Paint performance studies at DOT lighthouse stations, Nova Scotia: a preliminary report

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NATIONAL RESEARCH COUNCIL OF CANADA

DIVISION OF BUILDING RESEARCH

PAINT PERFORMANCE STUDIES

AT

DOT LIGHTHOUSE STATIONS, NOVA SCOTIA

A Preliminary Report

by

D. R. Robson

Atlantic Regional Station

Internal Report No. 348

of the

Division of Building Research

OTTAWA

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PREFACE

Studies of the performance of buildings in service has always been an important part of the field activities of the Division of Building Research, NRC. This report is, therefore, one of a series recording careful observations of various aspects of the performance of buildings under different Canadian climatic conditions.

The introduction to the report explains how this study of lighthouse stations was initiated - most appropriately - through the Atlantic Regional Station of the Division, the Atlantic Coast of Canada being justly famous for its scenery and, therefore, necessitating a remarkable collection of lighthouses.

The Division is most grateful to the Department of Transport and in particular to the members of its staff in the Atlantic provinces who have assisted so kindly in facilitating the field studies of Mr. Robson who is a research officer attached to the Atlantic Regional Station of DBR/NRC in Halifax.

Ottawa
September 1967

Robert F. Legget
Director

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The maintenance of paint on wood siding is a continuing problem and one of particular interest to the Atlantic Regional Station of the Division of Building Research because of the predominance of wood construction in the Atlantic Provinces. From detailed observations of paint performance at various projects in the area, it appears that the influence of maritime weather (wind, rain and sun) is a more important factor in paint failure than the more popular theory of the condensation of indoor-derived moisture. Many factors other than weather, such as surface preparation, type of paint used, conditions under which the paint is applied, type of occupancy, orientation, and design details, affect the performance of the paint film and most of these are difficult to assess.

During a field trip to northern Nova Scotia, the excellent appearance of a small, wood-frame lighthouse prompted further investigation. It was thought that the Department of Transport might have developed better methods of surface preparation, a particular type of paint or a frequent repainting schedule to achieve the apparently good results. Subsequent discussions with the District Marine Agent and the Superintendent of Lights at the Dartmouth Marine Agency of the Department of Transport indicated that the lighthouse owed its excellent condition to regular maintenance. These dicussions resulted in a joint study of paint performance on buildings at lighthouse stations.

Preliminary talks revealed the two main problems of the DOT Marine Agency relating to paint performance. The first problem is to prevent deterioration of the buildings due to typically severe exposure, and the second is to

maintain a bright paint film so that the buildings are clearly visible from seaward as daymarks. They have been using a good quality bright red enamel for the roofs and a 1GP109 or 1GP28 white for the siding. In the last few years they have adopted a policy of repainting every two years in order to satisfy these two main requirements. The end result, however, is still not satisfactory from their point of view.

A detailed study of this problem was particularly justified because of the ready availability of relevant data: the paint used by the Department of Transport is identifiable by CGSB number; the work is generally done by their own staff including the staff at each lighthouse station; maintenance records are available; and the various buildings are exposed in all directions because of their peculiar location. This is a preliminary report of the first two series of visits to the sites - one in the fall (September to December) of 1965 and the other in the summer and fall (May to September) of 1966. Nineteen lighthouse stations located along the south and east coast of Nova Scotia from Baccaro at the West end of the "South Shore" to Cranberry Island at the East end of the "Eastern Shore", a distance of approximately 270 miles, were selected for detailed examination. The stations were chosen so that more than two, and both heated and unheated buildings were at each station. The stations were fairly evenly spaced throughout the 270 miles and could be easily visited by helicopter.

DESCRIPTION OF PROJECT

Ninety-two buildings, 40 unheated and 52 heated, were examined in detail at 19 lighthouse stations along the south coast of Nova Scotia (Figure 1). The buildings range in age from those built in 1965 to one sixty years old.

The exposure at each station would be considered severe, as no natural protection from the weather is provided in any direction. Fifteen of the nineteen stations are on islands, and four of them are on exposed headlands. Many of the buildings are subject to salt spray during a storm.

PROCEDURE

Most of the lighthouse stations were visited by helicopter, and aerial photographs of the sites were taken to record the relationship of the buildings to one another and to the sea. A sketched plan was made of each site and the

location of each building was recorded on this plan (Figures 2 to 21). Photographs at ground level were taken of some of the buildings and construction details were collected at each station (Figures 22 to 26).

Each side of each building was carefully examined and the results of the visual examination recorded. In addition, from discussion with the staff at each Station, data relating to the type of paint used, preparation of the surface prior to painting, weather at the time of painting, and condition of the building before surface preparation and repainting were recorded.

The above procedure was repeated during the second series of visits (May to September 1966), except for the aerial photograph and sketch plan.

Following the visits in 1965 and 1966, an examination of the maintenance records at the Dartmouth Marine Agency was made, which proved invaluable in establishing the age of the buildings, the number of times each had been painted, the type of paint used and the repairs made to the buildings. From these records it was also possible to establish which buildings had been insulated and what details had been specified for construction.

The data were then organized and summarized in an attempt to correlate the various factors involved in the deterioration of the paint film.

DATA SUMMARY

Age of Buildings (Figure 27 and Table I)

Forty-five per cent of the unheated buildings are 20 years old or less; 55 per cent of them are over 20 years old. Seventy-one per cent of the heated buildings are 20 years old or less, and 29 per cent are over 20 years old.

There are more heated buildings in the 20 years or less category, as the Department's policy in recent years has been to replace the combined buildings (dwelling and light) with separate dwellings and light towers.

All of the heated buildings 20 years old or less are insulated.

Type of Cladding (Figure 28 and Table II)

Most of the buildings used cedar siding in the form of shingles, shakes or clapboards (67 per cent of the unheated and 90 per cent of the heated buildings).

Masonry has been used in some of the unheated buildings (15 per cent). In this category, concrete light towers are included as masonry.

Type of Paint (Figure 29 and Table III)

Most of the buildings were painted with a conventional oil base paint (1GP109 or 1GP28) over 1GP55 primer.

Acrylic latex was used on a trial basis on $9\frac{1}{2}$ per cent of the heated buildings. Visual examination of these buildings indicates that latex paint performs well and possibly will give better service than the conventional paints.

Effect of Exposure (Figure 30 and Table IV)

There is very little difference between the heated and unheated buildings in the effects of exposure. On the buildings that exhibited paint failure, the south and east exposures are almost equally bad (35 per cent on the east, 36 per cent on the south) and the west exposure accounts for 21 per cent of the failures.

Ninety-two per cent of the paint failures occurred on the east, south or west walls. This follows the pattern established by extensive surveys on mainland houses.

Most of the severe storms that would cause wetting of the siding (wind-driven rain) would come from seaward, which is southerly in most instances (SE through south to SW).

All of the buildings are completely unprotected in all directions and the sides facing the prevailing weather would be expected to show the most deterioration; this has been substantiated by the data collected.

Type of Paint Failure (Figure 31 and Table V)

On all of the buildings with a failure of the paint film (59 per cent of the buildings had paint failure), 45 per cent of the failures can be attributed to cracking and checking, 31 per cent to peeling and the remainder to blisters.

More heated buildings (73 per cent) showed paint

failure in one form or another than unheated buildings (40 per cent). It should be remembered that only 29 per cent of the heated buildings are over 20 years old.

The heated buildings showed less failure in the paint film from blisters ($5\frac{1}{2}$ per cent) than the unheated buildings (69 per cent).

DISCUSSION

From records and observation of the buildings, the following data have been clarified:

1. The most severe exposure is south or south and east.
2. Condensation in heated buildings as the major cause of paint failure has not been substantiated; unheated buildings had more paint failure by blistering than did heated buildings.
3. The largest percentage of paint failures can be attributed to cracking or checking of the paint film.
4. More heated buildings showed evidence of paint failure than did unheated buildings; there were more newer buildings in the "heated building" category.
5. The paint film on some buildings consists of more coats of paint than the records show; this is particularly true of the heated dwellings and may indicate the reason for the high incidence of failure by cracking and checking.
6. Very little care is taken in some instances to clean the old surface and remove loose paint before repainting. There were several examples of paint being applied directly over a visible dirt film.
7. The paint film has become very thick due, in many instances, to frequent repaintings, and old paint should be completely removed before repainting is considered
8. The use of acrylic latex paint on a small number of buildings showed good results and indicates that further use of this type of paint should be considered.

Laboratory studies have been initiated to determine the effect of sealers and paint systems on the wetting of wood by rain. Microscopic examination of paint film samples to determine the number of coats of paint has also been started and eventually a photographic record will be made of each sample.

It is expected that additional visits will help to determine the reasons for the higher rate of failure on the heated buildings, and the effect of surface preparation on paint performance. Eventually, a controlled experiment on the preparation of surfaces, application of paint, and variation in paint type may be done to determine the effect of each. Due to exposure, an accelerated weathering condition exists at these lighthouse stations. A two-year cycle is considered equivalent to a longer cycle elsewhere, and results from a controlled experiment involving buildings at these exposures may be expected more rapidly.

The eventual aim is to develop a better understanding of the reasons paint fails on wood sidings, and to assist in developing a system that will give a longer period of good service before failure. This is important to the Department of Transport policy of maintaining these buildings in good condition for the two main reasons cited earlier.

SPECIAL STUDY

A special study has been started at one of the lighthouse stations not included in the original group of nineteen because of its location.

Because the paint failure at Flint Island off the coast of Cape Breton is serious, it was decided that rather than wait and include it in the proposed experiments with the other lighthouse stations, it should be made the subject of a separate study.

The three houses on this station were painted in 1960, just after they were built, and have been repainted three times since then, the last time in 1964. The paint has usually failed by peeling and blisters within two months of the time of painting.

At the request of the Dartmouth Marine Agency (DOT), the Division of Building Research made specific recommendations as to surface preparation and type of paint. It has been

recommended that removal of old paint by sanding and burning be done on each wall of each house (one half of the wall sanded, the other half burned). It has also been suggested that a different type of paint be used on each house - 1GP28 on one, 1GP59 on the second, and acrylic latex on the third.

A visit was made to this station in September 1966 and a survey carried out in the same way as that for the other 19 stations. In addition, photographs of each side of each building were made to record the existing condition.

Following this visit, the staff at the lighthouse station were to proceed with the surface preparation and repainting following the above recommendations, and to keep careful record of the weather during repainting, the general condition of the building, and the wood moisture content of the cladding during the repainting with the aid of a moisture meter on loan from the Atlantic Regional Station of the Division of Building Research. The study group intends to revisit Flint Island to observe the effect of the recommendations.

The Division is indebted to Mr. F. M. Weston, District Marine Agent of the Dartmouth Marine Agency (now Regional Director - Marine Services) and to Mr. K. C. Curren, Superintendent of Lights, for providing the opportunity to participate in this survey. Mr. Curren has been particularly helpful in including staff from the Atlantic Regional Station in his planning for visits to the stations, so that observations could be made and data recorded. Visits are planned for 1967 to enlarge upon the data already collected.

TABLE II

TYPE OF CLADDING

Type of Cladding	Unheated Buildings Number	Unheated Buildings Per Cent of Total	Heated Buildings Number	Heated Buildings Per Cent of Total	Heated + Unheated Per Cent of Total
Cedar shingle	24	60	41½	80	71
Cedar shakes	0	0	5	9	5½
Cedar clapboards	3	7½	½	1	4
Asbestos shingle	0	0	3	6	3½
Aluminum siding	0	0	1	2	1
Masonry	6	15	1	2	7½
Other	7	17½	0	0	7½
TOTAL	40	100%	52	100%	100%

TABLE III

TYPE OF PAINT

Type of Paint	Unheated Buildings Number	Unheated Buildings Per Cent of Total	Heated Buildings Number	Heated Buildings Per Cent of Total	Heated + Unheated Per Cent of Total
1GP109	30	77	38	73	75
1GP28	0	0	2	4	2
1GP138	6	15	5	$9\frac{1}{2}$	12
Acrylic Latex	0	0	5	$9\frac{1}{2}$	$5\frac{1}{2}$
Other	3	8	2	4	$5\frac{1}{2}$
TOTAL	39	100%	52	100%	100%

TABLE IV

EFFECT OF EXPOSURE

Failures from Exposure	Unheated Buildings		Heated Buildings		All Failures Heated + Unheated	
	Number	Per Cent of Total	Number	Per Cent of Total	Number	Per Cent Failed On
North	4	11½	4	5½	8	8
East	11	31½	26	37	37	35
South	13	37	25	36	38	36
West	7	20	15	21½	22	21
TOTAL	35	100%	70	100%	105	100%

TABLE V

TYPE OF PAINT FAILURE

Type of Paint Failure	Unheated Buildings		Heated Buildings		Heated + Unheated	
	Number of Failures	Per Cent Failed	Number of Failures	Per Cent Failed	Number of Failures	Per Cent Failed
By peeling	1	6	16	42	17	31
By blisters	11	69	2	$5\frac{1}{2}$	13	24
By checking	1	6	7	$18\frac{1}{2}$	8	15
By cracking	3	19	13	34	16	30
TOTAL	16	40% Failure	38	73%	54	59% of all buildings failed

