

NOTES ON BORINGS FOR WATER AND SALT IN THE COUNTY OF YORK.

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We are often told that the geology of England affords an epitome of that of Europe, and it is certainly equally true that an epitome of the geology of England may be found in the County of York.

Its wide diversity of strata, and difference of elevation and condition has a direct relation to its remarkable county boundary, which includes in an area of artificial limits, portions of river-basins draining into the eastern and western seas.

The county includes the northern and central groups of the rivers, making up the Humber basin, but the southern group of the streams of that basin are beyond its boundaries, while westward, where the Pennine Chain forms the Humber watershed, the West Riding of York overlaps the Pennine axis and occupies no less than 400 square miles of country draining into the Ribble, Lune, and Eden, the latter draining into the Mallerstang valley, should be considered as belonging naturally to the Cumberland rivers, while the two former should be under the jurisdiction of the Lancashire authorities.

The northern boundary of the Humber basin is the great east and west watershed crossing England from St. Bees Head to Robin Hood's Bay, north of Scarborough; but here also the County of York does not follow the physical feature but includes the south bank of the river Tees, which stream forms the county boundary from its mouth to Cauldron Snout, near its source under Cross Fell.

From the Tees the boundary ranges across the hills parallel to the Pennine axis, which it enters at Stanemoor and follows for a short distance, when it passes into the area of the western streams, draining into the Irish Sea.

Southward it again rejoins the Pennine watershed, below Colne, Skipton, and Blackstone Edge, leaving it at Mossley east of Staley-bridge, whence it turns eastwards, and follows the minor watershed between the tributaries of the Trent and the River Don which east-

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ward of Sheffield sweeps round by Bawtry and Crowle, to the mouth of the Humber at Adlingfleet.

In Yorkshire, west of the watershed, the rocks range from the *Silurians* to the *Coal Measures*, but the greater part of the area is occupied by the Lower Carboniferous Rocks, consisting of alternations of permeable limestone and sandstone, separated by impermeable shale, nearly the whole of the rainfall is rendered available, as the water absorbed is returned into streams as springs. The Gravitation Waterworks of the Preston and Blackburn Corporation are situated in this area.

Springs containing sulphuretted hydrogen occur in the shale and limestones lying below the Lower Beds of Millstone Grit, they are seen in the bed of the Hodder, and again at Clitheroe where there is a bath-house attached; over the watershed the Clitheroe anticlinal axis brings up the same beds as at Skipton, where the waters were formerly much sought after, which still further to the north-east on the same axis, are the well-known Harrogate mineral waters.

I am not aware that any boring for water exists in Yorkshire west of the watershed; east of it is a boring at Skipton, for Messrs. Scott & Robinson's Brewery, the boring was carried out by the London Diamond Boring Company. The boring is entirely in dark earthy limestone, and was carried to a depth of 500 feet without any alteration in the character of the strata. The water is very pure, but charged on reaching the top of the bore-hole with sulphuretted hydrogen.

The *Yorkshire Millstone Grit* has been very little bored into for water supply, but as the competition for surface water rights increase with the growth of trade and the increase of population in manufacturing districts, its valuable stores of water will doubtless be largely brought into requisition.

From the labours of Professor Green, F.R.S., and those with whom he was associated in the Geological Survey, it would appear that the First Grit (or Rough Rock) and the Fourth Grit (or Kinderscout Grit) are the constant subdivisions, between these two are a variable set of Middle Grits. The Kinderscout thickens steadily from Ashoweve to Keighley and Skipton by Huddersfield and Halifax. It is worthy of note that faults in the Millstone Grit become filled with shale

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material and form watertight boundaries ; water absorbed at the outcrop of the Grit beds flows down the dip, but if let off by a fault the water is thrown out as springs. In the Millstone Grits water is readily absorbed and flows mainly through joints, a supply from this source consequently quickly responds to rainfall, and has not the same retentive capacity as characterises the sandstone of the New Red Series. Barnoldswick, near Skipton, is supplied by a well and boring in the Millstone Grit, at a site chosen by the author.

The *Yorkshire Coal Measures* contain numerous beds of sandstone of considerable value for water-supply purposes. In search of coal their thickness has been proved, but they have not been rendered available for water supply as much as might have been expected. For the following details the writer is largely beholden to Professor Green, F.R.S.

