PRACTICAL SUGGESTIONS

BY

Mr. ROGERS FIELD, M. INST. C.E.,

AS TO

WATER SUPPLY, DRAINAGE, AND SEWAGE DISPOSAL

FOR

LUNATIC ASYLUMS;

ISSUED BY

THE COMMISSIONERS IN LUNACY.

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THE following remarks are only what the title implies, viz., "suggestions," and as a consequence many matters of importance are not even referred to, and the matters that are mentioned are dealt with exceedingly briefly.

Water Supply.

(1.) If an adequate supply of good water can be obtained from public waterworks, and at a moderate cost, this will probably be the best plan to adopt. Generally speaking, however, a special water supply will have to be provided. **Public waterworks.**

(2.) In designing a scheme of water supply, the first question to consider is the quality of the water from the proposed source of supply as, if there is the least doubt about the quality, much the best way is to look out for another source. It should be borne in mind that according to the highest chemical and sanitary authorities, chemical analysis of itself is by no means an infallible guide as to quality. If the water is undoubtedly bad, or if it is of such excellent quality as to be absolutely beyond suspicion, it may be possible to pronounce a definite opinion on it from the analysis, but in the vast majority of cases which occur in practice, when the water is between these two extremes, the results given by the analysis require to be supplemented by a careful examination, on the ground of the surroundings of the source of supply. **Quality of water. Chemical analysis not an infallible guide.**

(3.) It is a good plan when having the water analysed to have special tests made as to its action on metals as the result may affect the kind of pipes to be used in its distribution. For instance if the water has any considerable action on lead it will be unsafe to use lead pipes for the drinking or domestic supply. **Action of water on metals.**

Other waters corrode iron pipes to such an extent that special precautions have to be taken.

Sources of supply.

(4.) The following are the chief sources from which water supplies are derived, viz. :—

Wells.
Springs.
Gathering grounds.
Rivers or streams.
Rainwater collected from roofs.

Supply from wells.

(5.) The most usual sources of supply for asylums are wells.

These are generally divided into shallow wells and deep wells, and though the distinction between these is not very clearly defined, it may be said broadly that shallow wells generally draw the water from superficial beds of drift or gravel lying on impervious strata, and deep wells draw the water from deep-seated water-bearing geological strata.

Shallow wells objectionable. Precautions against pollution.

(6.) Shallow wells are very liable to pollution besides generally giving only a variable supply of water. They should therefore not be adopted, as the source of water supply to an asylum, and no site for an asylum should be selected where the supply would depend on such wells. In exceptional cases where shallow wells are used for the supply of out-buildings, &c., not only should it be ascertained that there are no sources of pollution in their neighbourhood, but the direction of the flow of the underground water should always be carefully determined and considered with reference to any sources of pollution at a distance. If the direction of the underground flow is from the source of pollution towards the well, there will always be danger of the water in the well being polluted whatever precautions may be taken. If on the other hand the direction of the underground flow is from the well towards the source of pollution, the same danger will not exist.

Most usual sources of pollution.

(7.) The most usual sources of pollution in the case of shallow wells are leaky drains and cesspools or their equivalents (fat traps, dip traps, &c.), but in some cases sewage irrigation grounds and even cemeteries are in dangerous proximity to wells. Shallow wells are also liable to contamination from surface soakage, especially in times of heavy rain. This can often be prevented by raising the top of the well above the adjoining ground, and making the upper portion of the well watertight by an impervious lining, for instance, cast-iron cylinders.

Deep wells. Precautions against pollution.

(8.) Deep wells are much safer than shallow wells, but still they are liable to pollution, and the possibility of pollution must never be overlooked. Pollution by surface infiltration can, of course, be easily detected and prevented in the way explained for shallow wells, but the pollution of the underground source of supply is a much more insidious matter. It is impossible to give any general rules for the investigation of the possibility of the pollution of the underground water, as so many conditions, physical and geological, have to be taken into account, but there are two main considerations which should never be forgotten. First, there is the question referred to above of the direction of the flow of the underground water, whether it is from or towards a possible source of contamination. Secondly, there is the question of the effect produced by pumping. The latter is so important that it requires special notice.

