

systems and planning for water-supply development. The number and size of wells and pumps needed to yield the required water depend upon the amount of water which can be yielded from each well.

All of Florida is underlain by ground-water reservoirs (aquifers) generally capable of yielding water in usable quantities to wells. In some areas, well yields are low while in others hundreds and even thousands of gallons per minute per well can be obtained. This map report depicts the great geographical variation of well yield for four major aquifers used to supply potable water in Florida. The map is too generalized to be used to locate specific wells; important environmental factors have been neglected which must be considered when actually locating water-supply wells. Some of these factors include the effect ground-water withdrawals will have on the water levels in nearby wells or in wetlands or lakes, the reduction of flow in nearby streams, or the flow of salt water or contaminants toward wells. Some areas shown on the map may yield much less water than that amount shown, and others much more because of variation in aquifer characteristics.

Aquifers are rock formations sufficiently permeable to yield water in usable quantities to wells and springs. Their water-yielding characteristics depend in part on the number and size of openings between rock particles that compose the aquifer and the extent to which those openings are interconnected.

Because hydraulic conductivity (the ease with which water will pass through a formation) of the aquifers is not everywhere the same, well yield at a given location can best be determined by drilling wells and performing aquifer tests. If test information is not available, the yield of a well can usually be estimated on the basis of the specific capacity and transmissivity data from nearby wells. The specific capacity of a well is its yield, in gallons per minute, divided by the drawdown of the water level in it, that is, yield per foot of drawdown. Transmissivity is the rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient. The specific capacity and transmissivity data used to estimate the yields of wells were obtained from well information on file, supplemented by aerial reports published by the Florida Bureau of Geology and open-file reports of the U. S. Geological Survey.

Well yields increase with increasing diameter of well bore and decrease with increasing pumping time. To show this graphically, curves were developed using an equation derived by Theis (1935). The curves in figure 1-A show that in a water-table aquifer a 20-inch diameter well yields about 16 percent more water than a 5-inch diameter well, and in an artesian aquifer, about 12 percent more. Curves in figure 1-B show that well yields decrease rather rapidly during the early stages of pumping, and then decrease gradually during extended periods of pumping, for both water-table and artesian aquifers.

Because well yields vary with well diameter and pumping period, and also depend upon drawdown, the yields of wells portrayed on the large map of Florida pertain to one specific set of conditions: a well diameter of 12 inches tapping the full thickness of the aquifer, a pumping period of 24 hours, and a drawdown of 10 feet.

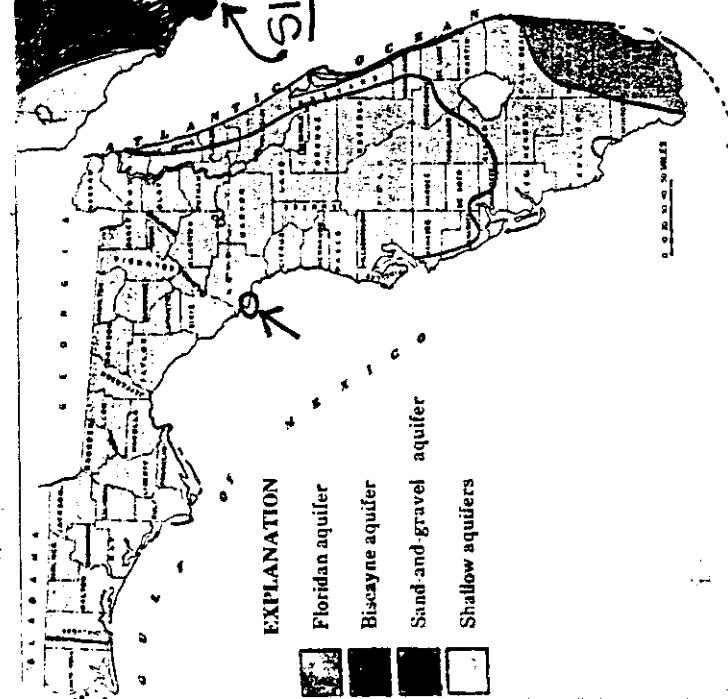
Most of the potable ground water used in Florida (3 billion gallons per day in 1970) comes from four major aquifers. They are the Floridan aquifer, the Biscayne aquifer, the sand-and-gravel aquifer, and the shallow aquifers throughout Florida (Hyde, 1965). Figure 2 shows the approximate area where each aquifer constitutes the principal source of potable ground water. In some areas, these aquifers contain water whose chloride or dissolved-solids concentration is substantially in excess of the limit recommended by the U. S. Public Health Service (1962) but for the lack of better water are still used as a source of supply. In areas where more than one major aquifer exists, only the principally used aquifer is shown. Other aquifers occur in the State but they have a limited areal extent and low water yield.

SAND-AND-GRAVEL AQUIFER

The sand-and-gravel aquifer underlies Walton, Okaloosa, Santa Rosa, and Escambia Counties in northwest Florida, but it is the principal source of ground water only in Santa Rosa and Escambia Counties. The aquifer is composed of quartz sand and gravel and discontinuous layers of clay and extends from land surface to depths ranging from less than 250 feet along the coast and from 400 feet in northeast Santa Rosa County to 700 feet in south-central Escambia County (Musgrove and others, 1961, fig. 4, p. 14). Generally the water in the sand-and-gravel aquifer is unconfined and the shape of the water table nearly everywhere conforms to the topography. In some areas the water is confined by clay lenses and the water is under artesian pressure (Musgrove and others, 1961, p. 17). The aquifer is recharged by rainfall that infiltrates to the water table.

Except along the coast, in Escambia and Santa Rosa Counties, wells tapping the sand-and-gravel aquifer generally yield 250 gal/min or more. Along the coast the aquifer is less than 250 feet thick and contains clay beds that reduce the transmissivity. Wells there yield less than 250 gal/min.

ESTIMATED YIELD

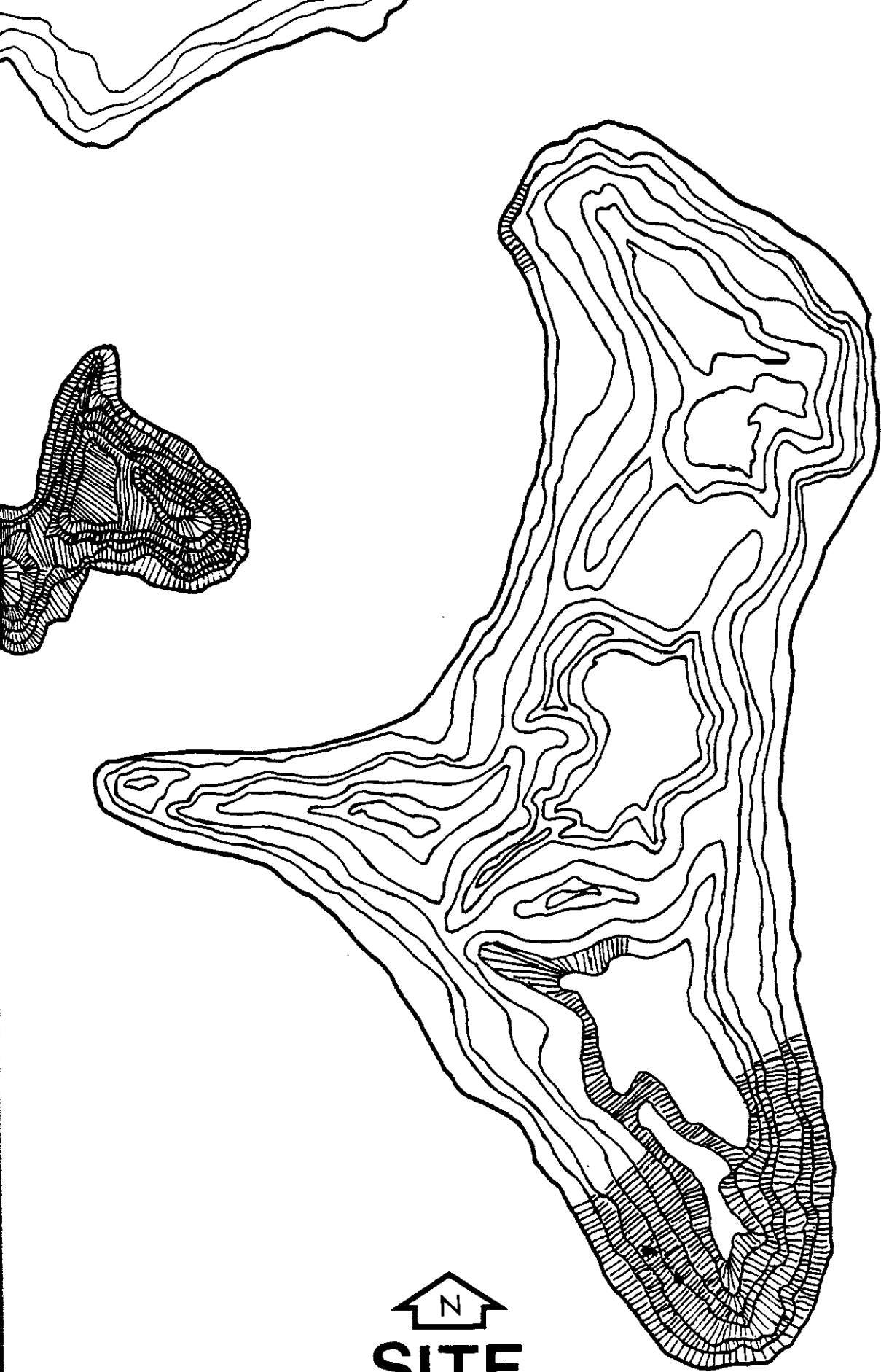


BISCAYNE AQUIFER

The Biscayne aquifer, underlying Dade and Broward and part of Palm Beach Counties, is the prime source of water for populous southeast Florida. According to Schroeder and others (1958, p. 1-26), the aquifer is composed mainly of limestone, coquina, coralline reef rock, and sand. The aquifer extends from land surface to a depth of about 10 feet in western Broward and Dade Counties and to a depth of about 200 feet along the coast. Water in the Biscayne aquifer is unconfined and the water table slopes generally eastward toward the coast except where influenced locally by canals. The aquifer is recharged by rainfall, and in some coastal areas by water infiltrating the aquifer from controlled canals (Appel, 1973).

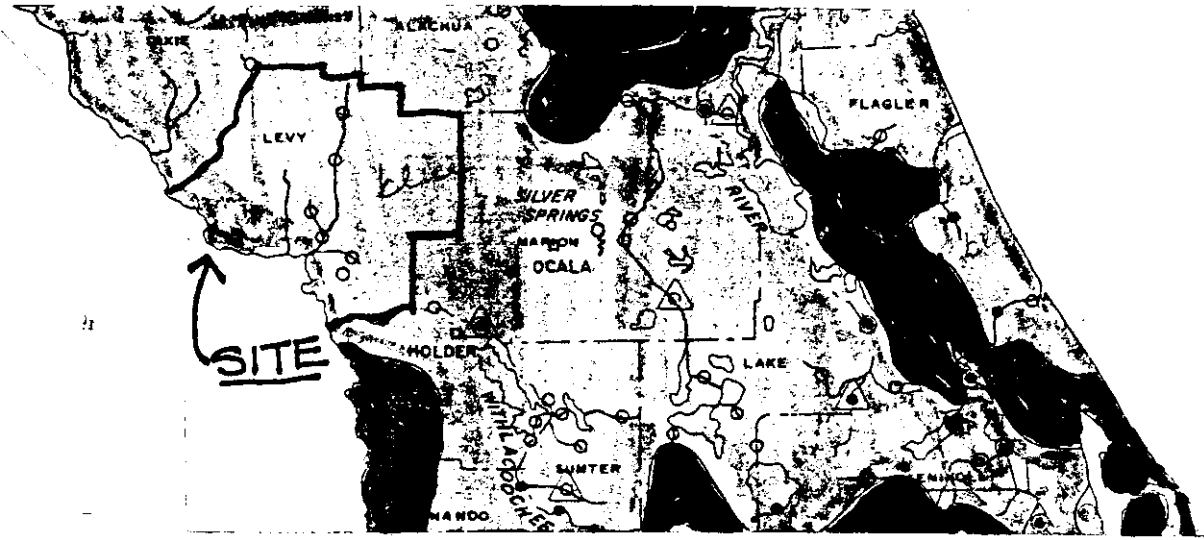
The Biscayne aquifer is highly productive; well yields commonly exceed 2,000 gal/min. The limestone of the Biscayne aquifer contains large interconnected solution cavities that greatly facilitate the ground-water movement (Schroeder and others, 1958, p. 38.).

OF FRESH WATER WELLS



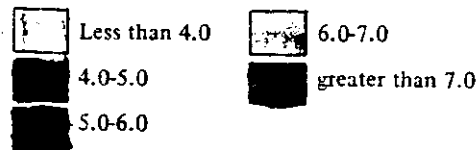

SITE

1: 5,600



EXPLANATION

Generalized areal distribution of minimum pH values of water in Florida streams and canals.



pH VALUES

INTRODUCTION

A knowledge of the distribution and range of the fluctuation of pH in surface waters, from natural as well as man-influenced sources, is important to the understanding and management of the quality aspects of Florida's surface-water resources.

According to the Florida Statutes, 1969 (28-5.05 through 28-5.11), for those waters categorized under classes I-IV, the pH shall not vary more than one unit above or below normal; and the lower value shall not be less than 6.0, and the upper value not more than 8.5. For those waters categorized under class V, the pH shall not be lower than 5.0 nor greater than 9.5 except certain swamp waters which may be as low as 4.5. Recognizing that certain waters of the State, due to natural causes, may not fall within desired or prescribed limitations, the Statutes provide for authorized exceptions upon presentation of good and sufficient evidence.

This report presents in a succinct and usable form information on the pH of streams and canals throughout Florida as an aid to water managers, users, and planners. The variations in pH are related to environmental causes.

The minimum pH of water and the range through which the pH of stream waters fluctuate in the various geographic areas (large map) is significant with respect to industrial, municipal, and recreational uses, aquatic productivity, the State of Florida's water quality standards, corrosivity, and selection of materials with regard to waterway structures such as culverts, in addition to governing the toxicity, mobility, and solubility of many compounds.

Florida's surface waters exhibit distinct regional variations in pH extremes, especially in regard to minimum values. Depending on environmental conditions, pH values in Florida waters range from less than 4.0 to greater than 8.5. Environmental controls such as surficial geology, the hydrologic flow system, soil types and vegetation, proximity to natural swamplands that are flushed by overland runoff, and industrial and agricultural effluents, among others, govern the pH. The map shows areas within which the minimum pH values of surface waters are about the same. The distribution pattern of these values provides insight into the hydrologic flow system and suggests certain environmental controls on water quality. This map is one step toward the portrayal of water quality data for Florida on a regional basis.

DEFINITION OF pH, SIGNIFICANCE, AND RECOMMENDED LIMITS

The pH of a solution is a measure of the hydrogen-ion activity and is expressed as the negative logarithm (base 10) of the effective hydrogen-ion concentration. The range of pH values from strong acids to strong bases is from 0 to 14. The pH of a neutral aqueous solution is 7. A change of one pH unit indicates a 10-fold change in the hydrogen-ion activity.

As noted by Mason (1952, p. 158-159), pH exerts a major influence on the mobility of many elements in the hydrosphere. Such factors as solubility, hydroxide precipitation, degree of complexation, and sorption of solutes by particulate matter may depend highly on pH (Lee and Hoadley, 1967). For example, the solubility of ferrous iron (Fe^{++}) at pH 6 is about 10^5 times greater than at pH 8.5. In addition, as discussed by McKee and Wolf (1963, p. 235), the concentration of H^+ ions controls the degree of dissociation of many substances, and as the undissociated compounds are frequently more toxic than the ionic

forms, a 10-fold increase in the acute toxicity of a metalocyanide complex, whereas the addition of strong alkalis may cause the formation of undissociated NH_4OH or unionized NH_3 in quantities that may be toxic (FWPCA, 1968, p. 41). Industrial wastes may be strongly acidic or basic and their effect upon the pH of the receiving waters depends largely on the buffering capacity of the receiving waters.

Waters with a pH below 6.0 can cause excessive corrosion in plumbing systems. Extremes in pH cannot usually be tolerated by industry; recommended values for industrial uses (process waters) normally range from 6.0 to 8.3. Recommended pH values for boiler feedwater range from 8.0 to 9.6, depending on pressure (McKee and Wolf, 1963, p. 235-236; Rainwater and Thatcher, 1960, p. 237).

The pH of primary contact recreation waters should be within the range of 6.5 to 8.3 except when due to natural causes, and in no case should be less than 5 or more than 9 (FWPCA, 1968, p. 4). The hydrogen-ion concentration with co-dependence upon the buffer capacity of the water is of importance in relation to eye irritation among swimmers.

The availability of many nutrient substances varies markedly with pH, and the tolerance of fish to low concentrations of dissolved oxygen is greater with higher pH. The nonlethal limits of pH are narrower for some fish-food organisms than for fish. From the standpoint of aquatic productivity it is best to maintain the pH in the range of about 6.5 to 8.2 (McKee and Wolf, 1963, p. 236; FWPCA, 1968, p. 41).

NATURAL RANGES OF pH, AND ENVIRONMENTAL CONTROLS

The pH of a water results from (1) the balance of a series of chemical reactions, and (2) equilibria among the ions in solution, the most important of which involves the hydrolysis of carbonate ($CO_3^{=}$) and bicarbonate (HCO_3^-) ions (Hem, 1959, p. 44-46). Natural waters commonly contain dissolved carbon dioxide (CO_2) and HCO_3^- ions, which form a buffered system with carbonic acid (Davis and DeWiest, 1966, p. 76). The pH of a solution with high buffer capacity tends to remain relatively constant when small amounts of acid or base are added, whereas the pH of a solution of low buffer capacity may be subject to pronounced changes. Carbonate rocks abound in nature and therefore are a source of bicarbonate in many terrestrial waters. The resulting buffering system tends to neutralize acids and bases and thus reduces the range in fluctuations of pH.

