GeoEssex
Promoting the geology and landscape of Essex

Chelmsford City Council
Report on Local Geological Sites

Prepared for Chelmsford City Council by

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Contents

Cover photographs:
***Above**: Cliff of glacial till at the old quarry edge in the southern part of the Phase 6 development area at Channels, Little Waltham. **Below**: Boulder of Hertfordshire puddingstone at the entrance to Channels.*

1. Introduction

The rocks beneath the Essex landscape are a record of the county's prehistory. They provide evidence for ancient volcanoes, deserts, glaciers and deep seas. Some rocks also contain remarkable fossils, from subtropical sharks and crocodiles to Ice Age hippos and mammoths. The geology of Essex is a story that stretches back over 100 million years.

GeoEssex

GeoEssex is the primary source of information about the geology and physical landscape of Essex. The GeoEssex team, or 'Steering Group', consists of professional and amateur geologists, representatives from local authorities, geological and natural history societies, and from Natural England, the Government's nature conservation body.

GeoEssex promotes geology in all its aspects, from quarries, cliffs and boulders to spas, springs and building stones. The fascinating and often magical world of geology is all around us, if only we know where to look.

A primary task of GeoEssex is to identify the best places in Essex to find out about the Earth's distant past and the landscape processes going on today. These sites are called Local Geological Sites, or LoGS (formerly called Regionally Important Geological Sites or RIGS).

GeoEssex aims to advocate and represent geodiversity in planning processes and other initiatives.

Spectacular chalk cliff at Chafford Gorges Nature Park, Thurrock. The cliff represents a section through an ancient sea floor that existed across England about 80 million years ago. The Chalk is present beneath the whole of Essex, appearing at the surface only in the north and south of the county

Geodiversity

What is geodiversity and why is it important?

Geodiversity is an integral part of the natural environment. It is the variety of rocks, fossils, minerals, landforms and soil, and all the natural processes that shape the landscape.

The only record of the history of our planet lies in the rocks beneath our feet. Here, and only here, can we trace the cycles of change that have shaped the Earth in the past, and that will continue to do so in the future. This is particularly true in Essex, where the record of climate change during the Ice Age is preserved in our quarries and coastal cliffs. The record is unique and much of it is surprisingly fragile.

Apart from the obvious benefits of providing mineral resources such as sand, gravel, chalk and clay, the diversity of the geology is what shapes the landscape, influencing soils, and in turn influencing all of our habitats and species. Geodiversity also has a cultural role to play, influencing the character of our built environment through building stones, providing inspiration to art, and helping to define where we live and our 'sense of place'. It is the link between geology, landscape, nature and people.

Local and national Geodiversity Action Plans

The UK Geodiversity Action Plan (UKGAP) sets out a shared framework for geodiversity action across the UK. It establishes a common aim, themes and targets which link national, regional and local activities. It encompasses how geodiversity can inspire people and what needs to happen to conserve Britain's geodiversity. The Plan for Essex has been drawn up within this framework.

A Local Geodiversity Action Plan (LGAP) has been produced for Essex. It sets out a framework for geodiversity action in Essex. It is an essential document to conserve the County's geodiversity.

The Essex Local Geodiversity Action Plan aims to:

- *Identify, conserve and enhance the best sites that represent the geological history of an area in a scientific, educational, recreational and cultural setting.*
- *Promote geological sites and make geoconservation relevant to people.*
- *Provide a local geodiversity audit (an audit of sites and skills).*
- *Influence local planning policy.*

