

No, 1,516.—“The Whiston Pumping Station, St. Helen’s, Lancashire.” By THOMAS SULLOCK STOOKE, Assoc. Inst. C.E.

THE requirements of the borough of St. Helen’s, Lancashire, having rendered it necessary to provide some additional water supply, the Corporation intrusted the Author with the preparation of the plans for the works, and with the direction of their execution. The selection of the site for the works was made under the advice of Professor Edward Hull, as being the best available, under the circumstance of a successful opposition by the proprietor of the one first selected, which was situated $1\frac{1}{4}$ mile to the south. The following reasons were advocated in its favour,¹ viz.: 1. That the rock was the Upper² and Mottled Sandstone of the Bunter division of the Trias; and that it, together with the Pebble beds, existed to a depth of from 200 to 250 yards, and these are the chief water-bearing rocks of the district. 2. That the beds of the New Red Sandstone to the east rise to the surface at a considerable elevation above the site of the well, the strata consisting of moderately soft and porous sandstones; this district, together with the tract of country to the north and south, being considered a good gathering ground for water supply. 3. That the site being about 200 yards to the east of a fault, towards which the sandstone dips, the water would have a general tendency to flow in the direction of the dip, or towards the fault, which would act as a barrier to its farther progress.

The area of land secured for the works was 1 statute acre, and the works were so arranged that there should be sufficient space above the natural level to allow for the deposit of material obtained from the sinking of the wells. The buildings consisted of an engine house, a house for three boilers, each 30 feet by 6 feet, a coal shed, a chimney, two cottages, a weighing-machine house, and smithy; also a cooling pond, having an area of about 8,250 square feet with a depth of 6 feet.

The permanent engine consisted of a 50-inch cylinder single-power expansion engine, with an equal beam and 9-feet stroke.

¹ Journal of Royal Geological Society of Ireland, vol. iii., part ii., new series.

² Since the completion of these works, facts have been placed before Professor Hull which have satisfied him that the beds passed through are those of the *Lower* and Mottled Sandstones, and not the Upper.

This was capable of delivering 1,000,000 gallons of water in twenty-four hours from a depth of 75 yards to the service reservoir, at an altitude of 60 feet above the level of the works, and at a distance of about $2\frac{1}{2}$ miles; the total lift was thus 285 feet. The lift of the pump consisted of 50 yards of 18-inch pipe with a 17-inch working barrel from the bottom of well, and of a plunger $17\frac{3}{4}$ inches in diameter, with a stroke of 7 feet $9\frac{1}{2}$ inches, worked 13 feet from the centre of the beam and 2 feet inside the centre for the drawing lift. The plunger pump, with valve chests, air vessel, and the necessary connections, was fixed about 20 yards under the engine-house floor, and received its supply of water from a cistern fed by the drawing lift, delivering it direct to the service reservoir, through the line of pipes shown on the map (Plate 5).

In the year 1870, two wells, each 9 feet in diameter, were commenced, 12 feet apart, so as to form independent shafts for duplicate pumps and engine power. At a depth of 25 feet rings were placed on the rock, and brickwork was carried to the surface. A depth of 18 yards was reached before water was met with, and the sinking was carried down 34 yards without the aid of pumps.

A 20-inch horizontal engine, with pumping gear in the ratio of 1 to $2\frac{1}{2}$ of the engine shaft, with two T pumping beams, were erected, each capable of working a 12-inch lift with a 4-foot stroke fixed in the duplicate engine well. The sinking was carried to a depth of 45 yards, when a heading was driven eastward, to a point underneath the other well. A semicircular arch of brickwork was built as the heading was driven. Both wells having been sunk to a uniform depth of 45 yards, the sinking was proceeded with as one well, 30 feet long by 9 feet broad. At a depth of 59 yards the yield was about 200,000 gallons in twenty-four hours, which at the full depth of 75 yards, being 25 feet below mean sea-level, increased to 400,000 gallons in twenty-four hours. A borehole 18 inches in diameter was then put down from the bottom of the main well, and, when at a depth of 104 yards from the surface, it was found that the character of the rock had changed, the boring tool coming up clogged with red clay, followed by a core of fine-grained purple micaceous sandstone, in all respects similar to the rock exposed in the adjoining railway cutting, and belonging to the triangular area of the Coal Measures marked D 5 (Plate 5). The boring operations were consequently suspended. No material increase of water was obtained by this borehole, but the position of the fault was thereby enabled to be determined with accuracy; for as the horizontal distance from the

outcrop of the fault to the well was about 200 yards, the slope of the fault was 2 horizontal to 1 vertical. This slope is so gradual that if not altogether unprecedented, it is at least of extremely rare occurrence.¹