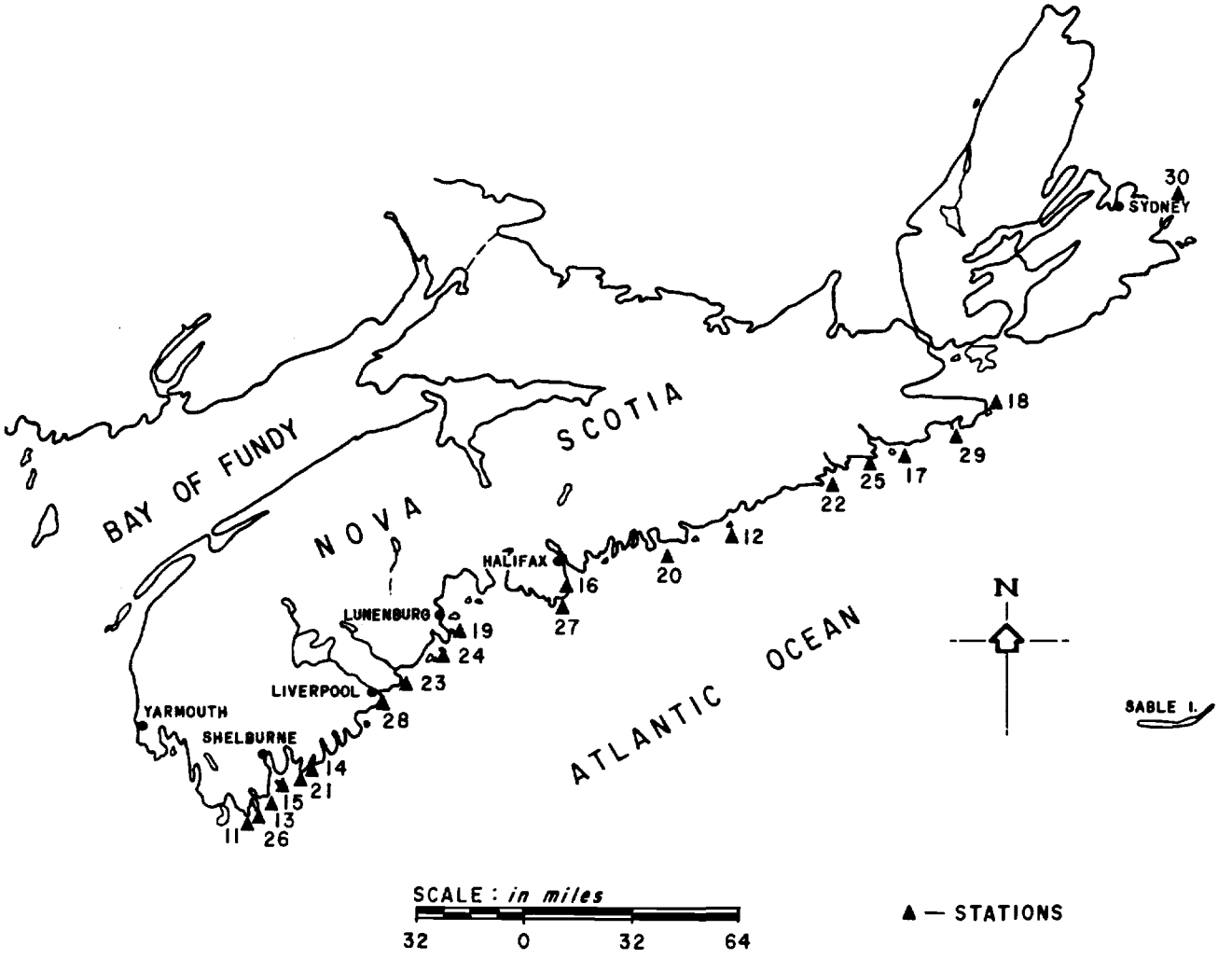

FIGURE 1

LIGHTHOUSE STATIONS ALONG THE SOUTH COAST OF NOVA SCOTIA

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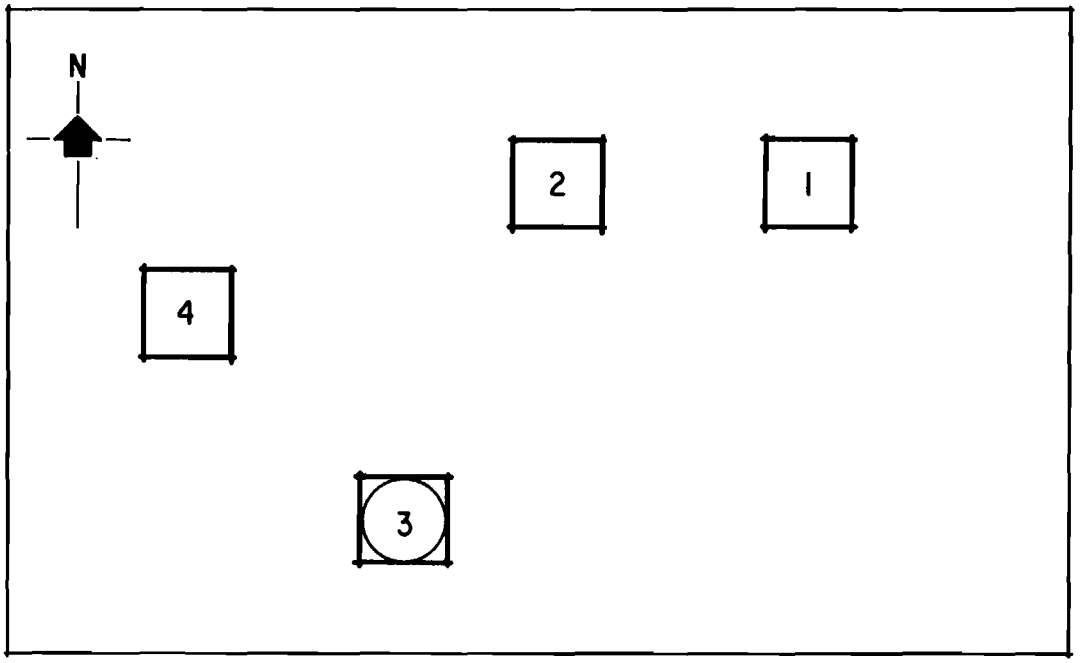
PLOT PLAN BACCARO - STATION 11



1. House
2. House
3. Light Tower
4. Storage Building

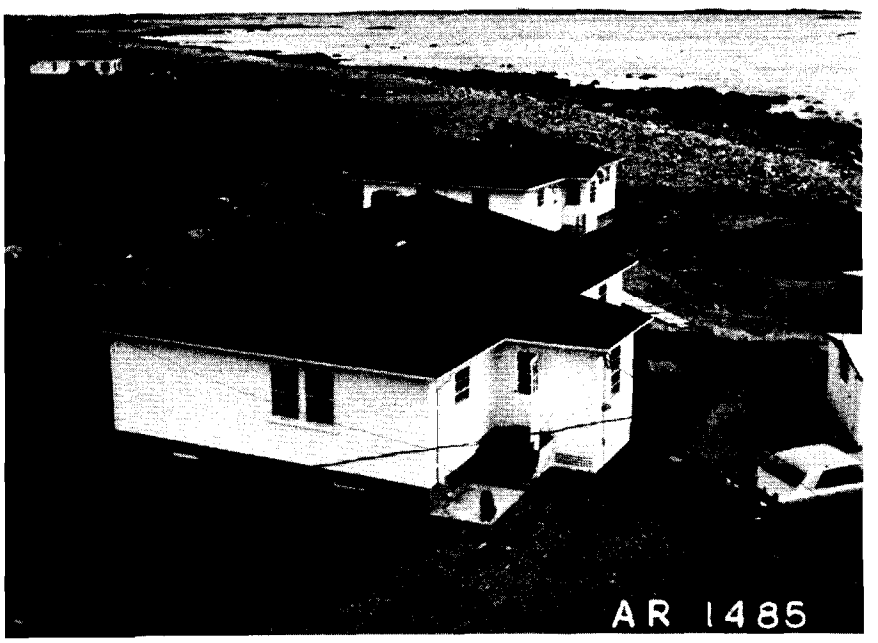
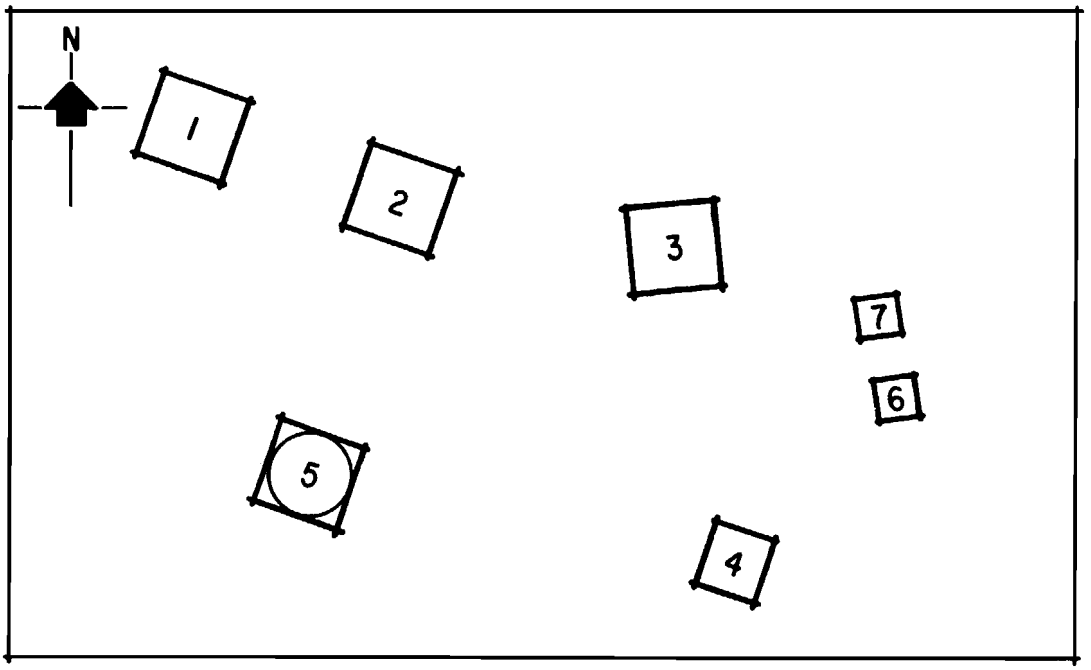


FIGURE 2

Houses 1 and 2 - Southwest Exposure from Light Tower.

PLOT PLAN BEAVER ISLAND - STATION 12



1. House
2. House
3. House
4. Fog Alarm
5. Light Tower
6. Storage Building
7. Storage Building

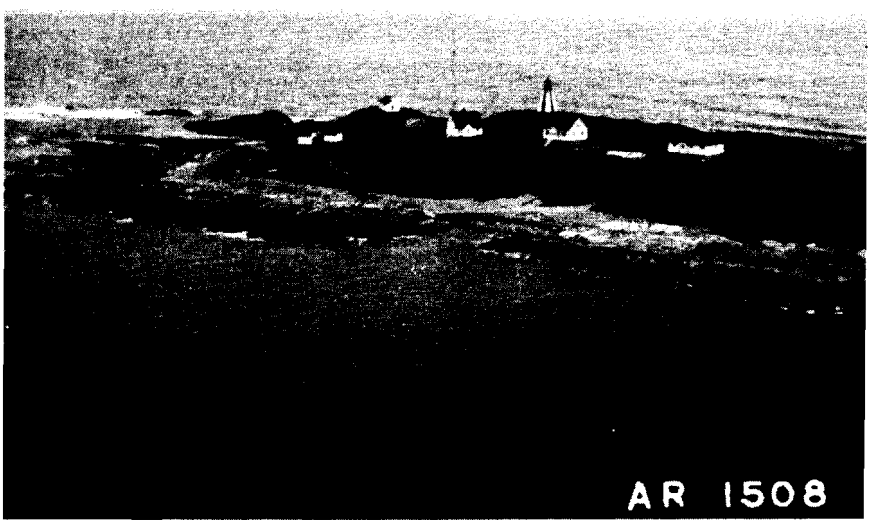
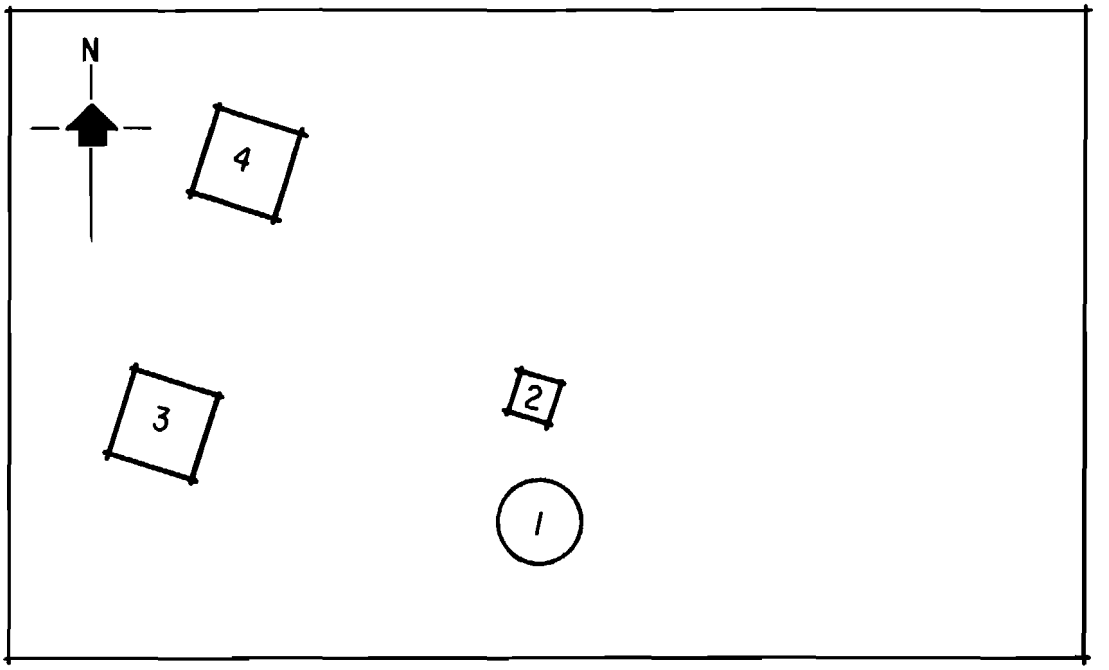


FIGURE 3

Aerial Photograph - Looking South.

PLOT PLAN CAPE NEGRO - STATION 13



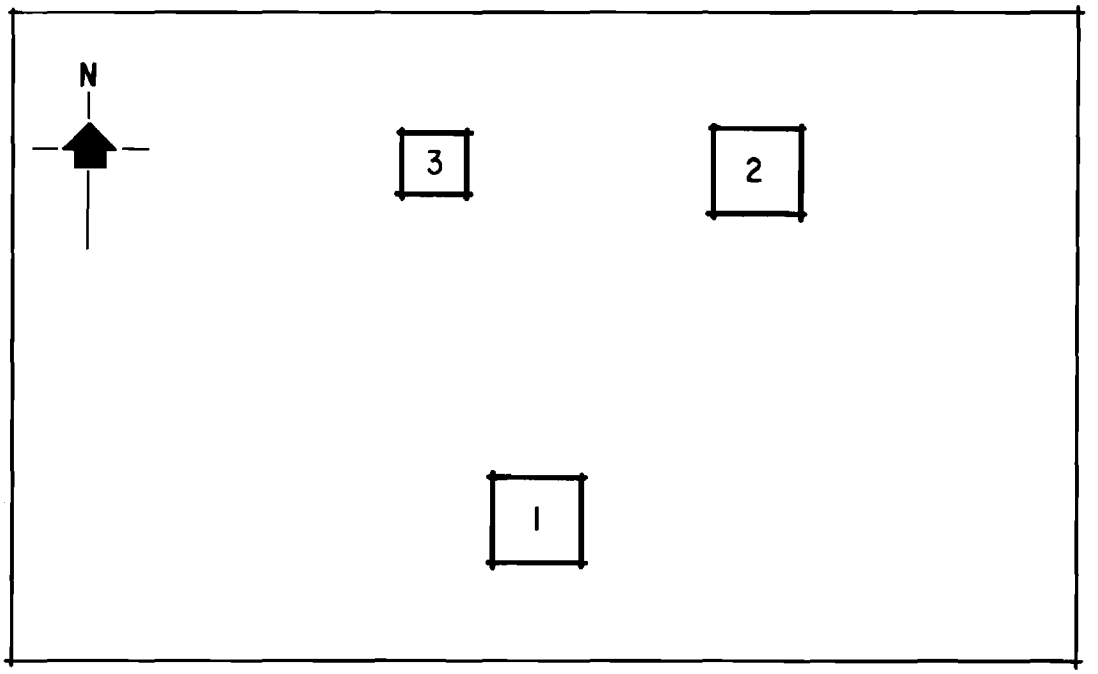
1. Light Tower
2. Storage Building
3. House
4. Storage Building

} 3 and 4 to be Demolished

FIGURE 4

Aerial Photograph - Looking Northwest.

