The Potential for ASR in Selected Areas of the Weald

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October 1996

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THE POTENTIAL FOR ASR IN SELECTED AREAS OF THE WEALD:
Report on a rapid desk study by the British Geological Survey

Introduction

Two areas of interest are considered, that is the chalk blocks around Eastbourne/Beachy Head, and Folkestone/Dover, in order to assess the potential for using surplus winter chalk water to recharge deeper formations. The chalk itself is not considered as a potential ASR formation. The two areas are geologically very different and are described separately; possible aquifers are listed, and relevant features drawn together in Table 1. The following descriptions focus on possible ASR formations, and do not describe the aquicludes between these.

This study should be regarded as a first pass, with the information drawn mainly from published maps and memoirs, with additional borehole data where readily available. It should be noted that, particularly for the deeper formations, information is very sparse. Where no data were available for these areas, information has been drawn from outside the area, and highlighted as such in Table 1.

It should also be noted that transmissivity values defined for formations at outcrop or near surface, may not be applicable to the same formations when buried at depth. This is likely to be a particular problem for limestones which rely on solution enlargement of fractures for much of their transmissivity development, although all formations will be affected due to the pressure of overlying rocks.

Formation water quality, as such, should not be considered as a reason to discount ASR, as the development of the formation will involve cycling until a fresh water bubble has been produced. More important is the possible chemical reactions between recharge and formation water quality, which would need to be assessed as part of the feasibility stage of ASR development, and is beyond the scope of this note.

The regulatory aspects of ASR are still under discussion. However, there may be a potential problem with using spare winter Chalk water if it has high concentrations of nitrates/pesticides. If such water is used to recharge, it may be considered to be contaminating another aquifer. If the concentrations fall within the limits for potable water, this is unlikely to present an obstacle.

Folkestone/Dover Area

Hydrogeological Considerations

The area lies on the northern limb of the Wealden anticline, with Cretaceous strata dipping to the north, while older strata dip to the south. The outcrop chalk is overlain, in some areas, by Pleistocene and recent deposits.

In this area, the Upper Greensand (UGS) is absent, the Chalk being underlain by the Gault clay. Beneath the Gault is the Lower Greensand (LGS), including the Folkestone Beds, Sandgate Beds,

Hythe Beds, and Atherfield Clay.

- Folkestone Beds comprise predominantly poorly consolidated, quartz sands, coarse in places eg Folkestone, and form a porous, non-fractured aquifer. The beds outcrop in a band extending northwest from a point in the middle of Folkestone. North of this line, the beds are confined beneath the Gault They are approximately 20m thick at Folkestone, thinning towards north and east beneath the Gault, and thickening towards west. They also deepen towards the north, following the general northern dip of the strata. Generally good quality water.
- The Sandgate Beds thin and deepen to northeast. They comprise silty clays and clays with subordinate sandstones, and generally act as an aquiclude, although locally act as an aquifer (eg in Ashford area).
- Hythe Beds - only about 10m thick at Hythe, rapidly disappearing north of their outcrop, and therefore unlikely to be important.

The underlying Wealden Formation comprises the Weald Clay, Tunbridge Wells Sand, Wadhurst Clay, Ashdown Sands, and Fairlight Clays, the latter 4 divisions being grouped as the Hastings Beds. In the Folkestone area, the beds are not differentiated. They are less than 100m thick in total, thinning and deepening to the northeast.

The Corallian beds, confined by the Kimmeridge Clay, consist of a very thick sequence, which is lithologically variable. Thick coralline limestones recorded in Kent boreholes and boreholes to north of Seaford/Beachy Head chalk block are believed to represent near shore 'fringing reefs'. In the Folkestone area thicknesses have been recorded as 90 - 104m at depths of 200 - 300m bgl; however, the beds are much thinner or absent at Dover and further north due to the successive overstepping of younger deposits.

The Great Oolite Limestone thickens south from the Deal area (0m) to 15 to 20m thick in the Dover and Folkestone areas, at depths of 300 to 400m. Due to its limited thickness and moderate depth, it is not a strong candidate for ASR.

