Report on the quality of the waters used in the in-wards of the parish of St. George, Hanover Square / by Dr. Druitt.

REPORT

ON THE

QUALITY OF THE WATERS

USED IN THE IN-WARDS

OF THE

PARISH OF ST. GEORGE, HANOVER SQUARE.

BY

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REPORT.

The importance of pure and wholesome water is too great to need remark. So soon, therefore, as I conveniently could, after receiving the appointment of Medical Officer of Health, I began to examine the waters used by the inhabitants of the In-Wards of St. George, Hanover Square. It appeared to me the more desirable to make such an examination at once, before the usual season of epidemic cholera, because grave doubts have been entertained by many of my medical brethren, as to the wholesomeness of the pump water which is largely used in this part of the parish, and because it has been suspected that water may be very unwholesome, and yet not betray its ill qualities by any sensible outward sign.

The waters used by the inhabitants of the In-Wards are—First, that supplied by the Grand Junction Company; secondly, that of the ordinary shallow wells; and, thirdly, that of the deep well in Berkeley Square. Each of these three sorts of water has peculiar properties which readily distinguish it from the others; but, before describing them, I will offer the following very short general remarks, on the manner in which the value of water for cleansing, and its wholesomeness for drinking purposes, are to be estimated.

The value of water for washing is proportionate to the

absence of that quality which is commonly called *hardness*, and which depends on the presence of salts of lime or magnesia dissolved in the water. These earthy salts decompose soap, and form with it an insoluble curdy scum ; and so long as any quantity of them remains, the water will not form a lather. Hence, in using hard water, a considerable quantity of soap is decomposed and wasted, unless the water is previously softened (*i.e.* unless the lime-salts are precipitated) by soda, or some other means.

In the analysis of water, the hardness is estimated by *degrees*—each degree of hardness corresponding to that which is produced by one grain of chalk in solution in a gallon. The way in which the hardness of any individual specimen is ascertained, is by the use of Professor Clark's *soap test*—that is, by determining the quantity of soap, which must be added, before the water is capable of forming a lather. Moreover, a distinction is made between *temporary* and *permanent* hardness. The temporary is that which the water exhibits at first, whilst cold ; the permanent, that which remains after long boiling. The temporary hardness depends on the presence of chalk or carbonate of lime held in solution by carbonic acid gas; and when this gas is driven off by exposure to the air and by heat, the chalk which it held in solution is precipitated. Hence, most waters are softened to a certain degree by long boiling, which causes precipitation of all the *carbonate* of lime; but that quantity of lime which is combined with other acids is not precipitated by boiling, but remains, and causes the permanent hardness.

It is estimated that each degree of hardness—or, in other words, each grain of chalk per gallon—causes about ten times its weight of yellow soap to be destroyed ; so that one hundred gallons of water, of fifteen degrees of hardness, would waste about two pounds of soap, unless an equivalent of soda or some other alkali, had been previously added.

The wholesomeness of water is judged of by several tests, some practical, some theoretical. Practically speaking, it is usually considered wholesome, if cool, clear, sparkling and well aërated, and agreeable to the palate, and more especially if it is known, ordinarily, not to produce any ill effects.

But it has been suspected that some waters, which may answer to this description, and which may be quite harmless under ordinary circumstances, may, like some other things, be extremely detrimental during the prevalence of cholera; and here it is the province of analytical chemistry to examine the composition of such waters, and to show whether they contain any ingredient which may be expected to do harm, under certain circumstances.

In following out this line of investigation, it will be seen by the Tabular Statement at the end, that I have determined the total amount of solid matter contained in an imperial gallon of each kind of water analyzed; and likewise how much of this solid matter was inorganic, and how much organic.

The inorganic part need not detain us. It consists mainly of the carbonate of lime dissolved in carbonic acid, and of other salts of lime derived from the earth, which, as I have before said, communicate to the water its hardness, both to the palate and in washing. I speak here more particularly of the Grand Junction and common pump waters. That of the Berkeley Square well, is of a totally different quality, as I shall show presently.