(9.) When considerable quantities of water are pumped from a well not only is the water lowered in the well itself, and in the porous strata immediately surrounding it, but the underground water at a considerable distance is affected and gradually drawn towards the well. A funnel-shaped depression is thus created in the underground water, and the depth of this depression and the distance to which it extends around the well will increase with the quantity of water pumped from the well. Consequently a well which may be quite safe from pollution, when only a small quantity of water is drawn from it, may be unsafe when large quantities are drawn from it, as in the latter case the sphere of influence will be largely extended.

Effect of pumping on possibility of pollution.

(10.) If water collected from springs is used for the water supply the question of possible pollution of the underground water must of course be considered as in the case of wells. It is also important to bear in mind that the amount of water yielded by the spring will have a *seasonal variation*, generally yielding least in autumn and most in the early part of the year. The only safe way therefore to estimate the amount which a spring can be depended on to supply is to have a series of gaugings taken extending over a considerable period, including the autumn, so as to ascertain the minimum yield during the year. Attention must also be paid to whether the season immediately preceding the gaugings has been unusually wet or dry. If the previous season, especially the winter, when percolation chiefly takes place, has been unusually wet, the yield of the spring in the ensuing autumn may be higher than usual, and thus be far from representing a true minimum.

Water collected from springs.

(11.) Water collected from gathering grounds is frequently adopted as a source of supply in the case of towns, but it is not generally available or desirable for asylums. There may, however, be instances where it could be adopted with advantage, and in such cases some of the chief points to be attended to are as follows:—

Water collected from gathering grounds.

(*a.*) The gathering ground from which the water is collected should be such that there is no danger of the water being polluted from sewage or manure or the droppings of cattle or any other source. Hardly any land except uncultivated ground, such as is found in mountainous districts, will fulfil this condition.

(*b.*) The gathering ground must be sufficient in extent to supply the required quantity of water in the driest year. In calculating the quantity of water that is required, it will generally be necessary to take into account, not only the water which is necessary for use at the asylum, but also that which is necessary for "compensation water," *i.e.*, the water which must be continually discharged into the stream to compensate for the water that is abstracted.

(*c.*) There must be a suitable position for the construction of an impounding reservoir of a sufficient size to store the flood water, and thus equalize the annual flow. This reservoir should if possible be at such an elevation as to enable the water to be supplied to the asylum by gravitation.

(*d.*) Ample provision should be made for the discharge of flood water from the impounding reservoir, so that there may be no danger, even in the most extreme floods of the water rising in the reservoir sufficiently high to flow over the top of the bank.

(*e.*) The construction of an impounding reservoir and the other matters involved in the installation of a water supply from a gathering ground, are things that require the most skilful engineering treatment, and should only be entrusted to a professional man, who has had experience in such matters.

Water drawn from rivers and streams.

(12.) In some cases the supply is drawn from rivers and streams, but this is a source of supply which should be looked upon with great suspicion, on account of its liability to pollution. If the pollution is simply from vegetable matter, this can be removed by efficient filtration, but if the pollution is of an animal origin, such as sewage and the like, it is, according to the most recent and reliable authorities, not safe to rely on filtration. Of course, it is possible that a stream may be available which is not liable to pollution, but the probability is, that if the course of the stream above the proposed intake is carefully examined, sources of pollution will be discovered which were quite unsuspected.

Rain-water collected from roofs.

(13.) Rain-water collected from roofs forms an excellent auxiliary supply, on account of its softness, for laundries, steam boilers, &c. It is, however, quite insufficient in quantity for the general supply of an asylum, and under no circumstances should be relied on for that purpose. If, however, it is determined to save the whole or a portion of the rain water, for the special purposes mentioned above, proper provision of storage tanks, &c., would have to be made, and the following observations may in that case be found useful.

Amount of rain-water available.

(14.) In order to calculate the amount of water that is available, the fall of rain in the driest year must be ascertained, and then an allowance be made for loss by evaporation, absorption, &c. The available depth of rain multiplied by the aggregate area of the roofs will give the annual amount of water there is available. When only an approximate result is required, the following very simple rule will enable it to be immediately obtained. If the area covered by the roof in square feet be multiplied by the average annual rainfall also in feet, and the result be divided by 100, it will give the average supply in gallons per diem, that may be depended on in a very dry year. Thus assuming the area covered by the roof to be 20,000 square feet and the average rainfall to be 36 inches or 3 feet, $\frac{20,000 \times 3}{100} = 600$, and the daily amount available is therefore 600 gallons.