The permanent engine and pumps having been erected, and the main laid connecting the pumps with the St. Helen's service reservoir, water was first delivered into it in the summer of 1871, eighteen months after the works had been commenced, and an average daily supply of 320,000 gallons was maintained for the remainder of the year. The quantity being less than one-half that for which the machinery had been constructed, it was decided to drive a tunnel eastward, about 240 yards in length, to the boundary of the township, and at this point to put down a borehole to intercept the tunnel; it being calculated that the sandstone existed there to a depth of fully 200 yards.

The tunnel was started from a scaffold fixed 9 feet above the bottom of the main well, in February 1872, and as the fissures in the rock were laid open, the water pumped out increased to about 430,000 gallons a day. In May, when the tunnel had been driven to a distance of 87 yards, a portion of rock was forced out by a strong current of water shortly after a shot had been fired, with such force as to endanger the men's lives. The water rose in the well to a height of 43 yards during the next twenty-four hours, notwithstanding that during this time upwards of 500,000 gallons had been pumped out. When the column was reduced, to test the rate of supply, 900,000 gallons were pumped in twenty-four hours, and a constant depth of $25\frac{1}{2}$ yards of water maintained in the well. At this date the requirements of St. Helen's necessitated the supply from these works of at least 600,000 gallons of water daily. It was, therefore, evident that the completion would have to be carried on so as not to interfere with the supply of water to the town.

The Author then proposed, and was instructed to sink, an auxiliary well on the site of the borehole at the eastern end of the projected tunnel; but the commencement of the work was delayed on account of the Corporation having to seek powers for the purchase of the land. The supply to the town was continued up to the 7th of December, with an average daily yield of 640,000 gallons, the depth of water in the well at no time being less than 25 yards. When this supply to the town ceased, the water quickly rose to a height of 42 yards.

Preparatory to carrying out the work for the auxiliary well the

¹ *Vide* "Philosophical Magazine," March 1872, No. 285, p. 239.

ground was tested by boring, and was found to consist of sand to a depth of 12 yards. This was charged with water from a stream close by, which formed the boundary of the township of Whiston. Recourse was therefore had to cast-iron cylinders. Having excavated sufficiently to a depth of 12 feet, a strong cast-iron ring was suspended by bolts to baulks of timber laid across the surface. On this was built a ring of 9-inch brickwork of 12-feet inside diameter, well-backed all round the outside. The object of this brickwork, which was temporary, was that guides might be placed for maintaining the perpendicularity of the cylinders during their descent. The first cylinder was 6 feet deep and $10\frac{1}{2}$ -feet inside diameter, and weighed about 5 tons, the lower end being pointed. As the excavation allowed this to descend, it was supplemented by another length of eight segments, $1\frac{1}{4}$ inch thick and 3 feet deep. The second series of segments consisted of three 1-yard lengths, $1\frac{1}{8}$ inch thick. The third series of segments consisted of three 1-yard lengths, 1 inch thick, thus making a total length of 9 yards of cylinders, all strongly bracketed and jointed together with $\frac{7}{8}$ -inch bolts. Each joint had a strip of pitch pine between the faces of the iron to make the joints watertight. When the cylinders were bedded on the rock, the temporary brickwork at the top of the well was replaced by cemented brickwork backed with puddle, forming a circle of equal diameter with the cylinders below. After proceeding a short distance with the sinking an open fissure was met with, which necessitated brickwork underneath the cylinders. This fissure was the same as that from which the large flow of water came into the tunnel.

The sinking of the auxiliary well was proceeded with to the depth of $34\frac{1}{2}$ yards without water. At 53 yards the yield had increased to about 380,000 gallons in twenty-four hours. At the depth of 75 yards there was a yield of about 470,000 gallons; and the combined yield of the two wells was then about 970,000 gallons in twenty-four hours. Previous to the completion of the sinking it was found necessary to make additional lodge room, to provide greater storage capacity for the water, and thereby to give more time for changing the clacks of the pumps. As a precautionary measure the clack pieces were bored to receive extra clacks, dropped through the pumps in case of accident, and this was of great use on many occasions. The clack piece of the drawing lift of the permanent engine had no door, the clack being dropped through the pump trees, and drawn by a "jack head," attached to the rods after the bucket was drawn.

