

CHAPTER 25

THE SAND TRANSFER PLANT AT LAKE WORTH INLET

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It is the intention of this paper to give a description of the soon to be completed Sand Transfer Facility at the north jetty of the Lake Worth Inlet in Palm Beach, Florida.

INTRODUCTION

A technical report of this nature would not be complete if it did not bring out, however briefly, the underlying causes which led to the design and eventual construction of the subject installation. The fundamental cause would be erosion, specifically, beach erosion, one of the most destructive forces of nature and, like other such forces, one which has come under the study of scientists and professional engineers.

The beach bordering on the east coast of Palm Beach Island is composed essentially of fine sand and shell fragments which are moved by the action of littoral currents and direct attack of the shoreline by severe waves. Although contour studies made prior to 1925 indicate minor shore recession, the major problem arose with the construction of the rock jetties which protect the Lake Worth Inlet and navigation channel. The predominant southward littoral drift was intercepted by the north jetty and impounded causing an interruption in the supply of sand to the south. The very striking and visible result has been starvation of the beaches along Palm Beach Island and accretion to the north where the beach now lies approximately 1400 feet seaward of the beach line south of the inlet.

ANNUAL SAND MOVEMENT

The Beach Erosion Board of the Corps of Engineers, U. S. Army, has estimated the natural southward movement of sand at Palm Beach to be between 150,000 and 225,000 cubic yards of sand per year and has expressed the opinion that the impounding capacity of the north jetty now has nearly been reached. They further estimate that the rate of accretion at the inlet, including material removed in maintaining the channel, amounted to 230,000 cubic yards annually from 1929 to 1955.

On Palm Beach Island, landward of the 18 foot contour, annual losses of 200,000 cubic yards were experienced during the same period. This loss of 200,000 cubic yards compares favorably with the volume which was prevented from reaching the island by the inlet.

REFERENCES

Corps of Engineers, U. S. Army (1956). Beach Erosion Control Report on Cooperative Study of Palm Beach, Florida.

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PREVIOUS OPERATIONS

Restoration of the beaches south of the inlet has been unsuccessfully attempted in the past by means of various type groins built normal or generally normal to the shore line. The subject is somewhat controversial but the general consensus of opinion is that while groins may be useful in intercepting sand movement and thereby impounding material, they are relatively ineffective where the primary trouble lies in a cessation of the supply of sand moving to the beach.

As an alternative to groins, stockpiles of sand amounting to 2 and 1/2 million cubic yards have been pumped from Lake Worth and deposited on the beach at various times over a period of years. Later observations indicated that this sand had noticeably benefited the beaches to both the north and south. On the basis of these operations it has been demonstrated that at least ten miles of shore line could be adequately nourished by furnishing sand at the approximate rate of 200,000 cubic yards per year.

Inasmuch as this operation appeared successful, the question naturally arises as to why it could not be continued indefinitely. Perhaps the most serious objection can be found in the inferior quality of the sand itself. The lake sand is finer grained, of a different color and intermixed with black earth, high in organic matter and gasses. These characteristics and the fact that the lake could not be considered as an unlimited source of supply forced a search for another solution to the problem.

SOUTH LAKE WORTH INLET

A situation identical in many respects to the one at Lake Worth Inlet has been successfully resolved at the South Lake Worth Inlet which lies about 15 miles to the south. In 1937, a sand transfer plant was installed at the north jetty which functioned satisfactorily until it was shut down for the duration of World War II. During its operative period it had furnished a supply of sand to the beaches south of the inlet causing them to accrete materially and considerably reduced the shoaling of the middle ground of Lake Worth. Following the termination of pumping operations in 1942 the beaches to the south eroded and shoaling was once more evident in Lake Worth. Operations were resumed in 1945 and in 1948 the 6 inch pump was replaced by the present 8 inch unit which effectively bypasses about 80,000 cubic yards of sand annually, the results of which have been indeed gratifying to local interests.

REFERENCES

Knappen-Tippetts-Abbett-McCarthy, (August 1954). Preliminary Report on SAND TRANSFER FACILITY at Lake Worth Inlet, Palm Beach, Florida - for State of Florida, County of Palm Beach, Town of Palm Beach.