2. The Geology of Essex

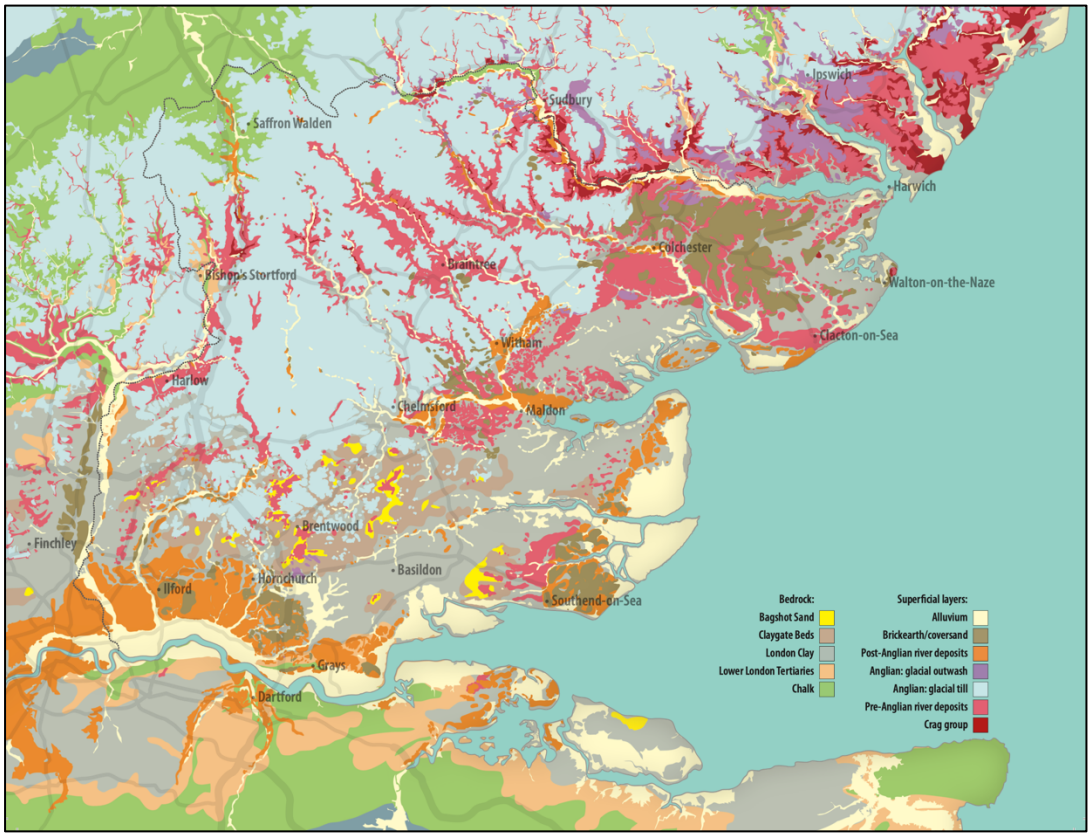
Compared to most other parts of Britain the rocks of Essex and adjoining counties are young in geological terms. Even the oldest surface rock in Essex (the Chalk) is only about 80 million years old. Much older rocks are, however, present at depth. We have some idea about these ancient rocks because of the records of boreholes that have been sunk in search of coal and oil.

The surface rocks of Essex that were formed before the Ice Age (from the Chalk to the Red Crag) are described as the 'bedrock' or 'solid' geology. Much of this bedrock geology is concealed beneath the deposits left behind by glaciers and rivers during the Ice Age. The material laid down during the Ice Age is known as 'Superficial' or 'drift' deposits.

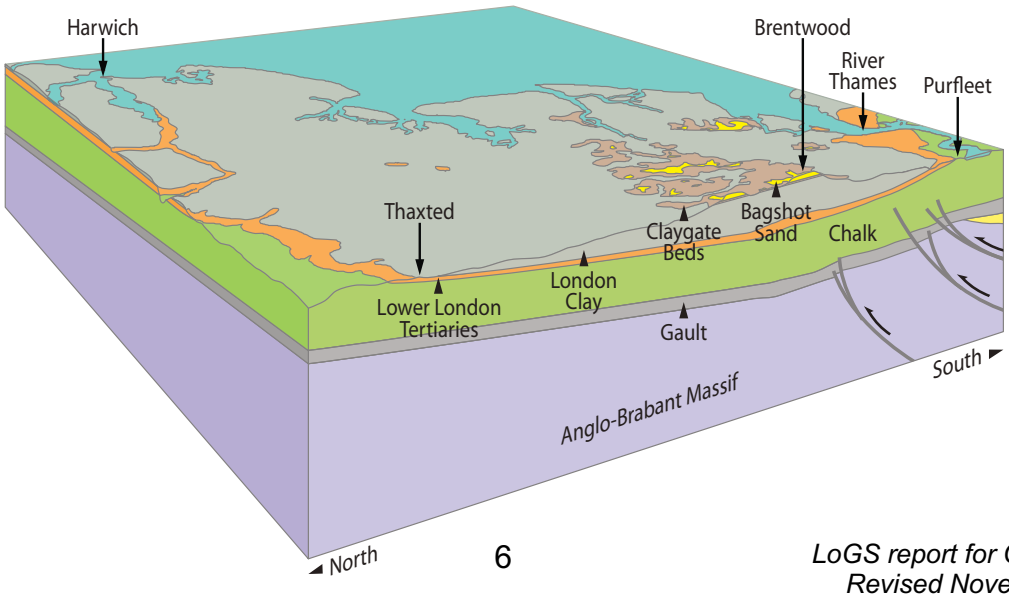
Era	Period or Epoch		Approx. age in millions of years	Geological formations in Essex
Caenozoic	Quaternary Ice Age	Holocene	0.01	Recent peat and alluvium
		Pleistocene	0.45	River terrace deposits and brickearth (loess)
				Boulder clay (till) and glacial gravel
			1	Kesgrave (Thames) sands and gravels
				Norwich Crag (Chillesford Sand)
			2.4	Red Crag
	Pliocene		10	*No evidence of rocks of this age in Essex but derived Miocene and Pliocene fossils are found in the Red Crag*
	Miocene			
	Oligocene		20	
	Eocene		50	Bagshot Sand
				Claygate Beds
				London Clay (includes the Harwich Formation)
	Palaeocene		55	Lambeth Group (Woolwich and Reading Beds)
				Thanet Sand
Mesozoic	Cretaceous		80	Chalk
			100	Gault and Upper Greensand (Beneath Essex)
	Jurassic		150	*No evidence of rocks of these ages beneath Essex with the exception of Jurassic Oxford Clay in a graben (a sunken part of the crust bordered by faults) beneath East Tilbury.*
	Triassic		220	
Palaeozoic	Permian		250	
	Carboniferous		300	
	Devonian		400	Shales and mudstones dating from these periods occur at depth (about 300 meters) beneath Essex
	Silurian		420	
	Ordovician		450	*No evidence beneath Essex, however, boreholes have not been drilled deep enough to confirm.*
	Cambrian		500	
Pre-Cambrian	Precambrian		Age of Earth 4,600	