But it is the organic matter dissolved in water, which occasions doubt as to its wholesomeness. By *organic* is meant anything which either has, or has had, life, or has formed part of any animal or vegetable. This term, therefore, includes a vast variety of substances, some quite harmless, others most deadly; some harmless uuder some circumstances, but most hurtful under others, and more especially

if they are undergoing any kind of decomposition or putrescence.

Now, almost all waters in common use, even waters from the chalk, and from the Berkeley Square well, contain some amount of organic matter. It may be readily seen that this is quite unavoidable, if it is considered that all the superficial strata of the earth—gravel, sand, clay, chalk, and limestone—are full of the *débris* of animal and vegetable matter, of which some strata are almost entirely composed. But the kind of organic matter which is really a serious source of danger, is fresh animal sewage, such as is poured into rivers, or may soak through the surface into shallow wells; and there is no doubt that water, contaminated in this way, is unwholesome at all times, and possibly, at certain seasons, may be deadly in its effects.

I believe the best test of the quality of the organic matter dissolved in water, to be its power of keeping sweet if exposed to air and light in a warm place; and if a water, under such circumstances, exhibit no sign of decomposition within a few days; if it have no unpleasant smell or taste and no ill effects are proved to result from drinking it, I see no reason why it should not be drank by any one who likes it.

Another test there is which is sometimes very unfairly applied to water, and that is the existence in it of living animals and vegetables. Now it is fair to state that the germs of these minute beings exist almost everywhere, and that the development of them depends not so much upon the water, as upon the mode in which the water is stored. Water kept in a dark, cold receptacle, may continue free from them for an indefinite period; whilst the same water exposed to air, light, and sunshine, would soon teem with animals and plants; and, it must be observed, that the greater part of the sediment found in tanks and reservoirs, consists, not of mat-

ter which was in the water when originally delivered, or which the water has actually brought with it, but of matters which have been developed in the water since it was delivered; and it must be added, that the decomposition of animals and vegetables, which have been developed in water kept in open tanks, may give rise to most offensive smells, which do not belong to the original water.

One other general point there is to be alluded to. In the Tabular Statement it will be seen that nitric acid has been found in almost all the pump waters. This is a point which is made much of in most analyses of water, inasmuch as the nitric acid is believed to proceed from the decomposition of sewage and other organic matter; and, although harmless itself (nay, it is believed to impart an agreeable, cool, pungent taste to the water), it is supposed to show that there is risk of some more dangerous contamination.

Having made these general observations on the objects of the analyses, I will now apply them to the various specimens of water that have been examined.

In the first place, the Grand Junction water I believe to be one which the parishioners may use with the utmost confidence in its wholesomeness. It is taken from the Thames at Hampton, and pumped into reservoirs at Kew. There it is, first of all, allowed to settle, and deposit any mechanical impurities; then it is filtered through beds of sand, gravel, and shells, six feet in thickness, and is delivered perfectly clear and bright, and free from any living impurities. The degree of hardness of one specimen, taken from the cistern of my house (9th of July), was 16·94; that of another specimen, taken (13th of August) from the reservoir at Kew, before filtration, was 12·6. Of course the hardness varies according to the amount of rain. By boiling, the hardness of the first specimen was reduced to 4·25; that of the second, to 4·45. Each

specimen contained a very small quantity of organic matter; and the first showed some traces of nitric acid; the second, absolutely none. This water keeps well; for a bottle half filled with it on the 8th of June, and kept in a warm place, in the light, but covered from the air, is perfectly sweet on the 1st of September, and, examined microscopically, contains the merest trace of vegetation, and no living animalculæ. But when exposed to air and sunshine, in open tanks, this water soon teems with animal and vegetable forms—diatomaceæ, paramœcia, cyclops, and other well-known miscroscopic inhabitants of water, which are developed out of germs too minute to be arrested by any kind of filtration, or which may be derived from the atmosphere.

I have never heard any complaint of the quantity or quality of this water, except that in some places it has been tainted with gas, which has leaked out into the earth. This taint soon passes off by exposure to air. In some cases, I have wished that the supply were less liberal—for in some houses, waste of water is considered an apology for bad drainage. The occupants admit that their drains are faulty and offensive, but say that they remedy this by letting off large quantities of water. With better-constructed drains, there would be less waste, less smell, and less dampness of the basements of houses.

