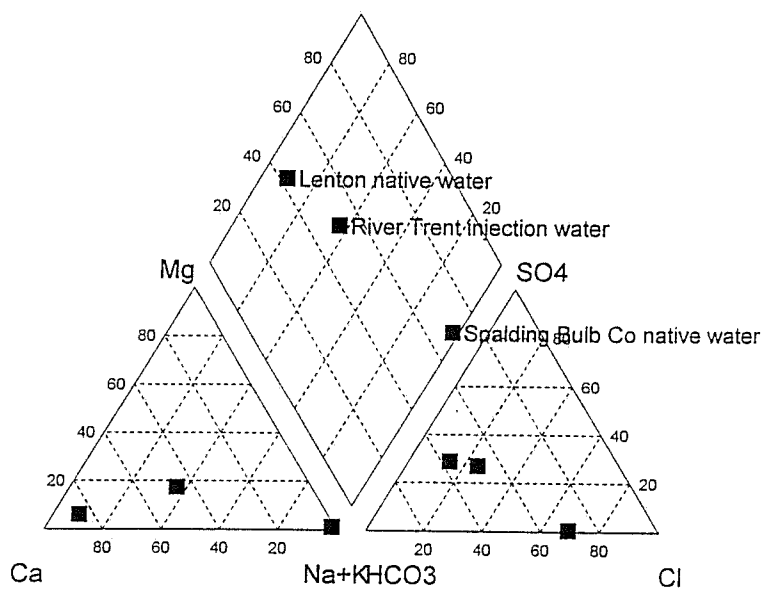
Fig. 14 Piper diagram of the injection and native waters used for the Lincolnshire Limestone.
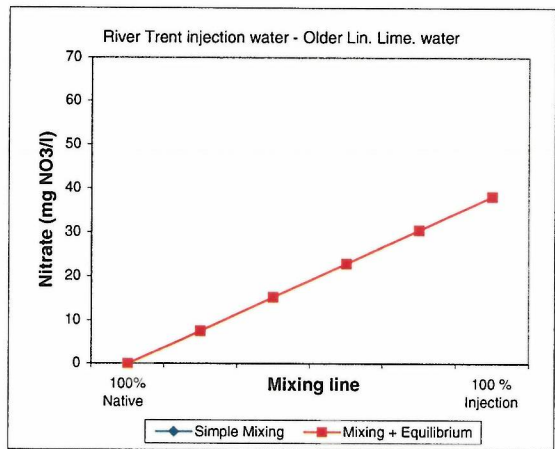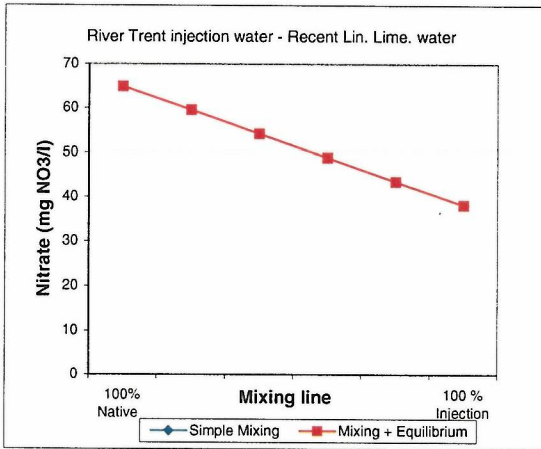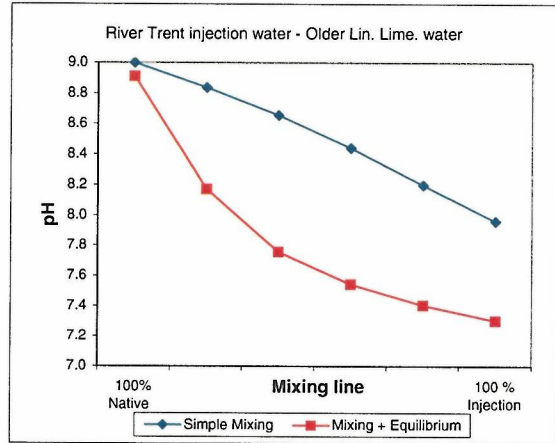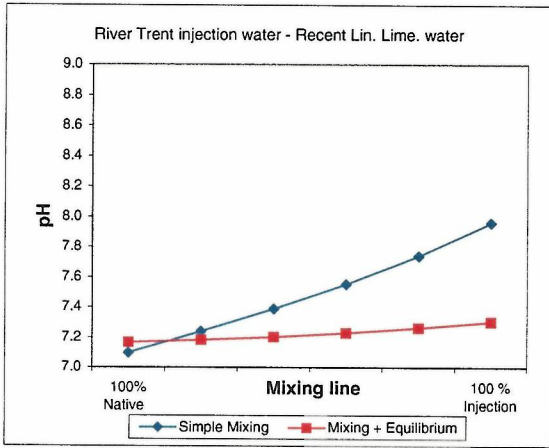
Fig. 15 Mixing modelling results for pH (upper) and iron (lower) for different injection and native waters in the Lincolnshire Limestone.
