TEXAS WATER DEVELOPMENT BOARD

REPORT 8

RE-USE OF EFFLUENT IN THE FUTURE

with an

ANNOTATED BIBLIOGRAPHY

By

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FOREWORD

This report was prepared under provisions of the General Research Agreement between Texas Technological College and the Texas Water Development Board. It is one of five reports by various members of the Texas Technological College staff arranged for as a direct contribution to the development of a State Water Plan. The Texas Water Development Board gratefully acknowledges the cooperation extended and the staff time and expense incurred by Texas Technological College in developing this information. The Board also thanks the author for providing valuable and useful data important to water planning.

Texas Water Development Board

Joe G. Moore, Jr.

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Executive Director

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SUMMARY AND CONCLUSIONS

That re-use of water through many cycles will be routine practice in fifty years seems so evident after a diligent survey of the technical literature, that the writer toyed facetiously with assigning to this study some such title as, "The 21st Century: an Effluent Society."

Two major forces will be responsible for this development. The first of these is water economics. With supply essentially constant, and with demand growing, the luxury of discarding once-used water will become but a bitter memory of ancestral squandering.

The second is the improvement in sewage treatment. Through utilization of modern developments in the production of effluent and in the disposal of sludge, sewerage systems can be made flexible enough to deliver effluent of a desired quality where and when needed.

The design--and the continuing redesign--of piping and plants to produce these results with the maximum economy will require sound engineering on a system-by-system basis. Broad knowledge of solutions which have been employed elsewhere, tempered with the modifications desirable to adapt them to local needs, will be required. It was these considerations which led to the writing of a short report introducing several hundred abstracts rather than an inadequate set of rules-of-thumb which would be inapplicable in some important way to each particular problem.

HISTORICAL DEVELOPMENT, CURRENT STATUS, AND UNRESOLVED PROBLEMS IN THE RE-USE OF EFFLUENTS

As one dusts off his crystal ball to prognosticate on the re-use of water a half-century hence, he might well begin by asking himself what a forebear would have done in a day when the hand-set headlines in Texas' press proclaimed the latest exploits of Pancho Villa.

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* Contribution No. 65-1, Texas Technological College Water Resources Center.

Unfortunately, no predictions made in those days have come to the writer's attention. Perhaps, however, even this fact is significant. At a time when sewage farms had lapsed into disfavor and before regional water shortages were of critical concern to large populations in arid areas of the country, the re-use of sewage effluent, when considered at all, was at best a subject of bawdy jests.

Effluent for Irrigation

Sewage has, of course, always returned. Whether by drainage from pits to springs and wells, or more directly by surface streams, one man's discharge has been the next man's supply. Historically, little concern was felt, since these waters were considered to have been "purified" by natural processes.

The fertilizing value of manure was appreciated by prehistoric man. Small wonder, then, that cities were often accompanied by sewage farms.

With increasing knowledge of public health, sewage treatment plants were introduced and sewage farms gave way to irrigation with effluent. The literature (and this collection of abstracts) is replete with the arguments between those who advocated the preservation of full fertilizer values and those who viewed any taint of previous contamination with the gravest suspicion.

Informed current opinion, supported by biological studies on the travel of bacteria in aquifers and of their presence on sewage- or effluent-irrigated vegetables, would appear to be that if any disease be traceable to irrigation with effluent, then the operation of the particular farm is faulty. Proper irrigation management, in time of application and choice of crops, can avoid any hazard to public health.

The index to the abstracts will lead the interested reader to papers expressing a wide gamut of views on the efficacy--physical and economic--of irrigation with effluents.

The utilization of domestic- or trade-effluent, as distinguished from in-plant recycling of water for progressively less-demanding uses or for the same uses after some form of treatment, has been predominantly agricultural to date.

The future of agricultural re-use, however, would seem to be essentially an economic problem. If the irrigation be viewed as primarily a means of sewage disposal with the added advantage of the avoidance of stream pollution, then the farmer should be paid for making his land available especially if, as is usually the case, he is required to accept the full effluent flow at all times.

If, however, the effluent be priced at its value to potential industrial users, or even priced at cost of raw water plus cost of treatment plus cost of delivery to the farm, the picture is very different. Todd (1965-7) quotes a study by Professor Nathaniel Wollman of the University of New Mexico which has "shown that the average value added to the economy of the Southwest through the use of water in irrigation is only \$44 to \$51 an acre-foot, whereas the value gained from recreational uses could be about \$250 an acre-foot and from industrial uses \$3,000 to \$4,000 an acre-foot. Because the quantities of water consumed by city-dwellers and their industries are much less than those in agriculture, the arid Western states would not require such a vast increase in future supply if they shifted from a predominantly agricultural to a predominantly industrial economic basis."

The most probable long-term development in Texas would seem to be an increasing industrialization of the metropolitan areas with a corresponding shift of their use of effluent from irrigation to industrial use. Smaller municipalities will probably continue the trend determined in an, as yet, unpublished study by Harvey and Cantrell[1/] in which they reveal an ever-increasing interest in the use of effluent for irrigation. The correlation of use with size of city is, of course, related to the shorter transmission distances, more moderate land and water values, and reduced competition for effluent in the smaller communities.

Effluent for Recreation

Intermediate on Wollman's list of values was that for recreational use. Reference to the index of abstracts under "parks" and "golf courses" would indicate that such applications have come early and often, as, indeed, it is reasonable that they should. Parks, waterworks, and sewage plants are commonly all part of the same municipal entity. If, then, reclamation plants can be located near parks the effluent will be available on interdepartmental bookkeeping, and a further saving to the municipality may result in that water mains which would be necessary to transport alternative water long distances need not be laid, or existing overloaded mains may be relieved of their park-supply function.

Golden Gate Park in San Francisco is an outstanding example of this. Its operation is described many times in the articles abstracted in this report.

Irrigation of golf courses, especially in some of the more arid localities of the Southwest, might not be feasible if it were not for the availability of sewage effluent.

Hygienic considerations are paramount in this type of application. Secondary or even tertiary treatment designed to produce water meeting U.S. Public Health Service Standards for drinking water should be employed, since wind-carried spray will inevitably coat drinking fountains. Also, waders, boaters, and water-skiers have been known to wet more than their feet despite the posting of signs forbidding bathing.

Vigilance is required in parks employing effluent since piping carrying potable water will inevitably be present also. The outlets must be carefully and permanently marked and cross-connections must be avoided.

Normally, storage facilities for effluent are small, unless the park contains one or more lakes which can perform this function. Thus, provision must often be made for handling more water than is needed at times.

With increasing costs of competing water and of mains to convey it on the one hand, and improvements in the quality of effluent as treatment plants are

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[1/] Harvey, Clark and Cantrell, Ronald: "Use of Sewage Effluent for Production of Agricultural Crops." To be published by the Texas Water Development Board.

replaced on the other, the use of municipally-owned effluent for municipally-owned parks would certainly appear to have a verdant future.

Effluent for Industry

In re-use of effluent by industry few categorical assertions should be made; nor need they be. Many industries are listed in the index to the abstracts. For these, papers treating specific problems and citing instructive examples are available. The diversity of problems, and corresponding diversity of solutions, will be apparent from a perusal of these abstracts.

Unlike agriculture, industry consumes only a small portion of the water it uses. Cooling water, wash water, and water used for the conveyance of materials remains available for other duties or, perhaps after being run through cooling towers or sedimentation tanks, for new cycles of the same duty. Technically, this is re-use and many of the abstracts herein cover such practices.

In addition to this in-plant re-use, many industries employ sewage-plant effluent rather than alternative water supplies for their process water. The factors which have influenced the decision to employ effluent have been discussed at length in many excellent papers. They are economic in nature--as industrial decisions should be--normally involving water availability and/or chemical quality (salinity and softness, particularly).

Effluent for Ground-Water Recharge

Effluent for agriculture, recreational use, or industry will normally have been in storage for a few hours at most. When longer storage is desired, it may often be most conveniently available in depleted aquifers--and the aquifers near cities in arid regions seem always to be depleted--since effluent has normally been unacceptable to potential users as long as an economical alternative ground-water source has existed.

Concentrated demand on ground water has frequently led to increased pumping and well-development costs as the water table declined. Often, also, salinity has increased as deeper strata were tapped and/or as natural hydraulic gradients were reversed. In fact, much of the interest in ground-water recharge has been associated with the creation of salt-water barriers to preserve the quality of over-developed aquifers.

In addition to Todd's paper previously cited, many articles deal with ground-water recharge. The earlier papers, in general, treat the unintentional recharge resulting from excessive application of irrigation water. Studies on bacteriological and chemical changes during percolation are abundant. Many reports, particularly those relating to site investigations in Southern California, are concerned with cost, quality, and quantity figures for planned recharge for the creation of barriers and/or the storage of water for later beneficial use.

Increasing water costs in the years ahead may well be expected to alter the choice of answer now usually made to the question of recharge or discharge.

Effluent for Potable Water Supply

Technically, effluent meeting the bacteriological standards for drinking water may be--and has been--produced. The classic examples are Ottumwa, Iowa, where for two months one-third to one-half of the water supply consisted of raw sewage from the upstream city of Des Moines, and Chanute, Kansas, which re-circulated its own effluent for several months without disaster.

Normally, however, such intensive use is not contemplated. Better effluent from increasingly effective treatment plants will presumably be diluted with river water which may, itself, be expected to be of better than present quality as pollution control becomes more general. Alternatively, recharged effluent, "polished" by natural filtration, and supplied in quantities to delay increase of salinity, will yield "perpetual" supplies of ground water.

As the word "delay" in the previous sentence indicates, however, more will be required ultimately than even the best present secondary treatment. While this produces "safe" water bacteriologically, it leaves many inorganic contaminants which, thus, become cumulative on recycling. The economic removal and disposal of these elements will provide continuing interesting research for the sanitary engineer of the future.

Two Significant Developments Affecting the Future of Effluent Re-Use

Two relatively recent developments in water management have an influence on the trend of re-use which completely invalidates forecasting by the statistical extension of data.

The first of these is the advent of regional water planning for the best use, and re-use, of all predictable water. This procedure is exemplified by the Texas study of which this report is a portion and by earlier studies in Texas, California, other Western states, and in many cases, by river basins.

The text of this report is shorter, and the bibliography longer, than would otherwise have been the case due to the appearance of several excellent studies of this nature in recent years. Any serious investigation of the subject of effluent re-use should include a reading of the following papers:

> Publications of the California State Water Pollution Control Board Nos. 6, 9, 12, 15, 18 (Abstracts 1953-9, 1954-4, 1955-27, 1956-17, and 1957-15).
>
> Report on Water Re-Use in Texas by Gloyna, Hermann, and Drynan (Abstracts 1957-7 and 1959-8).
>
> A Report Upon Present and Prospective Means for Improved Re-Use of Water by Gloyna, Wolff, Geyer, and Wolman (Abstract 1960-8).
>
> The Annual Literature Reviews published in the Journal of the Water Pollution Control Federation. These survey the recent trends and give comprehensive bibliographies.

The second development upsetting forecasting by the extension of trend lines is the impending perfection of tertiary treatment. With the promise that these methods hold, it would be temerarious to predict such characteristics as the BOD of next century's effluent.

While apparently of little direct concern in a study of effluent, it should be mentioned that the new combustion methods of sludge disposal permit location of treatment plants on small plots in vicinities which would be unthinkable for most present facilities. Thus, adjustments may be made to serve effluent users without serious dislocation of plant or sewers. This new flexibility provided by sludge combustion and the frequently-described reclamation plants (see index) renders the use of effluent economically attractive in sites where pumping and sewerage costs formerly excluded it.

While this report will not concern itself with desalinization of sea water, an effect of modern research in this field will be to reduce the cost of treatment of brackish waters, and thus to permit economical removal of salts and exotics which are resistant to secondary treatment.

ABSTRACTS OF ARTICLES FROM THE TECHNICAL LITERATURE DEALING WITH WATER RE-USE

Due to the great diversity of conditions encountered in effluent re-use, an evaluation of its feasibility in a given set of circumstances can probably best be arrived at by studying the results obtained in as similar a situation as possible. To aid in finding pertinent literature the following abstracts are supplied. An index with classification by subject and by author is also provided.

This list is incomplete because of limitations of time and of availability of materials. It should, however, constitute an adequate foundation for most inquiries.

As the list, which was prepared in the summer of 1965, ages, the question of finding current material will arise. For this, the reader is referred to the comprehensive annual survey of the literature which appears in three parts in the May, June, and July issues of the Journal of the Water Pollution Control Federation each year. The Public Health Engineering Abstracts of the U.S. Department of Health, Education, and Welfare and the Water Pollution Abstracts published by Her Majesty's Stationery Office in London are also excellent sources. Moreover, a perusal of these abstracts will indicate the titles of many journals which frequently contain valuable contributions in this field.

The abstracts which appear here do not necessarily represent the full content of the original papers; only the portion pertaining to re-use is summarized. In several cases the original publication was not accessible and reliance was placed on published abstracts. In others, both article and abstracts are cited so that reference may be more conveniently made.

In this connection, particular attention should be called to the excellent studies made by Robert C. Merz and his associates at the University of Southern California and published by the California State Water Pollution Control Board as Publications No. 12, 15, and 18 (Items 1955-27, 1956-17, and 1957-20 in this bibliography). Abstracts contained in these publications are referred to here by the designation Merz 12: X, 15: X, or 18: X where "X" is the page number in Merz' reports.

Most abbreviations used in the abstracts are self-explanatory. In the cases of a few governmental organizations and professional societies, however, it was expedient to use initials which might be unfamiliar. These are:

ASCE - American Society of Civil Engineers

FSWA - Federation of Sewage Works Associations (now WPCF)

IUPAC - International Union of Pure and Applied Chemistry

IWE - Institution of Water Engineers

PHE - Public Health Engineering

USBR - U.S. Bureau of Reclamation

USDI - U.S. Department of Interior

USGS - U.S. Geological Survey

USPHS - U.S. Public Health Service

WPCF - Water Pollution Control Federation.

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WPCF - Water Pollution Control Federation.

1892-1. ROECHLING, Herman A.
The Sewage-Farms of Berlin, with Discussion.
Minutes of Proceedings, Instn. of Civil Engrs. 109: 179-268.

These sewage-farms, with a total area of 19,000 acres, all city-owned, are claimed to be the largest and most successful in the world. No treatment is involved.

Much detail is related on the cattle and crops raised. Cost figures are included.

"Everything in connection with the irrigation of the land is done in military order; the day and night sewage-men parade at 6 A.M. and at 6 P.M."

The paper refers to extensive writing existing on sewage farms, but includes no bibliography.

1897-1. RAFTER, George W.
Sewage Irrigation.
U.S. Geological Survey Publn. No. 3, 100 p.

"Out of sight, out of mind, has been the universal principle thus far."

At the present time (1897) a fair profit can be made from sewage irrigation; purification by chemical treatment has been proven to be impractical.

"The most efficient purification of sewage can be attained by its application to land. On properly managed sewage farms the utilization of sewage is not prejudicial to health."

Methods of irrigation, largely as developed abroad, are described. Best crops are suggested. Cost data are given.

1899-1. RAFTER, George W.
Sewage Irrigation, Part II.
Water-Supply Paper, U.S. Geol. Survey No. 22, 100 p.

After an introduction covering the state of the art of sewage treatment, nearly fifty pages are devoted to a plant-by-plant description of sewage farms in the U.S. and Canada.

Ten pages of abstracts of the American and British literature on sewage conclude the report. Several books are cited with titles including "sewage utilization" or similar phrases.

1924-1. MITCHELL, George A.
Studies of Outlets and Crops on Sewage Irrigated Areas.
Engr. News-Record 92: 284-287. Edit. Note, p. 267.

The fundamental principles of sewage irrigation are:

1) Sanitary disposal of effluent from tanks

2) Distribution as evenly as possible: 50-100 persons per acre

3) Operation with minimum attention

4) Choice of crops to avoid technical or popular disapproval.

Detailed discussion is included on the best types of outlets to use to accomplish even distribution.

1924-2. WOLMAN, Abel.
Hygienic Aspects of Use of Sewage Sludge as Fertilizer.
Engr. News-Record 92: 198-202.

Lists results of survey of foreign and domestic uses of sludge or effluent. Concludes that well-digested sludge is safer than most regulations assume.

It should be applied to crops which will not be eaten raw.

1925-1. MILLS, Ralph G.; BARTLETT, C. L.; and KESSEL, J. F.
The Penetration of Fruits and Vegetables by Bacteria and Other Particulate Matter.
Amer. Jnl. Hyg. 5: 559-579.

Reports on series of tests on raw vegetables. Fifty-seven-entry bibliography.

1928-1. McINTOSH, J. S.
The Oil Field Salt Water Pollution Problem (ABST).
Sew. Wks. Jnl. 1: 108.

"The oil industry has tried various methods of impounding the salt water, which is the greatest source of pollution from the oil fields, and draining it off through streams during the season of high flow. The industry has even gone to the extent of acquiring riparian rights on streams not used for domestic water supply in order to secure proper drainage. No satisfactory method of treatment for the salt water has yet been found."

1928-2. OWSLEY, W. G.
Lake Pauline is Electrical Giant of West Texas Utilities Co.
West Texas Today 9: Dec., p. 8.

A 20,000 H.P. steam electric plant at Lake Pauline, five miles SE of Quanah, requires 6.8 mgd. "The water, however, is not wasted for it is used over and over again in the operation of the plant."

1928-3. RINEY, W. A.
Irrigation with Sewage Effluents (ABST).
Sew. Wks. Jnl. 1: 108.

"Abilene, Texas, disposes of effluent from septic tanks by contracting with farmers to use the effluent for irrigation of row crops."

1930-1. GOUDEY, R. F.
Reclamation of Treated Sewage.
Western City: December.
ABST: Sew. Wks. Jnl. 3: 162.

Describes 200,000 gpd plant in Los Angeles, California, which can produce drinking water which would be cheaper than imported water.

Test results are compared for raw sewage, plant effluent, and Los Angeles aqueduct water. The plant effluent is better than aqueduct water.

Some operating results of the plant are given in Sewage Works Journal 3: 214-222.

1930-2. GOUDEY, R. F.
Sewage Reclamation Plant for Los Angeles.
West. Constn. News 5: 519-524.
ABST: Sew. Wks. Jnl. 3: 160-162.

A 200,000 gpd activated sludge plant, designed to permit a wide variety of research studies, has been completed in Los Angeles. Among other effluents, drinking water may be produced.

The equipment is described and cost data are cited.

The effluent may be spread for recharge 1-1/2 miles upstream of the infiltration galleries.

1930-3. MITCHELL, George A.
Sewage Farm Displaces Filter Beds at Vineland, N. J.
Engr. News-Record 104: 65.

Vineland adopted sewage irrigation of crops with effluent from a settling tank. Asperagus prospered, as did cabbage (to be fed to poultry only). Much remains to be learned.

1930-4. STOKES, W. E.; LEUKEL, W. A.; and BARNETTE, R. M.
Effect of Irrigation with Sewage Effluent on the Yields and Establishment of Napier Grass and Japanese Cane.
Amer. Soc. of Agronomy, Jnl. 22: 540-548.

Comparative plots were investigated from 1922-1925.

Average productions reported under Florida conditions include:

Napier grass with sewage	40.57 tons/acre
Napier grass not irrigated	17.64
Napier grass with city water	18.86
Japanese cane with sewage	25.89
Japanese cane not irrigated	15.43

The ratios of production using sewage effluent to those with city water or with no irrigation increased with time.

<u>1930-5.</u> WILSON, Carl.
Los Angeles Successfully Reclaims Sewage for Replenishment of Underground Water Supplies.
West. Constn. News 5: 473-4.
ABST: U.S. Geol. Survey, Water-Supply Paper 1477, p. 101.
Sew. Wks. Jnl. 3: 160.

Los Angeles has operated a sewage treatment plant since 12 May 1930 with a capacity of 200,000 gpd, of which the effluent can be returned to the water mains or, with less treatment, be used for agriculture or for industry.

The plant was described by R. F. Goudey (1930-2).

<u>1931-1.</u> GOUDEY, R. F.
Plans for Sewage Reclamation in the Los Angeles Metropolitan Area.
Engr. News-Record 106: 443-446.

"Overdraft is increasing the deficiency of present supplies. Rising water costs will make reclamation economical. Exhaustive studies are under way to determine the basis of re-use."

"Paradoxical as it may seem, sewage, which is about 99.8% water, is cheaper, safer, and easier to reclaim than floodwaters."

A pilot reclamation plant was constructed in May 1930.

Use for irrigation only would involve heavy pump lifts, long pipelines, and exportation of water from the basin.

Industrial use is most economical.

Recharge-use runs the risk of storing water which could later cause floodwaters to flow off for lack of storage volume.

Municipal re-use merits study.

<u>1931-2.</u> GOUDEY, R. F.
Reclamation of Treated Sewage.
Amer. Water Works Assn. Jnl. 23: 230-240.

Los Angeles has been studying reclamation for several years.

By heroic means eastern water works plants, loaded far beyond what a reclamation plant would be, produce acceptable water from rivers rich in raw sewage.

Reclamation differs from sewage treatment in the attitudes and care taken. Costs are favorable.

1931-3. GOUDEY, R. F.
Some Operation Results, Los Angeles Sewage Reclamation Plant.
Sew. Wks. Jnl. 3: 214-222.

Describes a 200,000 gpd experimental sewage treatment plant capable of producing drinking water.

Procedural and cost studies are being made.

The influent--from canneries, pickle works, dye works, soap factories, etc.--averages 3 times the strength of domestic sewage.

Various processes are discussed in some detail.

1931-4. HARPER, Horace J.
Sewage Sludge as a Fertilizer.
Sew. Wks. Jnl. 3: 683-687.

Cites experiences at Milwaukee, Stillwater, Baltimore, etc.

Sewage sludge was the poorest fertilizer tried on cotton in a North Carolina study.

"Experiments comparing the value of dry and liquid sludge indicate that the liquid sludge is considerably more valuable than the dry sludge." "Sewage irrigation is an old custom in Germany and in Scotland and it has also been used to a limited extent in California, Colorado, and Texas with varying success."

Eleven references.

1931-5. IMHOFF, Karl.
Possibilities and Limits of the Water-Sewage-Water Cycle.
Engr. News-Record 106: 883-884.

Experiments indicate that eleven cycles of satisfactory purification are possible, with salinity being the ultimate determinant.

Considerations of the Ohio, the Rhine, the Elbe, and the Ruhr, and of Los Angeles' proposed water reclamation plants led to the study.

Changes in pH value and in six chemicals are given in a table.

1931-6. IMHOFF, Karl.
The Re-Use of City Sewage.
Gesundh.-Ing. 54: 699-703.
ABST: Sew. Wks. Jnl. 4: 201-203 (1932).

Cites a Los Angeles plant producing drinking water at one-eighth the cost of imported water. Points out the water-sewage-water cycles of the Ohio, Rhine, Elbe, and Ruhr, and notes the good water actually produced, even in severe droughts, from them.

About ten cycles would seem to be the limit since treatment does not remove chlorides. Thus, a city could employ 10% fresh water and waste 10% of its sewage.

1931-7. MITCHELL, George A.
Observations on Sewage Farming in Europe.
Engr. News-Record 106: 66-69.

Surveys sewage farming in Berlin, Paris, Moscow, Edinburgh, and elsewhere. Cites conversion of sand wastes to highly productive land with valuable crops.

"Sewage irrigation of crops is on the decline in England...at the present time of slack business, there must be taken into consideration the constant pressure from engineers and salesmen to install new and expensive equipment."

Advocates sewage farming in U.S.

1931-8. MITCHELL, George A.
Sludge Disposal at a Sewage Irrigation Farm.
Engr. News-Record 107: 57.

At Vineland, N. J., sludge is pumped to the fields with the effluent from time to time. It is then promptly plowed in.

1931-9. ANONYMOUS.
Help for Water Shortage May Lie in Reclaiming Sewage Waste.
California Citrograph 16: 498, 538.

Los Angeles' discarded wastes could irrigate the county's citrus orchards.

Pomona has an income of $6,000 per year from the sale of effluent for irrigation.

1932-1. DAPPERT, Anselmo F.
Tracing the Travel and Changes in Composition of Underground Pollution.
Wtr. Wks. and Sew. 79: 265-269.

Describes studies at Rockville Centre, Long Island, where 1.2 mgd of effluent from activated sludge treatment is spread on five acres of natural sand beds.

Bacterial counts were low in all cases but free ammonia was carried at least 1,500 feet through the sands.

1932-2. SKINNER, John F.
Sewage Sludge as Fertilizer.
Sew. Wks. Jnl. 4: 279-282.

Reports sale and use of dried sludge at Rochester, N.Y.

Reports experiments in Bedford, England, finding 86% more value in wet sludge than in dry. The wet sludge would weigh three times as much for these values. Savings in plant equipment and operation would result from use of wet sludge.

1933-1. McQUEEN, Frank.
Sewage Treatment for Obtaining Park Irrigating Water.
Pub. Wks. 64: Oct., p. 16-17.
ABST: Sew. Wks. Jnl. 6: 145-6.

Original irrigation of Golden Gate Park, San Francisco, was from an outfall sewer traversing the park. Odors were objectionable.

Next, for several years potable water was purchased. This was too expensive.

An activated-sludge plant capable of handling 1,000,000 gpd of sewage was completed in 1932. This supplies suitable clear, odorless water.

A plant description and statistics are given.

1933-2. RUDOLFS, Willem and CLEARY, Edward J.
Sludge Disposal and Future Trends.
Sew. Wks. Jnl. 5: 409-428.

Lagooning is satisfactory in areas of small rainfall.

About twenty cities in semi-arid Texas employ irrigation.

Sludge as fertilizer raises certain health questions; in general, its use should be avoided on vegetables eaten raw.

Fertilizer production (dry sludge) is viewed as a poor financial venture except, possibly, at large plants.

1933-3. WHITE, J. E.
Sewage Plant to Sell Effluent to Railroad for Industrial Use.
Municipal Sanitation 4: 16.
ABST: Sew. Wks. Jnl. 5: 743.

"The City of Herington, Kansas, plans to enter into a ten-year contract with the Rock Island Railroad whereby the railroad will purchase for industrial use all the effluent from a contemplated activated-sludge plant." Price: five cents per 1,000 gallons delivered to the water treatment tanks of the railroad.

1933-4. ANONYMOUS.
California Regulates Use of Sewage on Crop Land.
Pub. Wks. 64: Oct., p. 10.
ABST: Sew. Wks. Jnl. 6: 162.

Fertilization with sewage, sewage effluent, or sludge requires a permit from the State Board of Public Health. Under these regulations:

Raw sewage shall not be used on growing crops;

Sludge or screenings cannot be used on vegetables, garden truck, or low-growing fruits or berries unless the processing is approved by the Board.

Less stringent regulations affect nursery stock, cotton, hay, etc.

1933-5. ANONYMOUS.
Sewage-Plant Effluent for Boiler Water.
Engr. News-Record 111: 521-523.

An activated sludge plant at Herington, Kansas, will sell effluent to the Rock Island for boiler feed.

Maps, plant diagrams, and extensive cost data are given.

1934-1. BONO, Ugo.
Report on the Apulian Aqueduct (Italy) 1931-1932.
ABST: Sew. Wks. Jnl. 6: 641-644.

First-year-of-operation studies on sewage-effluent irrigation on ten plots subject to different regimes is reported.

Very good results are forecast.

Some later data is reported in Sewage Works Journal 6: 1194.

1934-2. RAWN, A. M., Chrmn.
Salvage of Sewage Studied.
Civil Engr. 4: 471-472.

Surveys the answers to a questionnaire. Sewage irrigation is not permitted in many states; only one state had no objection to it.

The committee disclaims holding any brief for "salvage of sewage."

1934-3. WEISE, Erich.
Proposals for the Future Development of the Berlin Sewage Management.
Gesundh.-Ing. 57: 248.
ABST: Sew. Wks. Jnl. 7: 129-130.

Berlin utilizes 56,800 acres of sewage farms. Loads of up to 6,300 gallons per acre per day occur.

The average rainfall is 20 in./yr, the sewage load is 79 in./yr. "Agricultural authorities" claim that about 12 to 24 in./yr of sewage would be correct.

"One of the disadvantages of these sewage farms is that Berlin sewage becomes septic before it reaches the farms and causes many complaints on account of disagreeable odors." Another disadvantage is the diversion to watersheds not supplying Berlin with water.

Complete purification plants are proposed with the effluent going to agriculture and to municipal water supply.

1934-4. WHITE, J. E. and VEATCH, F. M.
What Reclamation of Sewage Means to Herington, Kansas.
Wtr. Wks. and Sew. 81: 331-333.

Herington began supplying effluent to the Rock Island to be used as a boiler water supply on 13 December 1933. The operation has been successful to date.

"Naturally an unusual set of circumstances are necessary to make sewage reclamation by this method advisable." Here, water of the proper quality was economical. The project was self-liquidating under an RFC loan.

The plant is described.

1935-1. DE TURK, E. E.
Adaptability of Sewage Sludge as a Fertilizer.
Sew. Wks. Jnl. 7: 597-610. Edit. Comment, p. 742-743.

Documented by 23 references, the author examines the history of sewage use. Raw sewage is used on some 84,000 acres in Germany. Its water content is reported to be two to three times as valuable as its fertilizer value.

Treated effluent has been used in several American applications.

Evaluation of dried sludge, produced by the activated--or the digested--treatment, is well documented. The sewage-disposal function is reported to be more valuable than the fertilizer content.

1935-2. GOODWIN, Earl H.
Sewage Irrigation in Texas.
Pub. Wks. 66: Mar., p. 23.
ABST: Sew. Wks. Jnl. 7: 589.

San Antonio, since 1900, has irrigated 3,500 acres. "At present, of the 450 sewage treatment plants in the State, about 47 are using irrigation as a means of treatment, approximately 4,500 acres being irrigated."

Subsurface irrigation has advantages, but they are not felt to justify the added cost. Porous sandy soils seem most acceptable for irrigation.

Care is required for success.

1935-3. HOMMON, H. B.
Treatment and Disposal of Sewage in the National Parks.
Amer. Jnl. Pub. Health 25: 128.
ABST: Sew. Wks. Jnl. 7: 317-320.

At Grand Canyon, South Rim, an activated-sludge plant capable of handling 200,000 gpd was constructed in 1926. Numerical data are given. "The reclaimed sewage is used in locomotive boilers, boilers for heating purposes, for watering lawns, for flushing toilets, etc. The cost of the reclaimed sewage averages about $0.38 per thousand gallons."

At Giant Forest, the effluent is sprayed over porous ground with heavy vegetation.

At Zion, a settling tank two feet below ground supplies infiltration galleries five feet below the surface.

At Mammoth Hot Springs, Yellowstone National Park, the effluent is disposed of by broad irrigation.

1935-4. HYDE, Charles G.
Sewage Treatment Problems and Trends.
Sew. Wks. Jnl. 7: 222-232.

The final paragraph is quoted:

"Salvage of Sewage for Irrigation and Industrial Use.

In the semi-arid sections of the country where water is at a premium and relatively high in cost, the treatment of sewage to the point where it can be utilized for irrigation and industrial use continues to make progress. One of the first installations of that sort was at the Grand Canyon, Arizona, in 1926. Here the sewage is treated by the activated sludge process and by subsequent rapid sand filtration and is wholly utilized in locomotive boilers, for the washing of company automobiles, for the flushing of public toilets, for the sprinkling of lawns and for the irrigation of gardens."

1935-5. KREUZ, Councillor A.
Utilization of Domestic Sewage and Industrial Wastes by Broad Irrigation.
Gesundh.-Ing. 58: 190.
ABST: Sew. Wks. Jnl. 8: 348-349, 533.

"The ratio of the fertilizing constituents (nitrogen, phosphoric acid) in sewage is not far from optimum."

Broad irrigation, in plots about 1.25 acres in size, has the disadvantages of using too much land in roads, dikes, and ditches; of making the use of agricultural machinery difficult; of making surface smoothing and cereal cultivation unsatisfactory; and of creating summer odors. Sprinkling, while preferable, is too expensive.

Cyclical use of land, changing from agriculture to sewage disposal in alternate years, is recommended.

"In general, separation of wastes injurious to plant life is not recommended because the treatment of injurious wastes alone is usually very difficult and when the injurious and non-injurious wastes are mixed the injurious ones become neutralized and do not harm plant life."

1935-6. SCHILLINGER, A.
Sewage Purification in Fish Ponds.
Gesundh.-Ing. 58: 190.
ABST: Sew. Wks. Jnl. 8: 349, 533.

"The Munich sewage fish ponds consist of an area of about 575 acres... Fish ponds require only about one-tenth the area necessary for broad irrigation and produce at least as good, if not a better, effluent."

"At ordinary temperature one acre of pond will treat the sewage from about 810 persons... About 400 pounds of fish can be obtained annually from one acre."

This article is typical of a number in the early volumes of the Sewage Works Journal describing German fish ponds.

1935-7. SCHONNOPP, Gunther.
The Sprinkling of Domestic Sewage and Industrial Waste.
Gesundh.-Ing. 58: 190.
ABST: Sew. Wks. Jnl. 8: 349, 533.

"Sprinkling is the best method of using sewage for agricultural purposes... The preliminary treatment should be as simple as possible. Usually screens and grit chambers are sufficient."

1935-8. TANNER, Fred W.
Public Health Significance of Sewage Sludge When Used as a Fertilizer.
Sew. Wks. Jnl. 7: 611-617.

Citing 21 references, Tanner reviews the literature on sewage sludge irrigation. He concludes that it is imprudent to use it on growing food crops. The health hazards should never be ignored.

1935-9. SYMPOSIUM.
Experiences with Sewage Farming in Southwest United States.
Amer. Jnl. Pub. Health 25: Feb., p. 119-127.
ABST: Sew. Wks. Jnl. 7: 320-322.

1. TEXAS, V. M. Ehlers: 68 towns in the State use land disposal; 34 of these grow crops, two use sub-surface irrigation. The best crops are small grains, grasses, cotton, and alfalfa. Some food crops are sewage-irrigated. "Where land has not been overdosed, no nuisance has been reported." Eleven rules are given.

2. ARIZONA, F. C. Roberts, Jr.: Data are given for land disposal at Tucson (32,506 pop.) and Casa Grande (1,351 pop.).

3. CALIFORNIA, E. A. Reinke: "At present, the sewage from 53 municipalities is being disposed of by irrigation of cultivated crops, from nine others by irrigation of wild crops, and from another 28 on land with no crops. Thus, 90 out of 310 sewered municipalities in California now have land disposal." Health Department rules cover the treatments which the sewage must receive before use.

1936-1. DIEHL, Paul A.
Treatment Required for Sewage Re-Used for Irrigation Purposes.
ABST: Sew. Wks. Jnl. 8: 503.

A hundred localities in the U.S., mostly in California and Texas, were reported to be using sewage for irrigation. For field crops, the oil and grease should be removed as should particles which would settle out at ditch velocities of 1 fps. For garden crops the sewage should be sterilized and filtered.

1937-1. HYDE, Charles G.
The Beautification and Irrigation of Golden Gate Park with Activated Sludge Effluent.
Sew. Wks. Jnl. 9: 929-941.