The Oakenshaw, or Clifton Rock is generally a massive full-bedded sandstone, much divided by joints ; it is close in grain, and gritty in texture. In some districts it is in two beds, and the upper is called the Shortcliffe Sandstone Bed. The Thornhill Rock is the most important Middle Coal Measure Sandstone in the northern part of the field ; it is a close-grained, thin-bedded, valuable building stone, locally traversed by vertical joints. It occurs beneath the *Haigh Moor Coal* and above the *Joan Coal*, and is locally known as the Dewsbury Bank, Morley, Middleton, Robin Hood, and Oulton Rock.

Above the *Parkgate Coal* is the Parkgate, Croppingate or Birstall Rock. At Scholes Colliery it is 90 feet thick ; at the Old Pit Moor Colliery 170 feet, where it reaches its thickest ; it is thickly bedded, rather coarse, much jointed, and yields a large supply of water, requiring much pumping when it directly overlies the Coal. It was named the Bradgate Rock by William Smith, after the village where it is largely quarried.

The Woolley Edge Rock overlies the *Wathwood Coal* at Wombwell Main, where it is 120 feet 2 inches, with 12½ feet of shale intervening. East of Whitwell Main it lies above the *Wakefield Coal*, and 38 feet of it is described as the "Bleeding Rock," exuding acid water, this blistering the hands of the sinkers. The area of the rock is bounded by a line running west between Pontefract and Castleford, by Normanton ; then south by Woolley Edge, passing west of Hemingfield.

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Messrs. Mather and Platt have carried out the following borings :—at Walton, Wakefield, 9 inch boring to 770 feet, all in Coal Measures, Coal 4 feet 1 inch at 650 feet. Bradford 24 inch boring 295 feet, at bottom of well 55 feet deep, Coal Measures, to coarse sandstone. Bradford 12 inch boring to 327 feet through Coal Measure Shale, dark grey rock and very hard black rock.

The Oaks Rock is so called at Barnsley. At Trenton and the district south of Sheffield, it is called the Trenton Rock. It can be traced on its outcrop as far as Heath; east of Wakefield it appears to thin away along a line running roughly north-west, and south-east through Normanton. It usually carries a large quantity of water; when it is split up with shale the quantity is less. It is largely quarried for building stone and making grindstones, the most important quarry being near Barnsley, where the rock attains its full thickness, it is estimated to be 100 feet, and its base to be 850 feet above the *Barnsley Coal*. At Wath Main Colliery the total thickness of the rock was 55 yards; it yielded an enormous quantity of water, one feeder alone yielding 3000 gallons per minute, after the tubing was in the shop, but before it was fully “wedged,” the yield for months was 18,000 gallons per minute.

The Pontefract Rock is water bearing.

The following is the succession of the Trias and Permian in Yorkshire, given by Professor Phillips :—

Rhætic (?)	...	...	...	10 feet in thickness.
Keuper Marls, with thin greenish-white sandstone on the top	...	600 (?)	„	„
White solid Sandstone, or Waterstone	}	603 (?)	„	„
Soft Bunter Sandstone				
Conglomerate of the Bunter...	...			
Upper Permian Limestone	...	45	„	„
Gypseous Marls	...	50	„	„
Lower Limestone	...	150	„	„
Sands and Sandstone...	...	50 (?)	„	„

These lower beds are described by Phillips as resembling “the Lower Permian Sandstone of Manchester,” and I have no doubt that this identification is correct, and that the Colleyhurst Sandstone of Manchester, is on the same horizon as those of Tynemouth on the

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east coast. The overlaying Marl Slate of the Durham coast is represented in Yorkshire, by the fossiliferous laminated beds of Garforth. The Lower Limestone contains of carbonate of magnesia 45·7, while the Upper Limestone only contains about 4 per cent. of magnesia. Over this bed are the Knottingley red and pale laminated clays, which would appear to be on the horizon of the Marls associated with the slightly Magnesian Limestone of the Manchester area.