PLOT PLAN CARTERS ISLAND - STATION 14



1. House and Light Tower (Combined)
2. Storage Building
3. Boathouse

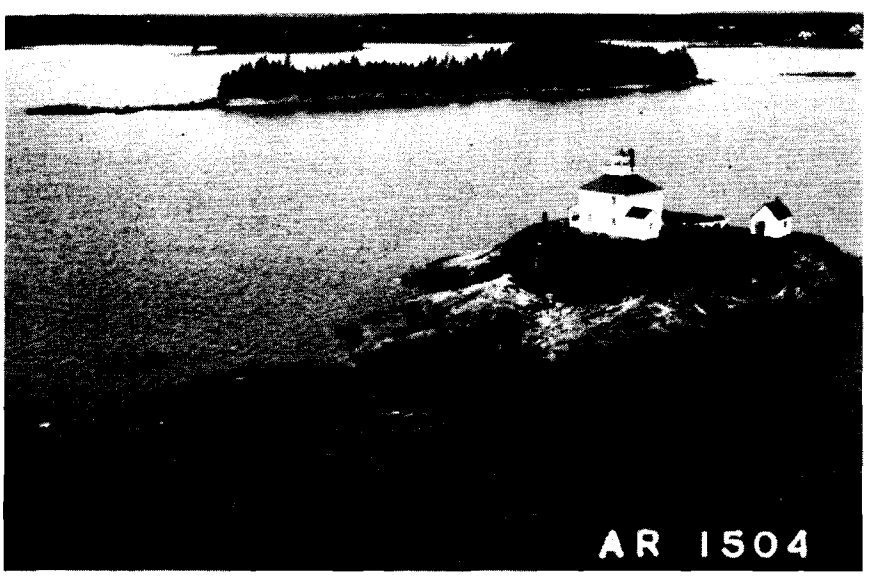
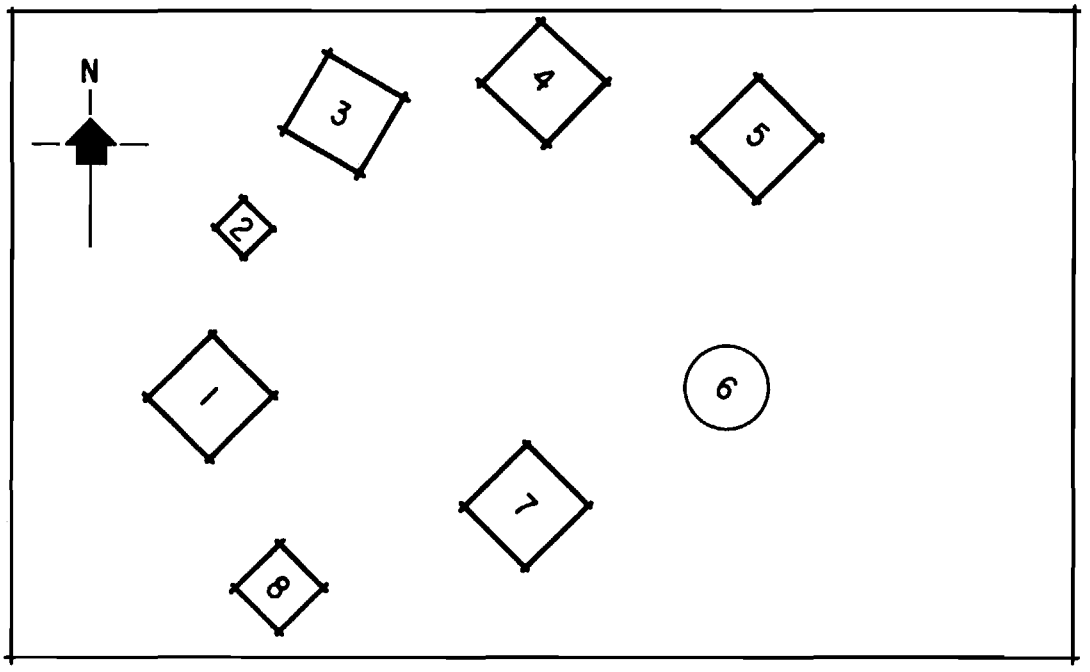


FIGURE 5

Aerial Photograph - Looking Northwest.

PLOT PLAN CAPE ROSEWAY - STATION 15

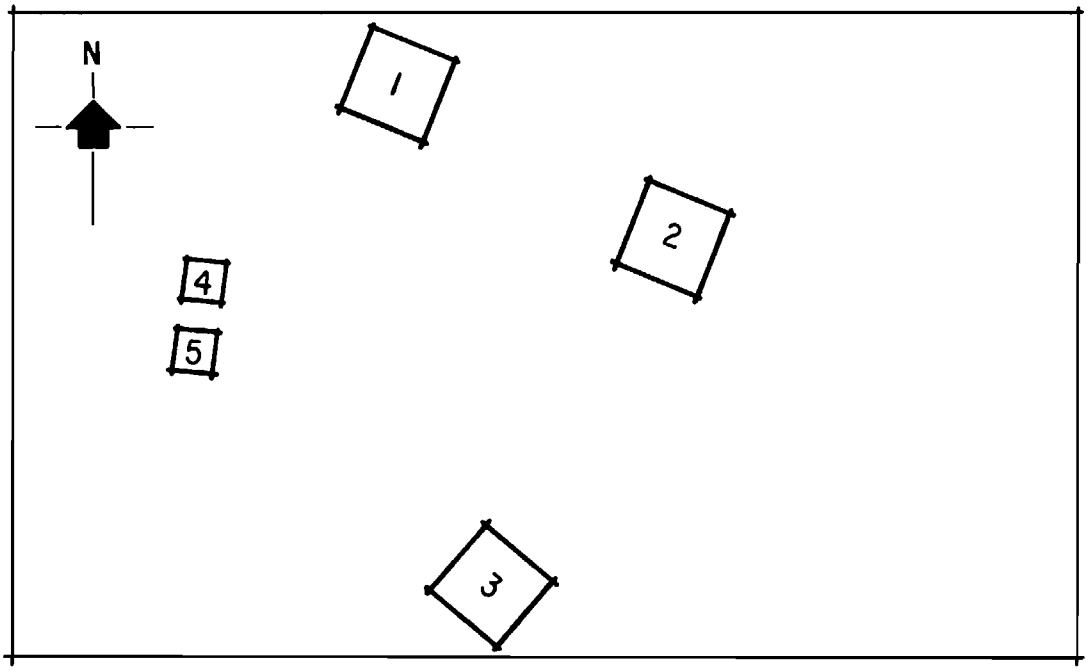


1. House
2. Storage Building
3. House
4. House
5. Storage Building
6. Light Tower
7. Fog Alarm
8. Storage Building

FIGURE 6

Aerial Photograph - Looking North.

PLOT PLAN CHEBUCTO HEAD - STATION 16



1. House and Light Tower (Combined)
2. Fog Alarm
3. House
4. Storage Building
5. Garage

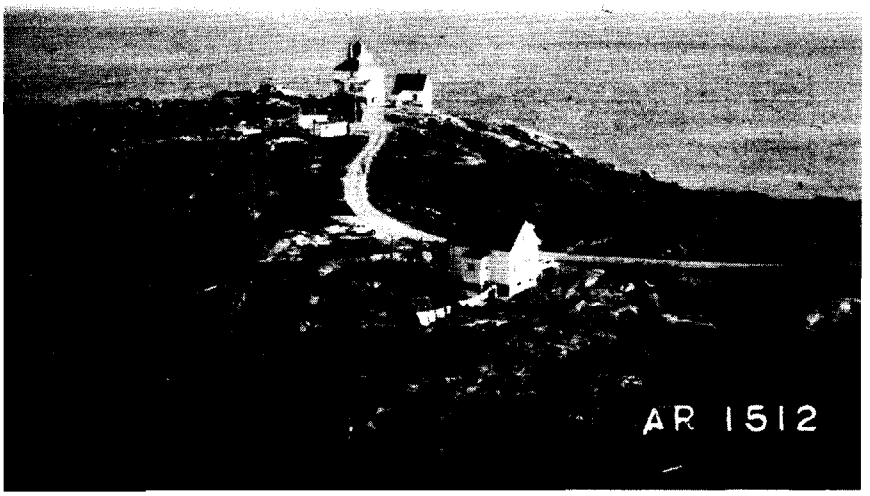
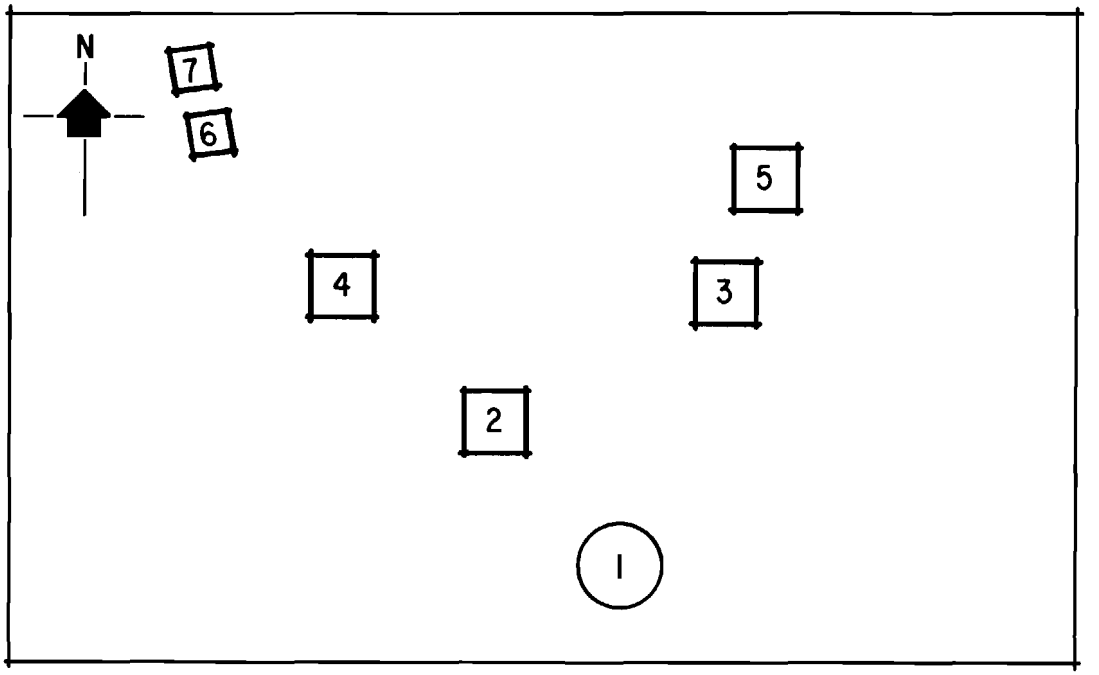


FIGURE 7

Aerial Photograph - Looking Northeast.

PLOT PLAN COUNTRY ISLAND - STATION 17



1. Light Tower
2. Fog Alarm
3. House
4. House
5. House
6. Storage Building (To Be Demolished)
7. Boathouse

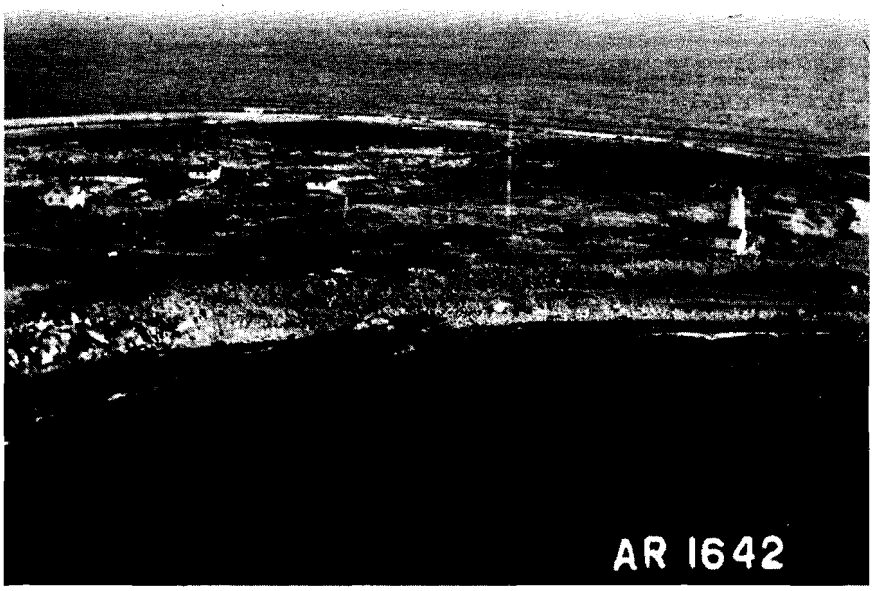
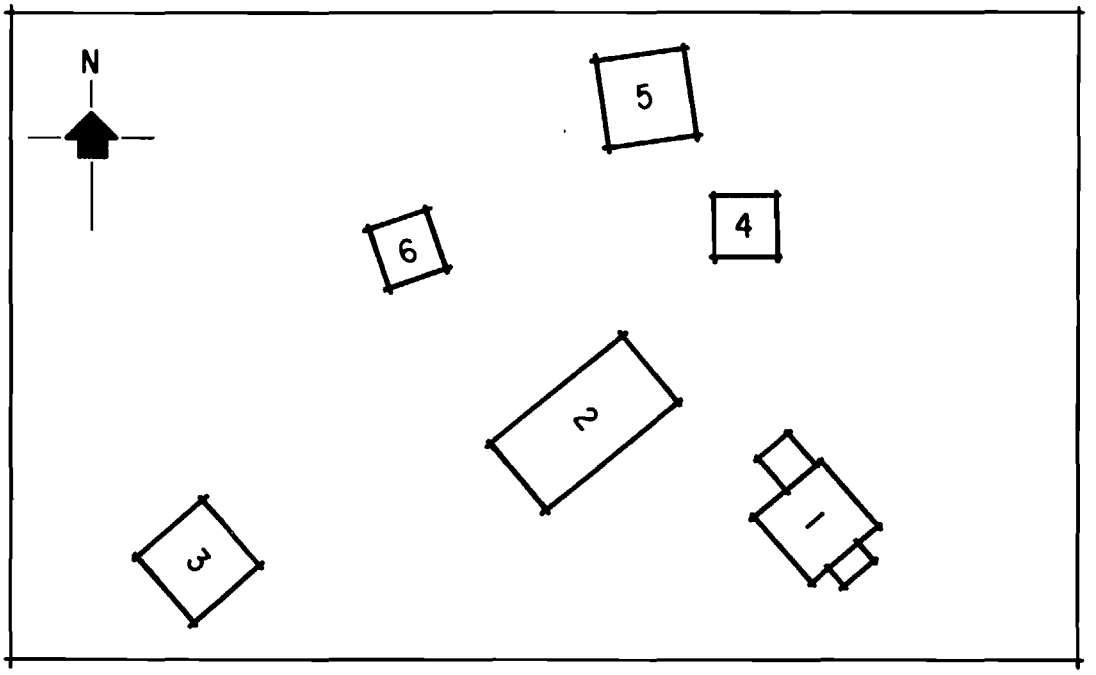


FIGURE 8

Aerial Photograph - Looking Southeast.

