

The town is built on Glacial Drift resting on Permian Red Sandstone, in which is a well at Higher Crookey.

Rainfall at Vale House, Garstang, 455 feet above the sea :—

1876.	1877.	1878.	1879.	1880.
44·71	61·50	41·50	38·46	43·38

Average of the past 18 years, 44·83 inches; average rainy days, 199.

Garstang registration sub-district contains 31,087 acres, with a population of 5833.

The *Lancaster Corporation Waterworks* take the upper portions of the feeders of the *WYRE* for their town supply, and the remainder, including *Tarnbrook Wyre* and *Marshaw Wyre*, forms their compensation water area for millowners who have a private reservoir lower down the *WYRE*.

Mr. Jackson, C.E., proposed the upper *Brock* as a source of water-supply for Liverpool; he proposed to make a reservoir at Admarsh, with an embankment 110 feet in height, which he calculated to yield a daily supply of 30,000,000 gallons, derived from 4250 acres drained by the *Brock*, and 6000 in Wyredale, and some feeders of the *Loud*, not appropriated by the *Preston Corporation Waterworks*.

CHAPTER XXXIII.

THE NORTH LANCASHIRE BASINS.

RIVER LUNE (XXXIV).

LENGTH, 42 miles; area, with tributaries, 418 square miles, of which about 104 square miles consist of Silurians, 144 of Carboniferous Limestone, 168 of later Carboniferous rocks, chiefly Yoredales, and 2 of Permian Sandstone.

The watershed trends east from the mouth of the river, over the crest of the Grizedale Fells, forming the northern margin of the *WYRE* and part of the *RIBBLE* Basin. West of Settle the watershed turns abruptly north, running parallel to the *RIBBLE*, over the ridge of Wherside, 2414 feet high, to a point west of Hawes, where it falls into the central Pennine watershed, separating the eastern from the western rivers. This it follows for a distance of only 2 miles, overhanging the head waters of the *URE*, after which it trends a little north of west, and separates the upper basin of the *LUNE* from the head waters of the *EDEN*, that river, the *LUNE*, and the *RIBBLE* rising within a few miles of each other. The northern boundary of the *LUNE* Basin is formed by the great east and west watershed traversing the north of England in nearly a straight line, with the exception of the southern deflection produced by the occurrence of the remarkable valley of Mallerstang, in which rise the *EDEN* and the *URE* within a quarter of a mile of each other. The watershed from Mallerstang, skirting the *EDEN* valley, crosses Ravenstonedale Common to Ashby Windersworth Common, and trends west over Shap Fells; the watershed generally coinciding with the division between townships, it is crossed by the London and North-Western Railway at Hardendale Fell, south of Shap Station,

which district is drained by the head waters of the *Lowther* draining into the *EAMONT*.

On Shap Fells, the margin of the *LUNE* Basin leaves the east and west watershed and trends south-east, separating the waters of the *KENT*, running by Grayrigg Forest, after which it runs south, parallel and close to the *LUNE* by Kirkby Lonsdale.

South of Kirkby Lonsdale it trends to the west of south, the watershed continuing parallel to it, by Hutton Roof and Arkholme Moor, 466 feet above Ordnance Datum, where it separates this Basin from the waters of the River *Keer* flowing into Morecambe Bay, and then crosses the peninsula intervening between the sea at Morecambe and the estuary of the *LUNE*.

The outlet of the *LUNE* between Sunderland Point and Chapel Hill is less than half a mile across. Between Trailholme and Old Glasson it widens to a mile and a quarter, again contracting to two-fifths of a mile between Bazil Point and Glasson, east of which it trends north to Lancaster with an average width of three-quarters of a mile. At Glasson there is a small dock at which terminates a branch of the Preston and Lancaster Canal. East of it, is the infall of the River *Gonder*, rising east of Lancaster, at 450 feet, and flowing south-west by Galgate, Sellerley, and Gonder Green. Following the left bank of the estuary by Ashton Hall Park, a small tributary comes down from the Racecourse, and passes on the east side of Scotforth, Glacial Drift here overlying Lower Carboniferous Sandstones.

Following the left bank of the *LUNE*, the town of Lancaster with its Castle is built on a terrace of Glacial Drift lying at the foot of the Fells of Carboniferous Sandstones and Shales, occupying the whole of the country up to Settle, south of the River *Greet*, and between that stream and the *LUNE* at Kirkby Lonsdale.

LANCASTER.—*Acres*, 1240; population, 20,724; supply from gravitation works collecting moorland springs on Grizedale Fells, about 8 miles distant; rateable value,

63,012*l*. Analysis made by the Rivers Pollution Commission gives 4.18 of total solid impurity; organic carbon, 0.235; nitrogen, 0.050; ammonia, 0.001; chlorine, 0.79; hardness, 2.7, all of which is permanent. Works under Lancaster Water and Gas Act, 1852; Amendment Act, 1855; Lancaster Local Board of Health Act, 1864, and Water and Improvement Act, 1876. Rainfall in 1880, 38.87 inches; average of 20 years, 40.87 inches; the average maximum monthly rainfall was in August and September, being over 4 inches; the minimum average was in April 1.92 inch. The annual average number of wet days in 14 years was 182.

The Lancaster Canal crosses the river at Dolphinlee, about a mile above the town, in the Bulk Road Aqueduct. Higher up the stream, east of Three Mile House, the river has a very sharp bend, and receives *Arth Beck* at Caton. This stream has two strong feeders, *Udale Beck* and *Foxdale Beck*, rising on the Littledale Fells, which form the *WYRE* watershed, rising to 1656 feet at Wards Stone.

The *LUNE*, at the infall of this Beck, trends south-west and north-east, winding through an alluvial plain 50 feet above the sea, rising to 75 feet at Hornby, west of which is the infall of the River *Wenning*, 15 miles in length. At the edge of the plain are the villages of Caton Green and Claughton, and the Midland Railway line. A mile and a half from the outfall of the *Wenning*, it receives the River *Hindburn*, which, with the River *Roe*, flowing in on the left bank at Wray, drains the wild moorland grit-country forming the *RIBBLE* Basin watershed in the Forest of Bolland, rising to 1731 feet at Woolfhole Crag.