In natural environments, pH ranges mostly from 4 to 9. The carbonic system (CO_2 , HCO_3^- , $CO_3^{=}$) is the principal control of the pH of most natural waters and is effective at pH above about 5. "A saturated solution of CO_2 at its partial pressure in the atmosphere has a pH of 5.2, and a solution of calcite in air-saturated water has a pH near 8" (Mason, 1952, p. 158). The pH of an organic-rich environment, under aerobic conditions, would be that of a carbonic acid solution in equilibrium with CO_2 at one atmosphere, or about 4. In the presence of decaying vegetation, the pH could be a little lower because of CO_2 and organic acids produced during decomposition (Krauskopf, 1967, p. 314).

Lee and Hoadley (1967) note that large populations of aquatic organisms may markedly influence the pH as well as the buffer capacity of waters as a result of respiration and photosynthesis (i.e., diurnal variations caused by addition and removal of CO_2 from solution).

What is the
[unclear]
[unclear]

- A. Fall Quarter 1978 - Final
- B. Winter Quarter '78-'79 - Midterm
- C. Winter Quarter 1979 - Final

THE REEF THE REEF THE REEF THE REEF THE REEF

THE REEF THE REEF THE REEF THE REEF THE REEF



XIII. DESIGN DEVELOPMENT
PRESENTATION DRAWINGS

ABSTRACT

This thesis book and all of the collected material contained within, will attempt to explain the thought and design process which this student experienced.

The Reef is an oceanarium located north of Cedar Key, Florida, on a secluded group of islands. Cedar Key is a small fishing town which is well known for its oysters throughout Florida. The town itself is located at the southern end of Highway 24, $\frac{1}{2}$ hour west of Gainesville, on the Gulf of Mexico. Cedar Key has a national park on its shores, an airport and all of the conveniences of a larger town (i.e. hotel, library, auditorium, etc.).

For Phase I, the Reef has incorporated one major island which has various inlets and peninsulas measuring 4,224 feet north-south and 2,800 feet east-west. All of the main exhibits and camping are located on this island, named Cedar Point. Support facilities are located on the mainland. These include registration for camping on the island and camping on the mainland, tickets, information, parking, kennels, offices and the elevated and water tram stations.

The Reef in its initial Phase will include educational programs, a research team to delve into the wonders of ocean life and the excitement of the exhibits. The sea-life included in the exhibits are explained in detail on pages 4-9.

The following pages will explain each drawing and show the progress in design which was reached through three major presentations. These occurred Fall Quarter 1978 through Winter Quarter 1978-79.

CREDITS

Credits are shown on pages 1-3
for the agencies contributing
information for this project.

The following professors set
guidelines and greatly helped
in the design process:

Mr. Jack Wyman
Thesis Professor & Assistant
to the Dean
CAP, BSU
Muncie, IN 47306

Mr. Sonny Palmer
Architecture Professor
CAP, BSU
Muncie, IN 47306

A. Fall Quarter 1978 - Final

SHEET NO. 1 - Site Plan

In the beginning, this plan seemed very strong with its bold axial street at a 30° angle off of the main circulation rotary at the center.

The most important point has always been the visitor having a sense of direction and having bearing points. In this plan, this was to be accomplished by the main rotary containing a fountain and a very high monument of stainless steel that all visitors could base their position on the island by seeing this.

The exhibits were fit together and placed to follow land forms and an original premise began for this project; place the exhibits in a manner to direct the visitors in a certain path throughout the island. This aspect was attempted, however, it became clear that this plan contained too many "alleys" or secondary circulation routes with an unclear path back to an identifying point of reference.

All of the streets and exhibits followed the existing limitations formed by several small rivers on the site and the shore line.

The water filtration system and maintenance is intermingled with the exhibits on this plan.

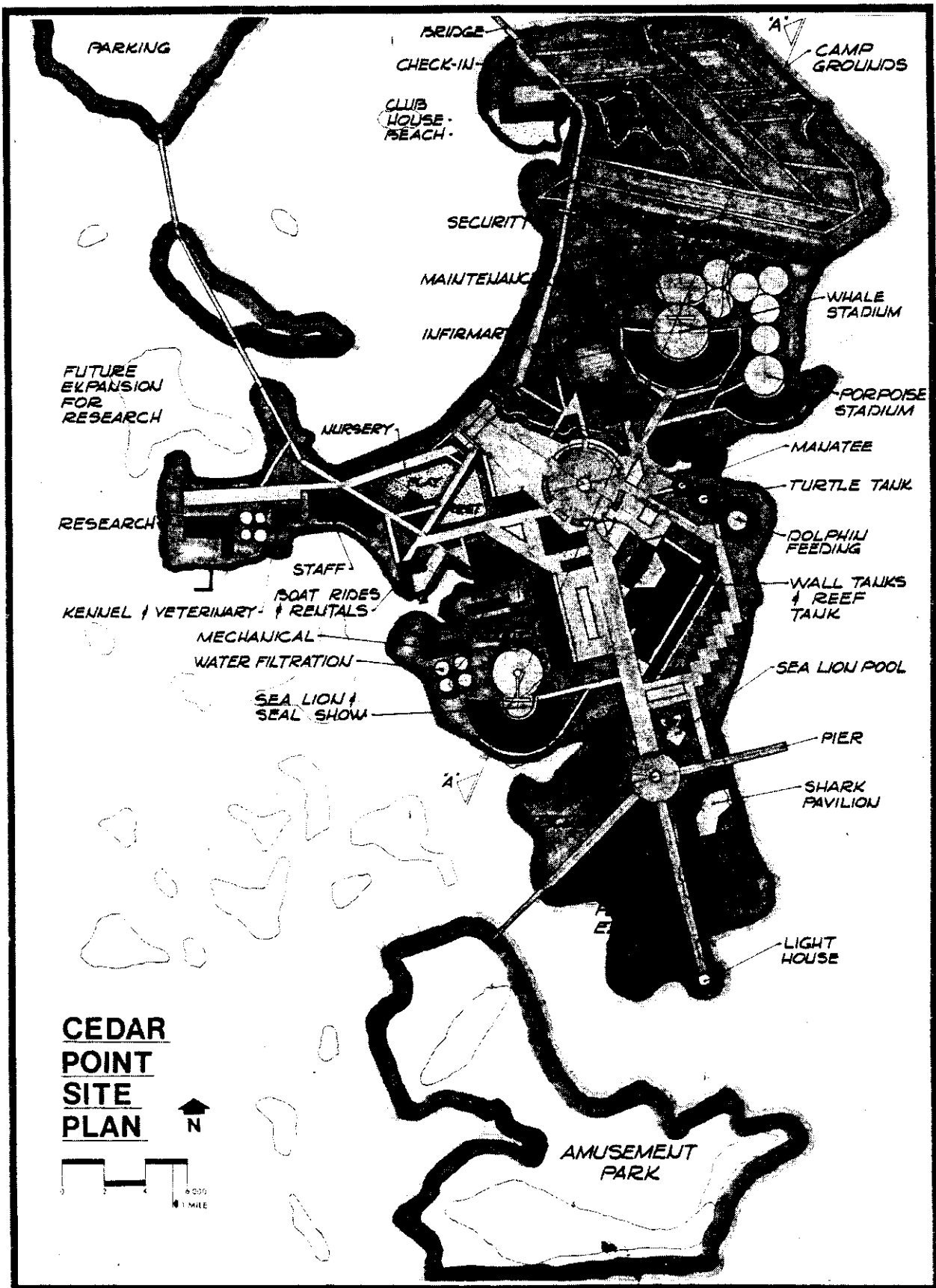
It was decided during this jury that an amusement park (i.e. King's Island) would be in conflict with the atmosphere of the Reef. Therefore, that major island was left for the Five Year Plan to include future expansion of the Reef.

All of the items which might be called support exhibits are important in creating the atmosphere of the Reef. These include the lighthouse, pier, boat ride, boat rentals, rest areas, shopping and restaurants. Interaction and visual contact with the water is important, not only in the exhibits.

The configuration of the tank exhibits changed quite a bit after this jury (to be explained in next section).

Therefore, priorities include:

1. Point of reference for visitors.
2. Direct circulation patterns.
3. Open grassy areas for resting.
 - a. Very active
 - b. Very passive
4. Visitors can set their own pace.
5. Interaction with sealife.
6. Visitors have a chance to participate in educational as well as research programs.
7. Visual contact with Gulf water, not just water and views of exhibits.



**CEDAR
POINT
SITE
PLAN**



SHEET
6

THE REEF
AN OCEANARIUM AT
CEDAR KEY, FLORIDA

10-12-78



KRIS
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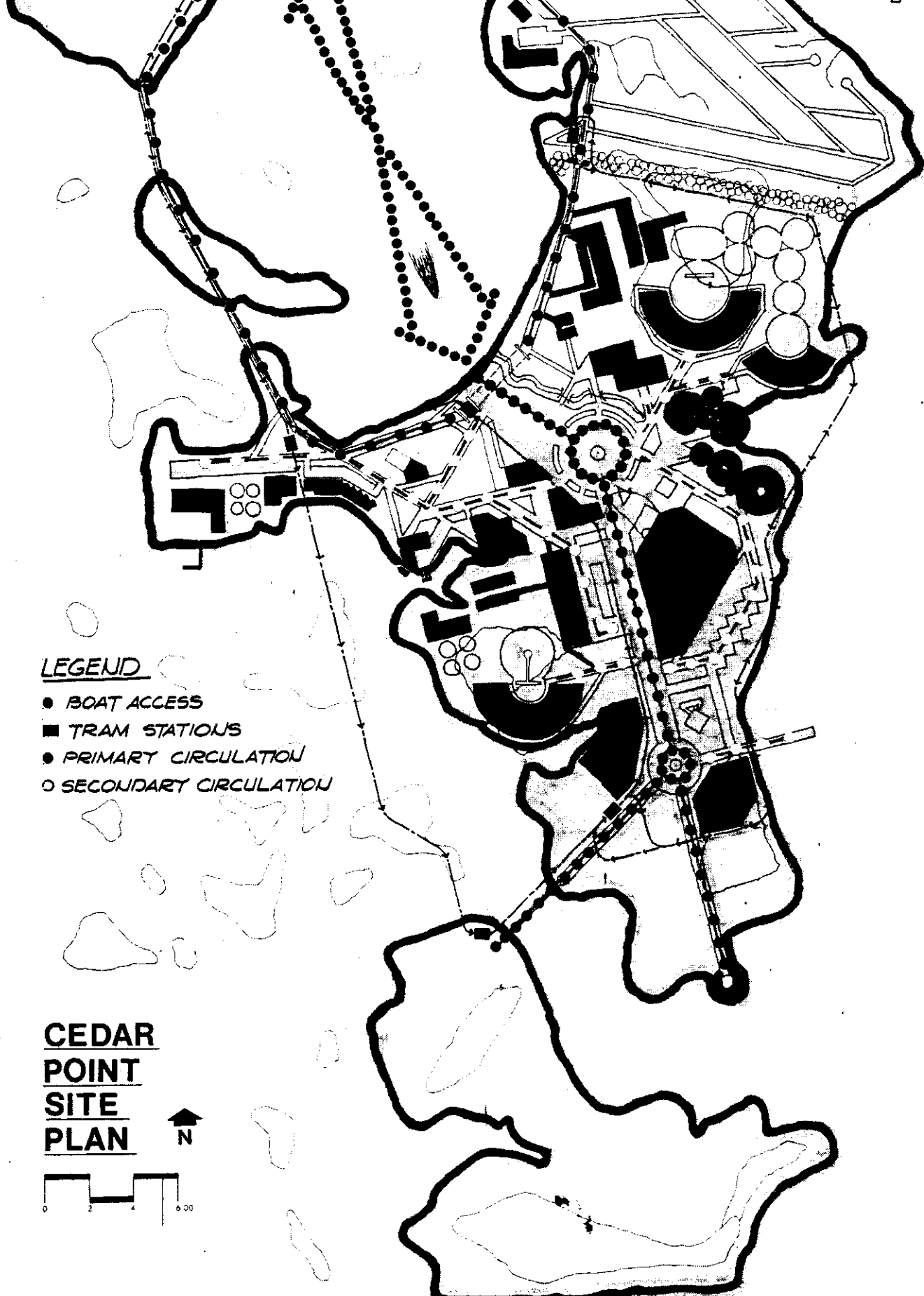
SHEET NO. 2 - Circulation

This plan shows the major circulation routes throughout the site for the elevated and water trams and visitor and service.

From analyzing this plan, it was found that the exhibits were too spread-out and needed a tighter grouping arrangement with more of a geometric layout.

During this jury, major questions were:

1. Distance visitors must walk to see all exhibits.
2. Layout of major tank exhibits-circulation: entry and exit from them.
3. Re-work water filtration and maintenance locations.
4. Profs. wanted to see a more geometric layout of streets.



LEGEND

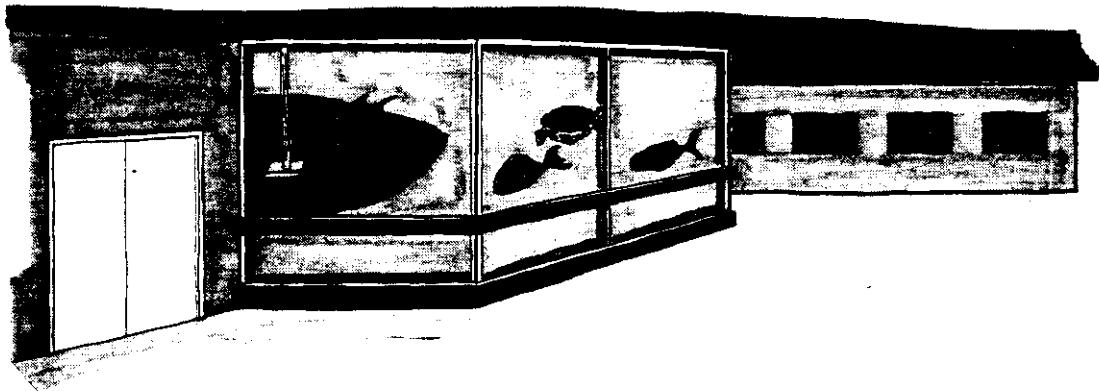
- BOAT ACCESS
- TRAM STATIONS
- PRIMARY CIRCULATION
- SECONDARY CIRCULATION

CEDAR
POINT
SITE
PLAN

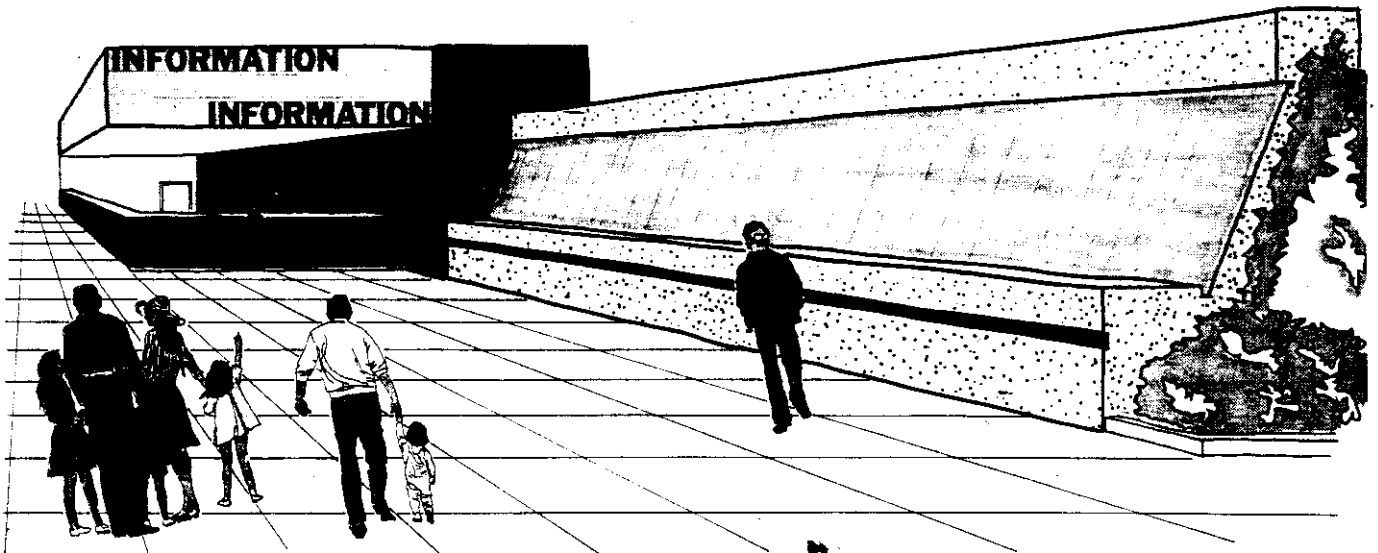




SECTION 'A-A'



REEF TANK + WALL TANKS



INFORMATION BOOTH + WATERFALL



B. Winter Quarter '78-'79 - Midterm

SHEET NO. 4 - Master Plan

For this presentation, the design was refined a great deal. The north-south main street was fully developed, bringing all three major stadiums to the southern end of the site. A new solution was developed to bring together the important dolphin and whale stadiums. The major essence of this new design in oceanarium stadiums is to provide a more convenient entrance and exit; allowing visitors to move freely from one to the other without climbing such a massive quantity of steps.

