

**Safeguards to be adopted in the operation and management of waterworks  
/ Ministry of Housing and Local Government, Welsh Office.**

**Contributors**

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MINISTRY OF  
HOUSING AND LOCAL GOVERNMENT  
WELSH OFFICE

# Safeguards to be adopted in the Operation and Management of Waterworks

*This seems to be an updated version of Memorandum on the safeguards  
to be adopted - along the day administration of water in districts -  
Memo 221/1967. min HCR., London.*

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# SAFEGUARDS TO BE ADOPTED IN THE OPERATION AND MANAGEMENT OF WATERWORKS

## 1. Introduction

(i) Between 1911 and 1937 there occurred twenty-one outbreaks of disease conveyed by public water supplies of such gravity as to merit detailed mention in the annual reports of the Medical Officers of the Local Government Board and the Chief Medical Officer of the Ministry of Health. Pollution prior to storage and distribution was responsible for thirteen of these outbreaks which involved four overground supplies and nine underground sources. In two cases pollution occurred during storage and in the rest during distribution. The numbers of known cases of disease resulting from these outbreaks were:—enteric fevers (including paratyphoid) 1,237; bacillary dysentery 2,800; and gastro-enteritis 7,439.

(ii) The serious typhoid epidemic in Croydon in 1937 focussed attention on the need for careful and constant supervision of water supplies.

(iii) The fact that since 1937 there have been no such outbreaks is almost certainly a result of better understanding of the problem, coupled with increased vigilance and greater care in treatment. While this must be considered an achievement it cannot be looked upon as ground for complacency. The incidence of enteric fevers has been dropping steadily over the years; in 1939 in England and Wales there were 1,379 cases while in 1964 there were 353. There is, however, plenty of evidence that there are many chronic carriers, some unidentified, who are all potential dangers to water supplies.

## 2. General Points

(i) Water undertakers are under a statutory obligation to provide wholesome water for the use of their consumers and should ensure that full use is made of competent medical and other expert advice. The medical officer whose services are employed should be experienced in the fields of public health and epidemiology.

(ii) All water undertakers will be aware of the need for unremitting care in the supervision of their water supplies. They will realise the importance of effective co-operation between the various officers responsible for the conduct and efficiency of the undertaking and also between the water undertakers and the local authorities served by them. The local authorities have a statutory duty\* to ascertain that the water supplies in their districts are sufficient and wholesome, and water undertakers should always be ready to furnish to the local authorities or their medical officers of health full information about the quality of the water and the precautions taken to safeguard it. They should also inform the local public health authorities of any incident or breakdown of plant that might jeopardise the supply. Equally, any local authority should

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\*Subsection (1)(a) of Section 111 of the Public Health Act 1936 as revised by Section 28 of the Water Act 1945.



inform the water undertakers of any case of disease capable of being water-borne, or of any operation or incident which might affect the quality of the water. Arrangements should be made with the river authority and police for the undertaking to be given immediate notice of any accidental or unauthorised discharge that might affect a water source. This might be the result of an accident to a river craft or road or rail tanker or of gross discharge of trade waste.

(iii) The object of this memorandum is to draw attention to the precautions which should be taken in the day to day administration of water supplies. These precautions are no more than are already recognised as good waterworks practice, and water undertakers should carefully review their arrangements and take any necessary steps appropriate to their undertaking to improve their practice.

(iv) Two-thirds of the population of the country are supplied with water obtained from overground sources—from rivers, streams and springs—and the remainder from wells and borings. The variety of sources and conditions is such that it is not possible to lay down any one method of ensuring the supply of wholesome water.

(v) Undertakers must have regard to the circumstances in their own areas, e.g. the nature and situation of the source from which the supply is drawn, and must themselves decide, on competent advice, the methods of control and treatment which are most suitable to local conditions.

### 3. Medical Examination of staff employed by water undertakings

(i) Care should be exercised in the selection of men to be employed on works where a risk to the purity of the water supply is likely to arise. The clinical history of each man, particularly with reference to any infection capable of being water-borne, should be thoroughly investigated and he should be examined by testing his blood to determine whether or not he is likely to be a typhoid carrier. When blood tests\* give a positive result which is not attributable to preventive inoculation, he should not be so employed unless repeated examination of his stools and urine fails to show the presence of pathogenic bacteria.

