Minerals Local Plan Background Document

Worcestershire County Council: September 2018

Salt and Brine in Worcestershire

Executive summary

Salt and brine are found in Worcestershire around Droitwich Spa and Stoke Prior and have been worked since the Iron Age. The last large-scale working closed in the 1970s following concerns about subsidence, but recent years have seen a return to brine extraction at a small scale for the production of salt, and there is outline planning permission for a brine bath adjacent to Droitwich Spa lido.

It is unclear whether salt and brine resources in Worcestershire will ever again be workable or commercially attractive at a large scale.

Any proposed new salt or brine workings would need to demonstrate that they would not create or be affected by unacceptable ground instability and subsidence. The Council does not currently have any information to suggest whether these issues could be overcome.

Contents

1. Introduction to salt and brine

1.1. Salt is extracted in two forms from the earth: as a solid called *rock salt* (or halite), and also as a liquid known as *brine*.

1.2. Brine is created where ground water percolates through and dissolves rock salt. Brine contains approximately 2.5lbs of salt per gallon, which is roughly ten times the proportion of salt found in sea water.

1.3. Rock salt is extracted by the 'pillar-and-stall' method. This is a traditional mining method in which salt pillars are used to support the ceiling of shallow underground cavities and tunnels where the excavation takes place[1]. This has very little effect on the surface, except in the cases where the cavities or tunnels collapse and subsidence occurs.

1.4. For brine extraction, a modern brine pump involves a double pipe inserted into the ground which uses hydraulic power to induce the brine to flow upwards. The extraction of brine through a pump therefore has very little impact, in the first instance, on its immediate surroundings.

1.5. Brine processing methods differ on the surface depending on the end result or product desired and facilities can cater for a variety of uses. The processing methods include vacuum pan refining or open pan refining. The vacuum pan refining method uses multiple evaporators all acting under vacuum in order to extract the salt. The crystallised salt is then removed as a slurry, dewatered in a centrifuge and rotary dried in a kiln[2]. Open pan refining is not as energy efficient as vacuum refining and uses large pans to evaporate the water. In this method the salt forms as flakes rather than cubic crystals.

Why is it needed and what is it used for?

1.6. In the UK rock salt is used to a large extent for de-icing roads, and to a lesser extent as an agricultural additive or fertiliser.

1.7. Brine is produced on a much larger scale than rock salt. Four main products are extracted from brine by the inorganic chemical industry: chlorine, caustic soda, soda ash, and hydrogen (an electrolysis by-product).

1.8. Chlorine is used in water and sewage treatment, in household and industrial bleaches and for making plastics and polymers. Chlorine is also used in crude oil refining and for making pesticides. Caustic soda is used in paper-making and manufacturing soap and detergents. Soda ash is used in manufacturing detergents and glass, and hydrogen is used as a fuel for power generation[3].

[1] Cooper A. H., Halite karst geohazards (natural and man-made) in the United Kingdom, British Geological Survey

[2] http://www.saltassociation.co.uk/education/make-salt/white-salt-production/

[3] British Geological Society (January 2006) Mineral Planning Factsheet: Salt

1.9. Brine can also be evaporated to produce white salt, which can then be used in water softening, chemical feedstock, food-processing and tanning[4].

1.10. Salt is an economic resource for the UK. In 2014 UK salt production amounted to almost 4.7 million tonnes, with a value of £225 million, accounting for around 0.8% of the total value of mineral production in the UK. In the same year, the UK imported 356,289 tonnes and exported 772,971 tonnes of salt [5]. The requirement for imports is partly due to the variety of uses derived from the compound, as in certain circumstances usage rates do not reflect production rates.

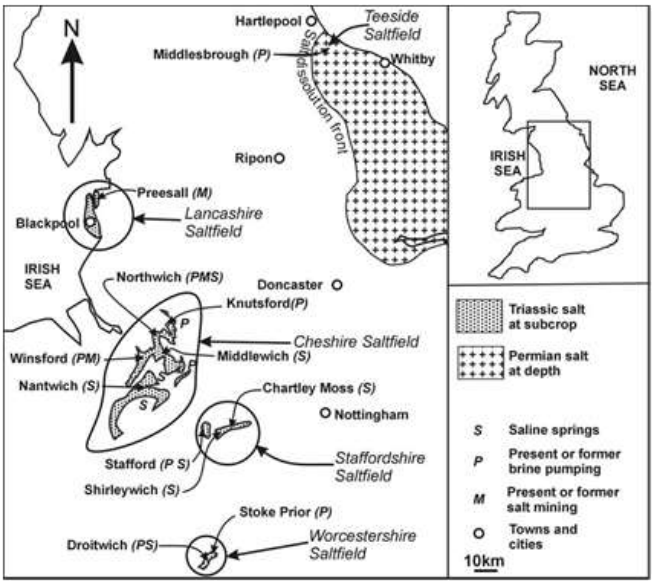
1.11. Importing rock salt can also be necessary if local authorities' stockpiles for treating roads become depleted, as "in times of maximum demand it is sometimes easier and quicker to import salt from elsewhere into a convenient port"[6]. Stockpiling very large amounts of rock salt for long periods of time is not economically viable as salt becomes less effective once exposed to the atmosphere.