	Magnesian Limestone.	Triassic.
River Tees, south bank ...	nil	74 square miles.
„ Esk ... ..	nil	nil „
„ Foulness ... ..	nil	72 „
„ Derwent ... ..	nil	? „
„ Ouse... ..	50	500 „
„ Aire and Calder ...	44	96 „
„ Don ... ..	55	120 „
	149	862

In the Tees basin, it is worthy of note that the first discovery of Rock-salt was accidentally made in a boring for water, carried out by Messrs. Mather and Platt, for Messrs. Bolckow, Vaughan and Company, commenced in July, 1859, and finished in August, 1863. This boring is now part of the undertaking of the Cleveland Salt Company. The following Table gives an abstract of the information that has been obtained by boring for Salt between this boring and the most recent bore-hole at Lackenby, completed in November of last year, and also carried out by Messrs Mather and Platt :—

	N. Ormesby.	Middlesbro' B., V. & Co.	Imperial Ironworks.	S. Bank Eston.	Lackenby.
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
Surface Deposits ...	34 0	70 0	66 6	41 0	13 0
Upper Gypsum Marls ..	242 0	86 0	149 10	453 0	584 0
Red Sandstone and Marls	859 6	902 6	1117 2	836 6	598 0
Lower Gypsum Marls ...	182 9	132 8	203 6	200 0	448 0
Anhydrite and Salt Beds	121 3	114 10	155 3	148 8½	142 9
Magnesian Limestone ...	...	7 4	...	...	...

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The East Coast Saliferous Beds have invariably a bed of Anhydrite as the top, which overlies the "rotten marl" resting on the Rock-salt, beneath which is the Lower Anhydrite Bed, averaging 30 feet in thickness, but abnormally thickening to 267 feet at Hartlepool. The Anhydrite is interbedded, and passes horizontally into the Magnesian Limestone, and the strata from the Upper Anhydrite Bed downwards closely correspond to the Permian Zechstein Beds of Germany, containing Rock-salt associated with Anhydrite.

It was expected that the base of the Lias would have been found beneath the drift, but the boring commenced west of the outcrop, so that the maximum thickness of the Keuper Marls on the East Coast is not yet absolutely ascertained. On the West Coast they have been proved to be 900 feet in thickness, and as the Rock-salt occurs in the upper 320, it is possible that Triassic Rock-salt underlies the Lias of East Yorkshire, and looking to the maintenance of the thickness of the Rock-salt at the Lackington boring, it is possible that Rock-salt beds occur in North-East Yorkshire of two distinct geological ages.

The following are the details of the Lackenby boring :—

	Ft.	In.					Ft.	In.
	13	0	Clay and Gravel	...	...	...	13	0
	24	0	Hard Red Clay (Gypsum)	...	...	...	18	8
	87	0	Red Marl and thin rock	...	...	...	62	4
	246	8	Red Marl and band of blue	...	...	...	159	8
	255	0	Very Hard Rock	...	...	...	8	4
	343	0	Blue and Red Marl	...	...	...	88	4
	373	0	Dark Red Marl, blue stone	...	...	...	30	0
	380	0	Hard Blue Stone	...	...	...	7	0
	597	0	Red Marl	...	...	...	207	0
	1195	0	Red Sandstone	...	...	...	598	0
	1272	0	Red Marl	...	...	...	77	0
	1643	0	Red Marl and Sandstone (63) beds	...	...	...	371	0
	1663	3	Hard White Rock ( <i>Anhydrite</i> )	...	...	...	20	0
	1672	0	Honeycomb Rock	...	...	...	9	0
	1685	0	Salt and Marl mixed	...	...	...	13	0
	1804	0	Clear Salt Rock	...	...	...	119	0
	1806	0	White Rock ( <i>Anhydrite</i> )	...	...	...	2	0(+)

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The thickness of the beds beneath this boring is not known, but in all cases, borings that have been carried sufficiently deep between Middlesborough and Hartlepool, have proved the Magnesian Limestone to underlie the saliferous beds. It is worthy of note that the rock-salt of the east coast is invariably associated with amorphous sulphate of lime *without* water of crystallization (*Anhydrite*), which in the higher beds in which the sulphate of lime with water of crystallization (*Gypsum*) occurs alone, salt is absent.

