1973 Buxton Beach Nourishment Project

An Annotated Photographic Atlas

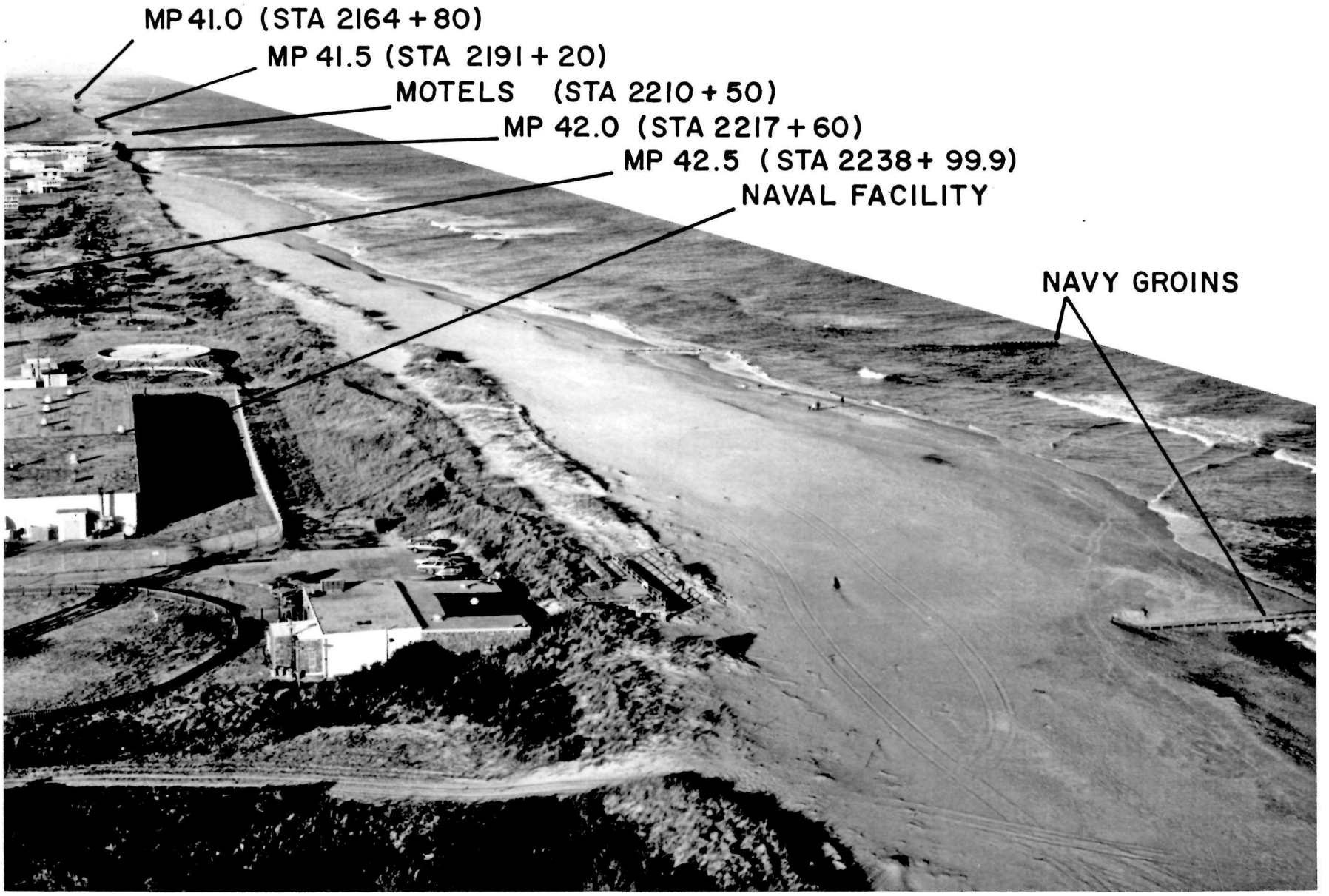
CAPE HATTERAS NATIONAL
SEASHORE
NORTH CAROLINA

COASTAL RESEARCH ASSOCIATES
CHARLOTTESVILLE, VIRGINIA

FEBRUARY 1974

NPS CONTRACT NO. CX5000031059

ROBERT DOLAN, BRUCE HAYDEN, PRESTON RIDDEL, JOHN PONTON


MP 41.0 (STA 2164 + 80)
MP 41.5 (STA 2191 + 20)
MOTELS (STA 2210 + 50)
MP 42.0 (STA 2217 + 60)
MP 42.5 (STA 2238 + 99.9)
NAVAL FACILITY
NAVY GROINS

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PREFACE

In 1972 Congress authorized the expenditure of 4.3 million dollars for beach restoration work within the Cape Hatteras National Seashore, including 1,300,000 cubic yards of beach nourishment at Buxton, North Carolina. This engineering project, the most recent in a long series of management actions at Buxton, was intensely monitored to permit an accurate assessment of its overall effectiveness as well as its environmental impact. The project is presented in this report as an annotated photographic atlas of the monthly shoreline changes that occurred during the period of beach nourishment. The photo coverage includes pictures from the months immediately preceding pumping through the discharge period which terminated in September, 1973. This document is designed to serve as a concise reference guide to the beach-fill project and as a baseline data log with which the long-term history of the fill may be compared.

INTRODUCTION

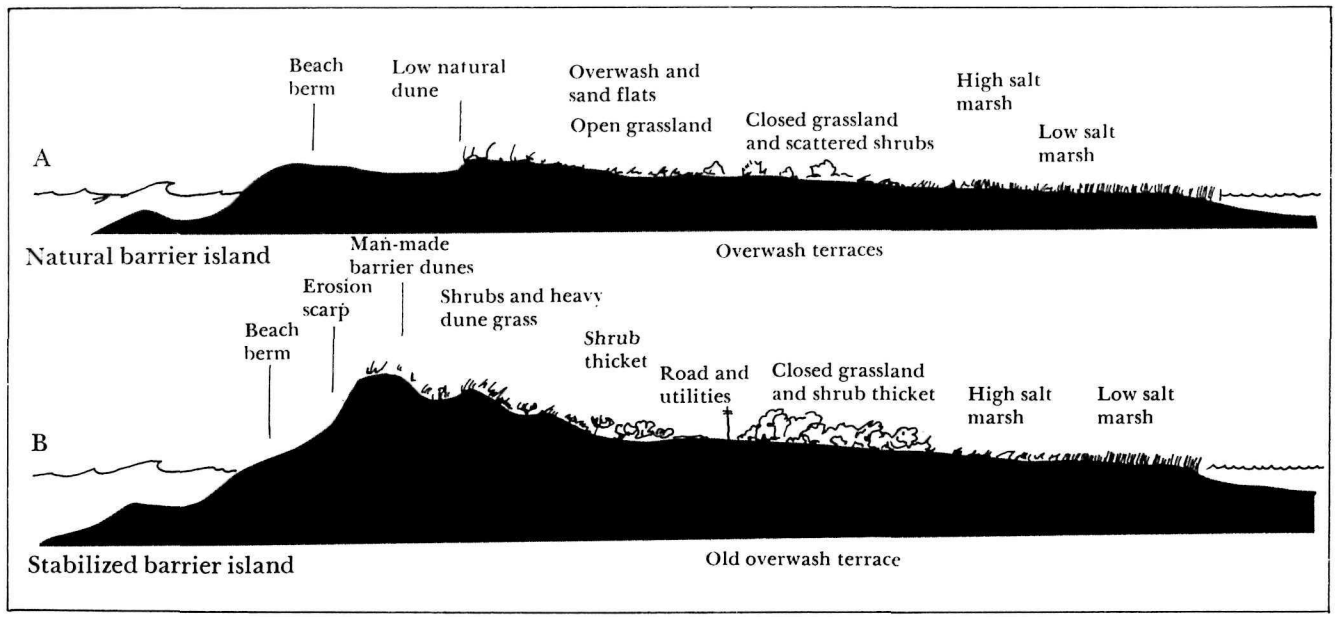
To the geologist the North Carolina barrier islands are temporary features of the coastal landscape; their history has been written within the last 5000 years. Since the last Ice Age, the sea level has been rising causing a steady landward migration of these shoreline deposits. This movement, which continues to this day, is incrementally forced by the periodic passage of migratory extratropical storms which drive sands along and across the islands. A characteristic island configuration is a broad beach, a dune field, overwash terraces, and a fringing marsh on the sound side of the island.

Early settlement of the Outer Banks was largely restricted to the sound sides of the islands: A clear indication of respect for and recognition of the significant oceanic overwashes. During the 1930's a bold program was started to control the overwash process. First sand fences were erected on the broad beaches trapping wind-blown sands and forming an unbroken chain of dunes, the barrier dunes. Once these dunes were established they were "stabilized" with grass plantings and periodically fertilized to insure a rapid and dense growth. Consequently all but the most severe storm overwashes were contained seaward of the barrier dunes providing a margin of protection. As a result of this protection, the patterns of land usage changed dramatically: Villages rapidly spread seaward to the barrier dunes and stable roadbeds and utility lines were constructed along the length of the islands. The Outer Banks had been changed from a system dominated by overwash to a more stable system, and the caution of earlier decades faded rapidly. However, because of the continuing rise in sea level and the restriction of waves and storm surge to the beach, the resultant prevailing erosion trend was a rapid shoreline recession. With the narrowing of the beach, progressively smaller and smaller storm-generated waves and surge eroded the barrier dunes. Scarping of the seaward edge became common.

Until the Ash Wednesday storm on March 7-8, 1962, the dune-maintenance program was a sufficient corrective action to maintain a fairly stable landscape. During the 1962 storm, shoreline recession and dune breaching were widespread, and episodic events with overwash again dominated the Outer Banks.

A

B



A. SAND FENCING AT BUXTON IN THE 1930'S

B. DEVELOPMENT FRONTING THE OCEAN

Management action also changed following the 1962 storm: Prior policy had been systemwide and had focused on the barrier dunes; subsequent action focused on specific beach-erosion sites. This transition was most pronounced at Buxton, North Carolina: Between 1958 and 1966 the shoreline receded more than 250 feet in the vicinity of the Cape Hatteras Lighthouse. By 1966 only 256 feet of beach separated the Lighthouse from the sea. Within four miles of the Lighthouse (MP40 to MP44) the following man-made features were threatened by erosion:

1] The U.S. Coast Guard Loran Station.

2] The Cape Hatteras Lighthouse.

3] The National Park Service Museum.

4] The U.S. Naval Station.

5] Several private homes.

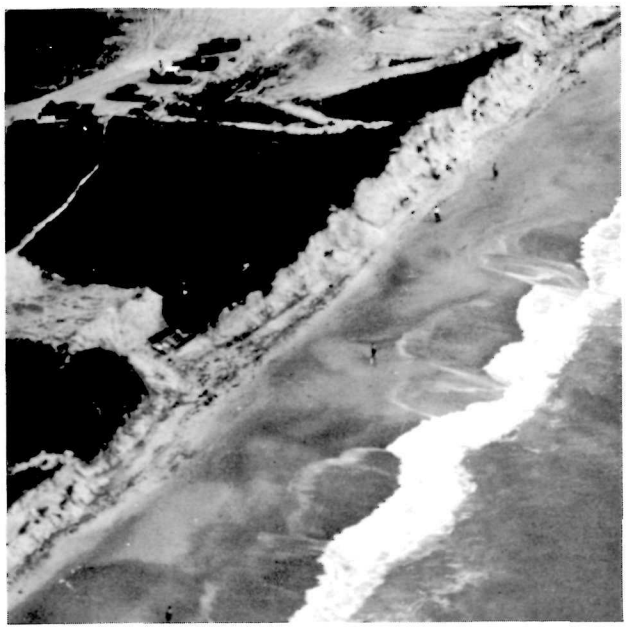
6] Numerous private businesses.

In 1966 the National Park Service contracted to have 312,000 cubic yards of sand placed along the Buxton area beaches of greatest concern. Sand for this project was extracted from a large sound-side tidal delta where it had been deposited during the 1962 Ash Wednesday storm. The borrow material, however, was too fine to remain as part of the subaerial beach system and the quantity too small to have any significant impact on the inshore zone.

By 1967 the prevailing erosional trend had placed the Cape Hatteras Lighthouse and U.S. Naval Facility in vulnerable positions. Following the recommendation of the Coastal Engineering Research Center, Army Corps of Engineers, in 1969 the U.S. Navy contracted to have three permanent groins constructed within the problem area.

The groins, which required several adjustments in design, did provide protection for the Lighthouse and Naval Facility; however, the adjacent shorelines, to the north and the south of the groin field, continued to erode at a rate equal to or greater than recorded earlier. Large embayments developed on either side of the groin field. During the winter of 1970 the erosion problem along the north embayment became so severe that another beach-nourishment project was planned for 1971. This 1971 project was more effective than the 1966 attempt in that the material remained on the beach for a longer period of time; however, as before the quantity of borrow material (200,000 cubic yards this time) was not enough to have any significant impact on the beach or on the inshore bar system.

GROIN CONSTRUCTION AT BUXTON



DUNE SCARPING

BULLDOZING SAND DURING A WINTER STORM

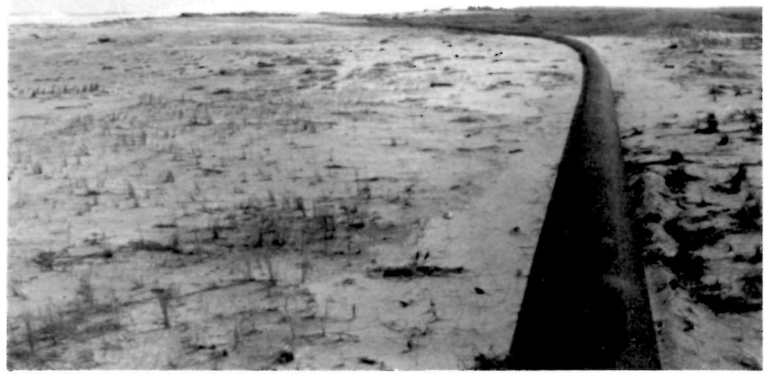
Erosion problems therefore continued along the north embayment. Overwash continued to occur requiring stopgap measures such as sandbag seawalls and sand movement by bulldozers. Subsequent analyses have indicated that the inshore bar system to the north of the groin field was lowered allowing larger waves to break along the shoreline. The embayments and the severe erosion were merely a manifestation of these bar-trough changes.