2. Where are salt and brine found?

2.1.

2.2. Figure 1 outlines the main areas of salt and brine deposits and workings in England. Cheshire is the most important centre for salt production, accounting for over 80% of national output. In the wider UK there is also an area of eastern Northern Ireland where salt and brine deposits have been exploited.

2.3. As at March 2016 there were seven salt workings in the UK, with none in the West Midlands.



[4] British Geological Society (January 2006) Mineral Planning Factsheet: Salt
[5] British Geological Survey (2016) United Kingdom Minerals Yearbook 2015
[6] Rock salt: an essential mineral keeps the country moving, accessed at http://www.bgs.ac.uk/research/highlights/2010/rockSalt2010.html

Figure 1: The distribution of salt karst and salt mining areas in the UK[7].

[7] Cooper, A H (2002) Halite karst geohazards (natural and manmade) in the UK *Environmental Geology, 42, 505-512.*

2.4. Salt can be found in two areas in Worcestershire: Droitwich Spa and Stoke Prior. Both these areas have Triassic period (248-205 million year old) salt deposits. During this period the Worcestershire and Herefordshire area was nearer the equator, and movements in the Earth resulted in mountainous areas from which minerals were eroded over millions of years. This led to mineral deposits occuring in clear strata on the plains, forming sandstones and mudstones. Dry, arid-like conditions created wind-blown dust which settled on the plains and also led to evaporation of the mineral-rich water. This formed the layers of salt in the Severn Vale under central Worcestershire.

2.5. Where salt dissolution has already occurred naturally in the earth due to groundwater coming into contact with the upper surface of a salt bed, this is known as a 'wet rock head'. The 'dry rock head' is the upper surface of the salt bed in places where the salt has not dissolved, due to it being sealed under another rock stratum. Droitwich Spa and Stoke Prior are known to have access to both a dry and a wet rock head. The depth of the salt karst[8] is 30m-130m[9], depending on where the rock heads are found. In Worcestershire, the salty stratum is approximately 90m thick, with 40% of this made up of siltstone and mudstone particles[10].

2.6. The deposits in these areas have been large enough in the past to be economically viable for large-scale extraction, although there are no current large workings in Worcestershire.

2.7. The last brine works (at Stoke Prior) was closed down in 1972 following potential subsidence and conflicts with housing development plans[11,12]. The naturally occurring surface brine stream around Stoke Prior had previously dried up following extensive extraction of the wet rock head by the salt works. However, recent investigations by the British Geological Survey show that brine is again beginning to reach the surface in the area. The survey shows that chloride concentrations of around 3,100mg/l - 3,400mg/l can be found east of Droitwich Spa[13].

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[8] Karst: 'A suite of landforms created by the action of water on limestone', available at http://www.bgs.ac.uk/mendips/caveskarst/karst_1.htm

[9] Cooper, A.H. (2002) Halite karst geohazards (natural and man-made) in the United Kingdom, Environmental Geology, Vol. 42, 505-512, available at http://nora.nerc.ac.uk/6218/2/Halite_karst_geohazards_Cooper_Env_Geol_vol42_505-512.pdf

[10] Cooper A.H., Natural and induced halite karst geohazards in Great Britain, British Geological Survey. In: Geotechnical and Environmental Applications of Karst Geology and Hydrology, Beck and Herring (eds), 2001, Swets & Zeitlinger, Lisse. Page 119

[11] *Railways in Worcestershire* website article on ICI Salt Ltd, Stoke Prior Salt Works, available at http://www.miac.org.uk/ici.htm

[12] Salt Subsidence at Droitwich report of meeting at Institute of Geological Science, London, 3rd February, 1969. Archive file of Worcestershire County Council, Corporate Information Management Unit, 107214 Salt, File 1.