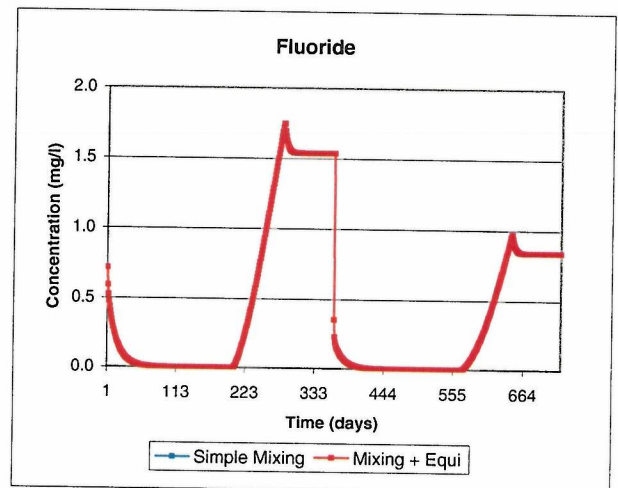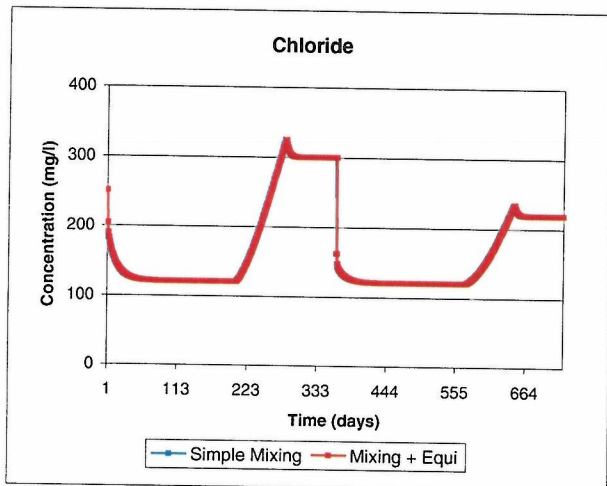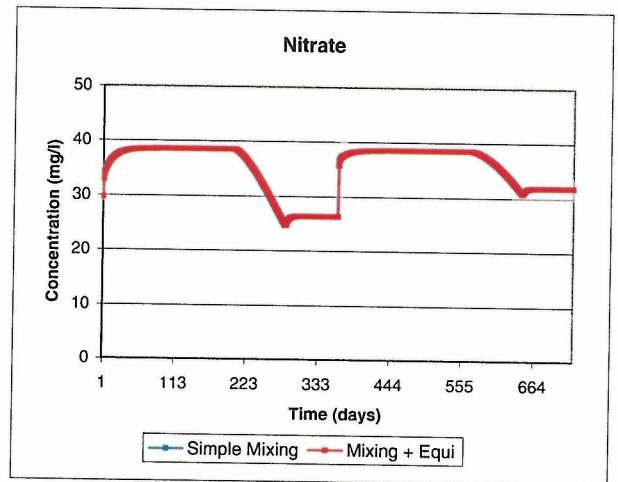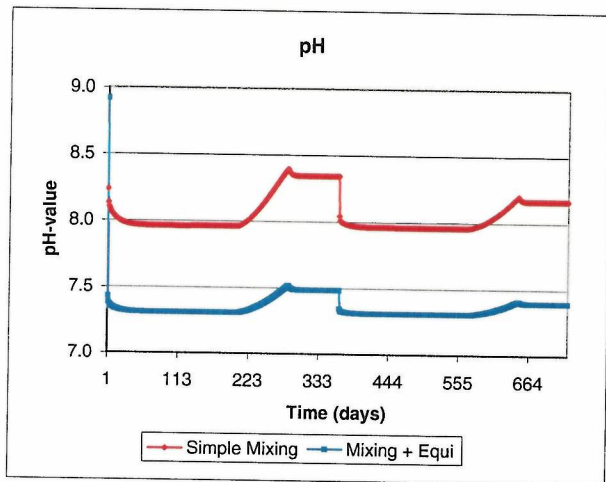
Fig. 16 Cycle modelling for pH, nitrate, chloride and fluoride in the Lincolnshire Limestone aquifer (injection of river Trent water into the Lincolnshire Limestone aquifer at Spalding Bulb Co).