River Wenning.

This river, 15 miles in length, rises west of Settle, near the *RIBBLE* watershed, and drains entirely Lower Carboniferous Sandstones and Shales. Following the *Wenning* from its source, it drains the southern slopes of the Carboniferous Limestone hills, forming part of Ingleborough, 2378 feet, the picturesque country above Clapham, with its

caves and subterranean streams, and passes by Low Bentham, Wennington, and Hornby, to the *LUNE*.

Further north, near Wrayton, a little below the 100-foot contour, is the infall of the River *Greet*, about 11 miles in length, rising in the deep valley between Whernside, 2414 feet, and Ingleborough, a feeder draining the north-west side of the mountain falling in at Ingleton.

At Burton-in-Lonsdale, or Black Burton, about 4 miles from the *LUNE*, the stream crosses a small coalfield, cut off to the north-east by the Great Craven fault, bringing up the Lower Carboniferous rocks. It is described by Mr. Tiddeman as partially overlaid by Permian Red Sandstones and breccias, and as resting on Yoredale and Millstone Grits, the whole being somewhat obscured by Glacial Drift, Clay, and Sand.

From the infall of the River *Greet* at Teinstall, numerous small streams drain the steep sides of the Barbon and Casterton Fells, rising to 2000 feet, at the foot of which are the villages of Ireby, Overtown, Casterton, Whelprigg, and Barbon. Where *Barbon* Brook has cut a deep gorge between the Barbon and Middleton Fells to the north, the stream falls into the *LUNE* at about 175 feet, it rises at 975 feet, falling 800 in 6 miles, or 133 feet per mile. It has cut back its gorge to within a mile of the River *Dee*, a tributary falling into the *LUNE* higher up the stream. The gorge is continued to the *Dee* valley, down to the 1000-foot contour. Below this, feeders of the *Dee* flow north, down the side of the *Dee* valley falling in at 400 feet, descending 575 feet in one mile, but cutting no gorge.

North of the *Barbon* Brook infall, numerous feeders flow off Middleton Fell, which is terminated above Middleton by the gorge of the River *Dee*. From Black Burton to Middleton the Ingleton Branch Railway contours the left bank of the *LUNE* at about 325 feet. The watershed between the *Dee* and the *LUNE* forms the county boundary of Westmoreland and Yorkshire, to within a mile of the infall of the *Rawthey*, after which it follows that river to the *LUNE*, and

then ascends the latter to a mile and a half below Low Barrow Bridge, where it trends east, and makes the watershed of Langdale Fell and the Calf.

River Rawthey.

This stream rises on Baugh Fell, 2216 feet, and Ravenstonedale Common, Westmoreland, west of Mallerstane, and flows in Yorkshire, and, with its tributaries, flows through Gorsdale and Dentdale. The *Dee*, 9 miles in length, drains the north-western corner of Yorkshire. On the right bank is Sedbergh, 400 feet above the sea, a mile below the infall of the River *Dee*.

Following the left bank of the *LUNE* valley from the infall of the *Rawthey* towards the source, it continues its northerly direction by Low Barrow Bridge as far as Tebay, where it turns eastward towards the village of Ravenstonedale, 800 feet above the sea, the watershed being 840; its head waters being chiefly fed by streams from the south flowing off Langdale Fell.

On the right bank of *Sanwith Beck* feeding the *LUNE*, descending the stream, are Newbiggen, Wath, where it becomes the *LUNE*, Kelleth, Rayne, and Orton. *Chapel* Brook, flowing past the latter, falls into the *LUNE* near Tebay, at 600 feet above the mean sea-level. The river is here about 36 miles from its outfall, which gives an average fall of about 16 feet per mile.

Another feeder, *Wasdale* Brook, rises near Wasdale Head; flows first to the north-east, and then, at Birkbeck, south-east to Tebay, the London and North-Western Railway here running along its left bank. The south part of Shap Fells, the Birkbeck Fells, and the north of Grayrigg Forest are drained by *Barrow* Brook, the infall of which is at Barrow Bridge, about 575 feet above the sea. Southwards from this point, the right bank of the *LUNE* is of small extent, the *KENT* watershed hugging the line of the river. The main line of the railway leaves the valley of the *LUNE* about 3 miles south of the Bridge at Low Gill Junction, and

crosses into the basin of the *KENT*. The *LUNE* descends to the 250-foot contour at Markthwaite Bridge, to 280 feet at Holm House, and 150 at Kirkby Lonsdale.

KIRKBY LONSDALE.—*Acres*, 3250; population, 1733; rateable value, 4309*l.* 12*s.* 6*d.*; constant supply from springs; reservoirs constructing under Public Health Act, 1875.

Above Whittington the 250-foot contour crosses into the next basin drained by the *Keer*, which rises in a col valley near Docker, at about 175 feet, the *Beckthwaite* rising in the same col, but flowing into the *LUNE* above Arkholme, between the watershed and the river, which run parallel to each other. At a distance of about 1½ mile are the villages of Gressingham, Hawkshead, Halton, Skerton, Ovangle, Overton, and Middleton, the watershed ranging through mosses south of Heysham and around Torrisholme.

RIVER KENT (XXXIII).

Length of this river, 23 miles; area, 255 square miles, of which about 188 consist of rocks of Silurian age, 67 of Carboniferous Limestone. In this basin the Ordnance Survey include (1.) the small streams draining the Heysham peninsula as far as Hest Bank, where the Boulder Clay forms the sea cliff, and many large boulders are scattered on the beach. Westwards a peaty tract intervenes between this low undulating land and the Heysham Carboniferous Grit, which forms a cliff at Heysham Point, masked to the north towards the town of Morecambe by Boulder Clay.