PLOT PLAN CRANBERRY ISLAND - STATION 18

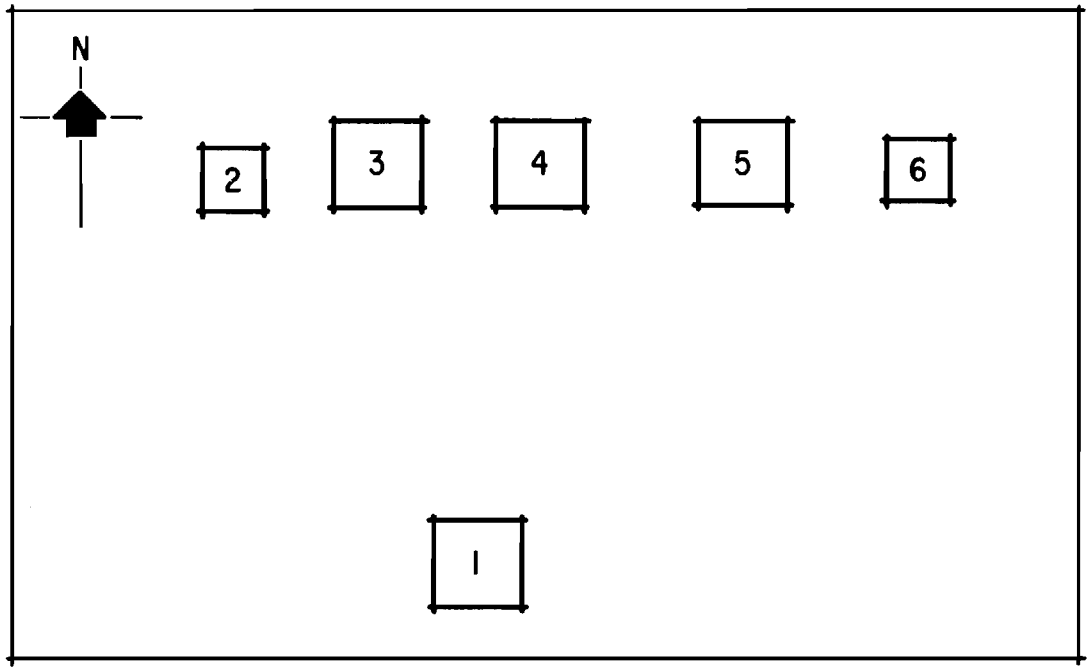


1. Light Tower and Fog Alarm (Combined)
2. House (Double)
3. House
4. Boathouse
5. Boathouse
6. Storage Building

FIGURE 9

Aerial Photograph - Looking North.

PLOT PLAN CROSS ISLAND - STATION 19

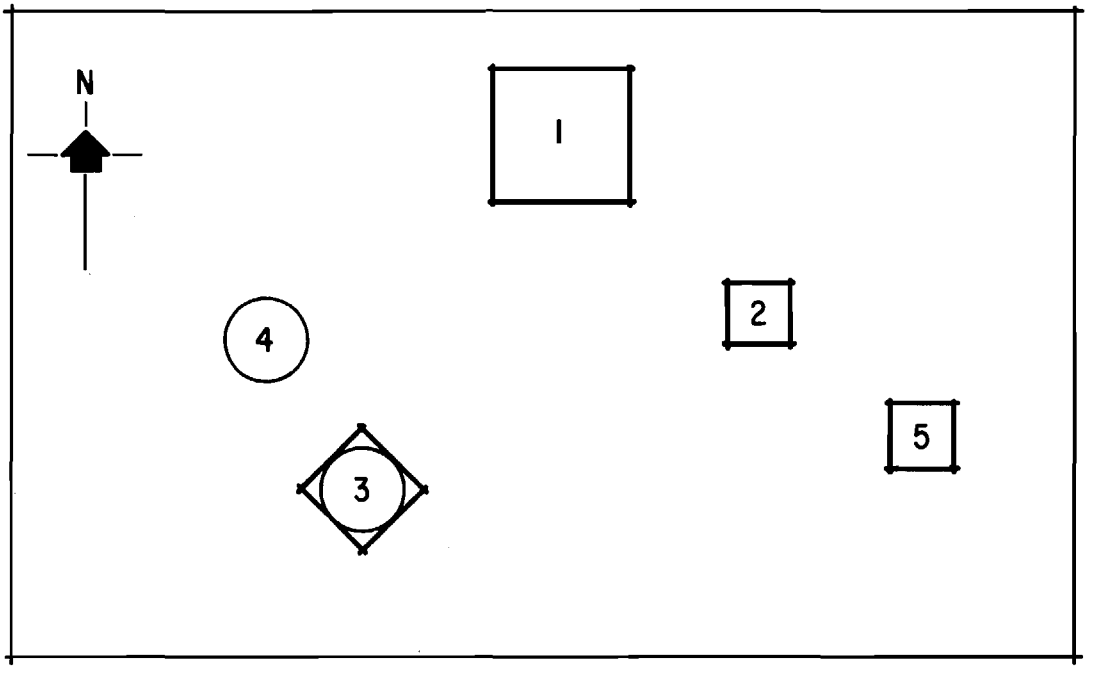


1. Fog Alarm
2. Storage Building
3. House
4. House
5. House
6. Storage Building

FIGURE 10

Aerial Photograph - Looking Northeast.

PLOT PLAN EGG ISLAND - STATION 20

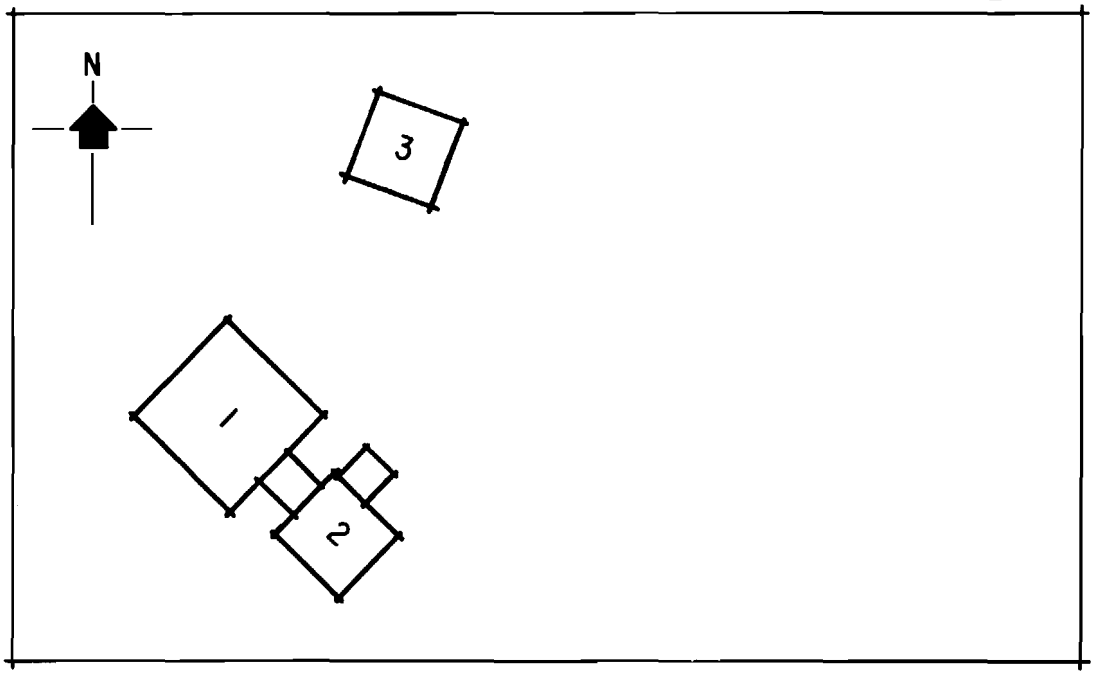


1. House
2. Storage Building
3. Light Tower
4. Engine House and Fog Alarm
5. Boathouse

FIGURE 11

Aerial Photograph - Looking Southwest.

PLOT PLAN GULL ROCK - STATION 21



1. House and Light Tower (Combined)
2. Engine Room and Fog Alarm
3. Boathouse

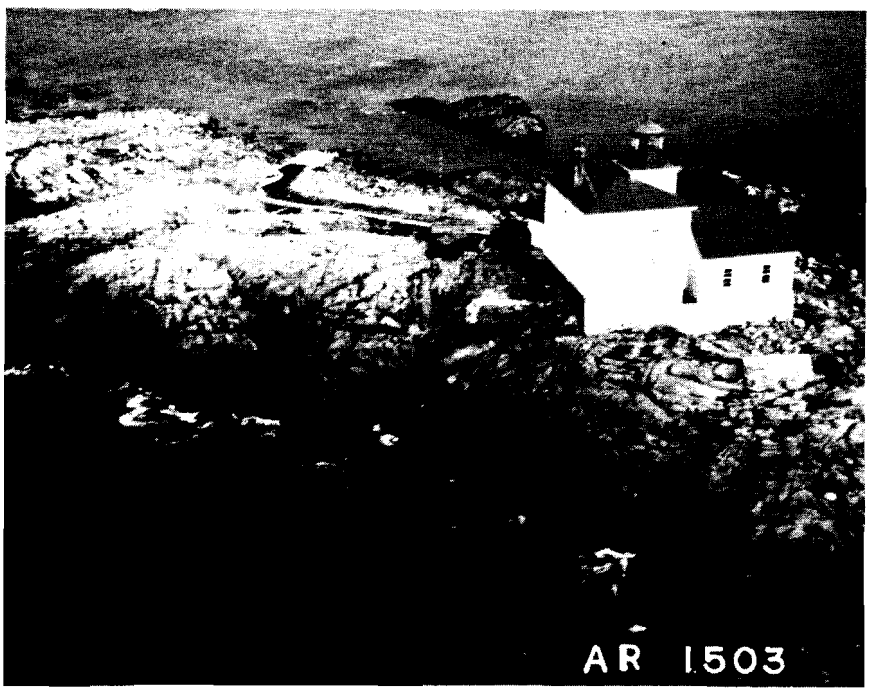
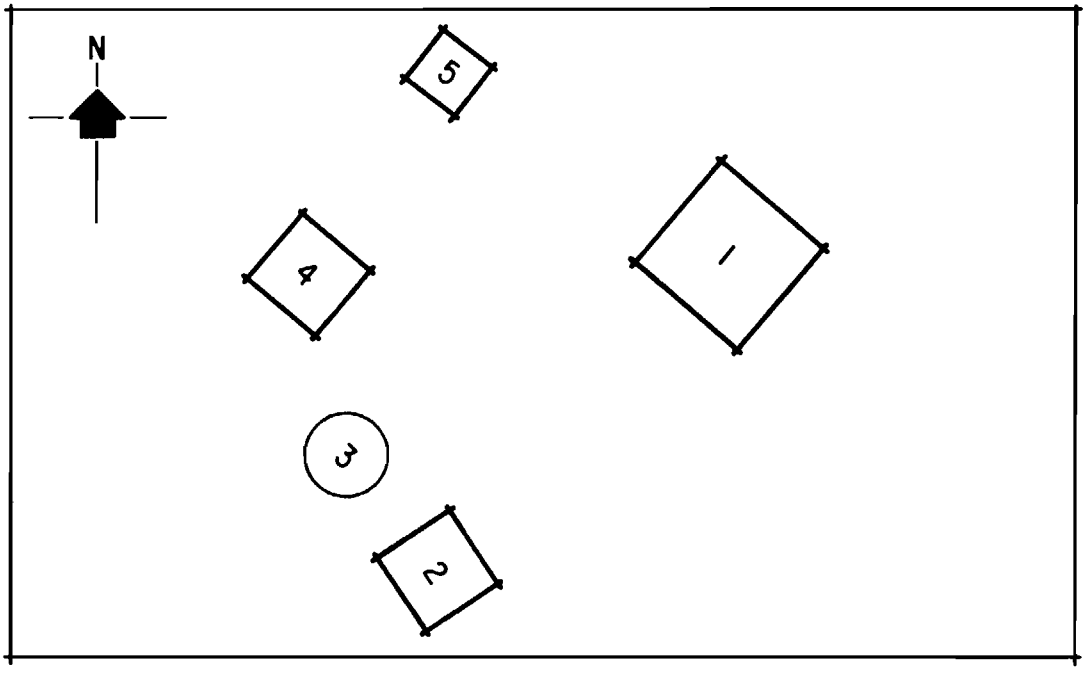


FIGURE 12

Aerial Photograph - Looking East.