(15.) In order, however, to utilise the whole amount of water that is available, it is absolutely essential that there should be a tank of sufficient capacity to collect the water that falls in heavy storms, and to tide over the longest droughts, and the necessary size should always be carefully determined in each case. The accurate calculation of the result is rather a troublesome matter, but it has been found by actual experience that it will be sufficiently near for practical purposes to make the tank contain from 2 to 3 gallons for every square foot of roof area. In the East of England, where the rainfall is small, 2 gallons per square foot will be sufficient. In the West of England, where the rainfall is greater, from 2½ to 3 gallons per square foot will be required. Taking as an example the case previously mentioned, where the rainfall was assumed to be 36 inches, at least 2½ gallons per square foot ought to be allowed, which would make the total capacity required for the tanks equal to 20,000 × 2½ or 50,000 gallons. **Size required for rain-water tanks.**

(16.) Another point of importance is to prevent leaves, soot, and other refuse off the roofs, from entering the storage tank. The simplest way to effect this is to have a rough filter or straining chamber constructed, through which the rainwater passes before running into the tank. This chamber should consist of two portions, the first portion being merely a settling chamber, which will intercept the greater part of the refuse, and the second portion being a rough filter of small well-washed stones. **Rough filter for rain-water.**

(17.) The quantity of water required for the general supply of Asylums varies in different cases. If undue waste could be prevented, from 30 to 35 gallons per head per diem ought to be an ample allowance, but the difficulty in preventing a large amount of waste is so great, that generally from 40 to 50 gallons are required Even this amount may be exceeded unless proper precautions are taken to control the waste as far as practicable by the use of suitable waste-preventing apparatus, and by constant supervision. **Quantity of water required.**

A minimum supply of at least 40 gallons per head per diem should therefore always be secured, and no site should be selected in which this quantity cannot be obtained in the driest season.

(18.) It is impossible within the limits of these suggestions to go into the details of construction of waterworks, but a few im- **Details of construction of waterworks.**

portant points may very briefly be alluded to. The engine and pumps for raising water, especially in the case of deep wells, should be in duplicate, otherwise a break down may leave the asylum without water. The water supply arrangements should be designed so that the quantity of water supplied can be measured. Filters of any kind to purify water must be arranged so that they can be regularly cleansed, or they will become pollutors Service reservoirs should be covered, but be fully ventilated. The overflow pipes for reservoirs or tanks must not join any sewage drain, but should discharge with an open end on to the suface of the ground, or into an open ditch. Cast-iron pipes, coated at the foundry with Dr. Angus Smith's composition, should be used for the mains. Water-pipes must be laid at a sufficient depth below the ground to secure them against frost, say not less than 2 feet.

Water appliances and fittings.

(19.) Water-closet cisterns should be quite distinct from cisterns supplying drinking water, or those supplying sinks, baths, and lavatories. Drinking water cisterns should be constructed of slate or iron, not of lead. They should be situated in carefully selected places, well lighted and easy of access, and should have movable match-board covers, and be protected from frost if in exposed positions. The overflow pipes of all cisterns should discharge through an outer wall into the open air. If the building is supplied direct from a high pressure main, it is best to have the taps which are or may be used for drinking water, connected directly with the main. All water pipes should be fixed on the face of the walls or in open chases, so as to be easily accessible, and when exposed to frost should be wrapped with slag-wool and cased. Stop cocks should be provided on all the principal lines and branches. Common plug draw-off taps should not be used, but those of the screw down principle, or self closing spring taps.

Drainage.

Disposal of sewage must be considered before designing drainage.

(20.) Before designing a system of drainage the question of the disposal of the sewage should be considered, not only because it is essential to provide for the proper disposal of the sewage, but also because the particular arrangements adopted for the disposal may largely affect the design of the entire scheme, especially as regards the levels and directions of the drains. As explained in the Commissioner's suggestions and instructions about sites, a position should if possible be chosen for the Asylum sufficiently elevated to admit of the application of the sewage on land by gravitation. Some information with reference to this question will be found under the head of sewage disposal, page (15).

Separate system of rainwater drains.

(21.) It is generally desirable to divert the rainwater, at any rate for the most part, from the sewage drains, and for this purpose to have a separate system of rainwater drains. In most cases it is advantageous to collect the rainwater in tanks for use for boilers and laundry purposes. If this is not done the rain-water drains must discharge into ditches or water-courses.

