Salt and Environmental Planning: An Historical Perspective to a Contemporary Land-Use Problem

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ABSTRACT

The salt working and salt using industries of Cheshire have a long history of conflict with other forms of land use, and the problems of reconciling the need to abstract salt with those of developments on the surface have increased, rather than diminished, with the passage of time. Cheshire produces 82% of the United Kingdom's salt output, three-quarters going directly to the heavy chemical industry. At the same time major improvements to the communications system across the Saltfield, and its proximity to the Liverpool-Manchester axis of economic growth have combined to stimulate non-traditional forms of urban-industrial development.

Subsidence caused by pumping natural brine from the wet rock-head dates back to the 1790s, but became a major problem from the mid-nineteenth century onwards. It is still actively increasing in the southern part of the field. Elsewhere natural brine pumping has been replaced by the I.C.I. controlled method, but not before extensive damage had been caused in the northern sector of the saltfield. In addition to disruption caused by mining and brine pumping the steady decay of the salt industry, particularly the open-pan section, has added to the volume of dereliction, as an analysis of recent air photographs shows.

The area of greatest damage at Northwich was subsequently used as a dumping ground for chemical waste by the ammonia-soda plants which were also major consumers of brine. In the 1950s surface disposal of waste was replaced by dumping into the evacuated cavities of the controlled pumping brinefield—an outstanding example of constructive environmental planning by industry. However, 11 per cent of the brine yield in Cheshire still comes from natural sources with an attendant risk of subsidence. It is the policy of the planning authority to encourage solution mining as an alternative, which would cause important changes in the location of brine working. The decision, in 1972, of the British Salt Company, to substitute controlled pumping for its present mode of abstraction indicates the probable end of almost two centuries of disruption by salt working, although a substantial legacy of past damage survives.

INTRODUCTION

Although the Cheshire salt industry can claim a lengthy history its activities produced no major land-use conflicts or forms of disruption before the second half of the nineteenth century. It is true that subsidence caused by the collapse of rock-salt mines was recorded as early as 1750, and that subsidence due to the abstraction of natural brine first occurred 40 years later, but it was not until the 1870s that substantial problems began to emerge. Between about 1873 and 1923 damage caused by salt working was at its most extensive and impressive. During the past 50 years the more spectacular forms of subsidence have given way to subtler forms which, by virtue of their extent and general unpredictability have become important factors conditioning environmental planning decisions. Thus although the damage now caused by salt working subsidence does not excite the kind of attention directed towards its nineteenth-century counterparts, it is nonetheless a significant feature of the saltfield's current pattern of development.

The history of salt working, salt-based industry, and the related forms of land use which evolved on the Cheshire saltfield have been the subject of several papers published by the writer since 1956 (Wallwork 1956, 1959, 1960, 1967). In addition the nineteenth-century subsidences came under the scrutiny of both governmental enquiries and private studies (Dickinson 1873, Ward 1898, 1900), so that there exists a body of contemporary published material which is unequalled in the mining districts of the United Kingdom during the nineteenth cen-

tury. The Geological Survey has also made substantial contributions to understanding the complex geology of the saltfield, both during the 1920s (Sherlock 1921) and more particularly during its program of exploration during the 1960s. Unfortunately, but understandably, the industrial concerns responsible for the abstraction of brine have been more reticent about revealing the nature of their discoveries, and there is still much contentious argument about the relationship between brine working and related environmental problems. In this account it is intended to outline some of the salient features which help to explain the nature of present-day problems, and to concentrate rather more emphasis on the kinds of solutions now envisaged.

Knowledge as to why the various nineteenth-century subsidences took place was greatly limited by ignorance about the geology of the saltfield. The deposits were much more extensive than the worked areas, because the latter were tied to lines of communication, particularly the waterways which linked the saltfield with the port of Liverpool and the south Lancashire industrial region. In particular there was the problem of deciding how, if at all, the various salt producing areas were geologically interconnected, what the significance of faulting in the Keuper Marl had in this context, and whether the full sequence of salt beds had ever been located. For as long as subsidence stemmed from rock-salt mining, where the precise extent of the workings was known, the answers to these questions were academic. But once the major source of damage was attributed to brine pumping it became important to know to what extent the abstraction of brine at a given point would cause subsidence within the vicinity. Even so, it never has been possible to attribute a particular subsidence to a particular point of abstraction with the degree of certainty that would, for example, stand up to legal scrutiny in a compensation case. For this reason the Cheshire Brine Compensation Board was set up in 1891 (after much strenuous opposition from the salt proprietors) in order to exact a levy from brine pumpers which would form the revenue for claims relating to compensatory damages in the saltfield.