As soon as the auxiliary well had been sunk to the same level as

the main well, the driving of the tunnel was commenced, and the connection between the two wells completed in September 1875. Arrangements were then made for driving a borehole from the bottom of the auxiliary well. With a view to avoid difficulty from the large quantity of sand yielded by the fissures in the rock, and to enable the general yield of water to be utilised during the progress of the boring, the Author fixed a 20-inch bore-pipe, lagged on the outside with wood, in a 26-inch hole, bored 9 feet deep in the bottom of the well. This being fixed in place and stayed by strong oak bearers across an enlarged flange, another 20-inch pipe was fastened on it with a branch, to which was attached an 18-inch sluice-valve open at the bottom, to prevent pieces of rock obstructing the valve. This valve was controlled from the surface by a screw and pillar. The 20-inch pipes were carried up the auxiliary well so as to form an independent shaft, within which the boring operations were carried on. The dirty water rising from the borehole was thus kept separate from the ordinary supply of water in the well, which was pumped to the service reservoir.

The boring operations were commenced on the 28th of December, 1875, with Messrs. Mather and Platt's machine, the borehole being 18 inches in diameter. The level of the water in the pipes rose but little above the level in the well, until the 6th of January, when a layer of sand (marked A in the section, Plate 5) was pierced, and the water immediately rose 6 feet higher in the pipes. In continuing the boring operations, on reaching the points B, C, and D, successive increases in the height of water were obtained within the pipes, the consequent variations in the levels being indicated by the lines in the section. On reaching a depth of 240 feet below the bottom of the auxiliary well, a fault of white clay was encountered, which it was considered undesirable to penetrate. These boring operations were carried forward at the rate of 6 feet per working day of twelve hours; on some days a depth of $9\frac{1}{2}$ feet was bored.

A general account will now be given of the water supply during the conduct of the works (see Appendix).

Early in 1872 the average daily yield of water was about 430,000 gallons. The level of the water in the well was kept during the early months of the year about 3 yards in depth, until by the tunnelling operations a large supply was tapped, which suddenly raised the level of the water in the well to 43 yards from the bottom. During the remainder of the year it was never below 25 yards, while the average daily supply of water for the entire year was 640,000 gallons. When the supply to the town was

[1876-77. N.S.]

stopped in the middle of December, the column of water in the well rose to the height of 42 yards.

In January 1873 the pumping was recommenced, and the average daily delivery throughout the year was 684,000 gallons. In February and April the water-level in the well was reduced to 8 and 9 yards respectively, for the purpose of testing the yield, which proved to be about 1,000,000 gallons in twenty-four hours. During the course of this year the general level of the water fell progressively, and this may be fairly attributed to the reserve stored up in the sandstone being drawn upon. From the 9th of July to the 13th of August the pumping was continuous; but from the 13th of August to the 3rd of December the pumping ceased for twelve consecutive hours in each week. During the periods in which the pumping was discontinued the water rose at first to the height of 37 yards, but that height progressively decreased.

During 1874 the average daily delivery of water from the main well was 599,000 gallons; but early in the year the operations connected with the sinking of the auxiliary well necessitated the pumping of a large quantity of water to waste, and this double demand upon the supply caused a steady decrease in the level of the water. In August, when the column of water had been reduced to 6 yards, sand was brought away through the pumps. It was therefore arranged to maintain for a time a uniform depth of 8 yards of water, and in order to provide for the decrease in the supply from the main well, water was largely utilised from the auxiliary well. For this purpose two Universal pumps were employed in connection with the pumps used for drawing off the water from the auxiliary well, a connection with the pumping main having been previously made. The total yield of the two wells was 1,000,000 gallons daily.