In 1972 the National Park Service proposed a large-scale beach nourishment program to fill in the embayment to the north of the groin field. In all 1,300,000 cubic yards of material were pumped onto the beaches. The authors of this report undertook a research program to assess the environmental impact of this beach nourishment project on the physical and biological elements of the beach system and the design effectiveness of the sand nourishment. A month-by-month sequence of annotated photos are presented here as a supplement to the series of technical reports on the detailed findings of the research effort.

During the months before the dredging at Cape Point and the discharge of sand onto the Buxton beaches, procedures for implementing the nourishment project were formulated. The ensuing strategy stressed the discharge of sediments onto the active portion of the beach, permitting the natural fluid motions of the swash and inshore currents to distribute the borrow material.

National Park Service scientists and technical personnel agreed that an elongated and sloping beach of natural, morphological characteristics was most desirable and that this end was best achieved by permitting natural forces to organize and distribute the sediments discharged along the beach. Although the winter storms of January, February, and March of 1973 and technical delays and breakdowns precluded strict adherence to the proposed discharge schedule, the essence of the strategy for nourishment was fully adhered to.

During the Lincoln's Birthday storm, February 10-12, 1973, the shoreline near the large crescentic embayment north of the groin field receded dramatically. Several units of one motel were destroyed. After the storm even spring tides extended across federal lands and onto private property. Because of this shoreline recession, placement of the dredge pipe on federal lands was impossible. After reviewing legal implications of running the dredge line across private property, it was decided that an alternate discharge plan was necessary. Therefore, discharge began along



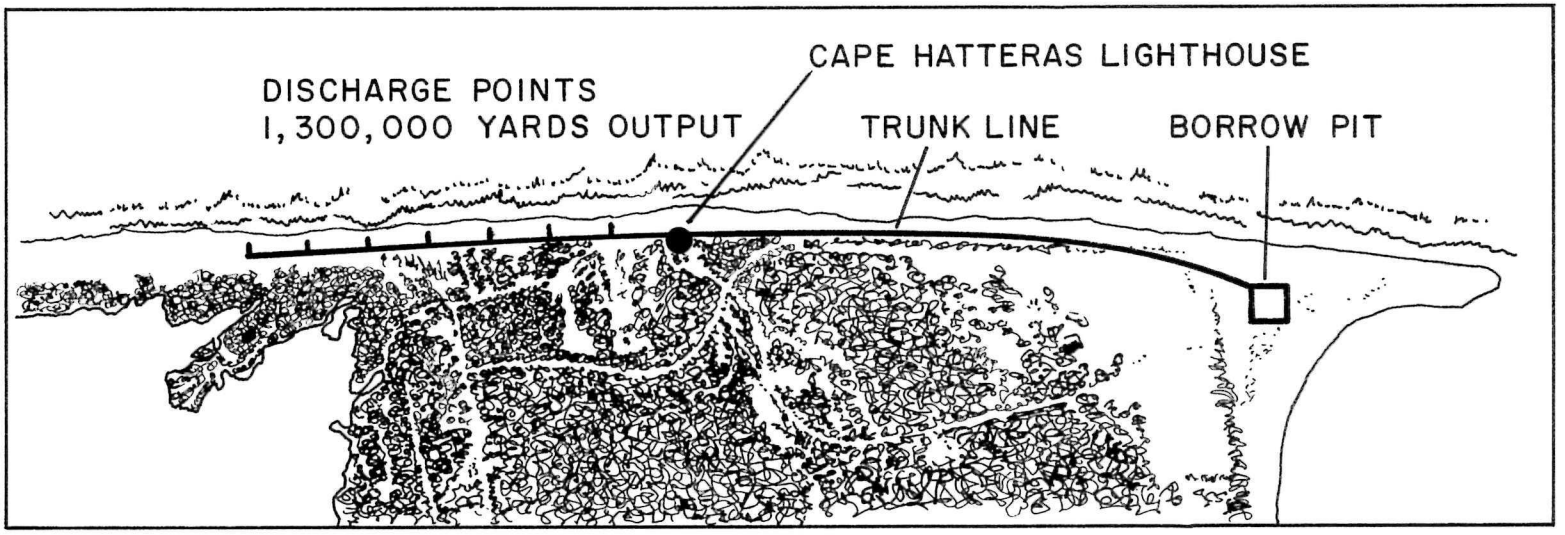
TRUNK LINE AT HATTERAS PT.

DISCHARGE AT 2220 + 50

the southern reach of the project area and moved northward so that a berm of "federal land" would be built up on which the dredge pipe could be placed for further pumping.

After deciding that a beach of natural morphological characteristics was desired and that the sediments could best be so organized by the natural, nearshore fluid motions, it was essential that the discharged material be of appropriate size characteristics; i.e., as near to the size of the native beach sands as possible. During the months preceding the engineering phase, detailed surveys of the sediments at Cape Point were made. These studies showed that most of the sands at Cape Point were indistinguishable from the native beach sands. Sediment analyses of the material discharged during the project subsequently confirmed the similarity between Cape Point and beach sands.

A 16-inch portable dredge was used at Cape Point. Three boosters were needed to generate the necessary power to lift and transport the dredged material some four miles to the discharge area. In addition, a 24-inch water siphon between the ocean and the borrow-site pond at Cape Point was needed to maintain adequate water for the dredge.



THE 1958 AND 1973 SHORELINES AT BUXTON

FRAME NO. 73 CAPE HATTERAS LIGHTHOUSE **North**

DATE: 12/19/72 TIME: 1530

TIDE: Low -0.5 ft. (1607) WAVES: SE

WAVE HEIGHT: 1.0 ft.

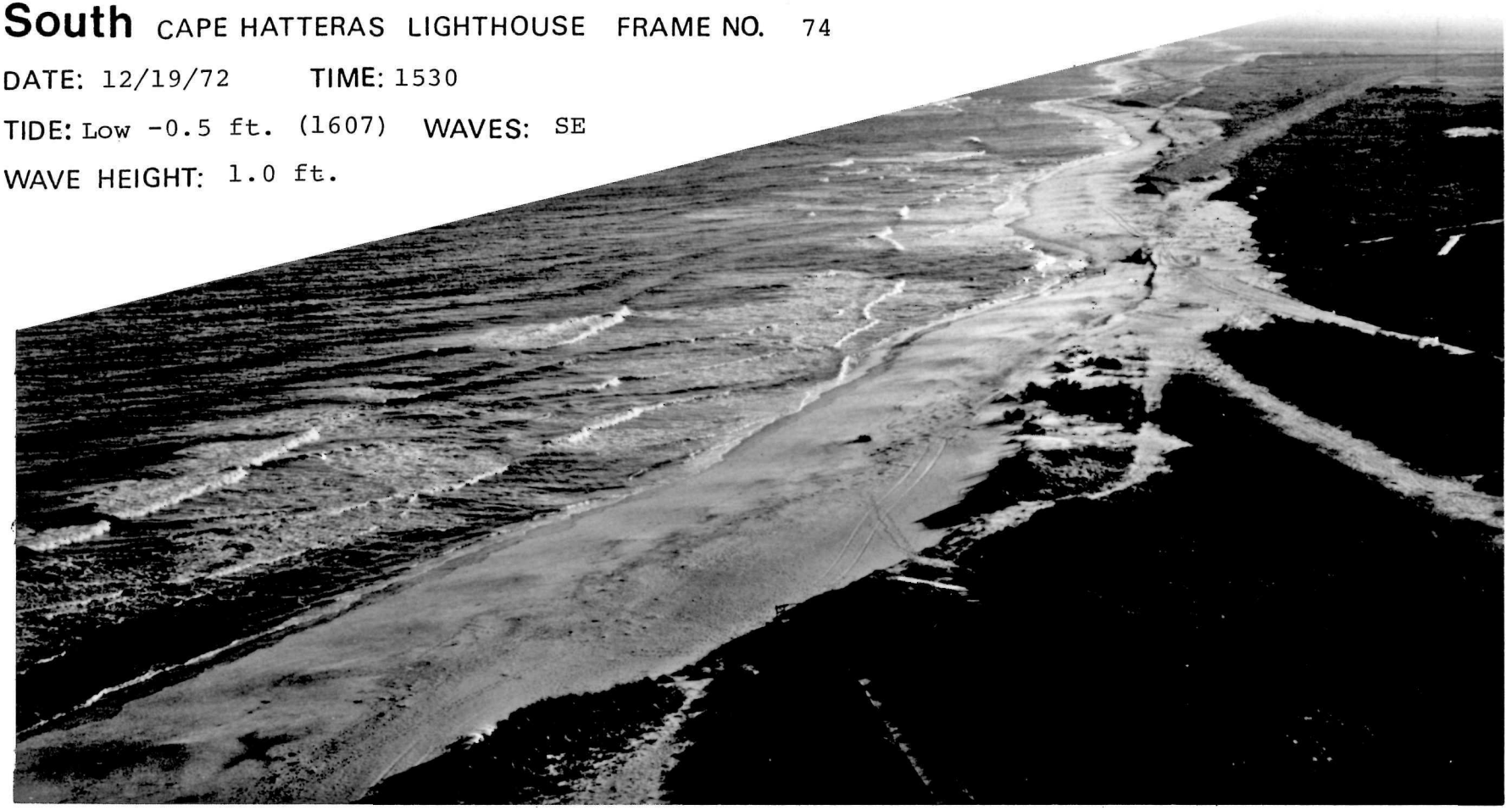
Prior to the start of the 1973 nourishment project, little evidence of the 1972 nourishment project (250,000 yd.^{3}) remained near the motels. Storms during October, 1972, prompted a sandbagging project to protect the motels where 80,000 yds.^{3} of beach material were lost. Dune erosion between MP42 and MP41 has continued threatening both private property and North Carolina Route 12. Shadows cast by the dune crests show the height of the dune scarps. MP42 is especially vulnerable at this time because of the bar-trough embayment located offshore. Two of the three Navy groins are seen in these pictures. The prevailing NE waves of winter have created a 40- to 50-foot wider beach on the updrift (north) side of the middle groin. This deposition, characteristic of groins, has not developed around the north groin because the center section of the structure (150 ft.) failed soon after construction.

South CAPE HATTERAS LIGHTHOUSE FRAME NO. 74

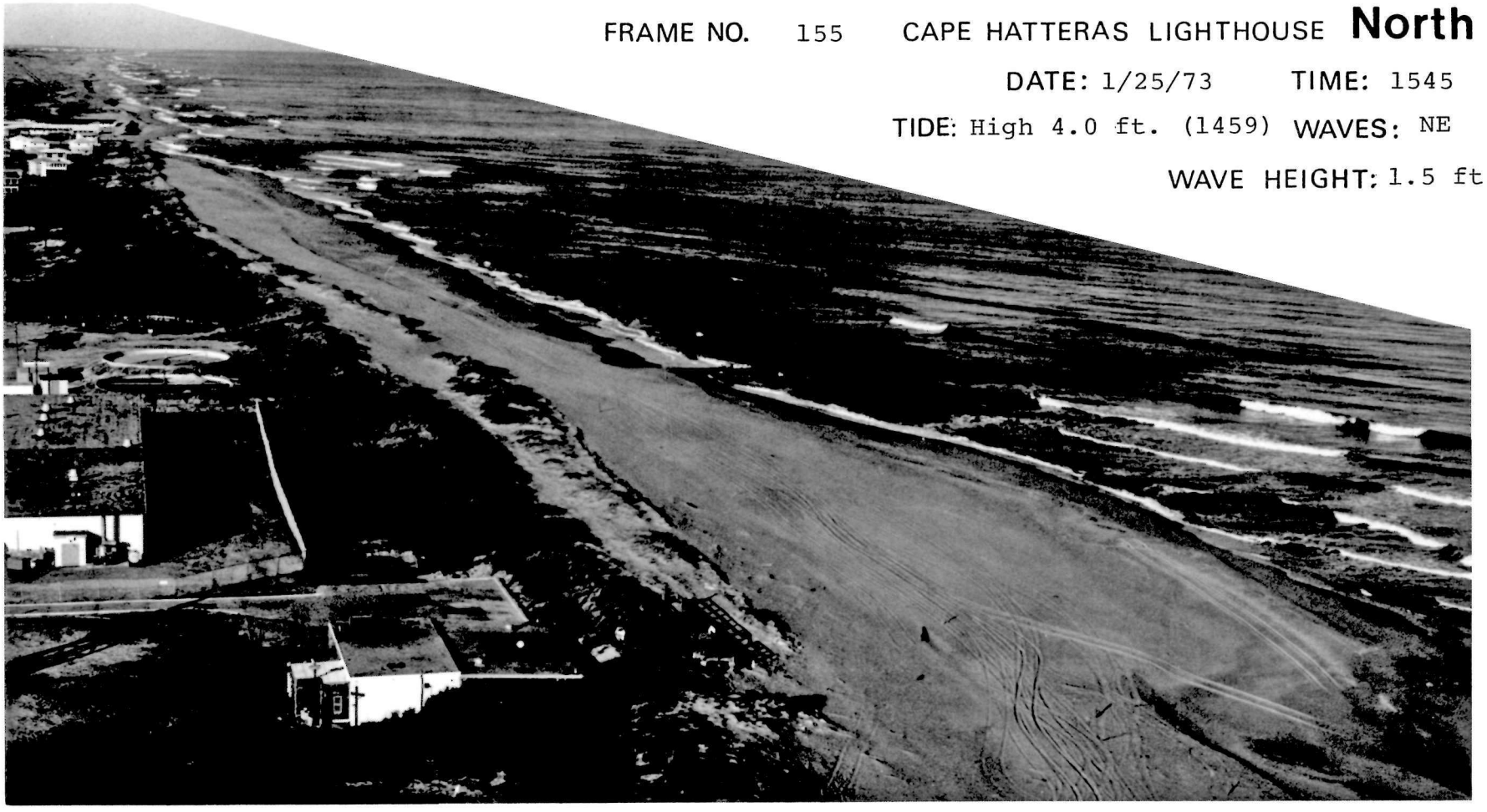
DATE: 12/19/72 TIME: 1530

TIDE: Low -0.5 ft. (1607) WAVES: SE

WAVE HEIGHT: 1.0 ft.