POULTON BARE AND TORRISHOLME.—Population, 3005; from Lancaster Corporation; average supply, 114,000; minimum, 100,000; maximum, 300,000 (constant); rateable value, 24,349*l.* 10*s.*; Local Government Act, 1858.

(2.) Streams draining into Morecambe Bay from Hest Bank to Bolton-le-Sands. The drainage here is obstructed, flat areas covered with peat mosses occurring, here and there interspersed by mounds or ridges of sand and gravel. Long ago these were believed by Dr. Buckland to be old glacier moraines, but they are certainly of marine origin; but

whether they belong to the Sands of the Middle Drift period, or to the later "Eskers," appears to be somewhat doubtful. They probably belong to the Gravels, containing large masses of scratched Mountain Limestone, occurring in the railway cutting at Carnforth.

(3.) The *River Keer*, draining the south side of Hutton-Roof Cray, Priest Hutton, Borwick, Carnforth, and Warton, west of which is Warton Cray, with its ancient Beacon, rising to 500 feet above the sea. West of this hill is a depression, at the bottom of which is Silverdale Moss, through which the Ulverstone Railway is carried, crossing the watershed of the *KENT* proper at 28 feet, from which it ascends to the top of Middlebarrow, 257 feet, and Arnside Knott, 522 feet, descending to the sea at Milnthorpe Sands.

The estuary of the *KENT* extends from Milnthorpe Sands to Halforth, a distance of 5½ miles, with a width at the entrance of three-quarters of a mile, winding further inland 1½ mile, contracting at Dallam Tower to half a mile. A little north of the point where the sands are crossed by the railway, *Leigh Brook* drains Holme, Burton in Kendal; much of the tract is covered with peat-moss. Further north at Dallam Tower is the infall of the River *Beetha*. Ascending the stream on the left bank is the village of Beetham. Further east it receives *Peasey Brook*, rising near the *LUNE* watershed. The latter has an important tributary, *Lupton Brook*, flowing through the gorge between Scout Hill, 933 feet, and Farleton Fell, 800 feet, and rising in a col valley connected with the *LUNE*. On the right bank of *Peasey Beck* are the Powder Works, at 250 feet, Crooklands, and Milton; on the left bank of the *Beetha*, Deepthwaite and Stainton. Higher up the stream divides into two streams, *Saint Sunday Beck* and *Beehive Beck*. The right bank of this stream is limited in extent, the watershed between it and the *KENT* running close to it, by Woodhouse, Heversham, and Milnthorpe.

Following the *left* bank of the River *KENT* up stream, by Sedgwick, Natland, and Oxenholme Junction, and the east

side of Kendal, which is situated on the left bank of the river, about a mile north of the town, trends to the north-west, and receives a tributary, the River *Mint*, from the north-east, at an elevation of about 150 feet. Following the left bank of the latter, it receives a feeder at 350 feet, rising in Grayrigg Forest at 1300 feet above the sea. From the Forest the *KENT* watershed trends north-west over the tops of Whinfell Common, 1515 feet, Bannisdale Fell, 1737 feet, Tarn Cray, 2176 feet, Adam Seat, 2180 feet, and Lingmell End, 2183 feet. Parallel with this ridge on the *LUNE* side runs *Borrow Beck*, and on the *KENT* side *Bannisdale Beck*, the River *Sprerit* flowing through Long Sleddale. The former rises at 1600 feet, and falls into the right bank of the *Mint*; the latter rises at 2400 feet, under the Knowe, and falls into the left bank of the *KENT* at Burnside, at 175 feet.

From Burnside to Staveley, small feeders drain the slopes of Potter's Fell, the most important rising on Green Quarter at 1250 feet, flowing through Skegges Water at 1017, over Staveley Head Fell, and falling into the *KENT* at 300 feet. Three and a half miles further up the *KENT*, at Kentmere, it has risen to 600 feet, or 171 feet per mile. Two and a half miles further north, the stream is impounded, and forms Kentmere reservoir, with a top water of 973 feet, with feeders rising on the crags above or about 2000 feet above the sea. The northern watershed of the *KENT*, from Harop Pike to High Street, a distance of about 5 miles, is formed by a portion of the central east and west watershed. The western margin of this basin ranges south from High Street by the sharp ridge formed by Froswick, 2539 feet, Ill Bell, 2476, the Sallows, 1691, separating Troutbeck from Kentmere valleys, descending to 465 feet, in the col through which the Windermere branch railway is carried, which crosses the watershed about a mile and a half east of Windermere Station. Southward the watershed runs parallel to the Lake Windermere, and within a mile of it.

Following the *KENT* from its source, the first feeder

of importance is the River *Gowan*, falling in at Staveley. Between it and Kendal no stream of importance falls into the *KENT*, nor are there any between it and Beethwaite Green, 100 to 140 feet above the sea.

KENDAL.—*Acres*, 2622; population, 13,696; rateable value, 46,203*l.*; constant supply of 300,000 gallons from two reservoirs impounding streams, supplemented by pumping from a well; under Kendal Union Gas and Water Company Act, 1846 (9 & 10 Vict. c. 116).

Messrs. Hassard and Hemans, in calculating the periods of drought to be expected in the Lake District, quote the observations of Mr. Samuel Marshall of Kendal, taken for forty-four years from 1822, during which the longest drought occurred in the spring of 1852, which was, curiously enough, the wettest year of the period. From 19th February to 29th April (70 days) but 0·21 inch of rain fell, and all on three days.

The next drought approaching this in duration was from 1st April, 1861, to 8th of June (69 days), rain falling on nine days to the amount of 1·65 inch. In 1839, from 28th March to 4th June (67 days), rain fell to the extent of 1·97 inch on 12 days. In 1826, out of 60 days (28th April to 28th June), only 1·12 inch of rain fell on eight days. In 1829, in the 55 days from 14th December to 8th February, 1830, only 0·65 fell in five days. In 1844, 1853, 1864, 1865, droughts of shorter duration occurred.

River Gilpin.