The underlying Inferior Oolite Beds are represented by only the Upper Inferior Oolite with a maximum thickness of 13 m in the Dover/Folkestone area, consisting of sandstones and sandy limestone. Again unlikely to be suitable for ASR because of its thickness and depth.

The Middle Lias is more sandy than either the Lower or the Upper Lias (shales/mudstones), and is subdivided into a lower shaley portion overlaid by a pronounced limestone facies. Probably not thick enough to be of interest.

The underlying Carboniferous Coal Measures are encountered at depth between -250m OD near Deal, deepening to -400m OD near Folkestone. In Kent, they are divided into a lower shale division and an upper sandstone division. The upper sandstone division (representing part of Middle CM, and all of Upper CM), is approximately 600m thick, consisting of sandstones and sandy shales. The alternating sandstones and sandy shales would be useful for ASR, due to layering of the aquifer.

The Carboniferous Limestone subcrops most of the area. It is a massive, crystalline limestone. However, its occurrence at depths of around 1000m in Dover/Deal area probably excludes it from consideration for ASR.

Potential for ASR

From this preliminary survey the major potential formations for ASR appear to be the following:

- Folkestone Beds - the main disadvantages being that they are fairly thin, and their thickness reduces away from the outcrop. However, reasonable yields.
- Upper sandstone division of the Coal Measures - very thick sequence of alternating sandstone, shales and coals, therefore providing layered aquifer. However, aquifer properties are not known in this area. Transmissivity values from other areas range from 0.2 to 20 m^2/d

Seaford/Beachy Head Area

Hydrogeological Considerations

The area lies on the southern limb of the Wealden Anticline. Chalk outcrops at the surface. The structural dip of the strata is generally to the south, although Lower Jurassic strata are flat-lying or have a gentle northerly dip.

The UGS consists of variably indurated silty sands and sandstones; apparently in hydraulic continuity with the overlying chalk. In the area the sequence is probably thin; in the Lewes area it is locally absent. Boreholes in Eastbourne have yielded up to 11 l/s, believed to be partly contributed from the overlying Chalk.

The LGS is not subdivided in this area as recent surveys have shown that usual subdivisions cannot be recognised. The total thickness ranges around 60m to a few metres at Eastbourne, at depths of between 150-350 m (?), deepening away from outcrop, towards sea. In the Lewes area, the top 15m is described as almost invariably fine grained, pale sand.

The Tunbridge Wells Sand of the Wealden Series comprises lower interbedded silts and fine silty sandstones, overlain by massive cross-bedded sandstone. The sands occur at depths of 300 - 500m, deepening to the south overall. Not very much detail in Eastbourne area, however to northeast of area, they are 70-80m thick, at depths of less than 100m, and are confined by the Weald Clay.

The Ashdown Beds comprise fine-grained silty sandstones and siltstones. They are more developed in this area, and are 180 m thick near Hastings. Sandstones predominate in top 50 m, and only top 15 m are considered to yield appreciable quantities of water. They have been quite extensively developed for water supply, although block faulting of the formation requires careful borehole siting.

Jurassic sediments are somewhat thicker in the Seaford/Beachy Head area, due to its closer

proximity to the Jurassic sedimentary trough. The Corallian beds in this area are thicker and therefore potentially more useful than in the Folkestone/Dover area, but are at greater depth (400-500m).

The Purbeck Beds form small inliers, and are not hydrogeologicaly significant.

The Great Oolite Limestone is recorded as being 50-60m in the centre of the trough, and would therefore be thinner than this towards coast. It probably occurs at depths of greater than 600m. The Inferior Oolite is present but relatively thin

Carboniferous deposits underlie the area, but at great depth, and are unlikely to be considered for ASR use

Potential for ASR

- Lower Greensand - has more potential in the western part of the area where it is likely to be thicker.
- Tunbridge Wells Sand - may have potential, depending on thickness, depth and transmissivity; yields of boreholes are reported to be unreliable due to limited storage and recharge.
- Ashdown Beds - possibly has more potential than the Tunbridge Wells Sand, as sandstones appear to be more reliable in terms of supply. However, boreholes have been reported as being prone to silting up, therefore requiring careful borehole construction. Also, block faulting of formation leads to careful consideration of borehole siting.