Coatham 1567, communicated by Mr. Peacock, M.E. :—

Ft.	In.					Ft.	In.
6	0	1.	Clay ... ..			6	0
		2.	Blue Shale ... ..			39	0
		3.	Nodular band ... ..			1	6
		4.	Blue Shale ... ..			1	8
		5.	Nodular band ... ..			2	0
		6.	Blue Shale ... ..			6	4
		7.	Nodular band ... ..			1	6
		8.	Blue Shale ... ..			21	0
		9.	Bastard post (grey) ... ..			5	0
165	0	10.	Blue Shale, hard band ... ..			33	0
		11.	Dark Shale, Pyrites ... ..			12	0
		12.	White and grey post, <i>brine</i> ... ..			9	0
		13.	Red and white mottled posts ... ..			12	0
		14.	Dark-blue Shale, hard bands ... ..			19	0
223	0	15.	White Shale ... ..			18	0
		16.	Red Marl, Gypsum ... ..			74	0
		17.	Hard band ... ..			0	2
		18.	Red Marl ... ..			23	0
		19.	Hard band ... ..			0	3
		20.	Strong Red Marl ... ..			9	0
		21.	Gypsum ... ..			1	4
341	6	22.	Red Marl ... ..			0	9

Works for the manufacture of salt formerly existed on Tod Point, but whether from sea water or a brine spring is unknown. Strong brine was met with in a futile shaft sunk for coal in 1856, on Coatham Marsh by the late Mr. Slate, of Redcar, which led to the above boring being made, which however did not realize expectation.

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Boring for coal commenced in 1856, and continued in 1857-8, for Lord Falkland, at Kirk-Lavington; near Yarm, details from Mr. P. S. Reid, Mining Engineer :—

1.	Reddish Clay	...	...	27	0	} Drift	Ft.	In.
2.	Fine Sand	...	...	7	0			
3.	Common Sand	...	...	4	0			
4.	Fine Sand	...	...	10	0			
5.	Reddish Clay	...	...	51	0			
6.	Yellow Sandstone	...	...	0	8			
7.	White Sandstone	...	...	0	9			
8.	Sand and Gravel	...	...	4	0			
9.	White Sandstone	...	...	1	6			
10.	Sand and Gravel	...	...	3	3			
11.	Light-bluish Sandstone	...	...	...	...	119	10	
12.	Very hard White Sandstone	...	...	...	...	0	11	
13.	Light Fire Clay	...	...	...	...	1	5	
14.	Light Shale	...	...	...	...	2	6	
15.	Red Sandstone	...	...	...	...	204	3	
16.	„ Shale and Sandstone	...	...	...	...	1	0	
17.	„ Sandstone Hard	...	...	...	...	1	1	
18.	„ „ Soft	...	...	...	...	18	0	
19.	„ „ and Shale	...	...	...	...	0	3	
20.	Very Hard Sandstone	...	...	...	...	2	3	
21.	Shale	...	...	...	...	7	3	
22.	Very Hard Sandstone	...	...	...	...	2	6	
23.	Shale	...	...	...	...	7	8	
24.	Sandstone	...	...	...	...	4	0	
25.	Shale	...	...	...	...	4	8	
26.	Sandstone	...	...	...	...	2	1	
27.	Shale and Clay	...	...	...	...	2	8	
28.	Sandstone	...	...	...	...	3	9	
29.	Clay	...	...	...	...	0	7	
30.	Light Red Sandstone	...	...	...	...	1	9	
31.	Red Sandstone	...	...	...	...	13	9	
32.	„ „	...	...	...	...	3	0	
33.	<i>Magnesian Limestone</i>	...	...	...	...	6	9	