Expensive water and long dry spells led in the early days to irrigation of part of the park by raw sewage. Complaints finally prevailed, and water was purchased. In 1932 a 1,000,000 gpd activated sludge plant was constructed; the chlorinated effluent has been used for ditch and pressure-pipe irrigation, and for lakes, artificial brooks, and waterfalls.

Costs and other data are given.

Plans exist to triple the amount of effluent by construction of an additional plant.

1937-2. MITCHELL, George A.
Municipal Sewage Irrigation.
Engr. News-Record 119: 63-66.

Describes successful nine-year operation at Vineland, N. J. Soil and crops must be considered. Cost data are given.

1937-3. RUDOLFS, Willem.
Salvage from Sewage?
Engr. News-Record 119: 1055-1057.

"Irrigation and re-use--In dry climates and sandy areas the use of treated sewage for irrigation purposes has been well developed. Re-use of water for industrial purpose is practiced where the water supply is deficient."

"Beautification--Highly treated effluents are used in some places where water is scarce for supplying ponds, lakes, waterfalls, and lawn sprinklers in city parks..."

1937-4. ANON. REPORT of the Committee on Sewage Disposal, APHA:
The Utilization of Sewage Sludge as Fertilizer.
Sew. Wks. Jnl. 9: 861-912. Edit. Comment, p. 1045-1046.
ABST: Amer. City 53: Feb., p. 54-55 (1938).

Reports a survey of U.S. and Canadian practice on sludge disposal. Of the cities surveyed only Canton, Ohio, and Plainfield, N. J., applied wet digested sludge directly to the soil. Canton had good results on 550 acres of wheat, corn, and oats; Plainfield did well on oats the first year, corn the second.

A table (p. 885) shows 412 cities, grouped by states, using sludge exclusive of activated sludge. Twenty-six of these were in Texas. Several cities use activated sludge.

A bibliography of 89 entries is included.

1938-1. BOVRIE, E. F.
Design, Construction and Operation of the Melbourne Sewerage System.
Jnl. Inst. Engrs. Australia 10: 351-65.
ABST: Sew. Wks. Jnl. 11: 566.

Sewage for a population exceeding one million is disposed of on a farm of 22,634 acres, well isolated. Methods of treatment are: land filtration, grass filtration, and lagooning.

Statistics are given.

Further details are given in an Abstract of the Report for the Year ending 30 June '40 in Sewage Works Journal 13: 831.

1938-2. ANONYMOUS.
Annual Report of the City Engineer, Johannesburg.
ABST: Sew. Wks. Jnl. 11: 566-567.

Settled sewage is distributed over grazing land.

1938-3. ANONYMOUS.
Irrigation with Sewage.
Engr. News-Record 121: 821.

Abstracts a paper by R. L. Peurifoy describing a 90 acre-feet lake which stores sewage of Kingsville, Texas, for irrigation. Year-around irrigation from relatively short ditches was found most effective.

Irrigation from the pipeline leading to the lake is planned.

1939-1. HARRELL, Riley B.
Sewage Irrigation as a Method of Disposal.
Proc. 21st Texas Water Works and Sewage Short School, p. 121-123.
ABST: Sew. Wks. Jnl. 12: 1019.

Describes cotton irrigation at Munday, Texas. Results are highly satisfactory.

1939-2. HUTCHINS, Wells A.
Sewage Irrigation as Practiced in the Western States.
USDA Tech. Bull. No. 675, 60 p.

This is a comprehensive treatment of the use of sewage in agriculture in the Western States in the 1930's with consideration for public health aspects and economics.

Possibilities of ground water pollution are discussed, the question of salt build-up is outlined, and legal problems of ownership of effluent are sketched.

Localities practicing sewage irrigation are listed (32 in Texas).

1939-3. PEURIFOY, R. L.
Sewage Irrigation as a Method of Disposal.
Proc. 21st Texas Water Works and Sewage Short School, p. 115-121.
ABST: Sew. Wks. Jnl. 12: 1018-1019.

ABST: "Conclusions: Success of failure in sewage irrigation depends upon operation. Sewage irrigation can be made practical and profitable, through increase in crop yield and land improvement. Sewage disposal by irrigation is safe, effective, and economical (24¢/person/year for labor and energy to pump Kingsville sewage). Continued sewage irrigation in outcropping artesian water formations will increase water available in formation. Artesian water drawn from a formation fed by sewage is safe provided the aquifer is sand instead of fissurized limestone. Municipalities in Texas can well afford to seriously consider irrigation as a possible method of disposal."

1939-4. POUQUET, F.
Sewage Purification in the Parisian Area. Construction of a Biological Sewage Treatment Works at Acheres.
Travaux 79: 87-95.
ABST: Sew. Wks. Jnl. 11: 719-720.

A comprehensive network of sewers is under construction in the Parisian area which will terminate in the agricultural area of Acheres. Paris sewage at present is spread on farms, but increased loads require another solution.

In the new works wet sludge from activated sludge treatment will be disposed of on farm areas.

1939-5. ANONYMOUS.
Inventory of Sewage Disposal Facilities.
Engr. News-Record 122: 98-99 + folding plate.

A table includes the heading "Sewage Farms or Land Disposal" with two columns: "Without Disinfection" and "With Disinfection." Texas had 58 without and seven with; the U.S. total was 84 without, and ten with. The total number of communities surveyed was 4,667, of which 425 were in Texas.

1940-1. CRAWFORD, A. B. and FRANK, A. H.
Effect on Animal Health of Feeding Sewage.
Civil Engr. 10: 495-496.

Swine and cattle fed raw sewage, effluent, and sludge for six months in a Maryland test remained in good condition.

1940-2. CROCKETT, Vernon P.
Treatment Methods for Creamery and Dairy Wastes.
Proc. 22nd Texas Water Works and Sewage Short School, p. 148-151.
ABST: Sew. Wks. Jnl. 13: 848.

"Broad irrigation is recognized as a satisfactory method of disposal under favorable conditions."

1940-3. THOMAS, Franklin.
The Sewage Situation of the City of Los Angeles.
Sew. Wks. Jnl. 12: 879-894.

Historically, Los Angeles sold sewage for irrigation from 1883 to 1907. The purchaser, at $2 per acre-foot, irrigated about 2,200 acres.

Other troubles since are recounted in the paper.

In the general revision which seems necessary, it would be possible to return some treated effluent to ground water by proper location of treatment plants.

1940-4. ANONYMOUS.
Biofiltration Effluent Used for Irrigation at Santa Paula [Calif.].
Engr. News-Record 125: 834.

Orchards are irrigated.

1941-1. DAMOOSE, N.
Liquid Sludge--The Vitamin B_1 Fertilizer.
Sew. Wks. Engr. 12: 308-312.
ABST: Sew. Wks. Jnl. 14: 342-343.

ABST: "Damoose has promoted the sale of liquid sludge at Battle Creek, Michigan, as a means of establishing and maintaining public good will... A 600-gallon wood stave tank fitted with a 6-inch cover and a 2-inch valve on the bottom has been mounted on a delivery truck, equipped with a pump and hose, for delivery of liquid digested sludge to the public... Astounding results were reported..."

1941-2. ANONYMOUS.
Baltimore Will Sell Sewage Effluent for Industrial Water Supply Uses.
Engr. News-Record 127: 73. Editorial: Salvage from Sewage, p. 80.

Bethlehem Steel has contracted for effluent for steel plant use. It will get 40 mgd for $24,000 annually. A 48-inch pipeline and treatment plant will cost the company two million dollars.

Quality provisions are cited.

1941-3. ANONYMOUS.
Combining Old and New in Sewage Disposal.
Engr. News-Record 126: 811-812.

Describes an operation at Bakersfield, California, where 600 acres of pasture land are irrigated with primary effluent. "No nuisance" is reported.

Plant details are described.

1942-1. OLIVER, J. C.
Experiences with Oil Field Wastes.
Proc. 24th Texas Waterworks and Sewage Short School, p. 129-132.
ABST: Sew. Wks. Jnl. 15: 798.

Describes the suit by riparian owners on the Neches River against 155 East Texas oil field operators, and the subsequent provision of dilution pits and deep well injections. Of 80,000 bbl of brine produced on the Neches watershed each day, about 35,000 are injected.

1942-2. SCHRINER, Phillip J.
Disposal of Liquid Sludge at Kankakee, Illinois.
Sew. Wks. Jnl. 14: 876-878.

Liquid sludge is hauled to a park in a 1,000-gallon tank. Data and costs are cited.

1942-3. ANONYMOUS.
Final Report of the Joint Committee of the Sanitary Engineering Division and the Irrigation Division, ASCE: The Salvage of Sewage.
Trans. ASCE 107: 1652-1687.

Principal concern for irrigation re-use is salt content; boron must be checked. Sodium may be troublesome. Good land management is required with effluent irrigation.

Little incentive exists (1942) for effluent irrigation now; it would not pay even in Los Angeles County.

Legal and aesthetic complications may be involved.

It is unlikely that any use other than boiler feed or cooling and condensing can be found for effluent in industry. Grand Canyon and Baltimore are cited. The probable future is dim.

1943-1. O'CONNELL, William J., Jr. and GRAY, H. F.
Emergency Land Disposal of Sewage, With Discussion.
Calif. Sew. Wks. Jnl. 15: 86-102.
REPRINT: Sew. Wks. Jnl. 16: 729-746.

The war emergency merely points up a relatively overlooked situation--land disposal of effluent may well be the best method for small cities in arid or semi-arid regions. Water and sludge should be conserved.

Land disposal may have as its chief value either the agricultural benefit or the sewage-disposal benefit. Minimum pre-treatment should be screening and one to two hours of sedimentation. Little odor results if application is intermittant followed by cultivation. Chemical treatment for odors should be regarded as a factor of safety only.

For agriculture, use half the land for crops each year, rotating the halves used. Do not over-irrigate. Two thousand-three thousand gal/acre/day is probably an upper limit, though Melbourne transports sewage in an aerated tunnel 40 miles and uses 7,000 gal/acre/day with enviable success.

A discussion by C. G. Gillespie relates the history of lagoons in California. One by Willis T. Knowlton adds further endorsement of lagoons.

1943-2. SPENCER, B. R.
Sewage Disposal by Irrigation.
Public Health (South Africa) 7: Oct., p. 15-28.
ABST: Sew. Wks. Jnl. 16: 655-657.

Cites the history of sewage irrigation from 1869 when Bromford, England, was probably the first municipality to sell sewage.

Cites data on water requirements and water tolerances of various crops, concluding that for South Africa, at least, Italian rye grass is the best crop.

Application of 6,343 gal/acre/day (102 in./yr) has led to a rising water table and brackish conditions. Since drainage to a river cannot be permitted, deep plowing has been resorted to.

A table comparing data for Klipspruit, South Africa, and eight English cities is included in the Sewage Works Journal Abstract.

1944-1. WILSON, H.
Some Risks of Transmission of Disease During the Treatment, Disposal, and Utilization of Sewage, Sewage Effluent and Sewage Sludge.
South African Branch, Inst. Sewage Purification.
ABST: Sew. Wks. Jnl. 17: 650-652, 1297-1300.

Reviews the subject for the last 100 years with literature citations and a list of eight recommendations.

1944-2. ANONYMOUS.
Stream Pollution in Oil Fields Lessened by Salt Water Disposal Systems.
Pipe Progress. Dec., p. 9-11.
ABST: Sew. Wks. Jnl. 18: 589.

Describes operations in the East Texas oil fields where treated, filtered water is injected.

1945-1. GEHM, Harry W.
Waste Treatment Pays in a Paper Mill.
Wtr. Wks. and Sew. 92: 105-106.

Discusses heat economy effected by White water recovery and re-use, and cites secondary benefits of the recovery system.

1945-2. HILL, William P.
Industry Converts Sewage Works Effluent into Water Supply.
Wtr. Wks. and Sew. 92: 383-387.

Describes operation of the Bethlehem Steel Company's Sparrow Point (Md.) plant.

1945-3. PILLAI, S. C., et al.
Investigations on Sewage Farming. Main Progress Reports.
Indian Inst. of Sci. 1945: 84 p., 1946: 76 p., 1947: 32 p., 1948: 36 p., 1949: 16 p.
PHE Abst. 31: S: 72.

Lists impressive array of subjects investigated.

1945-4. SOUTHGATE, B. A.
Treatment and Disposal of Waste Waters from Paper Mills.
The Paper Maker and British Paper Trade Jnl. 109: June, TS 43-46; 110: July, TS 1-3.
ABST. Sew. Wks. Jnl. 18: 340-343.

Re-use of some waste waters is suggested.

1945-5. SYMONS, G. E.
Industrial Waste Disposal.
Sew. Wks. Jnl. 17: 558-572.
ABST: Merz 12: 25.

Discusses economics of by-product recovery and the cost of damages chargeable to pollution.

Allocation of treatment costs is discussed at some length.

1945-6. WARRICK, L. F.; WISNIEWSKI, T. F.; and SANBORN, N. H.
Cannery Waste Disposal Lagoons.
Natl. Canners Assn. Bull. No. 29-L, 48 p.
ABST: Sew. Wks. Jnl. 17: 1044-1047.

Summarizes experience with storage lagoons, absorption lagoons, and irrigation fields.

1946-1. BRANDON, T. W. and TAYLOR, C. B.
Recent Developments in Retting of Flax and Disposal of the Waste Waters.
Jnl. of the Soc. of Chem. Industry: Trans. 65: 390-396.

Retting is a soaking process normally producing large volumes of polluted water. British research led to an aerated process which avoided this pollution, by treating and recirculating the retting water.

Physical and cost data are cited.

1946-2. BURRELL, Robert.
Use of Effluent Water in Sewage Treatment Plants.
Sew. Wks. Jnl. 18: 104-109.

At West Haven, Conn., the sewage treatment plant substituted effluent for the four million gal/yr of potable water previously used for chlorinators, for wash-down water in sludge tanks, etc.

The installation paid for itself within three years.

1946-3. CONKLING, H.
Report to West Basin Water Assn., Los Angeles County, Calif., 36 p.
ABST: Sew. Wks. Jnl. 19: 942-943.

Cost data are given for Colorado River water and for recharge with purified sewage effluent.

R. F. Goudey in Appendix No. 4, "Sewage Reclamation," details the purification process. He concludes that, while Colorado River water would be softer, rectified sewage would be better for irrigation and industrial use.

1946-4. EBAUGH, N. C.
Conservation of Municipal Water Supplies in Air-Conditioning Systems.
Amer. Wtr. Wks. Assn. Jnl. 38: 206-214.

Stresses importance of cooling towers in reducing peak loads on water plants and sewers. Usually economic considerations alone would dictate the use of towers on large installations. "City water is too expensive to use as a cooling medium."

1946-5. HART, W. B.
Refinery Waste Disposal--XI. Designing Disposal Systems for Discharge of Uncontaminated Waste Waters.
Petroleum Processing 1: No. 3, p. 193-196.

"Disposal by re-use can be applied in any refinery... re-use of cooling water may remove a major part of the load on the treatment facilities or permit the use of smaller equipment."

1946-6. ANONYMOUS.
Cut Operating Costs By Using Sewage Effluent.
Amer. City 61: Jan., p. 13.

West Haven, Conn., utilized effluent in its sewage treatment plant for all water purposes except drinking and washing. Yearly savings on a $1,400 installation are reported to be $500.

1946-7. ANONYMOUS.
Sewage Farming at Tucson.
Sew. Wks. Jnl. 18: 1211.

The entire sewage flow of 4 mgd is used to irrigate 300 acres with primary-treatment effluent. Crops raised include oats, barley, and ensilage. The net profit is $3,000 to $5,000 per year.

1947-1. AXE, Earl J.
Paper Mill White Water Treatment.
Proc. Third Indust. Waste Conf., Purdue Univ.
ABST: Merz 12: 28-29.

Discusses white water treatment at eleven eastern mills. The re-use of white water is considered routine.

1947-2. BOLTON, Paul.
Disposal of Canning Plant Wastes by Irrigation.
Proc. Third Indust. Waste Conf., Purdue, p. 272.
ABST: Merz 12: 46.

Describes two irrigation installations in Iowa. Procedures for success are suggested.

1947-3. BRANDON, T. W.
Industrial Wastes--Results of Operation of Small-Scale Diffusion Batteries with and Without Reuse of Process Water.
Intl. Sugar Jnl. 49: 154-156.
ABST: Sew. Wks. Jnl. 20: 360.

Describes test in parallel in same plant using fresh water and return-process water simultaneously. The conclusions reached were:

1. Density and purity was similar in the two cases.

2. Return water had no adverse effect on purity.

3. Return water had no adverse effect on the proportion of sucrose.

4. Spent pulp from return-water was more easily processed than that from fresh water.

1947-4. BRANDON, T. W.
Industrial Wastes--Waste Waters from Beet Sugar Factories, Their Treatment and Disposal.
Intl. Sugar Jnl. 49: 98-100, 124-126.
ABST: Sew. Wks. Jnl. 20: 360-362.
ABST: Merz 12: 31.

Untreated waste water runs to 5,000 gallons per ton of beets. This is accounted for by:

Transport water (1,900-3,500 gal/ton). Simple sedimentation and re-use.

Process water (300-615 gal/ton). Screening and re-use thru 100-day season.

Drainage from lime sludge (40-80 gal/ton). Dry and dispose of sludge (50% moisture) for agriculture.

Condenser water (1,000-3,500 gal/ton). Cool, chlorinate, and re-use.

The total waste problem can be reduced about 90% by means of the proposals above.

1947-5. ELDRIDGE, Edward F.
Industrial Wastes: Canning Industry.
Ind. and Engr. Chem. 39: 619-624.

"Irrigation fields are satisfactory where soil is porous and will rapidly absorb the waste."

1947-6. GOUDEY, R. F.
Discussion of "Factors Controlling the Location of Various Types of Industry."
ASCE Trans. 112: 589-592.

Cites seven locations where industrial re-use is being practiced, including Barnsdall Oil at Corpus Christi.

Ten sources of trouble with wastes are listed. These include cannery wastes which polluted ground waters, dairy wastes, packing house wastes refinery brines, etc.

Troubles at nine California cities are mentioned as typical.

1947-7. GREENFIELD, R. E.; CORNELL, G. N.; and HATFIELD, W. D.
Cornstarch Processes.
Proc. Third Ind. Waste Conf., Purdue.
ABST: Merz 12: 31.

Re-use of waters has decreased pollution in cornstarch manufacture. The operations of the complete process are described.

1947-8. GREENFIELD, R. E.; CORNELL, G. N.; and HATFIELD, W. D.
Industrial Wastes: Cornstarch Processes.
Ind. and Engr. Chem. 39: 583-588.

Describes the development of processes which re-use waste water rather than requiring fresh water. This leads to recovery of soluble losses in the form of valuable feedstuffs.

The processes are diagrammed and an installation at Decatur, Illinois, is described.

1947-9. HAUCK, Charles F.
Trends in the Re-Use of Water by Industry.
Pub. Wks. 78: May, p. 24, 26, 28.

Summarizes current practices in water conservation through treatment and re-use.

Economic studies should consider the value of water, heat, and by-products.

Several installations are described and cost data are quoted.

1947-10. HESS, R. W.
Bibliography on Chemical Wastes.
Ind. and Engr. Chem. 39: 676-682.

Cites publications 1937-1947 under the following headings (among others):

Water pollution and its control,
Water pollution and the law,
Organizations for pollution control,
Reviews,
Regional problems,
Water sanitation,
General treatment of wastes, and
Miscellaneous wastes.

1947-11. JACKSON, Leon W.
Sewage Plant Sells Sludge and Effluent.
Engr. News-Record 139: 56-58.

Describes the 5 mgd capacity plant at Riverside, California, which serves a connected population of 41,000.

The effluent spills to an adjacent river when it is not wanted for irrigation.

1947-12. JONES, Ogden S.
Subsurface Disposal of Inland Oil-Field Brines.
Civil Engr. 17: 60-63.
ABST: Sew. Wks. Jnl. 20: 184.

Subsurface disposal and water flood are described and advocated.

1947-13. MALOCH, M.
The Effect of Sewage Water on the Yield and Quality of Grassland.
Sborn. Csl. Akad. Zemed. 19: 57-107.
ABST: Soils and Fert. 13: 364.

Sewage irrigation for three years raised hay yield by 132.9% and crude protein yield by nearly 300%. It increased drought resistance of grasses markedly.

1947-14. McDILL, Bruce M.
Industrial Wastes: Beet Sugar Industry.
Ind. and Engr. Chem. 39: 657-669.

Describes classes of waste water, indicating the types of re-use for which they are suited, with land irrigation being the final destination.

Describes the operation of a plant at Ottawa, Ohio.

1947-15. PICKETT, Arthur.
Protection of Underground Water from Sewage and Industrial Wastes.
Sew. Wks. Jnl. 19: 464-472.

Describes sewerage system of Los Angeles County with emphasis on its inadequacies.

Many septic tanks, cesspools, etc. discharge to ground water. Public policy has protected sewers from damaging industrial wastes; these have gone into pits to pollute the ground water.

Re-use must be closely regulated to prevent build-up of BOD. "Pollution cannot be prevented simply by enacting new legislation."

1947-16. RAWN, A. M.; HYDE, Charles G.; and THOMAS, Franklin.
Report Upon the Collection, Treatment, and Disposal of Sewage and Industrial Wastes of Orange County, California.
Lithoprint, 46 p.
ABST: Sew. Wks. Jnl. 20: 351-352.

Quoting ABST, "Concerning sewage reclamation as related to water supply, the report concludes that the excessive costs involved in producing an acceptable effluent, the limited availability of spreading-ground with respect to both area and period of use, together with the hazard of introducing boron into the underground waters, combine to make the use of reclaimed sewage by the method of percolation impracticable. The cost of reclaiming sewage would be of the magnitude of twice the cost of purchasing fresh water."

1947-17. SOUTHGATE, B. A.
Re-Use of Waste Waters from Industrial Processes.
Instn. of Chem. Engrs. (6 May '47), 8 p. [Preprint].
ABST: Sew. Wks. Jnl. 20: 169-170.
ABST: Merz 12: 31.

Describes re-use, through a season, of flax-retting liquor and of beet sugar wastes. Lagooning is used at the end of the season.

"Re-use of process water did not adversely affect the process of extraction or the purity and quantity of the sugar produced."

1947-18. TREBLER, H. A. and HARDING, H. G.
Industrial Wastes: Dairy Industry.
Ind. and Engr. Chem. 39: 608-613.

Urges re-use, by means of cooling towers or spray ponds, of cooling waters.

Broad irrigation may be used under special climatic and soil conditions.

1947-19. ANONYMOUS.
Water Rate Increase of 30 Percent Needed to Offset Higher Costs.
Engr. News-Record 139: 147, 153-154.

At a joint convention of the AWWA and the FSWA Veatch reported that industrial re-use is attractive economically. Unless desalination is required, treatment is easy and cheap. Uses cited were:

Herington, Kansas--Rock Island R.R. boiler water,

Grand Canyon, Arizona--boilers, locomotives, toilet flushings, irrigation,

Corpus Christi, Texas--oil refinery,

Big Spring, Texas--oil refinery,

Enid, Oklahoma--oil refinery,

Duncan, Oklahoma--oil refinery,

Goldfield, Nevada--metallurgical mill,

Providence, Rhode Island--cooling at municipal incinerator,

Cheyenne, Wyoming--under consideration,

Baltimore, Maryland--steel plant.

1948-1. ABBOT, A. L., et al.
Grazing of Cattle on Sewage Farms and Disposal Works.
Public Health, Mar. '48, p. 76-88.
ABST: Sew. Wks. Jnl. 21: 185-186.

ABST: "Consumption of sewage effluents by cattle has no harmful effect on milk production or disease incidence, and introduces no possibility of milk contamination except indirectly from unhygienic dairy procedure."

1948-2. ALBRIGHT, John C.
Recover Usable Water From Waste by Extracting Condensable Gases.
Petro. Proc. 3: 1116.
ABST: Sew. Wks. Jnl. 21: 374-375.

Describes removal of hydrogen sulfide and ammonia from plant water at Union Oil's Wilmington refinery.

1948-3. ALEXANDER, Gordon W.
Utilization of Disposal Plant Effluent in Refinery Cooling Water Systems.
Petro. Refiner 27: 24-26.

West Texas refineries are often plagued with water supply problems. Cosden at Big Spring solved this by re-use of effluent.

Earlier Cosden "relied" on 20 gpm wells with poor quality water. Effluent has been used since August 1944.

Chemical and cost analyses are tabulated.

1948-4. DUFOURNET, R.
By-Product Recuperation in Sewage Treatment Plants.
L'Eau 35: 3-7, 29-32.

Sewage farming should begin with treated effluent. He commends Pomona, California, for its sale of secondary effluent.

1948-5. GARNER, J. H.
Report Upon Trade Refuse (Coal Trade) in the West Riding.
The West Riding of Yorkshire Rivers Board, 97 p.
ABST: Sew. Wks. Jnl. 21: 193.
ABST: Merz 12: 29.

Discusses re-use of colliery wash waters, with a description of equipment and operations. Data are included for 105 collieries. One thousand five hundred lmp. gallons of water are circulated for each ton of coal washed. Twenty-two lmp. gallons per ton are required for make-up water.

1948-6. HALAMEK, Ferdinand
Agricultural Utilization of Domestic Sewage in Europe and U.S.A.
Vestnik Ceskoslov. Aka. Zem. 22: 396-402.
ABST: Biol. Abst. 23: 3092.

ABST: "Germany uses sewage irrigation and often overlooks the hygienic problem. In Britain the use of sewage as a fertilizer is decreasing. In the U.S.A. sewage irrigation is practiced only in the southwestern states and there hygienic regulations are severe."

1948-7. HOOT, Ralph A.
Plant Effluent Use at Fort Wayne.
Sew. Wks. Jnl. 20: 908-909.

Fort Wayne, Ind., saves $2,400 a year by using effluent for general duty in the sewage treatment plant. (Meter flushing, chlorinator feed, grease skimming, grit washing, lawn sprinkling, etc.)

In winter the 50° plant effluent is far preferable to the 32° city water; at no time is it a disadvantage.

1948-8. POWELL, Sheppard T. with discussion by A. M. BUSWELL.
Some Aspects of the Requirements for the Quality of Water for Industrial Uses.
Sew. Wks. Jnl. 20: 36-51.

"This paper has been prepared to present certain phases of the requirements of industry with respect to desired quality of water and to warn against the wide-spread use of sewage effluents until all engineering and economic phases of the undertaking have been surveyed."

1948-9. REINHOLD, F.
New Viewpoints on the Agricultural Utilization of Sewage.
Gesundh. 69: 296-302.
PHE Abst. 31: S: 45.

Treatment improves the fertilizer value of sewage. Crude sewage should not be used for irrigation.

1948-10. SIEBERT, C. L. and ALLISON, Claire.
Some Rights and Wrongs of Cannery Waste Treatment.
Wtr. and Sew. Wks. 95: 227-230.

Describes spray irrigation at Hanover, Pa., where the effluent is screened and held in lagoons for approximately ten days. Improvements are suggested.

1948-11. VEATCH, N. T. with discussion by Earnest BOYCE and R. F. GOUDEY.
Industrial Uses of Reclaimed Sewage Effluents.
Sew. Wks. Jnl. 20: 3-14.
ABST: Merz 12: 27.

"A survey of the general practice in this country brings out the facts that:

1. The use of sewage effluents for industrial purposes is limited to a relatively few instances.

2. Such use is limited to instances where an adequate supply from ordinary sources is either very expensive or actually not available.

3. The problems involved in fulfilling the requirements of the public health and of the industry simultaneously are actually not difficult."

A letter survey uncovered only nine cases of industrial re-use in the U.S. These were:

Herington, Kansas--Rock Island R.R.,

Grand Canyon, Arizona--boilers, locomotives, flush toilets, irrigation (probably earliest use),

Corpus Christi, Texas--oil refinery cooling and condensing,

Baltimore, Maryland--steel mills, cooling, quenching, etc.,

Big Spring, Texas--oil refinery cooling and boiler feed,

Enid, Oklahoma--oil refinery cooling and boiler make-up,

Duncan, Oklahoma--similar to Enid,

Goldfield, Nevada--metallurgical processes,

Providence, Rhode Island--cooling at a municipal incinerator,

Cheyenne, Wyoming--under study.

A three-page table lists the cities re-using sewage effluent. Most are for irrigation. (135 locations in 18 states.) Thirty-five are in Texas.

Discussion by BOYCE, Earnest:

Benefit would accrue if industrial wastes containing salts or other unoxidizable content could be re-used consumptively by industry. Oil field repressuring is cited as an example.

Discussion by GOUDEY, R. F.:

"If a city discharges sewage into a stream and another city takes out water below, is this not again 'reclamation'?"

"It would seem that other factors such as conservation, common sense, and a fairer consideration of values should be placed ahead of the usual prejudices."

Pleads for better cost accounting.

1948-12. WILCOX, L. V. with discussion by Dario TRAVAINI.
Agricultural Uses of Reclaimed Sewage Effluent.
Sew. Wks. Jnl. 20: 24-35.

"The purposes of this paper are: (1) to define the properties that determine the quality of the water for irrigation use, (2) to describe typical irrigation waters and (3) to discuss the effect of contaminants in an effluent on its use for irrigation."

"Great care should be exercised in permitting the disposal of trade wastes into sewer systems if the effluent is to be used for irrigation water."

Discussion:

Sewage effluents are often of better quality than the water in irrigation ditches. Effluent often is far more effective than river water or ground water in irrigation. Standards should be set.

1948-13. WOLMAN, Abel with discussion by R. F. GOUDEY.
Industrial Water Supply from Processed Sewage Treatment Plant Effluent at Baltimore, Maryland.
Sew. Wks. Jnl. 20: 15-23.
ABST: Merz 12: 27.

Describes Bethlehem Steel's re-use which was undertaken because dangerous depletions had occurred in the ground-water supply previously used, and its salt content had increased.

The total use is 185 mgd. Of this, 35-50 mgd are fresh water for various industrial purposes, boiler feed, and potable supply of the town of Sparrows Point. Sea water serves for cooling and condensing.

The Back River sewage treatment plant handled 90-100 mgd in 1941. All other sources were inadequate or excessively expensive.

Operating costs are 1.73¢/1,000 gallons. Capital expenditures were over $2 million for 100 mgd. Plant specifications are cited in detail.

Discussion by GOUDEY, R. F., p. 22-23:

Praises the terms of the contract.

1948-14. ANONYMOUS.
Flax Retting with Aeration.
Tech. Paper No. 10, Water Pollution Resch. Lab., London., 146 p.
ABST: Sew. Wks. Jnl. 21: 758-760.

ABST: "This book outlines methods of retting flax; experiments, both successful and unsuccessful, to treat and to re-use retting liquors; and small plant and full-size plant studies of the most promising methods of re-using the liquors."

1948-15. ANONYMOUS.
Progress Report: Advances in Sewage Treatment and Present Status of the Art.
ASCE Proc. 74: 1315-1368.

A section entitled "Sewage Effluents for Industrial Use" (p. 1345-6) cites the Baltimore price schedule in summarizing a paper by Veatch.

Goudey's proposed injection wells in Los Angeles County are cited, as are Rawn, Hyde, and Thomas' conclusions that recharge in Orange County would be impractical because of limited spreading grounds and excess boron in the effluent.

1949-1. ARNOLD, C. E.; HEDGER, H. E.; and RAWN, A. M.
Report upon the Reclamation of Water from Sewage and Industrial Wastes in Los Angeles County, California.
Planograph., 159 p., 9 pl.
ABST: Sew. and Ind. Wastes 22: 576-577.
ABST: Merz 12: 64.
(See also Ludwig, 1950-8).

At present 95% of the county's waste water is discharged at sea (over 100 mgd).

The cost of reclaimed water is $9.30 to $19.05 per acre-foot, that of surplus unsoftened Colorado River water is $15.00 per acre-foot, while that of surplus softened Colorado River water is $20.00 per acre-foot.

1949-2. BRANDON, T. W.
Treatment and Disposal of Waste Waters from Decortication of Sisal.
East African Agric. Jnl. 15, No. 1 (July '49).
ABST: Sew. and Ind. Wastes 22: 582-583.

ABST: "Large-scale pilot experiments showed that the waste waters could be treated readily by biological filtration, with re-use of effluent for further decortication. ...water consumption could be reduced by over 80%, and no waste waters need be discharged."

1949-3. FALK, Lloyd L.
Bacterial Contamination of Tomatoes Grown in Polluted Soil.
Amer. Jnl. of Pub. Health 39: 1338-1342.

Conclusions:

1. Residual coliform contamination on the surface of tomatoes with normal uncracked stem ends grown on polluted soil was no greater than that on tomatoes from unpolluted soils.

2. Split skins showed pollution regardless of soil. This was three times higher on soils with sewage irrigation than on those without.

3. Wind-carried dust and insects seem to have more influence than water-splash (elevation of fruit unimportant).

4. Organisms sprayed on healthy fruit had a rapid death rate.

1949-4. FOWLER, James A.
The Waste-Disposal Program of the Sinclair Refining Co., East Chicago, Ill.
Proc. Fifth Indust. Waste Conf., Purdue.
ABST: Merz 12: 29-30.

Describes installation of cooling towers which reduced water use from 34,000 gpm to 4,000 gpm while the refinery output increased from 55,000 bbl/day to 85,000 bbl/day. Pollution control on a dead-end branch of the Indiana Ship Canal, rather than water shortage, was the motivation.

1949-5. JESSEN, Frank W. with discussion.
Subsurface Disposal of Oil Field Brines.
Chem. Engr. Prog. 45: 11-16.

Reviews current practices with attention to technical requirements and economics. Analyses literature (19 entries).

Repressuring is not discussed.

1949-6. MULLER, Wilhelm.
The Agricultural Use of Sewage.
Wasser und Boden., 1949, p. 124.
ABST: Sew. and Ind. Wastes 22: 589.

ABST: "The agricultural use of sewage by different technical means may appreciably increase the productivity of a country."

1949-7. ORENSTEIN, A. J.
Hazard of Ascaris Infestation from Sewage.
Jn. Inst. Sewage Purif. 4: 481-483.
ABST: PHE Abst. 31: S: 43.

Investigations in South Africa have shown little risk to players on golf links, to handlers of well-dried sludge, or to eaters of vegetables grown on land irrigated with settled sewage even where the effluent is contaminated.

1949-8. PEARSON, E. A. and SAWYER, C. N.
Recent Developments in Chlorination in the Beet Sugar Industry.
Proc. Fifth Indust. Waste Conf., Purdue.
ABST: Merz 12: 31.

Chlorination has made re-use of sugar waste-waters feasible.

1949-9. RAWN, A. M.
Water from Wastes: Concepts and Costs.
Engr. News-Record 143: 172-174.

Due to prejudices, reclaimed water must undergo some "natural" purification and some blending.

A reclamation plant must be free to reject all or any part of its influent. It should be located near a source of satisfactory sewage and near spreading grounds permitting recharge.

Because of seasonal variation in requirements irrigation and sewage disposal should be completely divorced.