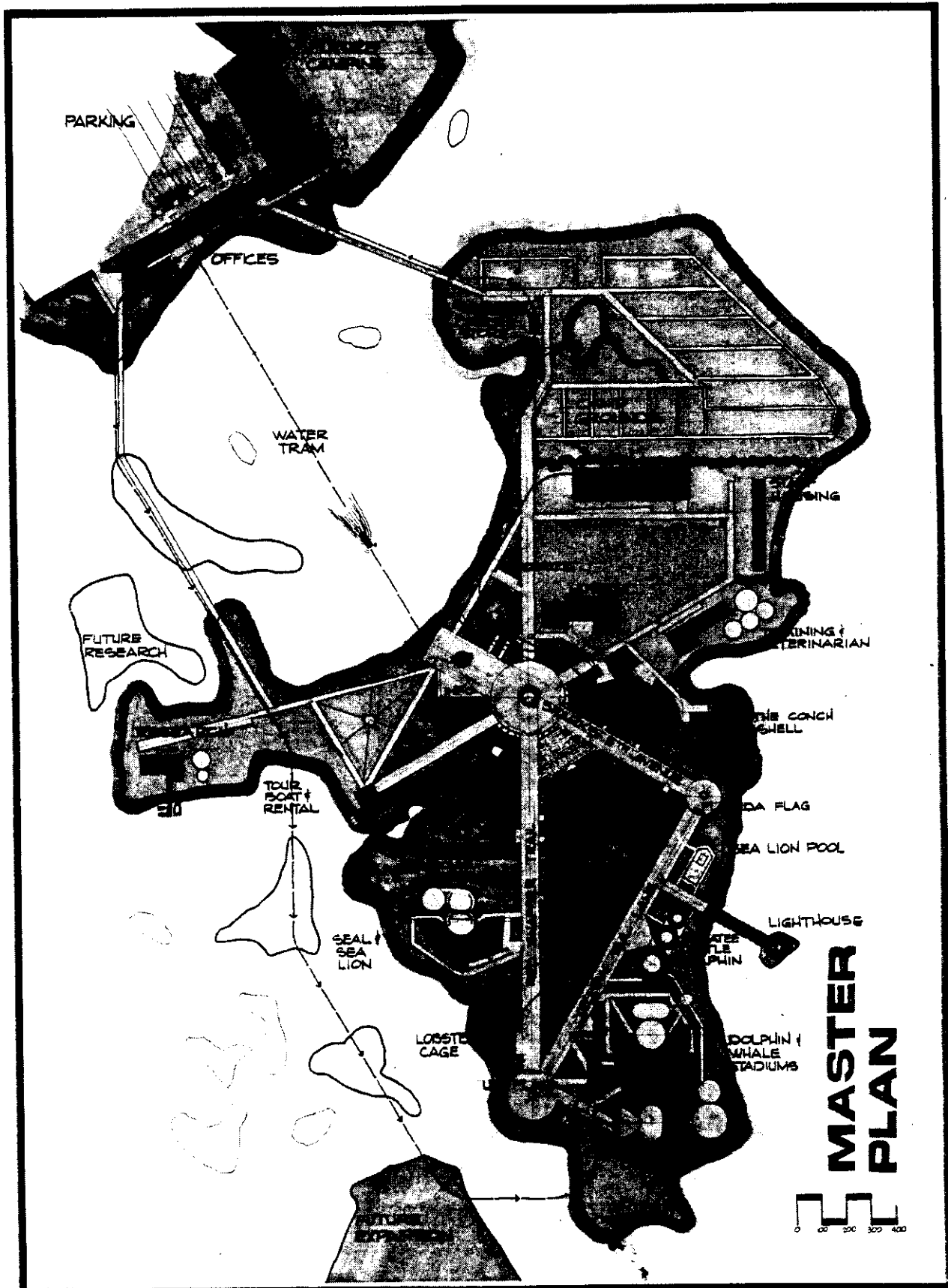
Rather than use one central water supply and filtration system, each water exhibit has its own system with a central backup system in the ocean and reef tank building.

All of the main streets off of the central circulation rotary are at 30° and 60° angles, lending a strong symmetry to the plan.

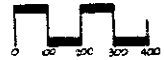
The three main points of reference have been reinforced at each point of the main triangle. The emphasis of this plan is in separating the major services. The camp grounds on the island retain their northern shore location on the site with a strong visual and audio break using dense vegetation. The north-central area of the site is devoted to maintenance functions including staff housing, security, training and veterinarian services.

The western peninsula of the site is devoted to research and research expansion.

In this plan, the elevated tram has taken on a different, more direct route through the site, using a one direction closed-loop pattern.



MASTER PLAN



SHEET
1

THE REEF
AN OCEANARIUM AT
CEDAR KEY, FLORIDA

2-16-79

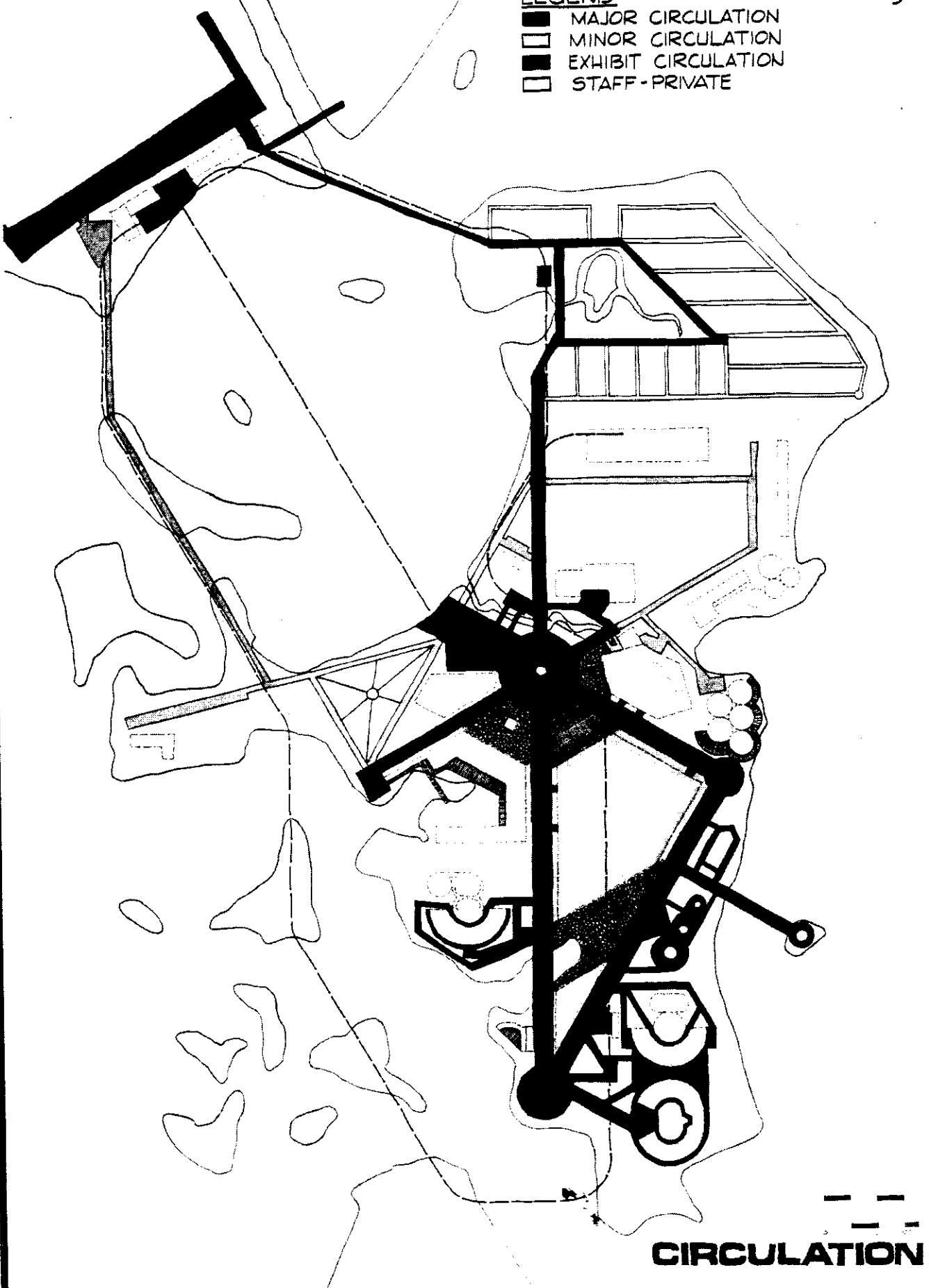


KRIS
ANDRESEN

SHEET NOS. 5 - 8

These plans have broken-up the various services into separate entities denoting circulation, exhibits, eating and shopping and service.