Early in 1875 the level of the water in the main well was considerably reduced by the advance of the tunnel, which on the 13th of February had been driven within a distance of 100 yards of that portion of the tunnel coming from the main well. At this time it appeared desirable to make arrangements for the removal of the sand which had accumulated in the tunnel connected with the main well, and for this purpose the water was pumped to its lowest level. It was then found that upwards of 350 tons of sand had been washed from the fissures in the rock. This was not altogether undesirable, as it increased the underground storage space for water. During this year the average daily yield of the wells was 1,000,000 gallons, of which about 629,000 gallons were delivered into the service reservoir for the use

of the town. As the progress of the works, and the urgent demand for an increased supply, rendered the delivery somewhat irregular, the varying depth of the water in the well (Plate 5) loses much of its importance for the present purpose. During the greater part of the year the supply was chiefly delivered by the Universal pumps at the auxiliary well.

In 1876, the mean daily supply was 868,000 gallons; for the latter half of the year the average daily delivery was 938,000 gallons. The height of the column of water in the wells was less variable than in preceding years. The more equable supply was largely dependent upon the fact, that from the latter part of May the water from the borehole at the bottom of the auxiliary well was utilised at discretion. It will be seen from the diagram (Plate 5) when the water was so employed. The portion marked shows the height of the column of water in the pipes connected with the borehole from the auxiliary well, and it therefore represents, to some extent, the available reserve of water in the sandstone beds tapped by that borehole. It is worthy of remark that the supply from this borehole was held under complete control by the valve near the bottom of the auxiliary well, which was regulated on the surface by a screw and pillar. In this way the water supply of a new and extensive tract of country, representing 500,000 gallons daily, supplemental to that drawn upon by the wells, was available for use or reserve at discretion. This arrangement is also advantageous in the command it gives over this large flow of water, whenever it is desired to lower the water in the wells.

From an engineering point of view, works of this description, dependent upon a single pumping arrangement, which may be liable to get out of order, are so far undesirable. The complete scheme proposed to the Corporation of St. Helen's embodied a duplicate engine and pumps. It has, however, been decided that the permanent works already executed are sufficient, inasmuch as the valve gives control over the deep water supply. The temporary pumps used in the sinking operations are retained for cases of emergency.

This pumping station has had an important influence upon the supply of water in other wells in the immediate neighbourhood, particulars of which are given in the following schedule. (See next page.)

There have been indications recently of the water being drawn from the wells near Rainhill Mill, $1\frac{1}{4}$ mile to the south-east; also from the well at Higher Shaw Farm, upwards of 1 mile to the

	Distance from Pumping Station.	Bottom of Well.		Water taken away.	Depth of Pumping-Station Well or Borehole at time.
		Depth under Surface.	Height above Mean Sea-level.		
	Yards.	Feet.	Feet.		Feet.
Cumber Lane well	110	66	134	November 1870	141
Higher Sides well .	265	75	115	May 1871	207
Prescot Union well	600	84	143	Summer of 1871	225 ¹
Wells marked A, B, C, D, E, F, G .	600 to 800	21 to 33	about 200	Late in 1871	312
O O O	{ 550 to } { 1,100 }	75	160	November 1873	312
Sandfield Cottage well	600	51	109	Late in 1873	312
Fairchild's Farm well	1,020	50	100	Early in 1874	312
Dean's House well.	1,130	10	178	Ditto	312 ²
				Water largely reduced.	
Holt Hill House .	1,000	83	147	1876	465
Twist's Quarry .	1,300	30	240	1876	465

south of the Whiston Pumping Station. Many of the wells mentioned in the above schedule were the only sources of supply for portions of the rural district of Whiston. The loss of water from these wells necessitated the supply from some other source; and, acting under the instructions of the sanitary authority of the district, the Author carried out a scheme for giving the district an independent supply. Incidentally it may be mentioned that any extensive arrangements for the supply of water to towns from deep wells, which lower the level of the water in the district, facilitate the percolation of surface water, which is too often rendered impure by mixture with sewage matter into old wells, and afford temptation to divert such sewage into the wells thus laid

¹ In June 1874 a borehole was put down to a depth of 68 yards. The water stood in it to a depth of 49½ feet, but in March 1876 it was reduced to 40 feet, in July it had fallen to 32 feet, and in November to 25 feet, being a total reduction in height of water-line of about 95 feet.

² In the summer of 1876 this well was deepened 28 feet, and a borehole put down from the bottom to a depth of 90 feet; this at present yields a good supply of water.

dry. The objections arising from such a course of procedure are obvious, and demand the attention of local authorities.

The cost of the works is an important feature in the success of any scheme. The statement which follows represents the actual outlay upon these works. It is, however, desirable to mention that, as a considerable quantity of water had to be delivered to the town during the execution of the works, their progress was interfered with, which enhanced their cost, especially that of the auxiliary well and tunnel.

