

and the daily gaugings show a constant diminution of discharge until 3rd August (111·8 gallons per hour), the reservoir having in the meantime been allowed to obtain a depth of 23ft. 4in.

The east branch on the 2nd August had almost ceased to run, and had to be collected into a small spouting to facilitate the measurement of such a small discharge—namely,  $3\frac{1}{2}$  gallons per hour.

A glance at the tables will show, therefore, that between Dr. Black's measurement on the 16th July and mine on the 3rd August, there was a decrease of discharge from the alleged leak of 2,644 gallons per diem, or nearly one-half of the total flow on the 16th July; and this diminution of discharge took place with increased depth of water in the reservoir of 23ft. 4in.

On the 3rd August the weather broke up, after a protracted spell of exceptionally dry weather, and wet weather prevailed almost daily for the remainder of the month. On the 11th August the discharge from the supposed leaks became very considerable, especially from the east branch, and an excellent opportunity was afforded for tracing the course of the flow; and I commenced excavating at the outlet of the east branch, following up the run of water. In about three hours the men exposed a small stone-culvert, 15in. by 6in. (from which the east flow was issuing), about 12ft. back from the face of the retaining-wall, the mouth being partially closed, but on removing the obstruction (a displaced side-wall stone) the water came away freely, and it became apparent that the east branch was flowing from an old artificial channel that must have been built not later than 1875, when the upper basin was constructed, and the material excavated therefrom tipped over the outer face of the main reservoir-dam.

While the work of relieving the culvert was going on I turned my attention to the west branch, which began to show decided symptoms of diminution; and by the time the east-branch culvert was completely cleared out the run from the west branch almost ceased, and I found, on further examination, that it had only consisted of the overflow from the east-branch culvert, and that the east and west branches were derived from one and the same source. This also at once accounted for the theometrical observations, giving a uniform average temperature for the east and west flows. The middle branch also decreased, and it was found that the water drained by it was derived from a swampy piece of ground at the back of the wall, the culvert carrying the east branch not having been placed at a sufficiently-low level to drain the same.

The search for the source of the supposed leakage was thus considerably simplified, the three flows having been proved to be practically one stream within a few feet of the point of issue.

The excavation in the face was continued until the 3rd September, and the water followed up, still being carried by the culvert for a distance of 30ft. until it reached the face of the old pitching that formed the foot of the loose material originally obtained from the main reservoir-excavations. The culvert ended at this point, and the water divided into two branches—one exuding from the reef in the east spur in the form of a spring; the other branch turning to the westward, following the original course of the creek.

It may be here noted that all the water found its way to the face along the original creek-bed, amongst the boulders and clay that had been obtained from the reservoir-excavations, and tipped into the gully.

The excavations now being some 18ft. deep required the shifting of so much stuff that I determined to sink a shaft at a distance of about 80ft. from the face at the most likely point to reach the running water again, and I was fortunate enough to strike the run in the centre of the shaft, and had it followed by a heading for a distance of about 15ft. towards the embankment. This operation enabled me to gauge the flow of the supposed leak at three points—namely, at the outlet into the creek and at places 30ft. and 80ft. nearer the dam—and I found, on measurement, that the latter discharged one-sixth to one-third of the total quantity gauged at the outlet, the remainder being supplied between the 30ft. and 80ft. points from the rocky spur on the east side.

In endeavouring to arrive at a conclusion with respect to the source of the flow that was alleged to be a leak from the reservoir it was necessary to take into consideration three factors—first, local drainage or soakage of surface-water; second, springs; third, leakage from the reservoir.

Whatever quantity of the flow was due to leakage, drainage was bound to be represented in a greater or less degree proportionally to the collecting area and rainfall, while the supposition that springs either of near or distant origin also formed part of the flow was a fair one for consideration.

With regard to the drainage, it naturally follows that from an area of one acre, a large portion being made ground and of a porous nature, that a considerable proportion of the rainfall on the surface must find its way to the lowest point at the outlet in the creek at the foot of the dry wall, it being remembered that 1in. of rainfall over an acre of ground amounts to 22,600 gallons, and the average annual rainfall from 33in. to 35in. The actual area of land that must drain itself towards the old course of the creek-bed is as nearly as possible one acre.

Then, as to the contributions from springs, the gaugings show a total discharge (calculated between dates when the reservoir was not affecting this flow) that was greatly in excess of the amount of the observed rainfall on the available drainage-area, even supposing that the whole of the rain had found its way to the outflow of the supposed leakage.

As a means of eliminating as far as possible the element of drainage and springs in order to arrive at the balance due, if any, to leakage, the whole of the flow from the foot of the wall was divided in such a manner that it could be measured in five portions; and the sources of four—having been carefully examined, tested, and satisfactorily proved, the only one remaining in doubt was the flow in the shaft, which in conjunction with the others was also gauged, a commencement being made at this particular point with nearly a full reservoir—namely, a depth of 48ft. 4in.—when the flow was 180 gallons per hour. This quantity decreased steadily until the water in the reservoir was reduced to a depth of 36ft., the discharge then being 38·1 gallons per hour, with a total flow at the main outlet of 205·9, or about the same amount as was registered with an empty reservoir.

I will now detail what, in my opinion, is the origin of the outflow that has been the cause of the present investigation.

Commencing at the upper part of the dam, I shall first take what has been called the “concealed pipe.” The run of water through this pipe commences when the water in the reservoir rises