PLOT PLAN LISCOMB ISLAND - STATION 22

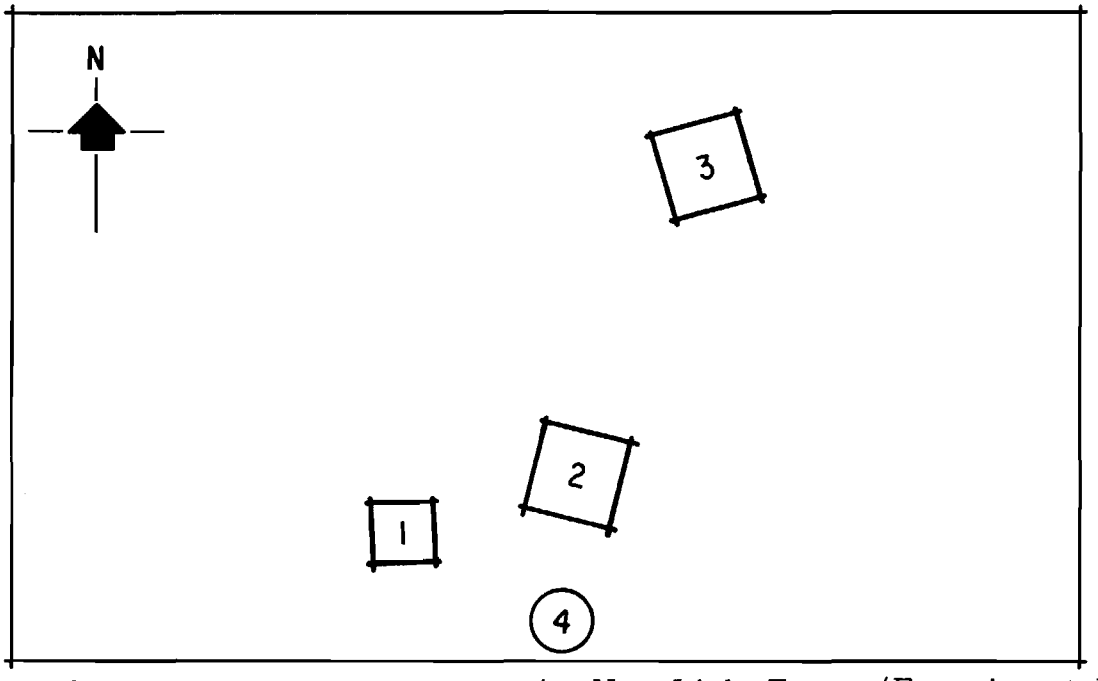


1. House
2. Fog Alarm
3. Light Tower
4. House
5. Garage

FIGURE 13

Aerial Photograph - Looking Southwest.

PLOT PLAN MEDWAY HEAD - STATION 23

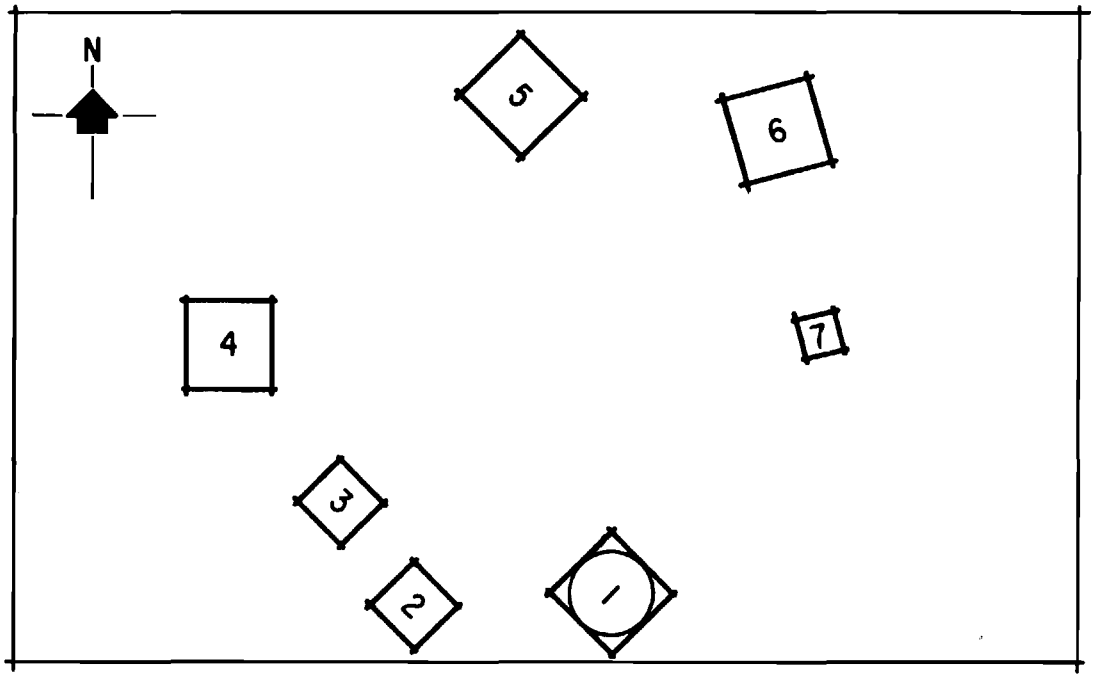


1. Fog Alarm
2. House and Light Tower (Combined)
3. House
4. New Light Tower (Experimental)

FIGURE 14

Aerial Photograph - Looking East.

PLOT PLAN MOSHER'S ISLAND - STATION 24



1. Light Tower
2. Storage Building
3. Generator House
4. Boathouse
5. House
6. House
7. Fog Alarm

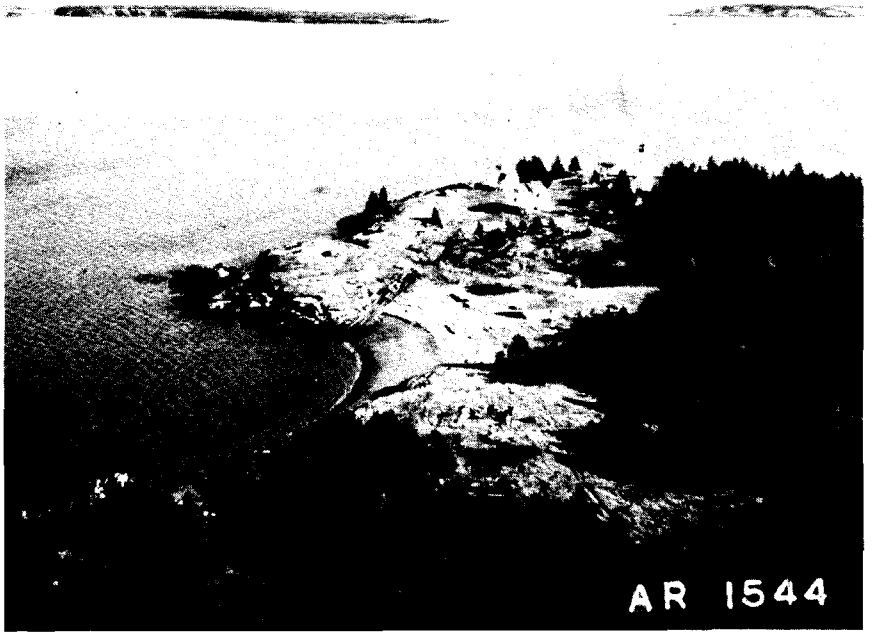
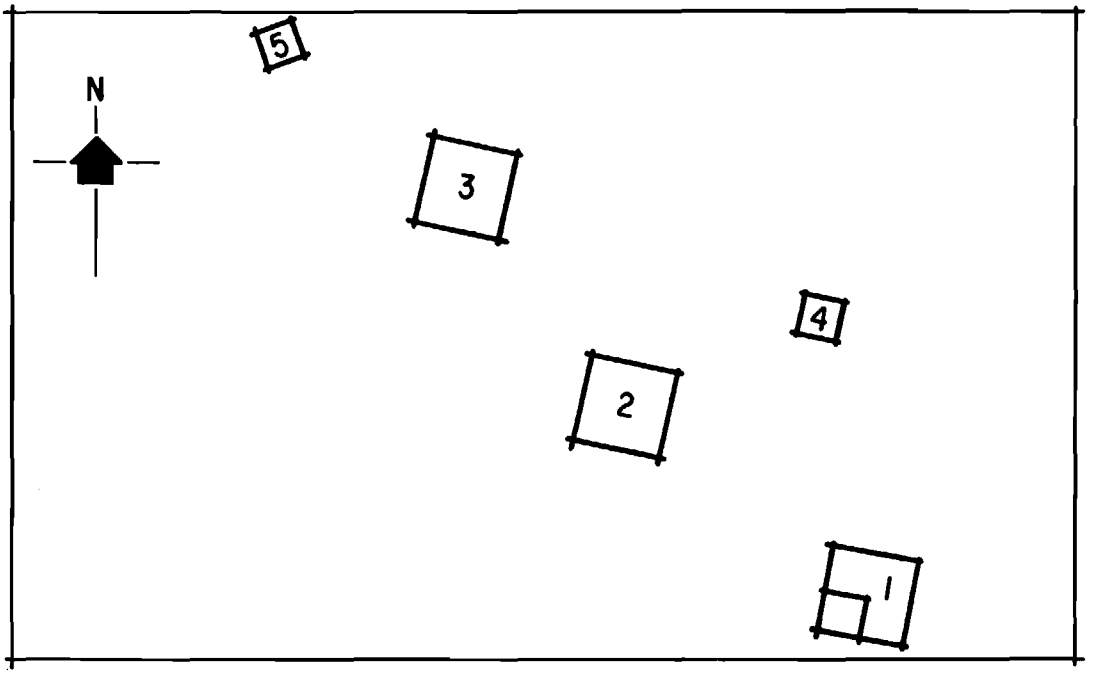


FIGURE 15

Aerial Photograph - Looking Southeast.

PLOT PLAN PORT BICKERTON - STATION 25



1. Fog Alarm and Light Tower (Combined)
2. House
3. House
4. Pumphouse
5. Storage Building

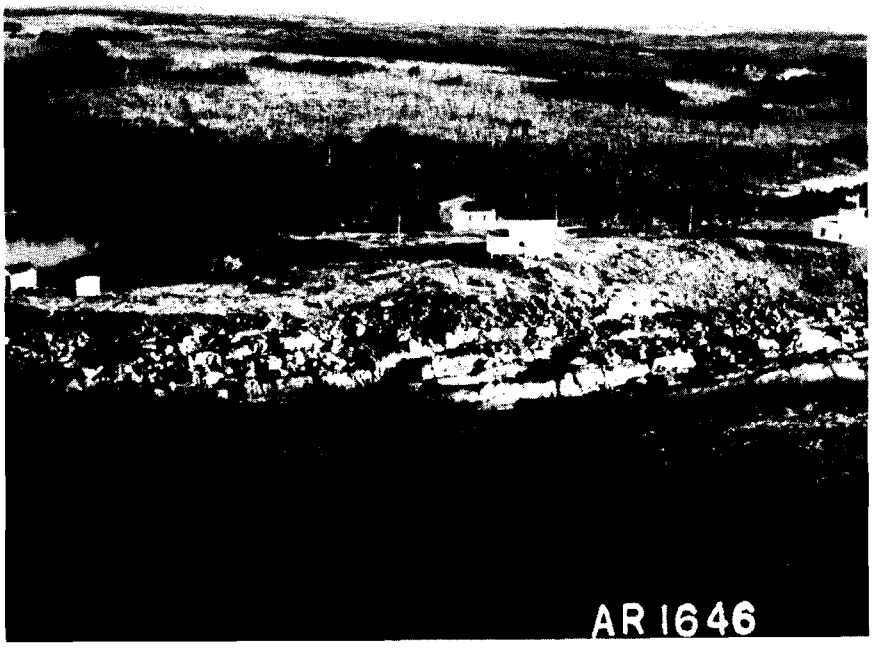
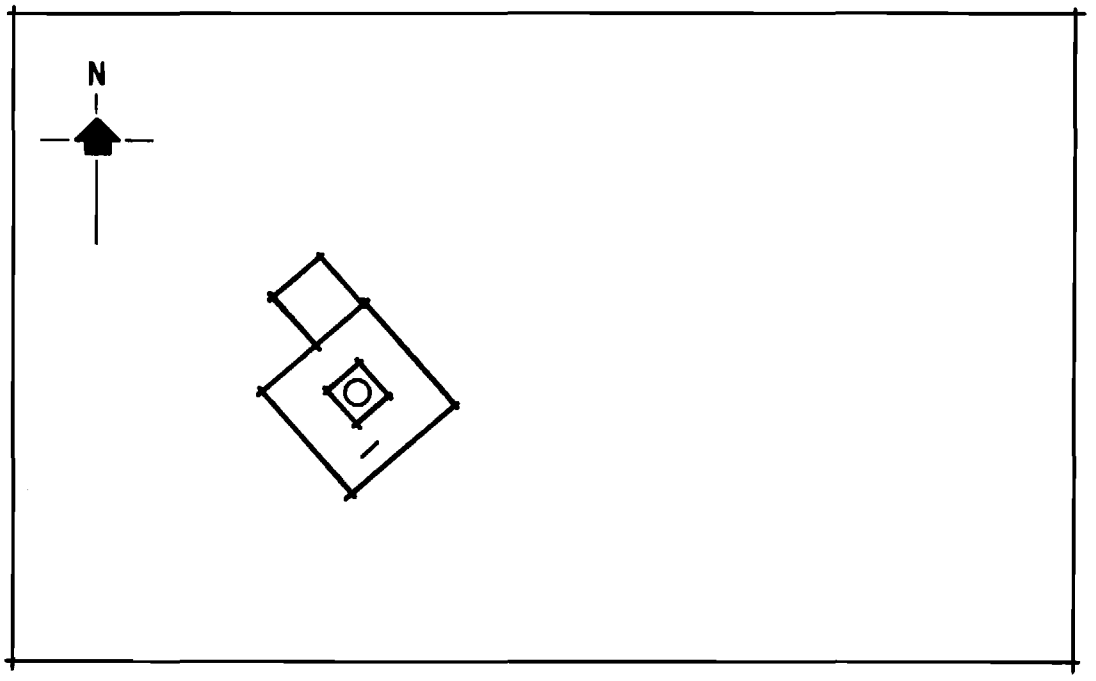


FIGURE 16

Aerial Photograph - Looking Northeast.