EXPENDITURE ON WORKS.

	£.	s.	d.
Parliamentary charges and purchase of land, &c.	3,434	4	5
Engine and boiler houses, cottages, and boundary wall	3,674	10	8
Engines, boilers, and pumps	7,217	1	3
Sinking engine and duplicate engine wells.	2,170	6	1
„ auxiliary well	6,411	11	8
Tunnel	4,295	4	7
Boring machine and boiler	633	3	0
Boreholes (including 20-inch pipes, &c.)	1,282	11	4
Cooling pond	560	11	5
Miscellaneous charges.	1,818	19	10
15-inch pumping main	5,000	0	0
	36,498	4	3

	£.	s.	d.
The annual charge for interest and for the repayment of a loan raised for the works extending over forty years amounts to	2,348	2	0
The annual working charges for the daily delivery of (say) 900,000 gallons of water (the cost of fuel being 5s. per ton) may be taken at	1,300	0	0

Total annual charges	3,648	2	0
The water delivered to the borough of St. Helen's is charged at a rate not less than 4d. per 1,000 gallons, and at this minimum rate the supply of 900,000 gallons per diem gives an annual revenue of	5,475	0	0

The town of St. Helen's, therefore, receives a net revenue of about £1,800 per annum, after deducting all costs and charges incurred in providing this portion of its water supply. Great as are the advantages which have already resulted from these works, by yielding to the borough a profitable supply of water of excellent quality, it is evident that the present supply can be largely increased.

The communication is accompanied by several drawings, from which Plate 5 has been compiled.

APPENDIX.—PUMPING

From May 21st to December 7th, 1872, 127,907,000 gallons delivered.

1873. Week ending	Number of Hours Pumping.	Thousands of Gallons Pumped.	Mean Height of Water in Well.	1874. Week ending	Number of Hours Pumping.	Thousands of Gallons Pumped.	Mean Height of Water in Well.
			Feet.				Feet.
..	..	..	..	Jan. 10 .	166	4,644	48
..	..	..	..	" 17 .	167	4,751	46
..	..	..	..	" 24 .	115½	3,424	58
..	..	..	..	" 31 .	72	2,299	71
..	..	..	..	Feb. 7 .	156	4,835	42
..	..	..	..	" 14 .	156	4,746	38½
..	..	..	..	" 21 .	163	4,974	35½
..	..	..	..	" 28 .	156	4,769	34¾
..	..	..	..	Mar. 7 .	156	4,772	34
..	..	..	..	" 14 .	163	4,898	31½
..	..	..	..	" 21 .	153	4,729	32
..	..	..	..	" 28 .	152	4,998	34
..	..	..	..	April 4 .	163½	5,356	29
..	..	..	..	" 11 .	156	5,103	33
..	..	..	..	" 18 .	156	5,098	33
..	..	..	..	" 25 .	162	5,219	29¾
..	..	..	..	May 2 .	166	5,221	25¾
..	..	..	..	" 9 .	136	4,396	34
..	..	..	..	" 16 .	156	4,968	30
..	..	..	..	" 23 .	156	4,893	29½
..	..	..	..	" 30 .	156	4,806	29
..	..	..	..	June 6 .	156	4,773	27¾
..	..	..	..	" 13 .	158	4,723	25
June 18 .	166	4,228	80	" 20 .	158½	4,643	23½
" 25 .	162	4,310	79½	" 27 .	162½	4,645	21
July 2 .	156	4,356	78	July 4 .	151	4,250	20
" 9 .	165	4,674	74¼	" 11 .	155	4,156	25¾
" 16 .	168	4,859	71¾	" 18 .	163	4,501	19
" 23 .	168	4,853	68½	" 25 .	158½	4,340	21
" 30 .	168	4,911	67	Aug. 1 .	165	4,522	19½
Aug. 6 .	168	4,996	63½	" 8 .	168	4,669	19
" 13 .	168	5,310	57	" 15 .	152	4,048	19½
" 20 .	156	5,076	56¼	" 22 .	164	4,230	26
" 27 .	156	5,059	56¾	" 29 .	156	3,947	24½
Sept. 3 .	156	4,750	59¼	Sept. 5 .	166	4,020	24
" 10 .	156	4,758	60½	" 12 .	160	3,848	24
" 17 .	156	4,632	62½	" 19 .	153	3,622	24
" 24 .	156	4,664	61¾	" 26 .	158	3,690	24
Oct. 1 .	156	4,745	60	Oct. 3 .	148	3,499	24
" 8 .	156	4,735	60	" 10 .	127	3,141	24
" 15 .	156	4,737	58¾	" 17 .	153	3,537	24
" 22 .	156	4,873	58	" 24 .	152	3,479	24
" 29 .	153	4,685	58	" 31 .	124	2,981	24
Nov. 5 .	156	4,729	57¾	Nov. 7 .	132½	3,184	24
" 12 .	156	4,651	58½	" 14 .	141	3,269	24
" 19 .	156	4,762	54½	" 21 .	156½	3,458	24
" 26 .	156	4,730	54	" 28 .	148½	3,224	24
Dec. 3 .	156	4,987	48	Dec. 5 .	144½	3,075	24
" 10 .	165	5,129	44¾	" 12 .	149	3,222	24
" 17 .	162	5,108	44	" 19 .	132	2,866	24
" 24 .	164	5,060	43¼	" 26 .	140½	3,021	24
" 31 .	160	4,672	48¼