(22.) The following are some of the main points to be borne in mind in designing a good system of sewerage. Main points to be borne in mind in designing a system of sewerage.

(*a.*) That the sewage must be rapidly removed from the buildings, and the drains be "self cleansing," so that there is no stagnation or collection of deposit in them.

(*b.*) That the drains should never pass under buildings where it can possibly be avoided, and when such passage is unavoidable, special precautions must be taken.

(*c.*) That the drains should be watertight, so as to void pollution of the soil.

(*d.*) That the drains should be readily accessible for being examined, tested, and cleaned.

(*e.*) That effective means should be taken to prevent the escape of any air from the drains into the buildings, or the accumulation of foul air in the drains.

(23.) Drains should be laid out in straight lines and with true gradients from point to point, with manholes or inspection shafts at every change of direction or gradient. These manholes and shafts should as a rule have movable iron covers at ground level (not buried beneath the ground). Laying out drains.

(24.) Drains should not be made larger than necessary, as the larger the drain in proportion to the quantity of sewage passing through it, the less the power of the sewage to carry solid matters along, and *vice versâ.* Where the rain-water is for the most part diverted from the sewage drains, and the falls are fairly good, a 9-inch drain will be sufficient for the outfall from the largest asylum, and a 6-inch drain sufficient for that from a small asylum. If much rain-water is admitted to the sewage drains, special calculations must be made to determine their size. In the case of the branch drains from closet blocks, the governing consideration is not the amount of sewage passing down them, but the foreign substances passed into them by the patients, and it is generally advisable to make such branch drains 6-inch, though 5-inch if that size could be obtained would often answer. Both 5-inch and 7-inch pipes, though not generally made in stoneware, are very useful sizes. Size.

(25.) The falls of the drains should, wherever possible, be sufficient to render them self-cleansing with the small amount of sewage that ordinarily passes down them. It has been found by experience that the following gradients will effect this: 4-inch pipes 1 in 30; 6-inch pipes 1 in 40; 9-inch pipes 1 in 60; and the falls should therefore approximate to these gradients as closely as circumstances will allow, though much flatter gradients will be satisfactory if systematic flushing is adopted. Where fall has to be economised drains near the buildings should have a greater fall than those at a distance. Falls.

(26.) If the available fall is not sufficient to give the gradients above mentioned, provision should be made for systematic daily Flushing.

flushing. In the case of branch drains, it may often be sufficient to arrange that one or more baths which are regularly used should have large outlets, so as to discharge sufficiently rapidly to flush the drains, but in the case of main drains automatic flush tanks should be adopted. Even where good falls are obtainable it is very advantageous to have automatic flush tanks at the heads of the principal drains.

Stoneware drains and jointing.

(27.) The stoneware drains should be of best glazed stoneware pipes, and may be jointed with portland cement or have an approved patent joint. Clay joints must under no circumstances be used. The drains should as a rule be laid on a continuous bed of portland cement concrete near buildings, and on soft ground such a concrete bed is essential everywhere.

Iron drains and jointing.

(28.) Iron drains must be constructed of heavy cast-iron socket pipes coated with Dr. Angus Smith's composition, and be of the following weight per 9-foot length; 4 inch pipe 1 cwt. 2 qrs.; 6-inch pipe 2 cwt.; 9-inch pipe 4 cwt. The pipes must be examined before laying to see that they are free from rough projections inside, and be properly jointed and caulked with lead. Unless the ground is very firm the iron drains should be laid on a concrete bed or concrete piers. Iron should always be used for drains which pass beneath buildings, and it is advantageous to use them in many other positions, especially in slippery ground.

Testing drains.

(29.) All drains must have the inside surface, especially at the joints, wiped out smooth and clean and be left thoroughly water-tight. The water test should be applied not only when the work is in progress, but also after the work is completed, so as to test manholes as well as drains.

Manholes.

(30.) Manholes should be sufficiently large to allow a man to use drain rods in them, a good average size being 3′ 0″ × 2′ 6″ in the clear inside. The inside surface should be rendered in cement 2 feet up from the channels and the bottoms made water-tight. The "benches" should be formed so that a man can stand on them, but at the same time should have a slight incline to the main channel. Curved channels should have extra fall, and all channels and curves must be tested with water to see that they will discharge the sewage properly without splashing it about. Deep manholes should be ventilated as near the top as possible, or an accumulation of foul air will take place in them.

