CHAPTER XXIX.

THE MERSEY BASIN.

O.S. LXXI. (in part).

West Cheshire Streams draining into the MERSEY.—Area, 155¾ square miles,* of which 10 consist of Keuper Marls, and 145¾ of Keuper and Bunter Sandstone.

Wallasey Pool.

The peninsula of Wirral is the promontory of Cheshire; it is surrounded on three sides by the *DEE* estuary, the sea, and the *MERSEY* estuary, and is traversed by a series of north-north-westerly faults which, corresponding in direction with the strike of the Triassic rocks forming the district, cause a repetition of successive lines of escarpment, the most picturesque being those formed by the hard and compact beds forming the base of the Lower Keuper Sandstone, resting on the soft Upper Mottled Sandstones. The valleys between these ridges are filled up to a considerable extent by Glacial Drift, which forms cliffs, ranging from 20 to 100 feet in height, on the *DEE* and *MERSEY* coasts. To the north the country is very low and peat-covered, and is drained by *Birket* Brook, flowing into *Wallasey Pool*, which occupies a gorge, breaking the continuity of the Bidston Hill and Wallasey escarpment. The latter district would even now become an island were the Blown Sand, Peat, and alluvium of the Leasowe plain removed. The central valley of Wirral, from Barnston and Brimstage, is drained by *Fender* Brook, flowing into the *Birket*. Formerly the latter must have

* 'Riv. Poll. Report,' vol. i., 1870.

received an important feeder from high grounds to the north, now destroyed and under the sea, which was instrumental in cutting the transverse gorge of *Wallasey Pool*, which is older than the Glacial epoch, Glacial deposits occurring beneath the bed of the Pool, which has been embanked, and forms the line of docks known as the Great Float, at Birkenhead.

WALLASEY.—Population, 21,501; two artesian wells in New Red Sandstone, yielding 800,000 gallons (constant); rateable value, 108,422*l*. The well is 20 feet above the sea-level; the shaft is 90 feet deep, with a 12 and 8 inch boring to 246 feet from the surface; the pumping-level is 30 feet below Ordnance Datum; the rest-level is 4 feet above it.

BIRKENHEAD.—Population, 83,324; supply from wells, headings, and borings in the New Red Sandstone, stored in reservoir, lifted by six pumping engines, supplying 1,810,000 gallons daily; deducting trade supply, 27 gallons are used per head; the rateable value, including Claughton, is 247,319*l*.; additional works are required. Rainfall in 1879, at Bidston Observatory, 182 feet above high-water mark, 29·79 inches; in 1880, 31·34 inches.

TRANMERE.—Population, 16,143 in 1871; well with bore-hole, yielding 530,000 gallons daily, stored in a reservoir; rateable value, 80,649*l*.

ANALYSES made by DR. CAMPBELL BROWN, 11th September, 1878.

Well.	Total solid impurity in solution.	Organic carbon.	Organic nitrogen.	Total combined nitrogen.	Chlorine.	Hardness.		
						Temp.	Perm.	Total.
Spring Hill deep well, rest-level + 11 ft. O.D.	23·0	·093	·002	·389	2·771	6·52	8·06	14·58
Flaybrick Hill, 833 ft., rest-level + 11 ft. O.D.	18·0	·116	·015	·274	4·0	2·12	7·02	9·14
Tranmere, rest-level + 11 ft. O.D. ..	23·0	·131	·004	·273	2·82	3·44	11·14	14·58

All these waters are free from sewage contamination, but are harder than when analyzed in 1874. The three Birken-

head wells, the Prenton well, and the Wallasey well, are all situated on the same belt of rock, lying between the *Fender* Brook and Tranmere Faults. The Wallasey, Flaybrick, and Spring Hill wells penetrate the Lower Keuper Sandstone and the Upper Mottled Sandstone, the Tranmere and Prenton wells the latter formation only. It appears to be somewhat doubtful that the Pebble Beds were reached, though possibly they were touched by the deep bore at Flaybrick and at the bottom of Prenton.

Part of the district south of Birkenhead is supplied by the *Wirral Waterworks Company*. Their well is at Prenton. It was sunk under the direction of the late Mr. J. Cunningham, C.E., and passed through 18 feet of Boulder Clay and 352 feet of soft Sandstone; 400,000 gallons are pumped daily, but it could yield more than 2,000,000; the rest-level is 79 feet above Ordnance Datum; the pumping-level 14 feet above it.

Bromborough Pool.

This stream drains a valley cut in the Glacial Drift, resting on the Upper Mottled Sandstone, from Hooton to Bebington and Bromborough, where the soft deep-red basement beds are well seen.

River Gowy.

Pebble Beds, Upper Mottled Sandstones, and impermeable Red Marls occupy about 22 square miles in the basin of the *Gowy*, and small streams east of it, flowing into the estuary of the *MERSEY* near Frodsham. These streams rise on the Red Marl plain, or in the Keuper Waterstones, and flow down the Triassic escarpment, between Burwardsley and Frodsham.

Tarporley.—*Acres*, 5915; population, 2669; supplied by wells and springs in the Keuper Sandstone, yielding about 10,000 gallons a day; rateable value, 13,402*l*.