1949-10. STEPHENSON, R. E. and BOLLEN, W. B.
Field Use of Sulphite Waste Liquor in Irrigation Water.
TAPPI 32: 422-426.

Several different concentrations of sulfite waste liquor were applied to different crops in four test plots at Lebanon, Oregon, over a five-year period. Concentrations as high as 120 tons/acre (one inch depth) depressed some crops. Smaller concentrations had little effect.

1949-11. WHITNEY, H. W.
Industrial Use of Sewage Effluents.
Wtr. and Sew. Wks. 96: 393-395.

For re-use, an adequate sewage plant and a market must both exist. Quantity and quality of alternate water supplies determine the desirability of re-use.

The paper describes the Big Spring, Texas, sewage plant and outlines Cosden's previous water difficulties. Effluent from this plant is used for boiler feed and refinery cooling.

1949-12. WIERZBICKI, Jan.
Disadvantages and Advantages of Sewage Disposal in Connection with Agricultural Utilization.
Gaz, Woda i Technika Sanitarna 23: 198.
ABST: Sew. and Ind. Wastes 22: 578-579.

Increased population and consequent increased land values lead to overloading of sewage farms.

Grasses and weeds flourish; pasture is most successful.

1949-13. WIERZBICKI, Jan.
Modern Methods in the Agricultural Utilization of Sewage.
Gaz, Woda i Technika Sanitarna 23: 298.
ABST: Sew. and Ind. Wastes 22: 969-970.

Use slopes of at least 2%. Base loading on 25 to 50 acres per 1,000 population. Spraying has many advantages but requires pretreatment by sedimentation.

Fish ponds or forests may take care of excessive flows.

1949-14. WIERZBICKI, Jan.
Sewage Farming at Ostrow Wielkopolski.
Gaz, Woda i Technika Sanitarna 23: 387.
ABST: Sew. and Ind. Wastes 22: 971-972.

Irrigation dates back to 1911 at sewage farms 2.5 miles from the city. The flow is 846,000 gpd. The area is 105 acres. The farms yield a net profit from rental.

1949-15. WIERZBICKI, Jan.
The Need for Pretreatment of Sewage Utilized for Agricultural Purposes.
Gaz, Woda i Technika Sanitarna 23: 162.
ABST: Sew. Wks. Jnl. 21: 1110.

ABST: "...the author concludes that primary treatment of the sewage is not necessary prior to disposal on fields for agricultural purposes."

Primary treatment reduces the fertilizer value and increases the cost.

1949-16. ZUFELDT, Roy H.
Treating East Texas Oil Field Water.
Petro. Engr. 21: Mar., B7-B10, B12.

Recharge of brines in the Woodbine Sand has maintained bottom hole pressure and solved an acute pollution problem. Chemical treatment and costs are discussed.

1949-17. ANONYMOUS.
Air Conditioning Water Affects Sewers.
Wtr. and Sew. Wks. 96: 263.

Milwaukee's sewers are undersize for their air-conditioner load. For the main street this is estimated to be 1 mgd. Beer cooling systems supply 7.5 mgd. Many stores have their own wells to get cooler water than city supplies.

Re-use was not suggested in the paper.

1950-1. BARBIER, G.; TROCME, S; and CHABANNES, J.
New Investigations on Chlorosis of Crops in Sewage-Disposal Areas.
C. R. Acad. Agric. 36: 179-181.
ABST: Soils and Fert. 13: 283.

"Chlorosis in leeks, beans and spinach was rapidly and completely cured by spraying the foliage with 0.2% solution of $MnSO_4$. Subsequent development was superior to that of apparently healthy untreated plants."

1950-2. CALISE, Vincent J.
Economics of Waste Treatment.
Wtr. and Sew. Wks. 97: 479-483.
PHE Abst. 31: S: 26.

Discusses economics of treatment for acid, plating, paper, and oil wastes. It considers re-use.

1950-3. EHEMANN, C.; BURNETT, L. K.; and WADDELL, J. C.
Application of the OCO Water System to Paper Mill White Water Recovery.
Sew. and Ind. Wastes 22: 1573-1582.
PHE Abst. 31: S: 25-26.

Describes a process for clarifying paper mill white water for re-use. Cost data are included. Sound design and careful operation are stressed.

1950-4. FERAUD, L.
Utilization in Agriculture of Waste Water, Domestic Garbage and Marine Sludge.
Agric. Prat. 114: 270-272.
ABST: Soils and Fert. 13: 358.

ABST: "Sewage water and its use for flood- and sprinkling-irrigation, with special reference to the Paris district are discussed."

1950-5. HAMMERSCHMIDT, E. G.
Recirculating Cooling System Waters.
Petro. Engr. 22: Mar., D-77-85.

Describes problems in the pumping stations of the Texoma Natural Gas Company's pipe line. Difficulties were due to scale formation, corrosion, and microbiological growths.

1950-6. HEDGER, H. E.
Los Angeles Considers Reclaiming Sewage Water to Recharge Underground Basins.
Civil Engr. 20: 323-324.

Describes the water supply of the Los Angeles area with emphasis on declining water tables. Effluent could be added to ground water to create a fresh-water barrier to ocean encroachment.

Tentative cost figures are given.

1950-7. HYDE, Charles G.
Sewage Reclamation at Melbourne, Australia.
Sew. and Ind. Wastes 22: 1013-15.
PHE Abst. 31: S: 6.

Describes the 24,610-acre sewage farm which has been in existence since 1892. It handles sewage from 1,250,000 people at 36¢ per capita per year, and raises 14,000 head of cattle.

1950-8. LUDWIG, Russell G.
Reclamation of Water from Sewage and Industrial Wastes in Los Angeles County.
Sew. and Ind. Wastes 22: 289-295.

This paper summarizes a report to the County Board of Supervisors.

The establishment of a separate reclamation plant would have three important advantages over a mere sewage treatment works:

1. It would not have to process all the flow in a line,

2. It would not process solids or skimmings, and

3. It could shut down at any time.

Sewage and industrial wastes from some areas should be segregated, with the less treatable by-passing the reclamation plant. In particular, brines would be by-passed.

Effluent could be used for:

1. Recharge by spreading grounds (oxidized secondary effluent), and

2. Agriculture and industry directly.

Cost data are cited.

1950-9. PEARSON, E. A. and SAWYER, C. N.
Beet Sugar Process Waters--Treatment and Utilization.
Chem. Engr. Prog. 46: 380-388.

Recirculation and re-use has essentially solved the flume water problem. Condenser water can also be re-used.

Process waste water (battery wash water and pulp press water) is the main concern of this paper. The usual range is from 300 to 500 gal/ton.

Several attempts at re-use have led to various difficulties.

The authors' process of chlorination recovers considerable sugar and eliminates stream pollution.

1950-10. PLUCINSKI, F.
Waste Gas Liquors as a Source of Nitrogen.
Gaz, Woda i Technika Sanitarna 24: 268.
ABST: Sew. and Ind. Wastes 23: 328.

The liquor should be applied before seeding in dilute form or after harvest full strength. It has proved ineffective on meadow land.

1950-11. RAWN, A. M.
Blending of Sewage Effluent with Natural Waters Permits Re-Use.
Civil Engr. 20: 324-325, 373.

Reports on a study of reclamation plants for Los Angeles.

Water reclamation must begin with good effluent, not with raw sewage. The plant must have the right to be selective.

Recharge should be employed to avoid public aversion to direct re-use.

Mineral-content buildup on recycling is cited.

Re-use of water is feasible for agricultural and industrial purposes.

1950-12. RICKERT, E. E. and BISHOP, W. T.
Wash Water Treatment and Fine Coal Recovery.
Ind. and Engr. Chem. 42: 626-630.
ABST: Merz 12: 29.

Describes facilities at Tamaqua Colliery for settling coal-carrying waters to permit their re-circulation.

1950-13. SCHNEIDER, Ruben.
Waste Disposal at a Modern Brewery.
Sew. and Ind. Wastes 22: 1307-1313.
ABST: Merz 12: 46.

Describes operation of a brewery in Azusa, Calif., designed for recirculation and for "the reclamation of a large amount of water by returning a high-grade effluent to the county's underground basin."

1950-14. SCHREIER, Franz.
Problems in Sewage Farming.
Berichte der Abwass. Verein. No. 2, p. 118.
ABST: Sew. and Ind. Wastes 25: 241.
PHE Abst. 33: S: 25.

Pretreatment is considered imperative. Changes in farming methods are radical, and involve new capital investments. Spraying onto grazing areas is the best method.

Economics should govern.

1950-15. SEGAL, A.
Sewage Reclamation at Fresno, California.
Sew. and Ind. Wastes 22: 1011-12.
PHE Abst. 31: S: 13.

Fresno's sewage is utilized by the irrigation of 1,292 acres of land.

1950-16. VAN DAALEN, M.
Water Supply by Means of Condensate Water from the Royal Netherlands Salt Industry at Hengelo.
Water (Holland) 35: 271-275.
Chem. Abst. 25: Apr. '51.
PHE Abst. 31: W: 34.

Condensate from triple-distilled brine may contain some chlorides. The water is very soft.

1950-17. WIERZBICKI, Jan.
Economics of Sewage Disposal in Connection with Agricultural Utilization.
Gaz, Woda i Technika Sanitarna 24: 193.
ABST: Sew. and Ind. Wastes 22: 1508.

Summary of European experience with sewer farms. They are most satisfactory for small towns with short flow lines and no industrial effluent. Hay crops are excellent.

1950-18. WIERZBICKI, Jan.
Effect of Geographical Factors on the Widespread Agricultural Use of Sewage.
Gaz, Woda i Technika Sanitarna 24: 407.
ABST: Sew. and Ind. Wastes 23: 941.

England had less land, more industrial effluent, and less need for irrigation than mainland points. Hence, sewage farming disappeared early.

High labor costs and high rainfall (40 in./yr) in the Eastern U.S. militated against sewage farms. Two hundred sixty-seven small towns in the West are reported to be using them.

Gravity flow to the farm is desirable.

1950-19. WRIGHT, C. T.
Pollution of Irrigation Waters.
Sew. and Ind. Wastes 22: 1403-1412.
PHE Abst. 31: S: 10.

Effluent irrigation will increase.

Raw sewage and trade wastes dumped into rivers present serious pollution problems. Pathogenic bacteria will persist for days. Wash water may be the source of contamination.

Cattle may prefer effluent to fresh water. Their udders may become contaminated.

Research is needed. Uniform codes of practice are needed.

1950-20. ANONYMOUS.
Water in Industry.
Nat'l Assn. of Mfrs. Conservation Found., 51 p.
ABST: Sew. and Ind. Wastes 23: 820-821.

The survey covers more than 3,000 industrial plants.

Of 2,693 plants answering on re-use 61.3% made none, 9.4% used up to 10%, 4.8% re-used 10-19%, ... 7.1% re-used more than 100%.

1951-1. BARRACLOUGH, D. H.
Sewage and Water Treatment in Australia.
Surveyor 110: 48.
ABST: Sew. and Ind. Wastes 24: 116.

Melbourne treats its wastes on a sewage farm 29,000 acres in extent (flow 62 mgd). New areas are being prepared since flow increases 1-2 mgd/yr.

Adelaide is replacing a sewage farm.

1951-2. DAVIS, David E.; BROWN, R. Z.; and JACKSON, W. B.
The Effect on Mouse Populations of Sprinkling Industrial Effluent in an Oak Woods.
Trans., 16th North Amer. Wildlife Conf., p. 283-289.

A frozen-food plant in N. J. disposes of up to 12 mgd by sprinkler irrigation on a 140-acre plot. Some standing water and mechanical damage to plants results.

No detectable change in mouse population occurred during the first year's study.

1951-3. DRAKE, J. A. and BIERI, F. K.
Disposal of Liquid Wastes by the Irrigation Method at Vegetable Canning Plants in Minnesota, 1948-1950.
Purdue Univ. Engr. Bull. 35: No. 6, p. 70-79.
ABST: Sew. and Ind. Wastes 24: 803-804.

ABST: "Three plants using spray irrigation, two using ridge and furrow irrigation, and one using both, are described."

"Irrigation has the benefit of eliminating odors, reducing the cost (except where long pumping lines are needed to reach the field), and leaving the ground available for future use." Some dangers are cited.

1951-4. DUNLOP, Stuart G.; TWEDT, R. M.; and WANG, Wen-Lan Lou.
Salmonella in Irrigation Water.
Sew. and Ind. Wastes 23: 1118-1122.

Reports on studies which showed that even "with definite contamination of the irrigation water, no Salmonella were recovered from the vegetables irrigated with this water." Part of the time the ditch carried 60% raw sewage. Research continues.

1951-5. ELDER, Clayburn C.
Determining Future Water Requirements.
AWWA Jnl. 43: 124-135.
PHE Abst. 31: W: 23.

Cites Fontana Steel's re-use as indicating a future trend.

Re-use in air conditioning may require legislation as it has at Las Vegas, Nev.

<u>1951-6.</u> FALKENHAIN, H. S.
Treatment of Waste Waters from the Sugar Factory of Euskirchen.
Zuker (1951): 389-390.
Chem. Zbl. 123 (1952): 1222.
ABST: Merz 12: 45.

Waste water from a German sugar beet factory, after sedimentation, is spread on drained grassland to a depth of about 60 cm.

<u>1951-7.</u> GUYMON, Boyd E.
Brewery Builds Waste Plant; Flow is Larger than City's.
Engr. News-Record 146: 26 Apr. '51, p. 50.
PHE Abst. 31: S: 46.

The effluent from five separate spreading ponds totaling slightly less than an acre is recharged to the ground water.

<u>1951-8.</u> HAMLIN, E. J. and WILSON, H.
Future of Sewage Disposal in South Africa.
Surveyor 110: 397-398.
ABST: Sew. and Ind. Wastes 24: 686.

In arid regions re-use is an economic necessity.

Seven days ponding and sand filtering of effluents before discharge into a water course is recommended.

More effluent will be used as circulating water in power stations and industry as is now being done in Johannesburg and Pretoria.

<u>1951-9.</u> HAVIGHORST, C. R.
How West Coast Brewery Solved Disposal Problem.
Food Engr. 23: June, p. 142-143.
PHE Abst. 31: S: 49.

An Azusa, Calif. plant reclaims all water (670,000 gpd, ultimate to be 1,350,000 gpd). Ninety percent is used for irrigation, and 10% seeps from spreading ponds to the water table. Direct recharge by wells was avoided since this would pollute the ground water. The equipment is described and diagrammed.

<u>1951-10.</u> HOUK, Ivan E.
Irrigation Engineering Vol. 1.

Use of Sewage (p. 420-421):

Cites use in Fresno and San Antonio. Discusses soil types favorable to sewage irrigation and warns of health hazards on uncooked vegetables.

Contaminations of Quality (p. 469):

Industrial wastes and repeated use of return flows may affect the quality of irrigation water. Effluent from sewage treatment plants or raw sewage seldom contain excessive concentrations of dissolved solids.

1951-11. HOWSON, L. R., et al.
Domestic and Industrial Water Supply and Pollution.
Sew. and Ind. Wastes 23: 210-226.
ABST: Merz 12: 26.

Discusses factors responsible for water shortages and proposes corrective measures including re-use.

1951-12. KNACK, M. F.
Treatment of Board Mill Waste at River Raisin Paper Company, Monroe, Michigan.
Sew. and Ind. Wastes 23: 1533-1536.
ABST: Merz 12: 28.

Describes re-use of white water with some cost analysis.

1951-13. LUDWIG, Harvey F.; LUDWIG, Gordon W.; and FINLEY, J. A.
Disposal of Citrus By-Products Wastes at Ontario, California.
Sew. and Ind. Wastes 23: 1254-1266.
PHE Abst. 31: S: 80.

Untreated wastes may be spread onto porous sandy soils. Alternate spreading and cropping utilizes fertilizer value best.

Cost data are included.

1951-14. MANNBRO, N.
Waste-Liquor Recovery in Diffusers or Digesters Combined with Filter Washing.
Svensk Papp. Tidn. 54: 535-538.
Brit. Abst. 1952: B: 111, 66.
PHE Abst. 32: S: 46.

The filtrate from filter washing is used for washing in diffusers or digesters as well as for flushing out the pulp. The losses, dilution, etc., involved are calculated.

1951-15. MARTIN, Benn.
Sewage Reclamation at Golden Gate Park.
Sew. and Ind. Wastes 23: 319-320.
PHE Abst. 31: S: 36.

Operations and costs are described (7¢ per 1,000 gallons). The design capacity is one mgd.

Solids are by-passed to a sewage treatment plant.

Until 1947 effluent was used only to maintain lake levels; now it is used for irrigation also.

The plant effluent meets drinking-water standards.

1951-16. REINKE, E. A
California Regulates Use of Sewage for Crop Irrigation.
Wastes Engr. 22: 364, 376.
PHE Abst. 31: S: 55.

Summarizes State Department of Public Health's regulations.

1951-17. RUDOLFS, Willem; FALK, Lloyd L.; and RAGOTZKIE, Robert A.
Contamination of Vegetables Grown in Polluted Soil.
Sew. and Ind. Wastes 23: 253-268, 478-485, 656-660, 739-751, 853-860, 992-1000.
PHE Abst. 31: S: 36, 45.
Summary: Sew. and Ind. Wastes 24: 550-551.

The summary states, "on the basis of the studies the general conclusion was drawn that there was no evidence that pollutional bacteria, amoeba, or helminth eggs penetrate healthy unbroken surfaces of vegetables, causing internal contamination. Vegetables to be eaten raw can be grown without health hazard in soils that have been subject to sewage irrigation, night soil application, or irrigation with polluted water in years prior to the season in which the vegetables are grown."

Conditions for shorter periods of time lapse are discussed at some length.

1951-18. RUDOLFS, Willem, et al.
1950 Literature Review.
Sew. and Ind. Wastes 23: 555-642.
PHE Abst. 31: S: 50.

Calls attention to the recent increased interest in industrial use of effluent.

1951-19. SALZMAN, M. G. and ELLIOTT, Louis.
Type of Water Supply Influences Location and Layout of Texas Steam-Electric Plants.
Civil Engr. 21: 260-263.

No mention is made of effluent, though the paper stresses recirculation, cooling towers, etc., for arid locations.

1951-20. SMALLHORST, D. F.
How Texas Controls Water Pollution.
Pub. Wks.: May 1951, p. 46-48, 54, 56.
PHE Abst. 31: S: 53.

Texas streams require vigilance to maintain their condition rather than "clean-up." Fifty-two Texas cities are now irrigating with effluent. The most serious current problem is that of oil-field brines.

1951-21. SNYDER, Charles W.
Effects of Sewage on Cattle and Garbage on Hogs.
Sew. and Ind. Wastes 23: 1235-1242.

The "desire to make waste disposal services self-supporting presents problems in disease control."

There is no such disease as "sewage poisoning" in cattle. They have been shown to thrive on effluent. The same is true of hogs.

One hundred years of sewage farming has produced no proven epidemic.

Feeding hogs on uncooked garbage leads to trichinosis.

1951-22. STONE, Ralph.
Sugar Cane Process Wastes.
Sew. and Ind. Wastes 23: 1025-1028.
PHE Abst. 31: S: 65.
ABST: Merz 12: 31.

Mills should be located so that the effluent can irrigate surrounding cane fields. Pollution is unjustified.

Efficient plants require 1.32 to 1.55 cfs per 100 tons of sugar cane.

Conditions in Colombia are cited.

1951-23. STONE, Ralph and GARBER, William F. with Discussion.
Sewage Reclamation by Spreading Basin Infiltration.
ASCE Proc. 77: Sept., No. 87, 20 p.; No. D-87, 10 p.
REPRINTED: ASCE Trans. 117: 1189-1217.
PHE Abst. 32: S: 3.

Data are given for tests on two basins in Los Angeles County, Calif. Calculations for permissible loadings in terms of oxygen (DO and BOD) are outlined.

Aerobic conditions are important both to satisfactory sanitary quality and to rate of percolation.

Sewage effluents can be successfully percolated at rates as high as 0.6 cfs/acre for periods of several months. The actual operating schedule must be decided by local conditons.

Discussion by KRONE, R. B.; THOMAS, Jerome F.; and LUDWIG, Harvey F.:

Stone and Garber used a misleading method of measurement.

Discussion by RAWN, A. M. and BOWERMAN, F. R.:

Questions long-term effects on aquifer and on ground water.

Closure:

Krone, Thomas, and Ludwig are wrong.
Mosquitoes may be controlled by introducing their natural enemies.
Effluent may improve soils by leaching alkalis.
Long-time tests have led to no troubles.

1951-24. TRAVIS, H.
Brewery Water Conservation Practices and Some Theory.
Brew. Dig. 26: 52-55.
ABST: Merz 12: 31.

Reports revised operation of a New York brewery with bottle wash-water being re-used for cooling. Consumption was reduced from 7.9 to 5.94 bbls. of water per bbl. of beer.

1951-25. VAN PATTEN, Eric M. and McINTOSH, George H.
Waste Savings Accomplished by American Maize Products Co.
Wtr. and Sew. Wks. 98: 516-523.
PHE Abst. 32: S: 17.

The company reduced serious pollution of Lake Michigan from 10 population equivalent per bushel to 0.7 by re-use. Pending developments may yield further improvement.

Plant modifications required are discussed in detail.

Capital investment = $850,000.

Return per year = $175,000.

1951-26. ANONYMOUS.
Industrial Plants Can Conserve Water.
Engr. News-Record 147: 19 Jul., p. 40-41.
PHE Abst. 31: W: 42.

The steel plant at Fontana, Calif., uses less than 1,200 gal/ton; the U.S. average is 65,000 gal/ton.

Two water systems--domestic and industrial--exist in parallel. Four different qualities of industrial water exist in the plant. Treated sewage effluent is pumped to the second stage of the industrial system.

The industrial system consists of:

1st stage--motor room cooling,
2nd stage--cooling of bearings and rolls,
3rd stage--open-hearth furnace cooling,
4th stage--gas washing (smog control).

1951-27. ANONYMOUS.
Night Soil--U.S.A.
Ind. and Eng. Chem. 43: Mar., p. 15A.

Forty-two cities and towns in California use effluent for irrigation.

Fresno irrigates 1,292 acres with a net profit.

Use of effluent for cooling water and recharge are contemplated in Los Angeles.

1951-28. ANONYMOUS.
Small Unit Converts Sewage to Pure Water.
Chem. and Engr. News 29: 3016.

Describes a 12-lb. unit less than 1 cubic foot in size developed at Calif. Tech. which delivers 2 qts/min for 30 to 40 minutes by means of a hand pump. The filter must then be replaced.

1952-1. BLACK, Hayse H. and McDERMOTT, Gerald N.
Industrial Waste Guide--Beet Sugar.
Sew. and Ind. Wastes 24: 181-193.
PHE Abst. 32: S: 39.
ABST: Merz 12: 30.

The paper discusses segregation and re-use in some detail. Flume water is recirculated at many plants.

For pulp press water "The greatest single impelling force for re-using pulp screen and pulp press water is stream pollution abatement."

1952-2. BURGESS, F. J.; FROST, O. W.; and MERRYFIELD, F.
Disposal of White Water Waste from a Hardboard Manufacturing Process by Land Irrigation.
Proc. 4th Ann. Ind. Waste Conf., p. 29-32.
Bull. Inst. Paper Chem. 24: 264 (1953).
ABST: Merz 12: 46.

White water has been satisfactorily disposed of by irrigation on cultivated land at Forest Grove, Oregon. Problems arising from white water disposal are discussed.

1952-3. DUNLOP, Stuart G.
The Irrigation of Track Crops with Sewage-Contaminated Water.
The Sanitarian 15: 107-110.
PHE Abst. 33: S: 4, 28.

Adequate treatment of effluent before using it for irrigation of truck crops is advocated.

1952-4. FADGEN, T. J.
Metal Recovery by Ion Exchange.
Sew. and Ind. Wastes 24: 1101-1107.
ABST: Merz 12: 26-27.

Conservation of municipal water and abatement of stream pollution have dictated a careful study of water-using processes.

Details are cited for a General Motors plant.

1952-5. FINCH, John.
Report from Abroad: The Nottingham Report and Green Algal Growths.
Wtr. and Sew. Wks. 99: 125.
PHE Abst. 32: S: 37.

An average of 21 mgd of settled sewage is spread over 700 acres at Nottingham. This overload produces septicity. Some improvement has resulted from encouraging the growth of green algae.

1952-6. FLEMING, George S.
Treatment and Re-Use of Water in Beet Sugar Manufacturing.
Sew. and Ind. Wastes 24: 1382-1388.
PHE Abst. 33: W: 6.
ABST: Merz 12: 30.

This paper describes re-use of several classes of water.

1952-7. FOX, Arthur J., Jr.
Quenching Industry's Thirst.
Engr. News-Record 148: 1 May, p. 66-70.

Re-use is becoming important to industry. Fox cites Fontana where no water leaves the steel plant except by evaporation.

Cooling water often needs only be repumped. (Eighty-three percent of water in steel, 99% in steam-power is for cooling.)

Re-use of sewage effluent should be more common. Bethlehem Steel in Baltimore, and West Coast irrigation are cited as prime examples of efficient re-use.

1952-8. GOTHARD, N. J. and FOWLER, James A.
Symposium on Liquid Industrial Wastes: Petroleum Refineries--Pollution Abatement at Sinclair Refining Co.
Ind. Eng. Chem. 44: 503-507.
ABST: Sew. and Ind. Wastes 24: 1444.

Sinclair has reduced the volume of wastes by 95%. Methods for accomplishing this feat included:

1. Separation of sewage from refinery waste;

2. Installation of cooling towers--recycling;

3. Effective oil separation; and

4. Treatment of wastes at the refinery before release.

1952-9. GREENBERG, Arnold E. and GOTAAS, Harold B.
Reclamation of Sewage Water.
Amer. Jnl. Pub. Health 42: 401-410.

Reports on a study at Lodi, Calif., of the spreading of effluent to determine bacteriological and chemical changes during percolation, to determine an optimum operation program, and to evaluate nuisances (insects and odor).

Mosquitoes and odors of decaying algae on resting plots require attention.

Safe water can be produced by spreading.

1952-10. HAACK, J. E.
Treatment of Sewage for Industrial Utilization at Moose Jaw.
Munic. Util. 90: No. 10, p. 20-21, 36-41.
PHE Abst. 33: S: 88.

Secondary effluent is used by an oil company for cooling.

1952-11. HESS, F. and MEER, F.
Treatment of Milk Trade Wastewaters.
Wasser und Boden 4, No. 1.
Ost. Wasserw. 4: 229.
ABST: Merz 12: 46.

Spray irrigation--on meadows--appears to be the most practicable method of disposal. Fishponds have also been used successfully.

1952-12. HOLLER, Karl.
Fifteen Years of the Uthleben Sewage Cooperative.
Wasserwirt-Wassertech 2: 397.
ABST: Sew. and Ind. Wastes 26: 118.

Irrigation of grains, beets, and pastures is described.

1952-13. HOWELL, G. A.
Water Conservation in Steel Mills.
Sew. and Ind. Wastes 24: 1368-1371.
ABST: Merz 12: 27.

Describes water use in a plant with abundant water, in one with limited water, and in one with a very limited supply. In the latter case "...recirculation limits the amount of make-up water used to that which is lost through evaporation."

1952-14. HOWSON, L. R.
National Water Resources Policy as Related to Stream Pollution.
Wtr. and Sew. Wks. 99: 60-62.
PHE Abst. 32: S: 26-27.

Re-use may be dubious economically. It should not be made a requirement for Federal financing of plants. Effluent has negative value in the vast majority of cases.

Federal grants, in whole or part, should not be made for waste disposal. An expenditure of 1¢ per capita per day would pay for disposal.

1952-15. LUDDEN, John, Jr. and VOGLER, John F.
Water Conservation in a Chemical Plant.
Sew. and Ind. Wastes 24: 1377-1381.

Describes re-use in the Calco Plant in W. Va. which produces diversified chemical products.

Many excellent detailed suggestions are given for attaining water economy.

1952-16. MILLER, J. E.; ENTRIKIN, P. P.; and GEISER, F. J.
Conservation of Water in Petroleum and Petro-Chemical Industries.
Proc. 2nd Ann. Symp. Water Conserv. Ind. Dev.
La. Univ., Engr. Exp. Sta. Bull. No. 38, p. 46-53.
ABST: Merz 12: 29.

Re-use in refineries is discussed, and operations of a refinery in Baton Rouge is described.

1952-17. NELSON, Leonard E.
Cannery Wastes Disposal by Spray Irrigation.
Wastes Engr. 23: 398-400.
PHE Abst. 32: S: 74-75.

Increased crop production is claimed with no odors resulting.

The sprinkler lines of aluminum pipe are moved twice daily.

An installation in Minnesota is described where, in 1951, 24 million gallons were used on 110 acres of crops. Cost data are included.

1952-18. RENARD, M.
Waste Treatment at the Montierchaume Distillery.
La. Tech. Munic. et Sanit. 45: 226.
ABST: Sew. and Ind. Wastes 24: 1551.
PHE Abst. 33: S: 1.
ABST: Merz 12: 30-31.

Effluents from treating 300 tons of sugar beets per day are sprayed over deeply-plowed (18 in.) ground. Absorption is 3,780 gpd/acre.

More land is needed.

1952-19. RIEGEL, H. I.
Waste Disposal at the Fontana Steel Plant.
Sew. and Ind. Wastes 24: 1121-1129.
PHE Abst. 32: S: 67.
ABST: Merz 12: 27.

Having no nearby water, the Fontana plant carried re-use to a point where only 2-1/2% make-up water is required. (One thousand four hundred gallons consumed per ton of steel; total requirement: 50,000 gal/ton.)

The plant's water operation is discussed in some detail.

1952-20. RUDOLFS, Willem and HEUKELEKIAN, H.
Food Wastes.
Food Engr. 24: Aug., p. 104-116.

Recycling or direct discharge of unpolluted waters saves treatment capacities.

Land irrigation is recommended for effluents from milk plants provided constant cultivation is possible. Spraying of cannery wastes in forest areas is often practiced.

Contamination of ground water must be considered.

1952-21. RUDOLFS, Willem, et al.
1951 Literature Review.
Sew. and Ind. Wastes 24: 541-641.
PHE Abst. 32: S: 51.

Water pollution abatement and control, p. 614-641.

Little emphasis is placed on re-use in this year's report.

1952-22. SANBORN, N. H.
Spray Irrigation as a Means of Cannery Waste Disposal.
Canning Trade 74: 17-21.
PHE Abst. 32: S: 47.

Problems remain, but spray irrigation will become an important method of waste disposal.

The provision of an effective vegetable cover crop is the most important problem.

1952-23. SCHULZ - FALKENHAIN, H.
Treatment of Waste Water from the Textile-Processing Industry in Coesfeld/ Westfalen.
Melliand Textilber 33: 650-651.
Chem. Abst. 47: 3498.

Waste water from textile mills is combined with town sewage, run thru a trash rack, and let flow over pasture.

1952-24. SIMONSEN, R. M.
How Four Oil Refineries Use Water.
Sew. and Ind. Wastes 24: 1372-1377.
ABST: Merz 12: 29.

Re-use is dictated by water economy and stream pollution considerations.

Data of value appear in the text.

1952-25. SIMPSON, R. W.; DUKE, E. T.; and THOMPSON, K.
Asbestos Paper Wastes Treatment.
Wtr. and Sew. Wks. 99: 286-291.

Describes pilot plant studies leading to installation of high rate clarifier to prepare water for re-use at Norristown, Pa.

1952-26. SOUTHGATE, B. A.
Waste Disposal in Britain.
Ind. and Engr. Chem. 44: 524-530.

British climate makes disposal by irrigation or lagooning impossible.

The procedures used, industry-by-industry, are sketched.

The most important applications of re-use have been in beet sugar and in flax retting.

1952-27. STONE, Raymond V.; GOTAAS, Harold B.; and BACON, V. W.
Economic and Technical Status of Water Reclamation from Sewage and Industrial Wastes.
AWWA Jnl. 44: 503-517.
PHE Abst. 32: S: 60.

This paper surveys foreign and domestic use for agriculture, industry, recreation, and recharge.

Several pages of tabulated data (covering quality and costs) are included.

Thirty-three references are cited.

1952-28. VAN PATTEN, Eric M. and McINTOSH, George H.
Liquid Industrial Wastes: Corn Products Manufacture.
Ind. and Engr. Chem. 44: 483-487.

Describes re-use cycle of American Maize Products Company.

Started in 1907 in Hammond, Ind., without sewers, the plant contributed effluent equivalent to a population of 350,000 to Lake Michigan. Times changed. By a series of actions taken, this waste has been reduced to 28,000 equivalent.

1952-29. VON LOESECKE, Harry W.
Liquid Industrial Wastes: Citrus Fruits Industry.
Ind. and Engr. Chem. 44: 476-482.

Liquid effluents amounted to about four billion gallons in 1949.

Some reduction of waste is accomplished by re-use within the plant for increasingly less demanding purposes.

Discharge for orchard irrigation may be practiced, but it has led to defoliation of trees in some circumstances. Pasture irrigation has been successful.

1952-30. VOTAVA, J.
Possibility of Using Irrigation Fields in the Treatment of Waste Waters from Sugar Factories.
Listy Cukr. 68: 58-60.
Water Poll. Abst. 28: 2743.
ABST: Merz 18: 37.

To avoid pollution by tailwater reaching streams, it is recommended that only wash water from the cossettes be used for irrigation.

1952-31. WARRINGTON, Sam L.
Effects of Using Lagooned Sewage Effluent on Farmland.
Sew. and Ind. Wastes 24: 1243-1247.
PHE Abst. 33: S: 20.

The build-up of salts and the public health aspects must be considered. The degree of treatment and types of crop grown are of the utmost importance.

1952-32. WESTON, Roy F.
Waste Control at Oil Refineries.
Chem. Engr. Prog. 48: 459-467.

Cites two refineries treating their water and re-using it.

1952-33. WIERZBICKI, Jan.
Sewage Disposal by Land Irrigation.
Gaz, Woda i Technika Sanitarna 26: 2, 34.
ABST: Sew. and Ind. Wastes 24: 1554-1555.

Describes an installation in Lower Silesia built in 1906 and still operating.

Vegetables are grown but are not irrigated during the growing season. Results were good with tomatoes, cabbage, cauliflower, cucumbers, and onions; poor with celery. No health problems have arisen.

1952-34. ANONYMOUS.
Ventura, Calif., Sells Sewage Effluent.
Amer. City 67: May, p. 141.

Over 1 mgd now flowing to the ocean is to be sold to Shell Oil Co. to supply an ammonia plant and an oil field. Contract terms and prices are detailed.

1953-1. BAUMANN, Paul.
Experiments with Fresh-Water Barrier to Prevent Sea Water Intrusion.
AWWA Jnl. 45: 521-534.
ABST: Merz 12: 64.

Describes an injection plan for Los Angeles County. Economic considerations are discussed.

City water was used in the preliminary tests and no reference is made to effluent in this paper.

1953-2. BLACK, Hayse H. and MINCH, Virgil A.
Industrial Waste Guide--Wood Naval Stores.
Sew. and Ind. Wastes 25: 462-474.
PHE Abst. 33: S: 52.
ABST: Merz 12: 30.