The surface water abstraction points upstream of the Chalk outcrop on the River Ouse and Cuckmere are potential sources of water for recharge. The sites are both situated on the Wadhurst Clay, immediately overlying the Lower Greensand, and may be potential locations for ASR development. Spare winter water could also be piped to ASR sites further south, if the existing distribution network was suitable.

Formation	Seaford/Beachy Head area		Folkestone area		T m^2d^{-1}	Approx poros (%)	Yield (l/s)	Flow type (fracture or matrix dominated)	Comments
	Depth to top (m bgl)	Thickness (m)	Depth to top (m bgl)	Thickness (m)					
Upper Greensand	0-200	15-20?	Absent	Absent	*70-1500*	*30-45*	max 11	m&f	Ca bicarb type water, may be Fe rich. In hydraulic continuity with overlying Chalk
Lower Greensand: Folkestone Beds	150-350 (?), deepening away from outcrop, towards sea	Total LGS thickness (max) 150; thins to a few m at Eastbourne	0-200, deepening to NE	~ 20 @ Folkestone, thinning to N and E; maximum thickness along outcrop	*260* •	*30*	typically 25, max 50	m	LGS not subdivided in Seaford/Beachy Head area. Forms porous, non-fractured aquifer Good quality water Sandy nature necessitates careful borehole construction, and even then boreholes usually have limited life of < 20 years
Lower Greensand: Sandgate Beds	As above		0-?; deepens to NE		As above	*30*		m	Generally acts as aquiclude, although locally may yield water
Lower Greensand: Hythe Beds	As above		0-?	10 @ Hythe, thinning rapidly to N		*30*		m&f	Unlikely to be important due to limited thickness and extent Thins very rapidly away from outcrop
Wealden Series: Tunbridge Wells Sand	300-500	70-80 to NE of area	Deepens to NE	Total Wealden thickness 100 (?), thinning to NE			typically 8-17, rarely > 20	m&f	Wealden Series not subdivided in Folkestone area. Yields of Tunbridge Wells sand reported to be unreliable due to limited storage and recharge Free CO_2 may cause corrosion problems
Wealden Series: Ashdown Beds		180 near Hastings					typically 10-15, max recorded 63	m&f (?)	Top 50 m of Beds are likely to be most productive. Water soft, but may be rich in Fe and Mn; also free CO_2 may cause corrosion problems Block faulting of the formation results in need for careful boreholes siting Boreholes may be prone to silting up

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	Depth to top (m bgl)	Thickness (m)	Depth to top (m bgl)	Thickness (m)					
Corallian Beds	400-500		< 300					f	
Great Oolite Lst	Great Oolite Group: 600-700	20-60 in centre of Jurassic trough; thins towards south	300-400	~0 at Deal, thickening to 20m in west and south	*Mean 180*	*10-20*		f	
Inferior Oolite	600-700	40	300-400 (deepening to southwest)	8-13	*750-2000*	*15-20*		f	
Lias	700-900 (deepening to west)	< 200	300-400	<100 (limit of subcrop follows SE-NW line from ~ Dover)		*10-20*		m	Little data, probably too thin to be of use
Coal Measures: Upper Sandstone Division	1000	?	250-400 (shallowing to north)	700-800		*0.2-20*	*12-19*	m&f	

Table 1: Summary of characteristics of potential ASR formations in the Weald Area

* Pump tests from confined LGS at Sompting (west of Brighton) gave T values of only 70 m^2d^{-1} indicating transmissivity is greatly reduced when confined

N.b.

i. Figures in italics are extrapolated from other areas

ii. Depths to Jurassic and Carboniferous formations are taken from small scale maps, and are therefore very approximate