The types of disruption caused by salt abstraction and salt-using industries in the recent past can be summarised as follows.

SUBSIDENCE CAUSED BY ROCK-SALT MINING

Limited in occurrence to the area around Northwich the collapse of the rock salt mines was almost always caused by solution of the pillars which were left to support the roof of the mine cavities. The mines worked two beds of salt about 30 m thick, taking out about 10–12 m of rock-salt from each horizon. The supporting pillars were between 4–7m square, and under normal conditions of working quite adequate. However water was allowed to enter the mines due to bad management, and most were destroyed before 1880. The handful of surviving mines collapsed between 1880–1928, largely due to the fact that many of the workings were interconnected and it proved impossible to maintain barriers between them in a locality which was also an area of massive abstraction of brine. The collapse of the rock-salt mines would not in itself have presented problems of a general environmental kind; it was the subsequent exploitation of the floodwaters which led to major disruption.

SUBSIDENCE CAUSED BY BRINE PUMPING

This was, and indeed remains, the most contentious problem. Whereas it is a simple matter to relate underground mining to surface damage it is much more difficult to do so when subsurface brine runs of indeterminate origin are involved. This is now clear to us, but during the nineteenth century lack of scientific knowledge about the relationship between sub-surface geology and the pattern of brine abstraction enabled the salt industry to avoid its responsibilities to the community at large (although in this respect it was probably no worse than most other mineral industries).

Over the greater part of the saltfield the brine pumpers secured supplies by tapping natural brine from the wet rock head at depths of between 65–130 m. The brine runs thereby created did not follow predictable courses, and their effect in terms of surface subsidence was controlled by a number of variables: depth of run, strength or weakness or overlying strata, distance from the surface, and relationship to the surface topography were the most important factors. If the subsidence occurred along the line of a watercourse permanent lakes were formed (termed 'flashes' in Cheshire), and some particularly impressive ones developed in the Weaver valley south of Winsford during the closing years of the nineteenth century. During the period since 1930 similar lakes have also formed in the Sandbach area. Elsewhere subsidence of this type might result in nothing worse than the deterioration of meadowland as troughs and small sinkholes formed, but in urbanised areas very serious damage could, and did result from brine pumping subsidence. In Northwich hardly any of the buildings erected before the end of the nineteenth century survived damage from subsidence, and special forms of construction were devised to overcome this problem.

But the most impressive damage was confined to an area of about 200 hectares immediately to the north of Northwich. Here, from about 1873–1907 substantial damage was caused by pumping brine from flooded rock-salt mines, ultimately replacing the natural topography and the various buildings located in the district with a series of man-made lakes. Although the scale of disruption

would not be considered great by the standards of 'advanced' strip mining technology, at the time of the major occurrences in the 1880s contemporary observers began to exhaust their vocabulary of superlatives. The locality thus afflicted remains a wilderness and a major planning problem to this day, even though it had undergone a further transformation since the 1920s.

DAMAGE CAUSED BY DUMPING MINERAL/CHEMICAL WASTE

As in most of the world's saltfields the major form of industrialisation occurring during the nineteenth century and after was the development of heavy chemicals manufacture. In 1873 the ammonia-soda (Fresnel process) was introduced to the United Kingdom at Winnington, near Northwich. Between 1873–1913 several other locations on the saltfield were chosen by alkali manufacturers, using the Fresnel process or variants of it, and to a lesser extent using electrolytic techniques. In addition the saltfield had been a major supplier of white salt to the Le Blanc alkali industry in the mid Mersey region, and from the 1890s onwards the saltfield was linked to this area by pipeline in order to supply the growing demand for brine needed by the electrolytic process. The growth of demand from chemical manufacturers was parallelled by the decline of the conventional salt trade, but the net effect was a steady increase in brine production and, by implication, in brine pumping subsidence. In addition the alkali manufacturers needed to dispose of solid wastes, thereby adding to the range of land-use problems that could be related directly or indirectly to the presence of salt. Initially much of the waste from Winnington works was dumped into the adjacent subsidence flashes (a fortuitous circumstance which did not feature in the original choice of location). Elsewhere waste had to be dumped at the surface, and ultimately the same practice was adopted at Winnington. Not only was this unsightly, Cheshire is also an area of very high quality grass and arable farming, so that much good farm land was put at risk.