"Recirculation and re-use holds considerable promise as an economical means of alleviating some of the problems of naval stores wastes...the most effective re-use of waste waters is an individual plant problem."

1953-3. CHASE, E. Sherman.
Sewage Works Developments During the Year 1952.
Wtr. and Sew. Wks. 100: 45-55.

Broad irrigation is still used in Spain, Italy, Germany, and France. Irrigation and industrial use "offers interesting possibilities."

1953-4. DAVIS, C. Malcolm.
Surface Equipment for Gulf Coast Salt-Water Disposal.
Oil and Gas Jnl. 52: 20 July, p. 124.

Describes facilities for field repressuring at Chocolate Bayou, Brazoria County, Texas, and Hastings Field, Galveston and Brazoria Counties.

1953-5. DENNIS, Joseph M.
Spray Irrigation of Food Processing Wastes.
Sew. and Ind. Wastes 25: 591-595.
PHE Abst. 33: S: 71.

Spray irrigation was first used in 1947 in Pennsylvania. It is suitable for rolling terrain. Pastures, grass, and weeds are the most effective ground covers for erosion prevention. The effluent should be screened to avoid clogging of nozzles.

Spray works well with dairy wastes, provided they are fresh.

1953-6. FALKENHAIN, H. S.
Regulations for Irrigation and the Use of Sewage Sludge.
Wasserw.-Wass. Tech. 3: 293.
Water Poll. Abst. 28: 1805.
ABST: Merz 18: 39.

In discussing proposed German regulations for irrigation with effluent, the author reviews the divergent views on preliminary treatment requirements. Health hazards are cited.

1953-7. FLAIGG, N. G.
The Effect of Irrigation and Return Flow on Water Supplies.
Sthwest. Wat. Wks. Jnl. 34: No. 12, p. 9-12, 14, 16.
PHE Abst. 34: W: 35.

In British practice, 20-60% of irrigation water returns to the stream. Salt, insecticides, and herbicides will have been added.

1953-8. GEHM, Harry W. and MOGGIO, W. A.
Conservation of Water in the Kraft Pulp and Paper Industry.
Proc. 2nd Ann. Symp. Wat. Conserv. Ind. Dev.
La. Univ. Engr. Exp. Sta. Bull. No. 38, p. 1-11.
ABST: Merz 12: 28.

Flow diagrams are given illustrating various processes in which water is re-used.

1953-9. GOTAAS, Harold B., et al.
Final Report on Field Investigation and Research on Waste Water Reclamation and Utilization in Relation to Underground Water Pollution.
Calif. State Water Pollution Control Board, Publn. No. 6, 124 p.
ABST: Sew. and Ind. Wastes 26: 927-928.

"...this investigation was made (on specially prepared test plots) primarily for the purpose of determining rates of percolation through different soils, optimum spreading periods, extent of penetration of mineral and organic matter in the waste water, changes in mineral and organic characteristics of both soil and waste water, degree of treatment necessary and costs of spreading operations."

The conclusions reached were that:

(a) Bacteriologically safe water can be produced from settled sewage or from final effluent if the liquid passes thru at least 4 feet of soil.

(b) The chemical quality will be satisfactory if care is used in selecting the influent.

(c) Highly-treated effluent should be used to obtain a high rate of percolation.

(d) Mosquitoes must be controlled on spreading ponds.

1953-10. GRUBINGER, H.
The Problem of Agricultural Utilization of Sewage.
Boden Kultur 7: 279-291.
ABST: Soils and Fert. 18: 64 (1955).
Water Poll. Abst. 28: 1806.
ABST: Merz 18: 36.

Discusses the technical features of sprinkler irrigation with sewage effluent. Because of the nitrogen content, this is especially beneficial on grassland.

1953-11. HESS, R. W., et al.
1952 Industrial Wastes Forum.
Sew. and Ind. Wastes 25: 706-728.

Subsurface Disposal (p. 715-720).

N. J. LUSCZYNSKI: Bacterial quality of effluent filtered through sand is excellent; salinity and other chemicals remain. Recharge should be used with great caution.

S. MOGELNICKI: Reports brine disposal.

DAVID B. LEE: Florida's experiences have been such that underground disposal is no longer permitted.

C. O. HUNTRESS: Underground brine disposal requires close monitoring.

1953-12. HEUKELEKIAN, H., et al.
1952 Literature Review.
Sew. and Ind. Wastes 25: 511-547, 633-683.

"Re-use, combined with waste treatment, is the key to water conservation."

Spray irrigation is increasing.

1953-13. HEY, D.
A Preliminary Report on the Culture of Fish in the Final Effluent from the New Disposal Works, Athlone, South Africa.
Verh. int. Ver. Limnol. 12: 737.
Water Poll. Abst. 28: 2029.
ABST: Merz 18: 39.

Only one variety of fish (Gambusia) could be grown successfully in the effluent from this trickling filter plant. Even this required several days storage of the effluent to allow the dissolved oxygen content to increase sufficiently.

1953-14. HOAK, Richard D.
Water Use and Conservation Policy.
Chem. and Engr. News 31: 3448-3454.
ABST: Merz 12: 26.

This article condenses a symposium which included:

BUSH, A. F.: Re-Use of Water in Industry, and

WILCOX, L. V.: Irrigation Water Quality as Affected by Use and Re-Use.

Re-use of water in industry is increasingly prevalent. Cooling is industry's largest use; it can adapt to re-use easily. The Fontana Steel plant is cited as an example of effective re-use. Injection and spreading for recharge are feasible. Irrigation re-use often involves serious salinity problems.

1953-15. HUDSON, H. E., et al.
Water Conservation in Industry.
AWWA Jnl. 45: 1249-1260.
ABST: Merz 12: 26.

Recommends recycling, re-use of waste water from other sources, ground water recharge, use of salt water, etc. Forty-one references are included. Examples are cited.

1953-16. KHURODY, D. N.
Disposal of Milk Washings and Waste Water from Large Dairies Under Tropical Conditions, for Growing of Fodder Crops.
Intl. Dairy Cong. 3, p. 960, 961.
Dairy Sci. Absts. 15: 703.

A plant near Bombay has irrigated Para grass successfully with milk-plant wastes.

1953-17. KOZIOROWSKI, Bohdan.
Public Health Aspects of Sewage Farming.
Gaz, Woda i Technika Sanitarna 27: 100.
ABST: Sew. and Ind. Wastes 25: 1480.
PHE Abst. 34: S: 15.

Secondary treatment is recommended, but it is costly and it sacrifices fertilizer value (20% less than with primary effluent).

Spray with primary effluent on fields and forests may be justified if the produce is properly processed before consumption.

1953-18. MATHER, John R.
The Disposal of Industrial Effluent by Woods Irrigation.
Trans. Amer. Geophys. Union 34: 227-239.

Evaluates a year of hydrologic investigations of spraying to a depth of 400 to 600 inches. The process was economical, and no damage or annoyance resulted.

This is asserted to be the first successful use of woods irrigation (Seabrook, N. J.).

1953-19. MERCER, Walter A. and YORK, G. K.
Bacteriological Studies on Water--Re-Use Systems in Pea Canneries.
Canner 117: No. 6, p. 11-13; No. 8, p. 30-31, 43.
Chem. Abst. (1954) 48: 6044-6045.
ABST: Merz 12: 31.

Chlorination is recommended in pea canneries for fresh and for re-used water.

1953-20. MICK, Kerwin L., et al.
Progress Report of the Committee of the Sanitary Engineering Division on Sewerage and Sewage Treatment: Advances in Sewage Treatment in the Period from October 1, 1951 to September 1, 1952.
ASCE Proc. 79: Sept. No. 248, 38 p.

Re-use at Baltimore and Ventura are cited (p. 16).

A 139-entry bibliography is included.

1953-21. MILLER, Perry E.
Spray Irrigation at Morgan Packing Company.
Proc. 8th Ind. Waste Conf., Purdue, p. 284-287.
ABST: Merz 12: 46-47.

Compares results of spray irrigation of tomato packing wastes with previous river disposal. Lush Kentucky fescue grass pastures resulted.

1953-22. MONSON, Helmer.
Development of Vegetable Cannery Waste Disposal by Land Irrigation.
Proc. 8th Ind. Waste Conf., Purdue, p. 112-121.
ABST: Merz 12: 46.

Discusses experiences at twenty-seven Green Giant canneries in eight states and in Canada. Of these, seven use spray irrigation, and four use ditch- ditch- and furrow-irrigation. Costs are favorable.

1953-23. NORMAN, Noah N. and KABLER, Paul W.
Bacteriological Study of Irrigated Vegetables.
Sew. and Ind. Wastes 25: 605-609.
PHE Abst. 33: S: 55.

Reviews the literature (13 entries) and finds little real evidence of danger from sewage irrigation where reasonable precautions have been taken.

1953-24. PARTIN, John L.
Water Conservation--a By-Product of Industrial Waste Control.
Sew. and Ind. Wastes 25: 1050-1059.
ABST: Merz 12: 25.

Discusses the economics of the Los Angeles water supply: ground water, imported water, and effluent. Re-use saves in relieving over-loaded sewers.

Re-use figures are given for steel, soap, paper board, glass container, and auto battery plants.

1953-25. RAWN, A. M.
Waste Disposal in the Los Angeles Area.
Ind. and Engr. Chem. 45: 2677-2679.

Loș Angeles is in the enviable position of being able to re-use good effluent and to dispose of highly concentrated residue at sea.

Problems of various industries are discussed.

1953-26. RAWN, A. M.; BOWERMAN, F. R.; and STONE, Ralph.
Integrating Reclamation and Disposal of Waste Water.
AWWA Jnl. 45: 483-490.

Emphasizes that a reclamation plant must be free to reject unwanted sewage. Integration with a sewage plant, however, often improves performance.

The principles of land disposal of effluent have not been well understood.

Reclamation costs are paid by value of disposal plus value of reclaimed water; thus reclamation need not be limited to arid regions. Bethlehem Steel's plant in Baltimore is a good illustration of this.

The build-up of mineral content needs consideration.

Existing sewerage systems, carrying influent to near tide-water, may reduce or remove the economic advantage of reclaimed water.

Variable demand for agriculture makes recharge an often preferable use.

Each situation requires its own analysis and solution.

1953-27. SANBORN, N. H.
Disposal of Food Processing Wastes by Spray Irrigation.
Sew. and Ind. Wastes 25: 1034-1043.
PHE Abst. 33: S: 103.
ABST: Merz 12: 45.

Spray irrigation, as a means of disposal, has increased rapidly since its beginning in 1947 at Hanover, Pa.

Equipment and operation are discussed in detail, with cost data.

1953-28. SCHAAFSMA, J. H. A.
Purification and Utilization of Dairy Wastes by Overhead Irrigation of Meadows and Arable Land.
Landbouwkundig Tidj. 65: 203.
ABST: Sew. and Ind. Wastes 26: 926.
PHE Abst. 34: S: 70.
ABST: Merz 12: 46.

Since 1924, waste of potato flour has been sprayed on cultivated land with good results.

1953-29. SCHOEN, F. C.
Operating Experience with Waste Water Treatment Plants.
Iron Steel Engr. 30: 79-82.
ABST: Merz 12: 26.

Describes operations providing for recycling at three steel mills in Pennsylvania.

1953-30. SCHROPP, W.
Experiments Concerning the Influence of Dairy Waste Waters on the Development of Plants.
Int. Dairy Cong. 3: 966-969.
Dairy Sci. Abst. 15: 703.
ABST: Merz 12: 47.

Grasses, clover, and lucerne responded well to irrigation with dairy wastes. Sand performed better than loam.

1953-31. SHAFER, Ross A.
Ground Water and Used Water in Basin Recharge Areas.
Ind. and Engr. Chem. 45: 2666-2668.
ABST: Merz 12: 64.

"Return irrigation and waste water disposal in basin recharge areas are changing the character of receiving waters. Salinity and percentages of sodium have increased..."

Data are given reflecting a 15-year change in the Santa Ana River and in well water in the Santa Ana Basin.

1953-32. SIMPSON, R. W. and SAMSEL, J. J.
Paper Mill Waste Treatment.
Paper Industry 35: 551-553.
ABST: Merz 12: 28.

White water is re-usable in the showers of paper machines. Clarified effluent from de-inking is re-usable for wash water or de-inking make-up water.

Several diagrams are included.

1953-33. SKULTE, Bernard P.
Agricultural Values of Sewage.
Sew. and Ind. Wastes 25: 1297-1303.

Water re-use is becoming an economic necessity.

Recharge alone seldom is justified; irrigate also.

1953-34. SPARKS, J. T.
Sewage Irrigation in the Mitchell Lake Area, Texas.
Report to Texas State Department of Health.
Summary: Sew. and Ind. Wastes 25: 233-234.

Mitchell Lake is 12 miles S.W. of San Antonio (680 acres). It collects San Antonio's effluent, and is used for irrigation.

Data are given on four farms irrigating with effluent.

1953-35. STONE, Ralph.
Land Disposal of Sewage and Industrial Wastes.
Sew. and Ind. Wastes 25: 406-418.
PHE Abst. 33: S: 53.

"Aerobic environment is required for nuisance-free land disposal."

"The soil may be employed as part of, or in some cases, the whole treatment process."

Examples are cited and the variable factors are discussed.

Health hazards may be controlled by adequate supervision.

1953-36. VAUGHN, Reese H. and MARSH, George L.
Disposal of California Winery Wastes.
Ind. and Engr. Chem. 45: 2686-2688.

Two hundred gallons of brandy stillage is produced per ton of grapes in a highly-seasonal operation schedule. "Land disposal by intermittant irrigation is the best method of disposal at present."

The problem is not solved.

1953-37. VOTAVA, J.
The Purification of Waste Waters in Accumulator Ponds.
Listy Cukrovar. 69: 189-195.
Chem. Abst. 48: 6149.

Describes a method used to purify and re-use waste waters from beet sugar plants. Two Polish plants are described.

1953-38. ANONYMOUS.
Agricultural Use of Gas Liquor.
Gas Jnl. 276: 109.
ABST: Merz 12: 46.

Crude liquor from a gas works makes a satisfactory fertilizer on grasslands if applied after the grass is cut.

Dosages on experimental plots in England are cited.

1953-39. ANONYMOUS.
Cannery Waste Irrigation System.
Sew. and Ind. Wastes 25: 349-350.

Mt. Calvary, Wisc., disposes of food cannery wastes by sprinkler irrigation with plastic pipe. The system was installed in two hours by two men. It handles 4,300 gph.

1953-40. ANONYMOUS.
Public Works Digest--The Sewerage and Refuse Digest.
Pub. Wks. 84: 103-108.
PHE Abst. 34: S: 3-4.

ABST: "Irrigation of Food Processing water...by 1952, 42 plants were using spray irrigation." The usual application is three to four inches at 0.4 to 0.6 in./hr at intervals of about six days.

1954-1. BISHOP, Fred W. and WILSON, J. W.
Southland Paper Mills Waste Treatment and Disposal.
Sew. and Ind. Wastes 26: 1485-1490.
ABST: Merz 12: 28.

Irrigation is being studied at Southland's plant in Lufkin, Texas.

Because of an expensive water supply from deep wells, extensive re-use (2 mgd in cooling alone) is practiced.

Disposal of the final effluent by sprinkler irrigation is being tested on two 5-acre plots planted to lespedeza.

1954-2. BLACK, Hayse H.
The Future of Industrial Wastes Treatment.
Sew. and Ind. Wastes 26: 300-309.

The trend in waste handling is to more treatment at the source often with re-use. This may give improved process water, and reduce both water consumption and pollution.

Re-use is especially important when trace quantities of pollutants, which are of no concern in the process water, remain in the treated water.

Spray irrigation is gaining favor.

1954-3. BLACK, Hayse H. and McDERMOTT, Gerald N.
Industrial Waste Guide--Blast Furnace Department of the Steel Industry.
Sew. and Ind. Wastes 26: 976-990.
ABST: Merz 12: 26.

Remedial measures suggested include (a) plain sedimentation, (b) coagulation, (c) segregation and re-use.

1954-4. BUSH, A. F. and MULFORD, S. F.
Studies of Waste Water Reclamation and Utilization.
Calif. State Water Pollution Control Bd. Publ. No. 9, 82 p.
ABST: Sew. and Ind. Wastes 27: 119.
PHE Abst. 34: S: 99.

Reports on a survey of re-use of sewage effluent in California, with tables indicating the purpose served (106 places irrigation, 112 recharge, 1 industrial). Recycling through cooling towers is mentioned, but detailed figures are not given for this process.

Studies are reported on possible pollution travel when effluents are recharged to aquifers of various characteristics. Problems with mosquitoes and odors were noted.

Recommendations are:

1. Waste water should be considered a water resource.

2. More research on percolation through soils is needed.

3. Studies should continue to provide a better basis for predicting the quality of a recharged effluent at the instant that it reaches the water table.

4. Attempts must continue to find feasible means of salt removal (particularly sodium and boron) from waste waters.

Four pages of references and general bibliography are included.

1954-5. BUTLER, Robert G.; ORLOB, G. T.; and McGAUHEY, P. H.
Underground Movement of Bacterial and Chemical Pollutants.
AWWA Jnl. 46: 97-111.
ABST: Merz 12: 63-64.

Underground movement of bacterial and chemical pollutants was studied at the University of California as a background for reclamation by spreading for recharge.

Nineteen conclusions are itemized. These include the observations that bacterial pollution can be expected to vanish in about five feet of fine soil. Chemical pollutants travel farther and faster.

A 29-item bibliography is included.

1954-6. CALISE, Vincent J.
How to De-Oil Your Refinery Waste Waters for Economical Re-Use.
Power Engr. 58: June, p. 72-73.

Lists a six-step treatment, supplemented by diagrams and tables.

1954-7. DAVIDSON, C. H.
Parr Sewage Works, St. Helens.
Wat. Sanit. Engr. 5: 25-30, 32.
Water Poll. Abst. 28: 870.
ABST: Merz 12: 27.

The new activated sludge plant in Lancaster will employ its effluent for cooling water in a new power plant.

1954-8. DRUMMOND, R. M.
Pulp and Paper Waste Reduction by Mill Improvement.
Sew. and Ind. Wastes 26: 656-660.
ABST: Merz 12: 28.

"Large volumes of water are used in the paper mill, so the re-use of as much as possible is essential. This re-used water is normally called 'white water'."

Filtering is employed in the cycle.

1954-9. DWORSKY, L. B.
Industry's Concern in Pollution Abatement and Water Conservation Measures.
Pub. Health Rpts. 69, Jan.
ABST: Merz 12: 25.

From a general survey of the water resource situation, Dworsky concludes that reclamation and recirculation must be expanded.

Examples are cited.

1954-10. EATON, C. D.; EVANS, R. R.; and KOMINEK, E. G.
Reclamation of Refinery Effluents.
Ind. and Engr. Chem. 46: 319-324.
PHE Abst. 34: S: 42.

"The most probable use for treated refinery wastes is make-up to recirculated cooling water systems."

Re-use solves pollution and water shortage problems simultaneously.

Data are given and methods are discussed. Each plant is an individual problem. Economic justification may be borderline or worse.

1954-11. FABER, Harry A.
The Future of Waterborne Wastes.
Wtr. and Sew. Wks. 101: 466-470.

Cites examples of re-use for industry, agriculture, are recharge. Discusses recycling and the build-up of exotics.

1954-12. GREENBERG, Arnold E. and THOMAS, Jerome F.
Sewage Effluent Reclamation for Industrial and Agricultural Use.
Sew. and Ind. Wastes 26: 761-770.
PHE Abst. 34: S: 74-75.

Discussion of University of California's study of quality of recharged effluent. The conclusions in the California report are repeated here. Eleven references are cited.

1954-13. HAACK, Kurt.
A Hygienic Problem of Agricultural Utilization of Dairy Wastes.
Gesund.-Ing. 75: 226.
ABST: Sew. and Ind. Wastes 26: 1510.
PHE Abst. 36: S: 54.

Discusses tuberculosis transmission in cattle through spray irrigation.

1954-14. HATHAWAY, Gail A.
Water--A Critical Material.
Civil Engr. 24: 534-536.
PHE Abst. 34: W: 64.

"To meet the ever-increasing demand for water, more and more of our future water needs must be solved by recirculation, reclamation of used water, and better use of existing supplies."

1954-15. HENRY, C. D.; MOLDENHAUER, R. E.; ENGELBERT, L. E.; and TRUOG, E.
Sewage Effluent Disposal Through Crop Irrigation, with Discussion.
Sew. and Ind. Wastes 26: 123-135.
PHE Abst. 34: S: 52.
ABST: Merz 12: 47.

Irrigation is most useful in arid areas or by seasonal industries (canneries, etc.). Over-irrigation must be guarded against.

Reports field tests to establish practical limits. Forty inches were applied to Reed Canary grass without troubles developing.

Discussion by WEBSTER, R. A.:

Reports on 100-inch application by spray irrigation in New Jersey. Groundwater recharge resulted.

1954-16. HEUKELEKIAN, H., et al.
1953 Literature Review.
Sew. and Ind. Wastes 26: 573-615, 695-744.
PHE Abst. 34: S: 76.

Major interest in cannery waste disposal is in spray irrigation.

Spray irrigation may also be used for dairy wastes.

Stringent water supply is leading to re-use for irrigation and for recharge.

1954-17. HOPPE, T. C. and GASPER, W. L.
Plating Waste Treatment and Water Reclamation for the Maytag Company.
Proc. 9th Indust. Waste Conf., Purdue, p. 410.
Water Poll. Abst. 29: 962.
ABST: Merz 18: 36.

Chemical treatments for the various waste waters are described. As the treated effluent is softer than city water, as much effluent is re-used as is possible. Flow diagrams of the treatment plant are given.

1954-18. HUNT, Henry J.
Supplemental Irrigation with Treated Sewage.
Sew. and Ind. Wastes 26: 250-260.

Sketches the history of sewage irrigation from a British commission report in 1865 to date. Sewage farms using raw sewage were rather common in the late 19th Century. The first one in the U.S. was probably at Cheyenne, Wyoming, in 1883.

Supplemental irrigation would be beneficial at almost any U.S. vicinity part of the year. Statistics are given for several stations.

Questions of area requirements, best crops, etc., are discussed.

1954-19. IPPOLITO, G.
The Experimental Station of Foggia for the Purification and Utilization of Sewer Water.
Ingegneria Sanitaria 2: 153-166, 199-213.
PHE Abst. 35: S: 59, 61-62.

Properly treated effluent is used for irrigation in the vicinity of Foggia, Italy.

Good results have been obtained.

1954-20. JANERT, H.
The Suitability of Different Methods of Application for the Utilization of Sewage.
Wassweu-Wass. Tech. 4: 231.
Water Poll. Abst. 29: 1.
ABST: Merz 18: 36.

Advocates sub-irrigation on the bases of cost and of health safeguards.

1954-21. JOSEPH, James.
How Reclamation Reduces Steel Plant's Water Make-Up.
Wtr. and Sew. Wks. 101: 492-494.
PHE Abst. 35: W: 4.

Describes operation at Fontana Steel plant.

1954-22. KREY, W.
Agricultural Utilization--Including Application as Artificial Rain--of River Water and Sewage.
Disinfection 46: 82.
Water Poll. Abst. 29: 1.
ABST: Merz 18: 36.

Presents strong arguments against use of raw sewage, and emphasizes the necessity for strict supervision of agricultural use.

1954-23. KUHLEWIND, C.
The Necessity for Utilization of Sewage.
Kommunalwirtschaft, p. 376.
Water Poll. Abst. 29: 1934.
ABST: Merz 18: 36.

Discusses the fertilizing value of sewage.

1954-24. MATHER, John R.
The Disposal of Industrial Effluent by Woods Irrigation.
Proc. 8th Ind. Waste Conf., Purdue, p. 439-454.
Chem. Abst. 48: 9580.
PHE Abst. 34: S: 101.

Operations are described at a cannery which adds 400 to 600 inches of water with rotating sprays in eight months. The water table rises, but returns to normal in the four-month off-period. A three-year period of observation has revealed no damages.

1954-25. McCORMICK, E. B. and WETZEL, O. K., Jr.
Water Supply from Sewage Effluent.
Pet. Ref. 33: Nov., p. 165-167.
PHE Abst. 35: W: 20.

Describes Cosden's operation at Big Spring, and concludes that operating costs for treatment of the 1.5 mgd currently used are high, but not excessive.

The present effluent supply replaced an inadequate, chemically recalcitrant, ground water supply in July 1944. It is used for the production of steam, for make-up water in cooling towers, and for the gland cooling systems on engines and pumps.

Contract specifications and operating procedures are discuesed. Costs are tabulated.

1954-26. MILLER, Wallace B. and LUKAS, Vincent de P.
Water Conservation and Wastes Control at Electronics Park.
Sew. and Ind. Wastes 26: 1475-1484.
PHE Abst. 35: W: 14.
ABST: Merz 12: 26.

At the General Electric installation near Syracuse, N. Y., with an area of 200 acres, cooling water accounts for 40.3% of the total water use, process water for 32.5%.

Cooling water is recirculated with a resulting water saving of 95%.

Segregation of wastes is practiced.

1954-27. NICOLLE, N. P.
Humus Tank Performance, Microstraining and Sand Filtration.
So. Afr. Branch, Inst. of Sew. Purif., Aug. 1954.
Water Poll. Abst. 28: 2013.
ABST: Merz 15: 30.

The effluent from the Pretoria sewage works is to be used for the cooling water for the municipal power plant. Treatment procedures are under study.

1954-28. POMEROY, Richard.
Disposal of Waste Water From Oil Fields in the Coastal Counties of California.
Sew. and Ind. Wastes 26: 59-70.

Much water is now discharged to the ocean; some is used for repressuring.

Problems encountered include: oil content of the waste water, high BOD and sulfide production, lime incrustation, and corrosion.

1954-29. POWELL, Sheppard T.
Industrial Wastes. Sewage May be Re-Used for Miscellaneous Requirements to Augment Fresh Water Supplies.
Ind. and Engr. Chem. 49: July, 91A-92A.
PHE Abst. 34: S: 90-91.
Water Poll. Abst. 28: 1141.
ABST: Merz 15: 30.

By 1953 more than 150 communities practiced re-use. Thirty-five of these places were in Texas with thirty-three irrigating and two furnishing cooling water.

1954-30. REINEFELD, E.
Re-Utilization of Water in Beet Sugar Production.
Zucker 7: 262-270.
Water Poll. Abst. 28: 1368.
ABST: Merz 15: 30.

Recommends disinfection with chlorine and/or formalin before re-use of beet sugar diffusion water and pulp press water. The quality of the juice is said to be unaffected by re-use of the returned waters.

1954-31. SMITH, E. E.
Sewage Can Make a River More Attractive.
Amer. City 69: Apr., p. 90-91.
PHE Abst. 34: S: 54.

Lima, Ohio, is improving low flows by five dams and a 24-inch pipe carrying 8 mgd of effluent to the upper pool. This will create a green park in the midst of the city.

1954-32. STEEL, Ernest W. and BERG, E. J. M.
Effect of Sewage Irrigation Upon Soils.
Sew. and Ind. Wastes 26: 1325-1339.
PHE Abst. 35: S: 13.

Concludes that sewage irrigation is neither especially beneficial nor injurious to soils. It encourages the accumulation of chlorides and phosphorus. Pore space in increased and crumb structure shows some improvement.

1954-33. STOWELL, Edwin R.
Sewage Treatment in California State Institutions.
Sew. and Ind. Wastes 26: 1347-1354.

Hillside sprays in state parks have proven effective. Design considerations are given. Three parks are described.

1954-34. WAKEFIELD, J. W.
The Results of Research on Citrus Processing Waste Disposal.
Proc. Fla. Hort. Soc. 66: 246.
ABST: Sew. and Ind. Wastes 26: 1189-1190.
PHE Abst. 34: S: 97-98.
Water Poll. Abst. 28: 1389.
ABST: Merz 15: 31.

Spray irrigation was among the methods investigated. It is especially attractive for plants near cheap high land. A suitable cover crop resistant to acid is required.

1954-35. WANG, Wen-Lan Lou and DUNLOP, Stuart G.
Animal Parasites in Sewage and Irrigation Water.
Sew. and Ind. Wastes 26: 1020-1032.
PHE Abst. 34: S: 84.

Some parasites survive even activated sludge treatment. Only sand filtration seems fully safe.

The public health significance of the study is still indefinite.

1954-36. WOLLNER, Herbert J.; KUMIN, Victor M.; and KAHN, Peter A.
Clarification by Flotation and Re-Use of Laundry Waste Water.
Sew. and Ind. Wastes 26: 509-519.
PHE Abst. 34: S: 61.
ABST: Merz 12: 32.

Water use in laundries employing soap can be reduced 87 to 95%. The chemical processes for achieving this are described.

1954-37. ANONYMOUS.
Mill Waste Grows Cows and High Corn.
Pulp and Paper Indus. 28: No. 1, p. 36-38.
Bull. Inst. Pap. Chem. 24: 481.
ABST: Merz 12: 46.

Describes irrigation tests at Springhill, La., which have given good results.

1954-38. ANONYMOUS.
Some Factors in the Setting-Up and Working of Spraying Equipment for Dairy Waste Water.
Maelkeritidende 67: 708-710.
Dairy Science Abst. 16: 725.
PHE Abst. 34: S: 98.

Best results were obtained when the depth of water in seven months' spraying does not exceed 300 mm. Porous soils are the least suitable. Grass is the best crop.

1954-39. ANONYMOUS.
Spray Irrigation.
Tech. de l'Eau 8: 92: 23-28.
Water Poll. Abst. 28: 1490.
ABST: Merz 15: 31.

Advantages include: less waste of water, minimum land preparation, easier working conditions and larger effective land area because no furrows are used, may be used on sloping ground, usable on pervious soils, and lower maintenance costs.

1954-40. ANONYMOUS.
Wastewater: A Neglected Source of Supply.
Engr. News-Rec. 152: 29 Apr., p. 27.

In California about 700,000 ac-ft/yr are discharged to the Pacific; 350,000 ac-ft/yr are re-used.

Pollution of ground water must be prevented.

A California state report on recent studies is pending.

1954-41. ANONYMOUS.
Waste Water Deal.
Engr. News-Rec. 152: 29 Apr., p. 27.

"Shell Oil Company will get water for its plants in Ventura, California, free of charge for the next twenty years by building a plant to reclaim waste water from the city's sewage disposal plant." Two mgd are involved.

1955-1. AMBERG, Herman R.
Re-Use of Water in Pulp and Paper Mills.
TAPPI 38: Nov., p. 154A-155A.

Re-use may be dictated by water shortages or by the economics of treatment for pollution control. Re-use has serious limitations due to quality degradation. Much research will be required in the years ahead.

1955-2. BELL, James W.
Spray Irrigation for Poultry and Canning Wastes.
Pub. Wks. 86: Sept., p. 111-112.
PHE Abst. 36: S: 16.
ABST: Merz 18: 37.

Describes three plants in Arkansas. Screened wastes are applied at ten to sixty in./yr. Some monetary return is realized and the operation is satisfactory.

1955-3. BROWN, H. D.; HALE, Harold; and SHEETS, W. D.
Disposal of Cannery Wastes by Irrigation.
Food Packer 36: Aug., p. 28-30, Sept., p. 30, 32, 41.
PHE Abst. 35: S: 94-95; 36; S: 37.
ABST: Merz 15: 31: 18: 37.

Reports survey of existing facilities. Many specific figures are cited for furrow irrigation, flood irrigation, ditch irrigation, and sprinkler irrigation.

1955-4. CANHAM, Robert A.
Some Problems Encountered in Spray Irrigation of Canning Plant Waste.
Proc. Tenth Indust. Waste Conf., Purdue.
ABST: Merz 15: 31.

Discusses such factors as ground slope, type of soil, cover crops, and distribution systems.

1955-5. DUNSTAN, Gilbert H. and LUNSFORD, Jesse V.
Cannery Waste Disposal by Irrigation.
Sew. and Ind. Wastes 27: 827-834.
PHE Abst. 35: S: 103.
ABST: Merz 15: 31: 18: 37.

It is rarely economical for seasonal industries to use municipal disposal; frequently disposal by irrigation is the best solution.

Examples are cited. Woods have taken more than 1,200 in./yr. The paper reports on an experiment at Dayton, Washington.

Permanent pasture grasses appear to be preferable to alfalfa for cannery waste disposal by irrigation.

1955-6. ELKIN, Harold F.
Successful Initial Operation of Water Re-Use at Refinery.
Ind. Wastes 1: 75-76.
PHE Abst. 36: W: 20.

Describes modification of Sun Oil's Toledo refinery to permit re-use of large quantities of process water.

1955-7. ELKIN, Harold F.
Sun Oil's New Water--Re-Use System.
Oil and Gas Jnl. 54: 12 Dec., p. 88-89.

Rather than install an additional water intake line from a river, Sun Oil's plant at Toledo, Ohio, re-uses all suitable refinery waste water. This provides pollution control and unlimited fire-fighting water. The company has expressed complete satisfaction with four months' operating experience.

1955-8. FADGEN, T. J.
Operation of Ion Exchange Units for Treatment of Electroplating Wastes.
Sew. and Ind. Wastes 27: 206-208.
ABST: Merz 15: 30.

Water reclaimed by ion exchange is pumped directly into the steam condensate return lines for re-use in the powerhouse.

While costs and chemistry still require study ion exchange has a promising future in pollution abatement and water conservation.

1955-9. FRIES, W.
Agricultural Utilization of Sewage as Artificial Rain.
Der Volkswirt. 9: 19.
Water Poll. Abst. 29: 1350.
ABST: Merz 18: 36.

Describes and recommends spray irrigation on agricultural land. Hygienic risks should not be over-estimated.

1955-10. GEHM, Harry W.
Press Board Wastes Treated for Recovery and Re-Use.
Wastes Engr. 26: April.
PHE Abst. 35: 20.
ABST: Merz 15: 30.

Describes a treatment for removing suspended matter from press board wastes, thus allowing limited re-use of the effluent.

1955-11. GREENBERG, Arnold E. and McGAUHEY, P. H.
Chemical Changes in Sewage During Reclamation by Spreading.
Soil Sci. 79: 33-39.
PHE Abst. 35: S: 83.
ABST: Merz 15: 31.

Describes spreading at Lodi, Calif., thru four 19-feet diameter basins. Sampling pans were placed at depths of 1, 2, 4, 7, 10, and 13 feet in plots of Hanford fine sandy loam. The data obtained are tabulated.

Calcium, magnesium, and sodium remained practically constant. Ammonia was completely removed within four feet. Chlorides remained unchanged. Sulfates and bicarbonates increased roughly 30%. Nitrates increased several hundred percent. Nitrites and phosphates disappeared.

Explanations of the changes are proposed.

1955-12. HALDANE, W. P.
Extending the Drainage of Edinburgh.
The Surveyor 114: 427-428.
ABST: Merz 15: 30.

At Leith a factory utilizes crude sewage for cooling water in a steam power plant, then returns it to the main sewer.

1955-13. HARMSEN, H.
Hygiene of Land Treatment of Sewage.
Stadtehyg. 6: 253-259.
PHE Abst. 37: S: 16.
Water Poll. Abst. 29: 244.