To the south, most of the barrier dune has been lost. The truncated portions of the primary dune and the lower Loran Station dune were eroded during the fall. In duneless areas, overwash fans have been deposited. The shoreline adjacent to the four embayments in this picture is currently receding. Note the lack of offshore breakers seaward of each embayment, indicating a lower inner bar and higher waves at the shore. Scarping of the beach face within the first embayment contrasts with the depositional cusps on either side. Peat and highway pavement are being eroded with the remains littering the beach face.



The 30 to 40 feet of dune left at MP42 was washed away in late December, 1973, leaving the cottages less than 100 feet from the mean sea-level shoreline. Swash from moderate waves reaches the foundations of the cottages and surges up and onto the nylon sandbag seawall. Scarping can be seen beneath the southern end of the seawall. Dune erosion to the north has continued with losses of up to 20 feet; however, these losses have been limited to the beach sections landward of embayments. Other sections of the dunes between MP42 and MP41 have shown no significant recession. The sharp westward curve of the beach near MP41 is still evident with a corresponding curve in the inner bar indicated by the position of the breaker line.

South CAPE HATTERAS LIGHTHOUSE FRAME NO. 156

DATE: 1/25/73 TIME: 1545

TIDE: High 4.0 ft. (1459) WAVES: NE

WAVE HEIGHT: 1.5 ft.

Construction of almost one mile of the 24-inch welded discharge line from the main boosters has been completed. Only minor erosion of the truncated dunes has occurred; however, these dunes are vulnerable to erosion and scarping during moderate seas. The northern embayment in the previous photograph has been filled and is experiencing continued accretion, as evidenced by the beach cusps. A new embayment is developing to the north. Again, note the lack of beach cusps or an offshore breaker zone and the scarping of the beach face within the embayment.

AERIAL PHOTO OF BUXTON AND CAPE POINT

From February 10 to 13, 1973, the Lincoln's Birthday storm, one of the most severe winter storms on record, generated storm waves and surge onto the beaches of the Outer Banks. From MP42.1 to MP41.2 the barrier dune was completely destroyed, and an extensive overwash fan was deposited across this gap. In the village, the fan was up to 600 feet wide. North of Buxton, sand was carried over the island and into the sound, covering North Carolina Route 12 with up to 4 feet of sand. Approximately one-half mile of the road had to be relocated to the west. Beach loss ranged from 100 to 150 feet.

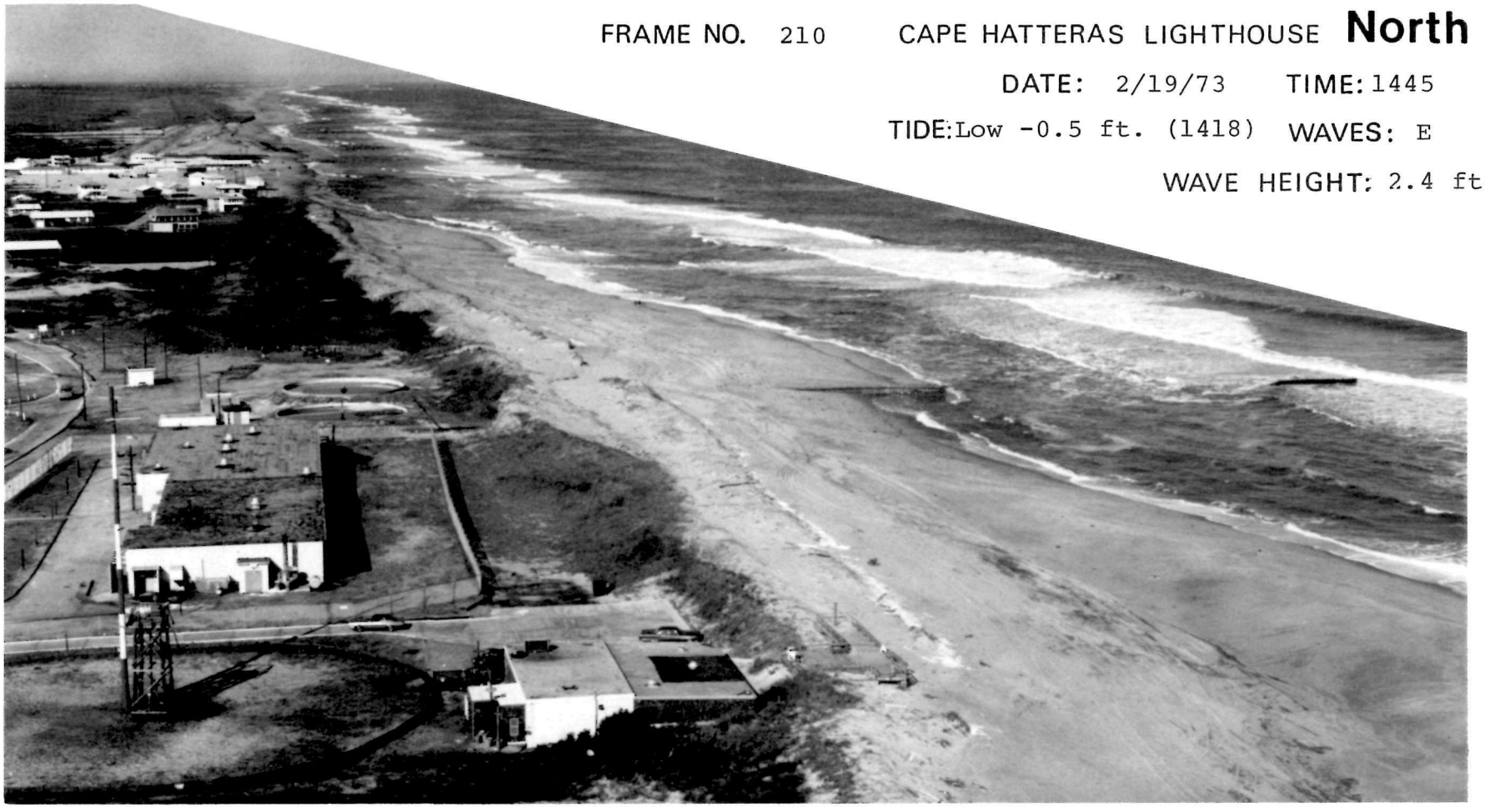
PROPERTY DAMAGE AT MP42

FRAME NO. 185

DATE: 2/12/73

Two cottages at MP42 were destroyed. A third cottage to the south (see above) was severely damaged while others received extensive wave and water damage. In addition, cottages in the path of the overwash fan had up to 4 feet of sand deposited under and around them.

The sandbags in front of the motels provided little protection: Several of these two-ton bags were washed 100 to 200 feet offshore. Extensive damage occurred to the ocean-front units of each motel. One three-room unit was moved 20 to 30 feet inland. The motels are now less than 100 feet landward from the mean sea-level shoreline.



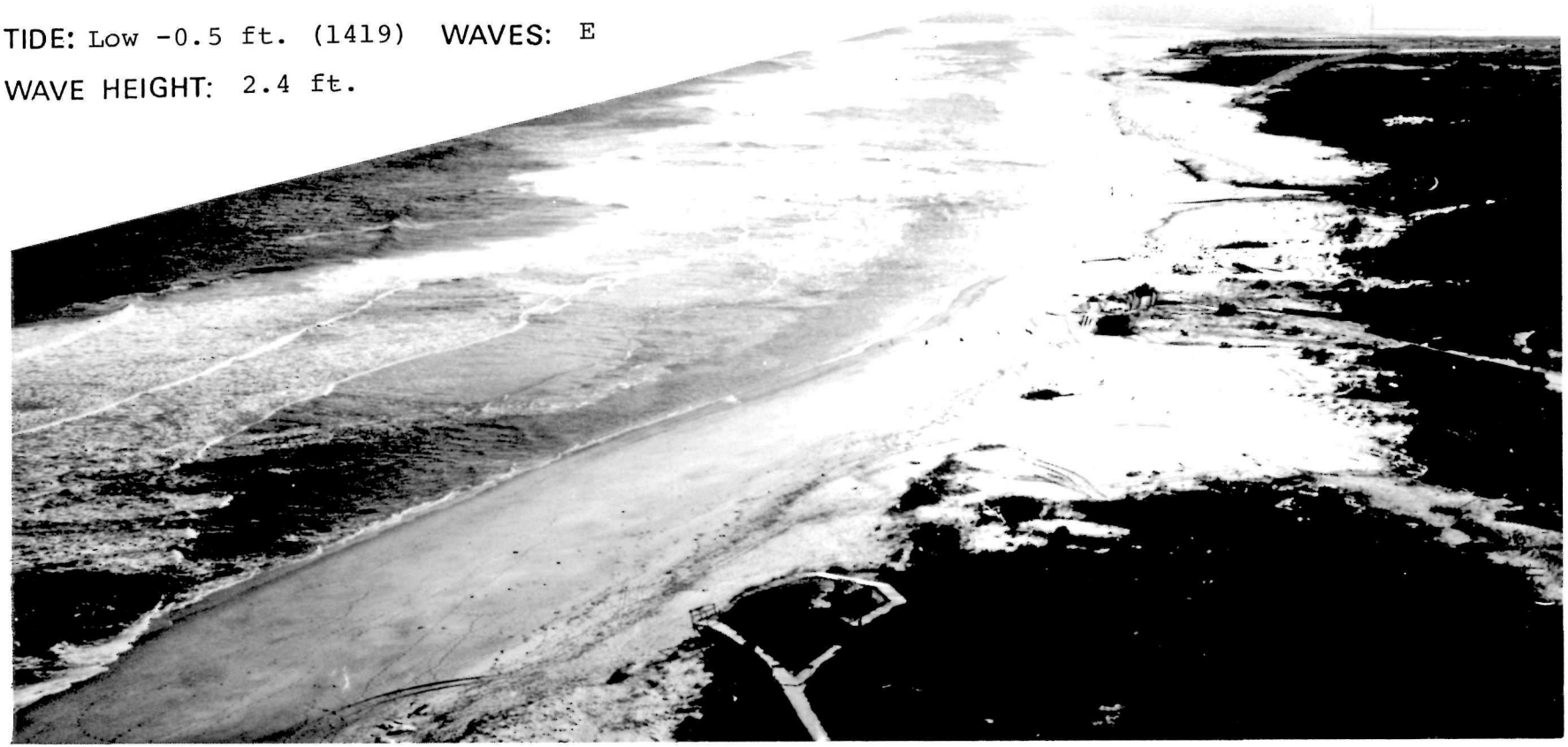
Less than one week after the Lincoln's Birthday storm, significant deposition had occurred on the beach face. The beach at MP41 was 50 feet wider than before the storm and little dune erosion had occurred. South of MP42.1 dune erosion was less prominent because of the groins. Although water and sand washed onto and over the dunes behind the groins, only minor damage occurred. The middle groin cannot be seen in this picture because the camera position has been shifted slightly to the left.

South CAPE HATTERAS LIGHTHOUSE FRAME NO. 209

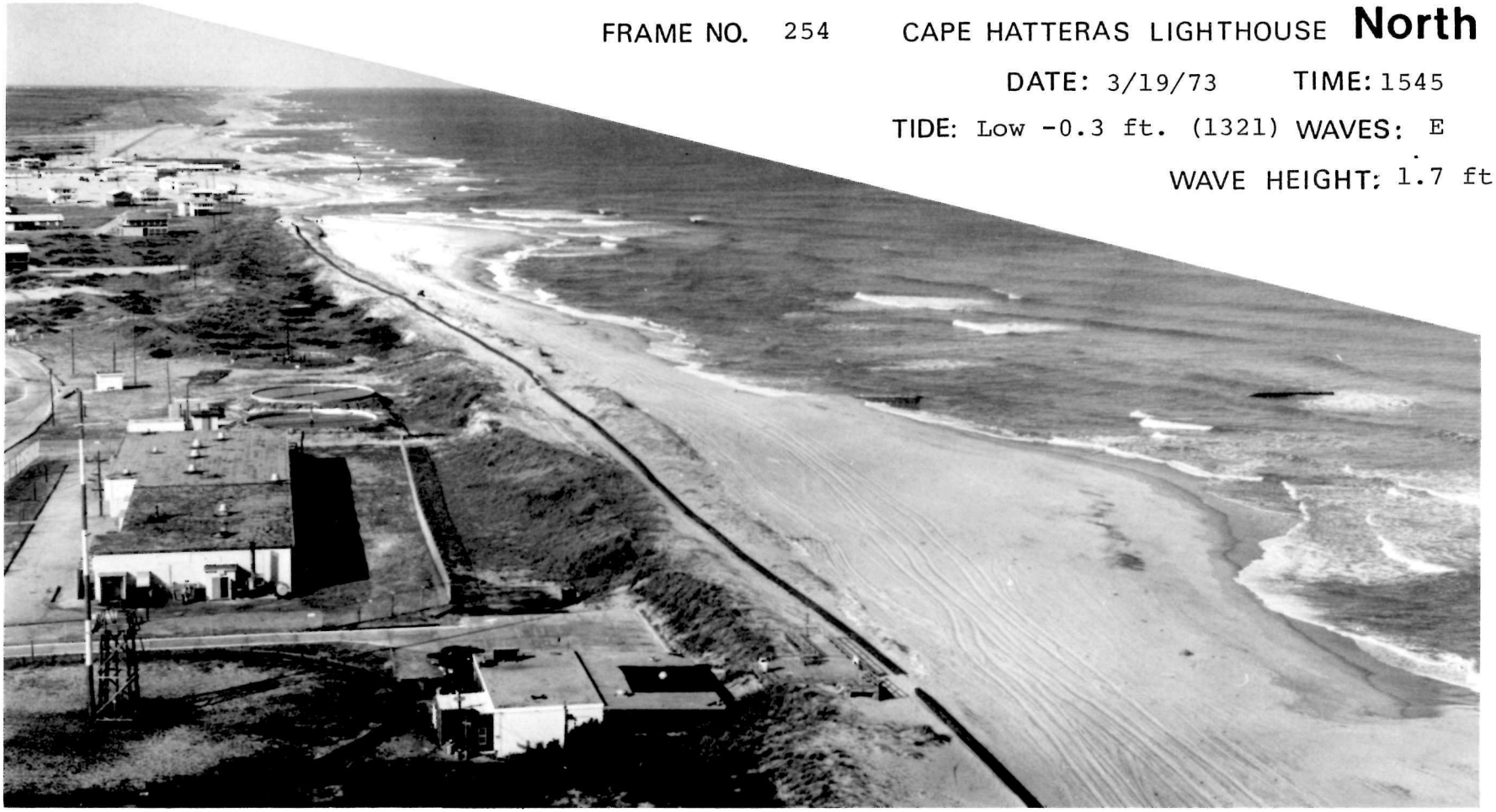
DATE: 2/19/73 TIME: 1445

TIDE: Low -0.5 ft. (1419) WAVES: E

WAVE HEIGHT: 2.4 ft.