Hargrave, Christleton, Dunham, and Thorbiton, all of which could get good supplies of water from the Bunter Pebble Beds.

RIVER WEAVER (LXXI., in part).

Length, 53 miles. This basin is bounded to the west by the watershed of the *DEE*, to the south by that of the *SEVERN*, east by the *TRENT*, and north by the *MERSEY*. The area of the united streams of this basin, including brooks draining directly into the *MERSEY* estuary, is 696 square miles.

The area of the *WEAVER* alone, with its tributaries, is 540¼ square miles, of which 45 consist of Coal Measures, 3 of Permian, and 474¼ of Triassic rocks, of which 7 are New Red Sandstone, leaving no less than 467¼ square miles occupied by Keuper Marls, while a further 10 miles are occupied by the Liassic outlier east of Whitchurch. Following the left bank of the *WEAVER* from its mouth at Frodsham, it passes at once from the Keuper Waterstones on to the Keuper Marls, which are thickly covered with deposits of Boulder Clay, Sand, and Gravels; water absorbed by the latter, at an average elevation of 300 feet, percolating through a porous band, above the upper Saltrock, is the source of the brine issuing at pressure in natural springs, and met with in the Artesian Shafts at the various brine pumping-stations. Pumping has reduced the level to which brine will rise, and most of the springs between Frodsham and Castle Northwich have ceased to flow. Near Whitegate and Marton, brine outbursts have recently taken place at more than 80 feet above the sea.

The *WEAVER* rises near the base of the Keuper Marls, at the top of the Triassic escarpment overhanging the valley of the *DEE*, near Rowton Heath; thence over the plain of Keuper Marl south-eastwards to the Lias east of Whitchurch. Reaching the margin of this outlier, it turns abruptly northwards, and flows past Nantwich, at 120 feet above the sea, and Northwich at 30 feet above the sea, where it receives the *Dane* and turns westwards, falling into the estuary of the *MERSEY* below Runcorn. The Ellesmere Canal, connecting the *SEVERN* and *WEAVER* basins,

crosses the extreme south-eastern corner of the *DEE* basin, the level of the watershed between the *DEE* and the *WEAVER* being 310 feet, and the same elevation between the *DEE* and the *SEVERN*. The canal crosses the head waters of the *WEAVER* at 251 feet, and joins the canal connecting Chester with Wolverhampton at 212 feet above the mean sea-level. The latter canal crosses the *WEAVER* and *SEVERN* watershed at 312 feet, near Market Drayton. An important feeder of the *WEAVER* rises near this point, falling into the main stream near Audlem.

NANTWICH. — *Acres*, 696; population, 7488; partially supplied by gravitation from Baddiley Mere, at a distance of 4½ miles from the town; gathering-ground of 600 acres. There are two reservoirs, capable of holding 14,000,000 gallons; water filtered through stone and coarse sand, in all 6 feet thick; supply constant, except in drought; rateable value, 1420*l.*; Public Health Acts. Rainfall in 1879, Cholmondeley Castle, 35·43 inches; in 1880, 41·02 inches.

In the district lying south of this town Brine Springs still rise to the surface at several points on the banks of the *WEAVER*. The most southern is that at Audlem, where a boring, carried through the Lias, and into the Keuper Marls, met with the brine at 300 feet, which rose to the surface 175 feet above Ordnance Datum. Other springs flow daily into the *WEAVER*, at Brine Springs Farm, at Austerson's Farm, at Shrew Bridge, at 112 feet above Ordnance Datum. Formerly it flowed to the surface at Welshman's Bridge, close to the old Brine Shafts, which are now no longer worked, though at one time this was a considerable centre of the salt trade, in the limited proportions that it formerly assumed. Brine outbursts took place in 1539 at Combermere Abbey, accompanied with subsidence, and the formation of a mere, and another subsidence took place 1659 at Barmere. Borings into the Lias between Whitchurch and Market Drayton prove the Glacial Drift to be there more than 50 feet thick. Between the latter place and Crewe, numerous feeders chiefly drain a Boulder Clay district.

CREWE.—Population, 24,372; intermittent supply from wells 11 miles south, at Whitmore, near Madeley, Staffordshire, belonging to the London and North-Western Railway, who sell the water to the Town Council by meter. The water from this well is remarkably soft, containing, according to Dr. Zeidler, only 6·10 grains of solid matter per gallon. The Lower Mottled Sandstone here is absent, and the well is sunk in the Pebble Beds; whether it reaches the underlying Permian Sandstones is doubtful. Rateable value, 63,019*l.* 18*s.* 7*d.*; main laid under Public Health Act, 1875.