Below Beethwaite Green, the *KENT* receives the River *Gilpin*, draining a low flat alluvial tract intervening between Whitebarrow, 706 feet, and Helsington Barrow, 600 feet. At the foot of the latter flows a tributary, *Underbarrow Pool*, draining Brigster, Underbarrow, rising above Crook, at 400 feet. The *Gilpin* rises east of Bowness, at 500 feet, descending to 100 feet at Churchtown, and to 25 feet east of Row.

From the infall of the *Gilpin* the low peat-covered tract occupies a large tract in Beetham, by Upta, and Meathop,

west of which is the infall of the River *Winster*, draining the valley between Whitebarrow and Ravensbarrow, 750 feet, rising at Brant Fell, near Bowness, at 500 feet, west of the source of the *Gilpin*, and flowing past Winster and Lindale to the estuary of the *KENT* at Blawith Point. Its low-water channel flows between this point and Holme Inland, past Grange, and then turning eastward falls into the channel of the *KENT*, near the point where the latter is crossed by the path across the "Sands."

The basin of the Upper *KENT* consists of consolidated ashes of the "Volcanic series," believed to be of Llandilo age, and called by Professor Sedgwick the "Green Slate and Porphyries," with a general west-south-west and east-north-east strike. When they approach the Shap Granite, they alter into a dark porcelaneous rock. The Granite is well known from the large oblong crystals of flesh-coloured orthoclase felspar, causing it to be largely used for ornamental purposes. Resting unconformably on the Volcanic series is the Coniston Limestone series, which is more or less earthy, fossiliferous, and associated with shales. It is on the same horizon as the Bala Limestone of Wales.

East of Kentmere, it is split up by ash-beds and shales, and is unimportant. It is overlaid by the Stockdale shales forming the base of the Upper Silurian. At the base are black shales, with graptolites above. They are pale-coloured, and are the equivalent of the Tarannon Shale of North Wales. They form *b*⁶ of the Geological Survey Maps. Over them are the Coniston Flags and Grits, which are on the horizon of the Denbighshire Grits and Flags of North Wales. To the west of the *LUNE* Basin there are three Sandstone beds, but they thin eastwards, the lower and middle beds disappearing. The Flags, when cleavage and bedding happen to coincide, are useful. They reach a thickness, according to Mr. W. T. Aveline, of 6800 feet, striking with the older formation east-north-east across country. A second tract also occurs, brought in by a broad anticlinal, at the tops of Whinfall Beacon, Grayrigg Common, and Langdale Fells, in the *LUNE* Basin.

Over these rocks are the "Bannisdale Slates," which are roughly correlated with the Welsh Wenlock Shale and Lower Ludlow. The thickness, according to Mr. Aveline, is 5200 feet. The quarries with roughly cleaved slate that give the name are low in the series, and were first described by Professor Sedgwick.

Still higher in the series are the Hay Fell and Kirkby Moor Flags, the equivalent of the Upper Ludlow. They occur below the Carboniferous Limestone of Scarfoot and Barrowfield, west of Kendal; and from Kendal, by Docker Fell and Benson Knot, towards the *LUNE* valley. East of that river they do not occur.

The Upper Old Red Conglomerate is a local shore deposit, forming the base of the Carboniferous Limestone, and rests unconformably on the Silurians. It is well seen north and west of Kendal, and about Grayrigg. The fragments are all local, sometimes round, sometimes angular.

The area of Milnthorpe registration sub-district is 37,528 acres, with a population of 6622.

RIVER LEVEN (XXX.).

Length, 7 miles; area, 202 square miles, of which 190 square miles consist of Silurians, 10 of Carboniferous Limestone, and 2 of Permian Sandstone.

This basin is 20 miles long by about 9 miles in width; in shape rectangular. Its eastern watershed separates its waters from those of the *KENT*. Its northern margin is part of the east and west watershed, separating the *EDEN* and *DERWENT* Basins from the *LEVEN* Basin, the western watershed of which separates it from the basins of *DUDDON* and *Dalton-in-Furness* streams.

The Ordnance Survey includes in this basin the small stream draining the Cartmel valley, the Limestone district of Grange terminating to the north by a north-west fault ranging to Newby Bridge. To the west it thins out on the Bannisdale Slates, along a line ranging from Cark to Cartmel. The former place is on the St. Bees Red Sand-

stone of Permian age, extending to Flockburgh, where it rests on the Carboniferous Limestone. Between Holker and Ulverstone the *LEVEN* occupies a broad flat valley, in which are mounds and patches of Carboniferous Limestone.

Following the left bank of the *LEVEN* from its mouth, Windermere Lake is reached; it is $10\frac{3}{8}$ miles in length, and lies in a valley excavated by the agency of running water; but the portion of the valley concealed by the waters of the lake is a rock basin, excavated below the level of the outfall of the lake at Newby Bridge, and due to the erosive action of glaciers during the Glacial period. The deepest part of the lake I found by sounding to be opposite Wray Castle, on the western shore, where a depth of 39 fathoms, or 234 feet, was obtained, a depth greater than the English Channel between Folkestone and Boulogne. The top water-level of the lake is 134 feet, so that the bottom is 100 feet below the mean level of the sea. The level of the foot of the lake is 0.2 foot below that of the head.

Analysis of Windermere, made by the Rivers Pollution Commission, gave 5.78 of total solid impurity; 0.299 of organic carbon; 0.99 of chlorine; 4.0 of hardness, of which 2.4 was permanent.

WINDERMERE.—Acres, 200; population, 1269; rateable value, 4828*l.*; constant supply from reservoir of *Windermere District Water Company*.

BOWNESS.—Acres, 995; population, 1855; rateable value, 8993*l.*; from *Windermere Water Company*.

The following ANALYSES are given by the RIVERS POLLUTION COMMISSION.

	Total Solid Impurity.	Chlorine.	Hardness.		Total.
			Temp.	Perm.	
Rydal Lake	4.44	0.69	0.7	2.4	3.1
Grasmere	4.18	0.79	0.0	2.7	2.7
Upper Rothay	3.06	0.59	0.0	1.3	1.3

River Rothay.