PLOT PLAN THE SALVAGES - STATION 26



1. Light Tower - Fog Alarm - Engine Room - House - (Combined)

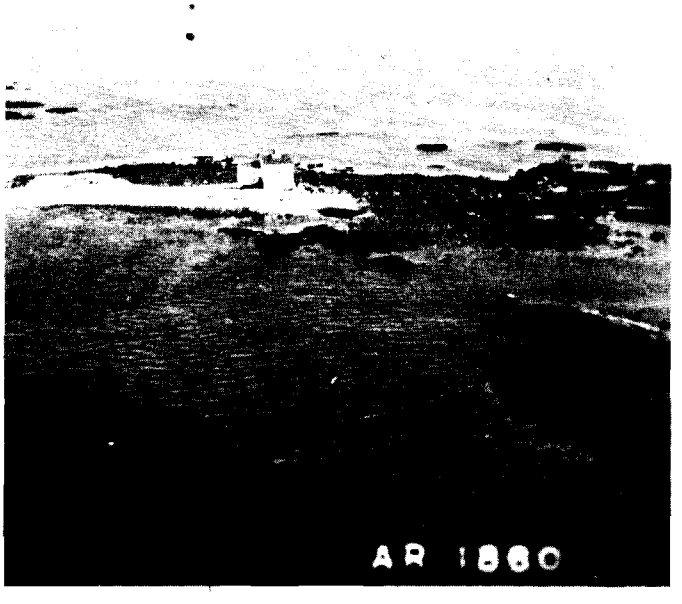
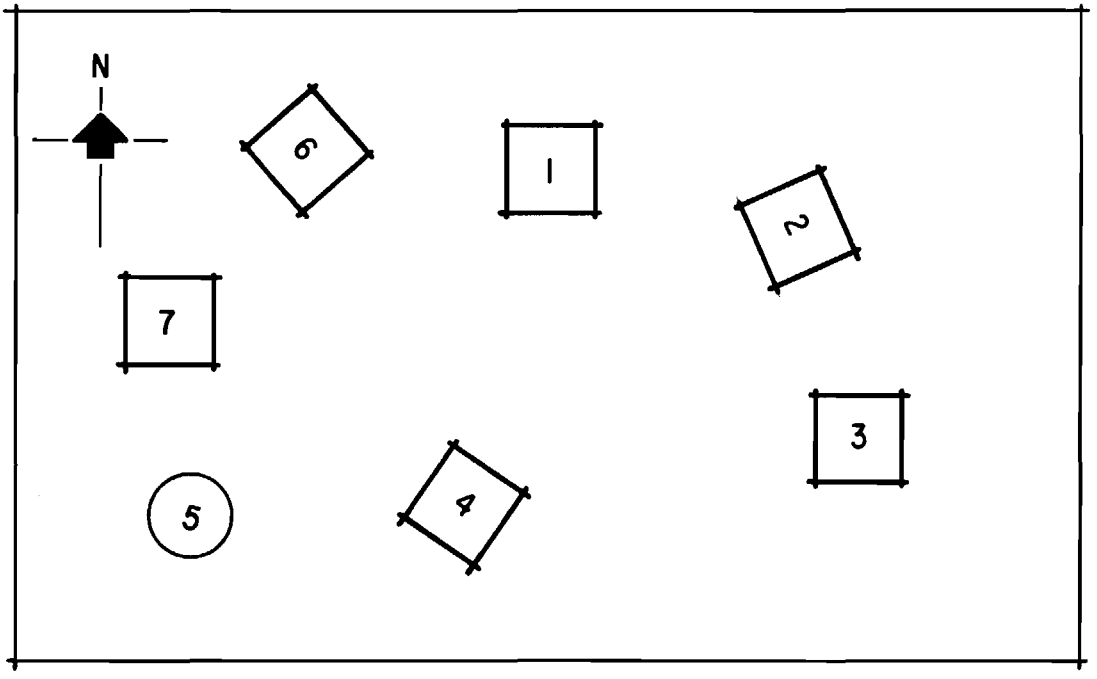


FIGURE 17

Aerial Photograph - Looking East.

PLOT PLAN SAMBRO ISLAND - STATION 27

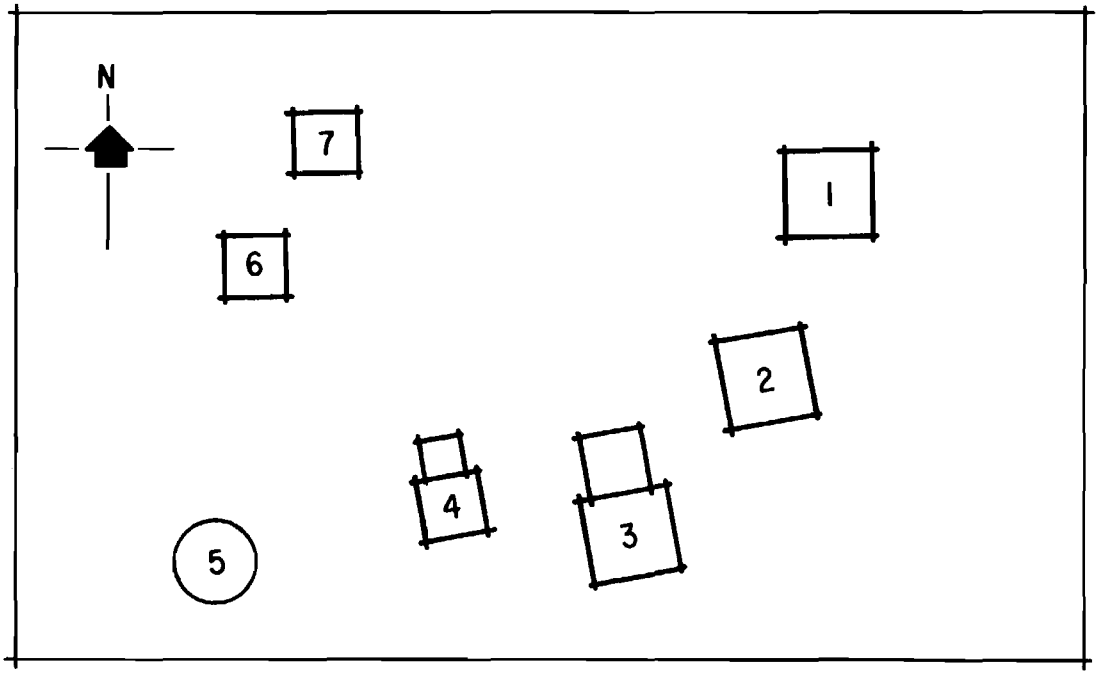


1. House
2. House
3. House
4. Fog Alarm
5. Light Tower
6. Boathouse
7. Storage Building

FIGURE 18

Aerial Photograph - Looking North.

PLOT PLAN WESTERN HEAD - STATION 28



1. House
2. House
3. Fog Alarm Radio
4. Storage Building
5. Light Tower
6. Garage
7. House

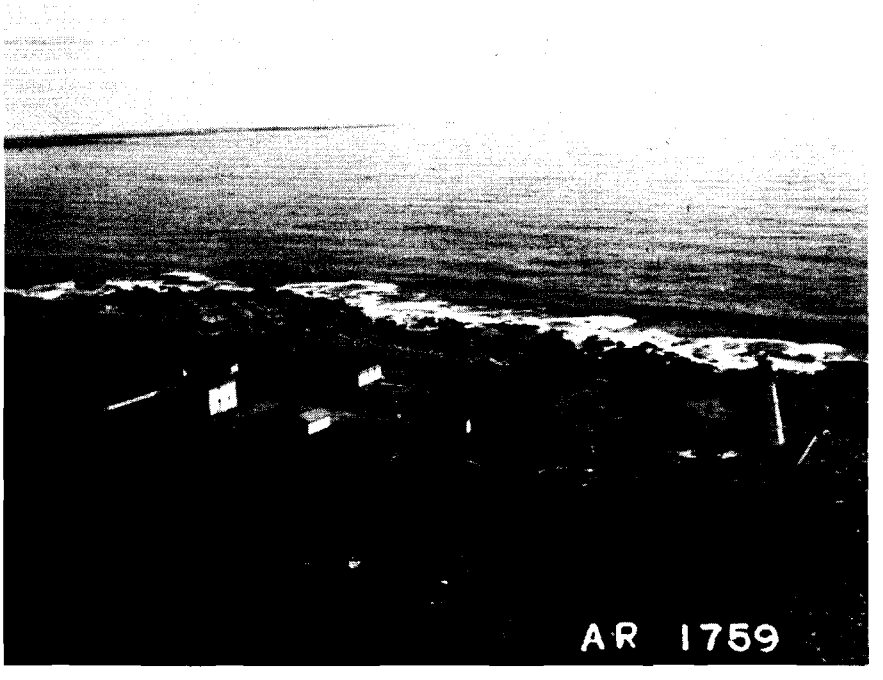
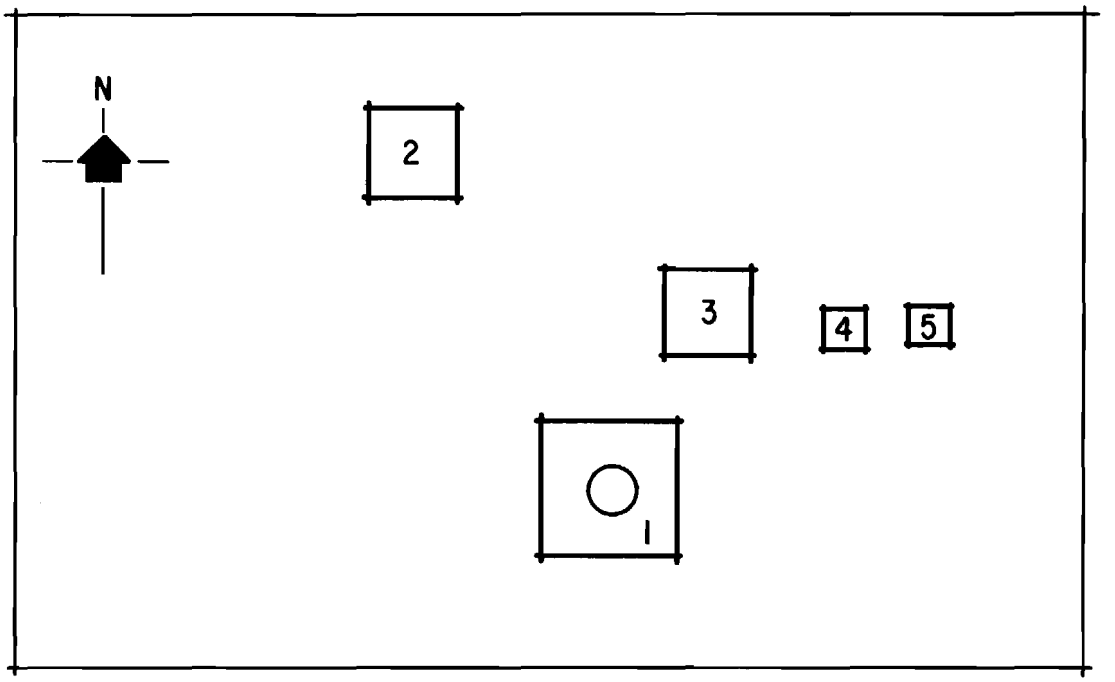


FIGURE 19

Aerial Photograph - Looking East.

PLOT PLAN WHITEHEAD ISLAND - STATION 29



1. Light Tower and Fog Alarm
2. House
3. House
4. Storage Building
5. Storage Building

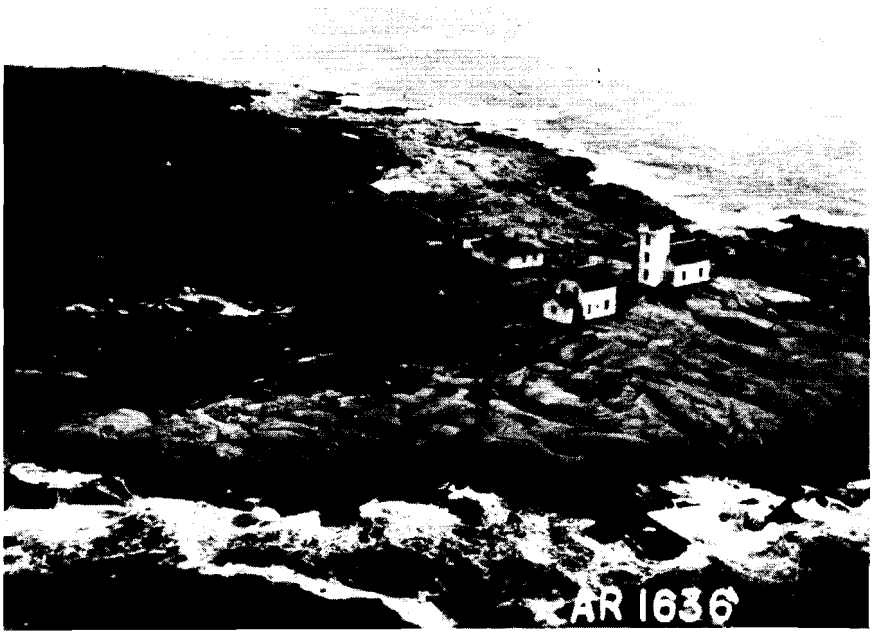
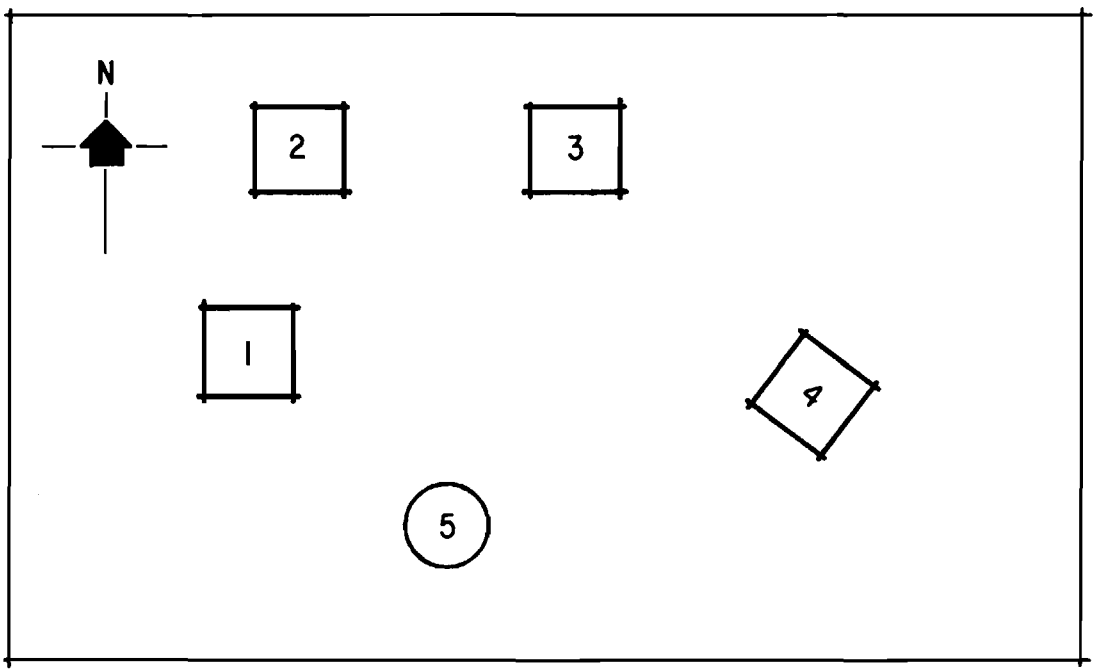


FIGURE 20

Aerial Photograph - Looking Southeast.