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ANALYSIS OF THE PROBLEM

In October of 1954, the New York firm of Tippetts - Abbott-McCarthy - Stratton delivered an engineering report to the Florida State Board of Conservation. This report provided an appraisal of the situation and dealt with various methods of supplying sand to the depleted beaches south of the Lake Worth Inlet.

After having evaluated several methods, the consultants recommended the construction of a fixed dredge type installation modeled on the South Lake Worth Inlet plant. They concluded that the new plant should be capable of transferring sand across the inlet at the annual rate of approximately 250,000 cubic yards. The plant would bypass material of essentially the same composition as that on the shore of Palma Beach Island and would, during periods of southward littoral drift, provide an almost continual flow of such material. It is further thought that maintenance dredging in the channel will be reduced considerably by the transfer of excess sand across the inlet, a fact which may be considered as a major point in proving the economic justification of the plant.

THE SAND TRANSFER PLANT

Basically, the Lake Worth Sand Transfer Plant consists of an arrangement of pumps, piping and other equipment designed to transfer the excess sand deposited by wind and wave action on the beach north of the inlet to a point where it will serve to nourish the starved beaches to the south. The facility includes the following basic features:

(1) A fixed pumping station - consisting of a dredge pump installation in a reinforced concrete building designed to withstand tropical storms of hurricane intensity and to harmonize with the surrounding resort-type area.

(2) A submerged discharge line - made up of steel pipe and rubber hose which will carry the dredged material across the Lake Worth Inlet to the depleted areas to the south.

(3) A protective groin - constructed of steel sheet piling and designed to maintain the beaches to the north in their present condition.

(4) Flushing Equipment - which will be used to prevent plugging or stoppage in the submerged line.

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PUMP HOUSE

The structure housing the pumping equipment is a heavily reinforced concrete building, elliptical in shape, and having two floors, the lower of which is at elevation - 1.0 (M.L.W.). This is the main floor of the pump house and contains the dredge pump and motor, service and gland water pumps, the sump or bilge pump and the power supplying transformer. The upper floor at elevation 11.5 houses the main operating control desk, motor controllers, ventilating equipment and the suction hose boom and mast operating equipment.

The pump house is supported on a reinforced concrete caisson, founded on sand at elevation -28.0 (M.L.W.). The lower part of the caisson has been sealed by means of a 3 foot tremie concrete slab. To increase lateral stability the caisson has been filled with about 380 cubic yards of beach sand and is closed at the top by the main floor of the pump house.

MAIN EQUIPMENT

The Dredge Pump - is a centrifugal type pump with a 12" suction inlet and a 10" discharge outlet. It has been designed for a rated clear water capacity of not less than 4000 G.P.M. at approximately 690 R.P.M. against a total dynamic head of 198 feet. The operating characteristics are based on the direct connection, through a flexible coupling, to a 400 H.P. - 720 R.P.M. wound rotor motor, all mounted on a common welded structural steel bedplate.

The pump impeller is enclosed and rotates in a volute type casing which has been designed to convert the velocity head created by the impeller to pressure head at the discharge. The casing is equipped with easily replaceable liner plates and all wearing parts are of an abrasion resisting steel alloy. The pump is capable of handling up to 15% solids at an efficiency greater than 60 percent. The rate of sand transfer, under ideal conditions, will be from 170 to 178 cubic yards of saturated sand per hour.

The Hoisting Equipment - consists of a mast and boom arrangement which carries the 12" suction hose while transporting it throughout the pumping area. The suction leg boom arrangement has been designed to control both horizontal and vertical movement over the entire pumping range. Horizontal movement is controlled by a slewing or rotating assembly which will turn the boom through an arc of 140 degrees at a periphery speed of 50 feet per minute.

The luffing or boom raising and lowering assembly is capable of raising the fully loaded boom through a vertical arc of 25 degrees in approximately one minute. Two mooring posts have been provided at the limit of westward travel to permit securing of both the boom and the hose during rough weather or inoperative periods.

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POWER SUPPLY

The suppression of noise was a primary consideration in the design of the plant and it was for this reason that internal combustion engines were ruled out as a source of power. In order to insure quiet operation, all of the equipment will be powered by electric current.