Discusses risks and suggests precautions to be taken in the agricultural utilizations of sewage.

1955-14. HEUKELEKIAN, H., et al.
1954 Literature Review.
Sew. and Ind. Wastes 27: 515-571, 633-688.
PHE Abst. 35: S: 79, 104.

The points receiving major attention in this year's review were: reclamation of sewage (p. 551-2), and spray irrigation of cannery wastes (p. 633-4).

1955-15. HOAK, Richard D.
Greater Re-Use of Industrial Water Seen.
Chem. and Engr. News 33: 1278-1282.
PHE Abst. 35: W: 29-30.

A general background on necessity of re-use is presented.

Process descriptions and cost ranges are given for various desalinization methods. These costs are high.

Recharge with effluent is often effective.

1955-16. HOAK, Richard D.
Use and Conservation of Water Resources in Eastern States.
AWWA Jnl. 47: 858-864.

Recycling can accomplish large savings. It has drawbacks, however, in that "mineral salts and organic compounds tend to concentrate, biological growths may become troublesome, and corrosion may cause difficulty. These factors can be controlled..."

Rivers have long provided unconscious re-use.

1955-17. IMHOFF, Karl.
The Final Step in Sewage Treatment.
Sew. and Ind. Wastes 27: 332-335.
PHE Abst. 35: S: 24, S: 51.

Fertilizing salts and excess nitrate should be separated from sewage effluent. Spray irrigation is a method which will accomplish this.

1955-18. IPPOLITO, G.
Agricultural Utilization of Sewage.
Ingegneria Sanitaria 1: 15-20.
PHE Abst. 35: S: 77-78.
ABST: Merz 18: 36.

Broad irrigation on otherwise unproductive areas is recommended. Plain sedimentation should be employed.

1955-19. JACOBS, H. L.
A 1955 Survey: Waste Treatment Methods--Recovery and Disposal.
Chem. Engr. 62: Apr., p. 184-188.
PHE Abst. 35: S: 44.

Eleven methods of disposal are discussed including tree farming for cannery wastes.

Oil field repressuring is mentioned in passing.

1955-20. JENSEN, L. T.
Recent Developments in Waste Water Treatment by the Beet Sugar Industry.
Proc. 10th Indust. Waste Conf., Purdue.
ABST: Merz 15: 30.

Describes sugar manufacturing processes with details on the plant at Bayard, Nebr., where 4.3 cfs of waste water irrigate 160 acres of grassland.

1955-21. KEATING, R. J. and CALISE, Vincent J.
Treatment of Sewage Plant Effluent for Industrial Re-Use.
Sew. and Ind. Wastes 27: 773-782.
ABST: Merz 15: 30: 18: 35.

Cites Cosden at Big Spring. The paper is concerned largely with equipment design to provide proper quality water.

1955-22. KRUEZ, Councillor A.
Hygienic Evaluation of the Agricultural Utilization of Sewage.
Gesundheitsing 76: 206-211.
ABST: Merz 18: 36.

Considers practices in U.S., Britain, Russia, and Germany, and suggests the precautions which are appropriate in the use of effluent and sludge.

1955-23. LANE, L. C.
Disposal of Liquid and Solid Wastes by Means of Spray Irrigation in the Canning and Dairy Industries.
Proc. 10th Indust. Waste Conf., Purdue.
ABST: Merz 15: 30.

Spray irrigation is advocated as an answer to stream pollution and odor problems. It is effective in making waste land productive.

1955-24. LEE, David B.
Sewage and Industrial Wastes in 1954.
Wtr. and Sew. Wks. 102: 47-57.

Among trends mentioned is the use of spray irrigation for cannery, dairy, and slaughterhouse wastes. Spray irrigation of citrus wastes in Florida killed vegetation, including mature trees.

Re-use of effluent for irrigation or recharge continues to interest arid areas.

1955-25. LEWIS, C. J.
Closed System Use of Industrial Water.
Proc. 10th Indust. Waste Conf., Purdue.
ABST: Merz 15: 30.

Advocates closed cycle operations for industrial use of water. Cites Denver's water shortages and resulting regulations requiring re-use of water.

1955-26. McKEE, Frank J.
Spray Irrigation of Dairy Wastes.
Proc. 10th Indust. Waste Conf., Purdue.
ABST: Merz 15: 30-31.

Spray irrigation is effective and economical in disposing of dairy wastes.

1955-27. MERZ, Robert C.
A Survey of Direct Utilization of Waste Waters.
Calif. State Water Poll. Control Bd. Publn. No. 12, 80 p.
PHE Abst. 36: S: 85.

"Beyond all doubt, the challenge of the future will be the finding of new and improved methods leading to increased utilization of waste waters."

The report concerns itself with present practices in the use of effluent by agriculture, by industry, and for recreation. Descriptions of American installations and abstracts from the world press cover the problems and accomplishments to date.

(Abstracts from Merz' report are indicated in this bulletin as "ABST: Merz 12: X," where X indicates Merz' page number.)

1955-28. MICK, Kerwin L., et al.
Progress Report of the Committee of the Sanitary Engineering Division on Sewerage and Sewage Treatment: Advances in Sewage Treatment in the Period from September 1, 1952 to October 1, 1954.
ASCE Proc. 81: Sept., No. 594, 56 p.

This is a survey of the field including a 270-entry bibliography.

"The trend in food processing waste is toward disposal by irrigation."

1955-29. MULLER, Wilhelm.
Irrigation with Sewage in Australia.
Wasser und Boden 7: 12.
Water Poll. Abst. 29: 1108.
ABST: Merz 18: 36.

Only treated effluent may be used. The amounts used vary from 350 to 7,500 mm./yr. Pastures and orchards are irrigated.

1955-30. NICHOLS, Marvin C.
Industrial Use of Reclaimed Sewage Water at Amarillo.
AWWA Jnl. 47: 29-33.

Amarillo voted $720,000 in bonds in December 1951 to improve a sewage plant, located about ten miles north of Amarillo, built in 1928.

Limited use of effluent for irrigation, sand and gravel washing, and stock watering occurs along East Amarillo Creek, which flows to the Canadian River.

A 30-year contract with Texaco was signed in 1953. The contract provisions and cost estimates are given.

These costs are competitive with those of other water sources, and the supply is more dependable.

1955-31. NICHOLS, Marvin C.
Re-Use of Water by Industry.
Southwest Wtr. Wks. Jnl. 27: Sept., p. 77-82.
PHE Abst. 36: W: 13.

Reviews Amarillo-Texaco contract and operation.

1955-32. NOLTE, E.
Treatment and Disposal of Waste Waters from Beet Sugar Factories.
Ost. Wasserw. 7: 62-65.
PHE Abst. 36: S: 87.
Water Poll. Abst. 29: 30.

Describes methods for the re-use of condensate water, washing and fluming water, and battery and press water.

1955-33. PAULSMEIER, F.
Agricultural Utilization of Sewage as a Municipal Duty.
Kommunal. 8: 406.
Water Poll. Abst. 29: 1931.
ABST: Merz 18: 37.

Discusses the economics of agricultural re-use with special reference to practices at Hamburg.

1955-34. PAULSMEIER, F.
Experiences in the Agricultural Utilization of Sewage.
Disinfection 47: 118.
Water Poll. Abst. 29: 1109.
ABST: Merz 18: 36-37.

Praises the Berlin sewage farms and answers the arguments raised against agricultural utilization.

1955-35. PHIPPS, O. H.
Effluent Treatment in Beet Sugar Industry.
Chem. and Ind. 1955, p. 1242-1247.

Under the right conditions a re-use of about 90% of process water can be achieved. Strict control is necessary.

Results obtained in a typical British plant are discussed.

1955-36. PILLAI, S. C.
Investigations on Sewage Farming.
Indian Inst. Sci., Bangalore, 86 p.
PHE Abst. 38: S: 16.
Water Poll. Abst. 30: 241-242.

Summarizes practices on two Indian sewage farms.

1955-37. PORGES, Ralph and HOPKINS, Glen J.
Broad Field Disposal of Beet Sugar Wastes.
Sew. and Ind. Wastes 27: 1160-1170.
PHE Abst. 36: S: 10.

Beet sugar requires 2,500-3,500 gallons of water per ton of beets.

This report studies the disposal of waste water on grassland which appears to be an effective method of waste treatment.

1955-38. POSTHUMUS, A. S. and PIENAAR, P. J. J.
A Survey of Sewage Disposal Practice in Southern Africa.
Surveyor 114: 7-8.
PHE Abst. 35: S: 34.

Effluent is being wasted to the sea; much concern is expressed that it be re-used.

Industrial re-use in South Africa totals 11.5 mgd, mostly for cooling water.

Irrigation with effluent is quite widespread.

1955-39. RAPSON, W. S.
Purification of Mine Water.
Optima 5: 43-46 + plate.

Describes electrodialysis procedures being used to rectify brackish water pumped from the mines of the Orange Free State. About 80% is recovered as usable water. The other 20% is evaporated, with salt recovery yielding some financial return.

1955-40. REPLOH, H.
Land Treatment of Sewage.
Kommunal. 8: 410.
Water Poll. Abst. 29: 1932.
ABST: Merz 18: 37.

Discusses the advantages and problems of the agricultural use of sewage.

1955-41. SALOMON, M. S. S.
Cooling Towers and the Re-Use of Cooling Water.
Afr. Indust. Chem. 9: 169-174.
Water Poll. Abst. 29: 642.
ABST: Merz 18: 36.

Water-short areas, such as much of Africa, cannot afford once-through cooling water. Cooling towers provide the practical answer.

1955-42. SCHWARZ, K.
New Experiences in Agricultural Utilization of Sewage.
Wasserwirt. 46: 55.
Water Poll. Abst. 29: 1110.
ABST: Merz 18: 37.

Discusses spray irrigation on various soils, the calculation of proper auxiliary manuring, subsoil irrigation, economic problems, and the fatigue of fields overloaded with sewage.

1955-43. SESSLER, R. E.
Waste-Water Use in a Soap and Edible-Oil Plant.
Sew. and Ind. Wastes 27: 1178-1182.
PHE Abst. 36: W: 67.

Describes a Lever Brothers plant in Los Angeles County, California, where 8,000 gpm of cooling water are circulated through a cooling tower.

Sanitary water and contaminated industrial water are discharged to a sanitary sewer; oils and fats are removed from some water for recirculation. Flotation methods are used.

1955-44. SISSON, W. H.
Recharge Operations at Kalamazoo.
AWWA Jnl. 47: 914-922.
PHE Abst. 36: W: 15.
ABST: Merz 18: 38.

Upjohn's pharmaceutical plant re-uses water up to five times then recharges clean warm waste water by means of artificial ponds. The pond bottoms are approximately five feet above water table.

Proper waste treatment is essential.

1955-45. STANDER, G. J.
Conservation of Water by Re-Use in Industry.
Optima 5: 94-99 + Plates.
Water Poll. Abst. 29: 1224.
ABST: Merz 18: 35.

Re-use is encouraged in South Africa to conserve water and to minimize pollution.

By-product recovery may help finance waste treatment. With reduced water volumes for the same volume of wastes, treatment costs may be sharply reduced.

Methods and limitations are discussed.

1955-46. STONE, Ralph.
Irrigation with Waste Water.
Pub. Wks. 86: Nov., p. 97-98, 134-135.
PHE Abst. 36: S: 4.
ABST: Merz 18: 37.

ABST: "Not all sewage and industrial wastes in all climates can be safely disposed of by irrigation." Over-irrigation may create nuisance and health hazards.

Favorable aspects far outweigh the unfavorable.

1955-47. THACKWELL, H. L.
Sewage and Waste Treatment for Coal Mining Community; Sunnyside, Utah.
Wastes Engr. 26: 352.
Water Poll. Abst. 29: 359.
ABST: Merz 18: 37-38.

The article describes a new plant, from which the final effluent is used for irrigation.

1955-48. TREBLER, H. A. and HARDING, H. G.
Fundamentals of the Control and Treatment of Dairy Waste.
Sew. and Ind. Wastes 27: 1369-1387.
PHE Abst. 36: S: 48.

Spray irrigation is cited, with the usual references. A 34-entry bibliography is included.

1955-49. WATSON, Kenneth S.
Need for Water Management Program in Industry.
AWWA Jnl. 47: 973-981.
Water Poll. Abst. 29: 1223.
ABST: Merz 18: 35.

Suggests that recirculation and re-use be employed where economical. Describes the water conservation features of the General Electric plant at Syracuse, N. Y.

1955-50. WEILAND, K.
Development and Present Condition of Sewage Treatment and Utilization in Berlin.
Wasserw.-Wass. Tech. 5: 229.
Water Poll. Abst. 29: 1897.
ABST: Merz 18: 37.

Gives an historical sketch of the Berlin sewage farm, then generalizes on the problems and operations of such an establishment.

1955-51. WELLS, W. N.
San Antonio Sewage Treatment Plant.
Sthwest. Wtr. Wks. Jnl. 37: 37.
Water Poll. Abst. 29: 1336.
ABST: Merz 18: 37.

San Antonio's two plants are described in some detail. The effluent used for irrigation is first treated, then stored in Lake Mitchell, before being distributed for fodder crops and pasture.

1955-52. WIERZBICKI, Jan.
Agricultural Utilization of Sewage Waters.
Gospodor. planowa. 10: No. 8, p. 23-27.
Chem. Abst. 52: 15806.

Irrigation with sewage water increased the yield of hay by 300-400%, cereals by 20-50%, roots by 100%, and the protein content in hay from 6 to 17%.

1955-53. ZUNKER, F.
Fundamental Points on Agricultural Utilization of Sewage.
Wasserw.-Wass. Tech. 5: 258.
Water Poll. Abst. 29: 1933.
ABST: Merz 18: 37.

Discusses the requirements, advantages, problems, and economics of agricultural utilization of sewage.

1955-54. ANONYMOUS.
Putting Waste Water to Work.
Chem. and Engr. News 33: 4972.
PHE Abst. 36: S: 11-12.
ABST: Merz 18: 35.

Sun Oil at Toledo, Ohio, reports excellent results after four months of recirculation.

The process is described and sketched.

1955-55. ANONYMOUS.
Sewage Reclamation Studied at Calif. Tech.
Civil Engr. 25: 881.

Dr. McKee predicts that in twenty to thirty years, Southern California will require twice the available supply. Reclaimed water at $20-35 per acre-foot or demineralized sea water at $125-150 per acre-foot would seem to be the alternatives.

1956-1. ARBINGAST, S. A.
Some Economic Aspects of the Nationwide Water Problem.
Ind. Wastes 1: 223-226.
PHE Abst. 37: W: 19.

ABST: "Several water conservation methods such as re-use, evaporation control, use of ocean water or brines, vegetation control, and seepage control are discussed."

Plants at Big Spring, Odessa, Baltimore and Fontana are cited.

1956-2. BOCKO, J.
The Effect of Sprinkling Irrigation with Sewage on the Productivity of Meadows.
Zeszyty Nauk. Wyz. 1: 111-150.
Chem. Abst. 52: 15808.

The hay yield increased in proportion to the amount of sewage applied. The number of bacteria increased markedly.

1956-3. BROWN, H. D.; HALE, Harold; and SHEETS, W. D.
Cannery Wastes Disposal by Irrigation.
Ind. Wastes 1: 204-208.

Irrigation may be by furrow, ditch, flood, or spray. Sub-irrigation may also be possible. Cost data are cited.

In any case, avoid stagnant water.

Spray irrigation has the widest application.

1956-4. EICK, J. F.
Tannery Waste Disposal by Spray Irrigation.
Ind. Wastes 1: 271-272.
PHE Abst. 37: S: 83.

Fifteen acres of land absorb the total effluent load from a Pennsylvania tannery. The effluent is screened to prevent nozzle clogging. This method of disposal is used from May to November.

1956-5. ELIASSEN, Rolf and McKINNEY, Ross E.
Sewage and Industrial Wastes in 1955.
Wtr. and Sew. Wks. 103: 47-58.
PHE Abst. 36: S: 50.

Cites Laverty's study of a barrier to sea-water intrusion of an aquifer, McKee's economic analysis, and Keating and Calise's study of re-use at two petroleum refineries.

1956-6. ELKIN, Harold F.; MOHLER, Edward F., Jr.; and KUMNICK, L. R.
Biological Oxidation of Oil Refinery Wastes in Cooling Tower Systems.
Sew. and Ind. Wastes 28: 1475-1483.

"A new method of utilizing waste waters has been developed that does not require extensive pretreatment and achieves pollution reduction of the overall effluent."

Operation descriptions with typical measurements are given for the Sun Oil refinery in Toledo, Ohio.

The process is highly efficient and economical.

1956-7. GEHM, Harry W. and LARDIERI, N. J.
Waste Treatment in the Pulp, Paper and Paperboard Industries.
Sew. and Ind. Wastes 28: 287-295.
ABST: Merz 18: 36.

In 1951, 37% of all U.S. paper mills had waste treatment facilities; a survey in 1956 showed 55% of them with such equipment. Treatment methods are described.

Spray irrigation is used some, but not recommended generally because of large land requirements.

Research continues.

1956-8. GURNHAM, C. Fred.
Latest Developments in the Treatment of Dairy Wastes.
Ind. Wastes 1: 227-229.

"Spray irrigation is often less expensive than conventional treatment methods..."

1956-9. HERZIK, G. R., Jr.
Texas Approved Irrigation of Animal Crops with Sewage Plant Effluents.
Wastes Engr. 27: 418-420.
PHE Abst. 37: S: 52.

The Texas State Department of Health forbids use of effluent on produce grown for human consumption. For feeds and pasture crops it is encouraged with certain safeguards.

1956-10. HEUKELEKIAN, H., et al.
1955 Literature Review.
Sew. and Ind. Wastes 28: 595-636, 707-764.
PHE Abst. 36: S: 92.

Heavy stress is laid on spray irrigation with dairy wastes. Reclamation and industrial waste re-use are emphasized.

1956-11. HOPKINS, Glen J.; NEEL, Joe K.; and NELSON, F. L.
Evaluation of Broad Field Disposal of Sugar Beet Wastes.
Sew. and Ind. Wastes 28: 1466-1474.
PHE Abst. 37: S: 38.

Compares 1953 and 1955 studies at Bayard, Nebraska, after modifications in practice, indicated in 1953, had been made. Little change was made in land area, but many occurred in strengthening dikes, etc.

1956-12. JAFFE, Theodore.
Sewage Lagoons.
Wtr. and Sew. Wks. 103: 271-275.
ABST: Merz 18: 37.

The lagoon effluent at the University of Florida is used in the watering of plant and campus grounds. The nitrogen is of value in keeping the grass green.

1956-13. KEEFER, C. E.
Bethlehem Makes Steel With Sewage.
Wastes Engr. 27: 310-313.
PHE Abst. 37: S: 23.

Describes Baltimore's Back River plant of 1942. Costs are mentioned.

1956-14. LOVE, S. K., et al.
Symposium: Re-Use of Water by Industry.
Ind. and Engr. Chem. 48: 2145-2168.
ABST: Sew. and Ind. Wastes 29: 1409-1410.

The following seven papers were included:

I. Introduction. S. K. Love. In 1950 industry used 35% of the nation's water; by 1975 it will use 63% of a greater total. Re-use must be expanded.

II. Re-Use of Steam Condensate as Boiler Feedwater. D. E. Noll and H. M. Rivers. A very complete review.

III. Conservation of Water in the Pulp and Paper Industry. H. B. Brown. Emphasizes means of reducing water use.

IV. Recirculation of Cooling water in Petroleum Refining. A. J. Brandel. Description of a well-designed and operated plant.

V. Re-Use of Cooling Water in Atomic Energy Installations. A. L. Biladeau. Extreme purity is required.

VI. Biological Fouling in Recirculating Cooling Water Systems. J. J. Maguire. Chemical treatment is often required.

VII. Adaptation of Treated Sewage for Industrial Use. Sheppard T. Powell. ABST: "This procedure would appear to be an excellent answer to a growing water shortage and one which permits all parties to benefit."

1956-15. MATHEWS, C. Kelsey.
Effect of Air Conditioning on Distribution and Pumping Stations.
ASCE Proc. 82, SA 1, Paper 889, 7 p.

Unless non-conserved air conditioning is prohibited its peak-load characteristics may result in excessive investment in the water distribution system. Data are quoted for Kansas City, Mo.

Data is meagre; designs of air conditioners are changing.

Because of lower first cost, non-conserving systems will appear frequently unless prohibited.

1956-16. MERZ, Robert C.
Direct Utilization of Waste Waters.
Wtr. and Sew. Wks. 103: 417-423.
PHE Abst. 37: S: 1.

Reports on visits to projects. All may be classified into industrial use, agricultural use, recreational use, or ground water injection.

In industry; mining, metallurgical, and allied industries in the arid regions have pioneered. Re-use is often economical. One hundred fifty industries in 38 states reclaim industrial wastes; 15 in nine use sewage effluent. Many specific plants are cited.

Irrigation practices are discussed at some length, with many examples cited.

Reclamation: Golden Gate Park, Las Vegas hotel lawns, and many golf courses are cited.

Whittier Narrows and Azusa are mentioned.

1956-17. MERZ, Robert C.
Report on Continued Study of Waste Water Reclamation and Utilization.
Calif. State Water Poll. Control Bd. Publn. No. 15, 90 p.

Merz continued the studies reported in Publn. No. 12 (1955-27), and, in conjunction with other interested agencies, began intensive investigations on the reclamation of liquid digested sludge to enrich waste lands and to lessen pollution. He also makes a progress report on the obtaining of suitable economical irrigation water by treatment of raw sewage in lagoons.

Twenty-two abstracts and a short bibliography are included. (These abstracts are indicated in this bulletin as Merz 15: X, where X indicates Merz' page number.)

1956-18. ORLOB, G. T. and BUTLER, Robert G.
Use of Soil Lysimeters in Waste Water Reclamation Studies.
ASCE Proc. 82, SA 3, Paper 1002, 25 p.
REPRINTED: ASCE Trans. 123: 116-138.

Soil lysimeters are shown to be well suited for measurements of the penetration of effluent and its associated impurities in porous media. Behaviors of five typical agricultural soils are analysed.

Discussion by STONE, Ralph, V. 82, SA 6, Paper 1129, p. 5:

Due to perimeter effects, depth to water table, sunlight exposure, etc., lysimeters have scale effects which should not be ignored.

Closure, V. 83, SA 2, Paper 1227, p. 21:

Lysimeters are a very economical preliminary step. Use corrugated walls to minimize the perimeter effect.

1956-19. PETRIK, Miliroy.
The Agricultural Utilization of Effluent and Sludge.
Tech. de l'Eau: Nov. 1956, p. 29-39.

Reviews the literature citing typical legal requirements for quality of effluent used in irrigation.

In view of restrictions of a sanitary nature, irrigation finds its greatest value on forage in arid regions. Public ownership or close regulation is desirable.

Fifty-seven references are listed.

1956-20. PLENGER, Roger.
The Problem of Waste Water from Slag Furnaces.
Tech. de l'Eau: Aug. 1956, p. 43-44.

Polluted water from slag furnaces is often refused entry to streams.

Plenger describes a filtering arrangement which produces remarkably pure water which may be re-used. This is the usual practice in the majority of European steel plants.

1956-21. POWELL, Sheppard T.
Adaptation of Treated Sewage for Industrial Use.
Ind. and Engr. Chem. 48: 2168-71.
PHE Abst. 37: S: 37.

Re-use is recognized as a practical solution to many water problems. It has passed the experimental stage. There are problems, but in most cases these can be overcome.

1956-22. RAWN, A. M. and BOWERMAN, F. R.
Sewage--A Raw Water Supply.
Wtr. and Sew. Wks. 103: 463-467.
PHE Abst. 37: S: 42.
ABST: Merz 18: 40.

"Planned water reclamation plants do what nature has done for generations and cost less to build and operate than sewage treatment plants."

The functioning of Azusa and Pomona plants are described.

1956-23. RICE, William D., et al.
Forum: Prevention of Stream Pollution by the Treatment or Elimination of Wastes at Their Source.
Sew. and Ind. Wastes 28: 651-677.

RICE, Wm. D. (p. 654-7):

Describes water use in a paper plant as it has developed from 1,500 lb/day in 1864 to 500 tons/day now.

TREBLER, H. A. (p. 657-60):

By-product utilization and waste prevention are to be undertaken first. Disposal should then be to sewers or by spray irrigation.

Others:

Stressed water-conscious design and operation in a variety of industries.

1956-24. ROBERTS, A. L.
Waste Waters from the Production and Utilization of Fuels--Their Nature, Treatment and Disposal.
Fifth World Power Conf., V. 16, p. 5637-5656.

Reviews progress in re-use of water in Britain.

All new coal washeries are designed to operate on a closed circuit.

Ammoniacal liquor, a coke-making by-product, may be applied directly to the land as fertilizer. Cooling towers are becoming common to avoid disposing of warm water to rivers.

1956-25. SALZMAN, M. G.
Water Supply for Texas Steam Electric Stations.
ASCE Proc. 82: PO 4: Sept., 1044, 19 p.

Ninety-five percent of the water used in steam power plants is for cooling; this can be recycled.

Cooling ponds, cooling towers, and "extended circulation" are discussed in turn. Water supplies for several plants are described.

Re-use of effluent and demineralization of sea water are mentioned without elaboration in the conclusion.

1956-26. SCHLOMOV, V. N.; VORONOV, K. D.; and PEROV, V. N.
The Arrangement of a Closed Slime-Water System.
Koks i Khim. 1956, No. 4, p. 19-22.
Chem. Abst. 50: 16071.

Describes equipment for an economical closed circuit in coal washing.

1956-27. SKULTE, Bernard P.
Irrigation with Sewage Effluents.
Sew. and Ind. Wastes 28: 36-43.
PHE Abst. 36: S: 65.
ABST: Merz 15: 31: 18: 37.

Operation of the old-time sewage farms resulted in too much sewage being used on too little land.

Effluent may be used in any method of irrigation, but recent trends have been toward increased use of spray irrigation.

Primary treatment is often preferable since secondary treatment removes fertilizing values.

The emphasis of the article is on German practices.

Spray irrigation with dairy wastes is especially beneficial.

Study each plot and crop individually.

Many problems remain to be solved.

1956-28. TWICHELL, Trigg.
Investigations of the Hydrology of Small Watersheds in Texas.
ASCE Proc., V. 82, SA 4, Paper 1050, 18 p.

Cites needs to keep design-flow data current because of man's interference with natural flows. In particular, return of sewage effluent has increased dependable flows in some rivers.

Describes study underway on several watersheds from eight to 82 sq mi in area with some data.

1956-29. WELSCH, W. Fred.
Conservation of Ground Water.
Wtr. and Sew. Wks. 103: 468-473.
ABST: Merz 18: 37.

Regulations on Long Island require that all ground water pumped for refrigeration or air conditioning be returned to the aquifer in uncontaminated condition.

1956-30. ZILLMANN.
Organization of the Application of Sewage as Artificial Rain in Wolfsburg.
Stadtehyg. 7: 53.
Water Poll. Abst. 29: 1534.
ABST: Merz 18: 40.

Describes an agreement between the town of Wolfsburg and a farmer's co-operative to use sewage for irrigation.

1956-31. ANONYMOUS.
Dual-Purpose Towers...Purify While They Cool.
Chem. Engr. 63: July, p. 128, 130.
ABST: Merz 18: 36.

Describes towers at Sun Oil's Toledo refinery. By combining cooling towers with standard trickling filter action, the effluent, sent to the towers after gravity sedimentation only, returns treated. No adverse effects have appeared.

1956-32. ANONYMOUS.
Seek Economical Waste Treatment.
Milk Plant Monthly 45: Nov., p. 13-14, 32.

Reports several studies including one on spray irrigation by Rohlich and Englebert at the University of Wisconsin.

1957-1. ALLISON, S. L.
Is There a "Perfect" Trickling Filter Effluent? Corpus Christi Has Produced It and Now Sells It To Industry.
Wastes Engr. 28: 614-616.
PHE Abst. 38: S: 49.

The paper describes the processes in a refinery for which Corpus Christi's effluent is used.

1957-2. CANHAM, Robert A.
The Program of the National Canners Association on Waste Disposal.
Food Technology 12: 670-675.

Land disposal processes include impounding lagoons, absorption beds, ridge and furrow irrigation, and spray irrigation. Each method is discussed at some length. The first three have serious disadvantages in odor production and/or soil clogging.

1957-3. CANHAM, Robert A.
Spray Irrigation for Disposal and Crop Growth.
Ind. Wastes 2: 57-60.

"With proper operation the features of relative economy, complete elimination of stream pollution, and absence of odor make this system (spray irrigation) particularly attractive to canners."

He discusses land availability, application rates, cover crop, screening units, distribution systems, nozzles, and then outlines further studies desired.

1957-4. CONNELL, C. H.
Utilization of Waste Waters.
Ind. Wastes 2: 148-151. REPRINT: Ind. Wastes 3: D-32-D-34.
PHE Abst. 38: S: 50.

Forecasts that at least 50% of the total daily flow of municipal effluent in Texas will be effectively utilized by industry within 10 to 15 years.

Intra-plant water re-use has become standard practice.

Half the present industrial re-use in U.S. is in Texas, if Baltimore be excluded.

Big Spring: Cosden Refinery since 1944.
Amarillo: Texaco--more than two years.
Dallas: Power and Light.
Odessa: Butadiene.
Other plants are considering use of effluent.
USBR is studying Texas availability.

1957-5. DENECKE, K.
The Detection of Pathogenic Germs in Irrigation with Waste Water.
Arch. Hyg. 141: 624-631.
PHE Abst. 39: S: 54.

The sewage farms of Munster are inadequate due to overloading, poor design, and errors in irrigation procedure.

1957-6. GEHM, Harry W.
Modern Approaches to Pulp and Paper Mill Waste Problems.
Sew. and Ind. Wastes 29: 1370-1376.
PHE Abst. 38: S: 53.

Kraft pulp mill effluents and papermaking effluents have been used for irrigation sucessfully in arid regions. Economics is the only serious problem.

1957-7. GLOYNA, Earnest F.; HERMANN, E. R.; and DRYNAN, W. R.
Report on Water Re-Use in Texas.
U.S.D.I., Austin, Texas, 149 p.

For a 97-county area in Southeastern Texas, this report establishes the quantities and qualities of water available in 1956 and forecasts for a period extending to the year 2010. Cost estimates are included.

Elaborate statistical correlations applied to sixteen subdivisions of the area and to individual industries increase the value of the report.

A bibliography of 176 entries is included.

1957-8. GUYMON, Boyd E.
Sewage Salinity Prevents Use of Effluent for Golf Course Irrigation.
Wastes Engr. 28: 80-83.
PHE Abst. 37: S: 69.

Coronado, California, sewage was too salty for use on a golf course bordering San Diego Bay.

1957-9. HENRY, M., et al.
Symposium: The International Union of Pure and Applied Chemistry.
Recycling for Water Economy and Pollution Reduction.
ABST: Tech. de l'Eau 11: Nov., p. 33-36.

Industries discussed: sugar, paper, galvanoplasty, metal scraping, steel, and coal.

1957-10. HEUKELEKIAN, H.
Utilization of Sewage for Crop Irrigation in Israel.
Sew. and Ind. Wastes 29: 868-874.
PHE Abst. 38: S: 10-11.

Over-irrigation should be avoided. Arid conditions during the growing season favor disposal by irrigation.

Primary treatment is usually sufficient.

Salts have accumulated in areas irrigated with effluent.

1957-11. HEUKELEKIAN, H., et al.
1956 Literature Review.
Sew. and Ind. Wastes 29: 497-523, 613-653, 727-756.
PHE Abst. 37: S: 56, 98. 38: S: 12.

Spray irrigation of cannery wastes seems to be replacing the use of lagoons.

1957-12. KEHR, Dietrich.
The Sewage of Mexico City.
ABST: Tech. de l'Eau 11: Dec., p. 36.

The problems of land subsidence in Mexico City, due to ground-water pumping, could be eased by recharging with treated effluent.

1957-13. KRONE, R. B.; McGAUHEY, P. H.; and GOTAAS, Harold B.
Direct Recharge of Ground Water with Sewage Effluents.
ASCE Proc., V. 83, SA 4, Paper No. 1335, 25 p.

Reports on a three-year study of the technical feasibility and public health consequences of direct injection of effluent to an aquifer.

Bacteria were found to travel a maximum distance of 100 feet.

Discussion by STONE, Ralph, PASCE 83, SA 6, Paper 1466, p. 7-8:

Cites similar injections at Mattoon, Illinois, and Los Angeles.

1957-14. KUHLMANN, F.
Utilization of Dairy Wastes.
Fette, Seifen, Anstrichmitt. 59: 238-239.
Dairy Sci. Abst. 19: 907.
PHE Abst. 38: S: 47.

Discusses methods of storage of effluent prior to use for irrigation.

1957-15. LORKH, G. G.
Organization of Sewage Farms on the Basis of Moscow's Sewer Waters.
Gidrotekhn. i Melior 8: 8-11.
PHE Abst. 40: S: 8.

Land and pipe requirements are cited. Sewage farms are considered to be practical and economical.

1957-16. LUNSFORD, Jesse V.
Effect of Cannery Waste Removal on Stream Conditions.
Sew. and Ind. Wastes 29: 428-431.

Spray irrigation by the Green Giant cannery reduced the usual canning season load on the Touchet River, Wash. Typical measurements are cited.

The irrigation is raising 100 acres of asperagus.

1957-17. McGAUHEY, P. H.
The Why and How of Sewage Effluent Reclamation.
Wtr. and Sew. Wks. 104: 265-270.
PHE Abst. 37: S: 91.

Defines reclamation as the intentional preparation of water for re-use. The quantity of effluent in California is large, although it is not a large percentage of the total water needed.

Use in industry in local agriculture near the city producing the sewage, and for municipal re-supply is indicated. Direct re-use in homes requires too costly treatment; recharge and recreational use are common.

Reviews existing knowledge, listing 43 cities in six states (eight in Texas) with the nature of their re-use. Some cost comparisons are given.

Economic reclamation requires careful engineering study.

"There exists no undue legal obstacles to the reclamation and re-use of water from sewage; that reclamation is technically feasible;..." Reclamation will occur.

1957-18. McKEE, Frank J.
Dairy Waste Disposal by Spray Irrigation.
Sew. and Ind. Wastes 29: 157-164.
PHE Abst. 37: S: 94-95.

Stresses the economy of spray irrigation where sewers are unavailable. Describes typical installations. Cites needs in land area, slope, soil type, and vegetation. Discusses winter operation. Normally, no nuisance results.

1957-19. MEINCK, F.
The Problem of Toxic Industrial Effluents.
Tech. de l'Eau 11: Feb., p. 15-23.

Suggests re-use as a solution to the pollution problem, particularly for cooling water. Sugar, paper, and steel industries are cited.

Re-use limits discharge volumes and may assist in salvage of metals or other by-products.

Irrigation and injection are also suggested.

1957-20. MERZ, Robert C.
Third Report on the Study of Waste Water Reclamation and Utilization.
Calif. State Water Poll. Control Bd., Publn. No. 18, 102 p.