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						Ft.	In.
34.	Red Shale	...	...	...	...	3	0
35.	„ „ and Clay	...	...	...	...	8	8
36.	„ Fire Clay	...	...	...	...	9	5
37.	<i>Magnesian Limestone</i>	...	...	...	...	6	8
38.	Shale and Clay	...	..	..	...	2	3
39.	<i>Magnesian Limestone</i>	...	...	...	...	1	6
40.	Red Shale and Clay	...	...	...	...	5	1
41.	Sandstone hard	...	...	...	...	9	1
42.	„ „	...	...	...	..	4	9
43.	Hard light Red Sandstone	...	...	...	...	4	0
44.	Very hard „ „	...	...	...	...	1	4
45.	Red Sandstone, shale binds	...	...	...	...	6	4½
46.	„ Shale, Sandstone binds	...	...	...	...	16	2½
47.	Grey <i>Pyritic</i> Sandstone	...	...	...	...	1	0
48.	Red Shale, Sandstone binds	...	...	...	...	24	3
49.	Gypsum	...	...	...	...	0	9
50.	Red Shaly Sandstone	...	...	...	...	6	9
51.	Sandstone, Red Shale	...	...	..	...	20	6
52.	Shaly Sandstone, Gypsum	...	...	...	...	20	0
53.	Sandstone, Gypsum, and Carb. of Lime	...	...	...	...	17	6
54.	„ „ „	...	...	...	...	6	0
55.	„ „ „	...	...	...	...	14	6
						<u>710</u>	<u>0</u>

Mr. Reid doubts that the beds 33, 37, and 39 were truly referable to the Magnesian Limestone, but Mr. Morley, C.E., considers they belong to that formation, and the underlying beds to the Lower Permian Sandstone.

## SELBY WATERWORKS WELL.

Surface 20½ feet above mean sea-level. Yield 250,000 gallons from 6-inch boring carried to 330 feet ; water rises to 4 feet of the surface before pumping ; level restored in two hours.

	Alluvial soil	...	...	...	...	5	0	} 75 0
	Clay	...	...	...	...	24	0	
	Sand (water)	...	...	...	...	1	0	
	Clay	...	...	...	...	24	0	
75 0	Quicksand (spring)	...	...	...	...	21	0	

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93	0	Red Sandstone	...	...	...	18	0
93	1	Marl (like Fuller's Earth)	...	...	...	0	1
103	4	Red Sandstone	..	...	...	10	3
103	5	Grey „	...	...	...	0	1
167	2	Red „	...	...	...	64	9
285	8	„ „ harder	...	...	..	118	6
296	2	Very hard Rock	...	...	...	10	6
302	11	Red Sandstone	...	..	...	6	9
307	8	Very hard Rock	...	...	...	4	9
329	8	„ „	...	...	...	22	0

The water is 8 deg. of hardness.

The following is probably another account of the same boring :—

						Ft.	In.
Drift	{	Warp and Clay	...	...	...	10	0
		Strong Clay	...	...	...	10	6
		Sand and Clay	...	...	...	14	8
		Strong Clay	...	...	...	7	10
		Clay and Silt	...	...	...	8	9
		Grey Sand (water)	...	...	...	7	6
		Red Sand	...	...	...	6	6
		Indurated Sand	...	...	...	1	6
		Red Sandstone	...	...	..	54	6
		Red Clay and Fullers Earth, with Pipe Clay				5	0
		Red Sandstone	..	...	...	203	0
						<u>330</u>	<u>0</u>

A well at the opposite end of Selby was carried to a depth of 380 feet, and was still in the Red Sandstone. The water in these wells stands nearly up to the surface, and the Waterworks Well yields 243,000 gallons in 24 hours.

A well at Cawood, 300 feet in depth, is remarkable for the fact that at eleven in the morning of a certain day, the level of the water fell considerably, while at the same time the water at Selby was considerably augmented.

In the district occurring between Tadcaster and York the following sequence and thicknesses of the Trias and Permian Sub-divisions

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were estimated in 1875 by the late Rev. Clifton Ward, formerly of the Geological Survey :—

					Ft.
Trias.	{	Keuper Marls, red and blue binds, with sand-			
		stone and alabaster beds ... ..			400
		Bunter, Red Sandstone ... ..			900
Permian.	{	Upper Marls, thickness unknown ... ..			—
		Upper Limestone ... ..			40
		Middle Marls ... ..			30
		Lower Limestone... ..			200

At Tadcaster the Lower Permian Limestone was 170 feet in thickness, and rested directly on the Rough Rock of the Millstone Grit.

