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RECLAMATION AND DEVELOPMENT OF THE NEW JERSEY COAST.

By GEO. L. WATSON, A. M. Can. Soc. C. E.

(To be read before General Section, April 15, 1909.)

Three years ago the writer was called upon by the authorities of the cities of Holly Beach, Wild Wood, and Wild Wood Crest, N.J., to assume charge of their contemplated improvements, and as some of these and their methods were performed under difficult conditions, it is thought that they may be of some interest to the members of the Society.

Wild Wood, Holly Beach, and Wild Wood Crest are situated on one of the numerous islands of the New Jersey Coast, the whole being known as Five Mile Beach; and in common with the rest of the islands of this coast, there is the same marked peculiarity: the constant changing of the ocean currents shifting the sands and making and destroying land.

The first improvement contemplated was the reclamation of about 360 acres of meadow land adjacent to the city of Holly Beach, that was at one time proposed for an extension of the city, and with this end in view \$500,000 was subscribed by interested individuals.

The property in question was 7950 feet long, and from 680 to 3470 feet wide, bounded on the east by the Atlantic Ocean, on the west and south by Turtle Gut Inlet, and on the north by the city of Holly Beach. (See map, Fig. 1.) It was covered with a depth of three feet of water at high tide. Upon examination it was found to consist of a thick black mud, covered with heavy meadow sod, some rank growth, and irregular mounds of sand, which, owing to the currents, were constantly changing position.

As speed was to be essential in the entire undertaking, it was decided to do all work on force account, and with this end in view plans were at once commenced for raising the grade four feet and maintaining it at that level.

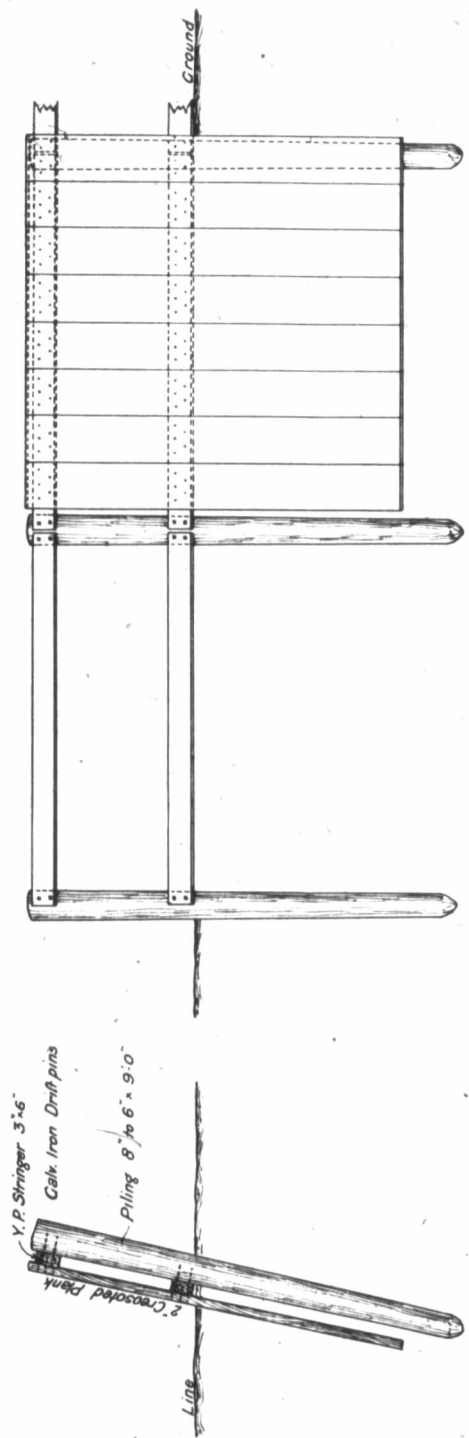
The method adopted in this filling was the use of two hydraulic dredges, one dipper dredge, ten scows, and a small, but powerful tug, with the necessary discharge pipe, etc. The hydraulic dredges were about 90 feet long and 32 feet wide, containing a centrifugal pump of 22-inch suction and 20-inch discharge; the dipper dredge had a capacity of three cubic yards.