ABANDONMENT OF PLANT

The final form of damage caused by the salt industry has been produced as a result of contraction and rationalisation of plant (excluding destruction caused directly by subsidence which, outside the mining area at Northwich, was relatively unimportant). For a variety of reasons the white salt industry, based on the open pan process, began to decline from the 1880s onwards. The formation of the Salt Union ultimately had two contrasting effects. Firstly, its manufacturing interests were gradually concentrated in Winsford, and its plants elsewhere on the saltfield closed. This mainly took place between about 1900–1930, and very few of the abandoned sites had been reclaimed by 1970. Secondly, rival firms set up new plants in localities which were not controlled by the Salt Union, which in effect meant Middlewich and Sandbach. This shift in locational emphasis had important repercussions on the spread of subsidence. The concentration of the industry under Salt Union control at Winsford did not save it from near extinction in that town. During the late 1930s, and more significantly between about 1948–54 almost all of the remaining open pan works were closed, leaving a single vacuum evaporator plant, and Great Britain's only rock-salt mine as the sole survivors of a once extensive industrial complex based on salt.

The chemical industry was also subjected to change brought about by contraction, some of it in the early days when pioneer plants failed to survive, but much of it after the formation of Imperial Chemical Industries (ICI) in 1926. By the 1960s ammonia-soda production in Great Britain was confined to three plants in the Northwich area. Electrolytic alkali manufacture, never strong on the saltfield, was confined to two relatively small plants established after 1940.

If we now turn to environmental planning problems there are three main areas of concern which have emerged during the years since 1945 in relation to the past and present exploitation of the saltfield. These are:

(1) the impact of subsidence caused by pumping natural brine.
(2) the problem of chemical waste disposal.
(3) industrial dereliction stemming from these two elements in the past, together with the abandonment of plant.

To these might be added disquiet over atmospheric pollution from saltworks and chemical plants, but this is part of a more general environmental problem which is not confined to these industries alone.

Subsidence continues to be a major planning problem, although the progressive adoption of the ICI controlled method of abstraction since the 1920s has diminished its impact, particularly in the Northwich area. In 1969 89% of the brine extracted in Cheshire was obtained by the ICI controlled method, amounting to 4,100 million gallons of brine. The remaining 11% came from natural brine runs, mainly in the Middlewich-Sandbach area. No brine at all is pumped at Winsford, as production ceased in 1962, being replaced by brine sent by pipeline from the controlled field outside Northwich. Controlled pumping is assumed not to cause subsidence because the solution chambers are below the wet rock head. Consequently the major problem area is now in the southeastern part of the saltfield between Middlewich and Sandbach. Here output of natural brine has steadily increased since the 1950s, and with it the extent of permanently flooded land and other forms of subsidence damage.

In 1947 the British Town and Country Planning Act

began to initiate controls over all forms of mineral extraction where they appeared to pose actual or potential environmental problems. This is not the place to investigate the success or otherwise of such legislation in general, but the point should be stressed that minerals planning has rarely, if ever, seriously interfered with the mineral operator's rights to work deposits. What has been normally attempted is the imposition of controls designed to protect the environment during, and more particularly after working. In the case of salt extraction in Cheshire four possibilities were canvassed:

(1) the establishment of a central brine pumping authority (possibly a state owned corporation) which would use controlled extraction and would sell brine to industrial consumers. This was never considered to be a practical proposition.

(2) control over surface development, locating new building projects in areas safe from subsidence. The difficulty here was determining what areas were safe if natural brine pumping was to continue. This was a reflection of ignorance about the detailed geology of the saltfield and the precise mechanics of brine-pumping subsidence. Although such a policy has been followed where expedient it could never be fully adopted without, for example, preventing all forms of new building within the existing towns of the saltfield.