- LEGEND**
- MAJOR CIRCULATION
 - MINOR CIRCULATION
 - EXHIBIT CIRCULATION
 - STAFF-PRIVATE



CIRCULATION

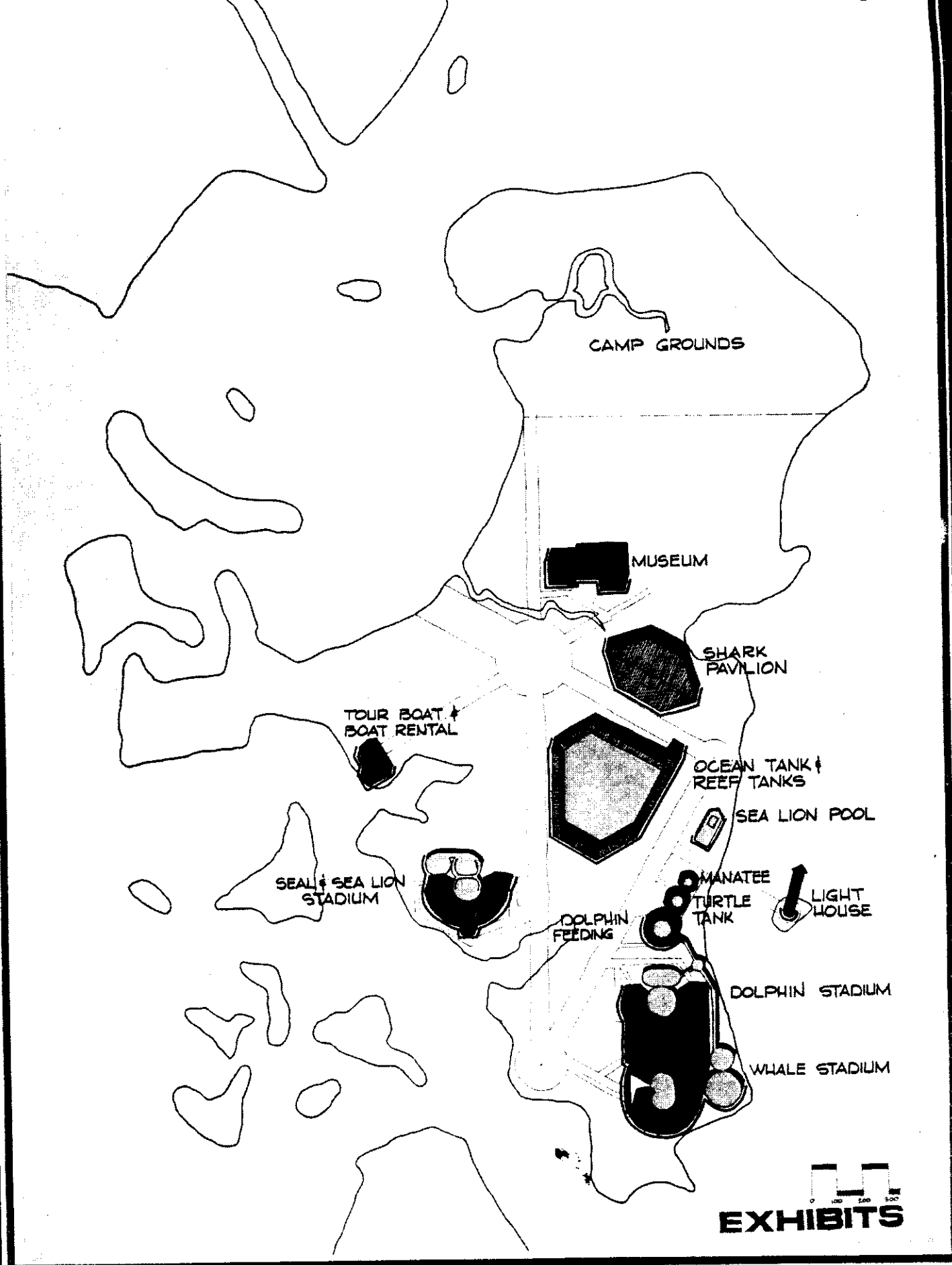
SHEET

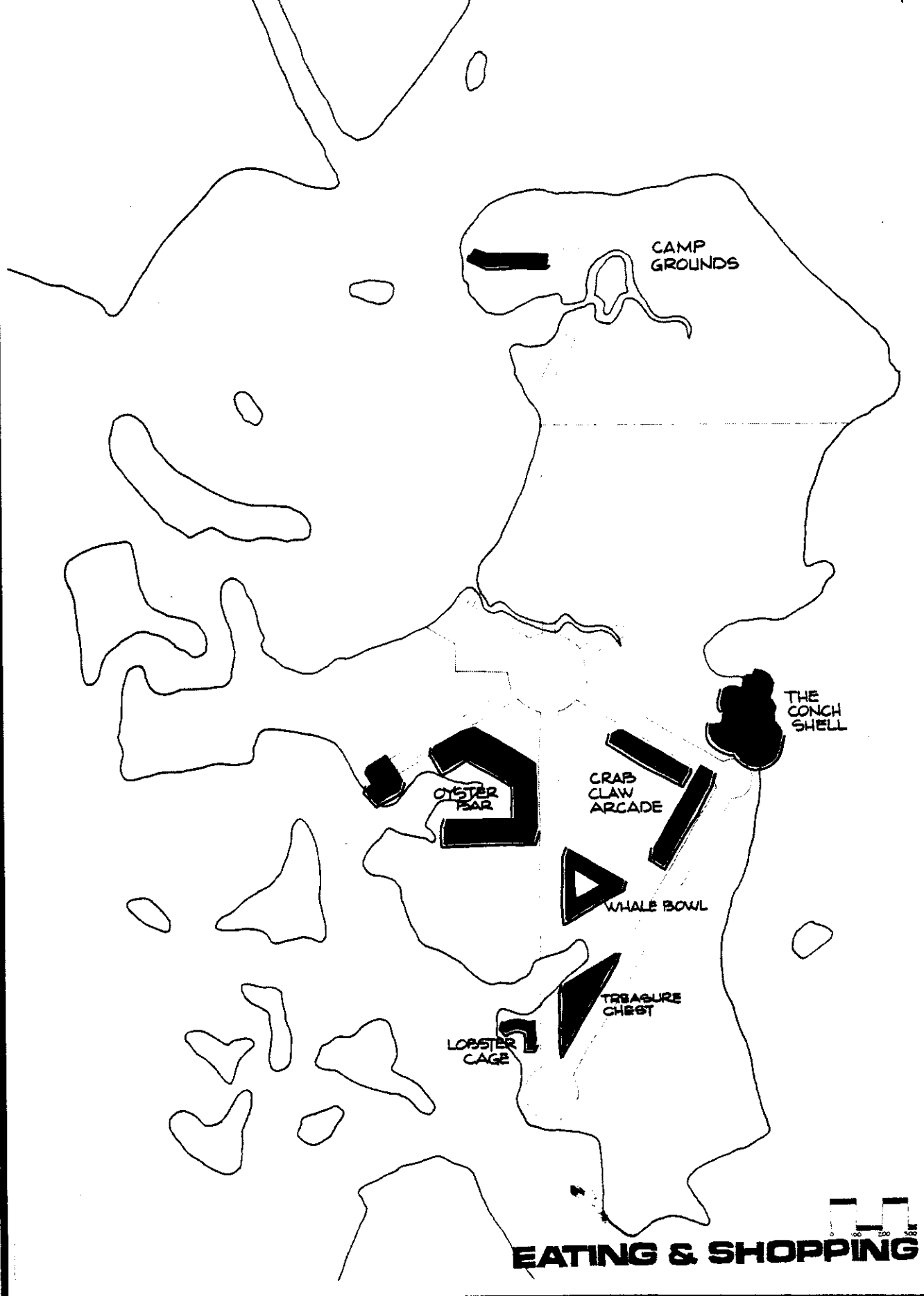
**THE REEF
AN OCEANARIUM AT**

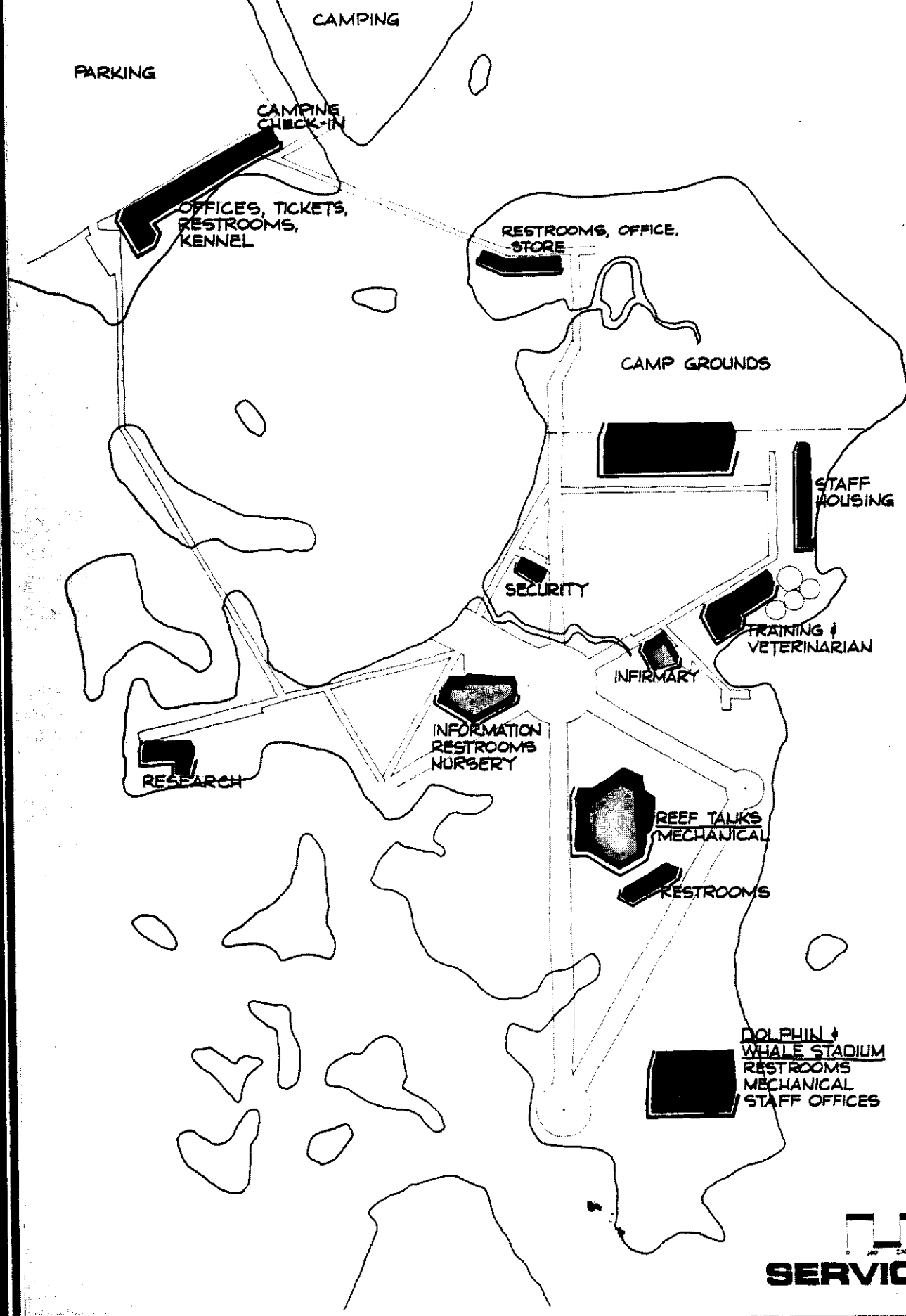
12-78



IS
DRESEN







PARKING

CAMPING

CAMPING CHECK-IN

OFFICES, TICKETS, RESTROOMS, KENNEL

RESTROOMS, OFFICE, STORE

CAMP GROUNDS

STAFF HOUSING

SECURITY

TRAINING & VETERINARIAN

INFIRMARY

INFORMATION RESTROOMS NURSERY

RESEARCH

REEF TANKS MECHANICAL

RESTROOMS

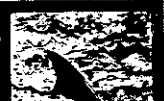
DOLPHIN & WHALE STADIUM RESTROOMS MECHANICAL STAFF OFFICES

0 100 200 300
SERVICE

SHEET

**THE REEF
 AN OCEANARIUM AT**

1-12-78



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SHEET NO. 9

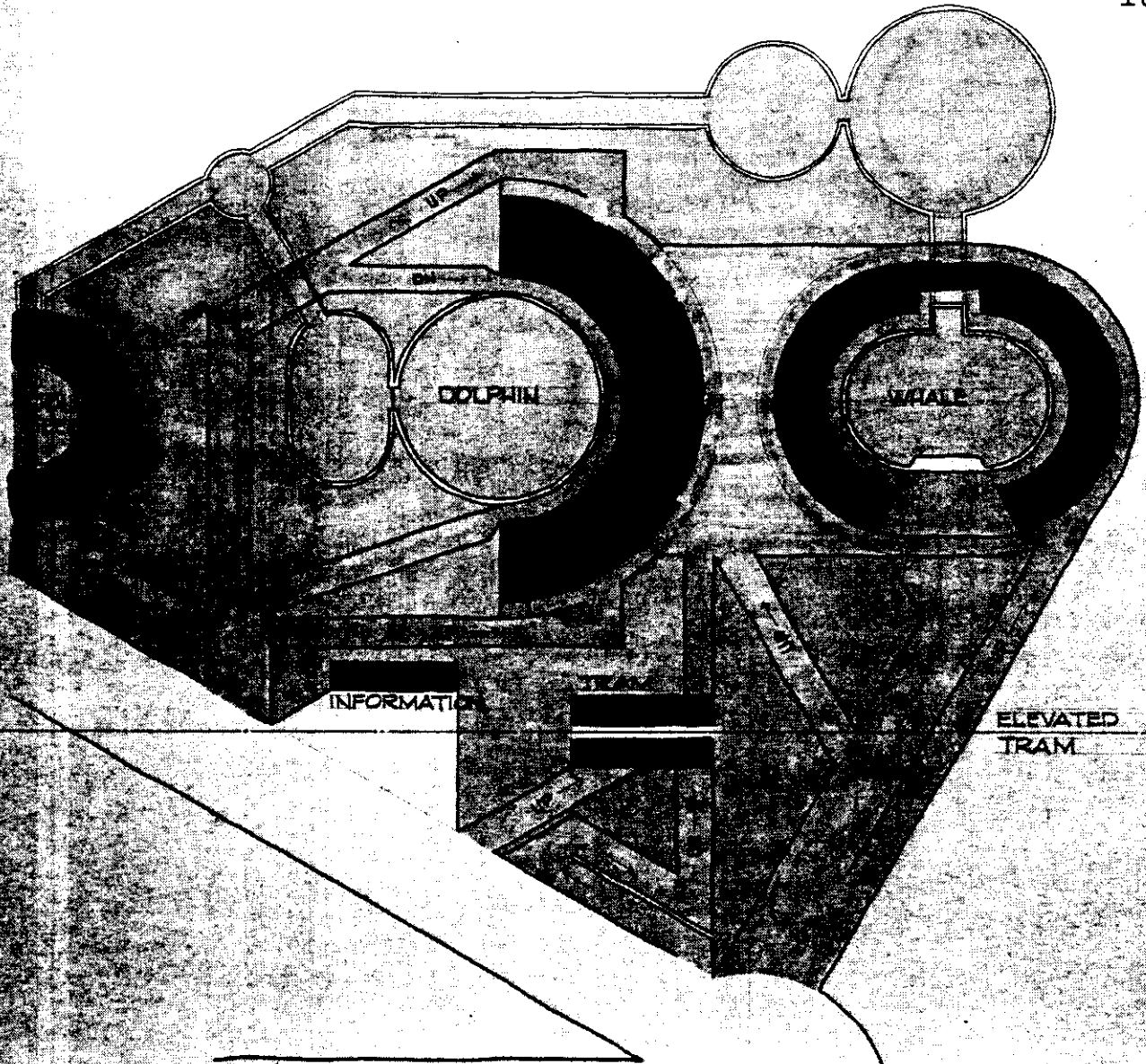
Large-scale plans of the Conch Shell Restaurant and shops, ocean and reef tanks, mechanical (water filtration back-up system), rest-rooms and snack bar.

SHEET NO. 10

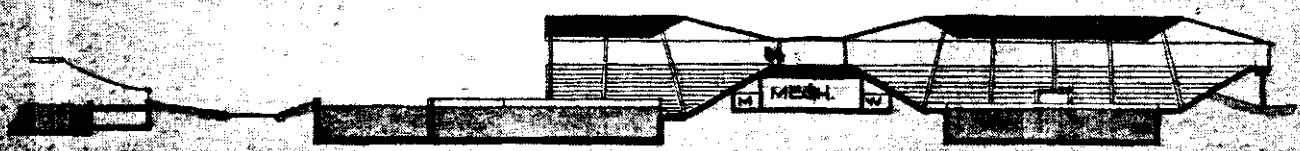
Dolphin and Whale Stadiums with connecting pools to the Dolphin Feeding tank.

For this exhibit, it was deemed important to provide a connecting water link to these three main show tanks, to allow movement of the animals between the three tanks. This grouping of exhibits is the strongest node at the southern shore of the site, therefore; it was important to provide many services at this point.

There are three information booths on the site; at the ticket gate, at the water tram shore entrance and here at this exhibit. All three of the main formation booths have a close link to a tram station. It was felt that the information booths would be a vital part of the security of location for each visitor. Therefore, at each possible entry point for a visitor, a information area is conveniently located.



DOLPHIN & WHALE STADIUMS

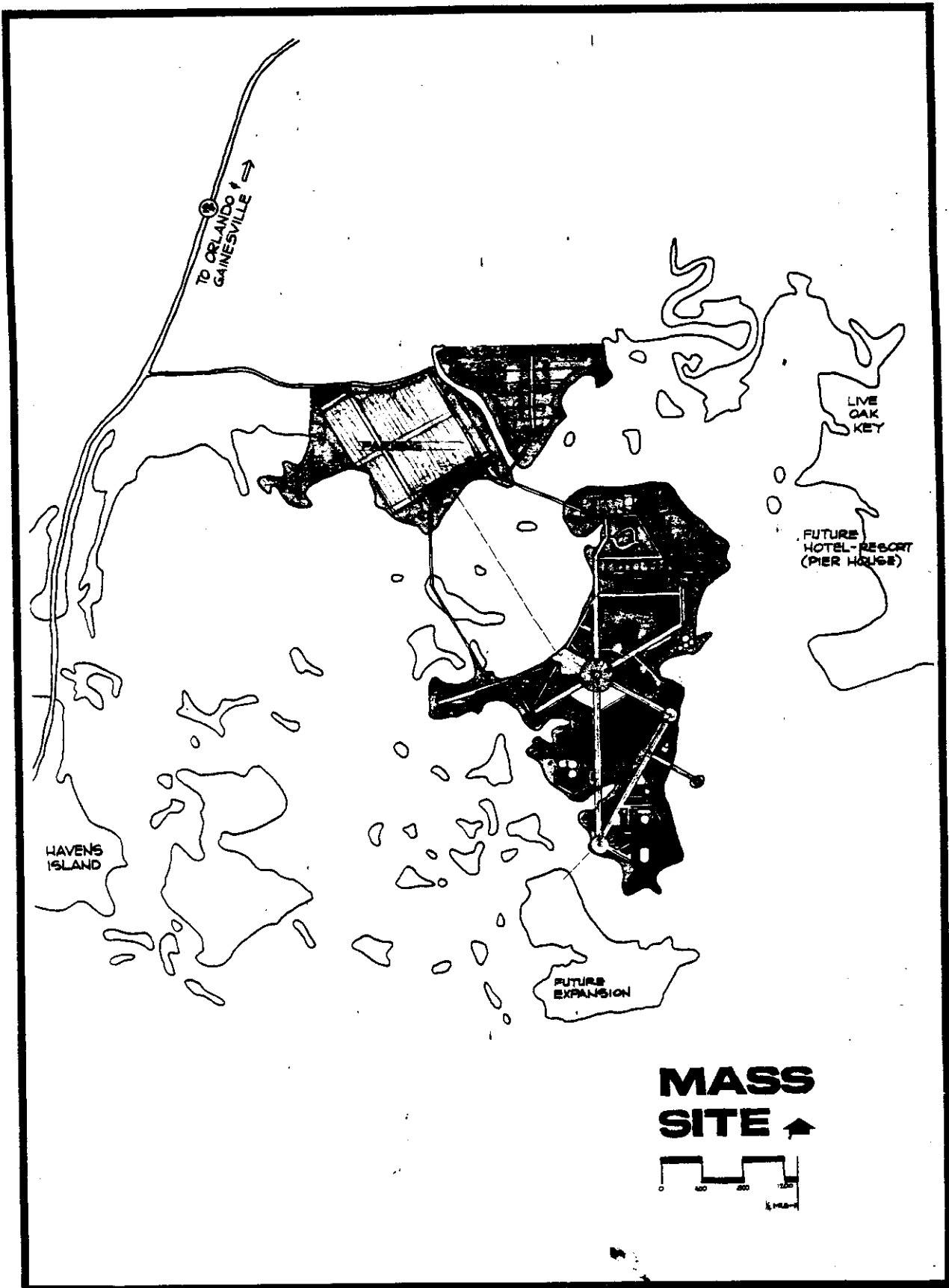


C. Winter Quarter 1979 - Final

SHEET NO. 11 - Mass Site Plan

This plan offers a complete picture of the oceanarium, parking, camping, future needs and the distance to Havens Island - the closest inhabited area.

This site is in a very good location in Florida. The area north of Cedar Key is totally undeveloped, except for Highway 24. Much of the land is somewhat swampy, however, it is a very common practice in south Florida and the Keys to "pump-up" this land. This process involves a vacuum which takes sand from the ocean floor, mixes it with a concrete and coral rock and is distributed over the land to form a very durable rock-like surface. It takes several weeks for this material to set into its rock-like state. After this period, topsoil and construction begin re-forming the earth's surface.



MASS SITE →



SHEET
1

THE REEF
AN OCEANARIUM AT
CEDAR KEY, FLORIDA

2-16-79



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SHEET NO. 12 - Master Plan

This plan has kept much of the same geometry with many subtle refinements.

The water tram's route has changed slightly at the mainland and the island. The main entry street now has at its shoreline an elliptical viewing area with the water tram drop-off to the north side. The elevated tram has kept the same route. These two tram drop-offs are directly across the main entrance street from a major information, restroom and nursery building.

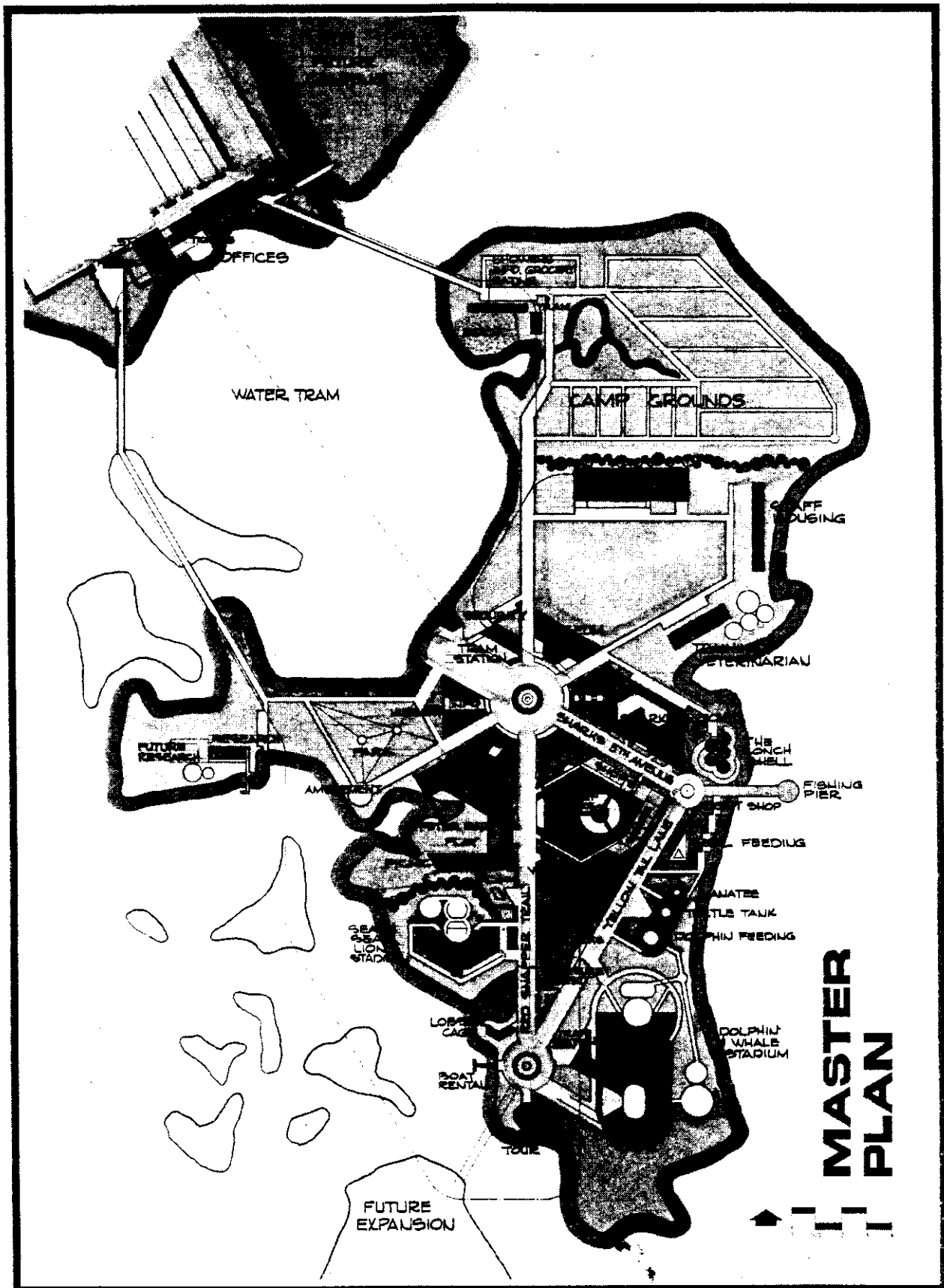
Moving to the circulation rotary, it is apparent that there are symmetrical in configuration, plazas and buildings (museum, tram and security and information). This suggestion became a unifying element for this central space.

The river has been removed at this entry point because it was causing a psychological division of the site which many visitors may not have crossed. Therefore, man-made water forms were added around walkways, rather than a visitor being forced to walk over and around the river. In the camping area three of the small streams have been removed. It was feared that these inlets would become dirty, laden with drifting objects from the Gulf and be a source and breeding ground for various insects. In the center of the camp grounds, a natural river exists with a loop. Due to tides and assuming this water will move and not stagnate, it has been left in its natural form.

The emphasis of this design was to incorporate each section of every street with a great deal of activity for visitors.

The southern point of the major triangle has been moved north to allow the transfer of the boat tour and boat rental to this location.

Points of reference and identification of location has remained of a dominant importance. The three points of the major triangle have attempted to provide this. The main circulation rotary has kept the stainless steel monument, the southern point has incorporated a lighthouse and the eastern point uses a Florida flag for its visibility object.