Owing to the rise and fall of the tide covering the base of operations, provision had to be made for the protection of the sand after having been deposited, and with this purpose in view a light bulkhead was constructed (Fig. 2 and 3) around the entire property, same being completed in sections as fast as the filling progressed.

The material for the bulkhead was unloaded from cars at the wharf in Holly Beach, directly upon scows, and brought through the back channel to destination. The construction of the bulkhead was very crude, as it was merely to act as a protection for the sand filling, and was composed of creosoted piling nine feet long and of an average thickness of eight inches at the butt. These were driven on a batter of two to twelve by means of a jet, for a depth of five and one-half feet, and eight feet centre to centre. To these piles, by means of drift pins, stringers three by six inches, and seven to eight feet long, were fastened, at the top of the piling and at the original grade line. Creosoted plank two by twelve inches, and seven to eight feet long were next pumped in and bolted to the stringers. In front of these a trench six feet wide and four feet deep was excavated and filled with brush, which was then covered over; the object of this last was to prevent backwash.

For the construction of this bulkhead very little plant was needed, and owing to the fact of the tide covering the base of operations it had of necessity to be portable. A six-inch centrifugal pump mounted on a truck with wide tread wheels, six hundred feet of three-inch cast iron pipe with anchor and strainer, four hundred feet of three-inch woven hose, portable tripod for lifting and handling piling, and a twenty horse-power gasoline engine that could be connected either to the pump, or the saw, completed the outfit.

Upon the completion of the filling it was found that unless some further precautions were taken, on the ocean front, the bulkhead would be demolished by the action of the waves, owing to a marked change in the currents. Therefore strong measures were taken; these consisted of driving a double row of piling thirty-five



CROSS SECTION OF BULKHEAD

Fig. 2

ELEVATION OF BULKHEAD

Fig. 3

feet further seaward from the bulkhead and parallel to it. They were set six feet in the sand with a six-inch space between each; in back of this was placed a brush mattress two feet high and eight feet wide, fastened securely to the piling and firmly anchored. At intervals of four hundred feet crib jetties extending three hundred feet seaward, while in other places sand bags were piled, and at the mouth of the inlet two large coal barges were filled with rock and sunk obliquely across the current.

The object of all this was to turn the current off shore, make a gradually sloping beach, and to protect the bulkhead, behind which reposed our jealously guarded sand. By the addition of two extra rows of piling, eight feet centre to centre, and ten feet apart, parallel and adjacent to the bulkhead on the land side, and with three by eight inch stringers and two by ten inch by twenty feet plank, a broadwalk was constructed along the entire ocean front for the entire length of the property.

This construction necessitated a heavier plant, floating pile-driver and jet scows and tug, worked constantly at low water, for, owing to the current, nothing could be done at high tide.

On the completion of the dredging and bulkheading we were now ready to proceed with the other improvements, and three corps were placed in the field—one to lay out the streets and give grades and levels; the second to lay out the sewer system and water mains and to give locations for telephone ducts and railroad; while the third had the location of building and lot lines, sidewalks and grades.

It may be well to mention at this point that on the two main streets, instead of having one large sewer in the centre of the streets as is customary, two smaller sizes were laid under each sidewalk; while between the sidewalk line and the property line in a strip eight feet wide that had been reserved for this purpose were located the water and gas mains, telephone and electric conduits. The reason of this change was that it was proposed to lay a vitrified block pavement, one of the features to be permanency, which could not be had if every public service corporation that desired could rip up the pavement and replace it in any half-hearted way that they chose; and from investigations that had been made it was found that if success were attained in getting the pavement down at all, it would not be in such a way that it could be tampered with.

To serve the buildings a system of terra cotta pipe sewers were built. The trench for the entire distance, sixteen miles, was through quicksand, known locally as "boiling sand." This was both expensive and difficult work, as it was difficult to keep the

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pipes in proper grade and alignment, and the joints were hard to caulk, owing to the water in the ditch.