Extensive overwash also occurred south of the old lighthouse. Over 1,000 feet of the Loran Station dune was washed away while another 600 feet of this dune was covered by the overwash deposits. Altogether over 2,000 feet of the barrier dune was destroyed or buried. In the area south of the Lighthouse overwash deposits penetrated up to 400 feet inland along one mile of the beach. A channel between the borrow pit and the ocean was established and remained open for 3 to 4 weeks. This cut occurred in the embayment seaward of the NE corner of the borrow pit.



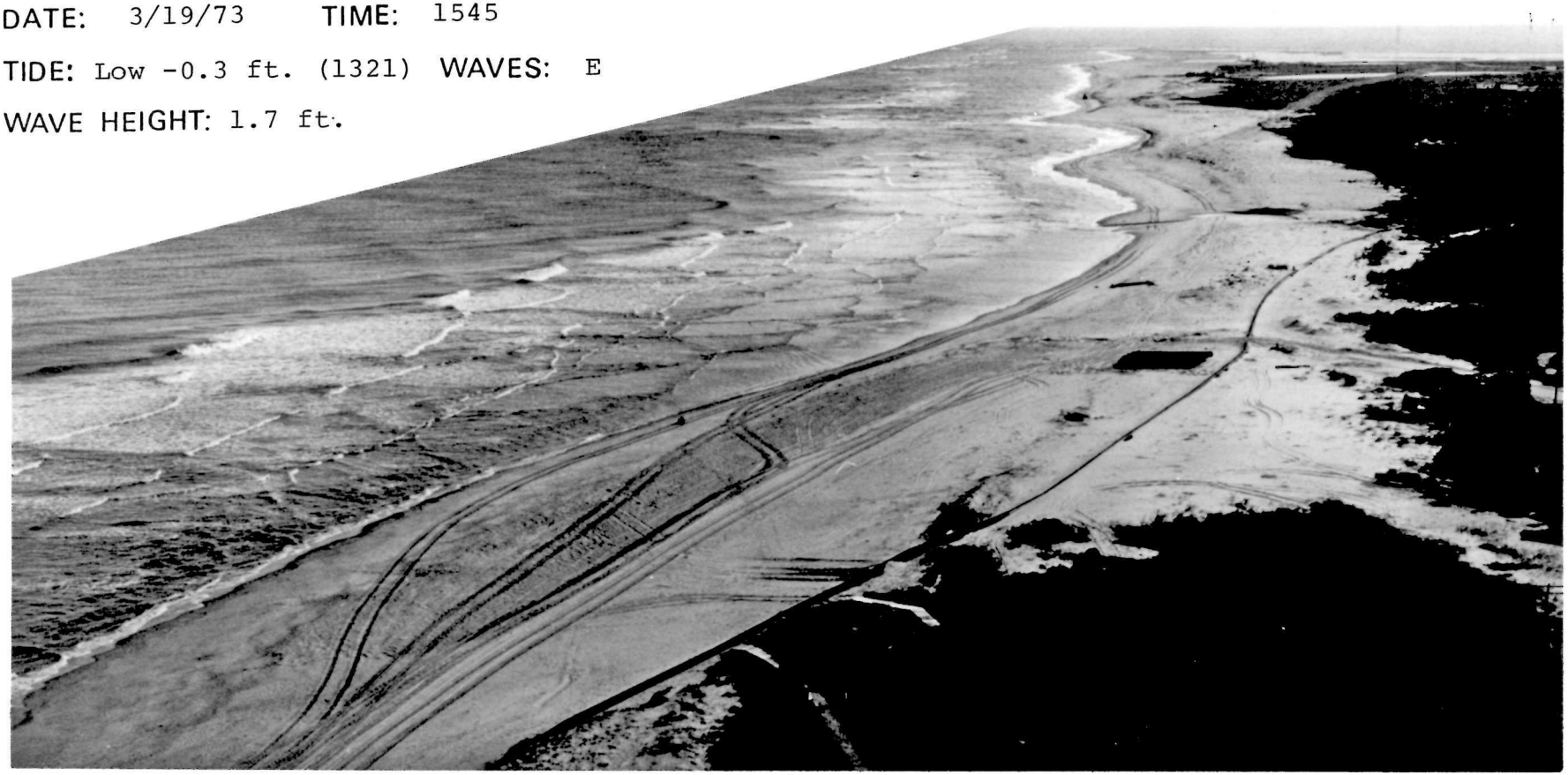
Because of the major change in beach conditions resulting from the February storms, the original north-to-south pumping plan had to be changed. Instead nourishment was to start near station 2230+00 and proceed northward. Pipe had been laid to the starting point, and pumping was expected to start within a few days. Dune erosion had continued at the southern embayment: 200 feet of dunes had been eroded since mid-February. A second embayment threatens the motels and there are two other deep embayments north of the motels.

South CAPE HATTERAS LIGHTHOUSE FRAME NO. 255

DATE: 3/19/73 TIME: 1545

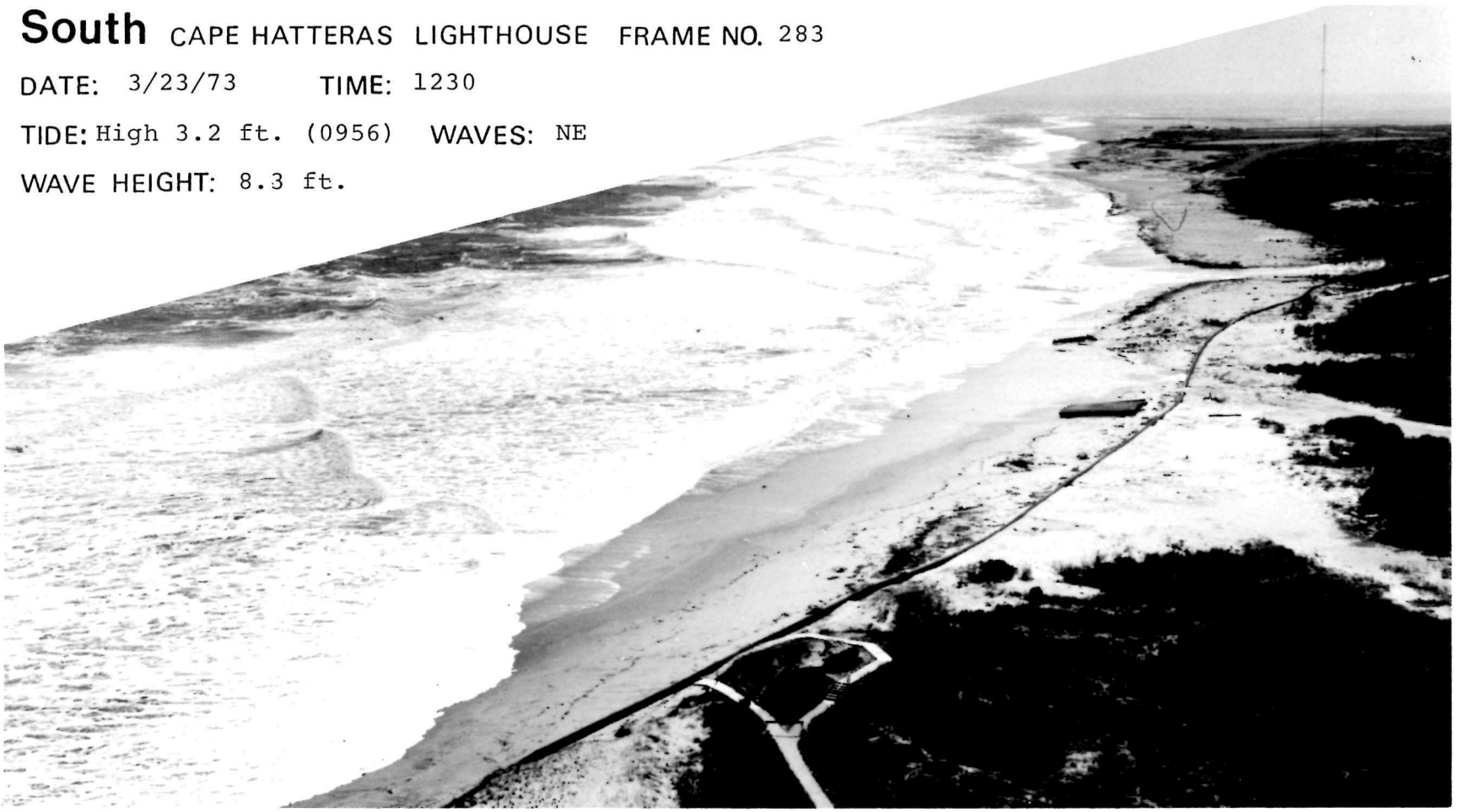
TIDE: Low -0.3 ft. (1321) WAVES: E

WAVE HEIGHT: 1.7 ft.



Accretion has occurred along much of the shoreline south of the Lighthouse. The beach is 75 feet wider adjacent to the old lighthouse ruins, and the channel to the borrow pit has filled, building beach elevation as high as 5 feet and beach width as broad as 250 ft. In spite of the general trend of accretion, some erosion has taken place in the two embayments seen in the foreground. The channel to the marsh cut during the Lincoln Birthday storm is still draining and has built a small delta in the first embayment. A wide offshore bar extends for over one-third of a mile south of the groins.

The northeaster occurring at the time of this photo caused additional overwash and property damage. Relocated North Carolina Route 12 was covered with water and sand, briefly stopping traffic. Additional dune destruction took place south of MP42.1, and one of the cottages damaged in February was destroyed. During high-energy conditions, the position of the outer trough and bar can be seen. Note that the outer trough, indicated by the dark area between the two areas of breaking waves, closely parallels the beach face. Fathometer profiles taken during the summer have shown a deeper trough and lower bar seaward of the areas of overwash than seen here. The extensive overwash and property damage at the north end of Buxton is at least partly a result of this offshore configuration.



Some of the contractor's equipment, mostly stockpiles of pipe, was scattered and buried during this storm; however the damage caused only minimal delays. Overwash occurred along the southern beach and once again in the northeast corner of the borrow pit. Over 15 feet of sand were deposited in some areas of the borrow pit by the overwash from winter storms.

Five days after the 1973 beach nourishment project began, the outlet had been moved 100 feet north and pumping began on the south side of the large embayment at MP42. A peat layer up to 2 feet thick was exposed along the entire beach face of this embayment and has been carbon-dated at 580±205 years B.P. Recent storms deepened this embayment and deposited a wide bar offshore. This bar inhibited later beach-face erosion and facilitated filling the embayment by causing a decrease in the loss of nourishment material.

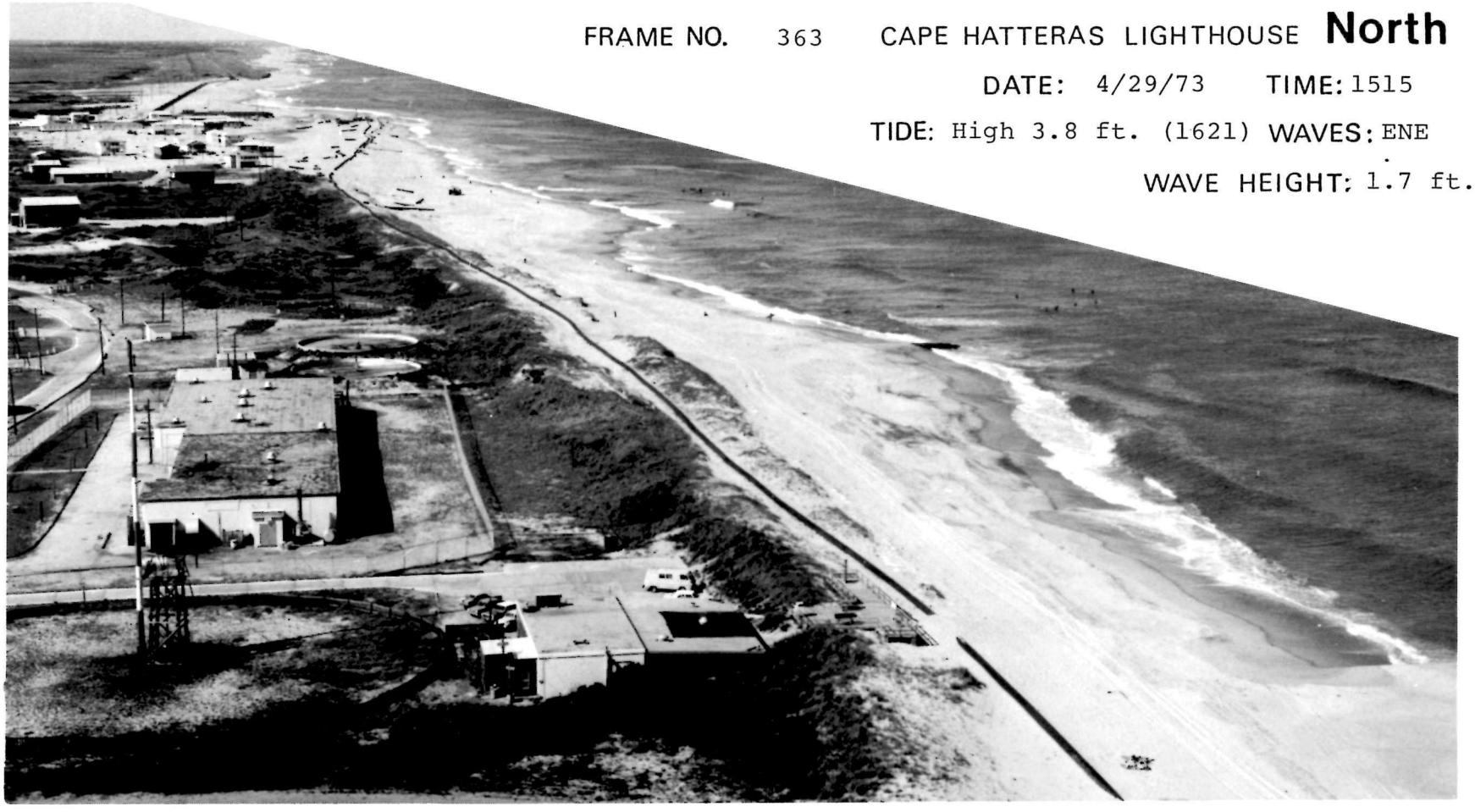
AERIAL PHOTO OF BORROW PIT

FRAME NO. 537 DATE: 7/12/73 TIME: 1630

TIDE: High 3.8 ft. (1630) WAVES: NE

WAVE HEIGHT: 1.7 ft.