Alsager.—A boring has been carried to a depth of nearly 1000 feet, at a point 300 yards from the Station (North Stafford Railway) and 310 feet above the sea. The water was reached in the borehole at 553 feet, and therefore 243 feet below the sea, and the water rises 12 feet above the surface. Marls, with bands of grey rock, with thin bed of gypsum, occupied the first 553 feet, the water occurring at the top of the Sandstone; this was bored into to a depth of more than 400 feet without increasing the supply. The outcrop of the Keuper Waterstones is about three-quarters of a mile south of this borehole, and the dip of the beds is at 25 degrees to the north-north-west, which would take the base of the Marls down to the depth they were found in the borehole. The water obtained was of good quality, and was doubtless absorbed in the area of Lower Keuper Sandstone, about a square mile in extent, lying west of the north-east fault, cutting off the Keuper Marl tract, and throwing up the Bunter Sandstones and the North Staffordshire Coalfield. Half a mile north of the boring there is a lake, 11 acres in extent, called Alsager Mere, without inlet or outlet, the water of which is very clear, and believed to be pure. The lake is said to ebb and flow, and to sometimes rise in level even in dry weather.

Following the right bank of the *WEAVER* from Nantwich, the valley is cut through Middle Glacial Sands at Minshull Vernon, Winsford, and Clive, and they underlie the Upper Boulder Clay at Wharton and Moulton.

WINSFORD.—*Acres*, 5647; population, 10,041; Stretches Springs at Little Budworth, collected in reservoir (with water tower), could supply 239,750 gallons, but only 45,500 gallons are taken, only 5000 of the population being supplied; rateable value, 50,516*l.*; Public Health Act, 1875.

River Dane.

This tributary is 32 miles long, rising between Congleton and Leak, near the head waters of the *Churnet* and *Wye*, tributaries to the *TRENT*, and those of the *MERSEY*, which is formed by the junction of the *Goyt* and *Etherow* at Water Meetings. The *Dane* rises on the western flank of Axe Edge, and runs at first with south-westerly course along the hollow of the Goyt Trough; then, turning to the west, it cuts through the Grit ridge of Back Forest, and flows past Congleton and Middlewich into the *WEAVER* at Northwich. The southern feeder of the *Dane* rises on Yoredale rocks, thence it flows over the Pebble Bed outlier near Leak. Another feeder gives a very good section of the Lower Coal Measures of the North Staffordshire Coalfield, occupying a synclinal fold in the Millstone Grits between Wetstone Hale and Goldsitch House, thence it cuts a gorge through the third Millstone Grit in Back Forest. At Hug Bridge it passes across an outlier of Pebble Beds, resting on Permian Sandstone, lying on the Yoredale rocks, which it then traverses up to the Red Rock fault throwing in the Red Marls. These have been bored into at Howford Bridge, Buglawton, near Congleton, to a depth of 165 feet, of which 137 feet consisted of alternations of Marls with thin seams of blue, hard, fine-grained Sandstones, the remaining 28 feet being hard grey rock.

CONGLETON.—*Acres*, 2584; population, 11,116; wells in drift sand and gravel, belonging to the Glacial Drift, which deeply overlies this country, supported generally by the Lower Boulder Clay; rateable value, 30,687*l.*

BUGLAWTON.—*Acres*, 2852; population, 1550; wells and spring; rateable value, 10,209*l.* Rainfall at the Vicarage

in 1879, 347 feet above the sea, 34·41 inches; in 1880, 37·28 inches.

MIDDLEWICH.—*Acres*, 237; population, 3379; springs and wells; rateable value, 6201*l.* Brine Springs have been worked here for centuries. The tops of the shafts are about 100 feet above Ordnance Datum, and the brine rises to about 15 feet from the surface; the level is higher on a Monday than on a Saturday. Borings have been carried down from the bottom of the shafts, but no rock-salt was met with. Rainfall at Bostock Hall, 157 feet above Ordnance Datum, in 1879, was 32·46 inches; in 1880, 35·11 inches.

River Wheelock.

The *Dane* receives this tributary at Middlewich. It is 7 miles in length; it rises on the Red Marls, thence flows to the Red Rock fault, between Congleton and Talk, as does its southern feeder *Creswellshaw* Brook, which falls into the *Wheelock* at the village of that name. At the same point also falls in another brook, rising near the fault, and flowing through Betchton. The Grand Trunk Canal follows the lines of these valleys, crossing into the *TRENT* basin above Stoke, at 363 feet above the mean sea-level. At Wheelock, Malkin Bank, and Lawton, in the *Wheelock* valley, are brine pumping stations; at the latter place rock-salt was discovered at the end of the last century. The rock is not now mined, but brine is pumped from it.

SANDBACH.—*Acres*, 2584; population, 5493; supply from wells in Glacial Drift; rateable value, 19,104*l.* 3*s.* 5*d.*

The sands of the Middle Drift are well seen at Sandbach station, and northward to the valley of the *Dane* the whole country is deeply covered with Drift. From the latter valley to the watershed at Macclesfield the country rises steadily to 500 feet above the sea, the base of the Keuper Marls there attaining that elevation. Westward *Peover*, *Twam*, and *Wincham* Brooks drain chiefly an Upper Boulder Clay country, and fall into the *WEAVER* at Northwich.