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\*The object of blood tests is to detect carriers of the group of bacteria causing enteric fever. Sera are tested for agglutinins against the following antigens:

<b>Salmonella typhi</b>	Vi, O, H
<b>S. paratyphi A</b>	H
<b>S. paratyphi B</b>	H specific
<b>Non-specific salmonella</b>	H

The finding of H agglutinins against more than one of these organisms suggests that the subject has previously been inoculated with TAB vaccine, a fact which cannot always be determined from his history. The demonstration of H agglutinins against only one of these organisms is more suspicious, and calls for investigation of the subject's excreta.

It is commonly thought that paratyphoid A fever does not occur in Britain, but with the arrival of large numbers of immigrants from areas in which it is endemic (the Americas, Africa, Asia), this disease may be introduced. Paratyphoid A and B fevers are rarely water-borne, but this is not an absolute rule. The detection of H agglutinins against *S. paratyphi A* in the serum of an immigrant coming from an area in which the disease is endemic is at present more significant than their demonstration in the serum of a native of this country, where they are probably the result of inoculation with TAB vaccine.



(ii) If preliminary blood tests are not used, bacteriological examination of stools and urine must be carried out on at least three occasions at weekly intervals in all cases. This should reveal 70-80 per cent of chronic carriers.

(iii) If any employee is known to have any disease that could be water-borne or is suffering from an illness associated with looseness of the bowels or an illness necessitating his absence from work for more than five days there should be standing arrangements to ensure that he is not employed on work where a risk to the purity of the water supply is likely to arise until he has been seen by the undertaking's medical officer who will decide whether examination on the lines indicated above is necessary to show that it is safe for him to be so employed. Standing arrangements should also be in force to ensure that each member of the staff is examined by the undertaking's medical officer at intervals of not more than three years.

#### 4. Protection of Sources of Supply

(i) *General.* Whatever the source of supply and however pure the water from it may be today, it cannot be regarded as free from risk of pollution in the future.

(ii) Every reasonable effort should be made to ensure that the raw water is protected from contamination, and it should not be put into supply without appropriate treatment to remove any risk of bacterial infection. Reliance should not be placed on a single line of defence.

(iii) Where there is an indication of an unusual deterioration in the quality of the raw water, the cause should be traced immediately and any necessary remedial action taken.

(iv) All yards, buildings, machinery and apparatus used for waterworks purposes should be kept scrupulously clean.

(v) Adequate sanitary accommodation and washing facilities should be provided at any part of the works where men are working, and these should be inspected regularly.

(vi) The drainage system, especially where there are wells, boreholes or springs in the vicinity, should be specially designed to avoid leakage. It should be tested for water tightness at regular intervals.

(vii) *Gathering grounds for direct supply reservoirs.* Since it is usually impracticable for water undertakings to obtain control of the whole of the gathering grounds for the purpose of prevention of pollution of the water the following considerations become of paramount importance.

(viii) It should be part of the routine duty of the water undertaker's staff to make regular and frequent inspections of the whole of the gathering ground with a view to detecting possible causes of pollution.

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Special care must be taken in the investigation of immigrants from areas in which the enteric fevers are highly endemic (the Americas, Africa, Asia), and in which the incidence of chronic carriers is correspondingly high. Persons from such areas who show H agglutinins to *S. typhi* or *S. paratyphi* A or B at a titre of 1 in 15 or higher, and any persons, whatever their origin, who show Vi agglutinins of 1 in 5 or over or O agglutinins of 1 in 100 or higher should not be engaged unless 3 consecutive examinations of urine and faeces, at intervals of one week, are negative for all these organisms.

(Detection of typhoid carrier state J. Hyg., Camb. (1961), 59, 231.)



(ix) Drainage from farms, dwellings, camping grounds and lavatories should be disposed of in such a manner that it does not pollute the water courses or the reservoir.

(x) Much can be done by co-operation with farmers, householders, the local authority and river authority to ensure that sewage and manure are safely dealt with; and that manures and agricultural chemicals which might be toxic or might otherwise affect the quality and taste of the water are avoided.

(xi) Cattle and other animals should be kept away from the reservoir and from feeder streams near it.

\*(xii) *Public access to reservoirs and gathering grounds: regulating and compensation reservoirs.* There is no reason, save in wholly exceptional circumstances, why river regulating and compensation reservoirs, i.e. those which discharge into rivers, should not under suitable control be used for all the recreational purposes, including bathing, for which their siting and physical characteristics make them suitable.