Towthorpe Common, near York, sunk January to April, 1879. Bore-hole 9 inch diameter and 311 feet 4 inch in depth, subsequently plugged at 210 feet. Water stands 15 feet above the river Fors, and is not affected by pumping. The surface is 60 feet above the sea-level. The section was as follows :—

						Ft.	In.
Top Sand	..	...	...	...	...	4	6
Fire Clay	...	...	...	...	...	15	0
Boulder Clay	..	...	...	...	...	15	0
Loamy Sand	...	...	...	...	...	6	0
Fine Warp Clay	...	...	...	...	...	9	0
Grey Sand	...	...	...	...	...	10	0
Boulder Clay	...	...	...	...	...	4	0
Green Sand	...	...	...	...	...	16	0
Green Sand, with layers of blue bind	...	...	...	...	...	18	0
Blue bind or Marl	...	...	...	...	...	1	9
Light Sandstone, with blue bind	...	...	...	...	...	35	0
White Sandstone	...	...	...	...	...	5	0
Blue bind	...	...	...	...	...	1	0
Red Marl	...	...	...	...	...	2	0
White Sandstone	...	...	...	...	...	81	0
Blue Marl	...	...	...	...	...	0	6
Variegated Sandstone	...	...	...	...	...	23	0
Blue Marl	...	...	...	...	...	0	3
Variegated Sandstone	...	...	...	...	...	60	0
Red Marl	..	...	...	...	...	3	0
						<u>310</u>	<u>0</u>

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The hardness of the water (Clark's scale). At the bottom of the bore-hole :—				At the depth of 210 feet :—	
Fixed	...	...	66·50	57	· 35
Temporary	...	...	26·25	30	· 15
Total...	...	...	<u>92·75</u>	<u>87</u>	<u>· 50</u>

Sulphate of lime gave nearly 78 grains. and sulphate of  
magnesia nearly 26 grains.

## YORK.

Messrs, Brett, Sparringate :—

Ft.	In.		Ft.	In.
70	0	Clay and sand, with piece of good oak at bottom	70	0
100	0	Ferruginous sand	...	30 0
130	0	Sand	...	30 0
180	0	Gravel and sand (water)	...	50 0

The surface of the ground here is about 30 feet above the sea,  
so that the bottom of the bore hole is about 150 feet below it. It  
is probable that the sand forming the lower part of the last 50 feet  
is referable to the New Red Sandstone, met with in the other York  
borings. Water stands 6 feet from the surface, and does not sink  
more than 2 feet.

Messrs. Steward & Sons, Comb Works, Walmgate Bar :—

	Ft.	In.
Clay and Stones	...	24 0
Sand	...	60 0
Fine Sandstone...	...	54 0

The surface of this well is about 50 feet above the sea, so that  
the surface of the rock here is 34 feet below it. Another boring was  
carried to a depth of 387 feet in the Red Sandstone. There are  
three borings in all, yielding 500 gallons per minute.

## North Riding Asylum, Clifton.

	Ft.	In.	
Sand	...	7 0	} 74 0
Peat	...	1 0	
Dense Blue Clay	...	13 0	
Do. Boulders	...	43 0	
Red Sand	...	10 0	

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						Ft.	In.
	Soft Red Sandstone	...	...	...	...	16	0
	White Sandstone	...	...	...	...	23	0
	Red Sandstone, with clay layers	...	...	...	...	25	0
	White Sandstone	...	...	...	...	10	0
	Red Clay	...	...	...	...	0	6
	Red Sandstone	...	...	...	...	20	0
	White Sandstone	...	...	...	...	8	0
	Red Clay	...	...	...	...	1	0
	White Sandstone	...	...	...	...	15	0
	Red Sandstone	...	...	...	...	3	0
	White Sandstone (Water)	...	...	...	...	2	0
	White Sandstone	...	...	...	...	11	0
	Red Sandstone	...	...	...	...	42	0
	Well, at Mr. Swale's, Walmgate Bar :—						Ft. In.
	Clay and Stone	...	...	...	...	24	0
	Quicksand	...	...	...	...	60	0
	Fine Sandstone	...	...	...	...	204	0
	Parting (water)	...	...	...	...	0	2
567 2	Fine Sandstone	...	...	...	...	270	0
	Well at Bilton Hall, near York :—						
	Drift	...	...	...	...	60	0
	Red Sandstone	...	...	...	...	(+)	
	GOOLE.						
	Boring in connexion with Railway Bridge over the Ouse :—						Ft.
	Silt and Sand	...	...	...	...	...	20
	Black Peat	...	...	...	...	...	18
	Soft Brown Clay, Sand, or Gravel	...	...	...	...	...	18
	Soft Blue Shale (water)	...	...	...	...	...	18
104 0	Strong Blue Shale, with Gypsum	...	...	...	...	...	30
	HOLME, NEAR MARKET WEIGHTON.						
	Well at Blacksmith's Arms :—						
	Sand (sunk)	...	...	...	...	...	15
	Blue "Stone," with layer of "plaster" on bottom	...	...	...	...	...	60
300	Blue or Brown "Stone" (? Marl)	...	...	...	...	...	225