This photo shows the source of the nourishment material and the route over which sand was pumped to the north beach. The portable dredge and pontoon line can be seen in the borrow pit, with the first and second stage boosters along the edge. The third stage booster, the main booster, is 2,500 feet to the north. These engines generated 5,200 horsepower to lift approximately 600 yds.^{3} of sand an hour at normal efficiency. The 25-inch siphon line which was needed to maintain a workable water level of -5.0 feet in the borrow pit is shown on the northeast side of the pit.



With over 2,000 feet of nourished beach, a protective beach was established in front of the private property. Continued rapid movement of the discharge outlet to the north was expected to give added protection to North Carolina Route 12. Beach erosion continues in the two embayments north of the outlet although waves have been low. The width of the nourished beach has been increased as much as 260 feet with relatively little material loss. In general, there is an initial loss of 20 to 30 feet of beach once a section is out of the influence of the discharge. After this initial loss, the section appears to stabilize.

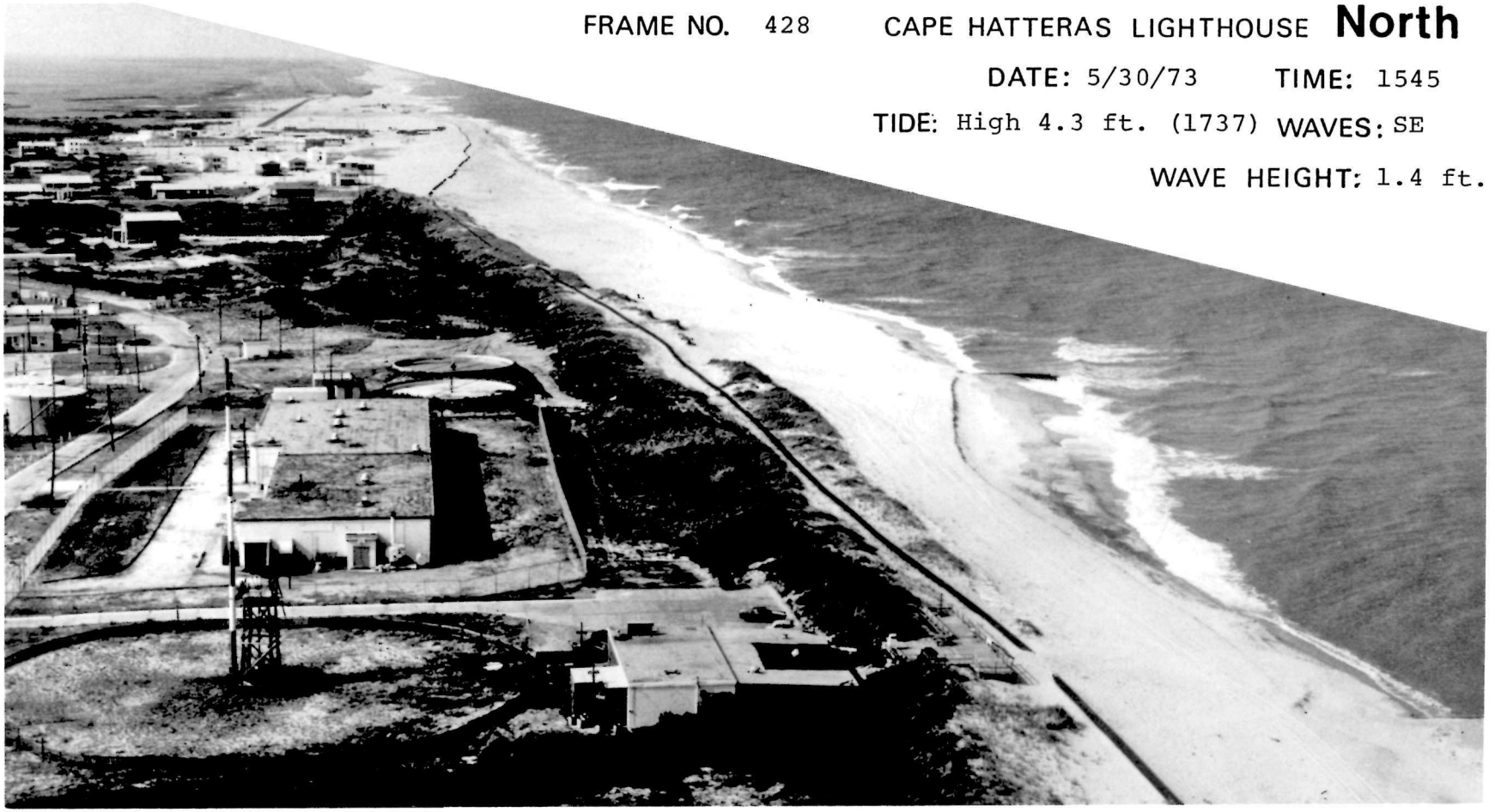
South CAPE HATTERAS LIGHTHOUSE FRAME NO. 364

DATE: 4/29/73 TIME: 1515

TIDE: High 3.8 ft. (1621) WAVES: ENE

WAVE HEIGHT: 1.7 ft.

Accretion in front of the old lighthouse ruins continues as a result of the change to SE summer waves. Erosion is still occurring at the head of the three embayments. Nearer Cape Point two wider embayments can be seen. The point separating these two features is seaward of the NE corner of the borrow pit in approximately the same location as the February overwash channel. This is an increase in beach width of over 300 feet.



By the end of May over three-fourths of a mile of shoreline had been nourished, establishing a protective beach along the vulnerable north shoreline. All of the embayments north of Buxton were filled and did not appear to be reforming. Because of the relatively small loss of nourishment material, a straight shoreline paralleling the discharge line has been produced.

South CAPE HATTERAS LIGHTHOUSE FRAME NO. 427

DATE: 5/30/73 TIME: 1545

TIDE: High 4.3 ft. (1737) WAVES: SE

WAVE HEIGHT: 1.4 ft.

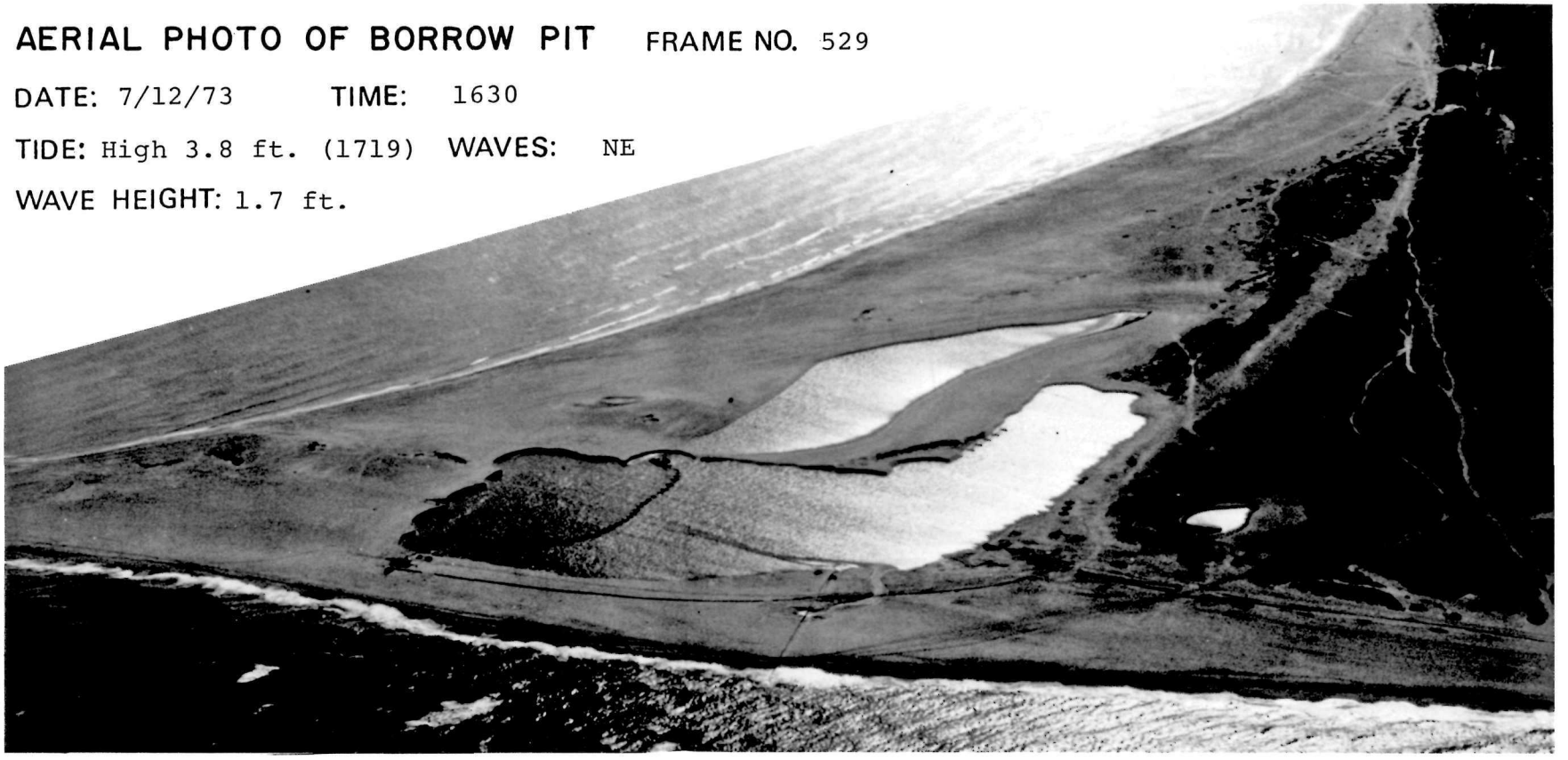
Along the southern beach relatively little change has taken place. An accretion trend continues except in the embayments where the position of the shoreline has remained unchanged. The shoreline is highly embayed with small waves breaking adjacent to each embayment. The spatial relationship between shoreline embayments, overwash fans, and shoreline recession is clearly evident.

AERIAL PHOTO OF BORROW PIT FRAME NO. 529

DATE: 7/12/73 TIME: 1630

TIDE: High 3.8 ft. (1719) WAVES: NE

WAVE HEIGHT: 1.7 ft.



Over 750,000 yards^3 had been excavated from the borrow pit at the time of this photo. At present, the distance from the dredge to the discharge outlet is near its maximum, over 3 1/2 miles. Excavation in the NW corner of the borrow pit was discontinued when finer material was encountered and coarser overwash material along the southern edge is now being dredged. Limited amounts of organic material were encountered in the area immediately adjacent to the natural lake west of the borrow pit.

Analyses of the Emerita talpoida (mole crab) population at the discharge location indicated a larger-than-normal population decrease. This, it is believed, is due to hydrogen sulfide in the discharge material: hydrogen sulfide is toxic to organisms, such as the mole crab, which have high oxygen requirements.