The faults that may be alleged against this water, are, in the first place, its high temperature in summer. Thus, on the 20th of July it was delivered at 65°; on the 10th of August, at 70°. On the 13th of August it was 69·5° in the reservoir at Kew. It is flatter to the taste than pump water. Being derived from a river, it is, of course, subject to contamination from the impurities derived from villages and cultivated land. Its 14 or 15° of hardness may be reduced by long boiling to 4 or 5, but then the difference is produced by the deposit of earthy incrustations in our boilers; to say nothing

of the expense of fire, or its substitute, soda. I do not at present enter on the question whether water direct from the chalk, or whether water softened by Clark's process might be better; but, as a matter of fact, the Grand Junction water is on the whole, satisfactory and wholesome at present. And here I must express my thanks to Mr. Hughes, the engineer of the Company, who, by permission of the Court of Directors, accompanied me over their works at Kew, gave me opportunities of seeing every part of the processes employed, and of taking specimens for examination.

The second class of waters is that of the shallow wells. The In-Wards of St. George, Hanover Square, are built on one of the healthiest spots in the world; on a gentle declivity, the surface being composed, for the most part, of a bed of clean gravel, twenty or thirty feet thick, which lies over that extensive bed of clay, commonly known as the London clay. Of the rain which falls on the higher ground to the north of the parish, part used to run to the Thames in the various brooks and burns, which are now swallowed up and diverted by the sewers, and have left their only traces in the names of various localities. Another part of the rain soaks through the gravel till it meets the clay, and there trickles down till it arrives at the Thames. This water it is which supplies the shallow wells (from twenty to thirty feet in depth), which are still very numerous in the parish, and were formerly more so. I have examined the water yielded by sixteen of these, taken indifferently from every part of the parish, Oxford Street, Hanover Square, Duke Street, Bruton Street, Mount Street, South Audley Street, Stratton Street, Hertford Street, Brook Street, and Chesterfield House, and have included the spring which is found at the east end of the Serpentine in Hyde-park.

Mr. Prestwich, in his work on the Waterbearing Strata of London, says that, "in appearance, these waters are

perfectly bright and limpid, and many of them are in much repute as good drinking waters. They certainly have suffered from the construction of sewers, the laying of gas-pipes, and numerous other causes of impurity; but it is a matter of surprise that the injury should not have been greater. There seems to exist in the common, ochreous gravel of London, some remarkable properties, not only as a filtering material, but also as one which tends to rid the water of its organic impurities."

These waters certainly have some excellent qualities. They are bright, sparkling, and well aërated, crisp, and extremely palatable from their coolness; for, during the last two months, I have not found them to exceed 55°., and in one case, 57°., whilst the Grand Junction water was delivered at 65°.-70°. Their extreme and remarkable hardness also renders them palatable to most people, and, I believe, not unwholesome, except to a few dyspeptics. One curious point is the difference there may be in the quantity of solid matter contained in the water of neighbouring wells, and of the same well at different times. Thus, on the 4th August, the pump in Hanover Square, opposite Princes Street, yielded 61·9, that opposite Hanover Street yielded 74·4 grains per gallon. On the 1st August, the pump at the Chesterfield Arms Tavern, Mayfair, yielded 121·3, on the 8th, only 29·7 grains per gallon: of the former, 19 were organic matter, of the latter, only 4. All of these waters deposit a scum of carbonate of lime when exposed to the air, and, if boiled, they let fall a copious precipitate of the same substance, deeply tinged with brown, from the organic matters present. All of them show copious traces of nitric acid. The only exception which I have found to this, is the water from a well in Hertford Street, which is surcharged with carbonate of iron; far too highly to render it wholesome as a chalybeate medicinal water.

Now for the serious question of the wholesomeness of these waters. Against them may be alleged the fact, that they contain abundance of organic matter and of nitrates; the possibility that they may be contaminated with leakage from sewers and cesspools, and from the streets; and the parallel fact, that the water of the pump in Broad Street, Golden Square, was proved—so far as such a thing admits of proof—to have been the cause of, at least, three deaths from cholera, in the year 1854; and the presumption, that pump waters may be unsafe in epidemic seasons, although used with impunity at other times.