Disconnection from sewer or outfall.

(31.) The air communication between the public sewer or outfall and the drains round the buildings should be severed at one or more "disconnecting" manholes. These manholes should have at the outlet a specially designed self-cleansing siphon trap, with a cleaning branch above it to give access to the drain beyond the trap. The cleaning branch should have a "Stanford" inspection cap, the stopper being prevented from falling out by a thin fillet of cement round it which can be easily chipped off when required. The manhole must either have an open grating as a cover or be ventilated by a pipe.

Ventilation.

(32.) The drains must be amply ventilated by openings, so arranged as to a create a current of air through the drains. At a distance from the buildings simple openings at or near the ground level, in connection with the manholes, will generally answer the purpose, but the openings must be so arranged that dirt cannot fall into the drains. Near the buildings or in the airing courts ordinary surface ventilation is generally inadmissible, and a system of low level air inlets and high level air outlets must be arranged, the inlets being situated at a few carefully selected points, and the outlets being formed by external pipes carried above the roof. The ventilators must be of ample size, and in no case have less than 12 square inches clear opening. Engine-house chimneys may sometimes be used with advantage for ventilating the drains, but rain-water pipes should not be used for this purpose, nor should ventilating flues for drains be constructed in the walls of inhabited buildings.

(33.) Sewage drains must not act as land drains, but if it is thought desirable to drain the land through which the sewage drains pass separate land drains should be laid in the same trench as the sewage drains, and these land drains should discharge into a ditch or watercourse. The same rule as to discharge should apply to land drains which are laid independently of the sewage drains. **Land drains.**

(34.) Gully traps should, as a rule, not be placed inside buildings but outside, and in easily accessible positions. They should have large iron straight bar gratings (not stoneware ones). In laundries and other exceptional cases when it is necessary to place gullies inside a building, the drain from the gullies should be "disconnected" immediately outside the building. **Gully traps.**

(35.) In asylum work it will be found advantageous to have the number of soil pipes as compared with closets larger than is the usual practice in an ordinary dwelling. The soil pipes should be fixed outside as nearly vertical and with as few bends as possible, and should be continued up full bore for ventilation above the roof. The top must be well away from windows, and have a stout copper wire cage on it. The best material for an external soil pipe is generally strong cast-iron, coated inside and out with Dr. Angus Smith's solution, care being taken that the pipe is smooth inside and has long sockets for caulking. A diameter of 4 inches is generally found to be sufficient. The weight of the 6 feet length should be at least 60 lbs. The joints should be very securely caulked, so as to be air-tight, the best way being to run the joints with molten lead. The joint between a lead closet branch and an iron pipe should be made by a brass "sleeve" wiped to the lead and caulked into the iron pipe. If iron closet branches are used they must be at least $\frac{1}{4}$-inch thick, and there must not be any joints in the wall. Brass screw caps flush inside not recessed should be supplied on each closet branch. The connection between the soil pipe and the drain at its foot must be very carefully made. If a soil pipe must of necessity be fixed inside a building, it must be of lead **Soil pipes.**

throughout, not less than 8 lbs. per foot and preferably 10 lbs. per foot with soldered joints.

Water-closets.

(36.) Water-closets should as far as possible be placed in projecting blocks, and be cut off from the building by a neck or lobby not less than 5 feet wide with ample cross ventilation. There should be plenty of windows in the walls of the closet block, and a door at each end of the neck. In some cases the neck or lobby is enlarged and the lavatories arranged in the neck; but this plan is not such a good plan as placing them in the block itself, and should never be adopted in new buildings. The urinals and slop sinks should, of course, be in the blocks. The closet partitions should be planned, so that there is no post or bar on which the patients could hang themselves. The closet doors should be half doors, swinging clear of the floor about 18 inches, and opening outwards. The closet floors should be of impervious material, such as concrete and cement or tiles.

Water-closet apparatus.