AERIAL PHOTO OF BUXTON SITE

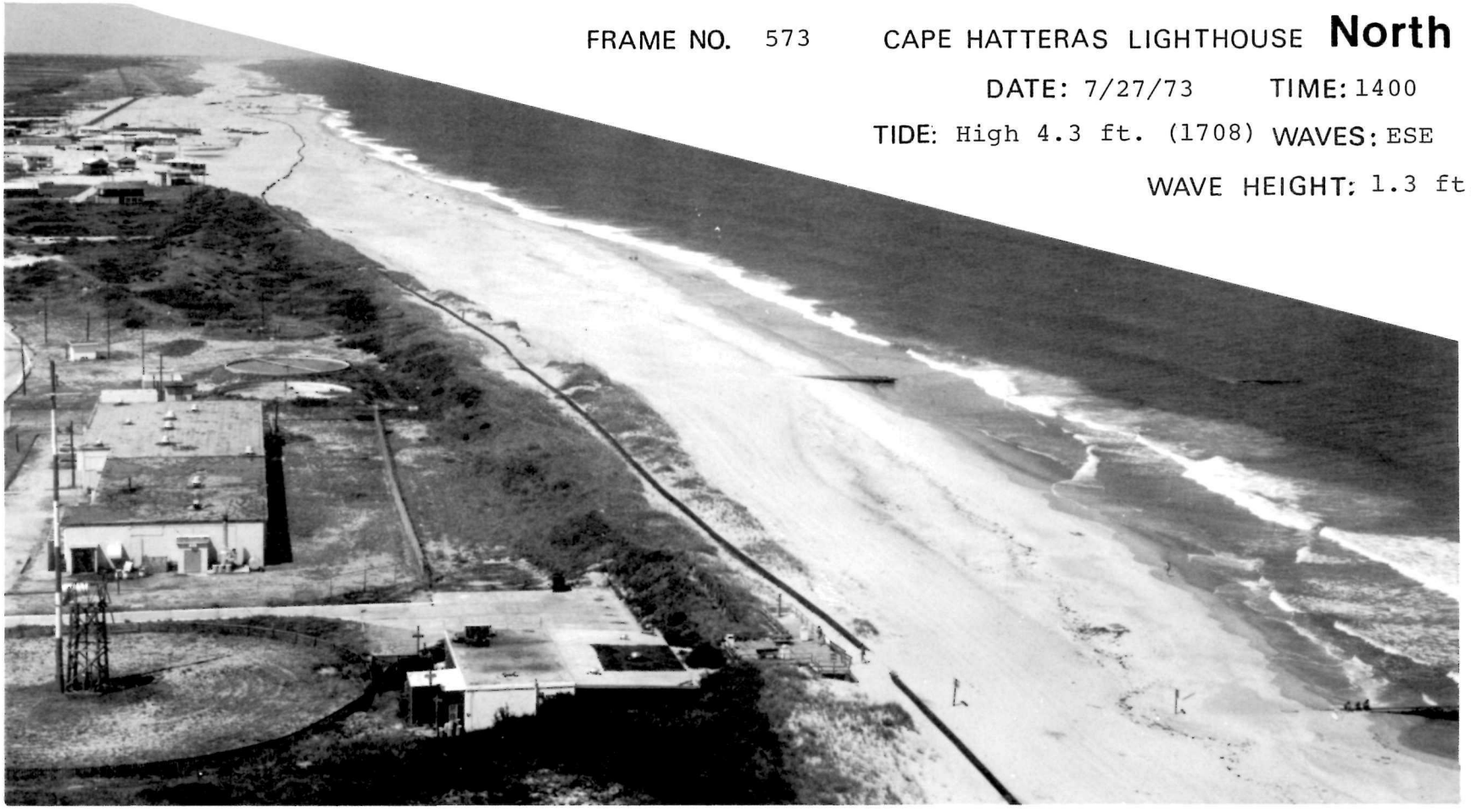
FRAME NO. 539

DATE: 7/12/73 TIME: 1630

TIDE: High 3.8 ft. (1719) WAVES: NE

WAVE HEIGHT: 1.7 ft.

In this photo the northern end of the project has been reached and the contractor has retreated to station 2180+20 for a second south-to-north move along the surf zone. It was anticipated that southeast waves should form a natural adjustment between the northern nourishment limits and the unnourished beach. Note the contrast which is shown between the straight nourished beach and the natural beach south of the lighthouse.



As the discharge outlet was moved to the south, the seaward slope of the fill adjusted to the energy patterns of each area. Calm seas and favorable winds continued to prevail, contributing greatly to the high retention of nourished material.

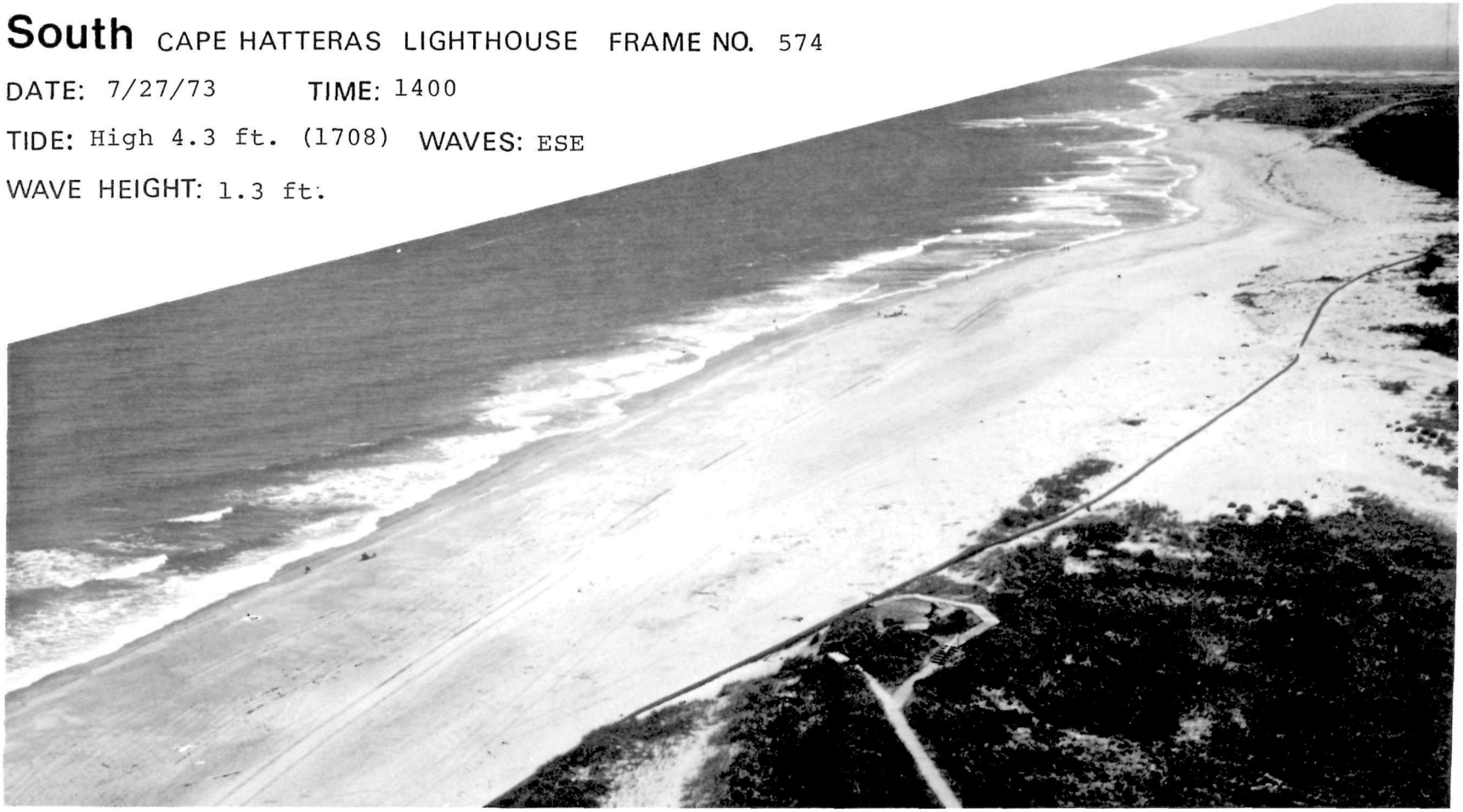
One noticeable feature of the nourished beach is the lack of an inner bar. Nourishment material has filled the inner trough, covered the inner bar, and filled the landward side of the outer trough. Fathometer profiles offshore show that the outer trough is immediately offshore of the beach face, 25 feet deep, and only 500 to 600 feet offshore.

South CAPE HATTERAS LIGHTHOUSE FRAME NO. 574

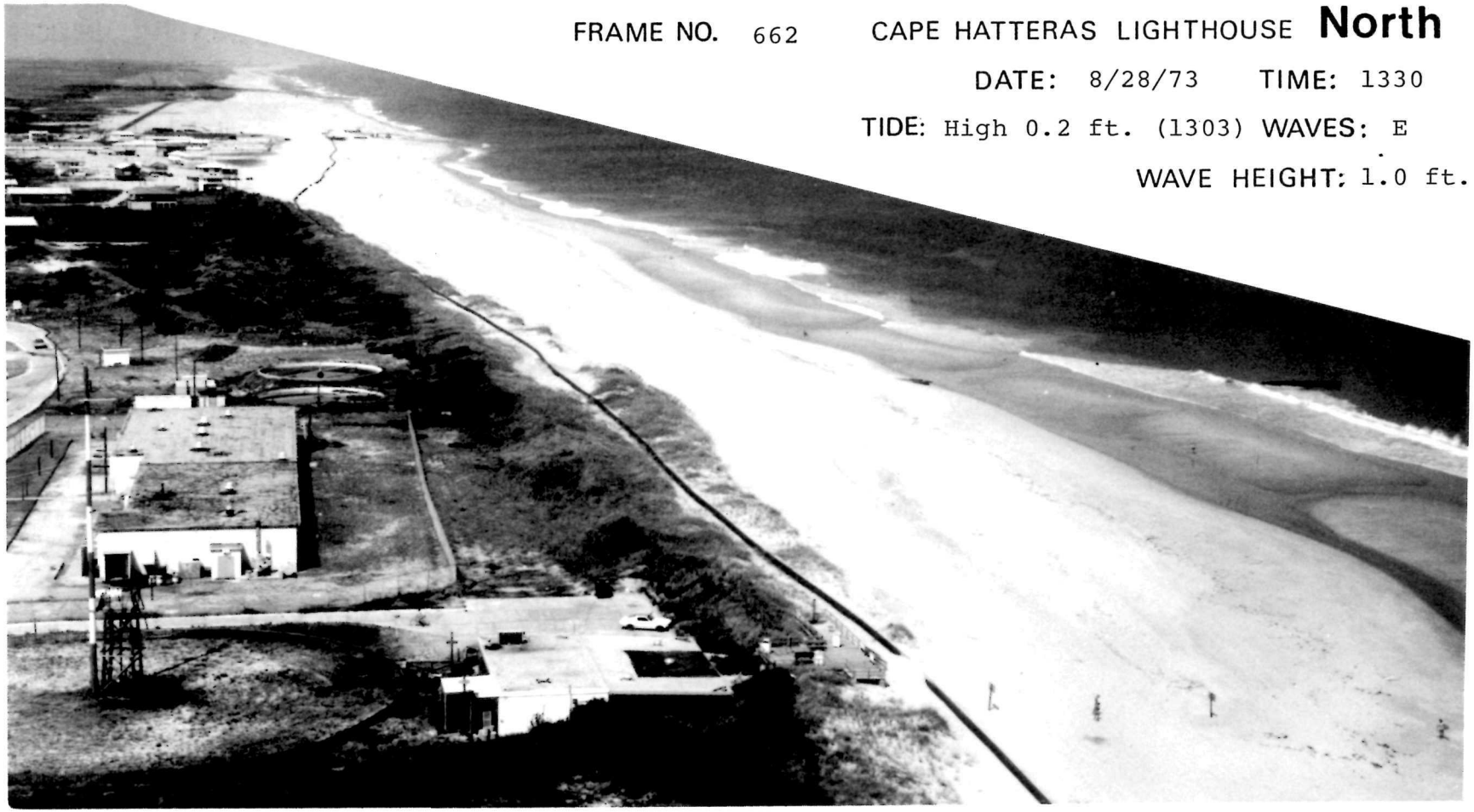
DATE: 7/27/73 TIME: 1400

TIDE: High 4.3 ft. (1708) WAVES: ESE

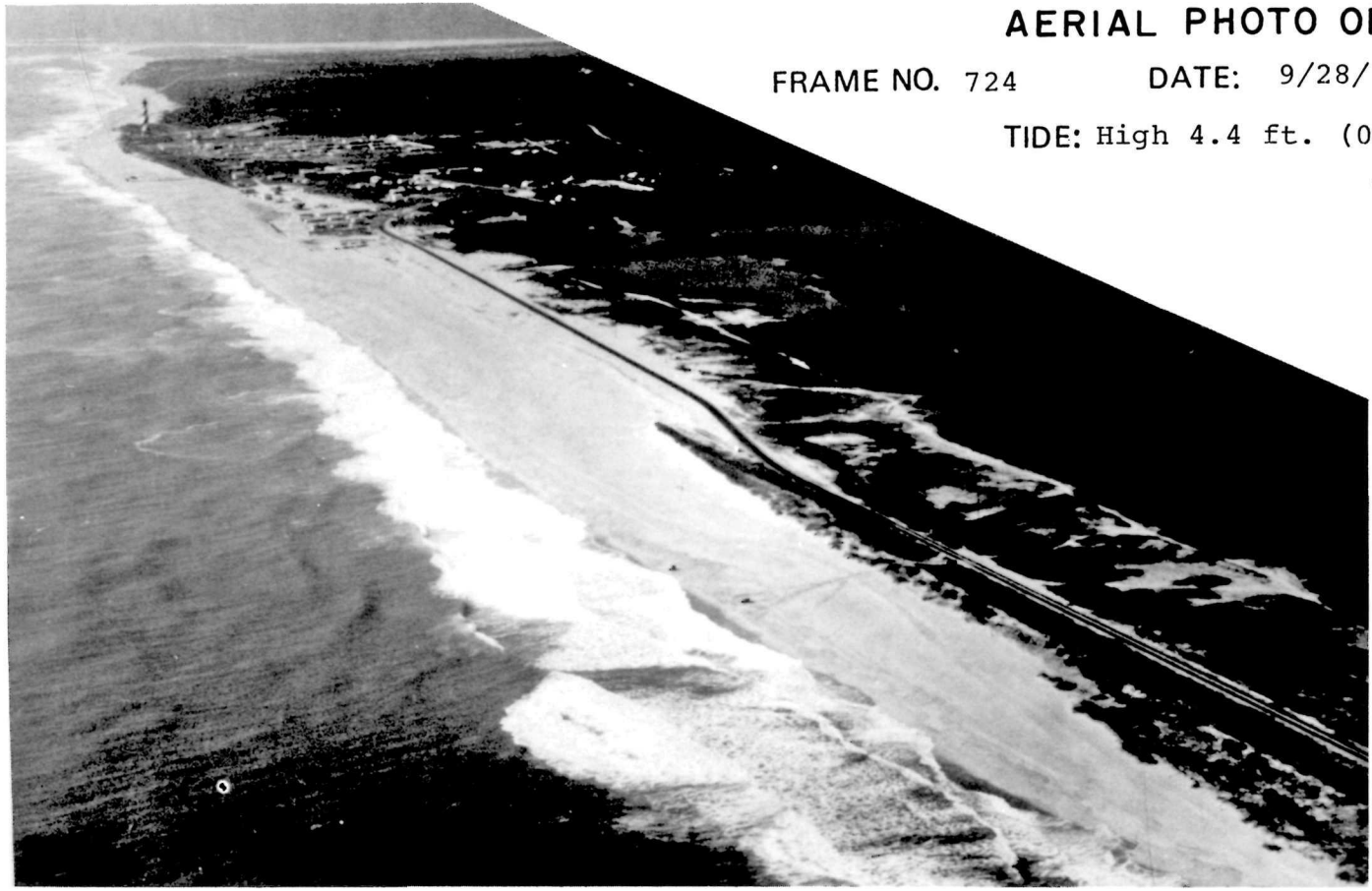
WAVE HEIGHT: 1.3 ft.