Geological Map of Essex

Geological map of Essex showing all the rocks exposed at the surface - bedrock and superficial deposits.



Cross section through Essex (bedrock only)



Essex through geological time

It is difficult to know where to begin with our geological story but the earliest evidence we have is the hard rocks deep beneath Essex that were formed some 400 million years ago in the Silurian and Devonian periods (part of the Palaeozoic era) and form what is known as the 'Palaeozoic basement' of Essex.

Deserts to Dinosaurs

- For a very long time (and before the age of the dinosaurs) these hard Silurian and Devonian rocks formed the surface of the land that was eventually to become Essex. During the Permian and Triassic periods Essex was a desert upland in the middle of a vast continent known as Pangea.
- By 200 million years ago, at the start of the Jurassic period, tropical seas had spread around this land forming a dinosaur-infested, forested island.

Buried Island

- If you could dig down 1000 feet (300 metres) under Essex you would reach the hard rocks of that dinosaur island.
- All trace of forests and animals from this time have been swept away from the eroded surface of the island, so there are no dinosaur fossils in Essex.
- By 100 million years ago, in the Cretaceous period, the sea flooded across the island to spread **Gault** Clay and **Greensand**. The sea then deepened to deposit hundreds of metres of soft white limestone known as **Chalk** all over the island as well as much of what is now Britain.

Pebbles and Clay

- The North Atlantic Ocean, which did not previously exist, began to open out to the west, the land of Essex lifted, chalk hills were worn down and flints were eroded out. Billions of these flints were tumbled on beaches to form layers of sand and beautifully-rounded pebbles across our area.
- Around 50 million years ago, in the Eocene period, a deep sea fed by muddy rivers spread across what is now Essex and London depositing a great thickness of clay known as **London Clay** on the sea floor, together with the remains of many plants such as palms and cinnamon, and animals including birds, sharks, turtles, and tiny horses. Atlantic volcanoes poured their ash into this sea.

The Alps and the Thames

- Colliding continents pushed up the Alpine mountain chain, bending the crust to form the vale of the Thames river system through mid Essex. About 2.4 million years ago offshore sandbanks formed red shelly sandstone layers across north Essex known as the **Red Crag**.
- Global cooling led to the present Ice Age, with many warm periods such as the one we are in right now. As the sea retreated, the ancestral River Thames spread a succession of flint-rich river gravels across the middle of Essex, through Harlow, Chelmsford and Colchester, and out across the area where the North Sea is now.

Ice and people cover Essex

- During an exceptionally cold stage 450,000 years ago a gigantic ice sheet covered most of Britain and Essex as far south as Hornchurch. The moving ice diverted the Thames towards its present-day course and dumped its load of boulder clay, or till, on top of these old Thames gravels.
- During the past million years of the Ice Age, there have been numerous cold and warm stages and humans have migrated to and from Essex, together with the animals they have hunted. They have left thousands of flint tools and tool-making debris on the banks of the ever-changing Thames and its tributaries.

3. Background to Geological Site designation in Chelmsford

What is special about Essex Geodiversity?

Essex is an area of predominantly subdued relief with gentle slopes, the result of its underlying geology of soft, relatively young rocks. These generally yield fertile soils. The result is an attractive 'lived in' landscape dominated by arable agriculture, but still retaining forested and heathland areas, particularly where gravels and sands, many of glacial and fluvial origin, have yielded poorer soils.