A third year of the studies reported in Publications No. 12 (1955-27) and 15 (1956-17) reaffirmed the earlier conviction that re-use is feasible and desirable.

The conclusions of the overall study may be summarized as:

1. Further research will overcome technical problems and reduce costs.

2. Farmers' co-operatives can handle irrigation with effluent successfully.

3. Golf course irrigation with effluent is feasible.

4. Recharge of effluent through injection wells is possible.

5. Raw or partially-treated sewage may be safely spread for recharge.

6. Sludge may be used for land reclamation.

7. Sewage lagoons in desert settings produce economical effluent suitable for irrigation.

8. Spray irrigation may involve health hazards within the range of mists of nondisinfected wastes.

The paper includes fifty-two abstracts. These are referred to in this report as "Merz 18: X."

<u>1957-21.</u> MERZ, Robert C.; MERREL, John C.; and STONE, Ralph.
Investigation of Primary Lagoon Treatment at Mohave, California.
Sew. and Ind. Wastes 29: 115-123.
PHE Abst. 37: S: 95.

A lagoon provides irrigation water for the Marine air base lawns. Eight years of operation indicate success, but such an installation must be operated with caution because of occasional odor nuisance.

Several tables of data are included.

<u>1957-22.</u> MORGAN, Paul E.
The Cost of Milk Waste Treatment.
Amer. Milk Rev. 19: June, p. 80, 82, 84, 86, 101-102.

Irrigation with milk-waste-treatment effluent has been successful in arid regions with deep-water tables. Spray irrigation should be approached with caution.

<u>1957-23.</u> MULLER, G.
Infection of Vegetables by Application of Domestic Sewage as Artificial Rain.
Stadtehyg. 8: 30-32.
PHE Abst. 38: S: 40.
Water Poll. Abst. 30: 385.

PHE Abst: "Salmonella were detected in the soil and on potato tubers after 40 days, on carrots after ten days, and on cabbage and gooseberries after five days.

1957-24. O'CONNELL, William J., Jr.
California Fruit and Vegetable Cannery Waste Disposal Practices.
Sew. and Ind. Wastes 29: 268-280.
PHE Abst. 37: S: 96-97.

Cautions on the re-use of effluent.

Nearly all California canneries discharge to municipal sewers.

1957-25. PIRK, G. W.
Water Conservation and Reclamation System for a Copper Wire Mill.
Sew. and Ind. Wastes 29: 805-809.
PHE Abst. 38: W: 7.

The Rome Cable mill, Rome, N. Y., uses city water. Planned re-use cut the water consumption from 1.2 mgd. Now 1,700 gpm of recirculated water replaces the former 1,300 gpm of city water. The change in water program led to the recovery of about 100,000 pounds of copper annually.

1957-26. RAWN, A. M. and BOWERMAN, F. R.
Planned Water Reclamation.
Sew. and Ind. Wastes 29: 1134-1138.
PHE Abst. 38: S: 48.

Considers advantages of re-use in Los Angeles County.

Ocean disposal is a mixed blessing. It solves brine and other mineral problems which could contaminate ground water; this is an economic advantage to many industries. On the other hand, it encourages waste of much good effluent.

Water reclamation works with recharge of the effluent are recommended.

Economics dictates that re-use begin now.

1957-27. REPLOH, H. and HANDLOSER, M.
Investigations on the Spread of Bacteria Caused by Irrigation with Waste Water.
Arch. Hyg. 141: 632-644.
PHE Abst. 39: S: 54.

Wind-carried spray may reach well beyond the proper zone of action. Hedges for interception are proposed.

1957-28. RHODES, R. S., et al [Orsanco Committee].
Site Selection for Chemical Industry Plants.
Ind. Wastes 2: 24-27.

"The re-use of waste streams, more than any one single factor, short of treatment, can be especially instrumental in reducing industrial effluents."

1957-29. SEABROOK, Belford L.
This Woodland Spray System Disposes Billion Gallons of Waste Water Annually.
Food Engr. 29: Nov., p. 112-114, 117, 118.

Benefits of spray irrigation at Seabrook Farms, N. J., are:

1. Enormous quantities of water are purified quickly as they percolate,

2. Underground run-off supplies clear water to streams,

3. Heavily-pumped aquifers are recharged, and

4. Crop-land spray irrigation may be included.

Spray irrigation is successful with organic wastes; it may not be with inorganic matter present.

1957-30. THEROUX, Robert J.
Enlarged Sewage Disposal Facilities for Los Angeles.
Sew. and Ind. Wastes 29: 124-133.
PHE Abst. 37: S: 95-96.

Provision is being made for restricting saline sewage flow to keep it out of the reclamation plant.

At present, water is purchased for injection for creating a salt-water barrier. It is hoped that Hyperion effluent can be substituted for this duty.

Flexibility is stressed in the system design.

1957-31. THOMAS, H. E.
Water Control and Use.
Ind. Wastes 2: 123-126, 154-158.
PHE Abst. 38: W: 22.

Reviews legal doctrines of water rights, including those to used water.

Doctrines vary, and changes may be expected.

1957-32. TKACHENKO, N. I.; TSAUKOVA, A. V.; and IVANOVA, Z. T.
Waste Water in Plants Processing Cottonseed Hulls.
Gidroliz. i Lesokhim. Prom. 10: No. 5, p. 11-13.
Chem. Abst. 51: 18406-07.
PHE Abst. 38: S: 42.

Waste waters from the processing of cotton hulls can be utilized for watering such crops as corn and winter wheat.

1957-33. VAN DER GOOT, H. A.
Water Reclamation Experiments at Hyperion.
Sew. and Ind. Wastes 29: 1139-1144.
PHE Abst. 38: W: 16.

Reports on the progress of water reclamation experiments. At present Los Angeles County's ocean discharge is 485,000 ac-ft/yr.

Each site for recharge presents its individual problems. Whittier, Azusa, and Hyperion are described.

Cost questions remain.

1957-34. VAN KLEECK, Leroy W.
Methods and Results of Operating Intermediate and Secondary Plants.
Wastes Engr. 28: 398-400.
PHE Abst. 38: S: 20.

Land irrigation is among five methods discussed. It is used "where sanitary, aesthetic, and economic considerations are favorable." California and other southwestern states qualify.

Rates of 5,000 gallons per acre per day are practical. Ponding should be avoided.

1957-35. WIERZBICKI, Jan.
Augmenting Water Supply Sources Through Agricultural Utilization of Municipal Sewage.
Gaz, Woda i Technika Sanitarna 31: 17.
ABST: Sew. and Ind. Wastes 29: 1096.

Bielefeld, Poland, is augmenting its ground water through spreading municipal sewage effluent. Six hundred twenty hectares have benefited in having meadow, pasture, and plowed land replacing formerly not-utilizable land.

1957-36. WRIGHT, R. L.
Treatment of Petrochemical Wastes at Port Lavaca, Texas.
Sew. and Ind. Wastes 29: 1033-1037.
PHE Abst. 38: S: 23-24.

Used cooling water may be returned to an irrigation canal for rice farming. Studies are underway to revise the installation to permit re-use of this cooling water in the refinery itself.

1957-37. ANONYMOUS.
Effluent Re-Use.
Sew. and Ind. Wastes 29: 725-726.

Describes re-use at Chanute, Kansas (see 1958-16).

1957-38. ANONYMOUS.
Improved Sewage By-Product Reclamation.
Fluid Handl. No. 88: 150.
PHE Abst. 38: S: 53.
Water Poll. Abst. 30: 422.

Effluent may be used in fish ponds where it promotes the growth of algae and protozoa on which fish feed, for irrigation, or for industry.

1957-39. ANONYMOUS.
L. A. Looks Further Into Well Recharge.
Engr. News-Record 158: 2, May, p. 24.

Study is underway to determine the feasibility of using Hyperion treatment-plant effluent to maintain a salt-water barrier in Los Angeles. Tertiary treatment would be required to avoid plugging of the wells.

1957-40. ANONYMOUS.
Percolation and Runoff.
AWWA Jnl. 49: Jan., P&R, p. 35.

Reports on Chanute, Kansas' recirculation of the effluent of its new $400,000 sewage treatment plant. "Purer than normal river water," said the State Board of Health.

1957-41. ANONYMOUS.
A Rational Utilization of Water is a Source of Considerable Economy in Industry.
Tech. de l'Eau 11: Nov., p. 28.

Summarizes Bull. A.F.F.E. No. 60. Recirculation of rinse water, perhaps with treatment, and separation of residual waters is advocated.

1958-1. BAFFA, John J., et al.
Developments in Artificial Ground Water Recharge.
AWWA Jnl. 50: 865-871.

Reports on a questionnaire survey in 1957.

"Treated sewage or waste effluents are not used in any state for the specific purpose of recharge." The Lodi and Hyperion experiments are cited.

1958-2. BERG, E. J. M.
Considerations in Promoting the Sale of Sewage Treatment Plant Effluent.
Sew. and Ind. Wastes 30: 96-98.

Data exist in the literature on the volume of water needed per ton of coal, ton of steel, etc. The water quality required and the cost must be considered.

The cost of additional treatment to meet requirements should be carefully determined before contracting to deliver effluent.

1958-3. BIERNATH, D.
New Viewpoints on the Treatment of Land with Dairy Effluents.
Fette, Seifen, Anstrichmitt. 60: 317-318.
Dairy Sci. Abst. 20: 922-923.

Discusses spray irrigation and pumping equipment.

1958-4. CANHAM, Robert A.
Comminuted Solids Inclusion with Spray Irrigated Canning Wastes.
Sew. and Ind. Wastes 30: 1028-1049.
PHE Abst. 39: S: 57.

Conclusions (for a pea canning operation):

1. Inclusion of comminuted solids in spray irrigation is feasible if certain mechanical problems can be overcome.

2. Costs are favorable.

3. Fertilizing values are substantial, and no nuisance resulted from the tests conducted.

4. Better machinery will be required.

5. Field pumping must be carefully controlled.

6. Each project must be given individual study.

1958-5. CORNUAT, Ed. and DECARREAUX, J.
Examples of Closed-Circuit Water Use.
L'Eau 45: 279-291.
PHE Abst. 39: W: 47.

The authors describe the plants of Sidelor-Micheville and Mont-Saint-Martin, respectively. Cost data are included.

Ninety-four percent of the water is recycled.

1958-6. CRAWFORD, Stuart S.
Spray Irrigation of Certain Sulfate Pulp Mill Wastes.
Sew. and Ind. Wastes 30: 1266-1272.
PHE Abst. 39: S: 41.

Describes installation at Franklin, Virginia, for a mill producing 400-600 tons of kraft pulp per day.

Crops grown included corn, peanuts, soybeans, tomatoes, sweet corn, and melons. Quantity and cost figures are given.

The results were highly satisfactory.

1958-7. DYE, E. O.
Crop Irrigation with Sewage Effluent.
Sew. and Ind. Wastes 30: 825-828.
PHE Abst. 38: S: 99.

Sewage effluent tends to offset the exhaustion of organic matter in the soil. Plants thrive on it. The hazards are slight.

1958-8. EDWARDS, Gail P., et al.
Report, ASCE Committee: Advances in Secondary Processes of Sewage Treatment in the Period Oct. 1, 1954 to June 1, 1957.
ASCE Proc. 84: SA 2, Paper 1612, 16 p.
PHE Abst. 38: S: 94-95.

"Spray irrigation is among the new methods of secondary treatment growing in application."

Re-use is receiving increasing attention. The Hyperion salt-water barrier is cited in particular.

Sixty-six references are included.

1958-9. HEUKELEKIAN, H., et al.
1957 Literature Review.
Sew. and Ind. Wastes 30: 601-633, 717-756, 839-873.
PHE Abst. 38: S: 85.

Re-use in industry, as contrasted to irrigation, is receiving increased attention. Municipal re-use at Chanute is particularly cited.

Spray irrigation continues to merit attention.

1958-10. INGOLS, Robert S.
Treating Food Processing Wastes.
Ind. Wastes 3: 95-98.

Discusses conditions requisite to success with furrow- or spray-irrigation using effluent. A review of the literature is included.

Irrigation should be avoided in disposing of citrus wastes.

1958-11. JOHNSON, William E.
Not a Drop Wasted.
Amer. City 73, Feb., p. 111-112.

Ephrata, Washington, sells its effluent to be used in the irrigation of 80 acres. Hay and corn are the principal crops grown.

1958-12. LAVERTY, Finley B.
Recharging Ground Water with Reclaimed Sewage Effluent.
Civil Engr. 28: 585-587.
PHE Abst. 39: S: 11.

The history of re-use for ground-water recharge in Los Angeles is reviewed.

Sea-water intrusion is discussed, and its control by the recharge of effluent is suggested.

Studies made on the feasibility of recharge by spreading of secondary effluent are described.

1958-13. MAGNUSSON, F.
Disposal of Dairy Waste Waters by Surface Irrigation.
Svenska Mejeritidn. 50: 261-267.
Dairy Sci. Abst. 20: 648.

ABST: "The author presents a comprehensive discussion and review of the literature on the disposal of dairy waste waters by surface irrigation."

1958-14. McDOWALL, F. H.
Dairy Wastes: Disposal by Spray Irrigation on Pasture Land.
Dairy Engr. 75: 251-254, 266.
Dairy Sci. Abst. 20: 923.
PHE Abst. 39: S: 36.

New Zealand has had many years experience with spray irrigation of dairy wastes. The technique of successful operation is discussed. A typical example is described.

1958-15. MERZ, Robert C.
Water Reclamation and Refuse Disposal.
Wtr. and Sew. Wks. 105: 306-307.

This paper abstracts five speeches delivered at a meeting in Stockton, Calif.:

W. C. Henderson:

Reported on a 2,250-acre tract in Orange County, Calif., being irrigated with settled sewage. The resulting recharge is halting sea water intrusion in a well field. The odors are objectionable.

W. G. Curry:

Reported that San Bernardino is now selling its effluent too cheaply, but plans changes in the price schedule when the present contract expires in 1965.

Benn Martin:

Added new figures on Golden Gate Park; it now uses 3/4 mgd for irrigation alone. Plans exist to increase the total to five mgd.

Edward O. Sampson:

Reported that Oceanside is constructing a plant which will produce 18,000 ac-ft/yr for industry and agriculture.

John C. Merrell:

Reported on re-use in the desert areas of Calif. It will increase.

1958-16. METZLER, Dwight F., et al., with Discussion.
Emergency Use of Reclaimed Water for Potable Supply at Chanute, Kansas.
AWWA Jnl. 50: 1021-1060.
PHE Abst. 39: W: 9.

Chanute's secondary treatment plant, completed in 1953, produced better water than that normally found at the city's water intake. Only a minor earth dam below the outfall was necessary to divert water to the intake.

The theoretical time per cycle was twenty days. Recirculation continued from 14 Oct. '56 to 14 Mar. '57. Highly increased chlorination was the principal change in standard operating procedure.

The water "had a pale yellow color and an unpleasant musty taste and odor... Even after double distillation it could not be used for making standard solutions or mixing reagents because of carry-over."

Water quality studies are tabulated in detail.

"Thus, the tap water, as judged by standard tests, was of satisfactory bacteriological quality during the entire time that water was being re-used."

Discussion by CONNELL, C. H.:

Suggests that experimenters in municipal re-use try summer next.

1958-17. PETER, Yehuda.
Sewage Effluent into Sand Dunes.
Wtr. and Sew. Wks. 105: 493.

Israel has pumped primary effluent for two years to grow cattle fodder and raise the water table. Sprinklers are employed. The shifting dunes have become stabilized.

1958-18. PROCHAL, P.
Agricultural Utilization of Sewage of the Town Zory.
Zesz. Nauk. Wyzsej. No. 5, p. 165-183.
Chem. Abst. 53: 8483.

ABST: "Used as fertilizer sewage should increase crops from meadows five times, field crops twice, and the yield of fish ponds four times."

1958-19. RIENOW, Robert and RIENOW, Leona.
The Day the Taps Run Dry.
Harpers 217: Oct., p. 72, 75-78.

This is a popularized survey of the U.S. water budget.

It cites the Amarillo refinery and exhorts other industries to do likewise.

1958-20. RISBRIDGER, C. A.
Presidential Address, Institution of Water Engineers.
IWE Jnl. 12: 237-246.
REPRINT: Wtr. and Wtr. Engr. 62: 247-250.

Industrial re-use will increase in response to economic pressures; legislation to require it is unnecessary.

1958-21. STONE, Ralph and MERRELL, John C.
Significance of Minerals in Waste Water.
Sew. and Ind. Wastes 30: 928-936.

Mineral contents, by type, are tabulated for about twenty localities and the increase in mineralization of the effluent is discussed. Seepage into sewers, some industrial wastes, and concentration due to water evaporation in cooling towers are largely responsible.

Several examples of water re-use are cited.

Demineralization by using elecrolytic membranes or zeolites should be far less costly than salt-water reclamation.

1958-22. STREATFIELD, E. L.
Some Recent Developments in the Economic Utilization and Purification of Water.
Chem. and Industry 1958, p. 841-846.
PHE Abst. 39: W: 30.

"Industry is faced with an ever-increasing demand for water and a diminishing supply." Suggested remedies include water import, water re-use, and recirculation. Effluent treatment is required in the second and third methods.

The steel, electroplating, and sugar refining industries have led in recirculation. Each is discussed briefly.

1958-23. SULLIVAN, Thomas F.
Sewage Effluent Used for Industrial Water.
ASCE Proc. 84, SA 3: Paper 1679, 15 p.

"The Odessa, Texas, Butadiene plant will require three or more mgd to meet the requirements of the cooling tower and the boiler make-up system. The only dependable source of water able to satisfy that demand is the Odessa sewage effluent."

Studies were made on well water, and sewage effluent for chemical content and, thus, for the treatment required.

1958-24. WATSON, Kenneth S.
Sewage and Industrial Wastes in 1957.
Wtr. and Sew. Wks. 105: 45-60.
PHE Abst. 38: S: 68.

Increased water requirements have stimulated re-use. California and Texas lead.

1958-25. ZAGRODZKI, Stan and WALERIANCZYK, E.
Mechanical Purification of Diffusion and Press Waters Prior to Recirculation Through a Diffuser.
Roczniki Technol. i Chem. Zywn. 3: 51-76.
Chem. Abst. 53: 20635.

Filter nests and a settling tank give satisfactory results.

1958-26. ANONYMOUS.
Clarification Permits Re-Use of Laundry Waste Water Thirteen Times.
Waste Engr. 29: 150-151, 162-163.
PHE Abst. 39: S: 56.

Reports tests by the U.S. Navy in which 86% of the grease from laundry waste water was removed by means of alum flocculation at 140°F with air flotation.

1958-27. ANONYMOUS.
Editorial: Conserving Our Water Resources--II.
Wtr. and Sew. Wks. 105: 310.

Methods:

1. Reduce runoff and evaporation.

2. Transmit water supply over greater distances.

3. Utilize supplies more efficiently. Recycle. Use effluent and cooling towers.

4. Reduce pollution.

5. Treated waste reclamation. Recharge ground water.

6. Salt water conversion.

"Within fifty years, all of these methods will be in rather wide use. Some, like the conversion of salt water, will become less costly per unit, but all water will be more costly in the future. Perhaps the price paid for it will be nearer its true worth."

1958-28. ANONYMOUS.
Waste-Water Re-Use Predictions.
Sew. and Ind. Wastes 30: 645.

Summarizes results of two-year study of potential re-use in East Texas.

Data are given by industry (ten classes) for 1954, 1975, 2010.

1959-1. AITKIN, I. M. E.; STREATFIELD, E. L.; and WHITE, H. C.
Water Recirculation in Steelworks.
Instn. of Water Engrs. Jnl. 13: 253-303 + plates.
ABRIDGED VERSION: Wtr. and Wtr. Engr. 63: 103-116.

Editor's note (W&WE): [This] "is the first major contribution on the important subject of the re-use of water in industry."

Even in England, water must be conserved.

"In steelworks, continuous reconditioning of the water is usually necessary."

Basic design is developed in considerable detail. The Park Gate 11-inch continuous bar mill is described as an effective example.

1959-2. BESSELIEVRE, E. B.
Industries Recover Valuable Water and By-Products from Their Wastes.
Wastes Engr. 30: 734-735, 760.
PHE Abst. 40: S: 58.

Industry is cooperating in pollution control.

1959-3. BLOSSER, R. O.
Land Disposal and Irrigation by the Pulp and Paper Industries.
ABST: Ind. Wastes 4: July, p. 37A-38A.

The land requirement for irrigation is about 1 to 1.5 acres per ton of daily pulp capacity.

Woodland irrigation deserves further study, as does the possibility of ground-water contamination. The geology should receive careful attention.

Local agricultural experiment stations may be of help in determining the requirements at a given site.

1959-4. BOOKMAN, Max.
Waste Water Role in Meeting Water Requirements.
ASCE Proc. 85, SA 6, p. 111-125.
PHE Abst. 40: S: 56.

The paper is concerned with an evaluation of waste-water use in Southern California for industry, agriculture, recreation, and ground-water recharge. Economics are considered. The water reclamation plant concept is discussed.

Ground-water recharge is regarded as the "best" use.

The conclusions are summarized (eight items).

1959-5. CANHAM, Robert A.
Industrial Waste Disposal by Spray Irrigation.
Southwest Wtr. Wks. Jnl. 41: Dec., p. 14-16, 18, 20, 22.
PHE Abst. 40: S: 89-90.

Spray irrigation affords complete treatment, minimizes odors, compares favorably in cost, and does not require highly trained personnel.

Effluent should be screened; land characteristics and cover crop affect the results obtained.

1959-6. CONNELL, C. H. and BERG, E. J. M.
Industrial Utilization of Municipal Waste Water.
Sew. and Ind. Wastes 31: 212-220.
PHE Abst. 39: S: 76.

The present use is 1%; the possible potential use is 25%.

Nineteen plants, including Amarillo, Big Spring, Odessa, and three in New Mexico, are listed.

No adverse health effects have been observed.

1959-7. ETTINGER, M. B.
Definitive Characterization of Industrial Wastes.
Sew. and Ind. Wastes 31: 846-849.

The desirability of re-use is a question of economics.

"Industry is doing a progressively better job of locating where there is a better supply of water in terms of quantity and presently expendable quality, and the unused water resource is disappearing." "...the attractiveness of re-use...will grow..."

1959-8. GLOYNA, Earnest F.; DRYNAN, W. R.; and HERMANN, E. R.
Water Re-Use in Texas.
AWWA Jnl. 51: 768-780.

"...the utilization of usable waste waters is indeed a feasible and necessary part of the overall water economy."

A forecast of water requirements, including re-use, in 97 counties of Texas is reported (Southeast Texas). Elaborate analysis of statistics on water, sewage, population, and industry in sixteen subareas permitted the derivation of equations from which future estimates have been extrapolated.

"In the next 20-30 years, it should be apparent that the most reliable and predictable source of used water will be domestic sewage... Reclamation of waste water, particularly domestic waste water, must have a place in future plans regardless of current public opinion towards drinking used water."

1959-9. GURNHAM, C. Fred.
Liquid Industrial Wastes--III.
Ind. Wastes 4: 48-52.

"The most obvious opportunity for salvage, frequently overlooked, is the re-use of water itself within the plant." It permits better utilization of waste-treatment equipment because of the smaller volume handled.

One should consider also possible down-grade utilization.

Examples of uses are cited for the paper, coal, metal plating, and food-processing industries.

1959-10. HEUKELEKIAN, H., et al.
1958 Literature Review.
Sew. and Ind. Wastes 31: 501-541, 615-661, 763-803.
PHE Abst. 40: S: 2, 18, 22.

Sewage re-use and spray irrigation continue to draw attention.

1959-11. HODGKINSON, Carl F.
Oil Refinery Waste Treatment in Kansas.
Sew. and Ind. Wastes 31: 1304-1308.

Recycling is becoming increasingly common.

1959-12. HOTTLET, L.
Recycling of Industrial Water.
Tech. de l'Eau 13: Feb., p. 23-25.

A water balance to compensate for evaporation is discussed. Chemical processes which would retard evaporation are considered.

1959-13. HUSMANN, W.
The Current Status of Industrial Waste Treatment in Germany.
Tech. de l'Eau 13: Oct., p. 24.

German industry uses six billion cu m/yr with resulting effluents of 2.5 to 3 billion.

Re-use and the salvage of by-products are well advanced, particularly in sugar, steel, and mining. Chemical and biological methods are used.

1959-14. KINT, E.; WAUTERS, L.; and VAN ACHTER, R.
The Purification and Re-Use of Waters of Flax Retting.
Centre Belge d'Etude, Bull. No. 107: 286-292.
PHE Abst. 40: W: 50.

The equipment used is described and the flow pattern is diagrammed.

1959-15. KOCH, Harold C. and BLOODGOOD, D. E.
Experimental Spray Irrigation of Paperboard Mill Wastes.
Sew. and Ind. Wastes 31: 827-835.
PHE Abst. 40: S: 17.

Large quantities of water are recirculated in the mills.

The results at a mill in Ohio where fourteen acres of alfalfa received 0.28 in./day of waste water in addition to rainfall are reported. Three crops were cut in summer and fall. Alfalfa was benefitted rather than harmed by this amount of water.

Winter freezing presents a problem.

1959-16. LAWTON, Gerald W.; BRESKA, George; ENGELBERT, L. E.; ROHLICH, G. A.; and PORGES, N.
Spray Irrigation of Dairy Wastes.
Sew. and Ind. Wastes 31: 923-933.
PHE Abst. 40: S: 29-30.

Study in Pennsylvania indicates that spray irrigation is practical and economical if the area to be irrigated is properly selected and due care is given the operation. Alternate disposal may be required in winter.

1959-17. LEVY, David and CALISE, Vincent J.
Fresh Water from Sewage.
Consult. Engr. 12: Jan., p. 100-105.
PHE Abst. 39: S: 72.

Re-use is much more common in Europe than in the U.S.

Treatment-plant effluent is often of better quality than the local river.

Cites Bethlehem at Baltimore, Kaiser at Fontana, and Golden Gate Park.

Costs and chemical analyses are given.

Wider use is indicated.

1959-18. LOEWENSTEIN, P. R.
The Purification and Re-Use of Sa Sol's Effluents.
Inst. of Sewage Purif., Jnl. and Proc. 1959, Part 3, p. 369-379.
PHE Abst. 40: S: 88-89.

A plant gasifying low grade coal on South Africa's Rand has as effluent sources: water purification, water softening, boilers, cooling towers, gasification and gas purification, synthesis and product work-up, domestic sewage, and ash handling. All the effluents are re-used in ash handling.

Details of plant design are explained.

1959-19. MERZ, Robert C.
Waste Water Reclamation for Golf Course Irrigation.
ASCE Proc. 85, SA 6, p. 79-85.

"At Eagle Pass, Texas, the Country Club golf course is kept green by pumping from the last lagoon of the treatment plant."

Discussion by STONE, Ralph, PASCE 86, SA 2, p. 125-126:

Cautions on excessive chlorination leading to corrosion, to difficulties with clay soil, and to over-irrigation. Dead-ends on pipe should be avoided.

Automatic sprinkling in early morning hours is preferred.

Discussion by SLOAN, Garrett, PASCE 86, SA 3, p. 167-168:

Describes re-use in sewage treatment plant at Miami, Fla., for chlorination, elutriation, incinerator ash disposal, and irrigation of extensive grounds.

Salt-water infiltration into sanitary sewers has resulted in too high a chloride content for irrigation without dilution by city water. About 50% dilution is required.

1959-20. METZLER, Dwight F.
The Re-Use of Treated Waste Water for Domestic Purposes.
Pub. Wks. 90: May, p. 117-119, 208-209.
PHE Abst. 39: W: 61.

Reports re-use at Lyndon, Kansas (pop. 840) in 1954 and 1955. Chanute (pop. 12,000) re-used sewage in Oct. 1956-Feb. 1957. "The water was of good bacteriological quality the entire time."

Lyndon re-used its water twice; Chanute 8 to 15 times. The chemical quality decreased severely.

Sixty to 180 days storage should be employed to effect ammonia reduction in chlorinated sewage before re-use.

Kansas' experiences have advanced knowledge.

1959-21. NEVEUX, M. M.; JAAG, Otto; and KEILING, J.
Agricultural Utilization of Sewage Effluent.
Tech. et Sci. Mun. 54: 425-432.

A symposium consisting of:

NEVEUX, M. M.: Presentation, p. 425.

JAAG, Otto: Sludge utilization, p. 426-428.

KEILING, J.: Utilization of sewage effluent and of industrial wastes, p. 429-432.

1959-22. ONGERTH, Henry J. and HARMON, Judson A.
Sanitary Engineering Appraisal of Waste Water Re-Use.
AWWA Jnl. 51: 647-658.
PHE Abst. 40: S: 21.

Cites the history of re-use, and lists the methods.

"In planning reclamation projects, two considerations override all others: public health and economics."

This is an excellent general discussion. Twenty-six references are included.

1959-23. SCHERER, Clarence H.
Sewage Plant Effluent is Cheaper Than City Water.
Wastes Engr. 30: 124-127.
PHE Abst. 39: S: 89.

Recounts the Amarillo-Texaco arrangement.

1959-24. SCHERER, Clarence H. and ALEXANDER, Dean E.
Waste Water Transformation at Amarillo.
Sew. and Ind. Wastes 31: 1103-1108.
PHE Abst. 40: S: 36.

Amarillo has supplied cooling and boiler-makeup water to Texaco since March 1955, from a plant located about ten miles north of Amarillo.

Toxic industrial influent has led to trouble, but remedies have been applied. Quality and cost figures are cited.

Effluent was a logical choice for the refinery based on its long-term availability.

1959-25. SHRAUFNAGEL, F. H.
Disposal of Industrial Wastes By Irrigation.
Pub. Health Rpts. 74: 133-140.
PHE Abst. 39: S: 86-87.

Combinations of ridge- and furrow- and of spray-irrigation may have advantages over either alone.

ABST: "Properly operated systems should not pollute wells except in creviced limestone areas or where wastes contain sulfite liquid that can pollute over a long distance and time."

Conclusions: "In general, waste irrigation has accomplished a good degree of treatment at low cost."

1959-26. SCHUETTE, W. H.
Water Resources and Industrial Management.
Sew. and Ind. Wastes 31: 268-273.

Industry recognized the growing water shortage and is cooperating in meeting the challenge. "Waste treatment units must be built to anticipate a complete change of process or product."

1959-27. SCOTT, T. M.
Effluent Grows Crops on "Sewer Farm."
Wastes Engr. 30: 486-489.
PHE Abst. 40: S: 37-38.

Describes city-owned sewage farm of Bakersfield, California. The land is leased for raising of cotton, feed corn, etc. 8,480 acre-feet of primary effluent have reclaimed 2,500 acres of marginal alkali land.

1959-28. VOLLBRECHT, H. A.
Meat Packing Plant Effluent as an Irrigation Medium.
Dissertation Abst. 20: 824.

Reports on an eight-year study of the effect of treated meat packing plant waste on crops, soils, and percolate.

Some wastes are unsuitable for long-time irrigation of some soils.

1959-29. ANONYMOUS.
Control and Analysis (Summary 30th Ann. Penna. Sew. and Ind. Wastes Assn. Mtg.).
Ind. Wastes 4: 9-10.

LAWTON, Gerald W. and ROHLICH, G. A., Spray Irrigation of Dairy Wastes:

Some thirty dairies in Wisconsin use this method with satisfaction. High sodium concentration and ponding should be avoided. Hot waste waters may be applied by elevating the nozzles.

EBBERT, S. A., Spray Irrigation of Plant Food Wastes:

Thirty percent of U.S. canners use spray irrigation. More research is needed.

1959-30. ANONYMOUS.
Effluent Re-Use.
Sew. and Ind. Wastes 31: 1109.

Southland Paper Mills, Lufkin, Texas, use effluent successfully.

1959-31. ANONYMOUS.
Long Beach Asks Re-Use of Purified Sewage.
Amer. City 74: Mar., p. 41.

Long Beach has requested the County Board of Supervisors to construct a demonstration reclamation plant at Whittier Narrows.

1960-1. ADAMS, Milton P.
Water Recources as Viewed by a State Agency.
WPCF Jnl. 32: 521-525.

Effluent quality must be raised since re-use is imperative.

Better treatment may be far cheaper than additional dilution water.

1960-2. BERGER, Bernard B.
Effluent Re-Use and Public Health.
Tech. de l'Eau 14: Nov., p. 23-28.

Chanute, Kansas, recycled its water eight to fifteen times in five months.

Re-use of sewage of upstream cities in common.

Public health aspects are discussed at some length.

1960-3. BRAMER, Henry C., et al.
Water Pollution Control.
Chem. Engr. Prog. 56: Mar., p. 81-84.

The chemical engineer can make his greatest contribution to water pollution control by in-plant measures. Recovery and re-use are included in these.

The use of sewage effluent is receiving increased favorable attention.

Eighty-seven references are included.

1960-4. CHASE, William J.
Spray Disposal of Domestic Wastes.
Pub. Wks. 91: May, p. 137-141.
PHE Abst. 40: S: 107.

To avoid adding treated or untreated effluent to Lake Washington, some localities east of the Lake have resorted to disposal by spray irrigation of primary effluent.

Many factors affect the success of spray irrigation. These are discussed at some length in the paper.

Hay crops irrigated with effluent should be burned. Thus, the method is recommended for disposal only, not for re-use.

1960-5. CONNELL, C. H. and BERG, E. J. M.
Reclaiming Municipal Waste Water for Industrial and Domestic Re-Use.
Southwest Wtr. Wks. Jnl. 41: Feb., p. 17-19.
PHE Abst. 40: S: 81-82.

ABST: "Re-use of all municipal waste water is envisioned with distribution one-half to industry, one-fourth to agriculture, and the remainder, after dilution in raw water, for indirect use for all purposes in general. Factors influencing re-usability on comparative basis: (1) dependable quantity, (2) quality and required treatment, (3) availability and accessibility, (4) attainable safety, (5) total costs, (6) overall community needs."

Irrigation with effluent is successful at Lubbock, Abilene, San Angelo, Midland, and smaller towns [30 mgd in West Texas].

Five mgd of effluent are used for industrial water at Amarillo, Odessa, and Big Spring.

1960-6. DIETZ, Max R. and FRODEY, Ray C.
Cannery Waste Disposal by Gerber Products.
Compost Sci. 1: Autumn, p. 22-25.
PHE Abst. 41: S: 18-19.

Gerber employs spray irrigation on a 140-acre plot three and one-half miles from the cannery. A depth of two to four in./week is applied to alfalfa and other crops. Operation costs are low.

1960-7. FAIR, C. M.
Economies in Metal-Finishing Wastes Management.
WPCF Jnl. 32: 632-639.

"If water is used only as needed and re-used when feasible, the problems of waste management and treatment are minimized."

"Waste solutions often have value and can be re-used at the same plant or sold or given to others for whom they may have value."

1960-8. GLOYNA, Earnest F.; WOLFF, Jerome B.; GEYER, John C.; and WOLMAN, Abel. Water Resources Activates in the United States. A Report Upon Present and Prospective Means for Improved Re-Use of Water.
86th Congress, 2nd Session, Committee Print No. 30, 54 p.