NORTHWICH.—*Acres*, 1758; population, 12,246; supply constant, 30,581 gallons from a well 36 feet deep, and water abstracted from *Wade* Brook, a mile distant from township boundary, filtered through gravel, sand, and charcoal into a reservoir, thence pumped into high-service uncovered reservoir holding 44,000 gallons. The Rivers Pollution Commission does not consider it a good water. The total solid impurity was 27·96; chlorine, 2·43; total hardness, 14·0, of which 11·6 was permanent; rateable value, Local Board, 31,000*l*. The Rivers Pollution Commission states the water of Rostherne Mere, near Knutsford, had a total solid impurity of 20·34, hardness of 15·4, of which 10·6 was permanent. Rainfall at Highfield in 1879, 118 feet above Ordnance Datum, 32·28 inches; in 1880, 35·34 inches.

Brine springs and two beds of rock-salt occur at Northwich. The following is the section of the oldest mine in the district:—

Marston Mine.

	Feet.	
1. *Drift:* Boulder Clay	144	
2. Red Marl		
3. *First Salt Rock*	75–84	
4. Indurated Clay	30	126
5. *Second*, or *great salt rock* bed	96	

The upper salt bed, Mr. Ormerod states, is 90 feet thick north-west of Northwich, decreasing eastward to 81 feet, and thinning also south-westward at the rate of 15 feet per mile. The upper portion of the lower bed is not worth working, but the lower 15 feet is mined; the entire thickness of this seam in one instance is more than 117 feet. The upper bed was discovered in 1680 at Marbury, in sinking in search of coal; the lower and more valuable bed was not discovered until the end of the last century.

The Rivers Pollution Commission states* that the basin of the *WEAVER* contained, in 1801, 71,919 inhabitants; in 1871, 135,787.

* Vol. i. 'Report.'

RIVER MERSEY (*CI.*).

The *MERSEY*.—Length, 56 miles; area, 912, of which the Keuper Marls occupy 105 square miles, the New Red Sandstone 227, Permian 24½, and Coal Measures and Millstone Grit 566, of which 181 lie on the south bank of the *MERSEY* and the *Etherow*, and in the basin of the *Goyt* and *Bollin*.

The estuary of the *MERSEY* occupies a broad and extensive area between Runcorn and Garston, contracted at the entrance between Liverpool and Seacombe. In the Ordnance Survey Catchment Basin Map the estuary of the *MERSEY* lying north of the *DEE* watershed is relegated to the *WEAVER*, and the Lancashire shore, west of Garston, is amalgamated with the *ALT* Basin.

RUNCORN.—*Acres*, 820; population, 15,133; rateable value, 44,638*l*.; constant supply from well in New Red Sandstone, pumped into high-level reservoir. The Runcorn, Weston, and Halton Waterworks Act, 1865.

The watershed between the *WEAVER* and the *MERSEY* commences at Runcorn Point, and trends south-east by High Leigh, Knutsford, to near Bosley, 5 miles south of Macclesfield, thence it turns north-east to Forest Chapel, and again south-eastwards for a short distance around the sources of the *Goyt*, and eastward terminating against the central watershed of England, which here separates the *TRENT* Basin from the *Dane* and the *MERSEY* Basin, trending west of Buxton, east of Chapel-le-Frith, following the high ground of the Peak, it passes east of Glossop and falls into the minor watershed separating the waters of the *TRENT* from those of the *DON*, at a height of 1700 feet above the sea, trending north-west.

At Todmorden, the direction changes where the *MERSEY* watershed leaves the Pennine chain at a point 1200 feet above the sea, and trends south-west to Garston in the *MERSEY* estuary, passing south of Burnley at 1248 feet, south of Accrington at 1238 feet, south of Over Darwen at 1295 feet, above Horwich at 1183. Descending the hill, and crossing Red

Moss, near Blackrod, it ascends the ridge on which the village is built, once traversed by a Roman road, thence it bounds the basin of the *Douglas*, passes south of Wigan, where the watershed is crossed at 110 feet above Ordnance Datum, trending thence north-west it rises to 436 feet at Upholland, thence near Bickerstaffe, where it has descended to 201 feet above Ordnance Datum, and trends southwards, passing west of *Rainford* Brook and St. Helen's to Garston.

From opposite Warrington to the infall of the *Bollin*, the strike of the strata runs parallel to the river; they consist of Upper Mottled Sandstone at the bottom of the hill at Latchford, Thelwall, and Statham, dipping under an escarpment of Lower Keuper Sandstone, by Appleton, Grappenhall, and Lymm. The upper beds are the true Waterstones, and contain Labyrinthodont footprints.

Lymm.—*Acres*, 4375; population, about 4665; this district and Oughton supplied by a Company; rateable value, 25,000*l.*; works under 37 & 38 Vict. c. 29, 1874; Lymm Water Act. Rainfall at Statham Lodge, 42 feet above the sea, was 30·17 in 1879; in 1880, 32·31 inches.

The south bank of the *MERSEY* above the infall of the *WEAVER*, exclusive of the *Bollin*, receives, according to the Rivers Pollution Commission, the drainage of 107 square miles.

The country south of Lymm consists of Red Marls, and is drained by *Bradley* Brook, while good sections of the Waterstones are observable on the banks of the reservoir and lower down in the village; the basement beds are seen resting on the Upper Mottled Sandstone; where the stream falls into the *MERSEY* at Lymm Ees, it is called *Sow* Brook.

River Bollin.