A mammoth tooth from Essex

Although lacking the more dramatic geology and landforms of many 'hard rock' areas, Essex geology and geomorphology is still of great interest, possessing abundant evidence of the huge environmental and biodiversity changes that our area has witnessed over the last 100 million years. Among the key themes are dramatic and sometimes long-lasting changes in the distribution of land and sea, major shifts in climate, and mass species extinctions. Many of these phenomena are of great relevance today, and so an understanding of our past is essential in interpreting the challenges to come.

Geodiversity's influence on Essex's development

Essex's geodiversity has exerted a major influence on land use, agriculture and landscape:

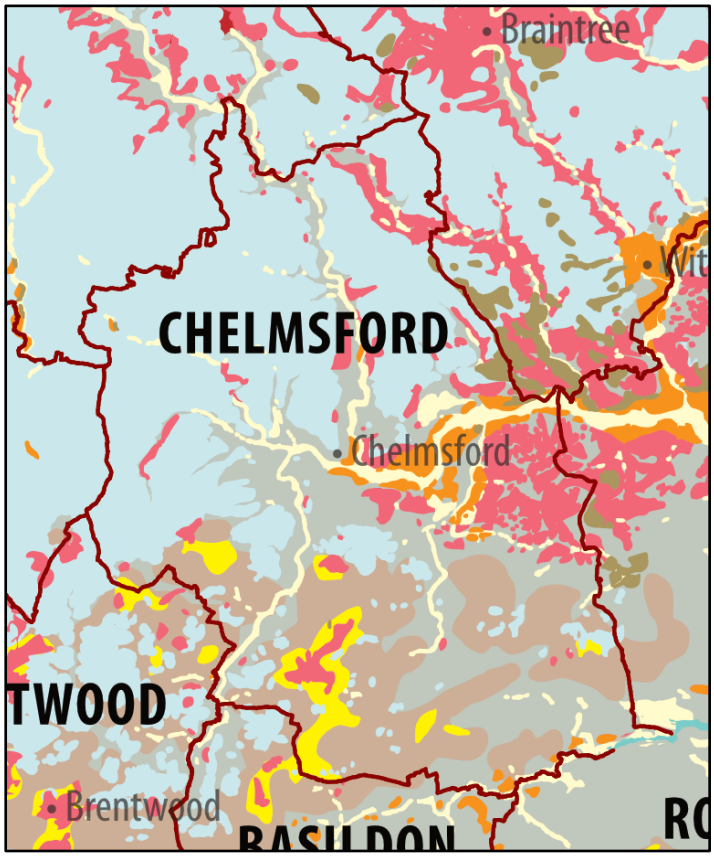
The distribution of less fertile ancient river and glacial gravels has been a major influence on historical land use, resulting in the preservation through to the present day of extensive tracts of woodland and to a lesser extent heathland, in a predominantly arable county, e.g. in the Danbury area. These are of great significance both for biodiversity and recreation.

London Clay outcrops south of Chelmsford, providing fertile soils for arable agriculture, especially wheat. The chalky till found in north and west of Chelmsford eg. the Pleshey Plateau, is also highly suitable for cereal cultivation.

In earlier times rivers penetrating deep inland, together with proximity to the Continent, provided a succession of invaders and colonisers – from Palaeolithic peoples, through to Roman, Viking and Saxon - with easy access.

The deposits of the ancestral Thames and its tributaries have provided Essex with a source of gravel and sand for construction since Roman times. A special kind of gravel naturally cemented by iron called ferricrete was used extensively as a building stone and is found in many medieval churches.

The Geology of the Chelmsford Area



	Recent alluvium	**Quaternary**
	Coversand/Brickearth	Ice Age deposits
	Post-Anglian river deposits	
	Glacial Till	
	Kesgrave sand and gravel	
	Bagshot Sand	**Tertiary** Eocene 54 million years ago
	Claygate Beds	
	London Clay	

The landscape of the area northwest part of the Chelmsford area is dominated by a plateau of chalky Glacial Till ('Boulder Clay'), where it has created especially fertile farmland. This extensive plateau occupying NW Essex is deeply dissected by rivers and streams flowing mainly SE. The rivers, the Chelmer, Wid, Can and Ter, cut down into underlying Kesgrave sand and gravel beds and, in places, through these into the London Clay and older rocks beneath. Patches of Coversand, a wind-blown storm deposit of fine silt and sand around the margins of the ice cap around 20,000 years ago, occur near Boreham, along the eastern border of the district. The riverbeds and adjacent flood plains are made of alluvium – soil, clay silt and sand being transported towards the present-day North Sea.