(37.) A simple and efficient kind of water-closet apparatus for asylums is that known as the short "Hopper-closet." A good form should be chosen in which the basin and trap are self cleansing and the trap is not unsealed, when a bucket of water is quickly poured into it. "Wash-out" closets are not suitable for asylums, as the basins and traps generally become foul. Excellent Hopper-closets are made in enamelled iron, very suitable for asylums, the trap (which is also of enamelled iron) having a flange at the outlet, and a brass ring with bolts for making a secure joint between the trap and the lead branch. Thick fireclay closets are also now made which will stand rough usage. White earthenware closets may be used for the officers and attendants, and in wards where they will not be likely to be broken. When a stoneware or fireclay trap has to join a lead branch, special precautions must be taken in making the joint. A good way is to solder a brass socket to the lead branch, to take the end of the trap, and then make the joint with portland cement, a rubber ring or coil of tarred yarn being first pushed tightly in. Water-closets should be so fixed that no accumulation of filth or rags can take place behind them, and the space under the seat should be left exposed.

Method of flushing closets.

(38.) Many different plans for flushing patients' closets have been tried in asylums, such as (*a*) the simple "stool valve"; (*b*) the "seat action"; (*c*) the "door action"; (*d*) the automatic flush tank applied to a range of closets; (*e*) the waste-preventing cistern actuated by a simple pull. The first three of these plans cannot be recommended. The fourth plan (automatic flush tank) is a better one; but if adopted it must be very carefully designed, and it has (amongst others) the disadvantage that, in the case of a closet being choked and not noticed, an overflow may take place when the tank discharges. The best plan on the whole is the last one (waste-preventing cistern) as experience shows that the objection which is raised to it, that the patients will not use the pulls, has not much weight. The waste-preventing cisterns should contain from 2½ to 3 gallons of water, and be on the siphon principle, so that they discharge the whole of the flush after one pull of the handle. This handle may consist of a wooden slide with a recessed finger hole or projecting rounded lug, the slide working in a groove and being attached to the pull chain or cord, which, as well as the cistern, must be cased.

Earth closets.

(39.) For out-door closets in the airing courts (if adopted) or at farm or garden buildings, earth closets may be used; but it is essential that provision should be made for regularly cleaning them out at least once a day.

Slop sinks.

(40.) A slop sink is primarily for the reception of foul discharges and urine, and must be treated as if it were a water-closet. Ordinary wash-up sinks must never be used as slop sinks, but in some cases the water-closets may be so used. As a rule, it is best to arrange for a slop sink in a separate compartment in each closet block, providing room in the compartment for pails and brushes. Slop sinks may be made of enamelled iron, slate, or thick fireclay enamelled white inside. The last of these materials is probably the best, the only objection being that with very rough usage the enamel may be chipped off. The best plan of flushing slop sinks is by a waste-preventing cistern like a closet, and the fireclay sinks are constructed with a flushing rim for this purpose. In Private Dwellings and in Infirmaries this plan of flushing should always be adopted; but in the ordinary wards of an asylum it is not so essential, as so much washing water is poured down.

Anti-siphonage pipe.

(41.) In cases where there are two or three closets one over the other discharging into one soil pipe, it may be necessary to fix air pipes to some of the closet traps to prevent them being unsiphoned.

Urinals.

(42.) Urinals should be placed in the same structure as the closets and not in the closet lobbies or placed in close proximity to wards, and the simplest and best arrangement is to make the urinals of plain slate, the stalls being quite open and without any troughs. There should be a channel at the bottom worked out of the slate or made in thick fire-clay glazed inside, and the floor for a distance of 2 feet back should slope towards the channel. Great care is required in the construction of urinals on upper floors to prevent leakage through the floor to the ceiling below. Flushing should be arranged by a perforated copper sparge pipe fitted so that the whole surface may be well washed. Either small automatic flush tanks may be used or there may be a properly regulated continuous flush capable of being readily turned off and on by the attendant. The waste fitting should be of thick brass and the grating fixed with screws so that it can be taken off. There should be a trap (preferably of brass or enamelled iron) immediately under the grating, and the waste pipe should discharge over a gully outside the building.

Waste pipes.

(43.) The waste pipes of all sinks, baths, and lavatories should be trapped immediately beneath the appliances, and also be disconnected by discharging with open ends either directly or indirectly into trapped gullies outside the building. The traps beneath the appliances must be accessible and have screw cleaning caps on them, and when necessary air pipes must be provided to prevent siphonage.

Wash-up sinks.

(44.) Glazed stoneware or fire-clay sinks are the best. The outlets, whether gratings or plugs, should be much larger than the waste pipe, so as to give a rapid discharge.