The greatest cutting was six and one-half feet deep, and the entire trench was double sheeted throughout, great trouble being experienced in keeping the trench even partially dry. Sumps or wells could not be made, as the pumps pulled out so much sand under the sheeting as to cause the ditch to either fill or the sheeting to cave in. Water was struck twelve inches below the sand grade in great quantity.

The sheeting was put down to a depth of ten feet with a water jet in advance of the excavation, this being the only way that any headway could be made. Owing to the numerous "salt holes" encountered, it was necessary to make a foundation for the manholes and pipe. This was done by piling spaced seven feet apart and six inches centre to centre. On the piles yellow pine timbers four by four inches and eight feet long were spiked, and to these were spiked hemlock planks two by eight inches and fourteen feet long. The pipe was laid on this and the hole filled with sand and salt hay.

If a manhole was located at one of these "salt holes," four piles ten to fifteen feet long were driven, four and one-half feet centre to centre. Four railroad ties were then spiked together with two battens, and the whole bolted securely to the piles. On this foundation was placed a box five feet square and ten inches deep, the bottom being covered with tongue-and-groove floor boards, and in some cases lined with canvas and the inside coated with hot coal-tar pitch. The concrete was placed in the box, the pipe line run through, inverts struck, and the brickwork completed.

The method of excavating was as follows: By using the piston pump the sheathing was put down for a distance of one hundred and fifty feet along the trench, and closure made at each end. Then ten laborers were put in the trench and excavation made to the water line, when rangers and braces were set.

The piston pump was then started pumping water into this "land coffer-dam." A centrifugal pump was moved in position, and the discharge pipe placed midway in the last section where the sewer pipe had already been laid. Thus the centrifugal pump excavated the material from the forward section and backfilled the last section at the same time.

When grade was reached the foundation piles were jettied down and the cradle constructed. The pipe was then laid, the joints being made with neat cement and boiling tar, as this was found, after experiments, to be superior to sulphur, cement, asphalt, or sulphur and sand. The next section was then done in a similar manner.

The sand excavated was quite coarse, and but little agitation was necessary with shovels, in order to allow the pump to pick up the sand. When the sand is fine grained much more water is needed, and likewise the sand must be agitated with shovels. With extremely fine sand the men must be relieved frequently, as the work is hard, and the pump taking up a much smaller percentage of the sand, means the ditch must be kept with a larger amount of water in it, and the men, being compelled to stand in the water, feel the effect of it quickly.

At times when we got as deep in the trench as the original grade line, we encountered roots and stumps that had to be cut out, but this was seldom necessary.

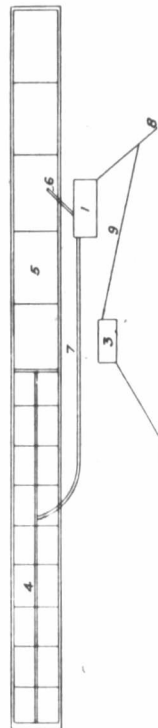
Fig. 4 shows the layout of the plant to do the work in the manner described. In this way three hundred lineal feet of trench was dug and pipe laid, per day, while on similar work under the same conditions in Holly Beach a contractor made but from thirty-five to fifty feet per day, doing the work by another method.

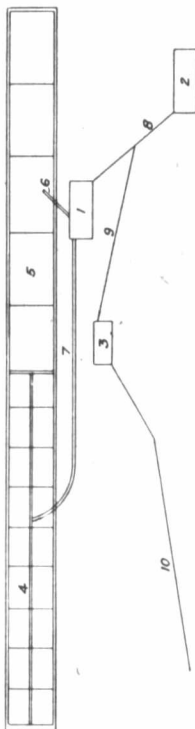
Very little trouble was experienced in laying the water and gas mains, as these were but two feet deep, and on all but two principal thoroughfares were located in the centre of the street. Fire hydrants were located on a radius of six hundred feet from one another, and but two electric light and telephone poles were allowed to each block of five hundred feet.