The Glacial Till was brought from the north by an ice sheet that covered most of Essex during the Anglian period 450,000 years ago. It contains ground up chalk and chalk pebbles, which give the soil a buff colour and provide its fertility. Hence the plateau has long provided richer farmlands than in the southeast of the area where the London Clay is at the surface, whilst its flat expanses permitted many wartime airfields to be constructed. In the south of the area, the London Clay grades upwards into the sandy clay of the Claygate Beds and the hills around Stock are capped by Bagshot Sand – a fine yellow deposit, which has been preserved by the protection of the overlying Kesgrave sand and gravel which was deposited much later in the early stages of the Ice Age. These sands and gravels have been and are still being worked for aggregate as at Bull's Lodge Quarry, near Boreham.

Sarsen stones

Sarsens are boulders of extremely hard sandstone that were formed at a time of great warmth, about 55 million years ago, when sandy strata on top of the Chalk were above sea level in desert conditions and were cemented by silica (quartz) from ground waters. This discontinuous layer was extremely resistant to erosion and boulders were transported by ice swollen rivers. They were removed from fields and often set up in conspicuous places.

Puddingstones

Puddingstone has a similar origin to Sarsen and was formed at the same tome in areas where there had been a pebbly beach. The boulders have been surrounded by much folklore and hence have been placed in prominent places as well.

Geodiversity and National Planning Policy

The importance of geodiversity as an integral part of nature conservation and the planning system is reflected in The National Planning Policy Framework (NPPF), and in legislation – Wildlife & Countryside Act 1981 and Countryside and Rights of Way Act 2000.

The NPPF states that:

(1) “the planning system should contribute to and enhance the natural and local environment by protecting and enhancing valued landscapes, geological conservation interests and soils” (Paragraph 109);

(2) “local planning authorities should set criteria based policies against which proposals for any development on or affecting protected wildlife or geodiversity sites or landscape areas will be judged” (Paragraph 113); and

(3) “to minimise impacts on biodiversity and geodiversity, planning policies should aim to prevent harm to geological conservation interests” (Paragraph 117).

Site designations

The most important geodiversity sites have been declared as **Sites of Special Scientific Interest** (SSSIs) which are statutorily protected for their scientific importance (see below for a list of Chelmsford geological SSSIs).

The next tier of geodiversity sites are known as **Local Geological Sites** (LoGS) These have replaced the earlier ‘Regionally Important Geological Sites’ (RIGS) terminology in line with government guidance.

Local Geological Sites (LoGS) are broadly equivalent to Local Wildlife (species and habitats) Sites (‘LoWS’) but have a broader remit as they can be designated for their scientific, educational, historical and recreational benefits. Typical Essex LoGS include quarries, pits, walls, boulders, cliffs, springs, and river meanders. Local Wildlife Sites and Local Geological Sites are both designed to provide a system of locally-valued, non-statutory sites.

Most importantly, the NPPF gives Local Geological Sites a weighting equal to Local Wildlife Sites, and both are collectively referred to as ‘Local Sites’. However, in actuality the attention and priority afforded to the designation and management of LoGS has historically lagged, and continues to lag well behind that of LoWS.

4. Objectives of current report

Supporting Local Planning Authorities

"*Local and neighbourhood plans and planning decisions have the potential to affect biodiversity or geodiversity outside as well as inside designated areas of importance for biodiversity or geodiversity"* (extract from: www.gov.uk/guidance/natural-environment)

Biodiversity protection is familiar to planning authorities but geodiversity less so. This report will assist planning authorities in meeting their obligations under the National Policy Planning Framework and helping them identify potential development impacts on LoGS.

GeoEssex is therefore seeking to help Local Planning Authorities fulfil their responsibilities with respect to geodiversity.

Further guidance on statutory obligations is given in Circular 06/2005 (*Biodiversity and Geological Conservation*). Geodiversity should be therefore included alongside biodiversity in local authorities' Local Plans. Identifying these non-statutory sites therefore helps local authorities to meet their obligations.

LoGS can also contribute to *sustainability* programmes by providing information about a key element of the environment that contributes to our natural heritage. In addition, the *awareness raising* and *education* function fits well with the principle of community involvement and enabling people to regain their sense of place.

A typical Local Geological Site – an inland cliff in a former quarry consisting of sand and gravel laid down by meltwater from a glacier about 450,000 years ago. The variety of pebble types in the gravel can tell us the route the ice has taken to get to Essex, sometimes from as far away as Norway. Sites like these are valuable for research and education but can easily be obscured or destroyed.

5. Site selection

Site selection and notification to planning authorities

LoGS in Essex are identified by **GeoEssex**, a largely voluntary group composed of representatives from the major Essex geological and conservation bodies and supported by Essex Wildlife Trust, Natural England and Essex County Council (Place Services). The site selection process is based on clearly defined criteria (see below) and includes scientific, educational, historical and aesthetic values. When selecting sites GeoEssex aims to gain the support of landowners whenever possible. The majority of LoGS are on private land and site selection does not infer any right of access.