At Heathley Hentin the River *Bollin* meets the alluvium of the main stream, into which it falls below Warburton. This tributary is 14 miles long, and drains 111¾ square miles, of which Carboniferous Rocks occupy 13¾, Triassic Sandstone 17, and Keuper Marls 81 square miles. Following its

left bank from its infall it receives *Agden* Brook, draining the Waterstones around Millington and the Red Marls of High Leigh, with this exception, the *Bollin*, for the first 9 miles of its course, and all its tributaries on both banks, drains a Keuper Marl country covered more or less with Boulder Clay and Middle Sand. South of Bowdon, it receives the River *Birkin*, draining Rosthern and Tatton Park Meres and Ollerton, and, with *Ashley* Brook, the country round Mobberley, Great Warford, and Alderley.

Beds of Keuper Marls with Gypsum rolling in various direction are seen in the *Bollin* from the infall of the *Birkin* to Quarry Bank Farm, between Ringway and Wilmslow, where the base of the Marls is seen resting on the Waterstones; thence, tracing it on towards its source, it flows by Wilmslow, Mottram Andrew, and Prestbury to Macclesfield, a distance of 10 miles, over Triassic Sandstones, following to a great extent the strike of the Upper Mottled Sandstone. East of Macclesfield it crosses the fault bringing up the Carboniferous rocks, and its feeders rise in the Yoredale rocks and Millstone Grits of Macclesfield Forest, between Forest Chapel and Wincle.

Following the right bank of the *Bollin* from its source, no tributary of importance comes in, until the River *Dean* joins it at Wilmslow. This stream flows south of Handforth over Keuper Marls, entering the New Red Sandstone south-east of the Railway Station, and passes south of Woodford and under the Manchester and Macclesfield Railway at Owlers Lane, 334 feet above the sea, following the strike of the Pebble Beds, and flowing nearly parallel to the course of the *Bollin;* crossing the Red Rock fault, it enters the Lower Coal Measures west of Bollington, and drains a Millstone Grit country between Rainow and Jenkin Chapel. The sandstones of this series are permeable, intercalated with impermeable shales dipping towards the Red Rock fault, so that all the water issuing at springs in this area is returned to the basin in which it is received.

Below the infall of the *Dean* and north of the *Bollin* lie the

villages of Styal, Ringway, and Bowdon, *acres*, 828; population, 2262; rateable value, 25,247*l.*; supply from the *North Cheshire Water Company*, who obtain water from the mains of the Manchester Corporation.

Sinderland Brook.

North of Warburton good sections of the base of the Keuper Marls and of the Waterstones are exposed in the banks of the *MERSEY* at Hollingfare, opposite which place the river receives *Sinderland* Brook, which follows the boundary between the Marls and Waterstones to near Timperley Station, where it divides; the southern feeder being *Timperley* Brook, rising on the Red Marls north of Ringway and flowing past Altrincham, the northern being *Bagnelly* Brook, rising on the Red Marls at Northenden Etchells and flowing over them to the north of Timperley.

ALTRINCHAM (Cheshire).—*Acres*, 657; population, 11,249; from *North Cheshire Water Company*, who obtain their supply from Manchester Corporation; rateable value, 51,489*l.*; North Cheshire Water Acts, 1864 and 1877.

The infall of the *Irwell* comes in at Carrington, at 40 feet above Ordnance Datum. The *MERSEY* from this point up to Stockport is often called the *Stockwell;* 4 miles east of the latter town it divides into the *Etherow* and the *Goyt.*

From Carrington to Ashton-on-Mersey the southern valley of the *MERSEY* consists of Upper Mottled Sandstone. At the latter place a north-north-west fault with an easterly downthrow throws the base of the Red Marls 3½ miles to the north, and the river flows over Keuper Sandstones to the bend in the stream east of Northenden, opposite Didsbury, where the Bunter Sandstone comes in.

A tributary rising on the Coal Measures of Lyme and Poynton Park, and flowing over the Pebble Beds of Bramhall and Adswood and the Upper Mottled Sandstone of Cheadle, falls into the main stream below the bridge.

Between Cheadle Bridge and Stockport the river flows over Pebble Beds resting on the Permian Sandstones, twice

brought to the surface by north-north-west faults. The Permian is again traversed for the third time at Stockport, and continues to the Red Rock fault, bringing in the Cheshire Coalfield near Offerton Green; the Lower Mottled Sandstones are absent all along the boundary of the Coalfield, the Pebble Beds resting on the Permian, and within is the coal area directly on the Carboniferous rocks. The bottom of the valley at Stockport is 140 feet above the mean sea-level, the top of the terrace is 256 feet (at St. Thomas' Church), the Permians at Hazel Grove, 295 feet.

STOCKPORT.—Population, 59,544; rateable value, 180,293*l.* 15*s.* 1*d.*; it is supplied by the *Stockport District Waterworks Company*, who obtain their supply from Lyme and Woodhead. The full supply is about 1,500,000 gallons per day to 60,000 persons, or 25 gallons per head per day for all purposes, partly supplied by the *Manchester Works*, under an agreement to provide any quantity of water required not exceeding 1,000,000 gallons per day, and partly by the *Stockport District Waterworks Company;* store reservoir at Lyme Park, and watershed 6 miles distant. During the 1868 drought, the Manchester supply was reduced in September, and it became apparent the Lyme Park reservoir would fail; recourse was had to wells existing at two old pumping stations in the town, from which the original water-supply was obtained.