MASTER PLAN

SHEET
2

THE REEF
AN OCEANARIUM AT
CEDAR KEY, FLORIDA

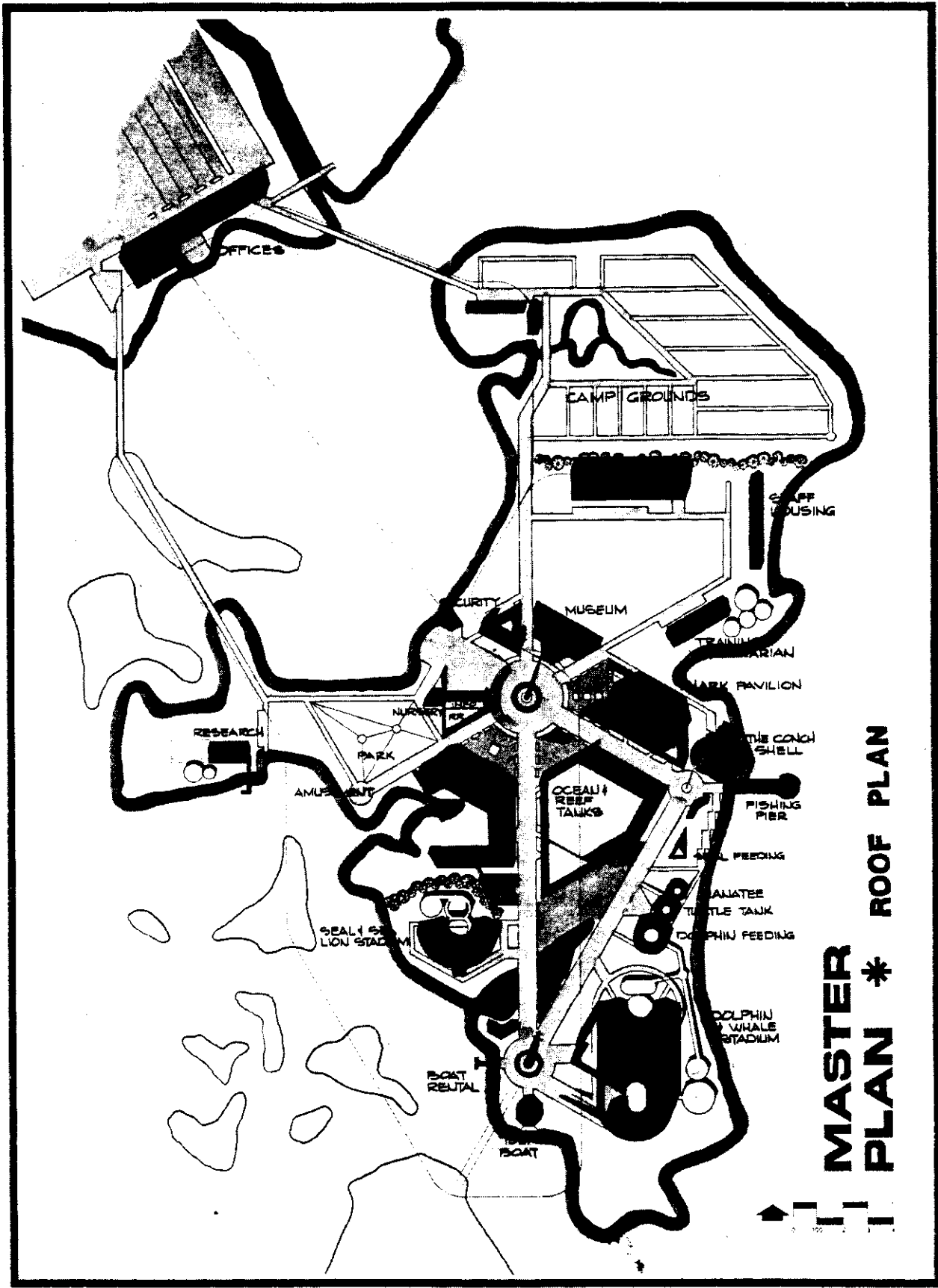
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KRIS
ANDRESEN

SHEET NO. 13 - Roof Plan

The roof plan shows the variable heights of the different buildings.



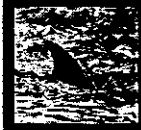
MASTER PLAN * ROOF PLAN

SHEET

3

**THE REEF
AN OCEANARIUM AT
CEDAR KEY, FLORIDA**

2-16-79



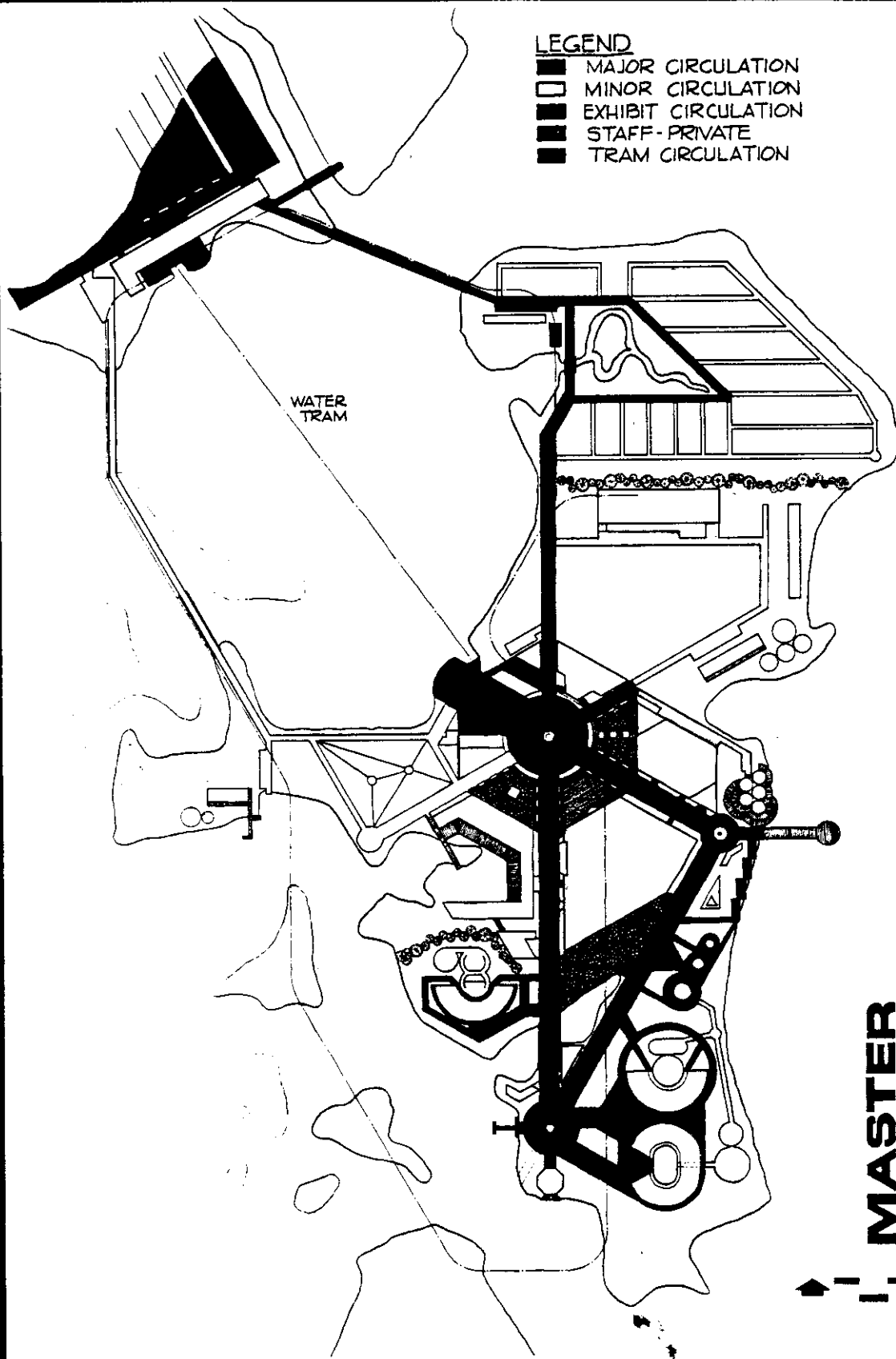
KRIS ANDRESEN

SHEET NOS. 14 - 17

These plans divide the design into the different services by circulation, exhibits, eating and shopping and service.