Like LoWS, proposed LoGS are presented to the Local Sites Partnership (chaired by Essex Wildlife Trust) for endorsement and then passed to local authorities for inclusion in their Local Plans. Local authorities receive a citation and boundary map.

The sites selected as LoGS in the Chelmsford district are summarised below, together with a list of other sites which are potential LoGS. Other sites may be identified in the future, occasioned by housing or other development and restoration following mineral extraction.

Site protection

Like their biodiversity counterparts, LoGS have no statutory protection and the conservation and management of individual sites relies heavily on the support of landowners. Inclusion within local plans also forms a vital role in the protection of LoGS. An example of a comprehensive natural environment policy incorporating geodiversity can be provided on request.

It is recommended that the Local Sites Partnership (c/o Essex Wildlife Trust) should be consulted if any development is proposed that would affect a LoGS.

A spring line runs around Danbury Hill where water seeps out of the permeable Danbury Gravel on meeting the impermeable London Clay below. The largest spring here is Buell Spring, which was an important source of water for the area and originally fed a pumping station. The crystal-clear water of the spring now emerges from a cast iron pipe.

While not appearing to be significant, sites like these are of historical and educational importance but can easily be obscured or destroyed.

Site Assessment Criteria

The assessment criteria used for identifying LoGS are based on DEFRA document *Local Sites: Guidance on their identification, selection and site management* (2006). The guidance states that assessment is a matter of judgement but must be based on an understanding of geological principles and processes, and the distribution and abundance of the resource (national, regional and local). Those sites selected must be 'of substantive importance to the geodiversity of the local area'.

There are four value categories: scientific, educational, historical and aesthetic. A site qualifies for notification as a Local Geological Site if it fulfils the criteria under one or more of these categories. Each site is also given a site assessment score. This score is not a measure of the site's value or importance but a relative assessment of the usefulness of the site in promoting geodiversity.

Land Ownership Notification

Where the landowner is identified as a public body eg. a local authority, Forestry Commission etc., notification is by letter to that authority. For sites under private ownership, where the landowner can be identified, they will be informed by letter.

Nineteenth century engraving of Rolston's Pit, Writtle – an example of a geological site that has been lost. This little disused quarry showed a spectacular section of glacial boulder clay overlying Thames gravels and was visited by several parties of geologists and academics at the time. The site is now an arable field. Illustration taken from The Geology of England and Wales by H.B. Woodward (1875).

6. Additional Sources of Information

Scientific literature
If a LoGS has been referred to in the scientific literature these references are of given in the LoGS citation. The fact that a site has been referred to in the scientific literature means that the site is of historical interest and some of these sites will have potential for future research.

Interpretation
If a site is accessible or simply visible to the general public, it is the aim of GeoEssex to provide interpretive information where possible and practical. This could be in the form of interpretive boards or leaflets. Such interpretation will be with the cooperation of landowners and other interested parties.

GeoEssex www.geoessex.org.uk
Background geological information for Essex, together with a selection of sites in each district (SSSIs and public accessible sites) can be found on the GeoEssex website

Essex Field Club www.essexfieldclub.org.uk
The Essex Field Club, founded in 1880, exists to promote the study of the county's natural history, and includes geology amongst its many activities. The club has a centre for Biodiversity and Geodiversity in Wat Tyler Country Park at Pitsea, near Basildon. It is open to the public most weekends. Their website provides comprehensive data on a large number of wildlife and geological sites which can be searched in a number of ways. Details of several hundred geological sites across Essex can be found here which includes LoGS and potential LoGS.

British Geological Survey www.bgs.ac.uk
Other geological resources, maps and borehole information are available on the website of the British Geological Survey.

Essex Rock & Mineral Society www.erms.org.
The Essex Rock and Mineral Society, founded in 1967, is the club for Essex amateur geological enthusiasts.

GeoEast
GeoEast is the East of England Geodiversity Partnership. It is a partnership of organisations active in conserving and promoting Earth heritage in the six counties of the region (including Essex).

Earth Heritage Magazine www.earthheritage.org.uk
Earth Heritage magazine is produced twice a year for the geological and landscape community by Natural England, Scottish Natural Heritage, the Countryside Council for Wales and The Wildlife Trusts.

Geologists' Association www.geologistsassociation.org.uk
The Geologists' Association, founded in 1858, is Britain's largest society for amateur geologists.

Books

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A selection of scientific papers relating to the Chelmsford district

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7. List of Sites

The following is a representative list of geological sites in the district. For completeness it includes geological SSSIs but these sites are statutory sites and do not form part of this report.