All that I can speak to as matter of fact, is, that I have not been able to hear of any ill consequences from the use of these waters; that, with some exceptions, they keep extremely well; that even when concentrated by boiling, and kept in a warm place, they do not putrify; and if water will stand these two last tests, there can be no great harm in it.

Nevertheless, there are some pumps which I should recommend not to be resorted to for drinking purposes. One is the pump at the bottom of Hanover Square, opposite Hanover Street. The water of this became suddenly muddy after the storm of the 15th of July. Moreover, when opened and cleansed by Mr. Richman, to whom I reported this fact, there was found in it a large quantity of black mud, of very offensive smell. This mud, kept with some of the water in a warm place, has developed vegetables, and particularly insects which can only have come from the surface. Now, as the well in Hanover Square, opposite Princes Street, was opened at the same time, and as the clay at the bottom of it was of a different colour, and free from smell, and has developed no organic life, though kept under precisely the same circumstances as that from the other well, I believe the well opposite Hanover Street to be exposed to some source of admixture, and that, for the present, it should be kept well pumped out, but not be used for drinking.

One other well there is, in Robson's Yard, which I found to yield water of an offensive odour. But, except these two, and the chalybeate well in Hertford Street, I see no reasonable objection to the use of either of the others by any one who prefers that kind of water.

But it is very desirable that all these waters should be occasionally examined—that the wells should be from time to time cleansed, and the water entirely pumped out at stated periods, so as to guard against stagnation.

In finishing this part of my subject, I may observe, that on the slope of the hill in Brick Street, there are springs in the basement of the houses which come to the surface, and which the inhabitants are oblige to bale out daily. Possibly, if these springs were tapped, and drained off into the sewer, there might be a quicker circulation and greater purity of the water throughout the district ; to say nothing of the diminished dampness of the neighbouring houses.

Lastly: concerning the Berkeley Square well. The water of this is of an entirely different source and quality from either of the foregoing. It comes from the sand or chalk, which lies deep under the London clay, and is fed by rain-fall outside the limits of that clay ; beyond Shooter's Hill, or Hertford. It is a soft alkaline water, containing not much lime, but a large quantity of salts of soda, altogether 60·5 grains per gallon. It contains absolutely no nitric acid, and a small, though very appreciable, quantity of organic matter ; 1·5 grains to the gallon. It is easy to distinguish it from either of the other two sorts, by its behaviour in boiling, for it keeps its white colour to the last, and the residue is white. Moreover, this residue, when charred, blackens slightly. The other waters, especially the shallow well waters, become of a deep ochrey yellow, when concentrated by boiling. The composition of this water is strikingly similar to that of Seltzer water, although much weaker, and free from effer-

vescence. It would be a good water, therefore, for such of the parishioners as are of an inflammatory habit, or who require cooling alkaline waters. When made into tea, it tastes soft and flabby, and it is not, on the whole, to most persons, so pleasant and bracing as the more crisp and hard waters of the surface gravel.

I have now made such observations on the subject of these waters as I conceive may be useful or interesting to the parishioners. I subjoin a tabular statement of the results of analysis, all of which are original, and made in my own private laboratory by Mr. R. V. Tuson, a very able experimental chemist, whom I have been fortunate enough to engage for the purpose of carrying on such chemical researches, as my own daily avocations in visiting the sick do not permit me to attend in person.

ROBERT DRUITT.

39A, Curzon Street,
September 2nd, 1856.

TABULAR STATEMENT.