North of Windermere is a tract of alluvial land which has been formed by materials brought in by streams silting up the lake. Across this tract flows the *Rothay*. On its left bank is the town of Ambleside, which is crossed by Stock Ghyll, forming the well-known waterfall behind the town. A few yards higher up the river is the infall of *Scandale Beck*. It is impounded in a small reservoir for the supply of the town. The direction of the valley is northward to the infall of *Rydal Brook*, draining the deep valley at the back of Rydal Park, where are the Upper and Lower Rydal Falls. At Thrang, the *Rothay* Valley turns westwards under Nab Scar, the Rydal Valley continuing the former north and south trend. At the foot of Nab Scar is Rydal Lake, 181 feet above the sea, and still higher up the valley is the larger lake Grasmere, 208 feet above the sea, and 180 feet in depth. Both these lakes are true rock basins, and the rock at the lower lip is glaciated, rounded, and smoothed.

Above Grasmere the east and west central watershed descends to 853 feet at Dunmail Raise, a col valley crossed by the coach road. The pipes of the *Manchester Corporation Water Supply* from Thirlmere will pass along the east side of the valley, through Nab Scar and Rydal Park, and above Ambleside. Following the right bank of the stream, an important feeder draining Easdale Tarn, 915 feet, comes down above Grasmere, and other feeders drain the steep sides of Silver Howe, 1345 feet, and Loughrigg, 1101 feet.

Ambleside registration sub-district contains 61,977 acres, with a population of 10,442 in 1881.

River Brathay.

On the right bank of the stream, near its outfall in the lake, is the River *Brathay*, flowing in from the west. Following its left bank is the village of Clappersgate, under the steep cliffs of Loughrigg, consisting of more or less altered volcanic ashes. At Skelwith Bridge a feeder

draining the picturesque lake, Loughrigg Tarn, 368 feet, comes in. Above the bridge the river is cutting a gorge through hard beds of the Volcanic Series, and forms Skelwith Force. Above it is Elter Water Lake, 187 feet above the sea, which receives on its southern shore the River *Brathay*, and on its northern *Great Langdale Beck*. On its left bank is Elter Water Village and the Powder Works, between which and Chapel Stile are well-glaciated mounds of rock. Higher up the stream the well-known Langdale Pikes tower above the valley, Harrison Stickle reaching 2401 feet, and Pike of Stickle 2325 feet. East of the former under Pavey Ark is Stickle Tarn, 1540 feet, and between the Pikes rises *Dungeon Gill*. West of the Pikes a number of feeders rise in the magnificent amphitheatre of rocks, the centre of which is Rossett Crag. The south side of the valley is formed by the hill called the Band, 1860 feet. Between it and Pike of Blisco is the deep valley of Langdale, whose southern feeder rises in Red Tarn, named from the redness, due to red oxide, of iron veins.

The *Oxendale* stream joins *Rossett Gill*, and becomes *Great Langdale Beck* at Wall End, a farm at the entrance of the col valley connecting Great with Little Langdale. The summit-level is a little over 700 feet; in it is Blea Tarn at 612 feet. East of the col, between the two Langdales, is Lingmoor Fell, 1410 feet, which is glaciated up to the top. Following the left bank of Little Langdale, a gorge is being cut back at Colwith Force. Higher up is an alluvial plain, representing a filled-up lake, of which Langdale Tarn, 340 feet is the remnant. From this lake to the source of the stream it falls 900 feet in less than two miles, or more than 450 feet per mile. From the Tarn to Windermere is a distance of $5\frac{1}{4}$ miles, with 206 feet of fall, or about 40 feet per mile. Immediately above the Tarn is the infall of *Greenburn Beck*, rising at 2200 feet above the sea, in the deep recesses of the Wild Valley lying at the foot of High Carrs, under the flank of Wetherlam; this stream falls 2000 feet in 3 miles, or 666 feet per mile.

The minor watershed dividing the waters of the *Crake* from the *LEVEN* ranges from High Carrs, through Wetherlam, north-east to Low Fell, then across the Tilberthwaite col valley, over Oxen Fells, across the col valley through which the coach road between Coniston and Skelwith is carried, over Arnside and Black Fell, 1056 feet. Thence it turns abruptly southwards, passing west of Hawkshead, ranges parallel to Coniston Lake, over Coniston Moor, the long slope to the east draining into the smaller tributaries of the *LEVEN*.

From the infall of the *Greenburn* to Windermere no stream of importance falls into the right bank. Here and there the rock in the valley is concealed by Glacial Drift, large scratched and smoothed boulders occurring in gravelly clay.

Following the right bank of the lake, glaciated rock mounds occur in Brathay Park; and at Pull Wyke Bay is the outcrop of the Coniston Limestone, striking south-west to the foot of Black Fell, where it is cut off by a fault bringing up the older Volcanic Series. On the south side of the bay is a stream draining Blelham Tarn, 138 feet above the sea. To the south the larger lake Esthwaite Water, near Hawkshead, a mile and a half in length, 80 feet in depth, and 217 feet above the sea, drains into the lower part of Windermere, below Near and Far Sawrey. West of this valley is Hawkshead Moor, and between it and Coniston Moor is *Grizedale Beck*, draining that village and Salterthwaite.

The southern continuation of the Windermere valley extends beyond the foot of the lake, and the flat tract is connected by a col with the valley drained by *Ayside Pool*, flowing through Cartmel to the sea at Cask. This probably was the line of flow of the united Windermere glaciers. The river at its present outfall trends south-west, and flows through the valley between Yew Barrow and Backbarrow, terminating in a north and south valley drained by *Rusland Pool*, falling into the *LEVEN*, west of Haverthwaite, draining Thwaite Head, Rusland and Bouth. West of

the latter plain is *Colton Brook*, draining the Furness Fells, and falling in at Legbarrow Point.

River Crake.