The south-eastward trend of the *MERSEY* valley is continued across the Red Rock fault to the base of the Middle Coal Measures, near Offerton Green, whence it trends north-eastward, which direction is continued by the River *Etherow*, one of the two streams into which the *MERSEY* divides at Water Meetings.

River Goyt.

This stream, flowing from the south-east, drains 70¼ square miles, entirely consisting of Yoredale and Millstone Grit area. The Peak Forest Canal is carried along its left bank, falling into the Macclesfield Canal between Hollins and

Marple. The Stockport and Buxton Railway also traverses the left bank of the upper portion of the valley. In 1801 the basin was inhabited by 9287 inhabitants, in 1861 by 17,790.

MARPLE.—*Acres*, 3210; population, 4421; no public supply; the existing wells are wholly inadequate; rateable value, 20,177*l*.

Following the east or right bank of the stream from its source, a synclinal of Lower Coal Measures, with a north-east axis, is crossed between Whitehough and NEW MILLS; the latter is on the Rough Rock or First Millstone Grit, *acres*, 4834; population, 6600; a reservoir, made by the late Mr. G. W. Newton, now the property of Mr. F. J. Sumner, gives an intermittent supply to one-third of the district; another part of the district receives a constant supply from the reservoir of Mr. T. J. Phillips Jodrel; rateable value, 20,146*l*.

River Etherow.

North of Mellor the *Etherow* comes in from the north-east, draining 59¾ square miles, and, like the *Goyt*, drains a Lower Carboniferous area. Following the left bank from its infall, it flows past the Lower Coal Measures of Ludworth Intake and the Rough Rock of Charlesworth, it receives the stream draining the Yoredale and the Lower Millstone Grits of Glossop Dale, and drains on this bank 32½ square miles. The *Etherow* may be considered as the Upper *MERSEY*.

GLOSSOP is situated on the Kinderscout, or Fourth Millstone Grit. There are 19,574 inhabitants; supply under the Glossop Waterworks Act, 1865; the two reservoirs are the property of Lord Howard of Glossop; negotiations for their purchase by the Local Authority are in progress. Rainfall in 1879, at Spire Hollin, 612 feet above the sea, 39·11 inches; in 1880, 48·45 inches.

In the angle formed by the junction of *Glossop* stream and the *Etherow* is the site of Melandra Castle. Between this and Hadfield, an east and west fault with a southerly downthrow cuts off the Lower Coal Measures and higher Millstone Grits at Mottram, and brings in the Kinderscout and

Yoredale Grits, until they are cut off by the north and south fault emerging east of Stalybridge.

RIGHT BANK OF THE *MERSEY* AND *Etherow*.

The right bank of the *Etherow* drains 25¾ square miles of Carboniferous Rocks. It rises on the western slope of the Pennine chain; its head waters, draining 18,900 statute acres, form the drainage-ground of the *Manchester Corporation Waterworks*, of which the following table gives some details:—

NAME.	Area.	Capacity. Million Gallons.	Depth.	Topwater Above O.D.L.	Distance, Higher End in Miles.
	Acres.		Feet.		
Woodhead	135	1235	72	777	18
Torside	160	1474	84	653	16
Rhodes Wood	54	500	63	576	15
Arnfield	59	209	52	541	12
Hollingworth	13	73	52	555	11¾
Godley	15	61	21	478	8¾
Denton	13	53	20	323	5
Gorton	57	223	29	245	4¼
Prestwich	4½	20	22	..	..

These figures are taken from Sir Joseph Heron's statistics of the works, given to the Rivers Commission in 1867. The first three reservoirs impound the *Etherow*, and Sir Joseph stated it was intended to construct below them the Vale House Reservoir, holding 355,000,000 gallons, and the Bottoms Reservoir, holding 399,000,000 gallons, in all giving a capacity of 4,602,000,000 gallons. The Hollingworth and Arnfield reservoirs are on tributaries of the *Etherow*, bearing these names, and are included within the drainage area mentioned above. All beyond the first five in the list are outside it, and the four last outside the watershed of the *Etherow*. The reservoirs are situated between the Manchester, Sheffield, and Lincolnshire Railway and the Manchester and Hyde turnpike road, and run parallel to the road from Tintwistle, being carried through the hill at Mottram in a

tunnel 2 miles in length. North of Broadbottom Station, from Godley the pipe is laid down the road, through Hyde, Denton, Gorton, and Ardwick; a branch conduit, branching off at Hyde, and looping back, crosses the old main at Denton, and traverses Openshaw and Cheetham Hill to Prestwich. The following figures are given by Mr. Bateman as the mean rainfall of the *Manchester Waterworks* district:—

Mean rainfall 50 inches.
Mean „ of 3 dry years 40¼, of which 33 inches can be collected.
Rhodes Wood Min. of 12 years 34·49 Mean 44·20 .. 78 per cent.
Woodhead „ „ 40·33 „ 48·83 .. 84 „

Manchester Reservoirs.