THE WHISTON PUMPING STATION.

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at WHISTON.

From January 18th to June 11th, 1873, 85,000,000 gallons delivered.

1875. Week ending	Auxiliary Well.		Main Well.		1876. Week ending	Number of Hours Pumping.	Thou- sands of Gallons Pumped.	Mean Height of Water in Well.
	Thou- sands of Gallons Pumped.	Mean Height of Water.	Thou- sands of Gallons Pumped.	Mean Height of Water.				
		Feet.		Feet.				Feet.
Jan. 2 .	..	..	3,000	22 $\frac{1}{2}$	Jan. 1 .	130	4,147	27
" 9 .	1,273	..	2,972	19 $\frac{1}{2}$	" 8 .	161	5,178	26
" 16 .	1,707	..	3,086	17 $\frac{1}{2}$	" 15 .	157 $\frac{1}{2}$	5,359	23
" 23 .	2,466	..	2,682	13 $\frac{1}{2}$	" 22 .	161 $\frac{1}{2}$	5,180	24 $\frac{3}{4}$
" 30 .	1,565	..	2,748	10 $\frac{1}{2}$	" 29 .	156	5,030	26 $\frac{1}{4}$
Feb. 6 .	866	..	2,796	9	Feb. 5 .	161 $\frac{1}{2}$	5,056	27 $\frac{1}{2}$
" 13 .	1,794	..	2,622	9	" 12 .	162 $\frac{1}{2}$	5,519	26 $\frac{1}{4}$
" 20 .	4,001	12 $\frac{1}{2}$	..	..	" 19 .	168	5,661	20 $\frac{3}{4}$
" 27 .	4,225	12 $\frac{1}{2}$	..	..	" 26 .	151 $\frac{1}{2}$	5,352	29 $\frac{1}{2}$
Mar. 6 .	3,951	15 $\frac{1}{2}$	..	..	Mar. 4 .	155	5,222	29 $\frac{1}{4}$
" 13 .	3,597	17 $\frac{1}{2}$	..	..	" 11 .	148 $\frac{1}{2}$	5,085	29 $\frac{1}{2}$
" 20 .	3,724	20 $\frac{1}{2}$	198	..	" 18 .	121 $\frac{1}{2}$	5,181	30 $\frac{3}{4}$
" 27 .	2,046	..	3,388	9 $\frac{1}{2}$	" 25 .	148	5,398	31 $\frac{1}{2}$
April 3 .	1,790	..	3,133	6 $\frac{1}{2}$	April 1 .	154 $\frac{1}{2}$	5,380	31 $\frac{1}{2}$
" 10 .	3,905	..	1,684	9	" 8 .	164	6,399	24 $\frac{3}{4}$
" 17 .	4,357	12 $\frac{3}{4}$	1,300	..	" 15 .	162	5,573	26 $\frac{1}{2}$
" 24 .	4,390	12 $\frac{3}{4}$	..	..	" 22 .	164 $\frac{1}{2}$	5,972	26 $\frac{1}{2}$
May 1 .	4,670	11 $\frac{1}{2}$	780	..	" 29 .	165 $\frac{1}{2}$	6,096	24 $\frac{1}{2}$
" 8 .	4,366	14	..	..	May 6 .	166 $\frac{1}{2}$	6,128	22 $\frac{1}{2}$
" 15 .	4,036	13	..	..	" 13 .	168	5,936	19
" 22 .	4,158	16	..	..	" 20 .	165 $\frac{1}{2}$	6,367	17 $\frac{1}{2}$