LEGEND

- MAJOR CIRCULATION
- MINOR CIRCULATION
- EXHIBIT CIRCULATION
- STAFF-PRIVATE
- TRAM CIRCULATION



MASTER PLAN * CIRCULATION



SHEET

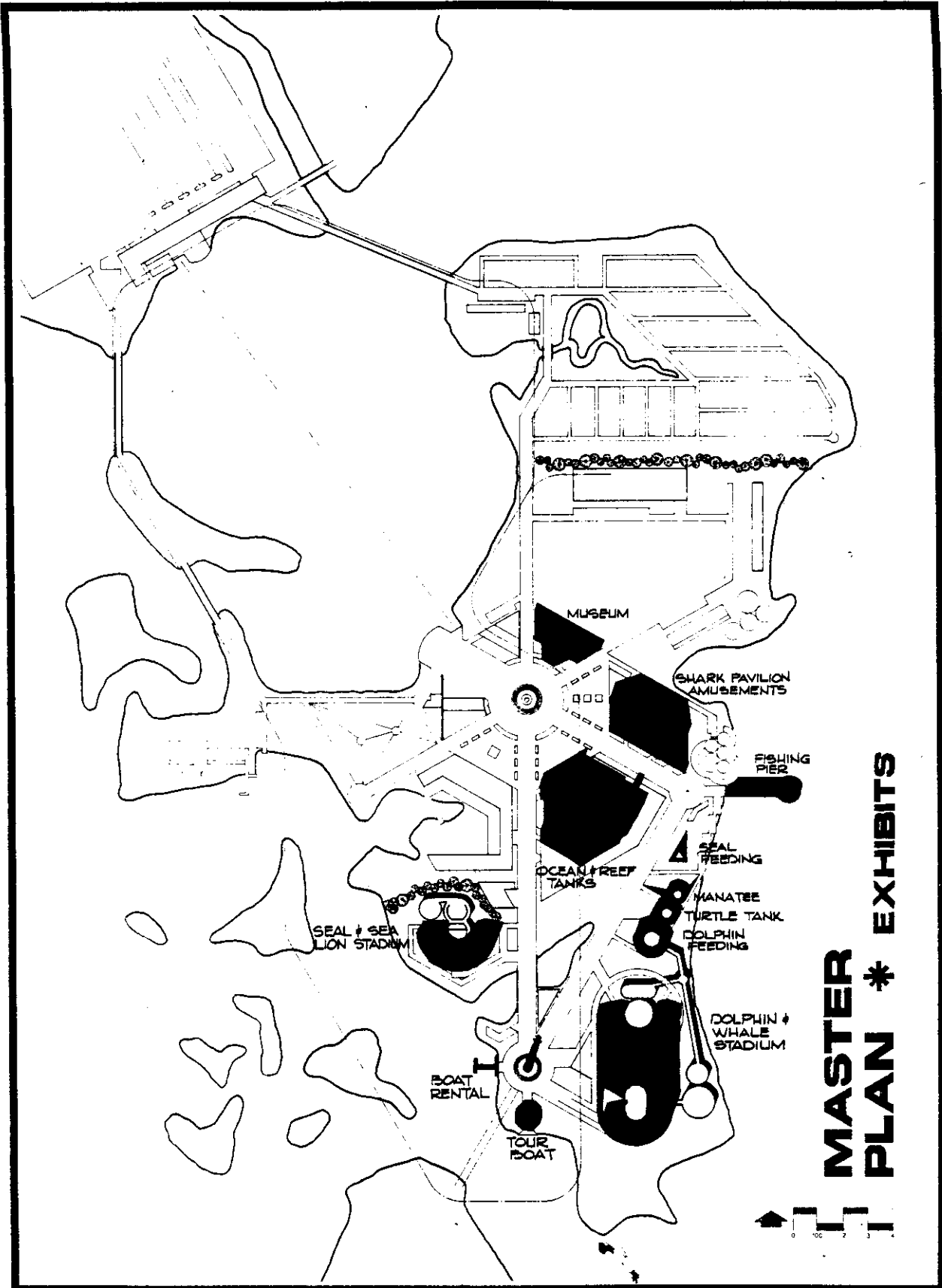
4

**THE REEF
AN OCEANARIUM AT
CEDAR KEY, FLORIDA**

2-16-79



KRIS ANDRESEN



MASTER PLAN * EXHIBITS

SHEET

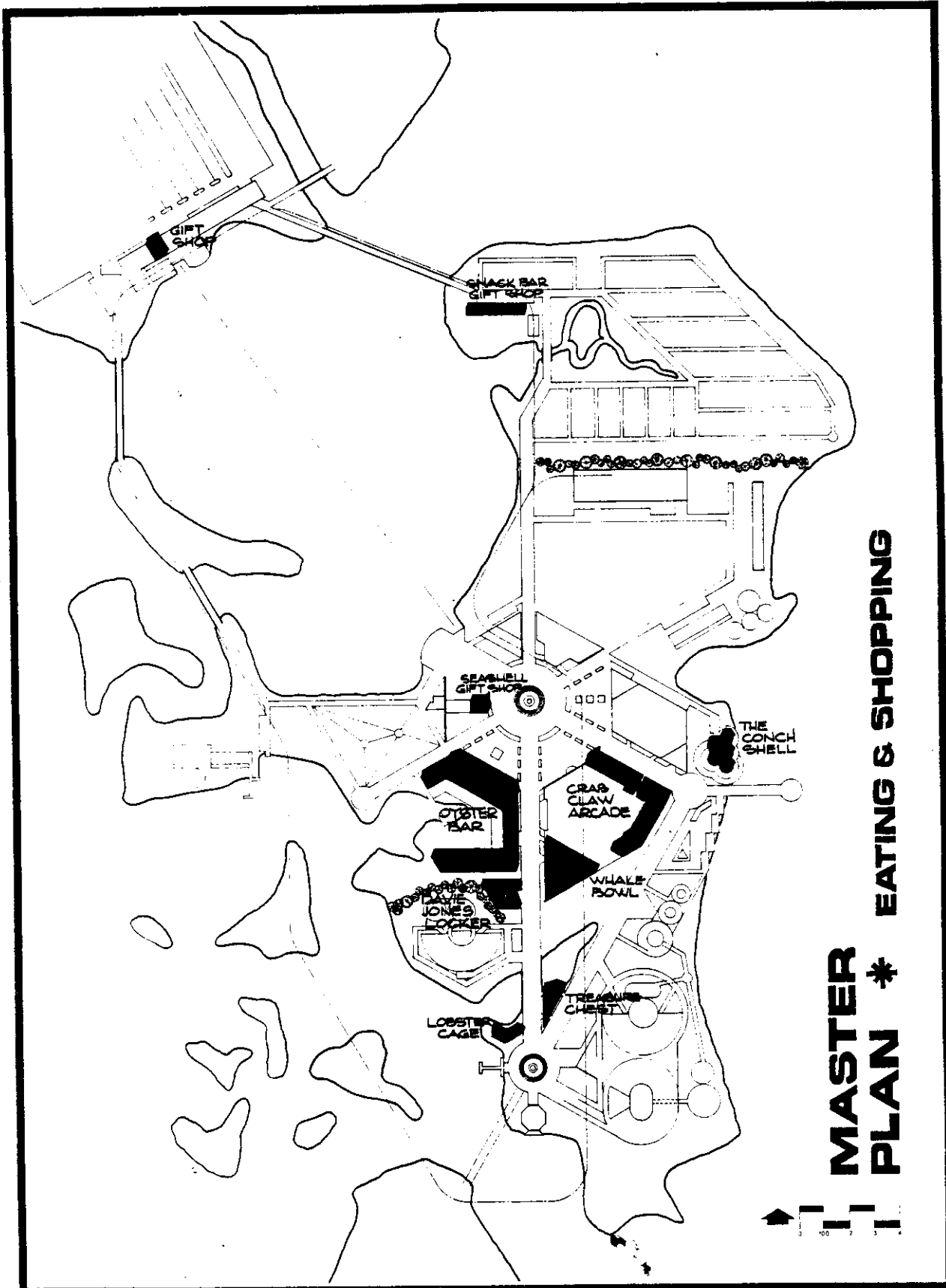
5

**THE REEF
AN OCEANARIUM AT
CEDAR KEY, FLORIDA**

2-16-79



KRIS
ANDRESEN



MASTER PLAN * EATING & SHOPPING

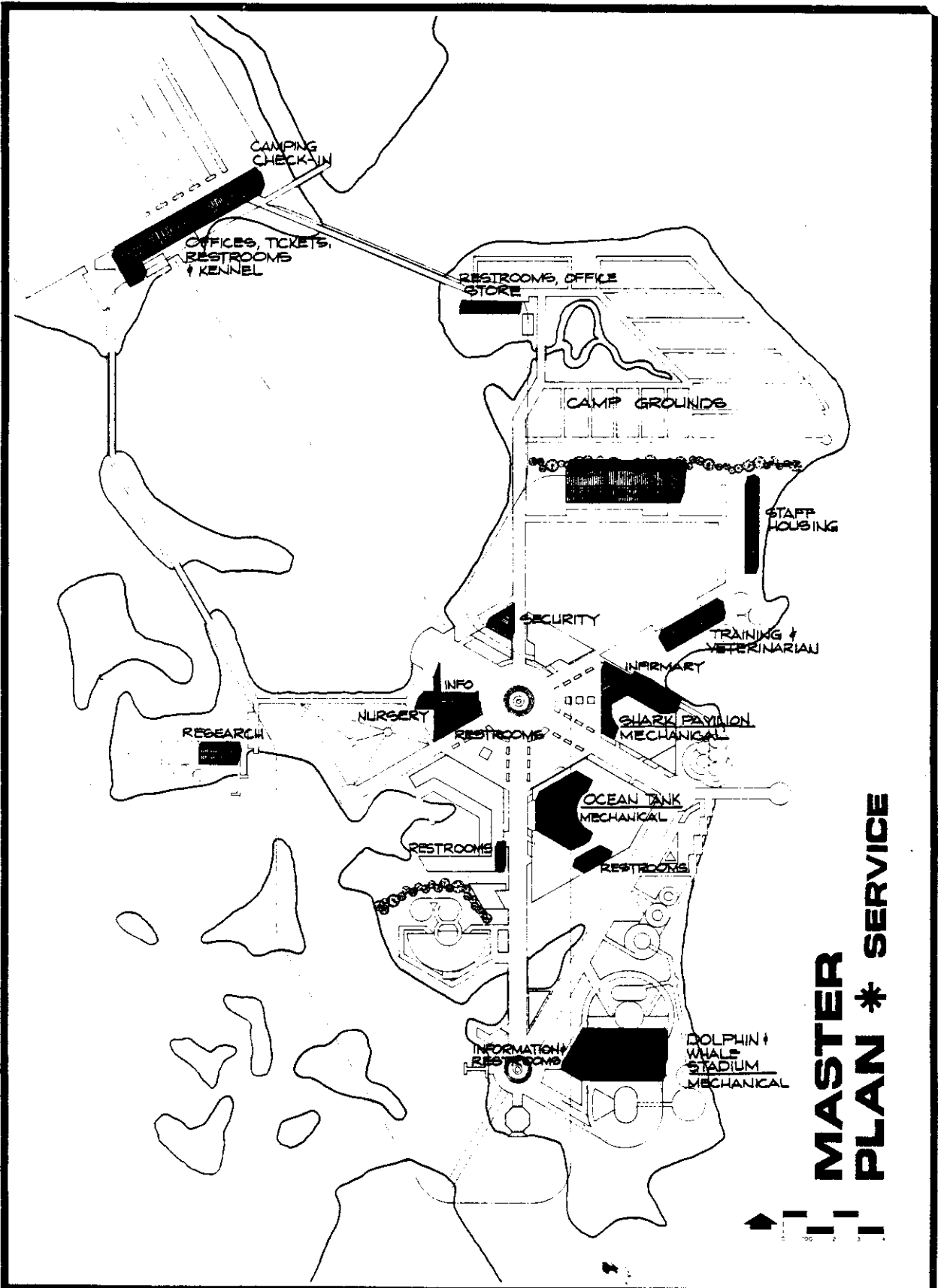
SHEET
6

THE REEF
AN OCEANARIUM AT
CEDAR KEY, FLORIDA

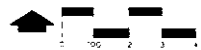
2-16-79



KRIS
ANDRESEN



MASTER PLAN * SERVICE



SHEET
7

THE REEF
AN OCEANARIUM AT
CEDAR KEY, FLORIDA

2-16-79

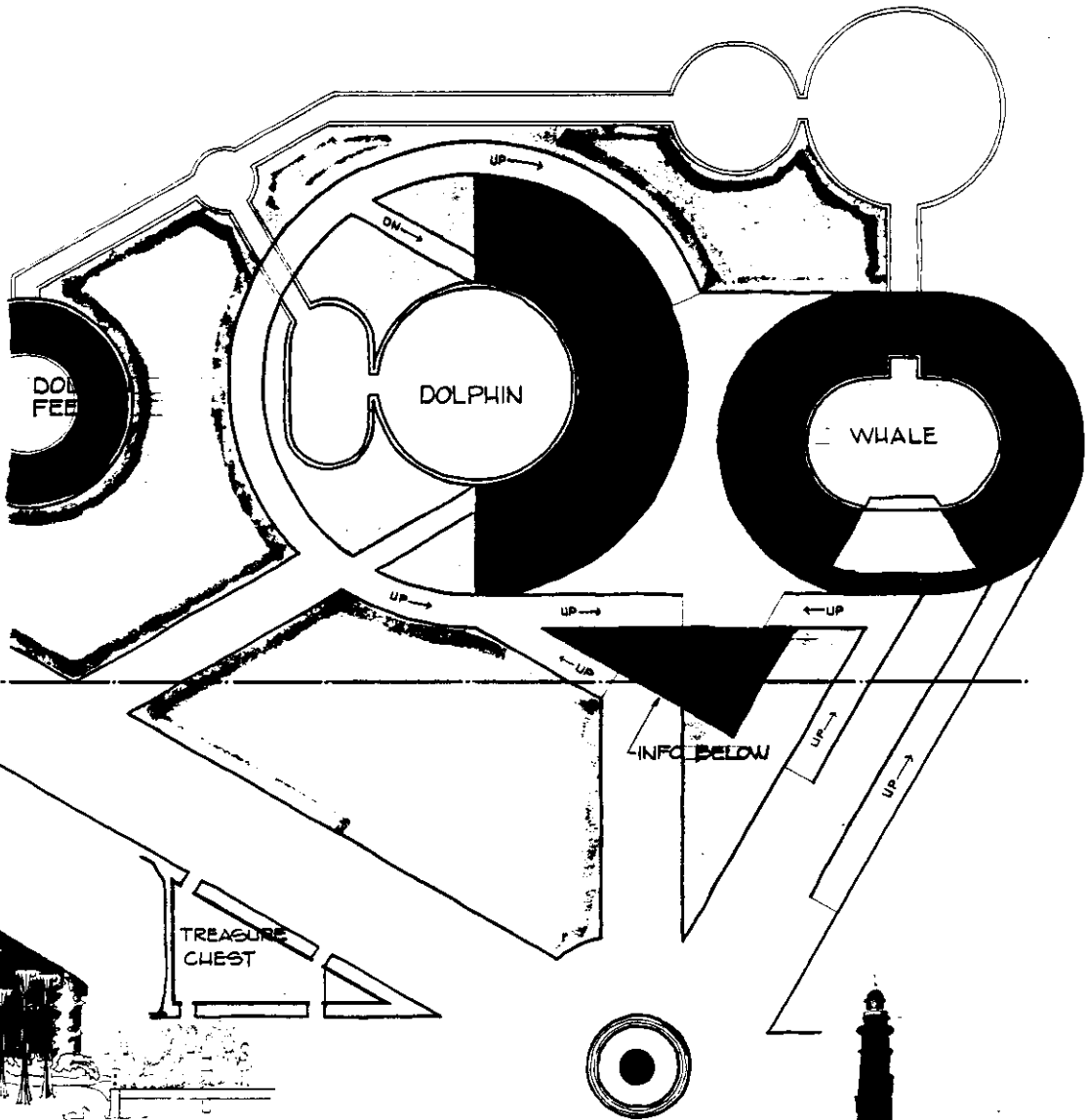


KRIS
ANDRESEN

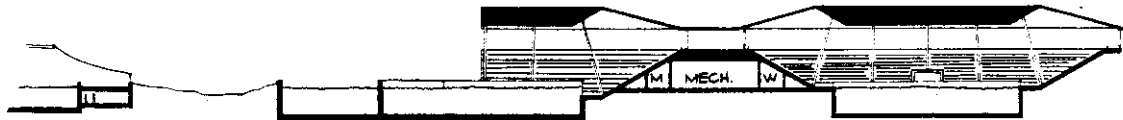
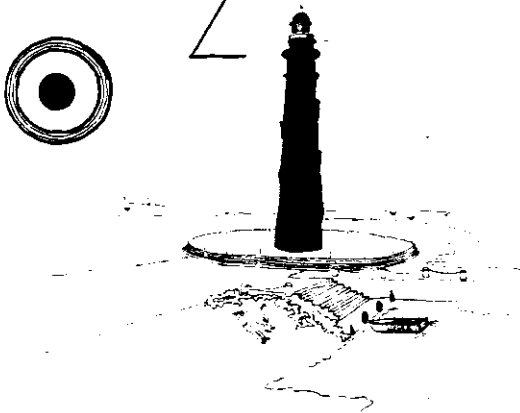
SHEET NO. 18 - Dolphin & Whale
Stadiums

This plan is very similar to the large scale plan shown at midterm. It differs in its ramping systems, tram station and information booth below the tram station.

Once again, this plan shows the importance of providing connecting tanks which the dolphins and whales can be moved about in. Due to this arrangement, only sick animals would be required to be moved out of the tanks. In most other oceanariums a great deal of manual movement of animals is required because they do not have connecting pools.



DOLPHIN & WHALE STADIUMS



SHEET
8

THE REEF
AN OCEANARIUM AT
CEDAR KEY, FLORIDA

2-16-79



KRIS
ANDRESEN

SHEET NO. 19 - Large scale plans

The Conch Shell Restaurant is a family restaurant and an adult restaurant. This is developed by the separate dining rooms. Each dining room has a nice view of the Gulf or of busy pedestrian walkways.

The building which houses the ocean and reef tanks includes many other busy areas (shopping, eating, rest-rooms, and mechanical). The ocean tank has three corridors that one can walk through and sit on a raised platform to view the ocean-life. A visitor can completely walk around the perimeter of the ocean tank. Another different concept in this building is the massive mechanical chamber. It has viewing windows which a visitor can obtain an idea of the systems required for water supply and water filtration. The reef tanks or commonly known as the wall tanks, contain exquisite specimens of oceanlife. Pages 4-9 explain the oceanlife which are incorporated in this building.

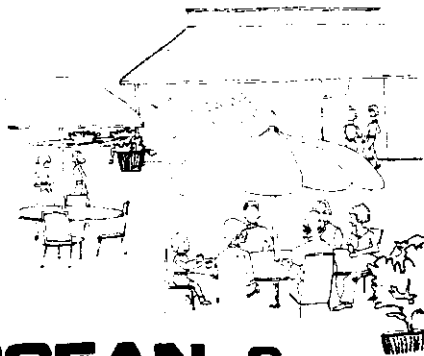
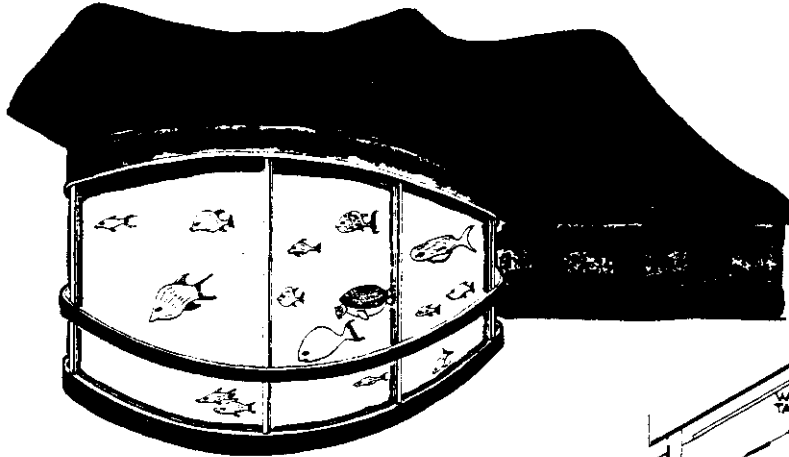
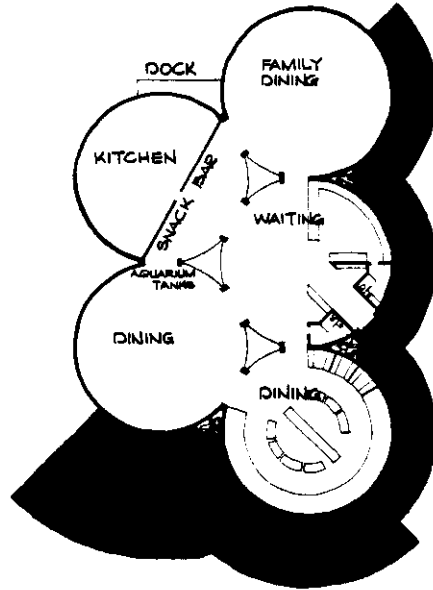
Restrooms are conveniently located throughout the site.

The snackbar in this building gives its visitor a choice. The visitor can either eat inside the screened porch or at covered tables outside on a stone patio with many views, mainly of the activity at the duck pond inlet.

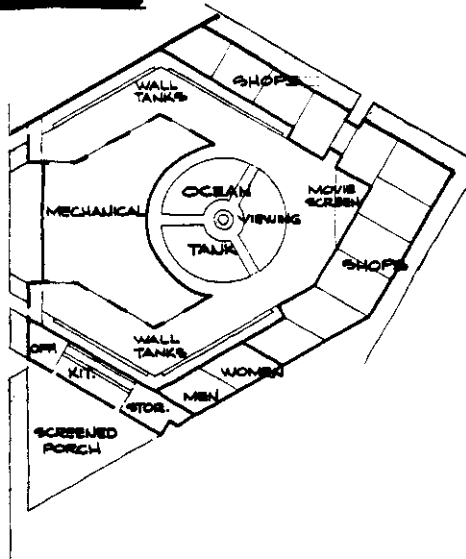
(Credit must be given to Sonny Palmer for the concept of walking through and under the ocean tank.)

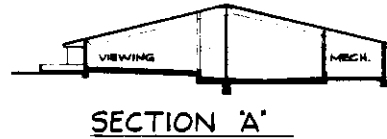
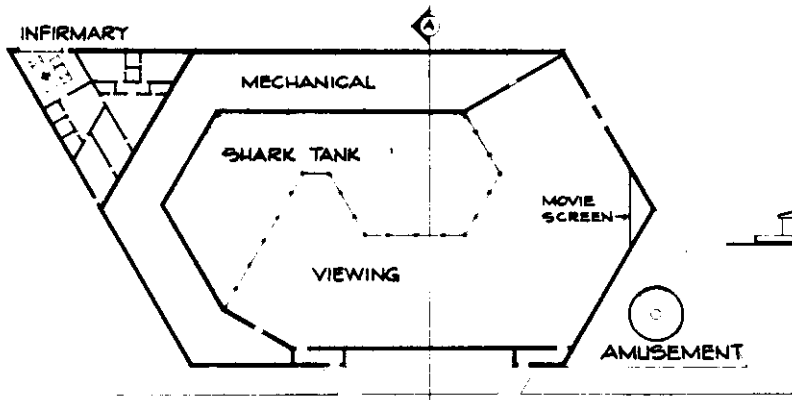


THE CONCH SHELL

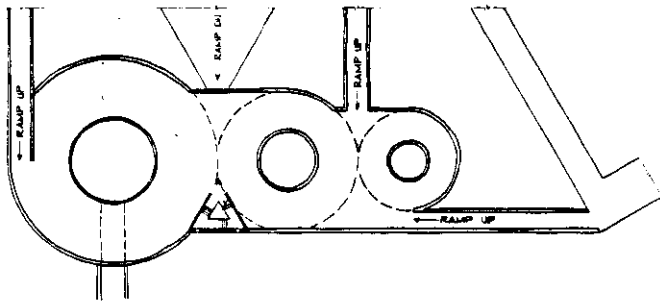


OCEAN & REEF TANKS

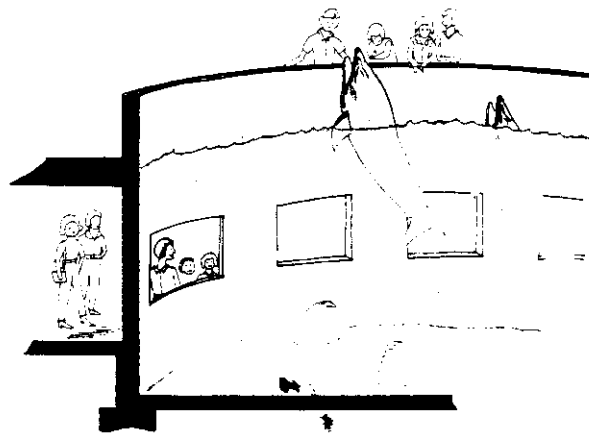
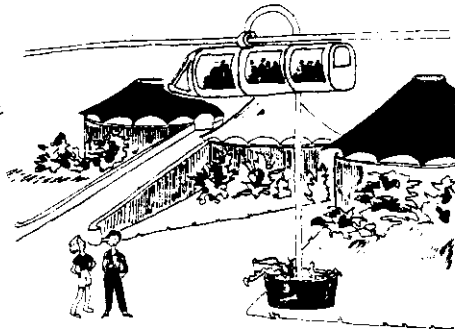


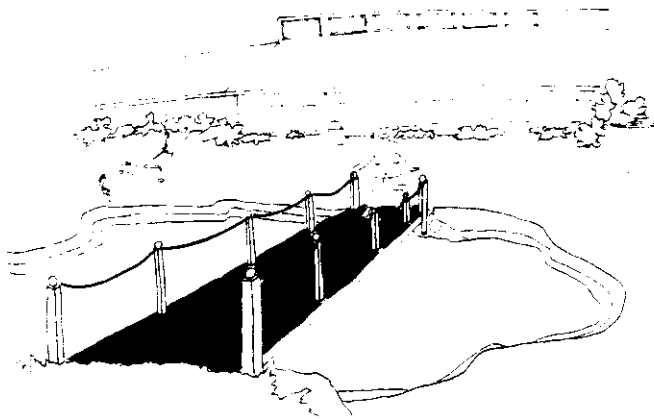
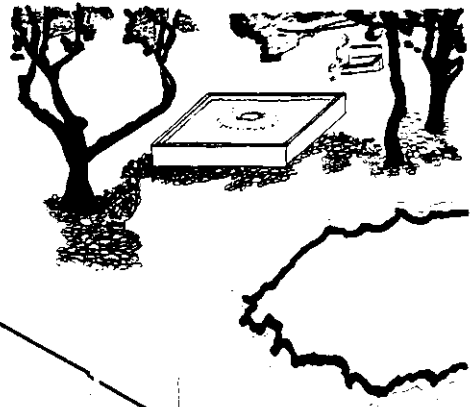
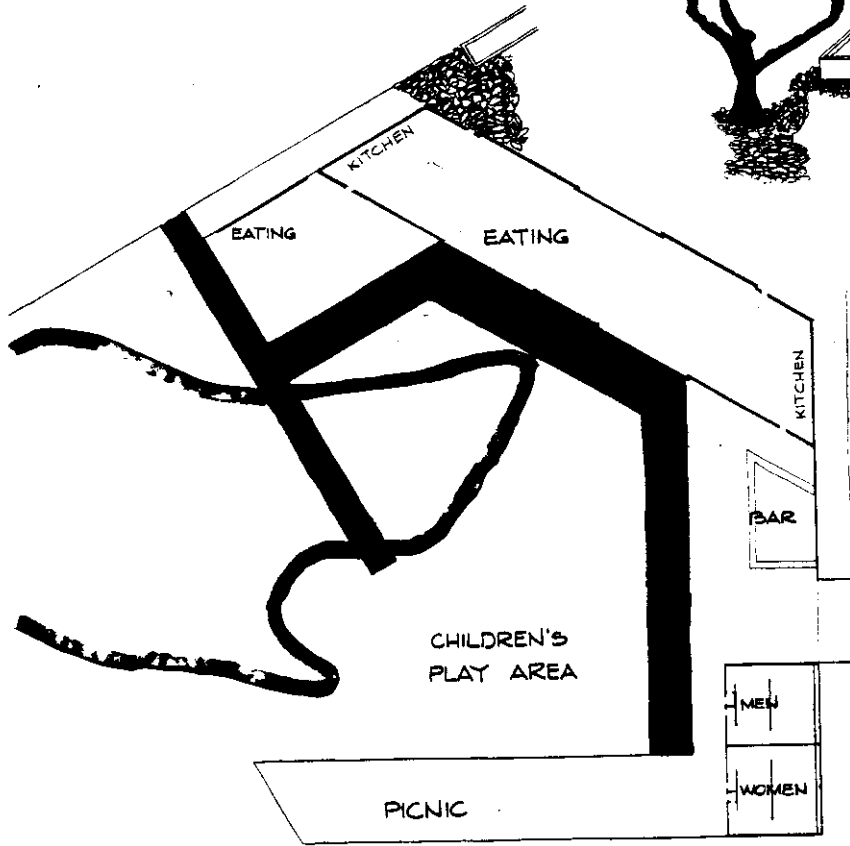