RAINFALL IN 1879 AND 1880, OBSERVED BY MR. BATEMAN.

	Feet above Sea.	Inches. 1879.	Inches. 1880.
At Godley Reservoir	500	31·18	37·09
„ Rhodes Wood „	520	41·91	50·73
„ Arnfield „	575	39·57	46·98
„ Torside „	600	43·14	52·90
„ Woodhead „	680	46·61	56·97

Mr. Taylor, reporting to the Rivers Pollution Commission in 1868, when the population of Manchester was 470,000, states the supply was 15,000,000 gallons per day, or 32 gallons per head, from a gathering-ground on the upper valley of the *Etherow* of 18,900 acres; the yield of the springs is 16 cubic feet per second, or 8,500,000 gallons per day, the balance of 6,500,000 being supplied out of the storage reservoirs. The compensation water to mills in 1868 was 55 cubic feet per second, for 12 hours a day, or 15,000,000 gallons per day, making a total demand of about 30,000,000 gallons per day, to supply which 25½ inches would be required to run off the ground and be stored, out of

an average rainfall of the last 14 years of about 46 inches; or, in other words, the safe limit of a gravitation supply, the *available minimum*, had then been nearly reached. In 1865 the Woodhead reservoir could not be filled within 20 feet of its full height owing to a landslip and the unsoundness of the embankment, and the Torside reservoir from a matter of prudence, it being thought desirable to increase the level year by year by a foot or two, and also because the raising of the level to the full height would have drowned out the Crowden Bleach Works, which have been since purchased and removed by the Corporation. Since 1865, two new compensation reservoirs have been constructed below the Rhodes Wood Reservoir, called the Valehouse and Bottoms Reservoirs, which hold 750,000,000 gallons, or 50 days' supply of compensation water, which has been reduced from 75 to to 55 cubic feet per second for 12 hours per working day, affording an increase of 5,400,000 gallons of water per day for the use of the town. This relief was effected by its purchase from the millowners. Had this not been so the works would have failed to give the requisite supply in 1865.

Following the right bank of the *Etherow*, it flows through Long Den, passes the reservoirs, and crosses the Mottram east and west fault; it drains tracts of Lower Coal Measures, much broken and dislocated, overlying the Rough Rock of Weneth Low; between Compstall and Chadkirk it is joined by the *Goyt*, and becomes the *MERSEY*, which drains the Lower Coal Measures of Romily, Bradbury Green, west of which the Upper Coal Measures come in, until they are cut off by the Red Rock fault, running north-north-west by Midway House and Hyde Hall, throwing in the Permian, which occupies all the country lying between the fault and the Rivers *MERSEY* and *Tame*.

HOLLINGWORTH.—*Acres*, 2130; population, 2658; rateable value, 96,009*l.*; one-fourth of the supply from reservoir, rest from springs, wells, and pumps.

MOTTRAM-IN-LONGDENDALE.—*Acres*, 1084; population, 2911; rateable value, 10,000*l.*; no public supply; natural

springs and wells; reservoir required to intercept the springs.

The basin of the *Etherow* in 1801 was inhabited by 7307 inhabitants, in 1861 by 30,384.

River Tame.

The *River Tame* falls into the *MERSEY* below Castle Hill, Stockport, from the north-east following it up stream past Brinnington and Reddish Mills for 3 miles, it crosses the fault at Horden Hall, the Permians overlapping the Upper Coal Measures; at a short distance from this point it crosses the whole of the North Cheshire Coalfield at right angles to the strike as far as Hougham Dale, where it turns northward to Hyde, and trends first nearly with the strike, and then obliquely to it, so as to flow over higher and higher beds, until at Guide Bridge it reaches measures above the highest seam of the Middle Coal Measures. It drains 59½ square miles of country, of which 3½ are Permian and the remainder Carboniferous.

Several brooks rise in the Millstone Grits and Gannister Measures of Matley Moor, Godley, and Newton, and flow west into the stream below Guide Bridge, north of which the stream again turns eastward, and for the second time cuts across the entire coalfield. The seams dip west at angles of 20° to 30°, so that the horizontal distance between the outcrop of Great and Roger Mines and the Royley Mine, the representatives of the Ince Mines and Arley Mine of Wigan, is only three-quarters of a mile. The outcrop of the Royley Mine, the base of the Middle Coal Measures, occurs at Dukinfield, near which is the Dukinfield Colliery, 760 yards deep. Eastward to Stalybridge the river traverses the whole of the Lower Coal Measures in the space of a mile, with an average dip of 20°.