West of these two central streams is the *River Crake*, draining the Coniston Valley area. Following the left bank to the foot of Coniston Lake, it flows through a north-north-west valley cut through Fells of Upper Silurian Grits and Flags, ranging up to 600 feet in height, rising to 748 feet above High Nithwaite at the foot of the lake.

Coniston Lake is 6 miles long, with an average width of two-fifths of a mile; its height is 147 feet above the mean sea-level, or 13 feet above the surface of Windermere; its depth is 160 feet. Its eastern slope is steep and abrupt, but only rises to 900 feet, or about 750 above the lake. The principal feeder is the *Yewdale Beck*, which falls in on the right bank about half a mile from the head of the lake. At High Yewdale the stream divides, the eastern feeder draining the Oxen Fells col valley, the western feeder Tilberthwaite Valley, which is a very narrow gorge, being 850 feet deep between Yewdale Fells and Holme. Its western feeders rise under Wetherlam, its eastern drain the peat-covered col valley, connecting Yewdale and Little Langdale. A little below the infall of *Yewdale Beck* is that of *Church Beck*, draining Levers Water, 1350 feet, the Coniston Copper Mines, and Coniston Village. Its waters are milky from the Mines.

Following the right bank of the lake, no stream of importance comes in until the *Torver* stream falls in, rising at the back of Coniston Old Man, which rises to a height of 2633 feet. It flows through Goats Water, 1646 feet, and at Torver receives *Ash Gill Beck*, rising on the eastern slope of Walna Scar. At the foot of the lake, at Low Water End, 150 feet, the river flows out, continuing the south-south-east direction of the foot of the lake. To the south are a group of fells, 1000 feet in height, drained by streams flowing north-east into the *Crake*. On the right bank lower down is Spark Bridge, Penny Bridge, and Greenodd, where the river falls

into the tidal *LEVEN*. Below this point the river widens out, the channel hugging the left bank. The interval between it and the right bank is occupied by Greenodd Sands, into which flows *Newland Beck*.

On the hills west of Ulverstone rises *Levey Brook*, reaching the *LEVEN* estuary between Hummerside Point and Conishead Bank. North of its infall is that of the Ulverstone Canal.

ULVERSTONE. — Population, 9197; rateable value, 48,867l. 15s.; constant supply of 275,000 gallons, including trade supply, 600,000 gallons could be supplied by agreement as to priority from Barrow Corporation reservoirs at *Pennington Beck*, rising in Kirkby Moorside; under Ulverstone Waterworks Act, 1852, Barrow-in-Furness Corporation Water Act, 1873, and the Ulverstone Local Board Act, 1874.

The coast-line of the *LEVEN* basin terminates between Bardsea and Baycliff, the watershed ranging north of Great Urswick.

CENSUS of 1881.

Registration Sub-districts.	Acres.	Population.
Ulverstone	8,463	12,237
Dalton	17,097	15,789
West Broughton	29,453	3,224
Hawkshead	33,570	3,371

O.S. CATCHMENT BASIN XXXII.

Area, 56 square miles, of which 26 consist of Silurians, 22 of Carboniferous and Yoredale Limestones and Shale, and 8 of Permian Sandstone. This basin has an extensive coast-line for its size, commencing near Baycliff, and trending south-west by Aldingham, the larger part of which parish has been washed away, Newbiggen, where a stream comes in from

Gleaston Castle, *Roose Beck*, to Rampside, thence north-west to Roose, and west to Barrow-in-Furness, then north by Cocken, Ormsgill, to the estuary of the *DUDDON*.

Between Haverigg Point and Walney Island, a distance of $3\frac{1}{2}$ miles, are Duddon Sands, extending out seawards in a convex curve, broken in the centre by the channels of the *DUDDON*, which unite near the Middle Buoy, where they are joined by the Scarth Channel, flowing in from the northern end of Walney Island, and draining at low tide the sand-banks between that island and the mainland, as far as Palace Nook, east of which these sands drain at low tide in the opposite direction, flowing into Walney Channel, which, after receiving the Barrow Channel, flowing between the Isle of Barrow and the mainland, becomes Peel Channel, which from Roe Island (attached to which is Peel Pier) turns south, and flows past the south-east corner of Walney Island, and passes over Peel Bar to the open sea.

Walney Island, west of this channel, is 8 miles in length. Its direction is south 30 east. Its western coast is straight, and covered with Sand Dunes rising to 50 feet above the sea. The eastern margin is deeply indented. On it are the villages of North Walney, North Scale, Biggar, and South Scale. Under the sand, and underlying Boulder Clay, is the St. Bees Sandstone.

At Ulverstone the Carboniferous Limestone rests on the Coniston Grits, Stockdale Shales, Coniston Slates, and Limestone, resting on Skiddaw Slates south of Ireleth, and on the Volcanic series north of that place. The Limestone extends from Bardsea, through Great Creswick, Dalton-in-Furness, extending to Duddon Sands. A west-north-west fault brings in the Permian south of the latter place, extending by Hawcoat, Ormsgill, Barrow, and Furness Abbey, where the north and south fault brings in the Yoredale rocks, extending from Newton, Gleaston, and Aldingham, south of which the Furness Abbey fault brings in the Permian, to the south at Roosebeck, Rampside, and Barrow.

The watershed ranges through Hawcoat, 270 feet, thence

by Ireleth, crosses the Lower Silurians, and ranges across Gunson, Height, and Woodland.

BARROW-IN-FURNESS.—Population, 47,111; supply varies from 750,000 to 3,000,000 gallons (constant), from two impounding reservoirs holding 200 million gallons of water from Silurian wells; four distributing reservoirs and a high-service filtering reservoir constructing; rateable value, 167,371*l.*; under Barrow-in-Furness Corporation Acts, 1868 and 1872. Rainfall at 60 feet above the sea:—

1876.	1877.	1878.	1879.	1880.
36·29	54·20	33·78	36·73	30·65

Average of 8 years, 37·08 inches.

Barrow-in-Furness: area in acres of registration sub-district, 9720; population, 47,276.

DALTON-IN-FURNESS.—*Acres*, 7908; population, 13,350; constant supply of 150,000 gallons from reservoir collecting mountain stream.