(3) extension of the provisions of the original compensation Act of 1891 to the entire saltfield. This was done in 1953, and in many ways this enabled development to continue at minimal risk of financial loss in areas that were subsidence prone.

(4) limitation of planning permission to establish new brine wells solely to those using controlled pumping. In this instance a compromise policy was adopted. If brine were to be pumped in an entirely new sector of the saltfield then only controlled pumping from below the wet rockhead would be allowed. However, planning permissions to pump natural brine would still be granted in areas where this practice already took place.

In effect policies one, three, and four worked concurrently between 1953–1968, but since 1969 a major shift in planning policy has been made. This will be considered in the final section of the paper which deals with the present-day relationship between salt and environmental planning.

ENVIRONMENTAL PLANNING AND SALT INDUSTRIES

In many respects the problem of subsidence was overshadowed in the 1940s by that of chemical waste disposal. The post-war expansion of the ammonia-soda industry brought with it an inevitable increase in solid wastes. Although much of this was still tipped on land made derelict by the ravages of subsidence an increasing proportion had to be deposited on sound agricultural land, much of it in areas that were free from all subsidence risks. By 1957 about 250 hectares of land in the Northwich area were covered by chemical waste, and only half of this land had been damaged by subsidence. In the early 1950s various alternative modes of disposal were investigated, and at first the most promising solution appeared to be pumping the waste (which leaves the chemical plant as a liquid slurry) out into the Irish Sea, or shipping it out in hopper barges. This would have been technically feasible (the distance involved being about 60 km), but whether it would have been entirely acceptable on environmental grounds is difficult to know. However, the issue was never put to the test, because an alternative mode of waste disposal was developed, whereby the slurry could be pumped into the abandoned cavities of the controlled brine wells, without contaminating the rock-salt which had been left behind as supporting pillars. This method was introduced in about 1954, and surface waste disposal became less common, although it may occasionally take place when technical difficulties prevent the normal underground disposal. Thus since the mid 1950s one of the major environmental problems has been solved in a singularly effective way.

This solution has not, however, done anything to remove the scars left by earlier forms of waste dumping and industrial abandonment generally. Very little had been achieved by 1970 in reclaiming derelict sites on the saltfield, but this, it should be stressed, simply put the area in the same bracket as the majority of Great Britain's mineral working districts, for very few had embarked on the state-financed program of reclamation before 1967–1968 at the earliest. All that had been done on the saltfield was confined to cosmetic schemes, including the planting of trees to screen wasteland and attempts to brighten up the immediate surroundings of factory entrances in order to improve the corporate image of the major chemical companies. The ramparts of the waste dumps, made from grey furnace ash and imported ironworks slag, were seeded and became grass-green.

We now come to the relationship between salt and environmental planning on the Cheshire saltfield in the 1970s. It is necessary to make some brief preliminary points about current trends in British planning generally, in order to explain the significance of certain recent developments. There has been growing concern about the problems of industrial dereliction, and it is the intention of the state to clear away as much as possible of the existing derelict land by the end of the 1970s. To this end substantial financial aid is available. Over much of the saltfield it amounts to 75% of the net cost of reclaiming land; in Winsford it amounts to 85% because this town is administratively linked to the Merseyside Development Area. The planning authority has produced detailed proposals to

deal with the existing dereliction on the saltfield (which amounts to about 200 hectares), and is considering what action to take about the extensive chemical waste dumps which are technically still in use, but to all intents and purposes remain derelict. Finally it should be noted that this concern over apparently small parcels of land (the total amount of dereliction on the saltfield is probably no more than 500 hectares) has to be viewed against a growing concern about land-use conflicts and land shortage in Great Britain. The Cheshire saltfield is not located in a barren desert, and all the indications are that it will continue to expand as part of the great urban-industrial complex centered on the Liverpool-Manchester axis. In such circumstances environmental planning is not a conservationist fad, it is an economic and social necessity.