Note: *Not all of the sites here described are accessible. Some sites are on private land and can only be viewed from footpaths that pass through or alongside the site. Inclusion of a site on this list does not, therefore, imply any right of access.*

Sites of Special Scientific Interest (SSSIs)

(included in this report for completeness)

River Ter SSSI, Great Leighs (TL 744 155 to TL 733 157)
The stretch of the River Ter in the vicinity of Lyons Hall has been notified as a geological SSSI because it is representative of a lowland stream with a distinctive flood regime. It illustrates well the relationship between river discharge and channel dimensions and has been used to test theories about why rivers adopt a meandering course. There are public footpaths alongside the river (including the Essex Way).

Newney Green Pit SSSI (TL 648 065)
Kesgrave (Thames) Sands and Gravels are present at this site with a palaeosol (fossil soil horizon) of pre-Anglian age. This is overlain by boulder clay (till) which was deposited by the Anglian Ice Sheet. Occasional patches of glacial gravel are also found, and an (Anglian) arctic structure soil is superimposed on the pre-Anglian palaeosol marking a change from warm interglacial to intensely cold glacial conditions. This site is of prime importance for the correlation between Pleistocene sites in the Thames and East Anglian areas. A vital locality in working out the sequence of events in the evolution of the Thames. The pit has now been infilled except for the small area of the SSSI. The site is on private land.

Local Geological Sites (LoGS) - *Sites agreed by Local Sites Partnership to date.*

ChG1 - GREAT BADDOW. Beehive Lane Sarsen Stone (TL 71948 05544)
A sarsen stone 90cm x 70cm x 60cm sits in the car park of the Beehive Public House in Beehive Lane. It was obtained from the old 'Beehive' gravel quarry before 1906.

ChG2 - Buell Spring, Danbury (TL 7839 0451)
Spring issuing clear water from a cast iron pipe. Remains of pumping station. Spring originates from the spring line that runs right around Danbury Hill (from between the Danbury Gravel and the London Clay). Historically important as the water supply for the area. Of particular interest is the accumulation of 'bog-iron' nearby - a cementing of the soil by the iron compounds leached out of the gravel. Land owned by the National Trust.

ChG3 - Channels Puddingstone Boulder, Little Waltham (TL 72382 11185)
By the entrance to Channels is a large boulder of puddingstone on a mound of grass by the roadside. It is one of the largest puddingstone boulders in Essex, measuring 2.1 metres long by 1.2 metres high by 0.4 metres in thickness. This boulder was found in one of the local gravel pits, all of which have now been restored.

ChG4 - Danbury Common Gravel Pits (TL 784 047 and TL 781 045)
Deep and extensive disused and overgrown gravel pits on east and west sides of Danbury Common (two separate patches of gravel) which provide visible sections through the Danbury Gravels - gravel that accumulated on the ice margin, where its southward progress was prevented by the London Clay high ground. Owned by the National Trust. Eastern pits heavily used by mountain bikers. The higher parts of the western pits are very sandy and used by badgers.

ChPG5 - Fultons Farmhouse Boulder, Bicknacre (TL 788 006)
On private land, next to the garage of Fultons Farmhouse, is a splendid boulder of basalt 90 centimetres (3 feet) long. Large erratic boulders of basalt are very rare in Essex.

ChG6 - Parsons Spring Pits, Highwood (TL 623 028)
Parsons Spring (also known as Parsons Wood) has numerous shallow but steep-sided pits where sand and gravel was once exploited. This sand and gravel is referred to on geological maps as 'Stanmore Gravel' (formerly called 'pebble gravel'). How it was formed has been debated by geologists since the 19th century. Its origin is still unclear today although one theory is that it was laid down by a river, probably over one million years ago, during the early part of the Ice Age. The pits are clearly visible as overgrown hollows either side of the public footpath that runs through the wood.

ChPG7 - Running Well, Runwell (TQ75119657)
The Running Well is an ancient spring that gave its name to the village of Runwell. Situated 300 metres south-east of Poplars Farm between Runwell and Rettendon**.** The well still exists and the water is said today to be of good quality. First recorded in Morant's History and Antiquities of Essex in 1768. The water flows from the junction between the Bagshot Sand and the Claygate Beds.

ChPG8 - Russell Green Gravel Pit, Boreham (TL746125),
Former gravel quarry providing exposures of Kesgrave Sands and Gravels (laid down by a former route of the Thames) dating from the early Ice Age. There is currently a fine vertical cliff of gravel on the west side of the lake, visible from the road. The site is privately owned with no public access.