SHARK PAVILION, INFIRMARY & AMUSEMENT



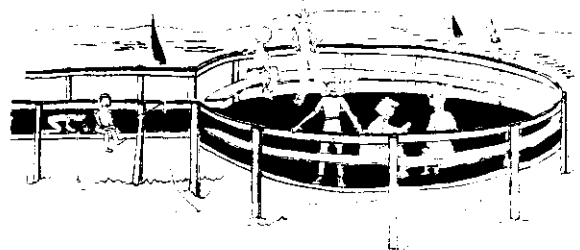
DOLPHIN FEEDING, TURTLE TANK & MANATEE POOL





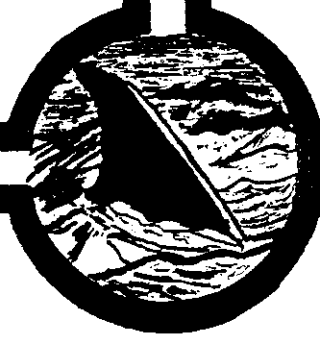
**FISHING
PIER**

**OYSTER BAR,
PICNIC &
RESTROOMS**



THE REEF THE REEF THE REEF THE REEF THE REEF


E REEF THE REEF THE REEF THE REEF



XIV. PRESENTATION NOTES

Palmer

IDENT	REQUIREMENTS					COMMENTS	GRADE
	PLAN SECTIONS ELEVATIONS MODEL	SITE RESPONSE PROGRAM RESPONSE	STRUCTURE MATERIALS SCALE CIRCULATION	QUALITY OF SPACE			
PERSON AY NES OWN KON GER FFS NZE PE ADE ONE BEL					<p>It appears to me that K is somewhat short of where she needs to be at this point. The site and its <u>issues</u> have not been dealt with thoroughly enough to produce a clear and logical master plan, and yet she is designing building parapets. There is an evolutionary step between concept and detail that has been missed. Because she appears to be behind schedule, I cannot recommend other than</p>	C	

STUDENT	REQUIREMENTS					COMMENTS	GRADE
	PLAN SECTIONS ELEVATIONS MODEL	SITE RESPONSE PROGRAM RESPONSE	STRUCTURE MATERIALS SCALE CIRCULATION	QUALITY OF SPACE			
ANDERSON BAY BARNES BROWN BUXON CUNGEF. DEFFS ENZE HOPE MADDE TONE OGEL	✓ ✓ ✓ ok	✓ ✓	✓ ✓ ✓ ✓	? Good potential (B)	Make entry circle more intense Was boat  rental? More light house? Make all nodes more intense (It takes more than a flag to make a node) How that facilities have be organized and placed can the circulation experience be more humane and delightful Strong circulation approach makes this better than "Sea World"	B-	

RESEARCH IN JUNE - Sea World and Seaquarium

Oceanarium in Florida incorporating
Entertainment
Research
Education

Located in Dedar Keys which is a small fishing port with a state park for camping and a airport

Access to the site is from State Road 24
Parking on the mainland with tram service to the ticket gate
From ticket gate visitors board a monorail take it to the southern tip of site

Most of site is marshy with a low elevation.
Sea level is fixed after survery of average of high and low tide.
Certain portions of the site will be pumped up.
All of Key West was developed by this process.
Coral reef is ground up with a mixture of concrete and rock and then topsoil is applied.

The propped expansion site is important as other oceanariums have been limited in their development because of limited space. San Diego and Seaquarium.

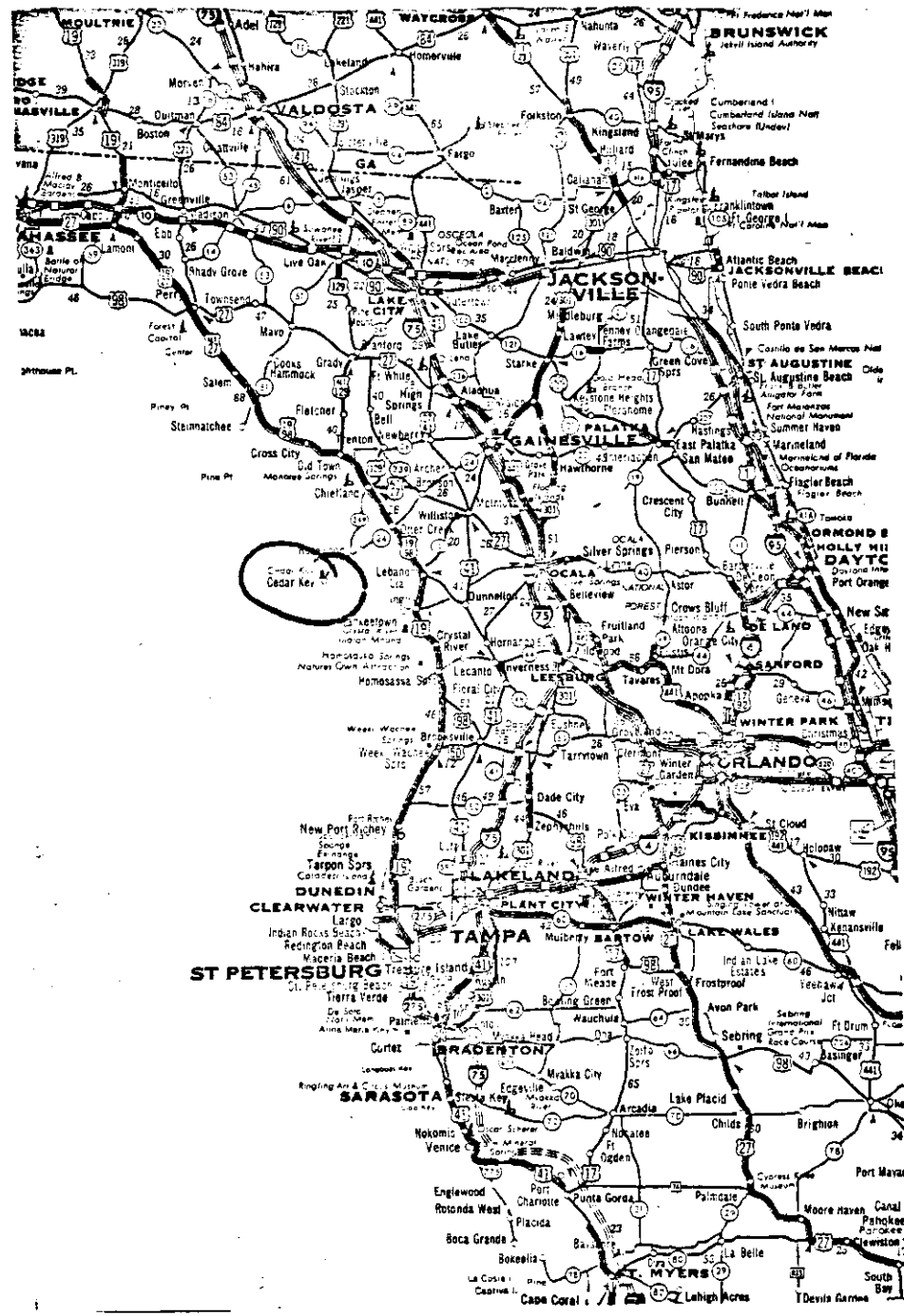
Research will be incorporated with the University of Florida at Gainesville.

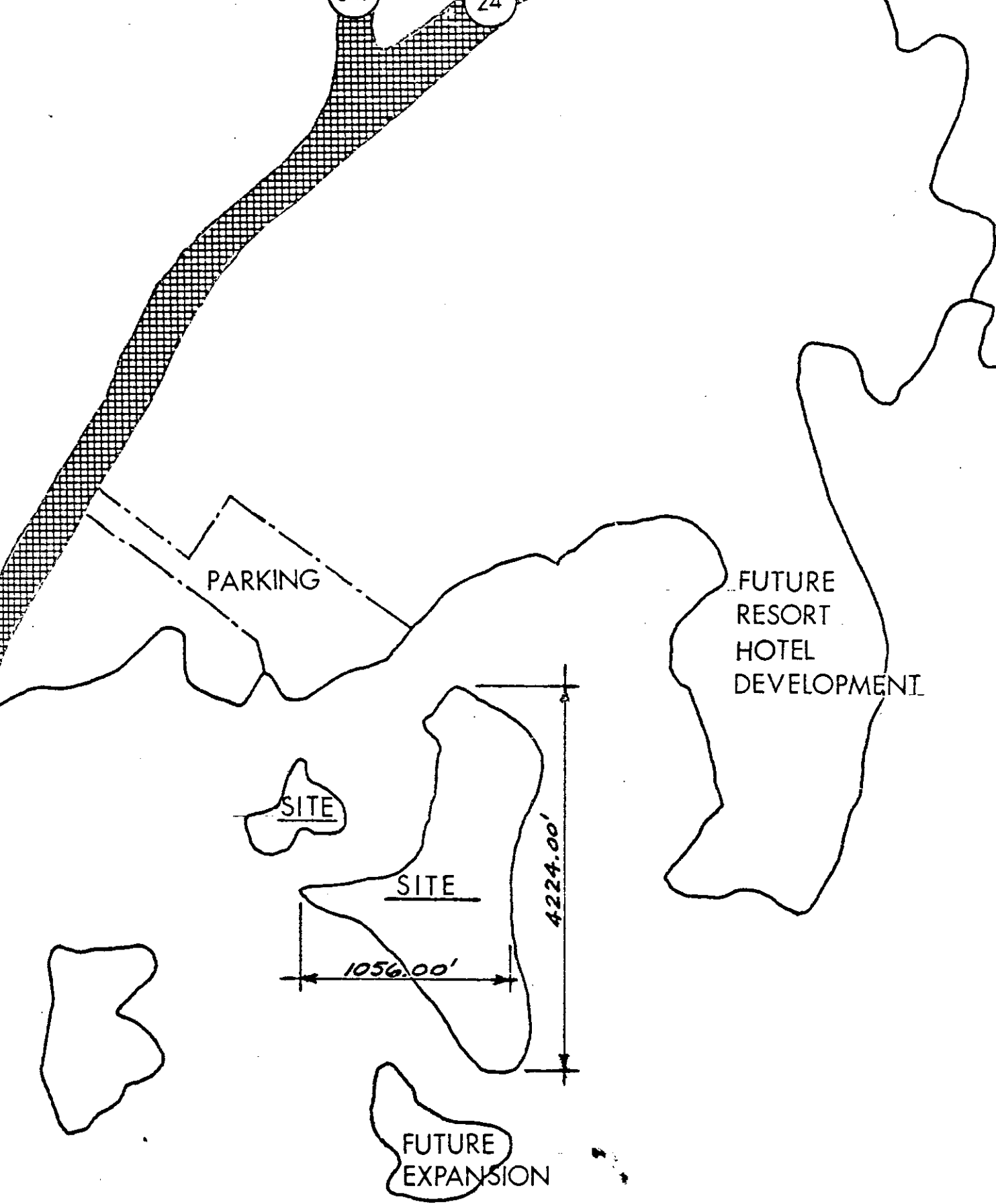
This entire area is ready for development - the adjacent area could be a hotel-resort development.

* CIRCULAR
SOUTH FLORIDA ACADEMY
OFFICE OF THE DIRECTOR OF THE DEPARTMENT OF
MARINE RESEARCH
UNIVERSITY OF FLORIDA
GAINESVILLE, FLORIDA

VI. A. Regional Location Map

Cedar Key, Florida

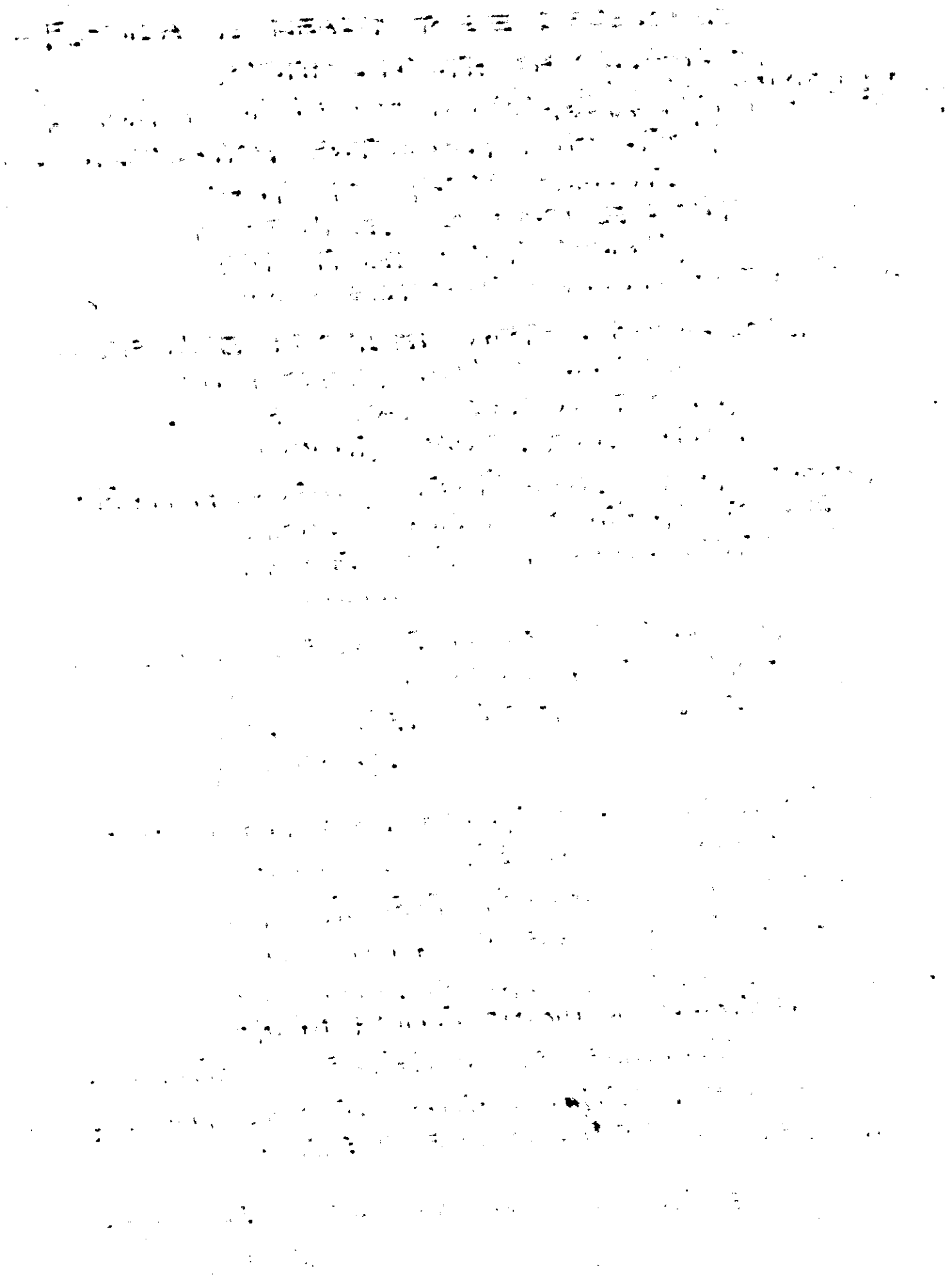




SITE



1:16,700



* presentation graphics: above average

verbal presentation: lacks direction

overall presentation: above average, could be more detailed

* concept direction: average

concept pieces: average

overall concept: having trouble dealing with large,

overall, project, needs priorities for all parts of project
such as zoning, circulation, image, etc.

* suggested grade B+

10-12-78

COMMENTS - KRIS

JACK: NEED TO EXPRESS ENTRY MEDIUM /
TRAM, BOAT, CAMPERS. ORGANIZING & ORIENTATION
IMPORTANT; PARKING LOT NEEDS CLARIFICATION.
AMUSEMENT PARK LOCATION & FOCUS (LOUD & ACTIVE)
QUESTIONED; AMUSEMENT PARK CIRCULATION
PATTERN IN OVERALL CONTEXT. PICNIC & OTHER ACTIVITIES
GOOD MIX & SEPARATE ACTIVITIES / ADD OTHER SIDE cont

SONNY: AMUSEMENT IS A QUESTION (DAY LIFE -
AQUARIUM; NIGHT LIFE - AMUSEMENT) SOME
MAY ONLY WANT AMUSEMENT; ? ON TRAM
DROP OFF POINT @ END; BOAT-TRAM ALTERNATIVE;
NEED SEPARATION OF PLANS / PEDESTRIAN, BUILDING,
PATHS, TRANSPORTATION, CIRCULATION; PRIMARY/
SECONDARY CIRCULATION (HOW DECIDED); ~~SEPARATE~~

OTHER JACK

LIGHTS; AMUSEMENT QUESTIONABLE; CHECK OUT
(SEAQUARIUM ETC)
& QUESTION & EXAMINE OTHERS CIRCULATION; DON'T
SHADE PERFORMANCE AREA;

OTHER SONNY - SEA LION/SEAL ON 2ND CIRCULATION PATH;
QUESTION 2 ENTRIES & PEOPLE FLOW; MORE
COHERENT PATTERN TO CIRCULATION; SUN & STADIUM
ORIENTATION — COVERED STADIUM

1912
The first of the year
was a very dry one
and the crops were
very poor. The
winter was also
very dry and the
crops were very
poor.

The first of the year
was a very dry one
and the crops were
very poor. The
winter was also
very dry and the
crops were very
poor.

The first of the year
was a very dry one
and the crops were
very poor. The
winter was also
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poor.

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was a very dry one
and the crops were
very poor. The
winter was also
very dry and the
crops were very
poor.