East of Stalybridge the river crosses the Rough Rock, and flows a little obliquely to the strike of the underlying Millstone Grits, so that it gradually in ascending towards its source gets on lower beds. On the hill-side above

it, and running about north, or nearly parallel to it, is a fault with a westerly downthrow, which crosses the *Goyt* between Disley and Mellor, and the *Etherow* at Compstall, and cuts off the Mottram fault. East of this fault, and north of the latter, is a tract of wild country, consisting of Yoredale Shale and Kinderscout Grit dipping east, while the Millstone Grits west of it are dipping west, which gives to this fault its name of the "Anticlinal fault," which crosses the *Tame* near Greenfield Station. East of this the stream flows through the Saddleworth valley, which is traversed by an anticlinal running east of, and parallel to the fault, bringing in the Yoredale series, consisting of shale, with a thick bed of Grit in the centre. At Dobcross the stream divides, the western feeder draining chiefly the country west of the anticlinal fault, the eastern feeder the Saddleworth valley. The Manchester and Huddersfield Railway, which runs along the right bank of the stream from Guide Bridge, here crosses on to the left, and north of Diggle Station is carried through the Pennine watershed in the Standige Tunnel, 2¾ miles long.

HYDE.—*Acres*, 3956; population, 28,629; constant supply from reservoirs storing springs of 200,000 gallons; rateable value, 99,000*l.*; the waterworks were purchased under 33 & 34 Vict. c. 17.

DUKINFIELD.—Population, 16,943; constant supply of 214,000 gallons from reservoirs, storing springs from the Millstone Grit hills; rateable value, 59,755*l.* Old works purchased under Ashton and Stalybridge Corporation Waterworks Act, 1864. New works being established under Ashton, Stalybridge and Dukinfield District Waterworks Act, 1870 and 1875. The works were vested in a joint committee on the 1st of July, 1878, under the Acts of 1870 and 1875, have to be worked, and then will be held jointly by those places and Mossley and Hurst.

STALYBRIDGE.—*Acres*, 783; population, 22,784; rateable value, 71,740*l.*; constant supply of 420,000 gallons, from impounding reservoirs at Knott Hill and Swineshaw,

and new works at Greenfield; joint waterworks, under 27 & 28 Vict., 1864, as above.

Rainfall in 1879, at Swineshaw, 884 feet above Ordnance Datum, 40·96 inches; in 1880, 44·31 inches.

The valley of the *Tame*, on the right or west bank of the stream, has a very short slope, the *Medlock* watershed running parallel to and often within a mile of the river. This ridge is tunnelled through by the Oldham and Delph Railroad, west of Lidgate; along the top of the ridge, known as Quick Edge, runs a Roman road, by Mossley. The short western slope continues by Lussley, St. George's, Stalybridge, Ashton-under-Lyne, Denton, Haughton Green, and Reddish.

The Manchester and Ashton Canal enters this valley on the right bank, near Guide Bridge; the Ashton and Huddersfield Canal crosses to the left bank, between Ashton and Stalybridge, recrossing at Greenfield Railway Station, whence the railway is carried beside it, and through the Pennine escarpment at Pule Hill.

Mossley.—Population, 13,372; rateable value, about 36,000*l.*; supply of about 30 gallons per head from Ashton Joint Waterworks; under 33 & 34 Vict., 1870, and Amendment Act, 38 & 39 Vict., 1875, as above.

Hurst.—Population, 6382; constant supply of about 30 gallons per head, from *Ashton Joint Waterworks.*

Ashton-under-Lyne.—Population, 37,027; constant supply from *Ashton Joint Works;* Ashton-under-Lyne Corporation Waterworks Act, 1855, and Ashton Joint Acts.

Audenshaw. — Population, 5930; constant supply from *Ashton Joint Works;* rateable value, 16,000*l.*

The *MERSEY*, from Stockport to Didsbury, flows through a broad valley, mainly excavated in Glacial Drift, from Heaton Norris and Withington to Manchester, consisting of Upper Boulder Clay, Middle Sand and Gravel, and Lower Boulder Clay, which outcrop in the valley, though to a certain extent they are there obscured by terraces of alluvial gravel in the valley, and on the plain above by a thin

covering of a post-Glacial sand. The Didsbury and Withington district is drained by a series of brooks running from east to west over the Drift; the most important of which is *Gore* Brook, rising over the Permians of Audenshaw, west of Guide Bridge, which is impounded at Gorton, flowing over Glacial deposits overlying Pebble Beds, through Rusholme, by Birch Church, and north of Withington, where Upper Mottled Sandstone crops to the surface, and thence north of Chorlton-cum-Hardy, where it enters the alluvium of the *MERSEY*, falling into the main stream, near Stretford.

From Stretford, by Urmston and Flixton to the *Irwell*, the whole country is deeply overlaid by Glacial Drift, more or less covered by post-Glacial Sand on the upland plains, and connected by terraces of alluvium in the bluffs bounding the alluvial plain of the river.

Manchester Corporation Waterworks supply: — Gorton, population, 33,091; rateable value, 100,000*l.* Withington, *acres*, 5729; population, 17,108; rateable value, 104,549*l.* 10*s.* Rusholme, *acres*, 1160; population, 11,237; rateable value, 72,350*l.* Stretford, population, 19,025; rateable value, 108,000*l.*

Rainfall in 1879 and 1880 at—

	Feet above Sea.	Inches. 1879.	Inches. 1880.
Urmston	80	31·51	35·22
Withington	110	31·15	34·65
Plymouth Grove	150 (O.D.)	33·35	36·00
Fairfield	312?	31·23	36·80
Alexandra Park	95	36·48	..