ChG9 - Sandon Gravel Pit (TL 747 043)
The disused Sandon gravel pit has good exposures in Kesgrave Sands and Gravels. Much of the pit has not been restored and therefore the quarry slopes and edges are largely as they were when quarrying ceased. This makes the site important for geology as there are several small exposures of gravel, for example on the southern lake edge. The Kesgrave Sands and Gravels were laid down during the early Ice Age by the River Thames when it flowed through mid-Essex and Suffolk. The gravel is mostly flint but also contains 'exotic' pebbles of rocks from far upstream. Sandon Pit is also a Local Wildlife Site

ChPG10 - Scrubs Wood Nature Reserve, Danbury (TL789058)
This site may have been a former gravel pit as the steep banks have plenty of gravel visible. The Danbury Gravel clearly dates from the Ice Age but its precise origin is still not clear, despite various investigations over the last 150 years. In 2017 the exposed gravel at Scrubs Wood contained abundant vein quartz and bunter quartzite pebbles. A ventifact (a wind-faceted stone) has been reported from here. Scrubs Wood is part of a biological SSSI known as Woodham Walter Common.

ChG11 - River Crouch Foreshore, South Woodham Ferrers (TQ 804 955)
River erosion at several places around the Essex coast has exposed evidence of human occupation dating from the Mesolithic Period. These settlements are now below high tide level and the most important of these is at Hullbridge/South Woodham Ferrers where a prehistoric land surface, possibly as much as 7,000 years old, is exposed on the foreshore of the River Crouch. The sites can only be examined at low tide.

ChG12 - Stock Road Gravel Pits, Stock (TQ 6965 9962)
In woodland just west of the Stock Road, north of the village of Stock, are disused gravel pits. These pits are an important geological site because it was one of the very few places where the 'Bagshot Pebble Bed' was formerly exposed. The pits are now overgrown but with the permission of the landowner it would be relatively easy to re-expose the gravel for study.

ChPG13 – Channels Till Cliff, Little Waltham (TL 7216 1102)
A section through the Anglian till (boulder clay) in the edge of the old quarry has been preserved. It is all that remains of a cliff of till that was the edge of the former Mid Essex Gravel Pit. This cliff forms the only accessible and visible exposure of glacial till in the whole of Essex. An access footpath and a signboard have been created at the site. There is also a large puddingstone at the site.

ChPG14 - CHELMSFORD. Chelmsford Museum Puddingstone (TL 7025 0555)
Boulder of puddingstone 70cm x 60cm x 30cm by the entrance to Chelmsford City Museum in Oaklands Park.

ChPG15 - The Channels Mammoth (TL 7172 1087)
This sculpture depicting a Steppe Mammoth encapsulates the essence of the Ice Age deposits exploited by the former gravel pits around which the Channels housing development is sited.

ChG16 - Bushy Hill, South Woodham Ferrers (TQ 813 986)
Bushy Hill to the north of the town is a prominent and locally important landscape feature. It is composed of London Clay capped by Claygate Beds with notable landslips on the southern and western slopes. There are fine views of the Crouch valley from the summit.

Other sites of geological interest in the district

Broomfield Sarsen Stones (TL 705 104)
Two relatively small but conspicuous sarsen stones by the church gate, the largest 60cm long.

Chelmsford Cathedral (TL 708 069)
Remarkable abundance of 'bunter' quartzite and puddingstone from the Thames gravels in the extension to the chancel, built in 1923, and the vestry block, built three years later, plus fine flint craftsmanship on the porch.

Church of Our Lady Immaculate, Chelmsford (TL 7050 0625)
Built in 1846 the Church of Our Lady Immaculate in New London Road is a fine example of the use of knapped flint. The flint walls have limestone dressings and the building has a roof of Welsh slate.

Former Moulsham Brickpits, Chelmsford (TL 702 060)
Large areas of old Moulsham were formerly brick pits and several of these produced Ice Age fossils in the 19th Century. Particularly notable were the bones of elephant and hippopotamus, some of which are on display in Chelmsford Museum. The conspicuous areas of low-lying ground on the north side of New London Road are former pits. In the latter part of the Ice Age hippos are only recorded as being present in Britain once, during the Ipswichian Interglacial period. These fossils are therefore considered to be Ipswichian in age (about 120,000 years old).

Pleshey Boulders (TL 648 143)
On the traffic island at a road junction west of the village is a fine erratic boulder of Carboniferous Limestone 1.1metre long with fossil corals and a sarsen stone 0.7 metre long.

All Saints Church, Rettendon (TL 770 960)
Typical church of Kentish Ragstone with a fine view. Splendid tomb of Italian marble.

The Church of Our Lady Immaculate in London Road, Chelmsford.
A fine example of architecture using knapped flints. Photo © G. Lucy