The Power Supply Transformer - is a double winding, 3-phase, dry type and is rated at 112-1/2 KVA providing a primary voltage of 4160 volts. The power cables are carried within steel, zinc-coated conduits which have been encased in concrete for protection against the elements. All possible measures have been taken to prevent objectionable radio and television interference.

DISCHARGE LINE

The total length of the 10 inch discharge line is approximately 1750 feet. For a distance of 750 feet across the floor of the navigation channel, the sand and water mixture will be carried through a heavy duty wire reinforced rubber hose. To facilitate removal for future deepening of the channel, the hose is made up in 50 foot lengths with built in steel couplings for easy disconnection. The hose is of the smooth bore type and is constructed of pure gum rubber protected by multiple layers of duck. It is resistant to sand abrasion and the action of salt water and will, according to its manufacturers, prove invulnerable to the attack of teredos and other marine borers. The land portion of the discharge pipeline is constructed of extra-heavy steel pipe with 0.5 inch wall thickness and is of a type particularly suited to the transportation of dredge sand.

PROTECTIVE GROIN

The pump house with its suction hose boom lies completely within an area bounded by an "L" shaped groin to the west and north and by the easterly extension of the north jetty to the south. The primary purpose of this groin is to maintain the beaches to the north in their present or "pre-pumping" condition. In this respect, the groin acts in the manner of a bulkhead or retaining wall. Only sand which moves over the top of this groin will come within range of the suction head. The groin, including its 198 foot seaward extension, is made up of 34 foot lengths of interlocking steel sheet piling driven flush with the existing beach profile and capped. Posts have been erected along the entire length of groin which will carry a safety line marking off the area to the public.

LINE FLUSHING EQUIPMENT

In the event that the submerged portion of the discharge line becomes clogged with sand due to a power failure or stoppage

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of the dredge pump, clean water, under pressure, will be automatically flushed through the line to eliminate the plug. Water for this flushing operation will be stored in a 17,000 gallon tank supported in a reinforced concrete cradle. The tank has been designed to hold sea-water under a pressure of 70 psig. A butterfly-type, air cylinder operated flush valve has been provided which under normal pumping conditions will remain closed. On failure of the power supply or other stoppage of the dredge pump, the solenoid operated valve opens an air pilot line which in turn opens the butterfly valve releasing water from the tank to the submerged line. Air required to close the valve at the end of the flushing run is supplied from a separate air receiver in which the air has been held during the pressure drop in the flush tank. A check valve will close automatically in the 10 inch line to prevent flushing water from flowing back toward the main pump while the operation is in progress. When current is restored following a power failure, the main pump will be started slowly, pumping clean water until the entire length of discharge line has been flushed out.

SUMMATION

Because the Lake Worth Sand Transfer Plant is a fixed-dredge type installation it must depend upon the action of littoral currents to bring sand within reach of the suction hose boom. Consequently the actual periods of sand by-passing will coincide with identical periods of sand movement from north to south. It would be well to point out that during these periods of southward littoral drift, the shoreline of Palm Beach Island will be experiencing sand losses due to erosion. Therefore it is assumed that during times of little or no sand movement to the pumping station only minor changes will be taking place along the beaches to the south. It is the accepted theory that southerly winds tend to build up the beaches while winds from the north cause them to erode.

The dredge pump in the new plant has been designed to handle the volume of sand as fast as it arrives within range of the suction hose. Assuming that such will be the case, it can be seen that the natural southward littoral drift will once more become available to the beaches of Palm Beach Island. The construction of this facility represents a forward step in the ever increasing program to combat beach erosion problems in the United States and throughout the world. A sufficiently wide beach or "beach berm" represents the best possible protection to shorefront and upland properties during periods of violent storms and resulting heavy seas.

The future alone will determine the degree of success which will be attributed to the Lake Worth Sand Transfer Plant. For the present let its construction reflect credit on the civic-minded men responsible for its planning. Their recognition of beach sand as a valuable natural resource for the future as well as the present should serve as an inspiration to others who are likewise dedicated to its conservation.