Two facets of planning policy impinge on the saltfield; the most direct relates to control over brine pumping. In 1968 the planning authority refused permission for an extension to natural brine pumping in the Sandbach area, and initiated a policy whereby it was the stated intention to phase out all pumping which did not use one or other of the solution cavity methods. (Although the planning authority would prefer to see the ICI method adopted, which on the basis of 45 years empirical evidence is best suited to the region, it is in no position to enforce this should other firms decide to adopt other, less sophisticated methods.) Had such a policy been suggested in the early 1950s it would have stood little chance of success, but there are now at least four reasons why it should succeed. Firstly the major share of brine pumping is in the hands of three corporations which have the finance and technical know-how necessary for controlled pumping. ICI is the obvious leader, but British Petroleum, and the recently formed British Salt group are equally well supported enterprises whose expansion plans would be best served by controlled pumping. Secondly the investigations of the Geological Survey in the 1960s have revealed that the saltfield is both more extensive and workable to greater depths than was supposed, with estimated reserves of 400 thousand million long tons of salt. Much of the newly discovered salt is particularly well suited to controlled extraction by one or other of the solution mining techniques. Thirdly the saltfield has become increasingly important as an area designated to receive population from the Liverpool and Manchester areas. Winsford is already a major reception center for 'overspill' population from Merseyside, and its recent industrial development has made its former dependence on the decaying salt industry a memory. The electrification of the railway system and the construction of motorways have combined to increase the region's attraction for settlement, and it simply cannot afford to have its plans thwarted, as they were thwarted in the 1940s and 1950s, by the threat of subsidence. (Admittedly there were times when the subsidence bogey was used as a means of frightening unwanted city development away for motives that were not altruistic, but the subsidence risk was a real and substantial deterrent.) Finally the climate of public opinion is now far less likely to accept continued damage and disruption when it can be prevented by technical means at the disposal of the salt industry.

During the 1970s, therefore, the salt industry in Cheshire will be obliged to phase out natural brine pumping, and to substitute some form of cavity solution mining. In 1972 British Salt announced its intention to comply with this policy, and it seems likely that by the mid 1970s very little natural brine will be abstracted. On the existing controlled brinefield technical developments have made it possible to replace the tall derricks at the brine wells (which commonly taxed the imagination of the innocent passer-by, whose stereotype for such landscapes was latter-day Long Beach) with unobtrusive pump houses. As most of the future developments of controlled pumping are likely to be located in areas of very rich farmland it is important that as little space as possible should be taken up by surface installations.

The second aspect of planning policy is that relating to the reclamation of existing derelict land. Already the scheme of town expansion at Winsford has made possible the removal of derelict salt workings to the north of the town, but elsewhere much remains to be done. In the Sandbach and Middlewich areas there are large tracts of flooded land, abandoned waste dumps, and the ruins of salt and chemical works. In the Northwich district the chemical waste dumps provide a particularly severe reclamation problem, particularly as part of the land which they occupy is already unstable due to subsidence. The development of this area of dereliction is depicted in Figure 1, which illustrates the impact of various forms of salt working during a period of eighty years or so. During the 1870s three forms of damage were evident, the numerous 'rock-pit holes' formed by the collapse of shallow mines, the more extensive lakes resulting from pumping natural brine, and the large hollows formed by pumping the floodwaters from abandoned mines. By the 1890s the areas damaged by natural brine pumping and by the abstraction of floodwater had greatly increased. In addition several salt works had been abandoned and the first dumps of chemical waste had appeared on the scene. During the first half of the twentieth century the salt industry virtually disappeared from the locality for a variety of economic reasons in addition to the massive disruption caused by subsidence. The practice of dumping chemical waste on the subsidence-damaged land also grew, so that much of the initial dereliction was compounded by waste tipping. By the 1970s the landscape was dominated by waste dumps, with little immediate prospect of reclamation. As in many other parts of Great Britain where derelict land is unlikely to be put to use for agriculture or building the intention is to reclaim much of the waste and