[13] Cooper, A.H. (2002) Halite karst geohazards (natural and man-made) in the United Kingdom, Environmental Geology, Vol. 42, 505-512, available at http://nora.nerc.ac.uk/6218/2/Halite_karst_geohazards_Cooper_Env_Geol_vol42_505-512.pdf

3. The history of workings in Worcestershire

Droitwich Spa

3.1. There is possible evidence of pre-Roman workings in the form of an Iron Age brine boiling spring hearth[14] at the Upwich brine spring in Droitwich Spa. During the Roman era Droitwich Spa was known as *Salinae*, which indicates its early associations with the extraction and distribution of salt.[15]

3.2. Between the 17th and 18th centuries, salt extraction at Droitwich Spa reached almost 22,000kg per day. The method of extraction used at this time was known as 'wild brining', whereby salt deposits are close enough to the surface for the rock salt to be dissolved by downward percolating groundwater, creating underground pools and streams of "wild brine".[16] The increase in extraction highlighted the need for better infrastructure, and a 1755 report indicated it would be more cost-effective to transport the salt by canal. A canal would enable the salt to reach Bristol and other markets via the River Severn, increasing trade and revenues, with the report stating that "A navigable river would be a Publick good".[17]

3.3. Wild brining continued to be the main method of extraction in this area and joined the traditional 'pillar and stall' method that was used for rock salt exploitation. Wild brining was the primary cause of subsidence in Droitwich Spa town and further afield.

3.4. In the 1850s, the railway began to undermine the use of canals for transporting products from Droitwich Spa to the River Severn. Of the two canals which serve Droitwich Spa, the wider canal (the Barge Canal) was officially abandoned in 1939[18]. As salt production and processing developed over the country, competition increased and kept prices low. The Droitwich Spa salt works began to struggle due to its relatively small scale of production[19], with salt production discontinuing in 1922[20].

3.5. The Council is not aware of any large-scale plans for brine extraction in or around Droitwich Spa, but a proposal for the supply of brine water from Tower Hill in limited quantities to develop salt products was supported in principle in 2017[21]. Small-scale commercial salt production is currently taking place on the outskirts of Droitwich Spa, using brine extracted within

[14] Hurst JD (1997) A multi-period salt production site at Droitwich, Excavations at Upwich. Council for British Archaeology, Research Report 107, 164pp. In: Cooper A. H., Halite karst geohazards (natural and man-made) in the United Kingdom, British Geological Survey.
[15] Roman Britain webpage on Droitwich, available at http://roman-britain.co.uk/places/droitwich.htm
[16] Report on the effect of Brine Pumping in and around Droitwich, archive file reference 11543/4/5/2)
[17] Bishop of Worcester Estates Parliamentary Records, BA 2636, 88, 45300. The Hive, Worcestershire County Archives, Original Documents.
[18] https://canalrivertrust.org.uk/enjoy-the-waterways/canal-and-river-network/droitwich-canals
[19] Decline of Droitwich Salt Production, Guerney's Lane Information Board. Droitwich Spa Heritage Centre, WR9 8DS
[20] http://news.bbc.co.uk/local/herefordandworcester/hi/people_and_places/religion_and_ethics/newsid_8473000/8473037.stm
[21] Minutes of a meeting of Wychavon District Council's Executive Board, held in Pershore on 8th February 2017.

the town. Outline planning permission was granted in 2017 for development including a brine bath adjacent to Droitwich Spa Lido[22].

Stoke Prior

3.6. Stoke Prior, the other main Worcestershire salt works, continued to exploit the resource after the Droitwich Spa works had closed. These works had received heavy investment since the 1830s when a large deposit of rock salt had been discovered. Extraction quickly changed to brine, however, due to the characteristics of the deposit. The works incorporated salt and chemical works and a soapery[23].

3.7. Following a period of decline, Stoke Prior salt works was rejuvenated by John Corbett, a local entrepreneur, after he bought it in 1853[24]. Updating the processing plant significantly increased salt production.

3.8. The Stoke Prior works changed hands a number of times before its closure in 1972 following potential subsidence and conflicts with housing development plans[25,26,27].

4. Planning context

National planning context

4.1. The NPPF states that planning policies should ensure that planning policies and decisions should contribute to and enhance the natural and local environment, including by preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability[28]. It is also a matter of law that development should not undermine adjoining land.

Local planning policy

4.2. Salt is listed in the adopted Hereford and Worcester Minerals Local Plan as a commercially exploitable mineral that can be found within

[22] Wychavon District Council planning application reference 17/02092/OUT
[23] *Railways in Worcestershire* website page on John Corbett's saltworks, available at http://www.miac.org.uk/corbett.htm
[24] Railways in Worcestershire website page on John Corbett, available at http://www.miac.org.uk/corbett.htm
[25] Cooper, A.H. (2002) Halite karst geohazards (natural and man-made) in the United Kingdom, Environmental Geology, Vol. 42, 505-512.
[26] Salt Subsidence at Droitwich report of meeting at Institute of Geological Science, London, 3rd February, 1969. Archive file of Worcestershire County Council, Corporate Information Management Unit, 107214 Salt, File 1.
[27] *Railways in Worcestershire* website article on ICI Salt Ltd, Stoke Prior Salt Works, available at http://www.miac.org.uk/ici.htm
[28] Ministry of Housing, Communities and Local Government (2018) National Planning Policy Framework, paragraph 170

Worcestershire, but that presently, and in the foreseeable future, salt will not be commercially exploited[29]. However, the new Minerals Local Plan will supersede the adopted Hereford and Worcester Minerals Local Plan, and it will need to consider the commercial viability and sustainability of the mineral resources in Worcestershire.