To the south the beach continues to widen concurrent with the filling of the embayments. Breaking waves in the foreground embayment suggest that a bar has formed or enlarged in this area which may be the beginning of sediment deposit from sands discharged to the north.



The straight nourished beach and the outlet fan continue to be typical features of each picture. As fall approaches the dominant wave direction is shifting from southeast to northeast. Northeast wave have caused the sediment to start to move south causing significant beach build-up in the groin cells.



AERIAL PHOTO OF BUXTON SITE

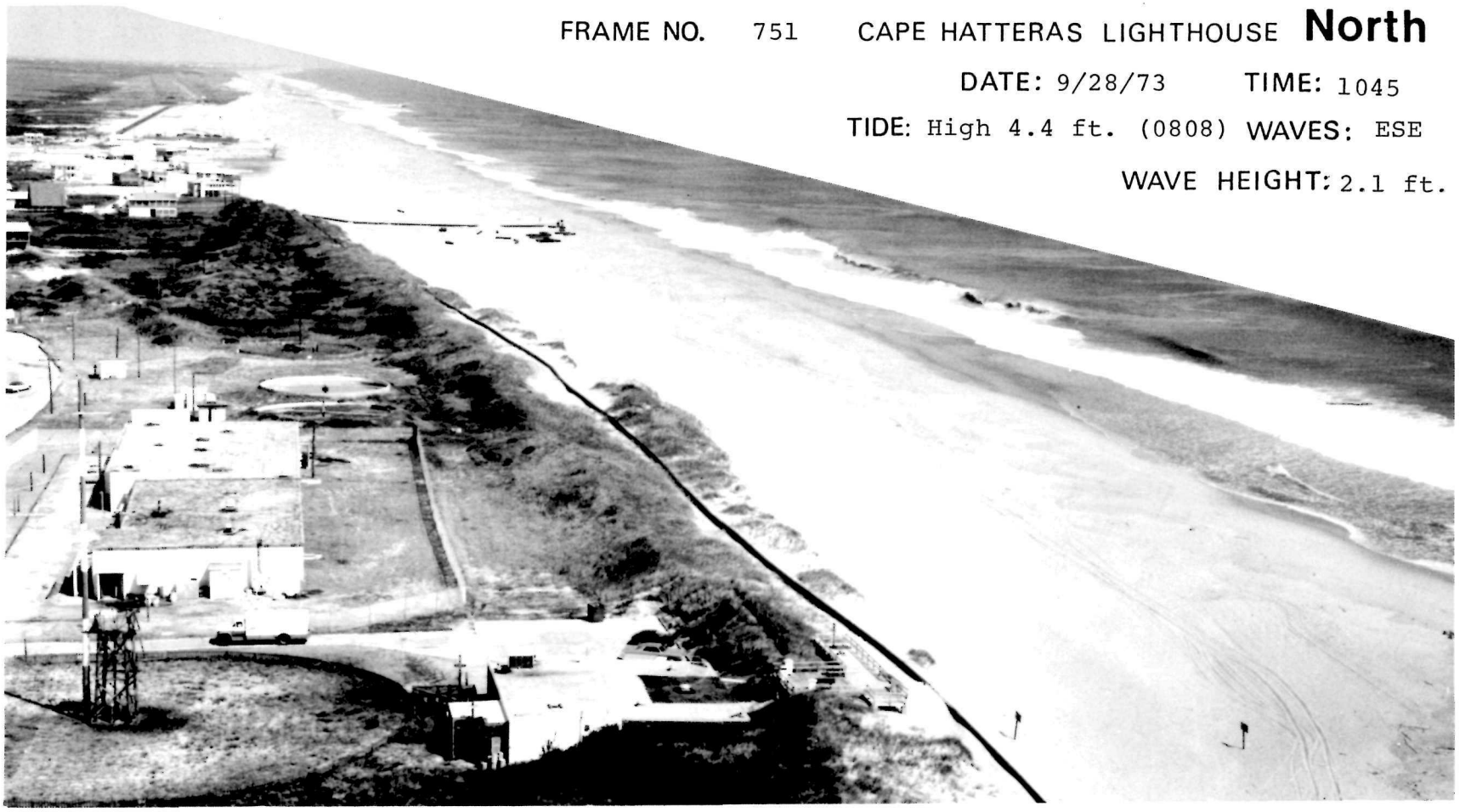
FRAME NO. 724 DATE: 9/28/73 TIME: 1000

TIDE: High 4.4 ft. (0808) WAVES: ESE

WAVE HEIGHT: 2.1

A straight beach is still a dominant feature after completion of the nourishment project. The northern protrusion noted in July has been eroded by southeast waves and the northward drift of fill material has formed a more natural beach face and shoreline alignment.

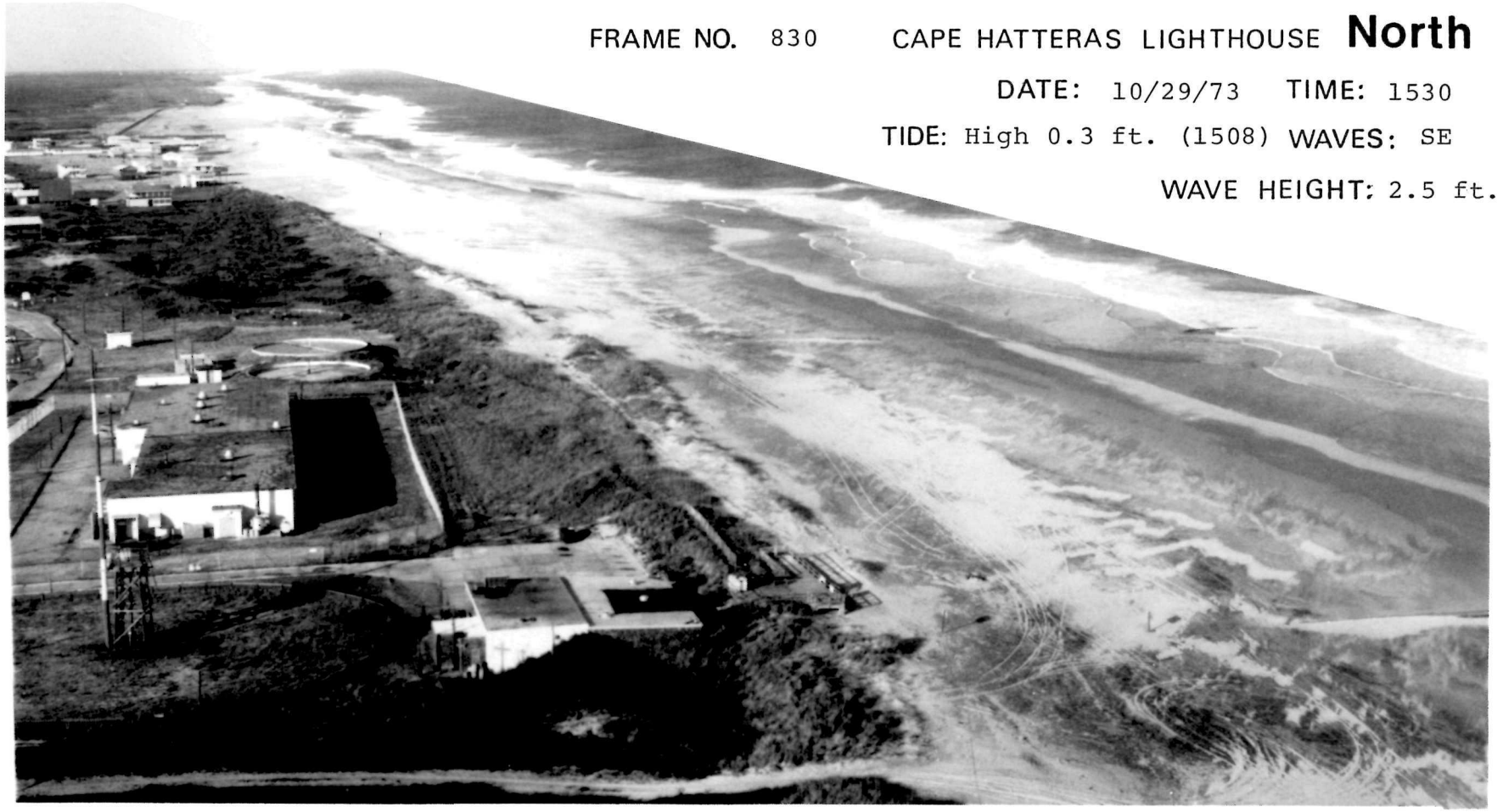
Southern sediment movement in August and September filled in the embayment that existed between the south end of the project at station 2235+00 and the groins. The westward curvature of the beach south of the Lighthouse remains unaffected by the 1,300,000 yds.^{3} of sand pumped.



When the nourishment project was completed, the beach was generally wider by 300 to 350 feet with some increases of over 400 feet. Although no material was pumped into the groin cells, southern sediment drift caused a build-up of up to 200 feet. In spite of this obvious loss of nourishment material to the southern beach, the final retention figure in the project area was approximately 85%.

An inner bar is still absent along most of the nourished area and the inner bar at the groins has been covered by deposition. However, a bar appears to be developing at the northern end of the project area. Although the nourishment appears highly successful, the entire area remains vulnerable to oceanic overwash.

There are also significant changes south of the Lighthouse. Sand continues to be deposited near Station 2175+00 where the cut to the marsh was made in February. However, north of this area erosion has replaced deposition. Up to 100 feet of beach has been lost in front of the old lighthouse ruins because of material trapped on the north side of the groins.



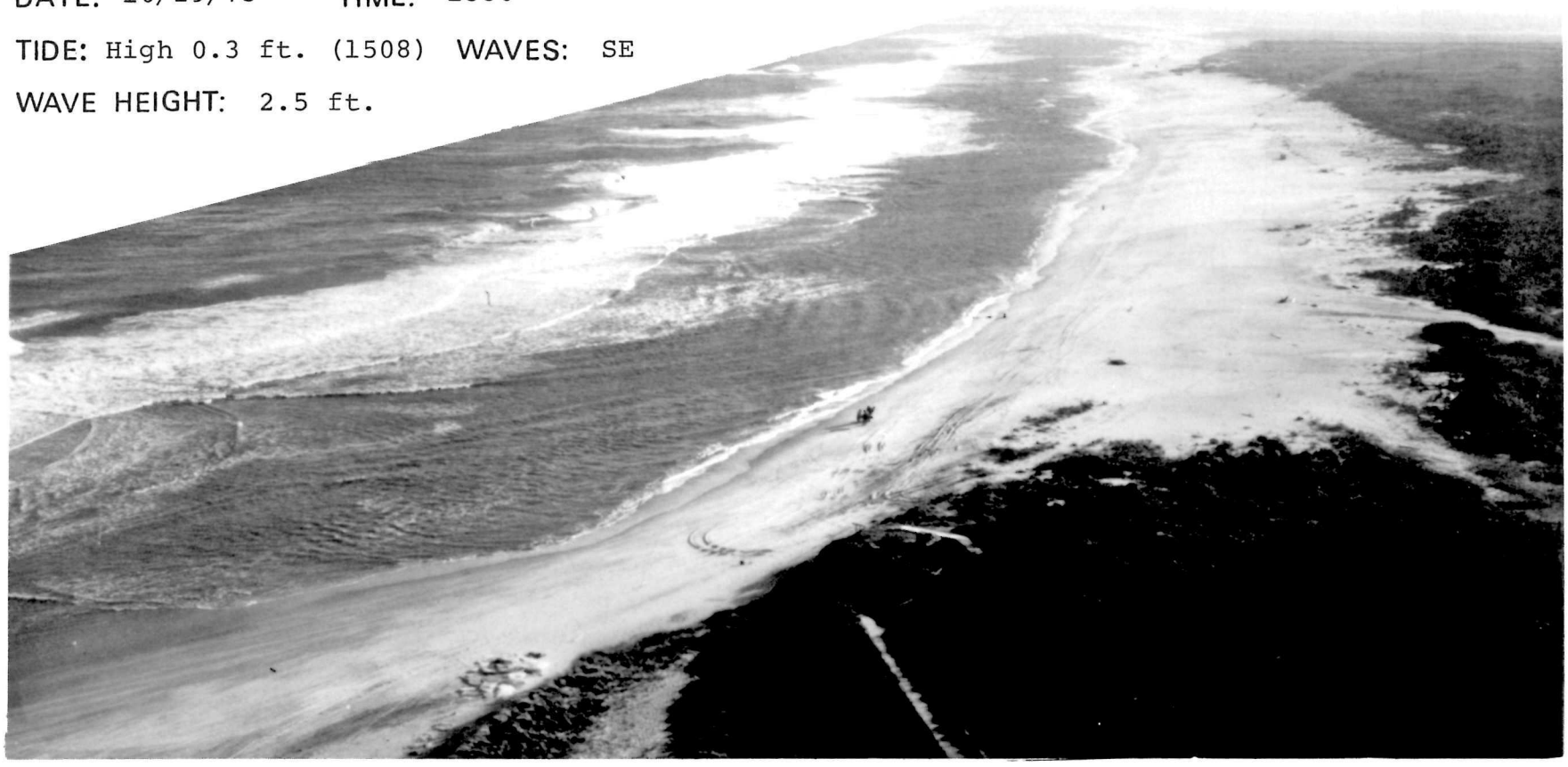
Tropical Storm Gilda was the first severe storm to influence the nourished beach. About 180,000 yds.^{3} of nourishment material moved offshore or was lost; an additional 50,000 yds.^{3} was moved from the beach face to the landward side of the fill by overwash. While Gilda caused some flooding of the highway, only minor property damage occurred. The nourished beach seems to have passed its first test. A significant percentage of the pumped material has moved from the beach face, but an inner bar has formed along the northern half-mile of the project area. Part of the "lost" material has moved into the groin cells and still more has moved offshore. By the end of November, over 50,000 yds.^{3} of material was re-worked back onto the nourished beach.