" 29 .	4,550	10 $\frac{3}{4}$	..	..	" 27 .	167 $\frac{1}{2}$	6,486	21 $\frac{1}{2}$
June 5 .	3,844	14 $\frac{3}{4}$	868	..	June 3 .	168	6,581	18 $\frac{1}{2}$
" 12 .	3,039	20 $\frac{1}{4}$	1,497	..	" 10 .	133	5,527	23 $\frac{1}{2}$
" 19 .	3,824	10 $\frac{3}{4}$	677	..	" 17 .	168	6,611	18 $\frac{1}{2}$
" 26 .	4,289	8 $\frac{3}{4}$	..	..	" 24 .	168	6,253	21 $\frac{1}{2}$
July 3 .	3,985	6 $\frac{3}{4}$	737	..	July 1 .	164 $\frac{1}{2}$	6,296	25 $\frac{1}{2}$
" 10 .	1,082	39 $\frac{1}{2}$	2,561	..	" 8 .	161	6,296	23
" 17 .	3,399	26 $\frac{1}{2}$	1,267	..	" 15 .	167	6,594	20
" 24 .	3,665	20	530	..	" 22 .	168	6,482	19
" 31 .	3,531	20 $\frac{3}{4}$	706	..	" 29 .	167 $\frac{1}{2}$	6,724	22
Aug. 7 .	3,849	13 $\frac{1}{2}$	800	..	Aug. 5 .	162	6,336	23 $\frac{1}{4}$
" 14 .	3,628	20 $\frac{3}{4}$	1,066	..	" 12 .	160	6,335	23
" 21 .	3,841	17	1,108	..	" 19 .	168	6,687	20
" 28 .	3,848	18	1,271	..	" 26 .	167	6,645	20
Sept. 4 .	4,022	13 $\frac{1}{2}$	1,011	..	Sept. 2 .	139 $\frac{1}{2}$	6,195	19 $\frac{1}{2}$
" 11 .	3,680	10	2,182	..	" 9 .	160	6,673	19 $\frac{1}{2}$
" 18 .	3,527	9 $\frac{1}{2}$	2,848	..	" 16 .	163	6,375	20 $\frac{1}{2}$
" 25 .	3,325	8	2,255	..	" 23 .	168	6,666	19 $\frac{1}{2}$
Oct. 2 .	3,757	9 $\frac{1}{2}$	2,595	..	" 30 .	167	6,523	20
" 9 .	3,508	10 $\frac{3}{4}$	2,503	..	Oct. 7 .	168	6,616	19 $\frac{1}{2}$
" 16 .	..	..	5,838	12 $\frac{3}{4}$	" 14 .	164	6,514	19 $\frac{1}{2}$
" 23 .	..	..	5,479	21 $\frac{1}{2}$	" 21 .	168	6,782	19
" 30 .	..	..	5,522	20	" 28 .	168	6,819	19
Nov. 6 .	..	..	5,711	16	Nov. 4 .	168	6,980	18
" 13 .	..	..	5,518	14 $\frac{1}{2}$	" 11 .	167	6,597	18 $\frac{3}{4}$
" 20 .	..	..	5,422	14	" 18 .	164	6,671	18 $\frac{1}{2}$
" 27 .	..	..	5,476	11 $\frac{1}{2}$	" 25 .	168	6,769	18 $\frac{1}{2}$
Dec. 4 .	..	..	5,393	11 $\frac{1}{4}$	Dec. 2 .	168	6,726	18 $\frac{1}{4}$
" 11 .	..	..	5,622	11 $\frac{1}{2}$	" 9 .	168	6,621	17 $\frac{1}{2}$
" 18 .	..	..	5,540	12 $\frac{1}{2}$	" 16 .	139 $\frac{1}{2}$	5,416	17 $\frac{1}{2}$
" 25 .	..	..	5,018	18	" 23 .	161 $\frac{1}{2}$	6,156	18 $\frac{1}{2}$