This valuable and comprehensive study can perhaps best be summarized by repeating its table of contents. Some four hundred references are given by footnotes.

PART 1. TECHNICAL MEANS OF IMPROVING WATER SUPPLY AND UTILIZATION

PART 2. SELECTED ABSTRACTS AND REFERENCES

TABLES

Part 1

1960-9. HEUKELEKIAN, H., et al.
1959 Literature Review.
WPCF Jnl. 32: 443-481, 545-593, 681-720.

Interest is increasing in the re-use of sewage effluents. Spray irrigation continues to receive attention.

1960-10. HICKERSON, R. C. and McMAHON, E. K.
Spray Irrigation of Wood Distillation Wastes.
WPCF Jnl. 32: 55-64.
PHE Abst. 40: S: 73.

Describes a series of tests of spray irrigation in a greenhouse. It was found that alcohol-pot wastes would kill any variety of grass; other wastes gave results ranging from poor to excellent.

Field results are discussed and procedures are recommended.

1960-11. HOLLIS, Mark D.
Water Resources and Needs for Pollution Control.
WPCF Jnl. 32: 225-231.

Plant influent is changing due to industry and, more particularly, due to build-up of chemical pollutants in runoff waters from agricultural and land use practices.

"...industry will go where there is water, and population will build up where there is industry."

Research needs include:

1. Assess total pollution. Put stream monitoring on a more scientific basis.

2. Seek completely new methods of waste treatment. "Salvage is actually more talk than reality." Change this.

3. Focus public attention on treatment.

1960-12. JEY, B. N., et al.
The Results of Sanitary and Hygienic Investigations of Ashkhabad Sewage Farms.
Gigiena i San. No. 12, p. 18-20.
PHE Abst. 41: S: 41.

Heavy soil contamination was found. Vegetables grown in contact with the surface are polluted.

1960-13. KLINGER, L. L.
Water Conservation by External Re-Use.
TAPPI 43: 669-672.
PHE Abst. 41: S: 3.

ABST: "Reduction of pollution, savings in heat, and reclamation of solids and clarified water are economically feasible."

1960-14. MONSON, Helmer.
Cannery Waste Disposal by Spray Irrigation.
Compost Sci. 1: 41-44.
PHE Abst. 40: S: 94.

Use of spray irrigation has increased from a few canneries in 1948 to an estimated 250 in 1957. Infiltration and permeability change after a few years.

1960-15. MORRIS, W. S.
Subsurface Disposal of Salt Water from Oil Fields.
WPCF Jnl. 32: 41-51.
PHE Abst. 40: S: 65.

In the East Texas oil field 3.2 barrels of salt water are produced with each barrel of oil.

Proposed solutions include:

1. Evaporation in open pits.

2. Evaporation in open pits with aid of heat (gas flares).

3. Continuous discharge to surface streams.

4. Storage in earthen pits with discharge to streams during rainstorms.

5. Transport to open sea by pipe or ditch.

6. Injection into subsurface formations.

First injection began in June 1938. Subsequent statistics are tabulated. Treatment of the salt water is necessary before injection.

Re-use (for maintaining pressure) avoids stream and aquifer pollution and results in far higher total recovery.

1960-16. NEMEROW, N. L., et al.
Report, Committee on Sanitary Engineering Research: Man Versus Environment.
ASCE Proc. 86, SA 4: 13-23.

Re-use of water is complicated by the growing number of contaminants in solution: syndets, insecticides, weed killers, etc.

1960-17. PARKHURST, John D.
Sewerage and Waste Disposal Practices of Sanitation Districts of Los Angeles County.
WPCF Jnl. 32: 1081-1087.

Palmdale sells effluent from oxidation ponds for irrigation of alfalfa [0.7 mgd].

An activated sludge plant at Pomona acts as a water reclamation facility [4.5 mgd]. Part is used for irrigation of pastures and citrus groves, part for recharge.

A high-rate filter plant treats 0.7 mgd for Azusa; another treats 0.5 mgd from a brewery. Both furnish effluent for recharge.

Ocean disposal has been favored to reduce costs.

1960-18. PETTET, A. E. J.
...and Wealth from Sewage.
Engr. 190: 545.

Irrigation with effluent has been practiced to some extent in Europe and America.

Use for industrial cooling water is frequent. Baltimore's 100 mgd is cited.

1960-19. SIMMERS, R. M.
Effluent Disposal by Irrigation.
N. Z. Engr. 15: 410-413.

Describes 15-year operation of meat freezing plant's disposal at Christchurch. Irrigation has improved pasture for sheep and cattle, and has solved odor problem of the ponds previously used.

Costs have been low.

1960-20. SVOBODA, M.
Utilization of Dairy Effluent in Agriculture.
Zpravy Vyzkumneho Ustavu mlekarensheko 8: (2), p. 44-51.
Dairy Sci. Abst. 23: 426-427.

Surplus sour whey was sprayed over peat compost, raising its nitrogen content from an initial 0.62% to 2.3%. The peat compost raised agricultural yields.

1960-21. TOWNEND, C. B.
The Economics of Waste-Water Treatment.
ICE Proc. 15: 209-230.

In Britain effluent is used for cooling towers and in some industrial washing processes. Elsewhere agriculture and recharge are important. These uses will increase in Britain in time.

1960-22. TRAVIS, Paul W.
Organizing a Sewage Effluent Utilization Project.
Pub. Wks. 91: Sept., p. 119-120.

Describes the history of agricultural use in Orange County, California, dating from preliminary investigations with test plots in 1950.

The district's rules are listed.

The project is giving satisfaction.

1960-23. ANONYMOUS.
Boosts Waste Plant Performance.
Food Engr. 32: Sept., p. 80-81.

Through redesign of its plant, Rath, at Waterloo, Iowa, saves about 3/4 mgd by re-use of settled waters.

Four steps to success are explained by word and diagram.

1960-24. ANONYMOUS.
More Refiners Re-Use Waste Water.
Petro. Wk. 11: 15 July, p. 40.

Describes Amarillo-Texaco arrangement with high commendations.

"Even in refineries where plenty of fresh water is available, considerable investment in water-treating facilities is required."

1961-1. BARKER, John E.
Mill Water Clarification and Re-Use.
ABST: Wtr. and Sew. Wks. 108: Oct., p. 20A.

Describes Armco Steel plant's treatment of 3,000 to 11,000 gpm for recirculation at Middletown, Ohio.

1961-2. BAUER, J. H.
Air Force Academy Sewage Treatment Plant Designed for Effluent Re-Use.
Pub. Wks. 92: June, p. 120-122.
PHE Abst. 41: S: 66.

Campus irrigation is to be by effluent; hence, a high quality is required. Plant details are described.

1961-3. BELL, J. W.
Spray Irrigation and Research of Canning Plant Wastes.
Canad. Fd. Ind. 32: No. 9, p. 31-33.
PHE Abst. 42: 349.

Discusses problems encountered and indicates research needed in employing spray irrigation for disposal of cannery wastes.

1961-4. BRADAKIS, H. L.
A Joint Municipal-Industry Spray Irrigation Project.
Ind. Wtr. and Wastes 6: 117-120.

Describes disposal of tomato canning wastes by Stokely at Timton, Indiana. Such wastes were previously treated by the municipal sewage plant.

The equipment used is described and pictured. Costs are cited.

The city financed the installation with provision for repayment.

1961-5. BUSH, A. F.; ISHERWOOD, John D.; and RODGI, Shiva.
Dissolved Solids Removal from Waste Water by Algae.
ASCE Proc. 87, SA 3, p. 39-57.

Reports investigation of the processes of preparation of water for re-use, including the reduction of dissolved salt concentration. Activated sludge effluent flowed through a third-stage algae pond. USPHS standards were met except for bacterial count.

1961-6. CONNELL, C. H. and FORBES, M. C.
City Sewage-Plant Effluent is Worth Your Study.
Oil and Gas Jnl. 59: 27 Nov., p. 94-96.
PHE Abst. 42: 112-113.

More than thirty U.S. industrial plants re-use effluent. Users in the oil industry are tabulated.

Costs must be computed plant-by-plant.

Effluent flow is dependable in quantity, but its quality and the potentialities of quality upset should be investigated carefully. The price is usually low. Typical water analyses are tabulated.

Accessibility may be an important factor.

Water treatment costs for effluent are usually about the same as for raw water.

1961-7. DUNLOP, Stuart G. and WANG, Wen-Lan Lou.
Studies on the Use of Sewage Effluent for Irrigation of Truck Crops.
Jnl. of Milk and Food Tech. 24: 44-47.

Reports on studies designed to assess the public-health hazards of irrigation under field conditions.

It would appear that no significant contamination results from the use of chlorinated effluent diluted in streams and used in furrow irrigation.

An eleven-entry bibliography is included.

1961-8. FINNERTY, J. J.
Unusual Applications of Cooling Towers.
Ind. Wtr. and Wastes 6: 187-190.
PHE Abst. 42: 234.

Cooling towers have been employed to cool salt water, to cool a river, and to remove excess heat from a waste so that biological treatment is possible. These unusual installations are described.

1961-9. GISLER, H. J. and BEARDSLEY, C. T.
Closed Cycle Coal Washing.
Ind. Wtr. and Wastes 6: 163-165.
PHE Abst. 41: S: 73.

A closed cycle conserves water, avoids stream pollution, and produces the maximum amount of saleable coal.

The key to success is the effective cleaning of the water. Typical practice is described and illustrated with diagrams.

1961-10. HEUKELEKIAN, H., et al.
A Review of the Literature of 1960.
WPCF Jnl. 33: 445-476, 549-584, 681-710.

Sewage re-use is discussed on p. 471-472.

1961-11. HOAK, Richard D.
Industrial Water Conservation and Re-Use.
TAPPI 44: Feb., p. 40A, 42A, 44A, 46A.

In a general survey of availability of water in the U.S., Hoak gives the values of an acre-foot of water according to the purpose for which it is used as computed by Renshaw.

These are:

Use	Mean	Maximum
Domestic	$100.19	$235.66
Industrial	40.73	163.35
Irrigation	1.67	27.04
Hydropower	0.71	5.90
Waste disposal	0.63	2.56
Inland navigation	0.05	1.17
Commercial fisheries	0.025	1.06

Industrial re-use is often justified on the basis of cost of water alone. Typical costs of re-used water are listed.

Water conservation should be considered most carefully in new plant design, so that plant piping can be most efficiently devised. Conditions vary so from plant to plant that few general statements would be valid.

1961-12. ISAAC, P. C. G.
The Treatment of Sewage as an Aid to Economical Disposal.
Research Applied in Industry 14: 131-136.

Sewage disposal is unlikely to be profitable; it may, however, yield some return.

"Today there are very few large industrial water consumers who use the water only once." Agricultural use is in order even in England. Industrial use provides a more steady demand.

Spray irrigation with cannery wastes is described.

1961-13. JACIR, J.
Recycling of Cooling Waters.
Tech. de l'Eau 15: Mar., p. 45-48.

Recycling permits industry to exist in arid areas.

The mechanism of cooling towers is described.

1961-14. KEEFER, C. E.
Improvements and Operation at Baltimore's Back River Sewage Works.
WPCF Jnl. 33: 22-47.

The plant equipment is described in detail.

Effluent is sold to Bethlehem Steel Company with delivery through two 5-mile conduits--one 60-inch, the other 96-inches in diameter. Quantities and prices are tabulated for 1948-1959.

1961-15. LAVERTY, Finley B.; STONE, Ralph; and MEYERSON, Lawrence A.
Reclaiming Hyperion Effluent.
ASCE Proc. 87, SA 6, p. 1-40. Disc: ASCE Proc. 88, SA 3, p. 177-182; SA 4, p. 69; V. 89, SA 1, p. 69-72.
PHE Abst. 42: 152-153.

Reports on tests extending over three years on the injection of effluent of an activated sludge plant into a ground-water aquifer after various secondary and tertiary polishing treatments. The results indicate the feasibility of reclaiming waste water at reasonable cost.

Further study of tertiary processes is needed.

Where land is available, spreading should be resorted to.

Discussion by McGAUHEY, P. H., V. 88, SA 3, p. 177-179:

Outlines results of ten years' study on clogging by spreading or injection. The solutions which have been proposed are discussed.

Discussion by BAFFA, John J., V. 88, SA 3, p. 179-180:

Minerals build up in repeated use unless adequate dilution occurs.

Discussion by SUTER, Max, V. 88, SA 3, p. 180-181:

Try to obtain higher rates of injection to lower capital costs.

Discussion by KEIM, Paul F., V. 88, SA 3, p. 181-182:

Re-use is vital. Provide spreading grounds early and hold them.

Discussion by GREELEY, S. A. and LANGDON, P. E., V. 88, SA 4, p. 69:

Cites water-sewage-water cycle on many rivers.

Closure, V. 89, SA 1, p. 69-72:

Local characteristics must be considered in each case.

Challenges remain for future investigators.

1961-16. McDOWALL, F. H. and THOMAS, R. H.
Disposal of Dairy Wastes by Spray Irrigation on Pasture Land.
N. Z. Pollution Adv. Counc. Publn. No. 8, 94 p.
Dairy Sci. Abst. 23: 539.

This extensive study of dairy waste disposal includes a consideration of the character and volume of wastes, water pollution and methods of abatement, methods of irrigation, sites suitable for spray irrigation, type of equipment available, application, design, and costs.

1961-17. MEIGHEN, A. D.
Spray Irrigation of Strawboard Wastes.
Ind. Wtr. and Wastes 6: 168-169.

Spray irrigation has proved especially valuable for handling either large-volume or high-strength wastes.

Studies in Terre Haute, Indiana, are described. The wastes were sprayed on to sandy loam in a river bottom area. Commercial disposal of 0.25 in./day would appear feasible summer and winter.

1961-18. ROBINSON, E. W.
Reclaimed Water Cools Station Condenser.
Elec. World 155: 30 Jan., p. 36-37.

Describes and pictures Nichols plant near Amarillo (SWPS Co.). The consumption is 1.2 mgd of effluent, piped through six miles of 18-inch cement-lined steel pipe. The cost delivered is 22¢/1,000 gallons. There was no economic advantage in the use of effluent in this first plant, but some will accrue in future additions.

Detergents cause scale. To combat this the lime consumption is 3 tons/day.

At present, the supply exceeds the demand by a considerable margin.

No serious troubles have occurred to date. No odor exists.

The provisions of the twenty-year contract for the sale of effluent are listed.

1961-19. SOLT, G. S.
Letter to the Editor.
Effluent and Wtr. Treat. Jnl. 1: 239.
Comment 2: 567, 605, 629.

Solt proposes "... The town could then work on a recirculated sewage with possibly no more than 10% make-up." Down-river towns now often work on a modified version of this plan.

O. Pathoharju comments (V. 2, p. 567) on 1931 papers by Goudey and by Imhoff proposing this and quotes a German slur on Los Angeles.

F. W. Roberts comments (V. 2, p. 629) that the prospect of drinking effluent does not deter immigration to London.

1961-20. SOUTHGATE, B. A.
The Industrial Water and Effluents Group.
Chem. and Ind. 48: 1936-1940.

Views irrigation trends in England with alarm.

There are many examples of re-use of effluent in America, and a few in England. Minimum flows can be guaranteed.

Recirculation can cut treatment costs as well as water bills.

1961-21. STEFFEN, A. J.
Where Industry Stands in Water Pollution Control.
WPCF Jnl. 33: 593-602.

Progress in water conservation has reduced stream pollution substantially. Several particular cases are cited.

1961-22. WELLS, W. N.
Irrigation as a Sewage Re-Use Application.
Pub. Wks. 92: Aug., p. 116-118.
PHE Abst. 41: S: 59.

Describes the history of operations at San Antonio, where the city operated a sewage farm until 1901.

Data are given on the composition of the water and on the crops grown. No damage to the soil is apparent after some 50 years of effluent irrigation.

Health hazards are negligible.

1961-23. WILLETS, David B., et al.
Feasibility of Reclamation of Water from Wastes in the Los Angeles Metropolitan Area.
Calif. Dept. of Water Resources, Bull. No. 80, 181 p. + plates.

The objectives of this investigation were to discover the quantity and quality of water available for reclamation in the Los Angeles area, the costs as compared with those of imported waters, and the possible general types of use.

This very detailed report with its abundance of supporting data gives an excellent picture of the type of planning required to obtain the maximum beneficial use of reclaimed water.

1961-24. WISNIEWSKI, T. F.
Irrigation Disposal of Industrial Wastes.
Pub. Wks. 92: July, p. 96.

Irrigation--spray or ridge and furrow--has proved effective for disposal of wastes from canneries, dairies, poultry processing plants, pulp mills, and meat packing plants.

The precautions which should be observed are discussed.

1961-25. ANONYMOUS.
By-Product Sales Cut Sewage Treatment Cost.
Amer. City 76: May, p. 23.

Amarillo recovers 60% of its sewage treatment cost by effluent sale and by use of sewage-sludge gas. Texaco and the Southwestern Public Service Company use about 1.5 mgd each.

The provisions of the contracts are listed.

Plans exist for expansion.

1961-26. ANONYMOUS.
"More" Water for San Bernardino, California.
Wtr. and Sew. Wks. 108: 438.

A water saving of 70% is reported at a Five-Minute Car Wash by filtering the waste water and re-using it.

Other water users--dairies, laundries, and food-processing plants--will also test filtering.

1961-27. ANONYMOUS.
Repeated Use of Municipal Water is Dow's Goal.
Wtr. and Sew. Wks. 108: 274.

Reports a study on activated carbon treatment of secondary sewage plant effluent by Robert M. Smith of Dow Industrial Service in Midland, Mich.

1961-28. ANONYMOUS.
Sewage Reclamation Studies for University City.
ASCE Proc. 87, SA 4, Part 2, p. 5.

University City is being planned in Orange County, California, for a Univ. of Calif. branch with an enrollment of 27,000 and a total population of 100,000. Reclamation of all sewage will irrigate crops, golf courses, and campus, with ten mgd scheduled to supply 2,000 acres. Artificial lakes will be maintained.

1961-29. ANONYMOUS.
Editorial: Which Water Shortage?
Ind. Wtr. and Wastes 6: 123.

Predicted shortages of the year 2000 will be met by re-use, elimination of "once-through" cooling water, improvements in quality of many sources, storage for regulation of stream flow, etc.

Industry must cooperate.

1962-1. BABOV, D. M.
Bacterial Contamination of Soil and Vegetables on Fields After Seasonal Sewage Irrigation in the Southern Ukraine.
Gigiena i Sanit. No. 11, p. 37-41.
PHE Abst. 43: 112.

ABST: "However, as the result of energetic processes of self-purification, the ripe vegetables harvested from these fields do not differ from those in the market by the level of bacterial contamination."

1962-2. BUSCH, A. W.
Activated Sludge Kinetics and Effluent Quality.
ASCE Proc. 88: SA 6, p. 1-13. Disc: V. 89, SA 3, p. 75-77; SA 4, p. 131.
PHE Abst. 43: 71.

Handbook solutions to the production of quality effluent should be avoided; each particular waste requires its own study.

Recycling is frequently advantageous economically to an industry, particularly if incorporated in the original plant design.

Discussion by McKINNEY, Ross E., V. 89, SA 3, p. 75-77:

Handbooks give the degree of accuracy required.

Closure, V. 89, SA 4, p. 131:

Points out McKinney's inconsistencies.

1962-3. CLARKE, Frank E.
Industrial Re-Use of Water.
Ind. and Engr. Chem. 54: Feb., p. 18-27.
PHE Abst. 42: 159.

Economic and pollution-control pressures are credited with a significant increase in industrial re-use of water between 1954 and 1959. Major re-use practices are reviewed. Profits and special problems of re-use are examined in case histories.

1962-4. CLEARY, Edward J.
Exciting Prospects for Waste-Water "Renovation."
Pub. Wks. 93: Apr., p. 74, 76, 78, 80.

The ideal goal is "to (1) concentrate the contaminants and provide for their permanent disposal; and (2) produce purified water of a quality that is suitable for direct re-use."

Techniques to be employed include absorption, electrodialysis, emulsion separation, evaporation, extraction, foaming, freezing, hydration, ion exchange, and oxidation.

Technical feasibility is proven; economics remains.

1962-5. DALTON, Thomas F.
Cooling-Water-Treatment Chemicals Stop Pollution for Re-Usable Water.
Natl. Engr. 66: No. 5, 6, 8, 10.
Chem. Abst. 57: 14896.
PHE Abst. 43: 109.

PHE Abst: "Selection and control of additives for specific purposes are recommended."

1962-6. DARLOT, DARVES-BORNOZ, and PERRIN-PELLETIER.
The Water Needs of an Industrialized Nation.
Ann. de Min. 1962, p. 9-20.

Surveys needs: domestic, industrial, agricultural, navigational, and recreational.

Predicts industrial recycling as follows (in percent):

	1960	1965	1970
Electricity	44	33	31
Steel	45	55	65
Other	30	35	40
Total	39	37	38

A higher standard of living tends to raise water demands in all five categories listed above simultaneously. Design must take into account a mid-future (10 to 15 years), but within a long-range (50 years ±) frame.

Figures are given for water use by categories in U.S.A., Great Britain, France, and West Germany.

1962-7. DAY, A. D.; TUCKER, T. C.; and VAVICH, M. G.
City Sewage for Irrigation and Plant Nutrients.
Crops and Soils 14: Jun.-Jul., p. 7-9.

Reports on tests in vicinity of Tucson. Water analyses and cost data are included.

1962-8. FITZNER, Stan.
Research on Irrigation with Paper Mill Wastes.
Ind. Wtr. and Wastes 7: 10.

Reports on studies of growth of slash pine in Louisiana from seed or seedlings by irrigation with paper mill wastes. The preliminary results are encouraging.

1962-9. HOAK, Richard D.
Are We Really Running Out of Water?
Trusts and Estates 101: 358-360, 362-365.

Hundreds of examples exist of re-use of sewage effluent. Baltimore is cited.

The Office of Saline Water should devote attention to sewage, not merely to brines. This readily-available source has received far too little attention. Buckeye, Arizona, is cited for its electrodialysis plant treating brines 1/15 as salty as sea water.

<u>1962-10.</u> JENKINS, S. H.
The Composition of Sewage and its Potential Use as a Source of Industrial Water.
Chem. and Ind. 1962: 2072-2079.
PHE Abst. 43: 110.

The composition of sewage depends on the water supply, sewer infiltration, quantity of water used per head, and type and volume of industrial waste discharged to the sewer.

Those quantities are predictable.

Effluent should be treated with re-use in mind.

Costs usually control.

<u>1962-11.</u> KEEFER, C. E.
Tertiary Sewage Treatment.
Pub. Wks. 93: Nov., p. 109-112, Dec., p. 81-83.
PHE Abst. 43: 110.

Part I (Nov.):

Five methods of tertiary sewage treatment are cited with a discussion of plants employing each; numerical data are given.

Land application has proven successful in arid areas.

Recirculation through some ten cycles at Chanute, Kansas, is documented. Golf course irrigation with tertiary effluent is frequent.

Part II (Dec.):

Re-use of treated effluent at Baltimore and Amarillo are described as typical of sound practice.

Ground-water recharge has been studied in California.

Further research is needed.

1962-12. LAURIE, K. W.
Effluent Disposal Trials at Leongatha South.
Dairy Farming Dig. 9: (2), p. 35-40.
Dairy Sci. Abst. 24: 2482.
PHE Abst. 42: 431.

Describes a series of trials being conducted on the disposal of casein whey by spray irrigation on permanent pasture. Full-strength, 1/3-strength, and 1/6-strength whey is being applied at different rates.

1962-13. LUDWIG, Russell G. and STONE, Raymond V.
Disposal Effects of Citrus By-Products Wastes.
Wtr. and Sew. Wks. 109: 410-415.
PHE Abst. 43: 311.

Analyses of well water downstream of a spreading area are tabulated for 1949-61. Organic pickup has been negligible, but mineral matter has increased significantly for about a mile downstream. Irrigation with sewage effluent has the same effects and, in addition, increases the nitrate.

1962-14. MIDDLETON, F. M.
Water Renovation.
Chem. Engr. Prog. 58: Oct., p. 63-68.
PHE Abst. 43: 119-120.

Many materials are surviving existing treatment processes. Information is sparse on most of the uncommon ions.

"The need for and intensity of re-use is inexorably increasing as population and industrial and agricultural activities expand."

"It will be essential to concentrate the impurities in municipal waste waters into small volumes and to dispose permanently of this concentrate." Such water, after use, must be re-used rather than being discharged into less pure water. The processes are described.

Each problem must be solved separately.

1962-15. OKUN, D. A., et al.
A Review of the Literature of 1961.
WPCF Jnl. 34: 419-458, 525-564, 629-703.
PHE Abst. 42: 277, 310, 344.

The pertinent sections are:

Sewage re-use: p. 451-453.

Irrigation and land application of industrial wastes: p. 542-543.

1962-16. OLDSEN, Charles B. and GUTIERREZ, Leonardo V.
Attractive Plant Reclaims Waste Water for a Small Community.
Pub. Wks. 93: June, p. 120-122.

Rancho Santa Fe, San Diego County, California, has recently completed a plant which recharges its effluent through a dry river bed for later agricultural and domestic well supply.

1962-17. ONGERTH, Henry J.
Reclamation of Waste Water.
The Sanitarian 24: 338-42.
PHE Abst. 42: 391.

Whether sewage effluent should be re-used or not is generally decided on the bases of economic and public health considerations alone.

Percolation recharge is safer than direct injection.

1962-18. REED, Wilson.
The Use of Water in Coal Preparation.
Effl. and Wtr. Trtment. Jnl. 2: 263-265.
PHE Abst. 42: 348.

Efficient dewatering and clarification is necessary to satisfy the "stringent conditions imposed by the River Pollution Act."

1962-19. SARD, B. A.
Recovery and Re-Use of Process Water.
Chem. and Ind. 1962: 2051-2052.

Cooling is the major industrial use. Usually only a cooling tower is needed to restore the water to usable condition. Canneries and automobile body plants introduce contamination. Means of correction are given.

1962-20. SCHRAUFNAGEL, F. H.
Ridge- and Furrow-Irrigation for Industrial Waste Disposal.
WPCF Jnl. 33: 1117-1132.
ABST: Compost Sci. 4: Spring, p. 32-40.
ABST: Effl. and Wtr. Trtment. Jnl. 3: 602-604, 606-608.
PHE Abst. 43: 67.

Reviews the history of sewage farming; Paris, Berlin, and Melbourne still practice it.

Irrigation with cannery wastes seems to date from 1913. Several case studies with dates, rates of loading, and degrees of satisfaction with the results are cited.

Results are also sketched for dairy, meat processing, and other wastes. Costs are given.

Both spray irrigation and ridge- and furrow-irrigation have their points of superiority. Which is to be chosen depends on site conditions.

A 44-entry bibliography is included.

1962-21. SCOTT, Ralph H.
Disposal of High Organic Content Wastes on Land.
WPCF Jnl. 33: 932-950.

This is a case study, with cost figures, for disposal of liquid digested sewage sludge, whey, and spent sulfite liquor. Ground-water pollution must be considered, especially with sulfite liquor.

1962-22. SILMAN, H.
The Re-Use of Water in the Electroplating Industry.
Chem. and Ind. 1962: 2046-2051.
PHE Abst. 43: 110.

"Very considerable economies can be achieved by re-using water in plating processes. Of the methods available, cascade rinsing and the full deployment of cooling water are the simplest and most easily incorporated, even in older plants. Ion exchange installations are costly initially; they may, however, be justified because of their effectiveness in controlling pollution."

1962-23. THOMAS, C. M.
The Application of Pressure Filters in Coal Preparation.
Effl. and Wtr. Trtment. Jnl. 2: 266-269.
PHE Abst. 42: 348.

Pressure filters have proved generally successful in the last dozen years in producing a filtrate suitable for re-use in coal washeries.

1962-24. ANONYMOUS.
Disposal of Farm Effluent.
Effl. and Wtr. Trtment. Jnl. 2: 512-513.

British regulations govern flow to rivers from agricultural lands as well as trade effluent.

Disposal by spray irrigation is recommended for its fertilizing value. The Minister of Agriculture can make grants to 1/3 of the cost.

1962-25. ANONYMOUS.
Effluent from Tertiary Treatment Feeds Chain of Recreation Lakes.
Wastes Engr. 33: 240-241.
PHE Abst. 42: 312.

Outlines process of water reclamation at Santee, California.

1962-26. ANONYMOUS.
Texaco Uses Sewage-Plant Effluent.
Oil and Gas Jnl. 60: 8 Jan., p. 92.
PHE Abst. 42: 312.

Describes Amarillo operation with water analyses.

1962-27. NOTE.
Waste Water Re-Use.
WPCF Jnl. 34: 100-101.

A University of California at Los Angeles study on tertiary treatment by algae ponds to reduce salt and bacteria contents is underway at Hyperion. If successful, some 280 mgd now discharged to tidewater will be re-used.

Creation of recreational lakes and recharge by seepage are envisioned.

1963-1. BAKELS, P. S.
Water Economy and the Pollution Problem in the Coal Industry: Reports from Germany, Belgium, Great Britain and the Netherlands.
IUPAC: Re-Use of Water in Industry, Chap. 3 (p. 31-116).

Up to 90% of the water used in mines may be of low quality. Most water used in collieries is for coal washing. The amount of water used varies with its ease of availability.

1963-2. BARDUHN, Allen J.; ROSE, Arthur; and SWEENEY, Robert F.
Waste Water Renovation.
PHS Publn. No. 999-WP-4, 45 p.
PHE Abst. 43: 190.

Part I, BARDUHN: A Design Study of Freezing and Gas Hydrate Formation.

Part II, ROSE and SWEENEY: Feasibility Tests of Freezing.

Studies indicate that water recovery from municipal wastes would cost somewhat less than sea water desalination by freezing.

1963-3. COLAS, R.
Recircualtion and Re-Use of Water as a Contribution to the Solution of Effluent Problems in Industry.
Intl. Union of Pure and App. Chem.: Re-Use of Water in Industry, Chap. I (p. 1-14).
ABST. of Symposium: Effl. and Wtr. Trtment. Jnl. 3: 284-285.

Summarizes the later chapters which are on a chapter-per-industry basis, emphasizing that each plant requires an individual study in its own environment.

Two commendable solutions to pollution are:

1) building of separate sewage canals leading to central treating plants, or

2) treatment at the source. (Most promising.)

On a plant basis, one may diagram the water uses, establish classes, and avoid needless waste or degradation. Effluent should be essentially pure or so concentrated that it can be stored and evaporated with some use being found for the residue.

Closer control with trained personnel will be required.

Costs must be shared.

1963-4. CULP, Russell L.
Tertiary Treatment for Better Effluents.
ASCE Proc. 89, SA 2, Part 2, p. 12-13.

Reports on pilot plant studies of tertiary treatment--chemical coagulation, primary absorption on alum floc, rapid filtration, and secondary absorption on activated carbon--which removes ABS and complex organic chemicals and reduces BOD. No flocculation or settling basins are necessary.

High operating costs and necessity of skilled operation restrict present use.

1963-5. CULP, Russell L.
Waste-Water Reclamation by Tertiary Treatment.
WPCF Jnl. 35: 799-806.
PHE Abst. 43: 33.

Describes pilot plant tests, with the equipment and processes covered in detail, to improve on the effluent from secondary treatment processes. Examples cited include:

Corvallis, Oregon, and Salem, Oregon: domestic and cannery wastes (combined),

South Tahoe, Calif. and Philomath, Oregon: domestic wastes.

The treatment is designed for removal of phosphates and ABS, and for general quality improvement. The processes involved include chemical coagulation, primary adsorption on alum floc, rapid filtration, and secondary adsorption on activated carbon. Such treatment is well adapted to seasonal use and to some industrial wastes.

Operating costs are high, but further research should reduce them.

1963-6. ELDRIDGE, Edward F.
Irrigation as a Source of Water Pollution.
WPCF Jnl. 35: 614-625.
PHE Abst. 43: 114-115.

Irrigation return water contains fertilizers, natural soil salts, and pesticides.

Evaporation and seepage decrease flow, thus adding to concentration caused by multiple use.

Algae thrive on fertilizer nutrients.

1963-7. ELIASSEN, Rolf.
Challenges in Research and Development.
WPCF Jnl. 35: 267-274.
PHE Abst. 43: 274.

Effluent disposal and sewage reclamation are discussed.

1963-8. FLEMING, Rodney R.
Water Re-Use by Design.
Amer. City 78: Oct., p. 106-108.
ABST: ASCE Proc. 89, SA 6, Part 2, p. 16.

Reclaimed water may be used for agriculture, industry, and recharge for storage or for help in controlling sea-water intrusion.

More than 25% of Texas' 800 municipal sewage plants furnish effluent for irrigation.

Sunnyside, Utah, irrigates park lawns with tertiary effluent. Golf courses are irrigated in Prescott, Arizona, and the five New Mexico cities of Jal, Carlsbad, Santa Fe, Los Alamos, and Gallup.

1963-9. FOULKE, D. Gardner.
The Economic Use of Water in the Electroplating Industry.
IUPAC: Re-Use of Water in Industry, Chap. 6 (p. 147-163).

"The trend toward closed circuit operation of electroplating plants will increase as the scarcity of water becomes greater and the cost of water moves upwards,..."

1963-10. GERSTER, J. A.
Cost of Purifying Municipal Waste Waters by Distillation.
USPHS Publn. No. 999-WP-6, 43 p.

Discusses the nature of the contaminants, the distillation processes available, and the sources of energy for distillation processes.

Comparisons are made with saline-water conversion problems, and costs are extrapolated from model studies on types of equipment proposed for sea-water conversion.

1963-11. HAZEN, Richard.
The Next Fifty Years in Water Purification.
AWWA Jnl. 55: 825-830.
PHE Abst. 43: 79-80.

"Much greater re-use of water is inevitable in some parts of the country,..."

1963-12. HENRY, J. M.
The Problems of Waste Waters in Sugar Factories.
IUPAC: Re-Use of Water in Industry, Chap. 8 (p. 201-247).

"Schemes for re-using are given for water coming from diffusers and for press water, by applying chlorine or pasteurization. Biological purification and acid treatment are also mentioned."

1963-13. HEWSON, J. L.
Economic Use of Water and the Solution of Effluent Disposal Problems in the Heavy Chemical Industry.
IUPAC: Re-Use of Water in Industry, Chap. 7 (p. 165-199).

"The chief means by which water economy is achieved is by the introduction, where economic, of circulating cooling water systems and the re-use of steam condensate."

1963-14. HICKMAN, Kenneth C. D.
Role of Distillation in a Waste Water Recovery Cycle.
AWWA Jnl. 55: 1120-1132.
PHE Abst. 43: 199.

Distillation of water from sewage effluent is simple and leads to an acceptable product.

Power requirements are extrapolated from a model.

Distillation is an excellent safeguard against disaster: pestilence, radioactive fallout, flood, and nuclear warfare. The plant can occupy widely separated buildings.

1963-15. HOWELL, G. A.
Re-Use of Water in the Steel Industry.
Pub. Wks. 94: Mar., p. 114-116, 168, 170.