The sidewalks were of cement and but three feet wide, and these, as well as a concrete curb, were placed as soon as the sewers, gas, water, telephone and other wire conduits were laid, after which provision was made for ballasting the streets.

Two spurs of the railroad were extended temporarily through the property, and with a plant of eighty carts, three steam graders, three steam rollers, and two hundred men, the work of grading sixteen miles of streets commenced. The roads and streets were finished with a nine-inch coat of Burleigh gravel, and no provision was made to carry off the storm water owing to the permeability of the soil, but the grade was broken and towards two shed lines, where sumps were located that were connected with the main out-fall sewer. The trolley line was then extended through the property on the main streets and operations commenced for laying the pavement.

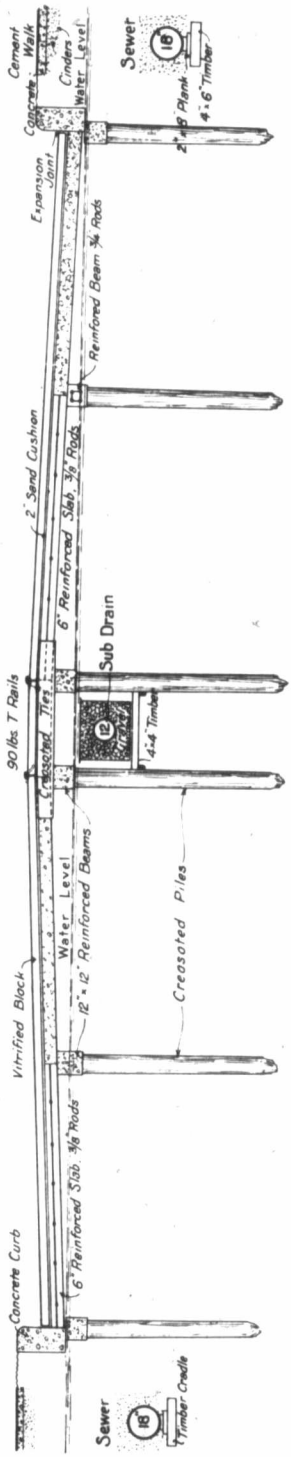
It was contended by many who were familiar with the then existing conditions that it would be next to impossible to secure a satisfactory foundation for the pavement, owing to the fact that three months previous the street was merely marsh covered with "springs" and "salt holes." Previous to starting the construction, notice was served upon all parties concerned that dig-





SKETCH SHOWING LAYOUT OF PLANT.
 1.- Centrifugal Pump and Engine on track. 2.- Boiler. 3.- Piston Pump
 4.- Trench with pipe laid ready for filling. 5.- Trench ready for excavation
 6.- Suction pipe. 7.- Discharge pipe. 8.- Pipe, boiler to engine.
 9.- Pipe, boiler to pump. 10.- Pipe to water supply.

Fig. 4.



CROSS SECTION OF STREET.

Fig. 5.

ging up the new pavement for any cause whatsoever would not be tolerated. The pavement proposed was a vitrified block on a six-inch concrete foundation. When test holes were opened, water was found twelve inches below the surface, and in numerous places running or boiling sand was encountered. This, of course, necessitated a different method of procedure than had at first been anticipated.

By means of a jet, creosoted piling six feet long and twelve inches at the butt were pumped to twelve inches below the ties of the trolley line six feet apart, directly under the rail, for the entire length of the line. A trench was then excavated along the lines of the piling, and concrete beams six feet long, twelve inches wide, and twelve inches deep, reinforced with three-quarter-inch twisted steel bars and projecting stirrups were moulded in place on the piling. At the curb lines on either side of the street, and between the curb lines and the rail on each side, a line of piling was placed similar to that under the rail, with the exception that proper allowance was made for the grade and crown of the street.

Upon these beams (for a like beam was placed upon all the piling) a six-inch reinforced concrete slab ten feet long and six feet wide was placed, the reinforcement consisting of three-eighth steel rods interlaced and wired. It took two slabs to reach from curb to rail. The concrete slab under the rails was finished in a similar manner, the ties resting directly upon the beam, the slabs being notched for the ties.