(xiii) *Direct supply reservoirs.* Where however the reservoir is one from which water is taken after treatment direct into public supply, different considerations apply. Public access and recreational use involve a risk of pollution, but the significance of the risk and the extent to which such activities can be permitted will depend upon the characteristics of the reservoir and its surroundings, on the size of the reservoir and on the treatment given to the water. Restrictions and control will be needed for most kinds of recreation, but they need not be greater than are required to safeguard the water supply.

(xiv) If rock climbing and rambling on the gathering grounds are allowed no special restrictions are necessary. If sailing, rowing and fishing are permitted, they will have to be controlled to an extent varying with the size of the reservoir and the treatment given to the water. Similar considerations will apply where bird watching, shooting and wild fowling are allowed. The safeguards required are fully set out in the Final Report of the Council of the Institution of Water Engineers on the Recreational Use of Waterworks—see footnote to paragraph 4(xii).

(xv) If picnicking, camping and the parking of caravans are permitted the number of people allowed to participate will have to be controlled and the activities confined to defined sites where there is no danger of contaminating the water supply. Adequate sanitary and refuse facilities, which should be cleansed and inspected regularly, and suitably designed and drained car parking space, should be provided.

(xvi) If canoeing is permitted this should exclude training in canoe capsizing except where the water from the reservoir is given treatment comparable with that given to water abstracted for domestic use from a lowland river intake.

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\*Attention is drawn to the Report of the Gathering Grounds Sub-Committee, "Gathering Grounds", published 1948 by H.M. Stationery Office, the Final Report of the Council of the Institution of Water Engineers on Recreational Use of Waterworks, published 1963, the White Paper "Leisure in the Countryside", and to the Joint Ministry of Land and Natural Resources (No. 3/66) and Department of Education and Science (No. 19/66) Circular "Use of reservoirs and gathering grounds for recreation".



(xvii) The risk of contamination of the water can be considerable if power-driven craft are extensively used. Accordingly power-driven craft should not be allowed except that where sailing is permitted one or two motor boats can be allowed for rescue purposes only.

(xviii) *Wells and Boreholes.* Where the source is a spring, well or borehole, a sufficient area of surrounding land should, if possible, be acquired by the water undertaker to enable local protection of the aquifer to be provided.

(xix) Spring water should be collected underground in properly designed water-tight chambers. The heads of wells and boreholes should be protected and they should be lined to a depth sufficient to prevent any surface pollution from entering; there should be an effective seal between the lining and the surrounding ground.

(xx) Periodically the wells and boreholes should be inspected to make sure that the lining is sound.

(xxi) Where the source is on or near the outcrop of the stratum from which the water is drawn, regular and frequent inspections of the area of the outcrop within, say, two miles of the source should be made by the water undertaker's staff with a view to detecting possible causes of pollution. Particular attention should be paid to any cesspools, soakaways or swallow-holes and the water undertakers should be satisfied that these are not a danger to the source of supply and an up-to-date map showing the layout of any sewerage system in the area should be kept.

(xxii) *Inspections.* All inspections by the water undertaker's staff referred to above should be carefully recorded and reports made to the Engineer.

(xxiii) Each report should draw special attention to any alterations which have occurred on the gathering ground since the preceding report. These reports will materially assist in interpretation of results of analyses of the water.

(xxiv) Where the reports indicate a possible cause of pollution of the source of the supply the water undertakers should take such action to remove it as may be available to them.

(xxv) The water undertaker should keep in close touch with the local planning authority so that proposals for new buildings or other development may be known at an early stage and any risk of contamination of the source of supply assessed.

(xxvi) *Rivers and Lakes.* Where a supply is drawn from a river or lake accessible to the public the possibility of controlling pollution is greatly reduced and an inferior and probably variable quality of raw water may result. Treatment of the water is likely to be more difficult than in other cases and, with the lack of protective measures, becomes of the greatest importance.

(xxvii) Regular consultations between the water undertaker and the river authority should take place, so that the former may be advised of any altered or additional discharge of sewage or trade effluents into surface waters or underground aquifers.



(xxviii) *Water Examination.* Chemical and bacteriological analyses\* of the raw water from all sources should be made regularly and frequently. How frequently and at what times analyses should be made must depend on local conditions and this question should be determined after consultation with the undertaker's expert advisers.