Baths.

(45.) White enamelled fire-clay baths are much preferable to iron ones, and the less woodwork about them the better. The outlets should be large, say 3 inches at least in diameter, so that the baths may empty rapidly and flush the drains. The simplest arrangement is to have plugs, and these should be vulcanite or solid rubber or light brass covered with rubber or leather. In the case of a general bath-room with a range of baths on a concrete or tiled floor the baths may be discharged into a white glazed channel in the floor covered with a grating, and then into one trap at the end, which reduces the number of traps and fittings. The inlets for the water must be distinct from the outlets, and are best arranged to deliver over the top edge of the bath.

Lavatories.

(46.) The lavatory basins should have plug outlets of vulcanite or rubber. A simple plan is to make the outlets discharge into an open enamelled iron trough fixed on brackets beneath the basins, care being taken to leave sufficient space for the trough to be readily cleaned from end to end. Tip-up basins hung in closed metal troughs should never be used.

Woodwork.

(47.) The more woodwork that can be dispensed with in connection with the closets, sinks, baths, and lavatories the better, as everything should be left as open as possible consistent with safety. All closet seats should be hinged and should be the full width of the closet or nearly so. All casings should be movable, and fixed with hinges and locks or brass cups and screws.

Rain-water pipes.

(48.) Where rain-water down pipes discharge into sewage drains they should be disconnected by discharging with open ends over open trapped gullies outside the building. In positions such as the corners of airing courts where the patients might use the gullies as urinals, they must be covered over with an iron door or a stone, and side ventilation be provided. Where the rain-water is collected in tanks by means of a separate system of drains, the rain-water pipes may be joined up to the drains without the intervention of gullies, but means must be provided for access to the foot of the pipes in case of stoppage by leaves, &c. The overflow drain from a rain-water tank must not be connected with the sewage drains, but discharge into a ditch or watercourse or on to the surface of the land.

Plan of drains.

(49.) An accurate plan should always be made of the drainage as actually constructed, showing the manholes, traps, ventilators, gullies, and other details, together with the sizes and levels of the drains. The contract plans are not sufficient, as alterations always take place during construction.

(50.) In the reconstruction of the drainage of an asylum, all old drains should, as a rule, be searched out and entirely removed, together with any contaminated earth. This is imperative in the case of drains in the neighbourhood of buildings, but an exception may sometimes be made in the case of drains which are at a considerable distance from buildings and laid at a considerable depth. In such cases openings should be made to the drains, they should be thoroughly cleaned out with drain rods, and washed with lime and water, and afterwards the ends should be closed up with cement concrete. If there are any cesspools, catch pits, or fat traps, they must also be destroyed. If the position of the closets is bad, new apparatus should not be put into the old positions, but new closet blocks should be built out. Old insanitary apparatus should not be re-used, as this is altogether false economy. This applies to baths and lavatories, as well as to closets, urinals, and slop-sinks.

Reconstruction of old drainage.

Sewage Disposal.

(51.) If the asylum is situated in a district where there is already a system of main sewerage and is within reasonable distance of one of the main sewers, it will probably be the best plan to arrange for the discharge of the drainage into such sewer. Even in this case, however, the question of the utilization of the sewage on the asylum farm land should not be lost sight of, as where sewage can be obtained by the farmer when he requires it, and need not be taken when he does not require it, it is valuable as a fertiliser. It may therefore often be advisable to arrange means by which the whole or a portion of the sewage can be diverted on to the asylum land when it is so desired, instead of being discharged into the public sewer.

Discharge into public sewers.

(52.) If, on the other hand, as is generally the case, there is no public system of sewerage available, a well-considered plan must be designed for the disposal of the sewage of the asylum. This will generally have to be arranged for on the asylum ground, as it is illegal and quite inadmissible to discharge sewage into streams or watercourses.

Disposal where there is no public system of sewers.

(53.) In the great majority of cases application of the sewage to land will be found to be the most effective and least expensive method of disposing of the sewage. It is usual to distinguish between two methods of applying sewage to land, viz., " broad irrigation " and " intermittent downward filtration," and although no hard and-fast line can be drawn between these two methods it may be well to say a word about their distinguishing features.

Application of sewage to land.