OCEANARIUM @ CEDAR KEY, FL.

PRIMARY EMPHASIS

PROVIDE A PLEASANT ENVIRONMENT
WHERE PEOPLE WANT TO SPEND AN
ENTIRE DAY OR MORE

IN BEGINNING:

SPREAD OUT

NOW:

TRYING TO MAKE TIGHTER MORE
ACTIVE AREAS

STRONG PRINCIPLE:

LOCATION OF VISITOR

BY 3 MAJOR NODES OR PODS

TYPICAL CIRCULATION THROUGH ~~FROM~~ THE REEF-

SERVICE ABOVE MUSEUM

5 YR. PLAN

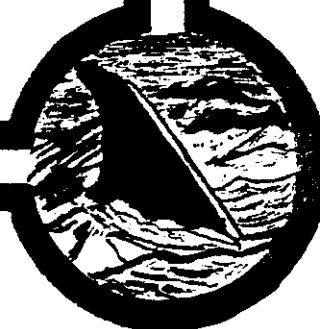
EXPANSION WOULD OCCUR WITHIN
THIS PERIOD ONCE THE REEF
STARTS SHOWING A PROFIT.

1. EDUCATION FACILITY - OCEANOGRAPHY
2. LOST ISLAND - BIRDS & VEG.
OF FLORIDA
3. PIER HOUSE - HOTEL/RESORT

PEAK TIMES OCT./NOV. OPENING

THE REEF THE REEF THE REEF THE REEF THE REEF

E REEF THE REEF THE REEF THE REEF



XV. DESIGN SKETCHES

A Q A R I U M S

S E A Q A R I U M S

KRIS ANDRESEN

Research Documents 451

May 17, 1978

ABSTRACT

The topic of this research (aquariums/seaquariums) was chosen as the writer plans to carry-out the facts and results of the tests for fifth year thesis in September, 1978.

This paper is a product of research which will be used as a vehicle to fulfill the requirements of "Research Documents 451" at Ball State University, Muncie, Indiana.

This paper will attempt to describe and document the processes used and the results of two questionnaires. The questionnaires were used to survey people's feelings and interest concerning aquariums/seaquariums.

The hypotheses of this experiment assumes that the majority of all people of all age groups are genuinely interested in aquariums/seaquariums.

The extent of their interest, how far they will travel to see such exhibits and what they would chose to see at an aquarium/seaquarium will be explored and detailed in the following pages.

introduction By using questionnaires, the tester attempted to establish the general public's genuine interest or disinterest in the topic, in the first device (See Figure 1 in the Appendix). Using the second questionnaire (See Figure 2 in the Appendix), the tester attempted to determine the comparable interest of pet shop owners and employees (shops which carry or specialize in sea-life) to the general public. 70 people were given Figure 1 and 23 people were tested with Figure 2, with only 4 people who were not interested in completing the questionnaires. For clarity, it may be added that the general public was presented with Figure 1 and the pet shop owners were given Figure 1 and 2.

method The independent variable or interest variable was quite high in this experiment. The variables were not changed when giving the questionnaire to the respondents, as the tester did not deem this procedure necessary. The static environment of the general public compared to the different environments of the shop owners and employees showed no "noticeable" difference in the results; for all responses were very closely the same in each age group.

The general public subjects were tested at the center of the Muncie Mall between L. S. Ayres and the Osco Drugstore at 2:30 to 3:30 pm. on Tuesdays and Wednesdays. The experimenter chose to use a vacant kiosk in the center of this area. The kiosk is usually used for civic group promotions. The kiosk in this experiment was used as a writing surface and a limit of boundaries.

As people walked by, the experimenter smiled and told them, "Hello!, I am a fifth year architecture student at Ball State University, working on a survey on aquariums for my research class. Do you have a few minutes to answer several short questions?" Only four people refused this request. As the tester gave the subject the questionnaire, she thanked them and said that the information would help a great deal as she was planning on doing her thesis project on aquariums.

The subjects were selected to attain a thorough range of ages. This was difficult as the majority of people at the mall are in the 16-25 year age bracket. The tester attempted to use one-half males and one-half females, with final results showing 51 males and 42 females. The experimenter desired to use middle to upper-middle socio-income class people.* The experimenter believes that the majority of people tested

were middle income with approximately 8% being upper-middle and approximately 10% being lower socio-income class.

One important point which must be noted were the subject's timid and hesitant reactions when first approached; however, after completing the questionnaire, all were smiling as the tester thanked them for their help.

results The most important result of this testing, was finding that all people surveyed were genuinely interested in aquariums/seaquariums.

A second, however very important fact, was that all young people surveyed wanted to visit an aquarium/seaquarium in the south, preferably in Florida. While young people felt a southern location would interest them; overwhelmingly, people 26 and over definitely were interested in a full-scale aquarium with mammals in the midwest. All people noted they were not especially interested in visiting the Shedd Aquarium in Chicago, Illinois.

The majority of people responded that given a choice they would greatly enjoy seeing the Miami Seaquarium in Miami, Florida.

Other aquariums which were not typed on the questionnaire, however generated interest were Musee Aquatique in Monaco; the Aquarium in the San Diego, California, Zoo; the Aquarium in Honolulu, Hawaii; and the Aquarium in Nassau, Bahamas.

Only one person tested, responded that they had never visited an aquarium/seaquarium.

The majority of people wrote that they would prefer to drive their car or motorhome rather than fly and rent a car.

55% of the people tested noted that they would travel to northern Florida if a new and exciting aquarium were built there. 28% said they would prefer a new aquarium 200-300 miles away for a long weekend of travel. 2% of the people noted they would like a new aquarium within 100 miles, while 15% said they would travel any distance to see such an aquarium.

When asked what they would like to see at an aquarium, 90% of all people checked both locations: southern and northern. 100% surveyed showed they would enjoy seeing porpoise, dolphin, seals, whales, sharks, deep sea fish, huge turtles and eels. Another suggestion by one respondent, mentioned including octopus, live coral and sponge. Most of the pet store owners and employees stated that they would greatly appreciate seeing displays with invertebrates and large displays with cohabitation of many varieties in a reef setting.

Most people were not overly interested in a kennel for their pets; however, the majority of people were interested in a nursery for their small children. The tester was somewhat puzzled by this finding, assuming that most people would want their children to be aware of and visualize the sea's inhabitants.

The suggestion of hotels on the site interested all people in the age groups of 56 and older. Limosine service to an airport generally interested the older age groups. A shuttle bus service from the parking area to the entrance showed a positive response from all people tested except three.

When surveying the pet shop owners and employees, all noted that if they had more room or money they would include at least one extremely large tank for fish and sealife. 200 Gallons was the most common response. For all stores tested, their biggest problem is that of space.

The rarest fish or any type of sealife that the stores have sold included elephant nose, puffers and clown triggers.

When asked which fish/sealife have sold the best in their stores, they noted black tailed baby sharks, mollies, neon tetras, butterflys, angelfish and scavengers such as a mudsucker.

All people surveyed had visited at least one aquarium with the most popular being in California - Marineland and Shedd Aquarium in Chicago.

All shops said that they did not feel that Florida has too many aquariums/seaquariums and that they do help their business. When asked for any personal comments, the tester found that people raising tropical and salt

water fish in their homes is one of the fastest growing hobbies in the United States and World, ranking third.

One pet shop owner noted that because of recent and pending legislation, the day is approaching that aquariums like the Shedd Aquarium in Chicago will be the only place to see fish, even the most common types.

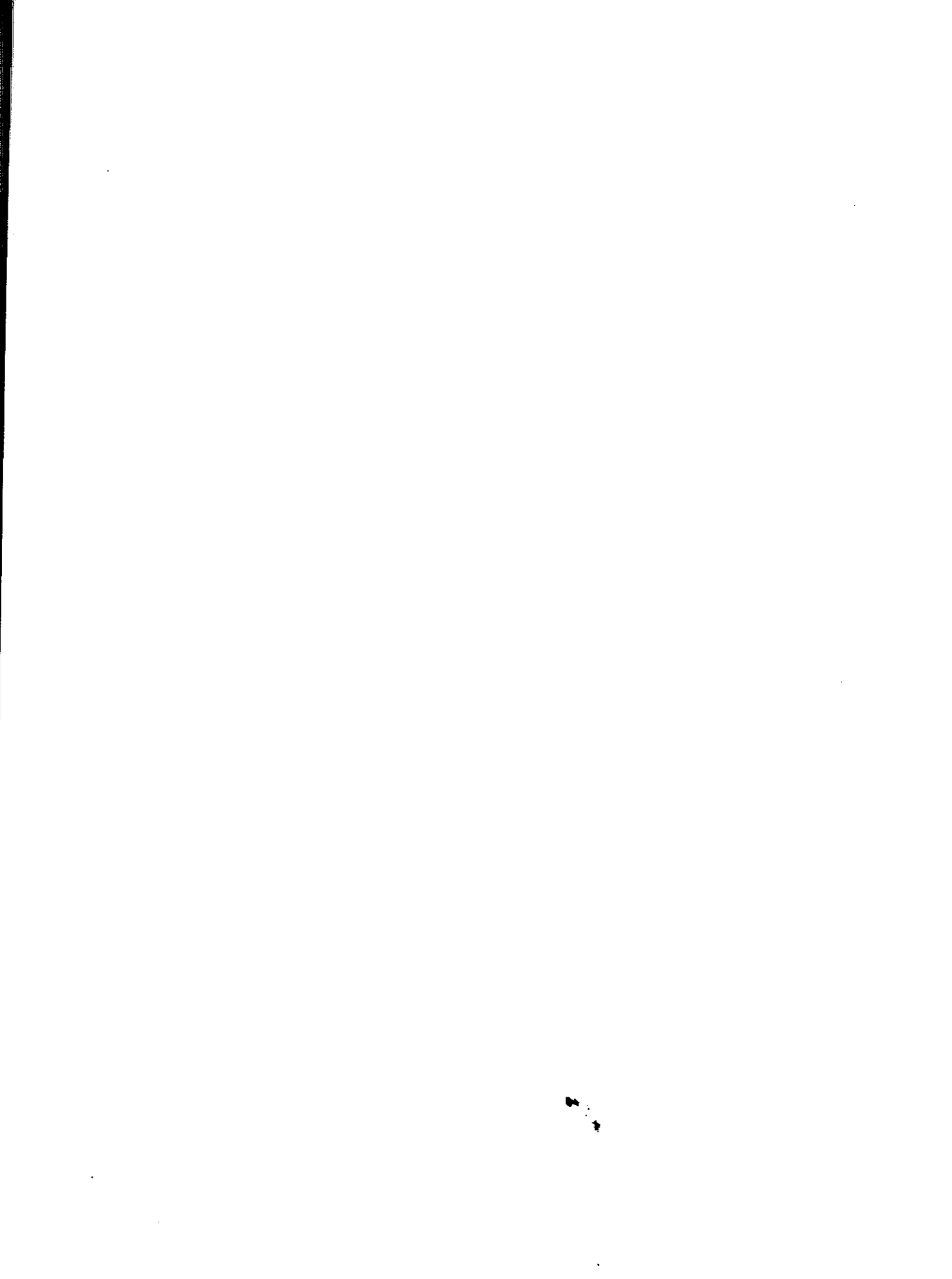
discussion The results of the questionnaire overwhelmingly confirmed the hypotheses stated in the introduction. Almost 100% of all people questioned, stated that they had visited at least one aquarium/seaquarium, would enjoy going to as many as they can in the future or have plans to visit one this summer.

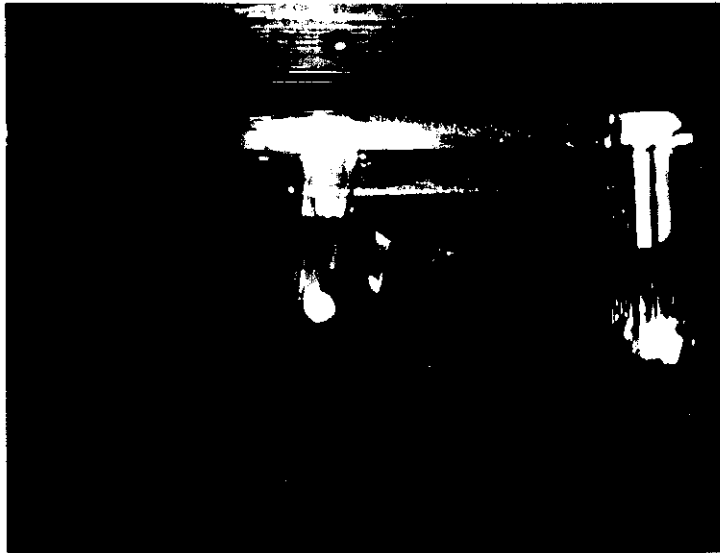
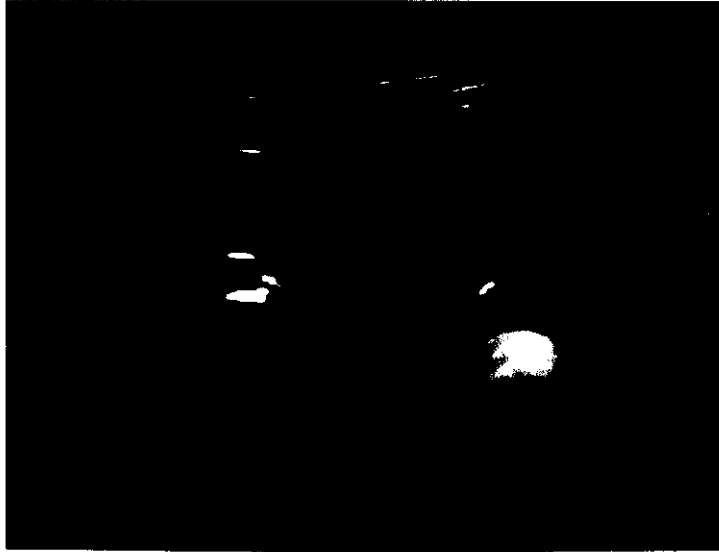
The tester was surprised by the encouragement offered by the results of both questionnaires. The results of these questionnaires will be helpful to the tester when developing the topic for fifth year thesis. The chosen location in Cedar Key, Florida, has been confirmed by the questionnaires in which 55% of the people surveyed chose northern Florida as an excellent site.

The tester is satisfied with the questions asked and the responses. The questions were quite difficult to write. The tester assembled over 20 possible questions for each questionnaire; then narrowed them down trying to write them clearly and to the point for the subject's clarity in understanding each question.

Photographs were originally intended to be included in this report. The tester desired to photo-document the people filling out the questionnaires and the exhibit space allotted to the sealife tanks and exhibits in the pet shops. Due to inadequate lighting and mirrors on the back of tanks producing double images, the attempt became futile. 3 photographs are included to display this fact. (See Appendix, Page 5.)

A P P E N D I X





YOUR OPINION PLEASE?

This survey will be used to gain information for an architectural research class at Ball State U.

1. Have you ever visited a aquarium/seaquarium?
 Yes No (Such as Sea World)
2. If yes, which one(s)?
 - A. Key West Aquarium, Key West, Florida
 - B. Miami Seaquarium, Miami, Florida
 - C. Aquatarium, St. Pete Beach, Florida
 - D. Sea World, Orlando, Florida
 - E. Sea-Arama, Galveston, Texas
 - F. New England Aquarium, Boston, Mass.
 - G. Niagra Falls Aquarium, New York
 - H. Sea World, Aurora, Ohio
 - I. Shedd Aquarium, Chicago, Illinois
 - J. Other _____.
3. Would you like to visit a aquarium/seaquarium?
 Yes No
If yes, which one(s)? _____.
4. If you visited a aquarium/seaquarium, would you?
 - A. Drive your car.
 - B. Fly and rent a car.
5. If a new aquarium/seaquarium is built and is FABULOUS, how far would you drive to see it?
 - A. 100 Miles
 - B. 200-300 Miles
 - C. Northern Florida
 - D. Any distance
6. Which of the following would you like to see at a aquarium/seaquarium? (Check as many as you wish)
 - A. Located in the sunny south- open exhibits
 - B. Located in a northern region-enclosed
 - C. Porpoise, Dolphin and Seal Shows
 - D. Whales and Sharks
 - E. Deep Sea Fish, Huge turtles, eels.
 - F. Kennel for your dog or cat.
 - G. Nursery for your small children
 - H. Hotels on the site
 - I. Limosine service to an airport
 - J. Shuttle Bus to entrance gate from parking
7. Your age group please?
 16-25 26-35 36-45 46-55
 56-65 66-75

FIGURE 1.

YOUR OPINION?

This survey will be used to gain information for an architectural research class at Ball State U.

1. If you had more space or money, what would you add to your store? _____
_____.
2. What is your biggest problem with your store?
_____ Space _____ Other _____
_____ Supplies _____.
3. Do you feel location is an important factor in your store's success?
_____ Yes _____ No
4. What is the rarest fish or any type of sealife you have had in your store? _____
_____.
5. What fish/sealife has sold the best in your store? _____.
6. Have you visited any aquariums/seaquariums around the country?
_____ Yes _____ No
If yes, where? _____
If yes, what impressed you
the most _____
the least _____.
7. Do you feel that Florida has too many aquariums?
_____ Yes _____ No
8. What would you include in a seaquarium besides fish, sharks, whales, porpoise, dolphin, seals, manatee, dugong, turtles, eels, sea horse? _____
_____.
9. Do you feel that aquariums/seaquariums help your business?
_____ Yes _____ No
10. Anything extra you would like to say, please do!

_____.

FIGURE 2.

YOUR OPINION PLEASE?

This survey will be used to gain information for an architectural research class at Ball State U.

1. Have you ever visited a aquarium/seaquarium?
 Yes No (Such as Sea World)
2. If yes, which one(s)?
 A. Key West Aquarium, Key West, Florida
 B. Miami Seaquarium, Miami, Florida
 C. Aquatarium, St. Pete Beach, Florida
 D. Sea World, Orlando, Florida
 E. Sea-Arama, Galveston, Texas
 F. New England Aquarium, Boston, Mass.
 G. Niagra Falls Aquarium, New York
 H. Sea World, Aurora, