Chapter 8

POST WAR ACCELERATION

By 1946, the Sanitation District procedure, as a solution for the sewerage problems in Los Angeles County, was well recognized as controlling for most of the area outside of the City of Los Angeles, except the North Santa Monica Bay Cities and the San Fernando Valley. District 3, which had tried in vain to finance District works in 1925 and '30, voted bonds in the amount of $4 million in February 1946, while Districts 15, 16 and 17, covering part of the area of original District 7 (dissolved) voted bonds in 1946-47, in the amount, collectively, of $6,529,000 after joining with the other active Districts in joint agreements for construction, operation and administration. This action set the stage for some immediate, and very much needed, new or extended, facilities.

Terms of joint ownership in existing, and new, structures were construed to mean that, irrespective of ownership rights in any structure, all districts participating had acquired the right to use the facility until the limit of the facility's capacity had been reached. Thus, capacities could be adjusted among Districts as needed by buying or selling capacity ownership, or by leasing. When the limit of facility capacity had been reached, or was imminent, additional jointly owned structures were financed and
built and the new construction cost properly assigned. All facilities were bought and sold at cost, exclusive of interest on the investment or depreciation and did not include in any transaction the value of any gift or subsidy of any kind. The Districts early adopted, and have consistently followed, the unwritten policy that adequate sewerage is the business of all the citizens and public bodies in the County. Many new District investigations, preliminary plans, costs of promotion, advertising and bond election have been financed from the funds of existing, operating Districts until the tax money allowed after District formation could be made available. Also, if expedient, one District may transfer some of its capacity rights in certain facilities to another for sufficient funds to tide it over a brief period, and then buy it back. A sort of District Facility Hock Shop.

As heretofore noted, the ocean outfall at White’s Point was originally planned to be a double barrel line reaching seaward about a mile. As built, the double barrel was laid through the breaker zone and to a point off-shore, from which the second line could be constructed from barges without the necessity for near-shore trestle facilities during construction. Friction losses in the eight-foot Palos Verdes tunnel and the single sixty-inch diameter outfall pipe, limited the gravity capacity of the couple to a discharge rate of about 52 million gallons per day at mean tide. This average daily flow, having been reached in 1946, it was desirable to expand the bottle-neck in the outfall works by building the second leg of the outfall. By so doing the tunnel and outfall capacity could be increased to a rate of some 70 million gallons a day at mean sea level.

The stub line to which the second ocean pipe was to be connected, was 60 inches internal diameter; it extended seaward about two hundred feet and was there blanked off with a timber bulkhead. The extension, however, was designed as a 72” internal diameter pipe in order to cut down head losses and increase capacity. It seemed desirable to have the district forces do the job of extending the pipe for both this reason, and, because limited funds rendered entering into a fixed contract inadvisable. It was so ordered.

The outfall construction in 1937 had, fortunately, required
that the rock trench in which the second outfall pipe was to be laid, should be excavated a couple of hundred feet seaward and at an angle to the east, so that further shooting in the foundation, when the second leg was built, would be far enough away from the existing line to avoid damaging shock in further blasting in trench excavation. As a further precaution against possible rupture of the existing pipe, all further required blasting for the new trench was done with four pound bombs, instead of twenty pound bombs such as were used in the original construction. This latter provision was extremely fortunate. As is pointed out in the legal discussion, the Districts brought suit against the Federal Government for damages sustained to their outfall as a result of exploding obsolete ammunition over and near the outfall as a means of securing fish. In the pre-trial discussions, it was evident that the Federal Investigators were under the impression that twenty pound bombs had been used in blasting the latter trench, causing the damage for which the District was blaming the Army personnel. When the facts were
REINFORCING CAGE FOR 72-INCH OCEAN OUTFALL PIPE—Pipe construction in the 72-inch outfall at White's Point was modified after using 8-foot lengths to about 850 feet offshore. At this point construction proceeded using 24-foot lengths. Double reinforcing and special cast iron end rings for 24-foot length.

discovered the Government offered a settlement which, although short of the actual damage sustained, was accepted on advice of Counsel.

Extension of the second outfall pipe was commenced using 72" diameter spun concrete pipes, 8-feet in length. Two pipes were joined on deck and lowered into place attached to a strongback. The pipe in rock trench were embedded in concrete, wholly or in part, as required and the annular space between adjacent end rings and pipe caulked with lead wool. All pipe were equipped with end rings, attached at the plant of manufacture. At about 900-feet seaward the construction procedure was changed; pipe was cast in twenty-four foot lengths and equipped with mechanite iron end rings which could be caulked from the pipe interior, under water. This length greatly facilitated construction and, additionally, provided a moderate amount of flexibility in the line. Beyond the rock bottom shelf, pipe were laid directly on the undisturbed sand bottom.

Although the second outfall pipe was an obvious need, it was
not a solution. The flow of sewage from the new District 16, comprising the cities of Pasadena, South Pasadena, Alhambra and San Marino, as measured at the Tri-Cities Plant west of San Gabriel, was known to be twelve million gallons a day. Districts 15 and 17 could be readily determined to contribute ten million between them as soon as lateral sewers were built, while the flow from District 3, not already taken into the District system, was estimated to be some 8 million gallons per day. Thus, it was apparent that upon completion of the second ocean pipe, or shortly thereafter, an average daily flow exceeding 82 million gallons per day, plus the normal increase in the connected Districts, impeded.

It may be well at this point to state that the average daily flow was not the factor controlling the quantity of flow which could be treated, and disposed of, at Bixby, neither was the gravity capacity of the tunnel and ocean outfalls. As early as 1942, the Districts found it necessary to provide equipment, for high flow pumping into the outfall. Two Climax gas engines, operating on sludge gas,
direct connected to 30" Peerless Cent. Pumps, were installed at Bixby. These pumps, secured with the cooperation of the War Production Board as essential to public health, were used to move the flow into the outfall during periods when high tide and high flow coincided, or otherwise as required. Adequate pumping facilities have consistently been a characteristic of Bixby, but, by economic limitations, are appropriate for use only to supplement an otherwise adequate gravity disposal. The District effort has consistently been to provide gravity flow through the outfall for average daily flow of sewage at mean water level.

With the second ocean pipe in place, providing some seventy mgd capacity, the next bottleneck would occur in the eight-foot diameter tunnel and it was apparent that, as acceptance of the District idea gained momentum, the next enlargement would need to be on a rather impressive scale in order to continue operating on the basis of ocean disposal of primary effluent. This indicated greater access to White's Point and obviously much greater tunnel capacity. The latter implied a parallel tunnel larger than the existing one. A twelve-foot diameter tunnel was indicated. Experience with the eight-foot tunnel and single 60" diameter ocean outfall pipe was used to determine that the gravity flow through the combination of 12 and 8-foot diameter tunnels in parallel, thence to sea through 5 and 6-foot diameter pipes, would amount to 165 mgd. Furthermore, that if a seven-foot diameter ocean outfall pipe were added to the other two the gravity capacity of the combined structures would amount to 250 mgd. A pump lift of 20 feet above maximum water surface, in the tanks, at the plant, coupled with mean tide, would permit discharge to sea of about 400 mgd of plant effluent. Such a flow, it was estimated, might occur about 1970, at which time further steps would have to be taken if the same means of disposal were continued.

The new Districts, parties to the Joint Outfall Agreement, were well supplied with bond money for purchase of capacity rights in the existing works of the four original owners of Bixby and the trunk lines leading thereto and to the sea. They were likewise bonded for construction of trunk lines leading to, and into, their respective Districts. Such anticipated additional treatment and disposal works as were imminent were, of course, includ-
ed. The original owners were without funds, excepting for those received from the new Districts under the Joint Outfall Agreement. I felt reasonably sure that there was enough money to finance construction of the additional 72" diameter ocean pipe
REINFORCED CONCRETE PIPE FOR SUBMARINE OUTFALL—The second leg of the ocean outfall at White’s Point was completed in 1947. Six-foot diameter pipe lengths were used to extend the stub which had been laid in 1937. Sewage flow had increased to 65 million gallons a day average flow, with maximum rates of about 90 m.g.d.

line but that it would be inappropriate to contract the work, but rather, to do it with District forces on a “pay-as-you-go” basis. The Directors authorized the work. Fred Bowlus, the Districts’ construction engineer and Dan Boom, the Districts’ diving inspector and consultant, organized the job. Work commenced in August 1946 and the structure was completed to 110’ depth at 5000’ seaward and in operation in November 1947. This pipe was extended seaward in 1954 far enough to reach a depth of about 165 feet some 7,000 feet from shore.

There was no doubt about the necessity for building a second outfall tunnel at this time, and the indications were that it had better be one of ample size and capacity. The four Districts (1, 2, 5 and 8), were without construction funds for such a costly undertaking but all signs pointed to an impressive increase in assessed valuation throughout the entire County in the immediate future, sufficient to provide funds for the tunnel construction if it were carried out over a few years. This gave rise to the plan of building the tunnel in four increments, beginning at the inlet end and
constructing a cross over to the original eight-foot line at the quarter points. Such a plan would increase the gravity capacity of the outlet works in increments of about 20 mgd for each quarter of tunnel completed.

Work on the 12-foot tunnel commenced in July 1948. The four increments were completed by District forces and placed in operation respectively in April 1949; December 1950; March 1954, and April, 1958.

Concurrently with the construction of the 12-foot diameter tunnel, the Districts built a third ocean outfall at White's Point. This one, a 90-inch internal diameter reinforced concrete pipe extended to a water depth of 200 feet and embodied advanced principles of sewage diffusion in sea water, investigated, and described in Technical Journals by District engineers. The additional data were based largely on the initial work of Palmer and Rawn. The practical application as well as an extension of the principles involved were developed more fully in the second paper which was authored by Bowerman (Engr. Dists.), Brooks (Professor, Cal-Tech) and Rawn. It is gratifying to be able to note that the
PRECAST WYE 90-INCH OCEAN OUTFALL.—The 90 by 60 by 60 inch wye placed in ocean outfall at connection to wye diffusion structure. White's Point.

prototype structure was most efficient in action and, in addition to promoting prompt diffusion of the sewage effluent and hence its oxidation, practically eliminated the view of the surface field, and therefore much of the criticism, from shore observers. This pipe line was built by District employees.

The prediction that the assessed valuation of the County would increase materially in the years immediately following the close of World War II, proved to be a valid one. In the Districts which had built their initial works in the first quarter of the century, the assessed valuation more than doubled from 1946 to 1948. From the latter year to 1958 it more than doubled again.
Assessed valuation of those Districts which were organized in the mid-'40's increased in about the same order. It began to appear that, by careful planning and programing of required new works, further construction could be carried forward without the necessity for additional bonding, save in Districts separate from the jointly owned sewerage works. A member of the engineering staff was designated to program all new works for extension and expansion of the system, including those for which original bond money was not available, which would be needed in the succeeding five-year period. In addition the program was to include an estimate of the assessed valuation for each of the five years ahead
and, under none but the most extraordinary circumstances, was the estimated cost of the work to be accomplished in any one year to produce an increase in the previous year's tax rate, but, preferably, reduce it. This was to be a continuing program, so that the District would know at all times what the needs for the next five-year period would be. The plan contained flexibility only to the extent of substituting some jobs for others. It did not include any increase in the tax rate over the previous year. The District Boards approved of the plan and it was followed thereafter.

In order to finance the proposed method of extension and expansion, it was necessary to increase the current O & M tax rate in Districts 1, 2, 5 and 8. The average O & M tax rate for the four Districts was 17 cents per hundred A.V. This was increased to an average of 30 cents in 1946 and by 1958 had been reduced to 14 cents per hundred. Tax rates for all other Districts participating in the jointly owned works were held at rates sufficient to defray cost of extensions and expansions in the system over and above those contemplated in the original bond issue of each, subject to the
APPEAL FOR ECONOMY — Most of the tunnel labor came from the District area. An appeal was made to their sense of economy in the use of construction lumber, since they were taxpayers who would have to pay the bill.

same conditions, in re-increasing the rates, as applied to the older Districts. In 1951 the rates were actually increased over the previous year but for a reason not connected with the disposal of sewage. The two cent increase in 1951 in many of the Districts had to do with fulfilling new provisions in the law requiring the Districts to dispose of rubbish. The matter will be discussed later in this narrative. Furthermore, the foregoing discussion of financing extension and expansion of facilities does not apply to Districts 4, 9, 11, 14 or 20, none of which were parties to the Joint Outfall Agreement. In some measure they apply to South Bay Cities, which District abandoned its connection to the Los Angeles City Plant at
Hyperion, in 1950 and constructed a connection to one of the mains in District 5; thence to the Bixby disposal works. S.B.C., thereafter, became a party to the Joint Outfall Contract.

The history of District 4, during the period 1946 to 1958, is quite uneventful. Los Angeles City annexed part of it, creating some question about payment of services in the Los Angeles system, finally settled by having the Improvement Maintenance District act in certain matters for the Sanitation District. It is a somewhat confused District at best. A small part of the sewage originates in what is now Beverly Hills; much of the District is in Los Angeles; the rest is unincorporated. Sewage from the City of
Los Angeles flows into the District lines along the north boundary of the District and then flows again into the Los Angeles lines south of the District. The District pays for what originates within the District but that from the City has to be measured at the north boundary and deducted. The matter is further complicated by annexations to Los Angeles from the southern part of District 4 where much the same confusion reigns, only more so, because in this case the annexed area sports a large hospital which overloads the District lines. Add to this the fact that Los Angeles City and Los Angeles County building laws are not the same and both are different from those of Beverly Hills and that the unincorporated area is developing into a high-priced, high-rise district and that Los Angeles is somewhat loath to extend service to such a formidable competitor; and District 4 is the result. From a sleepy little village before the last war it has developed into a roaring development of high-priced, high-rise apartments and office buildings. Sunset Boulevard bisects it the long way.

District 9 is a residential area of County, completely surrounded by Los Angeles, in the San Pedro annexation to that city.
Its history is that of a static area, improving in price as the surrounding land increases in value. It had no bonded indebtedness and pays an annual fee to Los Angeles for the disposal of its collected sewage through a Los Angeles sewerage plant on Terminal Island. District 11, organized for the purpose of contracting with Los Angeles for disposal of oil well brines, is gradually being absorbed into, or served by, District 5 as it develops residually.

District 14 has a history dating from 1940, when it sold bonds to build a small system in and about Lancaster. It was a W.P.A. job and cost the property owners in the District very little.

Lancaster was, and is, unincorporated and its Chamber of Commerce successfully undertook to guide the local destiny of the District. The Hon. Roger Jessup was County Supervisor of the area and for many years was Chairman of the Board of Supervisors. The Board of Supervisors, by law, constituted the Board of Directors of the District. Its initial district system served very well until 1952, at which time the District area was expanded from about 2/3 of a square mile to five, and two years later to seven square miles. During those two years the District used $340,000 of a $440,000 bond issue voted in 1952 for new facilities and cancelled the remainder of the issue. In 1956 the District expanded its boundaries to include thirty-five square miles and voted bonds in the amount of $2,653,000. Revenue from the sale of these latter bonds was used to extend and increase the trunk sewer and pumping system and to build a rather large and impressive oxidation treatment plant well North of Lancaster and its rapidly developing environs.

All efforts to dispose of the very acceptable irrigation water resulting from treatment of sewage at the District 14 plant have been unavailing. There is no outlet from the Dry Lake area, to which the plant flow is tributary, leaving the final disposal of the plant effluent to evaporation. This requires extensive pond areas which are not readily available because of the desire of military forces in the locality to use the dry lake bottom for military purposes. The treatment process employed at the plant is eminently successful and well adapted to an area, where there is a great deal of arid land in the immediate environs. Were it not that the highest and best use of the ancient Dry Lake area is for military
purposes, at least in the opinion of Federal personnel, the existing works in District 14 would end sewerage problems there, but disposal of the effluent from the plant still remains to be permanently resolved.

District 20 is in the same general location as District 14. Organized in 1951, bonds in the amount of $140,000 were approved in January 1952 and the proceeds used to build a modest system to serve some 2 square miles in the immediate Palmdale area. In 1957 additional bonds, in the amount of $2,400,000 were successfully floated and, in the same year $1,540,000 were sold to finance construction of additional works to serve an area of 28 square miles. Trunk sewers were extended to serve the entire area as it developed and a process of sewage treatment installed similar to that at Lancaster. District 20 has arranged with a nearby property owner for use of the sewage plant effluent in irrigation of hay.

In both Districts 14 and 20, the reason for the rather impressive expansion of sewered area was the advent of large air transportation industry. Since 1957, population of both districts has greatly increased, and growth is continuing although at a steadier and more conservative rate. It is stated that lots in the Lancaster area, now commanding very high prices were, in the early part of the century, given away with subscriptions to the Los Angeles Times and, perhaps, other newspapers.

The foregoing brief explanation of activities in some Districts, is related to indicate that the problems in Districts 4, 9, 11, 14 and 20, were quite different from the much more impressive difficulties confronting the Districts which were parties to the Joint Outfall Agreement, and facing the necessity, in the older Districts, of financing many millions of dollars’ worth of improvements and extensions. It is easy to say, now, that the problems attendant upon successful consummation of necessary works were resolved and the record of accomplishment is in public view, leaving to the narrator, the enjoyable, if somewhat nostalgic, task of filling in some of the unrecorded experiences.

Money began to accrue to all of the active Joint Outfall Districts in 1946. Sale of bonds and purchase, by the new Districts, of capacity rights in structures and facilities built ten to twenty
years before, spread the money around sufficiently so that some construction, very much needed, could be gotten under way. I was informed, at the time, that the Auditor would not recognize a contract executed by the Districts unless there was sufficient money in the Treasurer’s possession to cover the entire cost to each participating District. By Auditor and Treasurer, I mean the County of Los Angeles Officials who served in this capacity for the Districts. This factor was one of those which prompted us to go forward with the second ocean outfall pipe construction with District forces rather than by contract. Another reason, and a very potent one, was that the available contractors at the time, had been engaged in Federal, or Federal financed, construction and had grown accustomed to being paid for their efforts in a manner and amount which only the Federal agencies could readily afford. Bids received by the Districts for minor jobs were straws in the wind, but when the Districts offered the first quarter of the 12-foot tunnel section for tenders it became apparent that either the Districts would have to revise their estimates upward in a hurry or, get into construction operations on a large scale with their own forces.

The disparity between District estimates of cost for proposed work, and the contractors’ ideas of what price tag should be put on them, compelled the Districts to undertake building with District forces early in 1947. The decision put the Districts in the market for a considerable amount of construction equipment. Most of what existed was in war surplus stocks in the various cantonments, including, at Hueneme, some which would be very useful to the Districts. I tried to reach the proper contact locally, but was shunted around and finally told that the surplus was sold only to veterans who wanted to use it for their own purposes, and was otherwise not for sale. This was so far fetched that I decided to try to reach the right parties by going to Washington, where I had served on many occasions during the war as a dollar a year consultant on sewerage matters. It looked rather hopeless, upon arrival, because most of those I knew were back at their regular jobs all over the country. While nosing around I was informed that the allocations board had, on it, as a member, the National Commander of the American Legion and that he was the big wheel on
the Board. I called past National Commander, John R. Quinn, at
Los Angeles, and explained the dilemma to him. He knew the
current National Commander, gave him a ring and, immediately,
the Districts received a priority right to purchase, at heavy dis-
count, machinery from the surplus military stock. This put the
Districts in position to bid against the contractors on any job,
thanks again to John Quinn.

It is well to explain that, whenever a low bid was within five
to ten percent of our engineering estimate of what the submission
should be, I recommended to the appropriate Board that the
contract be awarded. If it exceeded that difference I offered to do
the work with District forces. Between 1947 and 1958, the Dis-
tricts were saved more than three and one-half million dollars in
this manner. The record of District operation was public, and any
qualified contractor or other individual could investigate it. All
were urged to do so.

The permanently employed construction force of the Dis-
tricts was always a very small one. There were four good, well
qualified construction men in the employ of the Districts during
the era when it seemed necessary to undertake a considerable
amount of construction with District forces. Two of these men
were professional engineers, while two were better identified as
practical construction superintendents. District practice was to
employ the entire working crew on each job from the Union Labor
Halls, if men with the required knowledge and experience could
be so obtained. The Districts are greatly indebted to the Unions for
help and assistance, particularly at times of critical stress. All
labor employed on construction jobs by the Districts, whether
union or otherwise, was paid union wages. When no new construc-
tion work was in progress, the limited construction force was
absorbed into the operation and maintenance supervisory groups.

The Associated General Contractors became quite critical of
the Districts activity in doing their own construction work and
sought to, and eventually did, amend the enabling legislation in an
effort to prevent it. To this, the Districts put up little resistance,
since the Directors, or a large majority of them, were enthusiastic
proponents of free enterprise and had no desire to build with
District forces without ample reason for doing so. The times and
circumstances appeared to warrant what steps were taken, following the war, and the District welcomed the amendment setting out in detail the steps preliminary to, so-called, "force account" work.

The Joint Disposal Plant was greatly expanded during the period (1947-58) but the work of expansion was done only as required and as money became available. There was probably no time during the twelve-year interval when new or extended construction was not being carried forward. All elements had to be expanded, changed or modified as conditions dictated. Experimental work was continuous.

Between 1947 and 1958, the average daily flow of sewage at Bixby increased some 435 percent or at an average yearly increase of 15 mgd. Flow in 1958 was 225 mgd average daily. The average daily high flow for the same year was 235 mg. Capacity of the outfall complex, at mean tide was estimated to be in excess of 250 mgd possibly 260. Sludge disposal, power development, pumping facilities, and land requirements, increased correspondingly. The Joint Outfall Operation, by 1958, was serving more than the territory envisioned by Warren in his original concept.

Six, multiple stage, sludge digestion tanks had been constructed and were in use at Bixby by 1947. Experiments completed by that time indicated a change in future construction and the desirability of supplementing the existing tanks. By 1958 sludge digestion facilities had been expanded to more than three times the capacity of 1947 and the process of digestion improved to the extent of doubling the efficiency of the process. Briefly — the original multi-stage digestion tanks were capable of digesting sludge at a rate of about seven pounds per cubic foot of tank capacity per month instead of the four pound capacity per cubic foot in tanks previously in general use; the tanks constructed later in the 1947-58 period digest at the rate of 12 to 15 pounds per cubic foot per month.

From the very modest start in 1938, when an 8-cylinder internal combustion engine, using sludge gas as fuel, was used to drive a generator at Bixby, power generation at the plant has kept pace with other requirements. A power house had been constructed, at Bixby in 1936 and in anticipation of future needs had been designed to accommodate four power units. In 1946 an Ingersol
BIXBY POWER PLANT—The first Chief Engineer’s preference for brick construction is demonstrated in the original power plant at Bixby. Built in 1936, the building was converted to concrete exterior finish later to bring it into harmony with other structures.

Rand, V-Type, eight-cylinder, 880 H.P., internal combustion engine, driving a 760 K.V.A. generator was installed in the power house. It operated on sludge gas. It was followed by three similar units installed, one each, in 1948, 1953 and 1954. The power house, which had been designed in 1936, with more compact units in mind, had to be enlarged to accommodate the fourth unit.

Power generation, using sludge gas for fuel, had paid off very well at Bixby. Purchased power, in this area and in the quantities needed at Bixby, costs about 1.7 times as much as power generated at the plant using sludge gas for fuel. The record discloses that since installation of the first gas engine generator at Bixby in 1938, a saving in power costs of $350,000 has resulted from generation and use of 14 million K.W.H. Excess sludge gas is currently being sold at Bixby for ten cents per thousand cubic feet. In its earlier history it had little value, if any, commercially.

Effluent pumping facilities kept pace with increased flows of sewage. Beginning with the two gas engine driven pumps installed in 1942, pumping facilities were supplemented with two motor driven pumps in 1947. In late 1948 a second effluent pumping
plant was constructed. In this structure were to be installed four sludge gas engines, each directly connected to a pump of 28,000 g.p.m. capacity at 35-ft. pumping head. The engines and pumps were installed and placed in operation during the first quarter of 1949. The engines proved to be entirely unsatisfactory and the Districts refused to pay wholly for them until obvious deficiencies were corrected. The manufacturer’s representatives worked with the District personnel for nearly two years trying to justify the sale, during which time the plant superintendent kept accurate records of the equipment, performance and deficiencies.

By late 1951 it was obvious that the equipment was totally unsatisfactory and the vendor was instructed to remove the engines and release the Districts from payment. It must be understood that, despite their shortcomings, the deficient engines had to be kept on the line and a very careful schedule for their removal timed with replacement by others. The vendor threatened suit, which the Districts welcomed but, after pre-trial conferences he decided against legal action. Merely being relieved from paying the
purchase price of the engines did not repay the Districts for the trouble, inconvenience or expense caused by the defective equipment but we decided against trying for recovery in view of the delays and confusion which such trials cause in an otherwise very busy organization.

Plant area, with particular attention to sludge drying and disposal, became critical after the war years. In 1947, the Districts owned 29.57 acres at the Bixby site, most of which was occupied, or reserved, for sewage purification structures. The sludge purchasing contractor had acquired a tract of land adjacent to the Bixby site which the Districts were using as a drying area and upon which
they had constructed extensive sludge drying beds. It was obvious that more land was, or shortly would be needed, for plant expansion and to provide a buffer strip around the works. Commencing in 1950 the Districts started acquiring property in the area and by 1958 had increased their holdings at Bixby to 234.24 acres. The average cost per acre to 1958 was a little over $3,300. Land in the area today is selling for upwards of $20,000 an acre.

Despite the expanded sludge disposal facilities, sludge was beginning to be a most formidable problem again. Digestion in the multi-stage tanks was good as a rule with only occasional departure from requirements, but notwithstanding a rather extensive area devoted to sludge beds, drying lagged to the extent that the beds had to be filled to a depth which aggravated the situation by retarding removal. There seemed but one alternative, at the time, to wit: disposal of digested sludge through the outfall to sea. In preparation for such an unusual (announced) departure, the Bixby chemist, Joe Candell, and Rawn, conducted an investigation upon the possible pollutional effects which might accrue if some, or all, of the digested sludge were to be wasted with the plant effluent, to the sea.

It was surprising to learn that little, if any, additional contamination would be added to the flow, however it did appear that certain components of the sludge which came through the digestion process unscathed, would cause an unsightly nuisance along shore. Results of the study and investigation are published in Transactions of the American Society of Civil Engineers 1950. They have had quite an influence on sludge disposal. Research, by the District staff members, and its application to screens and shakers, has successfully solved the matter of retaining, at the plant, the undesirable sludge solids while wasting the bulk of the sludge, without difficulty, to sea. The same investigations have enabled separation of solids from liquid components in digested sludge to a degree which permits vastly greater, and more efficient, use of the sludge bed areas. Much of the improvement in the sludge operations has been accomplished since 1958 but is tied in to it to a degree that seems to require mentioning here.

Construction with District forces, rather than by contract, was not limited to Bixby and the outfall works leading to the sea.
Bids were rejected on a score of jobs upon which tenders were considered higher than the work warranted. Such work was undertaken by District forces. The record of results seems ample justifi-
cution for this departure from customary free enterprise. Actually, the Districts have contracted for many times as much work of construction as has been undertaken by District forces.