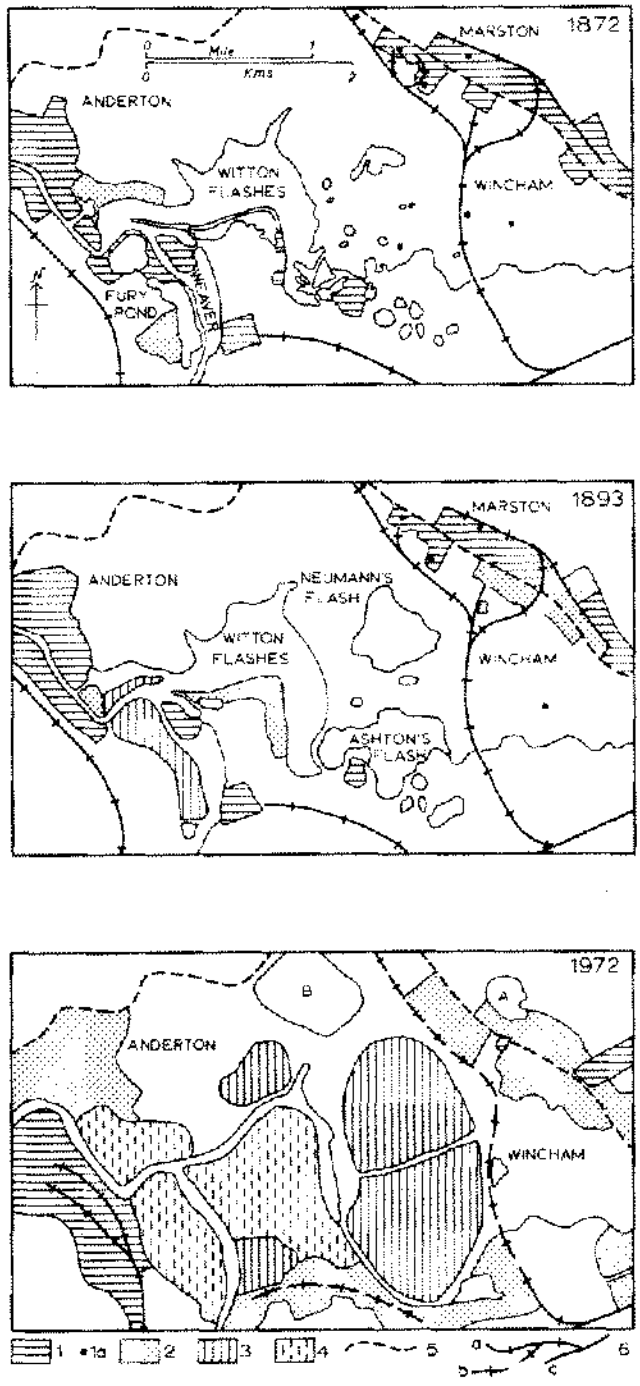

Figure 1. The development of derelict land at Marston-Wincham (Northwich) 1872-1972. (1) Salt works (and in 1972 only, chemical works); (1a) rock-salt mine; (2) derelict industrial land; (3) chemical waste; (4) vegetated chemical waste; (5) canal; (6a) mineral railway; (6b) abandoned mineral railway.

the industrial ruins to form an extension to a proposed recreational area.

The landscape of the area to the north of Northwich is also shown in the aerial photograph (Fig. 2). At the bottom of the photograph the two extensive lakes, formed after the collapse of flooded rock-salt mines are used as receptacles for chemical waste, having been embanked and sealed off for this purpose in 1950–51. The smaller lake (bottom left) marks the site of a rock-salt mine which was abandoned in 1928. At several points along the line of the Trent and Mersey canal (which runs diagonally across the photograph) the derelict sites of abandoned salt works are also to be seen.

The Cheshire saltfield is far from being one of the major environmental problem areas of Great Britain, and by American standards the largest British examples pale to insignificance when, for example, compared with strip-mining locations in Appalachia or the Lake Superior iron-core fields. Nevertheless the saltfield provides in microcosm examples of many of the problems which have been left by past periods of mineral working, and, more important, the area clearly shows the benefits which can accrue from the adoption of advanced techniques of solution mining, not only as a means of securing a steady supply of good quality brine, but also as a method of reducing the risk of subsidence to the minimum and of providing receptacles for chemical waste.

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Figure 2. Salt working dereliction at Marston-Wincham (Northwich) in 1967. For an explanation see text. (Ordnance Survey Photograph: British Crown Copyright Reserved).