South CAPE HATTERAS LIGHTHOUSE FRAME NO. 831

DATE: 10/29/73 TIME: 1530

TIDE: High 0.3 ft. (1508) WAVES: SE

WAVE HEIGHT: 2.5 ft.



Beach loss was greatest in the vicinity of the old lighthouse ruins. Further south there were only moderate decreases in beach width. This trend once again demonstrated the influence of the groins. Three days after the storm there is a wide inner bar which may have been formed by some of the material from the nourished beach. By the end of November, much of the material from this bar moved onshore. Transport of the sand from the nourished beaches is now beginning to have an impact on the southern beach.

IMPLICATIONS AND DISCUSSION

In terms of filling in the embayment to the north of the 1969 groin field and widening the beach, the 1973 beach fill was a success. The combination of excellent nourishment material, an effective discharge system, a sufficiently large volume of material, and a pumping period of exceptionally low-wave conditions contributed to the engineering success. The configuration of the subaerial beach system was effectively reverted to that prior to the installation of the groin field. Several noteworthy conditions have, however, remained unchanged. Sea level continues to rise, migratory extratropical storms continue to occur, and the gap or depression in the bar system immediately offshore remains unchanged. If the causative factors which resulted in the erosion problem in the first place are still present, what then is the future of the 1973 beach fill? Fortunately, careful monitoring of the sediment retention and the energy conditions allows estimation of long-term retention based upon the climatic normals of extratropical storms. Observations made during the pumping period indicated that a storm generating deep-water waves of 11 feet or higher resulted in a 16% loss of the in-place fill material.

Based upon 30-year climatic normals 1942-1973, such storms occurred 4.6 times a year; however variations from this mean are significant: During this period as few as two "11-foot" storms occurred in each of 5 years, and as many as ten "11-foot storms" occurred in each of 2 years. Using the data for the number of and frequency of storms which generated 11-foot waves during the thirty-year period of 1942-1973, Table I gives the percentage of fill retention should such storms occur during the first post-pumping year. If ten "11-foot" storms occur during the first year, only about 20% of the fill would remain in place. From a climatic perspective, expectations for the fill differ depending on what climatic normals are selected. In Table I the frequency of years with varying 11-foot storm frequencies are listed for two time intervals (1942-1973) and (1959-1973).

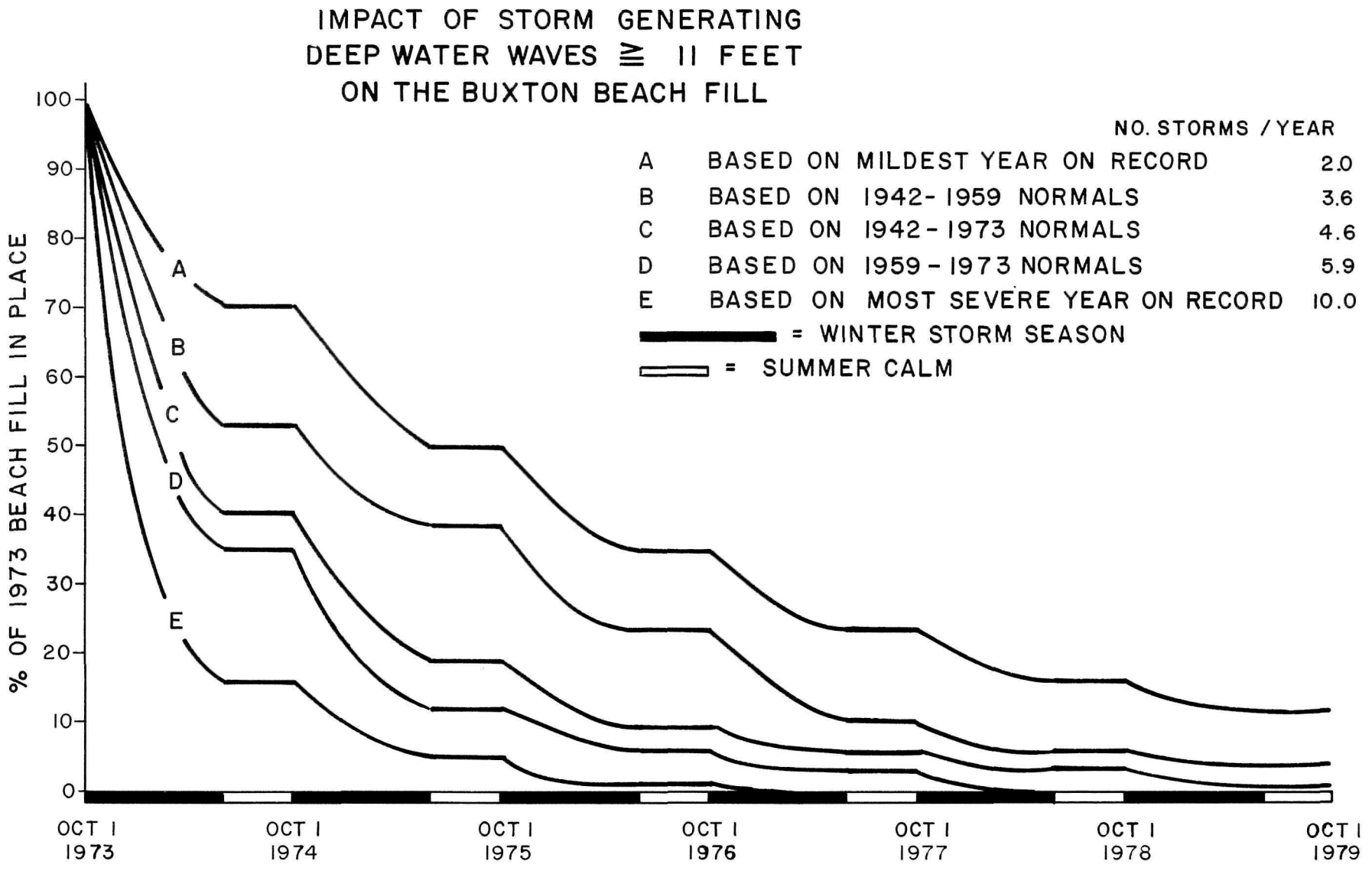
The most recent storm patterns differ significantly from the long-term normals; there has been a lower frequency of severe storm years. Based upon storm-frequency statistics, the yearly retention expected for various storm conditions can be calculated. Five curves are plotted: One curve for a series of the mildest years (two "11-foot" storms a year); another for a series of the

TABLE I

Number of Storms Generating Deep-Water Waves ≥ 11 Feet	Percentage of Fill Remaining at End of One-Year	Storm Frequency of Years 1942-1973		Storm Frequency of Years 1959-1973	
		Percentage	Storm No.	Percentage	Storm No.
0	100	0	0	0	0
1	84.0	0	0	0	0
2	70.6	16.7	5	0	0
3	59.3	26.7	8	21.4	3
4	49.8	13.3	4	21.4	3
5	41.8	13.3	4	14.3	2
6	35.1	10.0	3	7.1	1
7	29.5	3.3	1	7.1	1
8	24.8	0	0	0	0
9	20.8	10.0	3	14.3	2
10	17.5	6.7	2	14.3	2
11	14.7	0	0	0	0
12	12.3	0	0	0	0

most severe years (ten "11-foot" storms a year); and therefore expectations based upon the 1) 1942-1959, 2) 1959-1973, and 3) 1942-1973 climatic normals. Based on these estimates, under the most favorable conditions 25% of the beach fill would be retained at the end of 4 years, while under the most severe conditions only 16% would be retained after a single year and almost none after four years. Using the 1959-1973 mean figures, approximately 10% of the fill would remain at the end of 3 years, a condition more likely than those predicted by the use of extreme figures. If these figures are even in the right order of magnitude, the temporary nature of beach nourishment for high-energy coasts is clear.

The accuracy of predicting the effectiveness of any coastal engineering project is dependent on the systematic acquisition and assessment of data during implementation and during the post-project period. Research on the state of the Buxton beach system has continued since the termination of the engineering effort and will continue throughout the coming year. The resultant information log will be a valuable contribution to the evaluation process essential to shoreline management.


IMPACT OF STORM GENERATING
DEEP WATER WAVES ≧ 11 FEET
ON THE BUXTON BEACH FILL
NO. STORMS / YEAR
A BASED ON MILDEST YEAR ON RECORD 2.0
B BASED ON 1942-1959 NORMALS 3.6
C BASED ON 1942-1973 NORMALS 4.6
D BASED ON 1959-1973 NORMALS 5.9
E BASED ON MOST SEVERE YEAR ON RECORD 10.0
= WINTER STORM SEASON
= SUMMER CALM
% OF 1973 BEACH FILL IN PLACE
100
90
80
70
60
50
40
30
20
10
0
A
B
C
D
E
OCT 1 1973
OCT 1 1974
OCT 1 1975
OCT 1 1976
OCT 1 1977
OCT 1 1978
OCT 1 1979

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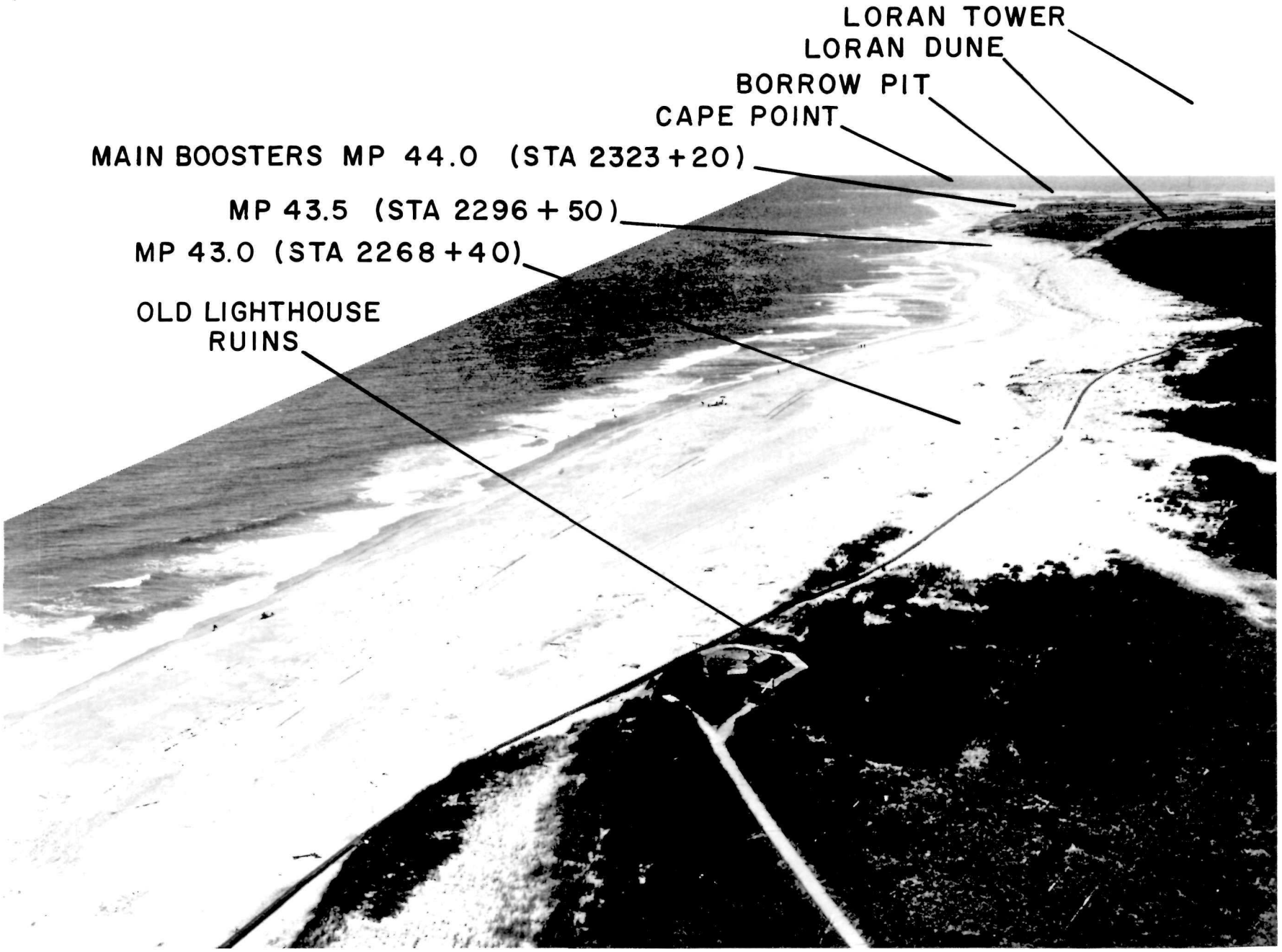
LORAN TOWER
LORAN DUNE
BORROW PIT
CAPE POINT
MAIN BOOSTERS MP 44.0 (STA 2323+20)
MP 43.5 (STA 2296+50)
MP 43.0 (STA 2268+40)
OLD LIGHTHOUSE RUINS