PLOT PLAN FLINT ISLAND - STATION 30



1. House
2. House
3. House
4. Fog Alarm and Storage Building
5. Light Tower

FIGURE 21

Aerial Photograph - Looking Northwest.

FIGURE 22a

Discoloration and General Failure - South Wall
(Whitehead - Building 3)

FIGURE 22b

Peeling and Discoloration - South and West Walls
(Whitehead - Building 4)

FIGURE 23a

Peeling and Cracking - Southwest Exposure
(Whitehead - Building 2)

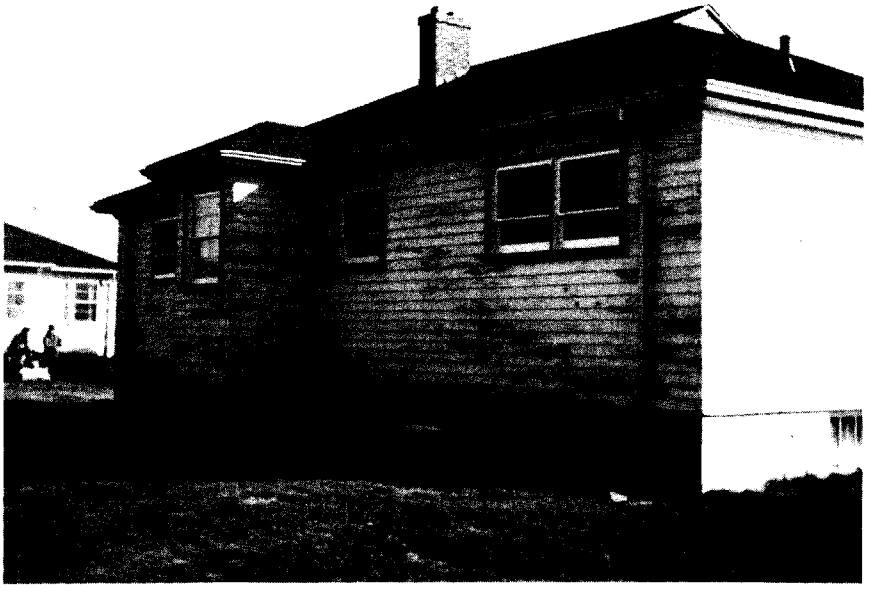


FIGURE 23b

Peeling - South Exposure
(Flint Island - Building 1)

FIGURE 24a

Mildew - Southeast Exposure
(Cape Roseway - Building 1)

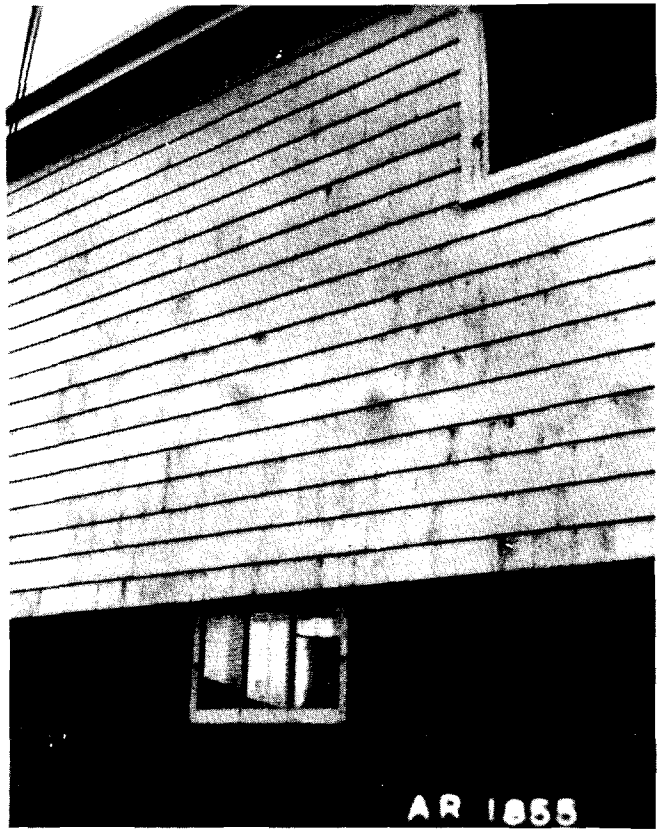


FIGURE 24b

Nail Staining - Southwest Exposure
(Country Island - Building 1)

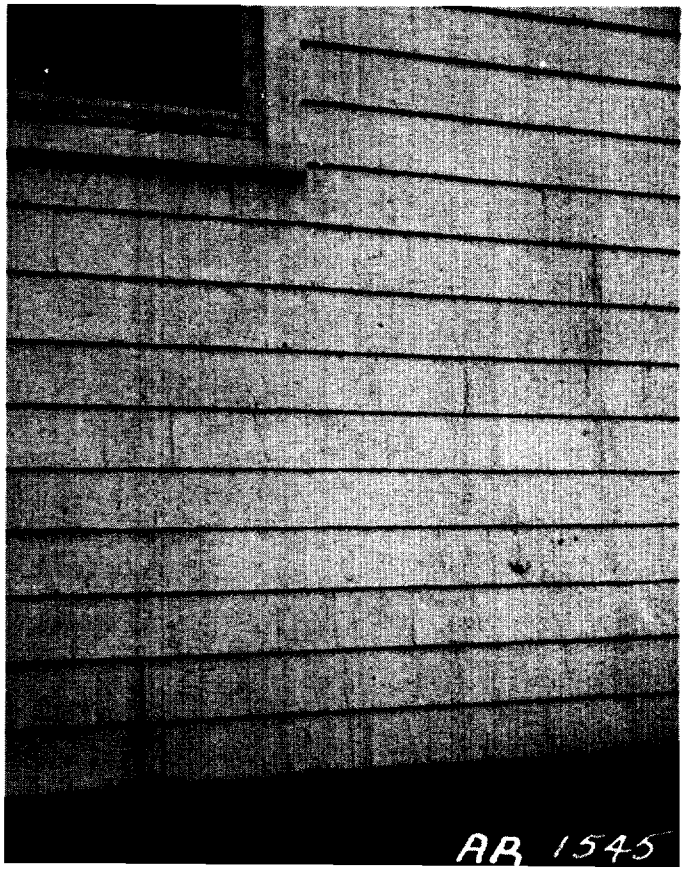


FIGURE 25a

Cracking and Checking - East Exposure
(Cross Island - Building 5)

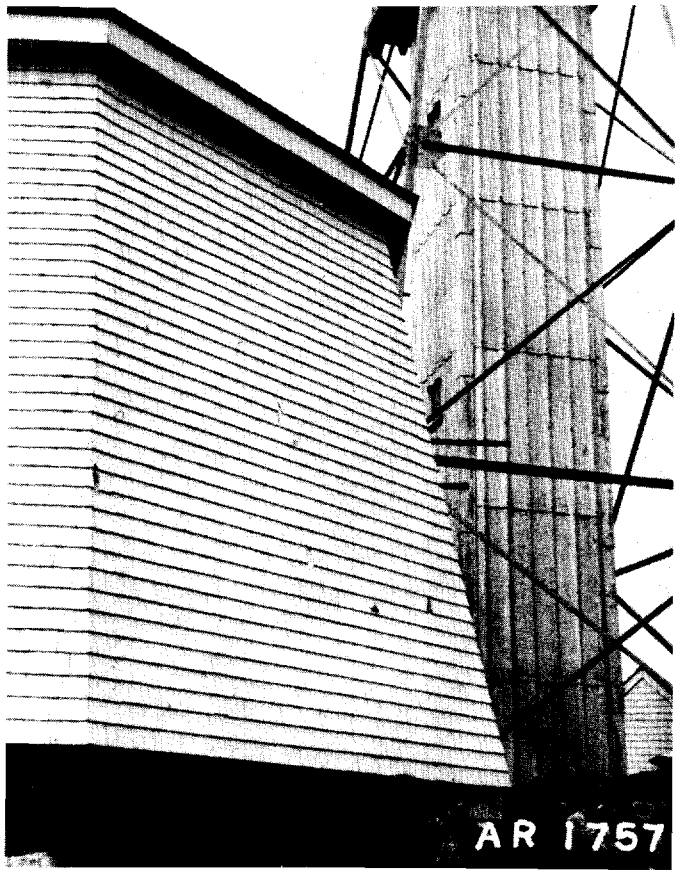


FIGURE 25b

Peeling and Cracking - Southeast Exposure
(Egg Island - Building 4)

FIGURE 26a

Staining - Southeast Exposure
(Bickerton - Building 2)

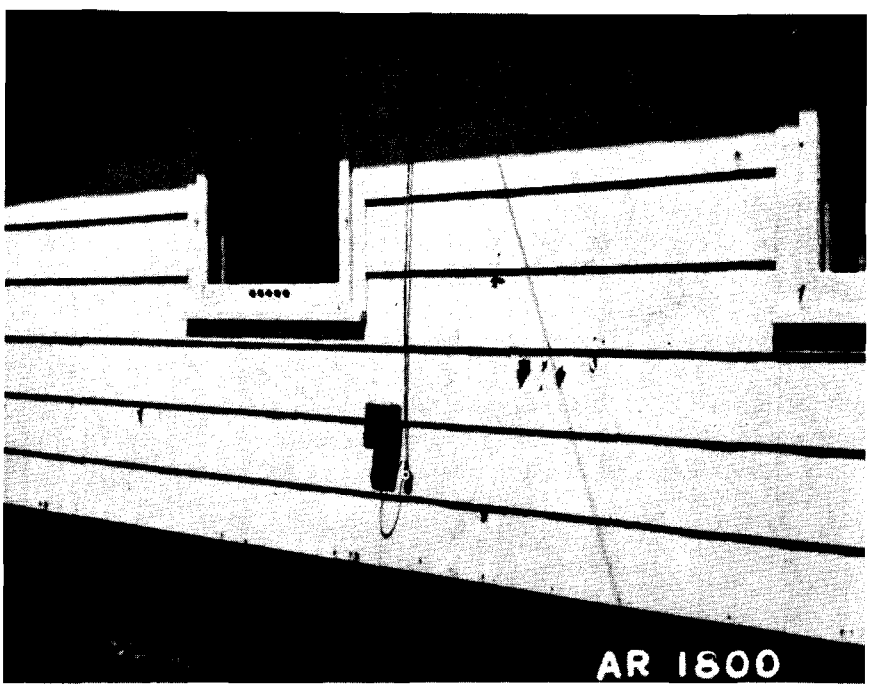


FIGURE 26b

Peeling - Southwest Exposure
(Bickerton - Building 3)