RIVER DUDDON (XXIX.).

Length, 10 miles; area, 46 square miles, of which all consist of Silurian and Granitic rocks.

The estuary of the *DUDDON*, on either side of the Sands, is fringed by a low alluvial and peaty tract, into which falls on the left bank *Kirkby Pool*, west of which is a low ridge of Coniston Grits, on which is Broughton-in-Furness. The ridge is taken as the *DUDDON* watershed. West of this tract, at the head of the estuary, is the River *Sickle*, which nearly corresponds with the boundary of the underlying rocks of the Volcanic series at Dunnerdale Fells.

The *Sickle* rises at Caw Moss, 1750 feet above the sea, on the southern slope of Walney Scar. Following the left bank of the *DUDDON*, it receives at Seathwaite a feeder draining the Seathwaite Tarn, 1210 feet above the sea. It rises in Wrynose, near the Three Shires Stones, in the high col lying between Pike of Blisco and High Carrs. The western water-

shed ranges through Yew Bank, Harter Fell, 2140 feet, Ulpha Fells, Woodend, and Burn Moor.

O.S. CATCHMENT BASIN XXXI.

Area, 28 square miles, of which 18 consist of Silurians, 7 of Carboniferous Limestone, and 3 of Permian Sandstone.

This basin is chiefly drained by *Whicham* Brook, draining the eastern slope of the Black Comb ridge; from Chappels to near Silecroft it flows south-west, but does not flow on through the sandhills to the sea, but turns east-south-east, and flows on the sandy area, by Kirksanton, to the *DUDDON* estuary at Haverigg. To the east another stream rises in Millom Park at about 500 feet, and flows by Holborn Hill to the estuary at Borwickrails Harbour. East of the infall of this stream is the watershed separating this basin from that of the *DUDDON*, which runs parallel to *Black Beck*, a tributary of the *DUDDON* estuary, and within the basin of that river.

To the west of the estuary of the *DUDDON* is the mountain called Black Combe, 1960 feet, composed of Skiddaw Slate, striking with the ridge north-east, and faulted to the east and north against the Volcanic series, with the exception of one point at Fellside, at the north-west corner of the mountain, where the boundary is a natural one. To the west the Slates are overlaid unconformably by the St. Bees Sandstones, by Kirksanton, Whicham, and Whitbeck.

East of Holborn Hill, the Permian rests on the Carboniferous Limestone, worked for iron-ore at Hodbarrow Point.

RIVER ESK (XXVIII.).

Length, 9 miles; area, 64 square miles, of which 44 are Silurians, and 20 Permian Sandstone.

The southern margin of this basin is formed by the Black Combe ridge; descending by Black Craggs, it crosses the Drift terrace at the base, fringed with Sand Dunes, between Whicham and Whitebeck. North of the latter place a stream comes down from western summit of Black Combe,

and north of it are several parallel streams draining Little and Bootle Fells.

The Rivers *ESK*, *MITE*, and *Irt* fall into the same estuary, the former stream being considered by the Ordnance Survey to form a distinct basin. To the south-east it is bounded by the Black Combe streams, to the north-east by the *DUDDON*, and for a short distance by the basins of the *LEVEN* and the *DERWENT*. This part of the watershed traverses some of the highest ground in England, trending north-west from Shelter Craggs, 2631 feet, by Bow Fell, 2960, to Great End, then, 2490 feet, then south-west over Scaw Fell Pike, 3210 feet, Scaw Fell, 3162, and thence by Eskdale Fells to the sea. *Linbeck Gill*, draining Devoke Water 766, falls into the left bank at Linbeck, 75 feet above the sea. On the right bank, *Whittle Beck* drains Burnmoor Tarn, 832 feet, and falls into the *ESK* at Bort, at about 130 feet.

On the right bank of the *ESK*, near its mouth, is Muncaster Castle and St. Michael's Church, on a prominence rising to 373 feet.

Muncaster registration sub-district contains 44,087 acres, with a population of 2655.

Bootle registration sub-district contains 47,214 acres, with a population of 9569.

RIVER MITE (XXVII.).

Length, 14 miles; area, 61 square miles, of which 52 consist of Silurian rocks, and 9 of Permian Sandstone.

The eastern boundary of the River *MITE* ranges from Ravenglass through Muncaster Fell. Its western boundary, or minor watershed, is formed by the Ill Gill Head ridge, 1978 feet, forming the top of Wastwater Screes. The stream rises 900 feet above the sea, on Eskdale Moor.

River Irt.

Trending eastwards, this river takes off the surplus waters of Wastwater Lake. Their surface is 204 feet, the cliffs on the left bank forming the well-known Wasdale Screes.

Wastwater is 204 feet above the mean sea-level, 3 miles in length, and 270 feet in depth. At the head of the lake is an alluvial tract, into which enters *Lingmell Beck*, and other mountain streams. At the foot of the lake is the village of Strands, and below it is the infall of the River *Bleng*, at 75 feet.

Below the infall of *Bleng*, on the right bank of the *Irt*, are the villages of Hall Santon, Holmrook, and Drigg. At this place the river does not continue its south-west course through the Sand Dunes of Drigg Common, but turns south-east and flows south-east to the channel of the Rivers *ESK* and *MITE*, which cuts off the southern prolongation of the Sand Dunes at Drigg Point.

RIVER CALDER (XXVI).

Length, 6 miles; area, 28 square miles, of which 12 consist of Silurians, 3 of Carboniferous rocks, and 13 of Permian Sandstone.

The eastern watershed commences on the sea-coast at Carl Crag, crossing the Sand Dunes at Low Moor, rises to 61 feet, ranges a little east of north through the Drift-covered Permians of Drigg Cross, to Gosforth, 338 feet, thence north-east to Swainson Knott, 1056, where it trends east by Stockdale Moor.