(xxix) Accumulated experience of a particular source is likely to be the best guide in assessing the frequency of sampling. For example, there may be seasonal variations in water quality which can be anticipated; there may be additional risks of pollution caused by an influx of holiday-makers with access to gathering grounds which would call for more vigilant monitoring of raw water quality.

(xxx) If there is a tendency to fluctuation in the chemical composition or bacterial content of the water, or if inspection of the gathering ground shows possible risk of pollution, analyses should be made at very short intervals.

(xxxi) In certain abnormal circumstances, such as flooding or accidental discharge on the gathering ground of polluting matter, it would be necessary to take additional samples of the water for examination.

(xxxii) The results of any raw water analysis must be read in the light of the nature and history of the source and will help to determine the appropriate treatment to be given to the water.

(xxxiii) Particular attention should be paid to the quality of the water passed into supply after treatment.

(xxxiv) Chemical analyses should not be needed very often except where the quality of the raw water is variable, but bacteriological examination should be undertaken regularly at short intervals in all cases.

(xxxv) Wherever practicable daily samples should be taken to check the effectiveness of treatment and periodically random samples from the distribution system should be examined to make sure that no deterioration of the quality takes place in service reservoirs or mains.

(xxxvi) For convenient and reliable sampling at waterworks and reservoirs it is generally advisable that special taps should be fitted, either directly on the mains or served by minimum lengths of pipe. Transparent plastic pipes are to be preferred for this purpose.

(xxxvii) In any case the water undertakers should train their staff to carry out, as a matter of routine, simple tests to determine residual chlorine, fluoride content, hardness, pH., and such other simple control tests as may be necessary.

## 5. Water Treatment

(i) Treatment of water is a process requiring the greatest care if the health of the consumer is not to be jeopardised; it should be based on expert advice and should be carried out under careful supervision. The degree of treatment

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\*For information as to the technique of water analysis see "Reports on Public Health and Medical Subjects No. 71—the Bacteriological Examination of Water Supplies" obtainable from H.M. Stationery Office. Also "Approved Methods for the Physical and Chemical Examination of Water" published by the Institution of Water Engineers (Heffer and Sons Limited).



will naturally depend upon the origin and character of the raw water and the extent to which it may have been exposed to the risk of contamination.

(ii) The plant should be kept in first class condition, should at all times be operated by properly trained attendants and should also be automatically controlled as far as this is practicable. All apparatus should operate on the "fail-safe" principle and warning of any fault should be given by visible or audible alarms. In the case of unattended stations any failure should result in automatic shutdown of all plant.

(iii) To ensure effective disinfection by chlorination the dosage should result in a suitable residual content in the water after an appropriate contact period. This residual should be tested frequently. Continuous automatic recording of chlorine residual is preferable provided the accuracy of the apparatus is regularly checked by manual tests.

(iv) Adequate reserves of chlorinating agent should always be readily available.

(v) If fluoride is added to the water supply the dose must be accurately controlled and recorded. The total fluoride content of the treated water should be measured regularly and the waterworks staff should make frequent routine tests.

(vi) The records of fluoride dosage and final content should be made available to medical officers of health of the local authorities whose areas are supplied.

## **6. Service Reservoirs**

(i) Reservoirs from which water passes direct to the consumer should be covered. An open service reservoir is dangerous and until it can be covered or taken out of use the water from it should be adequately chlorinated as a safeguard.

(ii) Care should be taken to ensure that pollution cannot enter reservoirs through ventilators, manholes, washouts or overflows. Service reservoirs should be periodically inspected for cracks or other defects which might permit the access of pollution to the water.

## **7. Mains and Hydrants**

(i) When a new section of main has been laid or a main cut and repaired all practicable measures should be taken to avoid pollution of the supply. Before being put into service, the main should be flushed out and thoroughly disinfected by filling with water containing at least 20 p.p.m. of free chlorine. A period of contact of at least 30 minutes, and preferably two or more hours, should be allowed and the main again flushed with pure mains water. It should, wherever possible, be established by bacteriological analysis that adequate disinfection has been achieved.

(ii) Jute yarn should not be used for packing joints unless it has been treated with some rot-proofing agent. It is best to employ inert jointing materials which are incapable of supporting bacterial growth.