[29] Worcestershire County Council Adopted Minerals Local Plan, paragraph 1.4.

5. Planning issues for salt and brine

5.1. The majority of activities associated with salt extraction are underground and remain unseen. However there are particular characteristics of salt extraction that have environmental implications.

Hydrology

5.2. Brine extraction in Worcestershire has had an impact on groundwater in the past, however, the new ground water exemption policy from the Environment Agency includes saline abstractions from the Cheshire brine fields. These are specific exemptions that also allow certain types of dredging operations and certain abstractions within water meadow systems[30]. If the brine fields were to be re-exploited in Worcestershire abstraction would almost certainly be less than at the current Cheshire fields. However, care would be required assessing the specific local impact to the area's groundwater and aquifers.

Geological and nature conservation

5.3. In the UK, the Geological Conservation Review (as part of the Department of Environment, Food and Rural Affairs) has been developed 'to provide a public record of the features of interest and importance at localities already notified or being considered for notification as 'Sites of Special Scientific Interest' (SSSIs). The sites selected – GCR sites – form the basis of statutory geological and geomorphological site conservation in Britain'[31].

5.4. The sites that have been selected have the potential to be used for scientific, education, training, economic, leisure and aesthetic purposes[32].

5.5. Salinity levels have dropped around the Salwarpe Valley and Terraces since the 1960s, and several halophytes are now extinct. Any potential effects on the nature conservation interest of habitats in and around proposals for brine or salt extraction would need careful consideration.

Emissions – noise, dust and vibration

5.6. Mineral extraction can result in adverse effects on surroundings unless the operation is properly controlled and the site appropriately restored. These impacts could include noise, dust and vibrations.

5.7. Noise and dust emissions are more likely to occur from rock salt workings than from brine extraction. Rock salt mining may involve blasting which can cause some emissions, although this is likely to be below the level that would cause structural damage at the surface.

[30] Environment Agency (2010) Managing Water Abstraction.

Visual impacts

5.8. One of the main impacts associated with salt mining or brine extraction is the visual impact of buildings and storage mounds and the effects of wind-blown salt. The surface impact of brine extraction is likely to be limited to control valves, kiosk housing and small-scale exposed pipework at the well head, unless brine processing works are also developed. These would have a visual impact on the surface akin to other industrial uses.

Transport

5.9. The distribution of rock salt by road can lead to impacts from heavy goods vehicles, particularly during spells of adverse weather. Brine from Worcestershire was historically transported by canal and rail, and if this resource was to be worked in future then sustainable transport methods should be explored. It may also be possible to use pipelines to extract brine and transport it directly to a processing plant.

5.10. Transport links will be an important consideration in developing the Minerals Local Plan.

Climate change

5.11. Brine and salt extraction and processing are energy-intensive, as the majority of extraction is undertaken in a vacuum. The Minerals Local Plan will need to address climate change issues, including energy efficiency.

Ground stability and subsidence

5.12. The history of salt and brine extraction in the UK has been marked by catastrophic surface subsidence. Some salt mines are still collapsing and the re-establishment of the post-brine extraction hydrogeological regimes means that salt springs may again flow, causing further dissolution and potential collapse. With the ending of most near-surface mining and brine extraction, the hydrological system has re-balanced itself, or is in the process of re-balancing. It may be expected that natural groundwater flows will be re-established through the disrupted saltfields and further subsidence problems may occur. The accurate mapping of the rock salt and associated deposits, plus an understanding of their dissolution and collapse characteristics, can help development and planning in these subsidence-sensitive areas[33].

5.13. At the historic salt and brine workings in Worcestershire, subsidence was a side-effect that impacted upon the local area. The zones of subsidence caused by brine pumping can be unpredictable. Not all of the effects of subsidence are always negative, however, as subsidence could provide opportunities to create wetlands with recreational potential and habitats with unusual flora and fauna, if appropriately managed.

[33] Cooper A. H., Halite karst geohazards (natural and man-made) in the United Kingdom, British Geological Survey

5.14. Modern management and extraction techniques are also more likely than historic methods to enable design and operation which minimises the risk of subsidence.

6. Conclusion

6.1. Based on the best information the Council is aware of, it is unclear whether salt and brine resources in Worcestershire are likely to be workable or commercially attractive at a large scale.

6.2. There could also be serious implications associated with new salt or brine workings which would need to be satisfactorily addressed, particularly in relation to ground stability and subsidence. The Council does not currently have any information to suggest whether these issues could be overcome.