(54.) By *broad irrigation* is generally understood the application of the sewage to a considerable area of land with a view

Difference between broad

irrigation and intermittent filtration.

to its profitable use for agricultural purposes. By *intermittent downward filtration* is understood the application of the sewage at regular intervals to as small an extent of land as will effectually absorb and cleanse it. In both processes, if properly carried out, the sewage will be utilised for the production of vegetation and also be effectually cleansed, but in the latter process (filtration) profitable use is treated as altogether of secondary importance, the primary object being purification of the sewage by a small quantity of land.

Particulars as to broad irrigation.

(55.) The minimum amount of land required for broad irrigation is very usually stated at 10 acres for the sewage of 1,000 persons, but the amount will vary considerably according to the nature of the soil. Whenever it is possible, porous land should be selected, and in such cases 10 acres may suffice for 1,000 persons. On the other hand, if only retentive land is available, a larger area must be provided, and it would probably be wise to have at least three times that amount for 1,000 persons, as with such land it is very difficult to obtain a good effluent, and it is therefore often an advantage to have sufficient area to enable the effluent to be re-applied to a lower portion of the land before being discharged into a watercourse.

Particulars as to intermittent filtration.

(56.) In the case of intermittent downward filtration, it is absolutely essential that the land should be porous, and if it is not naturally so it must be made so artificially. Special arrangements must also be provided for distributing the sewage uniformly over the land with proper intervals of intermission. The amount of land required for intermittent filtration may be stated roughly to be from 2 to 3 acres for 1,000 persons. The smaller the quantity of land in proportion to the population the greater the care required in preparing the land and in providing special arrangements for distribution of the sewage. It cannot, moreover, be too strongly insisted on that all the details must be efficiently worked out, and the greatest care regularly and constantly taken in the distribution of the sewage, or this method of sewage disposal, although in itself a good one, will be a failure.

Gravitation schemes and pumping schemes.

(57.) The land selected for the application of the sewage should always, if possible, be at such a level that the sewage can be conveyed to it by gravitation, and pumping be avoided. If in any case pumping must be resorted to, the pumping machinery should be in duplicate.

Irrigation ground must be far removed from well.

(58.) If the water supply for the asylum is obtained from a well on the asylum ground, another very important point that must be attended to in selecting the land for the disposal of the sewage is that there should not be the slightest risk of the sewage reaching the well. See the remarks on Water Supply, page (4).

Under drainage.

(59.) Where the land selected is wet it must be underdrained This is, however, a matter that requires the greatest caution, as if the drainage is not carried out with a special view to the irrigation, much trouble may result. The danger is that the sewage, instead of percolating through a sufficient extent of ground to become purified, may find its way directly into the land drains, and thus render the effluent from these little else than crude sewage. In the case of porous land this danger can be avoided by making the drains deep and at a considerable distance apart, and then, wherever possible, constructing paths over the drains so that no sewage can be applied close to them. In the case of retentive land, such as clay, on the other hand, the difficulty of avoiding a direct passage of sewage to the drains is so great on account of the cracking of the clay that some authorities advise that such land should not be drained at all when sewage has to be applied to it. This, however, appears to be wrong in principle, and a better solution would be to lay out the drainage so that the effluent from the land to which the sewage is first applied can always be reapplied to land at a lower level specially prepared to receive it.

Interception of solids.

(60.) Before the sewage is applied to the land, the rags, paper, and solid matters should be intercepted. This will be best effected by a simple form of straining chamber, the bottom of which is rather above the bottom of the outlet, so that the liquid sewage passes through the chamber without any obstruction, and only the solids are held back by the strainer. The straining chamber should be in duplicate and the solids should be removed every day and mixed with dry earth or ashes, when they will be inoffensive. Settling tanks in which the solids are allowed to deposit should always be avoided as they give rise to putrefaction, and are thus not only a nuisance in themselves, but contravene the important principle that the sewage should be applied fresh to the land. Moreover, the semi-fluid "sludge" which is deposited in the settling tanks is most offensive and difficult to deal with.

Necessity of proper attention to distribution.

(61.) In order that the disposal of the sewage by application to land should be successful, it is absolutely essential that intelligent attention should be constantly paid to the distribution of the sewage on the land in a careful and efficient manner. This is a matter that is too often neglected, the result being a failure which is frequently attributed to the system of disposal instead of to the true cause, viz., faults in the management.

ROGERS FIELD.