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## SALTMARSH.

Sinking and boring in 1834 :—

Drift	{ Earth ... ..	36	201
	{ Quicksand ... ..	18	
	{ White and Blue Plaster (Gypsum) and Red Marl	126	
	{ Blue Marl ... ..	33	
	{ Red Marl ... ..	42	
315	Soft Red Sandstone ... ..	60	

## DONCASTER.

Boring for water supply. Failed in obtaining one, 1867 :—

Warp	...	...	...	4 0	}	22 0	Up. Marl & Sandstone.
Blue Clay	...	...	...	14 0			
Quicksand	...	...	...	2 0			
Gravel	...	...	...	2 0			
Red Sandstone	...	...	...	90 0	}	Upper Magnesian Limestone Brotherton Beds, 110½ feet.	
Red Clay	...	...	...	36 0			
Limestone	...	...	...	0 4			
Red Clay	...	...	...	1 4			
Limestone	...	...	...	0 8			
Red Clay	...	...	...	1 5			
Limestone	...	...	...	0 1½			
Red Clay	...	...	...	0 6			
Limestone	...	...	...	0 4½			
Red Shale	...	...	...	2 3			
Limestone	...	...	...	0 1½	}	Middle Marls.	
Shaly Limestone	...	...	...	6 0			
Blue Clay	...	...	...	0 3			
Limestone	...	...	...	48 0			
Blue Clay	...	...	...	6 7	}	Middle Mag. Lime. Marl Slates (?)	
Red Clay with Sulphate of Lime	...	...	...	42 0			
Limestone	...	...	...	210 0			
Blue Shot	...	...	...	8 0			

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Fire Clay	...	...	...	18	0	} Coal Measure.
Coal and Marl	...	...	...	18	0	
Grit	...	...	...	0	9	
Shaly Clay	..	...	...	84	0	
Grit	...	...	...	4	6	
845 8½ Shaly Clay and Grit beds	...	...	...	244	6	

Rods broke, and could not be raised.

Boring at Reedness, upon the estate of Mr. John Egremont, commenced Oct. 7th, 1835, superintended by Mr. John Walker, C.E. The details were obtained by the late Rev. Clifton Ward, who divided the beds as follows.—

						Ft.	In.
Warp and Gravel	...	..	...	69	0		
Keuper	..	...	...	272	2		
1028 10 Bunter	...	...	...	687	2		

Dr. Parsons has given further details of this and adjacent borings in the Proc. Geol. and Polyt. Soc. of West Riding, 1877, p. 216.

The *Yorkshire Oolites* occupy the following areas :—

In the basin of the Tees	..	...	...	nil.	
„ „ Esk	...	...	..	183	sq. miles.
„ xxxvii. basin Ordnance Survey	...	...	...	57	„
„ xl. „ „	...	...	...	nil.	„
„ the basin of the Hull	...	...	...	nil.	„
„ „ Foulness	...	...	...	8	„
„ „ Derwent	..	...	...	57	„
„ „ Ouse	...	...	...	42	„
„ „ Aire and Calder	...	...	...	nil.	„
„ „ Don	...	...	...	nil.	„

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The average percolation of rain water will be 5 inches annually, or 200,000 gallons per square mile per day, giving an available quantity of 69½ million gallons, or a supply at 30 gallons per head for more than 2¼ million inhabitants. Amongst those who draw upon this supply is the town of Scarborough. The Waterworks Well is near Osgodby, it was sunk in October 1870, and has not been