Two independent small streams are included in this basin. The first drains the country near the *ESK* watershed, and falls into the sea at Leaside. The next has a longer course; rising near Ponsonby, it flows by Calder to the sea at Seascale How, half a mile south of the outfall of the *CALDER*. The first tributary of importance on the left bank of the stream is *Warm Gill*. On the right bank is Calder Bridge, 176 feet above the sea, and Sellafield, near the outfall, 67 feet.

RIVER EHEN (XXV).

Length, 10 miles; area, 72 square miles, of which 44 are Silurians, 3 Carboniferous Limestone, 3 Carboniferous rocks, and 22 of Permian Sandstone.

In this basin is included the whole of the area bounded by the coast-line, extending from Sellafield to the north of Whitehaven, in the centre of which is the promontory of St. Bees Head, formed of the Permian Red Sandstone, named after the Head, the St. Bees Sandstone.

The *EHEN* rises near the sea-coast, and flows south to Braystones. Were its valley depressed beneath the sea, the district around St. Bees Head would form a triangular-shaped island. At Braystones it receives a stream draining Hale, and St. John and St. Bridget Beckermet. The valley is cut through Boulder Clay, resting on the St. Bees Sandstone. The united stream has not a channel through the Boulder Clay direct to the sea at Braystones, but turns to the south-east, and flows for $2\frac{1}{2}$ miles parallel to the coast, falling into the channel of the *CALDER*. This deflection of the West Cumberland rivers outfall is due to the silting up of the flow-tide side of the stream, which here is the north side of the outfalls. The mouth of the *ESK* is the only stream not so deflected, but this is protected by Drigg Common Sand Dunes intervening between the sea and the *Irt*.

The country east of the Ehen Valley, consisting of the wild and deep valley of Ennerdale, is drained by the tributary River *Liza*, which rises under Green Gable, 2474 feet above the sea, and flows at the foot of the Pillar rock, 2827, on the south side, and of Scarf Gap on the north; thence through Ennerdale Lake to the *EHEN*, between Egremont and Cleator Moor. The lake is $2\frac{1}{2}$ miles long, 368 feet above the sea, and 80 feet in depth.

CLEATOR MOOR.—*Acres*, 814; population, 10,420; rateable value, 30,701*l.*; constant supply of 150,000 to 230,000 gallons from storage reservoirs, holding 4,500,000 gallons, collecting mountain streams; Public Health Acts, 1848, 1858.

The registration sub-district of Egremont contains 35,698 acres, with a population of 19,577. The registration sub-district of St. Bees contains 11,130 acres, with a population of 10,885.

These streams all terminate against an important watershed crossing England from east to west. In the Lake District to the south of it are the Lakes Ennerdale, Wastwater, Coniston, Esthwaite, and Windermere; to the north of it, Crummock Water, Buttermere, Bassenthwaite, and Derwentwater, in the basin of the *DERWENT*, and Ulleswater and Haweswater in the basin of the *EDEN*. On this watershed are situated the chief passes of the Lake District—Scarf Gap, the Langdale passes, Dunmail Raise, and Kirkstone Pass; its eastern prolongation forms the boundary between the *EDEN* on the north, and the *KENT* and *LUNE* on the south, crossing the Pennine axis between the *EDEN* and the Yorkshire *OUSE*, and still further east between the *TEES* on the north and the Yorkshire *OUSE*, *DERWENT*, and *ESK* on the south.

The top-water level of Ennerdale is 369 feet, the breadth of the lake at the base is a little more than three-quarters of a mile, the effluent river takes the name of *EHEN*, receiving on its right bank *Crossdale Beck* at Ennerdale Bridge, at about 365 feet, *Lingla Brook*, draining Frizington, at 275 feet, and the River *Keekle* at 175 feet, the village of Cleator occurring in the angle of the two streams. The *Keekle* rises on Distington Moor, 3 miles from the sea, flows to the south, receiving *Dub Beck*, draining Arlecdon on its left bank, joins the *EHEN* at Cleator, which takes the direction of the tributary flowing south by Egremont to the sea.

The St. Bees Head area, lying between Whitehaven and St. Bees, is drained by small streams, flowing in opposite directions at the bottom of the low, flat-bottomed col valley, running from sea to sea, traversed by the railway to Whitehaven, which is crossed in the centre by the Central or "pass" watershed of the North of England. The Catchment Basin Map of the Ordnance Survey represents the watershed as running westward to the sea from Watch Hill, 565 feet high, and the map includes Whitehaven in the *EHEN* Basin, though it is on the outfall of a stream flowing north. From Watch Hill the watershed runs south by Yew Bank 738 feet; to

Richmond Hill, Hensingham, south of which it descends to about 60 feet, ascending to 309 feet at Sandwith, and terminating at St. Bees Head.

POPULATION in 1871 in CESTRIAN and LANCASTRIAN GROUP.

COUNTIES.	Population.	Density.	Proportion in this Group.	Probable Population.
Flintshire	76,245	2·4	$\frac{2}{15}$	68,621
Merionethshire	47,369	7·3	$\frac{1}{3}$	15,787
Cheshire	561,131	1·2	All	561,131
Derbyshire	380,538	1·7	$\frac{1}{3}$	76,107
Lancashire	2,818,904	0·4	All	2,818,904
Yorkshire, W.R.	1,831,223	0·9	$\frac{1}{15}$	12,208
Westmoreland	65,005	7·4	$\frac{1}{2}$	32,502
Cumberland	220,245	4·5	$\frac{2}{11}$	40,088

POPULATION in 1881.

Flintshire	80,373	2·1	$\frac{2}{15}$	72,336
Merionethshire	54,793	7·0	$\frac{1}{3}$	18,264
Cheshire	643,237	1·1	All	643,237
Derbyshire	461,141	1·4	$\frac{1}{3}$	92,228
Lancashire	3,454,225	0·3	All	3,454,225
Yorkshire, W.R.	2,175,134	0·8	$\frac{1}{15}$	14,500
Westmoreland	64,184	7·7	$\frac{1}{2}$	32,092
Cumberland	250,630	3·4	$\frac{2}{11}$	45,568