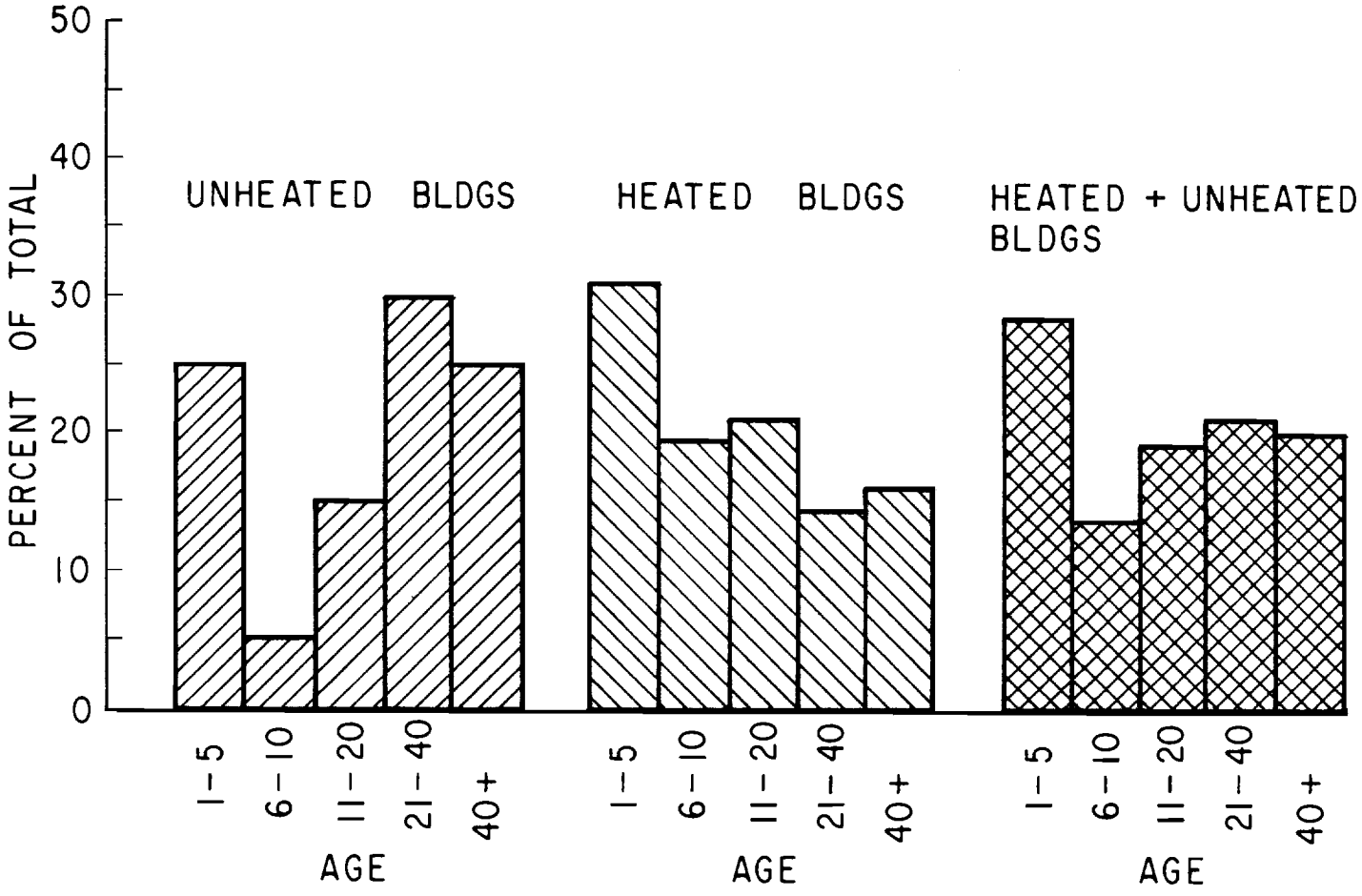


FIGURE 27 AGE OF BUILDINGS

BR 3969-2

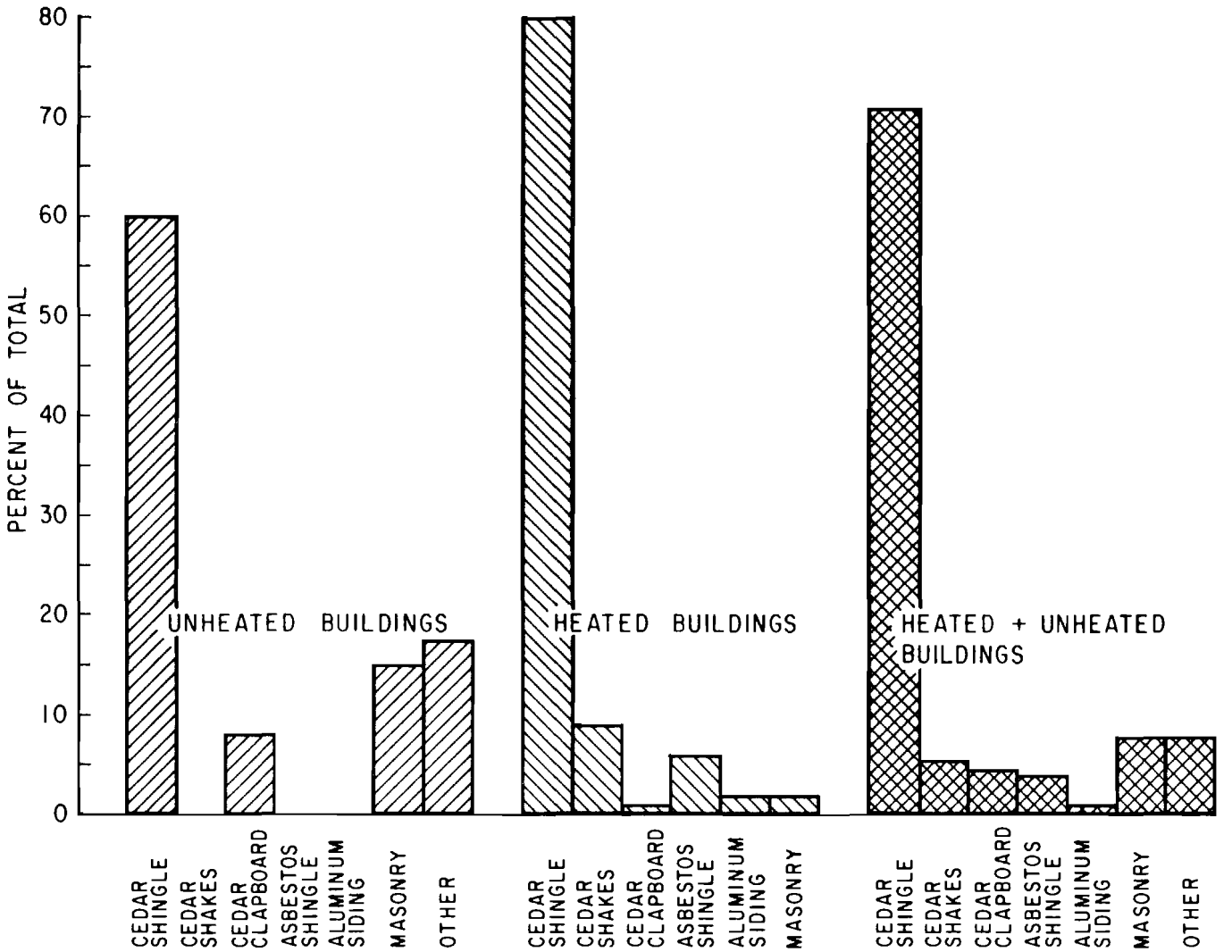


FIGURE 28 TYPE OF CLADDING

BR 3969-3

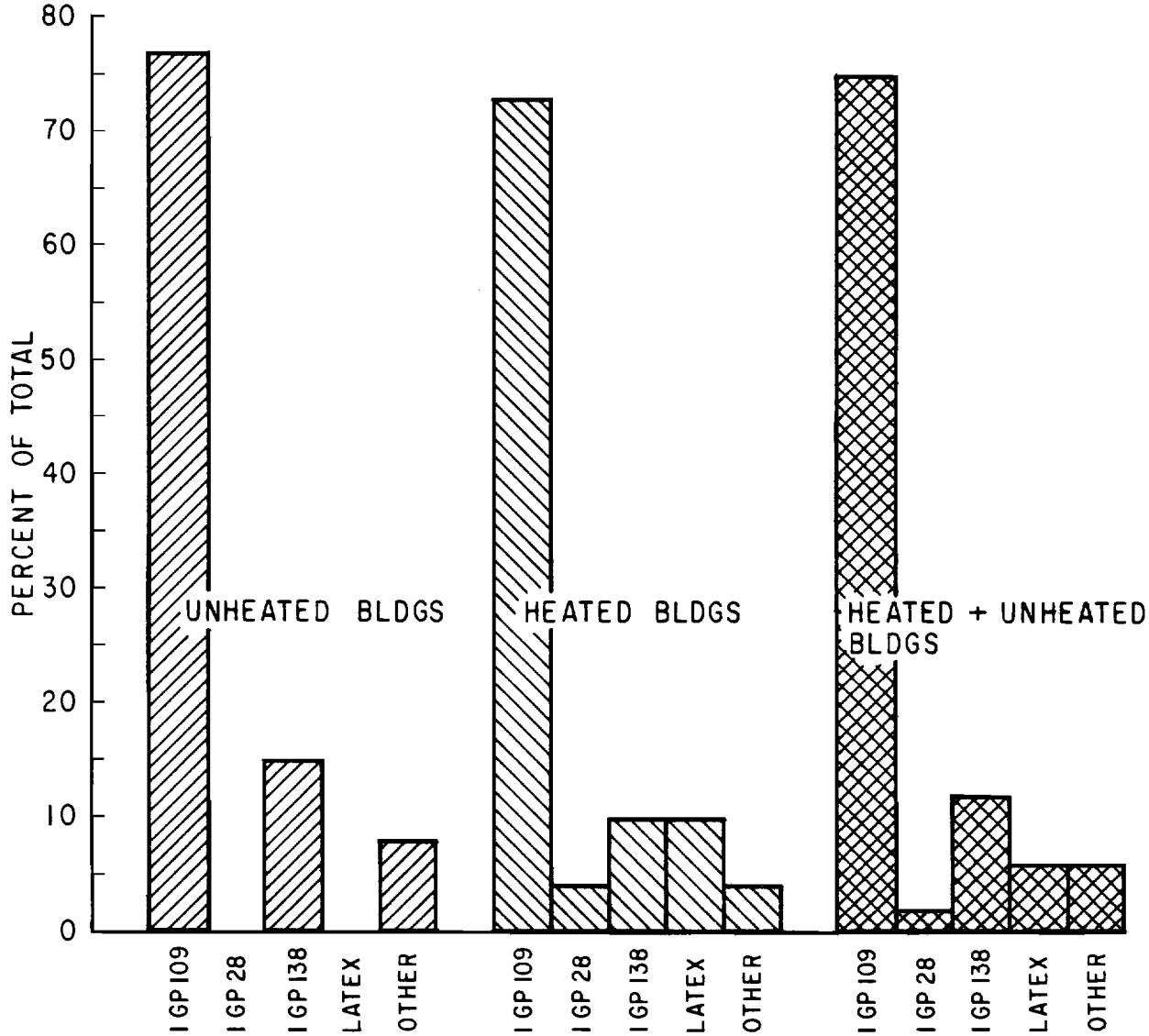


FIGURE 29 TYPE OF PAINT USED

BR 3969 - 4

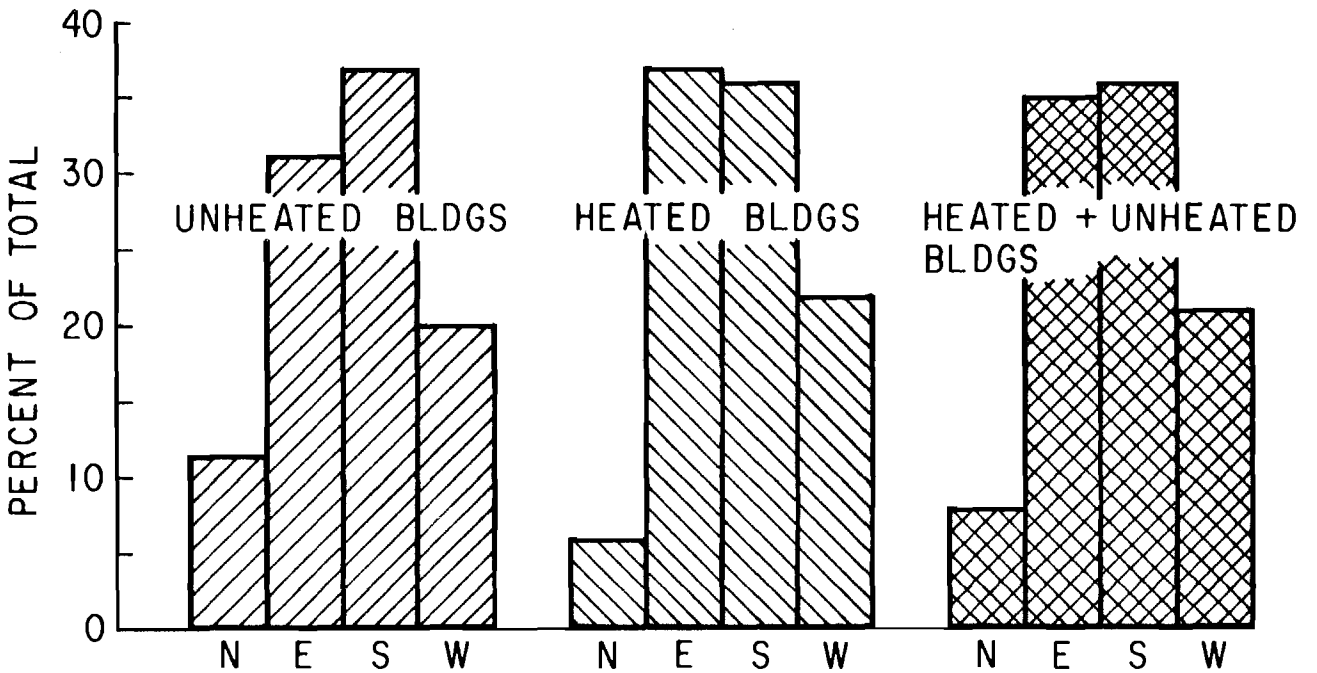


FIGURE 30 EFFECT OF EXPOSURE

BR 3969-5

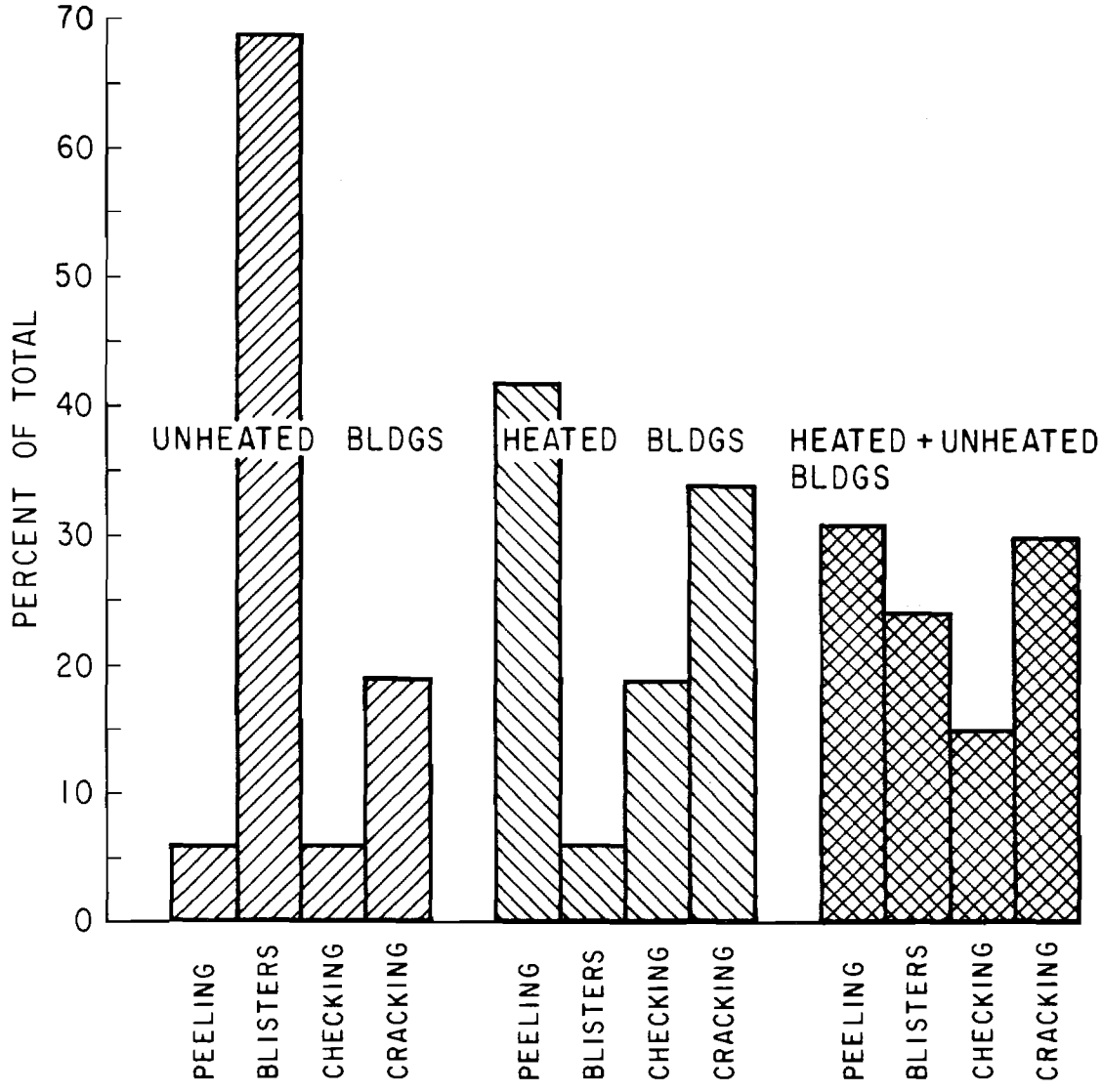


FIGURE 31 TYPE OF PAINT FAILURE

BR 3969-6