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deepened since. It is 160 feet above the sea, and a ten-foot shaft is carried to a depth of 91 feet, with a bore-hole at the bottom 6 inch in diameter carried a further 45 feet, or a total depth of 136 feet. Three headings are driven out from the shaft, with a total length of 70 yards. The water level varies with the speed of pumping and the season, no full record has been kept; the average pumping level is 70 feet from the surface, when 600,000 to 800,000 gallons of water are abstracted. The following is an analysis of the water :—

						Grains per gallon.
Carbonate of Lime	..	...	...	...	...	10·150
„ Magnesia	...	...	..	...	...	3·129
Sulphate of Lime	...	...	...	...	...	3·036
Chloride of Sodium	...	...	...	...	...	1·569
„ Calcium	..	...	...	...	...	1·792
Silica	...	...	...	...	...	·294
Alumina and Oxide of Iron	...	...	...	...	...	·126
Organic Matter	...	...	...	...	...	·280
Nitric Acid	...	...	...	...	...	·376
Iron	...	...	...	...	...	Trace
						<u>20·678</u>
Hardness in Clark's scale						
Before boiling	...	...	...	..	...	15°
After boiling half-an-hour	...	..	...	...	...	5°

Boring at Salton, near Malton, North Riding, carried out in 1880, at 150 feet above the sea, the water overflows the surface from a 4 inch boring, carried to a depth of 316 feet, the water is slightly sulphurous. The section was :—

					Ft.
Fluviatile Drift (R. Rye)	...	...	...	...	15
Kimmeridge Clay	...	...	...	...	276
					<u>316</u>

Boring at Irton, near Scarborough, finished August, 1882. The surface bank is 94 feet above the sea. A well was sunk 70 feet, followed by a boring 25 inch for 28 feet; 20 inch for 152 feet; 12 inch for 189½ feet, or to a total depth of 439½ feet. The water over-



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flows the surface at the rate of  $1\frac{1}{4}$  million gallons per 24 hours. The level does not vary, but after heavy rains the quantity increases :—

		Ft.	In.			Ft.	In.
Drift.	Clay and Soil	...	2 3	Light Compact Rock	...	9 0	
	Gravel	...	17 0	Hard Rock	...	34 6	
	Clay	...	2 9	Black Coloured Hard			
	Sand and Gravel	...	0 9	Rock	...	9 0	
	Marl...	...	1 0	Open Rock, with hard			
	Sand and Gravel	...	2 9	binds	...	19 0	
	Marl	...	8 6	Hard Rock	...	94 0	
	Sand with Boulders	...	4 9	Soft or Shaly Rock	...	8 0	
	Gravel	...	3 0	Hard Rock	...	86 0	
	Warp	...	5 9	Rock, strong bind	...	4 5	
	Brown Marl	...	5 3	Close Rock, mixed with			
	Kimmeridge Clay	...	44 3	Shale and Sand	...	14 6	
	Rock	..	21 0	Blue Shaly Clay	...	16 6	
	Very Hard Rock	...	25 6	Total	...	439 6	

Beneath the *Chalk* of Yorkshire the underlying strata have been uplifted by a gentle anticlinal, from which the beds northwards and southwards, the summit of this anticlinal axis has been truncated and denuded, before the deposition of the chalk, which rests upon the Kimmeridge Clay at Sherburn and the Lias at Huggate, where the upper beds of the Lias were penetrated by a deep well.

At Bridlington Quay occurred the following section :—

Brown Boulder Clay	...	28 ft.
Hard Conglomerate, Flints and Chalk	...	15 „
Chalk	...	(x)

An artesian supply of good water was obtained, which ebbed and flowed with the tide.

## DRIFT.

Professor Phillips [Geology of Yorkshire, p. 280, Part. 1] long since pointed out that glacial drift fills up an old sea-loch at the Vale of Pickering, and which contain a water-bearing gravel underlying Boulder Clay varying from 30 to 55 feet in thickness. Many artesian borings have been made, the deepest being that at Yeddingham, in the middle of the Vale ; they vary from 68 to 95 feet in depth, and the water rises by artesian pressure from 5 to 20 feet above the surface of the ground.