Primary metal industries increased in-plant re-use of water from 29% in 1954 to 53% in 1959. Steel output increased 5% in the same period.

Water use in steel mills is classified into eight categories, and each is discussed in turn.

The operation of the Geneva Works, Provo, Utah, is described as an outstanding example of effective re-use.

1963-16. KARASSIK, Igor J. and SEBALD, J. F.
"Pasteurilized" Water--Potable Supplies from Waste Water Effluents.
Public Works 94: May, p. 131-133.
PHE Abst. 43: 354.

Bacteria may be destroyed at temperatures of 176 to 248°F.

Bacteria are not transported in vapor produced even at low temperatures. Evaporation, however, requires much more heat energy than sterilization.

The "Pasteurilizing" process involves filtering on activated carbon or its equivalent and sterilizing at given temperatures for given times. Several modifications are possible.

Combinations with steam-electric plants could result in major economies.

1963-17. LULEY, H. G.
Spray Irrigation of Vegetable and Fruit Processing Wastes.
WPCF Jnl. 35: 1252-1261.

Describes operations at two H. J. Heinz Company plants in support of the thesis that the limitations on spray irrigation reported in earlier literature are too stringent.

Each site should be considered on its own merits.

Spray irrigation is practical, simple, and economical.

1963-18. MARKS, R. H.
Waste Water Reclamation: A Practical Approach for Many Water-Short Areas.
Power 107: Nov. '47-50.

Describes Whittier Narrows with tabulated data on plant and effluent.

1963-19. McCALLUM, Gordon E.
Advanced Waste Treatment and Water Re-Use.
WPCF Jnl. 35: 1-10.
PHE Abst. 43: 119.

"This discussion is intended to present in some detail the concepts involved in advanced waste treatment and its corollary, water renovation."

Refractory contamination produces aesthetic, economic, and physiological effects: taste, odor, foaming, color of water; corrosion or scale, disruption of sewage treatment processes, requirement of heavy chemical dosage, cost of soaps and/or bottled water; fish kills, algae stimulation, presence of pesticides, etc.

"Multiple re-use of water is even now a necessary and accepted practice in many areas of this country..."

"But prudence requires a look at used waters as the major source of new water supply in the future."

Wastes, once removed, cannot be disposed of in surface or ground waters of usable quality. This leaves:

1) recovery of usable products from waste,

2) disposal into controlled waste sinks or remote ocean areas,

3) deep well injection or sealed underground cavities,

4) conversion to innocuous form.

<u>1963-20.</u> OKUN, D. A., et al.
A Review of the Literature of 1962.
WPCF Jnl. 35: 553-586, 687-727, 819-876.
PHE Abst. 43: 395, 44: 32.

Re-use is reviewed on p. 580.

<u>1963-21.</u> PARKHURST, John D.
Reclaiming Used Water.
Amer. City 78: Oct., p. 83-85.
PHE Abst. 43: 153.

Describes Whittier Narrows plant at Los Angeles which recharged 13,000 acre-feet in its first year of operation.

<u>1963-22.</u> PARKHURST, John D.
10 Mgd From Whittier Narrows Reclamation Plant.
ASCE Proc. 89, SA 2, Part 2, p. 11-12.

Data are given on the first year of operation, with a plant description emphasizing its flexibility for research studies.

<u>1963-23.</u> PARKHURST, John D. and GARRISON, Walter E.
Water Reclamation at Whittier Narrows.
WPCF Jnl. 35: 1094-1104. (See also 36: 1057-1058.)
PHE Abst. 43: 114.

The elimination of the treatment of sewage solids at the plant resulted in a 25 to 30% saving in first cost.

Plant design data are summarized (three pages).

The effluent is sold for recharge.

The two-page note in Vol. 36, "Air Pollution Control at a Water Reclamation Plant," describes the cover for the sedimentation tanks which avoids escape of odors. Fiberglass panels were selected.

1963-24. STEPHAN, David G.
Possible Water Renovation Processes.
Chem. Engr. Prog. Sympos. Series 59: No. 45, p. 34-44.
PHE Abst. 43: 196-197.

ABST: "For the concept of advanced waste treatment to be feasible, it will be necessary to dispose of concentrated impurities permanently and to produce purified water of a quality suitable for direct re-use. Processes under consideration for separation of impurities from water include adsorption, electrodialysis, extraction, foaming, freezing, ion exchange, and chemical oxidation."

1963-25. STEPHAN, David G.
Technological Differences Between Water Renovation and Desalination.
Chem. Engr. Prog. Sympos. Series 59: No. 45, p. 53-54.
PHE Abst. 43: 197.

The differences include:

1) the problem of permanent disposal of concentrated waste,

2) types of impurities,

3) distinctive characteristics of the waters,

4) changing character of waste water as contrasted with relatively static brines, and

5) types of separation principles applicable.

1963-26. STONE, Ralph.
Waste Water Reclaimed for Golf Course Use.
Pub. Wks. 94: Mar., p. 88-90.

Reclaimed water is used on golf courses at three Marine Crops bases in California and at Carlsbad, Jal, Los Alamos, and Santa Fe.

Descirbes the planning for waste-water use on a golf course at Ontario, California. Tertiary effluent is used.

Trouble is an indication of incompetence.

1963-27. STORMONT, D. H.
Refiners Make Good Use of Fresh-Water Supplies.
Oil and Gas Jnl. 61: 25 Feb., p. 86-93.

Fresh-water intake is climbing only 10% as fast as crude-oil capacity. The re-use of fresh water has climbed substantially in ten years.

Cooling towers have aided re-use to the extent that if no re-use had occurred, fresh water requirements would be 6.62 times as great as they are.

Data are given for the U.S. by regions.

Treatment costs are given.

1963-28. WATSON, John L. A.
Oxidation Ponds and Use of Effluent in Israel.
Effl. and Wtr. Trtment. Jnl. 3: 150-153.
PHE Abst. 43: 272.

Suggested uses of effluent include irrigation, recharge, make-up water for fish breeding ponds, and direct industrial use.

1963-29. WELLS, W. N.
Sewage Plant Effluent for Irrigation.
Compost Sci. 4: Spring, p. 19.

San Antonio utilizes an 850-acre lagoon to oxidize effluent to be used in irrigating 4,000 acres of farm and pasture land.

"Any crop which grows in this climate seems to grow better under effluent irrigation."

1963-30. WESEMANN, F.
The Development of Water Economy in Iron- and Steelworks.
IUPAC: Re-Use of Water in Industry, Chap. 4 (p. 117-132).

Describes seven sets of plants in several countries each subject to more or less difficulty in water supply and effluent disposal. Uses in metres/ton range from 230 to 4.8 as circuits vary from completely open to completely closed. Water consumption and pollution can be restricted severely, but economically. They should be.

1963-31. WESTENHOUSE, Ray.
Irrigation Disposal of Wastes.
TAPPI 46: 160A-161A.
PHE Abst. 43: 72.

The land disposal of Kraft mill condensates by sprinkler is described. Dairy livestock utilized the disposal pasture. Higher system pressures and increased jet trajectory compensated for 150°F condensates.

1963-32. ANONYMOUS.
Closed Water Cycle Systems.
Effl. and Wtr. Trtment. Jnl. 3: 669.

Reports a model study in the U.S.A. of a closed-cycle system for a city of 500,000 with a 10% make-up allowance.

1963-33. ANONYMOUS.
Effluent Utilization.
WPCF Jnl. 35: 1348.

Stanford University research is sketched. Irrigation and/or other non-domestic uses are being studied. The economics is being carefully considered.

1963-34. ANONYMOUS.
Interest in Waste Water Reclamation Gains.
ASCE Proc. 89, SA 2, Part 2, p. 13.

Cites papers at California meetings on Hyperion, Whittier Narrows, and Santee projects as well as on golf course irrigation.

1963-35. ANONYMOUS.
1962 Inventory, Municipal Waste Facilities.
USPHS Publn. No. 1065, 9 volumes.

Gives data for all municipal plants in the U.S. including a column headed "Discharge to." In some cases the entry in this column may read "Irrigation (no effluent to water course)." Industrial use, as at Amarillo, is not noted.

1963-36. ANONYMOUS.
Reclaimed Water Solves International Problem.
ASCE Proc. 89: SA 3, II, 12-13.

A waste-water reclamation plant to handle the entire flow of Tijuana has just been completed. The effluent is to be used for irrigation sixteen miles south of the boundary.

The maximum flow is 36.6 mgd.

1963-37. ANONYMOUS.
Treated Sewage Irrigates Crops.
Engr. News-Record 171: 3 Oct., p. 45-46.

Pennsylvania State University is testing the spray irrigation of effluent on forest and cropland. "University researcher believes it may be the first such large-scale experiment."

1963-38. ANONYMOUS.
Waste Water Conversion.
Pub. Mgmt. 45: 188.

A pilot plant under construction at Tucson will test the technical and economic feasibility of re-use. A private company is building the plant at its own expense. Success is predicted.

1963-39. ANONYMOUS.
Editorial: Water Pollution.
Effl. and Wtr. Trtment. Jnl. 3: 64.

Quotes McCallum (USPHS) on the need for new disciplines in waste treatment research. "... As water is re-used, the residual contaminants left by the inadequacies of present treatment methods build up. This includes the new pollutants which, singly or in combination, may have significant health effects."

1964-1. AMRAMY, Aaron.
Waste Treatment for Groundwater Recharge.
ABST: WPCF Jnl. 36: 296-298.

The degree and type of treatment to be employed depend on:

(a) whether injection or spreading is involved,

(b) the ultimate use of the recharged groundwater,

(c) the geological nature of the aquifer, and

(d) the time between recharge and withdrawal.

Studies of a spreading basin near Tel Aviv are discussed.

1964-2. BLOSSER, Russell O. and OWENS, Eben L.
Irrigation and Land Disposal of Pulp Mill Effluents.
Wtr. and Sew. Wks. 111: 424-432.
PHE Abst. 45: 27.

Spray irrigation, perfected by the food processing industry, is applicable to pulp mill effluents as well. Twenty-one mills were studying or using land disposal in 1959; twenty-seven are now doing so.

Usually this is the most economical treatment, but soil and cover crop conditions lead to individual differences of large magnitude.

1964-3. BONDERSON, Paul R.
Quality Aspects of Waste Water Reclamation.
ASCE Proc. 90, SA 5: 1-8. Disc: V. 91: SA 1, p. 100-102; SA 3, p. 124-125.

Increasing water demands are directing attention to re-use.

The literature is asserted to be extensive on the "internal phase": methods or processes available for treatment and quality control of effluent. This paper examines the "external phase":

(1) Trends in waste-water reclamation.

(2) Modes of augmenting water resources.

(3) Quality aspects associated with such augmentation.

Demineralization would seem to be the greatest economic obstacle to multiple re-use. There are no absolute obstacles.

Discussion by LUDWIG, Harvey F. and FEENEY, Joseph L., PASCE 91: SA 1, p. 100-102:

Describes projects at Hemet and at University City, California (both pending). Hemet will ultimately re-use 10 mgd for irrigation and recharge; the initial plant will be for 2.5 mgd. Quality studies will be maintained.

University City will also attain 10 mgd of re-use. Costs are expected to be about the same as for an alternate ocean outfall.

Cost comparisons should improve as water requirements increase. Costs of tertiary treatment should be brought down by further research.

Discussion by WHETSTONE, George A., PASCE 91: SA 3, p. 124-125:

Re-use may permit increased efficiency in use of sewers and water mains by reducing peak-loads and by eliminating the necessity of paralleling existing installations.

1964-4. BUNCH, Robert L. and ETTINGER, M. B.
Water Quality Depreciation by Municipal Use.
WPCF Jnl. 36: 1411-1414.

Reports on the increment in organic and inorganic loads due to one cycle for five municipalities. Anticipates 6-time re-use by 1980 for the 75% of the U.S. population which will then reside in metropolitan areas.

Results are tabulated in detail. Organic matter has negligible increment.

Results vary from plant to plant depending on the source of influent. Averages must not be used blindly.

1964-5. CANNON, Daniel W.
Industrial Re-Use of Water: An Opportunity for the West.
Wtr. and Sew. Wks. 111: 250-254.
PHE Abst. 44: 346.

Surveys recirculation on an industry-by-industry basis. Nearly all major new construction makes some provision for re-use.

"If a raw material is scarce, they [the process industries] find more of it, or find a way to get by with less. And this is what will be done with water."

Agricultural re-use and re-use of municipal effluent complement rather than conflict with industrial water.

1964-6. CECIL, Lawrence K.
Sewage Treatment Plant Effluent for Water Re-Use.
Wtr. and Sew. Wks. 111: 421-423.
PHE Abst. 45: 112.

Re-use is economically sound even in well-watered areas. Refineries at Duncan and Enid, Oklahoma, and a desert zinc smelter are described.

References are given to chemical treatments.

1964-7. CLOUSE, John L.
Need for Water Re-Use.
TAPPI 47: Jan., p. 182A-183A.

"There apparently are three good reasons why increasing re-use of water by the paper industry is imperative: (1) economics; (2) public opinion; and (3) danger of future shortage."

Re-use introduces many quality problems in paper mills. Techniques for improvement are proposed.

1964-8. CONNELL, C. H. and FORBES, M. C.
Once-Used Municipal Water as Industrial Supply.
Wtr. and Sew. Wks. 111: 397-400.
PHE Abst. 45: 68.

"The total of used municipal water is approaching 20 bgd. Upwards of 40% of this rapidly growing supply may in time be used for industrial water."

Advantages: Collection, treatment, and disposal are responsibilities of the community; quantity is assured; planning should provide ready availability; quality may be controlled at acceptable levels. Costs can be minimized. It would be sound public policy to rename sewage, "reclaimed water."

Reviews the 1947 symposium of WPCF-AWWA and concludes that the findings are still valid.

Amarillo now supplies Texaco, The Southwestern Public Service Company, some irrigation, and will send the surplus to the Canadian River reservoir.

Treatment costs of modern effluent are not well documented. Phosphates are a major concern.

Recommends planning and research in re-use.

1964-9. DE LEEUW, A.
Waste Water Utilization in the Dan Region.
Bulletin of Hydraulic Research, IAHR. 18: 174.

This is an abstract (No. 14) of research completed at the Israel Institute of Technology on the movement of sewage effluent in a coastal aquifer after introduction through spreading basins. A report is in preparation (Nov. '64).

1964-10. DOISY, Georges.
Man's Great Thirst.
Tech. de l'Eau 18: Sept., p. 43-44.

With a subhead reading "Nearly half the water consumed in America has passed at least once through the sewer," the author discusses water shortages in industrialized nations.

He cites Los Angeles' Whittier Narrows, and recharging for domestic water in Germany, then "consoles those required to drink recycled water with the statement of certain hygienists that dead virus make a truly polyvalent vaccine." "'Tis by drinking the water of the Seine,'" he concludes, "'that Paris wards off epidemics.'"

1964-11. FISK, William W.
Food Processing Waste Disposal.
Wtr. and Sew. Wks. 111: 417-420.
PHE Abst. 45: 68.

Food wastes are variable. Their disposal by spray irrigation is often effective and economical. Several cover crops on sand benefit from such irrigation.

1964-12. HAWKINS, Gerald.
A Ten-Year Program of Fiber Loss Reduction and Water Re-Use.
TAPPI 47: Mar., 158A-160A.

Reports the means by which Champion Papers, Inc. (Pasadena, Texas) made drastic reductions in water use. This conservation program "has allowed the company to increase production without major capital outlay for additional water treating and handling facilities." Productivity and efficiency were improved without sacrifice of quality of product.

1964-13. HOATHER, R. C.
The Successive Re-Use of River Water: Its Effects and Its Limitations.
IWE Jnl. 18: 232-238, 262-264, 303-304.
Discussion, p. 282-311.

Discusses abstraction of water for municipal use from rivers carrying sewage- and industrial-effluents, with emphasis on drought flows. The chloride content provides a fair means of approximating previous use. Fish are important indicators of water quality; they do, however, react to impurities differently than humans do. Water which kills fish should be avoided.

Richard L. Woodward is quoted [JAWWA 55: 887 (1963)]: "... Because of the prospect of much more water re-use in the future than in the past, it is time to learn more, not only about what organic compounds are present in water and wastes, but also more about their effects on health."

1964-14. IVES, K. J.
Aquifer Recharge with Waste-Water.
Effl. and Wtr. Trtment. Jnl. 4: 184-188.
PHE Abst. 44: 400.

Discusses filter selection and legal restrictions.

1964-15. LANGWORTHY, V. W.
A Commendable Effort.
Wtr. and Sew. Wks. 111: 383.

Editorial comment introducing an issue (September 1964) featuring several articles on re-use. It is concerned largely with qualifications of plant operators.

1964-16. MERCER, Walter A.
Physical Characteristics of Recirculated Waters as Related to Their Sanitary Condition.
Food Technology 18: 335-340, 342.

In food processing, sanitary considerations would indicate once-through use of potable water. Costs of such a water supply and of its waste treatment bespeak recirculation. This paper reports on studies aimed at finding an acceptable compromise.

1964-17. MERRELL, John C. and STOYER, Ray.
Reclaimed Sewage Becomes a Community Asset.
Amer. City 79: Apr., p. 97-101.
PHE Abst. 44: 347-348.

Describes the Santee, California, program for re-use in recreational lakes. Tertiary treatment is provided at the first lake.

After it flows through four lakes (with pumping), the effluent is used for golf course irrigation and gravel washing.

1964-18. MIDDLETON, F. M.
Advanced Treatment of Waste Waters for Re-Use.
Wtr. and Sew. Wks. 111: 401-410.
PHE Abst. 44: 431.
ABST: Wtr. and Wtr. Engr. 69: 85-86.

Cites mounting interest in re-use, and gives examples of localities where it has been employed.

"To go much beyond 90% (BOD) treatment, new methods are needed."

Nine tertiary treatment processes are described. Costs can be expected to decrease with research. The nine are: adsorption, foam separation, electrodialysis, evaporation, liquid-liquid extraction, reverse osmosis, freezing, solids removal, and oxidation.

1964-19. MOHLER, Edward F., Jr.; ELKIN, Harold F.; and KUMNICK, L. R.
Experience with Re-Use and Bio-Oxidation of Refinery Waste Water in Cooling Tower Systems.
WPCF Jnl. 36: 1380-1392.

Bio-oxidation normally exceeds 99.9% efficiency, thus surpassing trickling filters or activated sludge units. The effluent makes excellent cooling-water with a minimum of pretreatment.

Savings at Sun Oil's Toledo refinery using this process are $100,000/yr.

1964-20. MOLLOY, D. J.
"Instant" Wastes Treatment.
Wtr. Wks. and Wastes Engr. 1: 68-70.
PHE Abst. 43: 18.

ABST: "A lagooning and spray-irrigation system has solved Nestle's instant coffee-tea wastes problems."

1964-21. NEALE, Joseph N.
Advanced Waste Treatment by Distillation.
USPHS Publn. No. 999-WP-9, 55 p.
PHE Abst. 44: 230.

Study of scaling and corrosion effects in a re-use cycle of municipal waste water indicated that such a cycle would often be feasible at 400°F. This should be more economical than a similar process applied to sea water.

Experiments were carried out on Ann Arbor sewage. It was concluded that secondary effluent should always be used.

Pilot-plant studies are recommended to obtain closer estimates of behavior and cost.

1964-22. NIXON, Marshall.
The Successive Re-Use of River Water: Its Effects and Its Limitations.
IWE Jnl. 18: 225-231, 261-262, 303.
Discussion, p. 282-311.

Considers re-use of water, devoting a paragraph to each of the topics:

1. With quality change

    a. Industrial processes

    b. Cooling

c. Public water supply

d. Transport of wastes

2. Without quality change

a. Navigation

b. Fisheries

c. Hydro-Power

d. Amenities

e. Regime.

1964-23. OKUN, D. A., et al.
A Review of the Literature of 1963...
WPCF Jnl. 36: 535-572, 659-711, 791-863.
PHE Abst. 44: 393. 45: 33.

Re-use (reviewed by C. H. Connell), p. 571-572 (11 references).

Irrigation disposal of pulp and paper effluent, p. 683.

1964-24. PARKHURST, John D. and GARRISON, Walter E.
Whittier Narrows Water Reclamation Plant--Two Years of Operation
Civil Engr. 34: Sept., p. 60-63.

Reports with enthusiastic approval on the first two years of operation.

1964-25. RANDALL, David J.
Reclamation of Process Water.
Wtr. and Sew. Wks. 111: 414-416.
ABST: Wtr. and Wtr. Engr. 69: 86.

Describes recycling in a water-short paper mill in New Brunswick. Side benefits are salvage of paper stock and heat.

1964-26. ROSS, Edward N.
Re-Use and Reduction of Paper Mill Water.
TAPPI 47: Jan., 180A-182A.

"Interest in water conservation is increasing as availability of water decreases, water costs increase, and waste treatment problems increase. Methods of increasing the re-use of paper machine white water are described, as well as re-use of fresh water by means of cooling ponds and diluting techniques. Conservation through use of piping loops in a mill supply is reported. Reduced pump seal and washup-hose water used are discussed. The use of wire showers to reduce water consumption is discussed. The importance of continuous maintenance and supervision in a water conservation program is emphasized. A conclusion is reached that water conservation usually decreases the cost per ton of paper and/or improves quality of paper."

1964-27. SHAW, Robert B.
Evaluating Unclassified and Off-beat Companies With Annual Sales of $30 Million or More.
Mag. of Wall St. 115: 311-313, 322, 324.

"The wise, or perhaps lucky, investor is often the one who recognizes important new industries while they are still in their infancy and before their destined role becomes a matter of household knowledge. Naturally, this process involves risks--in the selection of companies even if the industries are identified properly--but these need not be severe if commitments are confined to organizations that are already 'going concerns.'"

"One topic which has been discussed frequently in this Magazine is the shortage of pure water. This problem has two aspects: the desalinization of sea water, and the purification of inland streams polluted by sewage and industrial wastes. Engineers say that, while salt water projects have more appeal to the imagination, the purification of waste water is actually of equal importance. As population grows and existing water supplies become more severely contaminated, while cities must reach further and further into the country for water sources, the urgency for some economic solution of this problem will be greatly increased. Companies engaged in this field could prove to be the leaders in a great new growth industry of the future."

1964-28. STANBRIDGE, H. H.
From Pollution Prevention to Effluent Re-Use (Address at Institute of Sewage Purification).
Wtr. and Sew. Wks. 111: 446-451, 494-499.
Discussion: Effl. and Wtr. Trtment. Jnl. 4: 489.
PHE Abst. 45: 112-113.

Changing conditions are placing emphasis on effluent re-use rather than on pollution prevention.

The history of British requirements is sketched, with emphasis on the changes since standards were set a half century ago.

Sewage effluent is used by industry in Stoke-on-Trent, Croyden (cooling), Scunthorpe (cooling), and Sheffield (steel plant).

In South Africa in 1962 effluent disposal was: to industry 25.3%, to irrigation 45.7%, to sewer flushing 0.2%, to stream discharge 28.8%.

Discussion by FISH, A.:

Cites British use of polluted rivers, recirculation in industry, and at least six examples of irrigation in Essex.

In re-using water it would be well to design for the diurnal variation in sewage quality, to provide for handling increased ammonia in frigid weather, and to monitor trade waste closely.

1964-29. STEFFEN, A. J.
Control of Water Pollution by Waste Water Utilization: The Role of the WPCF.
Wtr. and Sew. Wks. 111: 384-385.

Mentions municipal re-use, industrial re-use, and intraplant re-use, and discusses WPCF encouragement of re-use studies through publications and awards.

1964-30. WATSON, Kenneth S.
Updating Water Resources Thinking to Meet Space Age Requirements.
Wtr. and Sew. Wks. 111: 160-164.

Forecasts increasing re-use of "treated and polished" municipal effluent. Cites Baltimore and Amarillo. Some thirty such installations are said to exist in the U.S. Waste-water irrigation of golf courses and crops must flourish.

Advanced waste treatment must be extended.

1964-31. WEISBERG, E.; PHILLIPS, R. A.; and HELFGOTT, T.
New Aspects of Waste-Water Reclamation.
Amer. City 79: Aug., p. 91-93.
PHE Abst. 44: 431-432.

The state of the art on re-use of municipal waste waters is presented. Economics is considered. Tertiary treatment to permit re-use must come.

1964-32. WILLIAMSON, J. N.; HEIT, A. H.; and CALMON, C.
Evaluation of Various Adsorbents and Coagulants for Waste-Water Renovation.
USPHS Publn. No. 999-WP-14, 91 p.
PHE Abst. 44: 431.

A study of cheap, commercially available materials is described. Costs are analyzed and recommendations made for further research.

1964-33. ANONYMOUS.
Conservation and Re-Use of Used Water.
Effl. and Wtr. Trtment. Jnl. 4: 442-443.

A survey of American practices with citation of typical plants.

1964-34. ANONYMOUS.
Dorr-Oliver to Study Methods of Removing Organic Contaminants.
Wtr. and Sew. Wks. 111: Feb., p. 80A.

A USPHS grant "designed to find ways to renovate waste water for re-use" has been awarded to Dorr-Oliver for study of powdered activated carbon.

1964-35. ANONYMOUS.
Effluent Utilized in Cooling Towers.
West Texas Today 45: Oct., p. 10.

The Southwestern Public Service Company has completed several years of successful use of sewage effluent in cooling towers at Amarillo.

The effluent is the chlorinated product of an activated sludge process. About 3 mgd are used.

Costs are approximately those of using well water; the capital investment is lower.

1964-36. ANONYMOUS.
Effluent Utilization.
WPCF Jnl. 36: 1443.

Pennslyvania State University sprays effluent on rye, wheat, corn, and alfalfa. The high phosphate content had previously caused serious stream pollution.

1964-37. ANONYMOUS.
Re-Use by Laundries Poses Problems.
ASCE Proc. 90, SA 2, Part 2, p. 14-15.

Describes the Niagara Waste Reclamation System.

Wash waters and rinse waters are treated separately for re-use.

Experience indicates the existence of operating problems and potential health hazards.

1964-38. ANONYMOUS.
The Re-Use of Water.
West Texas Today 45: Sept., p. 12, 22-23.

Oil field repressuring is, in general, done by re-use, after treatment, of the water produced with the oil.

Sewage effluent is used several places in West Texas, including:

by Cosden in a refinery at Big Spring since 1945 (0.7 mgd),

by Texaco in a refinery at Amarillo since 1950 (2 mgd),

by Humble for secondary recovery at Andrews (contract for 0.6 mgd), and

by El Paso Natural Gas in a refinery at Odessa since 1956.

At Odessa the effluent is used and re-used in four plants, and, finally, for secondary recovery.

1964-39. ANONYMOUS.
Scientist Says Water Re-Use Increasing.
Ind. Wtr. and Wastes 9: Jan.-Feb., p. 21.

Dr. Richard D. Hoak cited Bureau of Census figures showing that re-use in manufacturing increased from 82% in 1954 to 120% in 1959.

Steel was cited in particular.

1964-40. ANONYMOUS.
Using Effluents as Coolants.
Compost Sci. 5: Spring, p. 31.

"Dr. Walter A. Quebedeaux, Harris County (Texas) director of air and water pollution control, reported that the local industries will soon be clamoring for sewage effluents to provide an adequate supply of industrial water."

Use for irrigation and, ultimately, for domestic water supply was forecast.

1964-41. ANONYMOUS.
Water is Stored in Underground Bank.
West Texas Today 45: Nov., p. 22-23, 48-49.

Describes the operation of the Colorado River Municipal Water District which is storing water in the Ogallala formation in Martin County, Texas.

1964-42. ANONYMOUS.
Water, Water, ...
Fin. World 122: Dec. 30, p. 6-7.

"...On the other hand, what is sometimes overlooked is that 90% or more of all water taken by industry is returned for re-use. Faced with an acute water supply problem, industry undoubtedly will become more active in devising means of re-using more of the water required in factory operations."

Desalinization is yet some ways off economically; perhaps it will be combined with mineral recovery in "aquaculture."

1964-43. ANONYMOUS.
WTCC Water Re-Use Subcommittee is Formed at Lubbock.
West Texas Today 45: July, p. 21.

[Quoted in full.]

"A special subcommittee on water re-use was organized at Lubbock July 8 by the chairman of the WTCC's Water Resources Committee, J. W. Buchanan of Dumas."

"Appointed chairman of the water re-use subcommittee was Henry E. Meadows of Midland, who is associated with Humble Oil and Refining Company there."

"Other members of the subcommittee are J. A. Miller, production superintendent of SWPS Co. in Amarillo; Frank Gray, a farmer from Lubbock who has wide experience in water re-use; Olin Ivey of Big Spring, with the CRMWD; and James Valiant of Plainview, with the High Plains Research Foundation there."

"The Lubbock meeting was exploratory, to see what possibilities existed for service to West Texas in the matter of educating the public as to water re-use. Buchanan, who is an ex-officio member of the subcommittee, said the group would be of great benefit in an educational and informational capacity."

"It was agreed that the subcommittee leaders would develop a series of articles on the various methods of water re-use and publish them in West Texas Today, beginning this fall."

1964-44. ANONYMOUS.
Whittier Narrows Water Reclamation Plant.
Wtr. and Sew. Wks. 111: 34-36.

Discusses design features and operation. Five photographs and a map are included.

1965-1. FRANKEL, Richard J.
Water Quality Management: Engineering-Economic Factors in Municipal Waste Disposal.
Wtr. Resources Research 1: 173-186.

"In areas where reclamation of municipal waste effluents is feasible, present emphasis on maximizing stream assimilative capacity through minimum waste treatment is poor utilization of water resources."

Cost analyses for the cycle sewage treatment plant-river-water works are presented for many modifications of process, quantity, and distance.

1965-2. GRAY, J. Frank.
Irrigation Processes Using Reclaimed Water or Effluent Described.
West Texas Today 45: Jan., p. 18-19, 23.

Principles of effluent irrigation are those of general irrigation modified, perhaps, by requirements of taking all effluent produced.

Irrigation with effluent has the advantages of:

1. regular water supply,

2. some soil fertility addition, and

3. avoiding stream pollution.

It has the disadvantages of:

1. water must be used at all times,

2. odors may be objectionable,

3. labor is hard to get and keep, and

4. submergence may kill seedling plants.

Sewage effluent irrigation in Lubbock dates back to the early 1930's. Approximately 2,000 acres are irrigated.

Storage space should be available for about 30 days' flow.

Crop data are cited.

1965-3. ISAAC, P. C. G.
Water, Waste and Wealth.
Wtr. and Wtr. Engr. 69: 151-159.

Reviews re-use for irrigation and industry in many parts of the world, citing original references.

1965-4. McGAUHEY, P. H.
Folklore in Water Quality Standards.
Civil Engr. 35: June, p. 70-71.

Problems raised by re-use are leading to a re-evaluation of the validity of the standards promulgated so dogmatically by so many Bureaus.

1965-5. OKUN, D. A., et al.
A Review of the Literature of 1964.
WPCF Jnl. 37: 587-646, 735-799, 887-979.

Re-use is summarized on p. 640-644.

1965-6. PARKHURST, John D.
Progress in Waste Water Re-Use in Southern California.
ASCE Proc. 91: IR 1, p. 79-91.

Over half of Los Angeles County's waste water is "so located and of such quality as to be readily amenable to renovation and re-use."

The Whittier Narrows operation is described and discussed.

"The question is not whether there will be water re-use, but when, where, and how well it will be implemented."

1965-7. TODD, David K.
Economics of Ground Water Recharge.
ASCE Proc. 91, HY 4, p. 249-270.

Little information has been published on the costs of artificial recharge of ground water. The significant variables in the problem include the size, purpose, method of operation, land costs, and water costs.

By data tabulations of case studies an attempt is made here to supply a workable basis for estimating these costs. Variations are so large that no simple summary would have much validity.

1965-8. VIBERT, A.
An Essential Aspect of Ground-Water Recharge.
L'Eau 52: 227-232.

Artificial recharge, having become increasingly necessary in many parts of the world, has led to many problems of ground water contamination and of reduction of permeability. The recharging waters should usually receive preliminary treatment.

Other problems of quality degradation of ground water are due to inflows from salt water or from polluted rivers, such as the Seine at Croissy. Water table elevations must be kept high enough to prevent these incursions. A mound of recharged water of acceptable quality is often the best solution.

1965-9. VIESSMAN, Warren, Jr.
Developments in Waste Water Re-Use.
Pub. Wks. 96: Apr., p. 138-140.

A survey is made of quantities available and an indication given of the uses which they would satisfy economically. Irrigation with effluent, industrial use, and recharge are described with citation of locations where practices. Santee is cited as an excellent example of the use of effluent for recreation.

1965-10. WALLACE, W. Glen.
Reclaimed Water Will Help Fill Lakes.
Pub. Wks. 96: Mar., p. 82-83.

Minneapolis will divert up to 22 cfs of used air-conditioning water to a chain of recreational lakes.

Waste air-conditioning water in downtown Minneapolis now flows to storm sewers; the quality is good. Cross-connections with sanitary sewers are being sealed.

1965-11. ANONYMOUS.
Effluent Will Fight Salt-Water Invasion.
ASCE Proc. 91, SA 3, Part 2, p. 9.

Long Island will have a barrier consisting of injected effluent. Observations are being made on a test well.

1965-12. ANONYMOUS.
Foam Fractionation Takes Another Step.
ASCE Proc. 91, SA 3, Part 2, p. 10-11.

Reports successful field test using foaming to remove soluble organic compounds from petrochemical and plating wastes.

1965-13. ANONYMOUS.
Purified Sewage Will Provide Water Supply to the Jurong Industrial Estate, Singapore.
Wtr. and Wtr. Engr. 69: 208-209.

Industrialization of Singapore, site of recurrent water shortages, is being made possible by utilization of the effluent of a modern treatment plant.

Plant equipment and contract provisions are listed.

1965-14. ANONYMOUS.
Standards for Re-Use of Effluent.
Effl. and Wtr. Trtment. Jnl. 5: 250-251.

"...Few of us appear to have faced the not unrealistic possibility that we may eventually have to control both population and living standards to suit the availability of water."

Re-use is bound to be accompanied by higher effluent standards. BOD standards alone are not enough. COD and limits to toxic metals and organic matter should be controlled as well.

1965-15. ANONYMOUS.
Take a Dip in Safe Effluent.
ASCE Proc. 91: SA 1, Part 2, p. 17.

The Santee project which reclaims water for use in a chain of recreational lakes will open a small section to controlled swimming.

1965-16. ANONYMOUS.
Editorial: Two Waters.
Effl. and Wtr. Trtment. Jnl. 5: 305.

The economics of pipe duplication are such that the provision of parallel systems--one with potable water, the other with salt water or effluent--can be justified only when the transmission distances are small.

1965-17. ANONYMOUS.
Water Re-Use.
Effl. and Wtr. Trtment. Jnl. 5: 381.

The wisdom of demineralization of sea water containing 35,000 ppm, while sewage effluent at about 900 ppm is discharged in an ocean outfall is questioned.

Tokyo is reported to be preparing to use 37 mgd of effluent from a new treatment plant in over 100 adjacent industries. This step will reduce serious ground water depletion in the area.

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