(iii) Air valves on mains should be so arranged that there is no possibility of pollution entering through them.



(iv) Ball hydrants also form a ready means of ingress of polluting matter into water mains and any still in use should therefore be replaced by safer types of hydrant without delay.

(v) All valve and hydrant chambers should be efficiently drained to prevent the accumulation of water in them.

(vi) Sewer-flushing devices should be avoided if possible, but if fitted must be strictly supervised to prevent back siphonage from the sewer.

## **8. Works of Repair**

(i) It is of the first importance that the arrangements made when repairs or extensions of waterworks are being carried out are such as to avoid any risk of contamination of the water supply. Instructions to workmen about their conduct while engaged on such works should be in precise terms and notices should be placed in suitable positions. It should be made clear to them that any breach of the instructions will be followed by dismissal. When work outside normal routine is being carried out at a source the public health authorities for the area of supply should be informed.

(ii) Before any work is started in any well, heading or underground chamber, the person in charge must satisfy himself that there is no danger of lack of oxygen or of excess of carbon dioxide, methane, hydrogen sulphide, etc.\*

(iii) While work is being done in a well or heading the water therefrom should be taken out of supply and pumped to waste.

(iv) After the work has been completed and men and equipment withdrawn from the well pumping to waste should continue at the normal supply rate. The water should not be passed into supply until three successive daily bacteriological samples of the raw water show that any danger of contamination due to the work has passed. In exceptional circumstances, if it is not possible to interrupt the supply, the greatest care must be taken to ensure that treatment is adequate to remove any risk of water-borne infection.

(v) The workmen should be instructed in the importance of preventing contamination of wells and headings. Gum-boots and protective clothing worn during the work should be disinfected by scrubbing with a solution of bleaching powder or sodium hypochlorite containing not less than 1.0 per cent available chlorine before the wearer enters the workings.

(vi) Sanitary and washing arrangements should be provided at the surface and so designed that any risk of the men's boots being fouled is avoided. Pails, of a type which minimises the risk of splashing or overturning, should be provided for urination where the men are working. They should be emptied regularly at the surface and their removal after completion of the work should be checked. Strict instructions should be given that any man wishing to defaecate must be brought to the surface.

(vii) Where pumps or other machinery have been removed from a well or borehole for cleaning or repair they should be thoroughly cleansed with water containing at least 20 p.p.m. of free chlorine before being replaced. New

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\*See Memorandum on Safety Precautions recommended for Workers in Wells. Institution of Civil Engineers 1951.



pumps or other machinery should be similarly treated before being inserted in the well or borehole.

(viii) Sanitary and washing arrangements similar to those referred to in paragraph 8(vi) should be made for men working in or at reservoirs or filters. The pails for urination should be placed as near as conveniently possible to the place where the men are actually working but outside the reservoir or filters. In the case of service reservoirs the cleansing of boots and clothing described in paragraph 8(v) should be observed.

(ix) After a service reservoir has been emptied and entered for inspection or repair it should be cleaned out and disinfected by pouring on to the floor at several places enough hypochlorite solution to yield a dose of 20 p.p.m. chlorine when a minimum of 1 foot or so of water is introduced. A man wearing protective clothing and using a stirrup pump or similar device should then wash the walls, as high as he can reach, with this chlorinated water. The water should then be run to waste and the reservoir filled. It is desirable to make bacteriological tests of the water before putting it into supply.

## **9. Safety Equipment**

(i) All waterworks should be equipped with such lines, life-buoys, fire extinguishers, fencing, guards, gas masks, breathing apparatus and other equipment as may be necessary to protect persons and property from injury or death as the result of accident. First aid equipment should also be provided.

(ii) Staff should be given regular instruction in the use of the above equipment.

(iii) Protective clothing should be provided for the use of men handling chemicals or dangerous materials and rooms in which noxious fumes, such as chlorine gas, could be accidentally discharged should be provided with out-wash the walls, as high as he can reach, with this chlorinated water. The water similar safety devices.

(iv) Gas masks should be kept in an unlocked cabinet outside the chlorination room.

## **10. Maps**

Each water undertaking should keep an up-to-date record, in the form of maps and plans, of the sites of their sources of supply and reservoirs and of their distribution system so that they can ascertain readily how each property in their area is served. Diagrams of the pipes and valves in and around pumping stations, treatment plants and reservoirs should also be kept.



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