SOURCE OF WATER.	Degree of Hardness.		Grains of Solid Matter in an Imperial Gallon of Water.			REMARKS.
	Before Boiling.	After Boiling.	Inorganic Matter.	Organic Matter.	Total Solid Matter.	
Spring in Hyde-park, July 7, 1856	43·76	38·64	50·47	3·24	53·71	Abundant evidence of nitric acid.
Pump at the Grapes Tavern, Duke-st., Grosvenor-sq., July 7, 1856	50·64	27·30	48·62	4·16	52·78	A pleasant, bright water contained a trace of nitric acid.
Pump at 17 Stratton-st. Piccadilly, July 7, 1856	77·9	75·0	98·8	13·0	111·8	Abundant traces of nitric acid. A very clear, crisp palatable water.
Pump at the corner of Park-st. and Oxford-st., July 19, 1856.....	30·0	13·6	36·1	4·9	41·0	Abundant traces of nitric acid.
Pump in Bell-yd., Mount st., July 19, 1856.....	63·05	41·8	92·2	7·9	100·1	Very abundant traces of nitric acid.
Spring in the basement of a house, 11, Brick-st. Mayfair, Aug. 1, 1856	66·0	36·05	86·8	11·0	97·8	This spring wells up in the basement of the house, and is baled out every day. Contains traces of nitric acid.
Pump in Wimbush's yard, Oxford-st., July 21, 1856	25·0	21.5	35·7	3·5	39·2	Abundant evidence of nitric acid.
Pump in Wimbush's yard, Aug. 14, 1856...	22·5	18·6	54·0	5·2	59·2	
Pump in Berkeley-sq., July 19, 1856	7·21	1·54	58·9	1·5	60·4	No trace of nitric acid could be detected in either experiment. A bright soft, cool tasting, alkaline water.
Pump in Berkeley-sq., Aug. 14, 1856	—	—	58·8	1·5	60·5	
Pump at the Chesterfield Arms Tavern, Carrington-st., Mayfair, Aug. 1, 1856	91·0	—	102·3	19·0	121·3	On this occasion the well was pumped dry. Abundance of nitric acid.
Pump at the Chesterfield Arms Tavern, Carrington-st., Mayfair, Aug. 8, 1856	23·0	9·3	25·7	4·0	29·7	This specimen has kept quite sweet and bright to Sept. 1.
Pump at Chesterfield House, Aug. 8, 1856...	55·8	23·5	65·2	10·1	75·3	Abundant evidence of nitric acid.
Bottom Pump in Hanover-sq., July 7, 1856...	49·7	44·49	—	—	—	Opposite Hanover-st. This water became quite muddy after the storm of July 15. Abundance of nitric acid. Mud removed from this well is black and offensive, contains larvæ of flies, and yields abundant vegetation in three weeks.
Bottom Pump in Hanover-sq., Aug. 4, 1856...	39·2	31·2	66·0	8·4	74·4	

SOURCE OF WATER.	Degree of Hardness.		Grains of Solid Matter in an Imperial Gallon of Water.			REMARKS.
	Before Boiling.	After Boiling.	Inorganic Matter.	Organic Matter.	Total Solid Matter.	
Top Pump in Hanover-sq., Aug. 4, 1856	39·7	22·5	56·2	5·7	61·9	Opposite Princes-street. Abundance of nitric acid. Mud removed from this well yellow, not offensive, and yields no trace of vegetation to Sept. 1.
Pump at 23, Bruton-st., Aug. 4, 1856	38·65	19·5	48·5	7·5	56·0	Abundance of nitric acid.
Pump in Mr. Robson's yard in Chapel-st., Aug. 5, 1856.....	70·8	38·15	118·5	10·7	129·2	Abundance of nitric acid.
Pump in Mr. Robson's yard in Chapel-st., Aug. 5, 1856.....	—	—	118·0	10·3	128·3	
Pump at Mr. Robson's factory, South Audley-st., Aug. 5, 1856	60·8	40·0	111·1	9·0	120·1	Moderate traces of nitric acid.
Pump in Mr. Robson's yard, South Audley-st. Aug. 5, 1856.....	58·05	33·0	95·45	6·8	102·25	Ditto. Soon becomes offensive on being kept.
Pump at 44, Hertford-st., Mayfair, Aug. 8, 1856	51·9	10·0	59·8	7·2	67·0	Highly charged with carbonate of iron, which is deposited on exposure. No indication of nitric acid.
Cistern at 39A, Curzon-st., Mayfair (Grand Junction after filtration), July 9, 1856....	16·94	4·25	20·53	0·92	21·45	Very minute trace of nitric acid.
Grand Junction Reservoir at Kew (before filtration), Aug. 13, 1856	12·6	4·45	15·3	1·6	16·9	No trace of nitric acid. Some microscopic animals and plants.