At frequent intervals underdrains were laid connecting with the nearest manhole, and in some places the flow of water was so great as to necessitate a permanent sump being built under the foundation. This underdrain was composed of twelve-inch terra cotta pipe laid with burlap joints with gravel casing in a box crib resting upon stringers spiked to the piling every six feet, and discharging into the trunk sewer.

A two-inch sand cushion was then placed on the concrete foundation, after which the bricks were laid and the whole grouted, expansion joints were placed along the curb alternating every two hundred feet.

Six months after completion it was decided to extend this pavement for another thousand feet, and when excavations were made it was somewhat of a surprise to see that the sand had receded from its position against the slabs, and was now eighteen inches from them, and that water was flowing six inches deep under the principal streets of the town and has continued the same to date.

To-day this is one of the most popular resorts on the Jersey coast.

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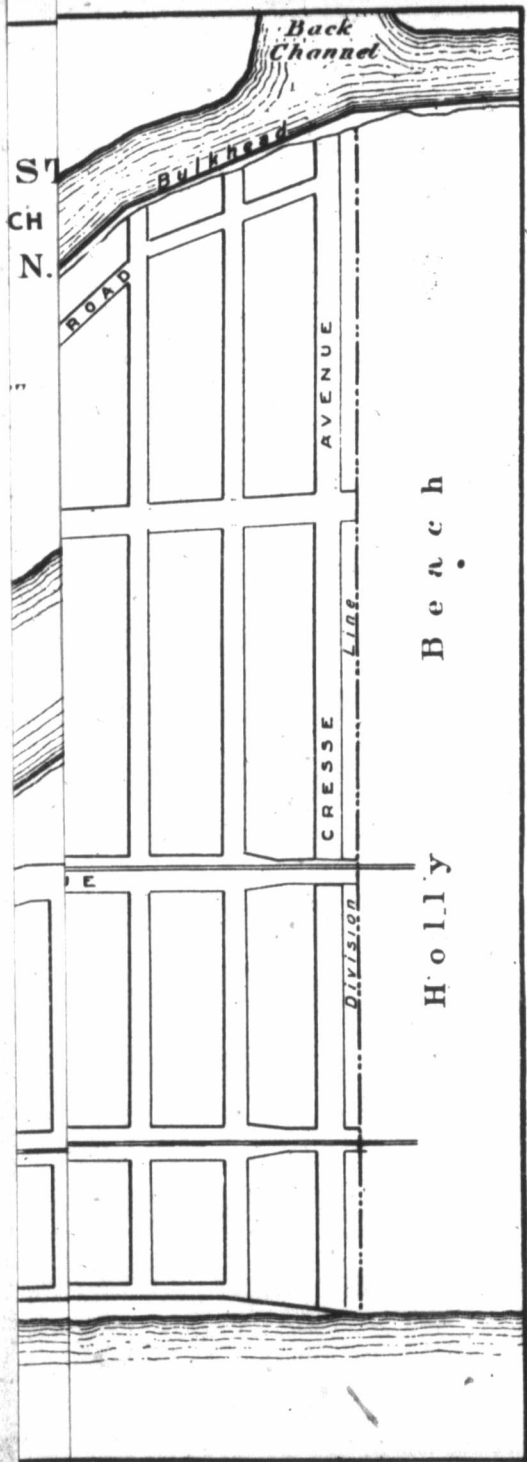
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Map of
WILDWOOD CREST
 ON FIVE MILE BEACH
 Cape May County, N. J.,
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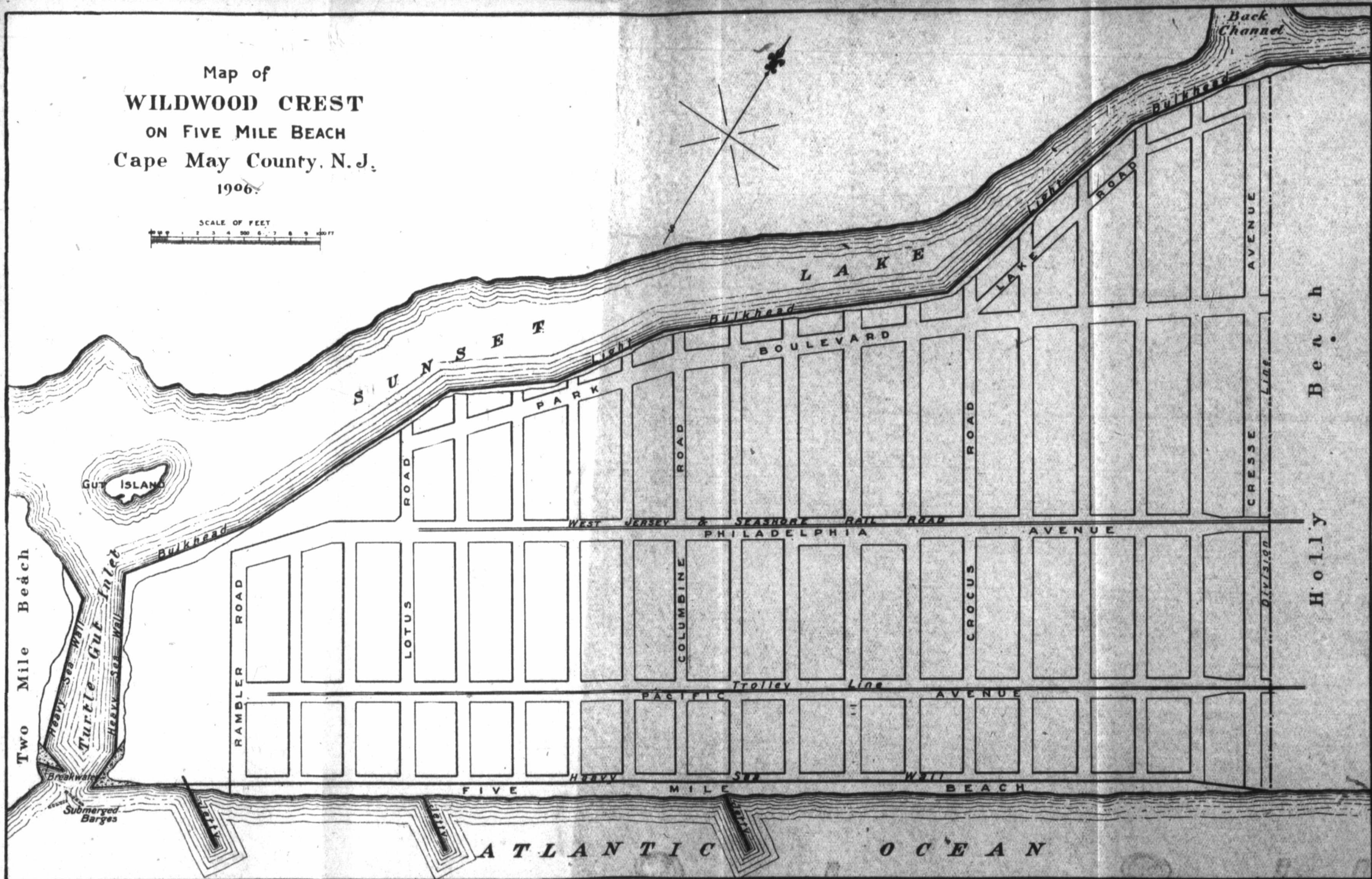
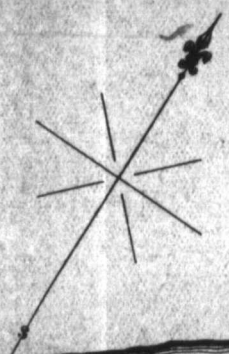
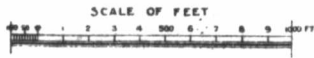


Fig. 1.

W. M. B. B. B.