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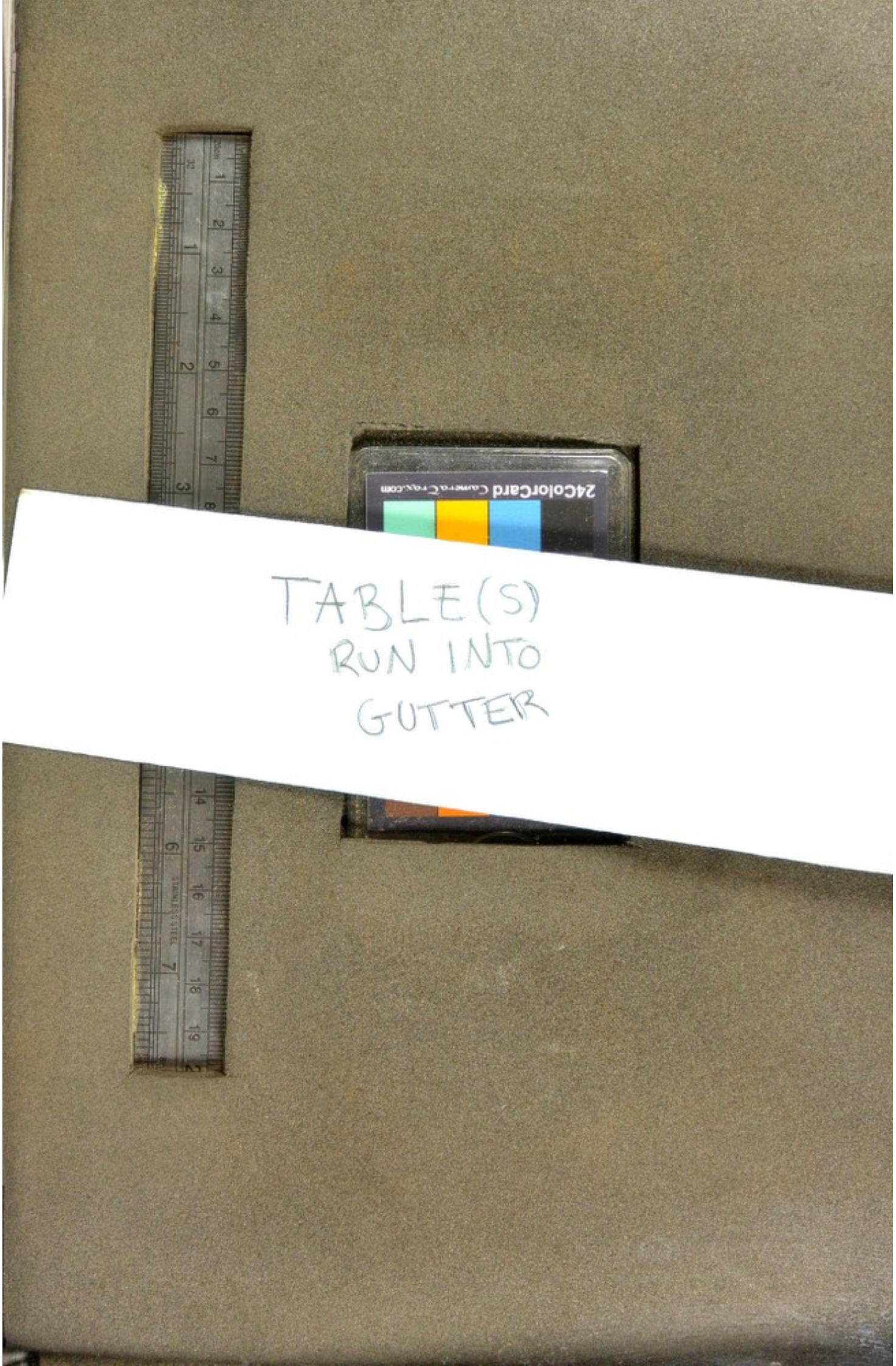
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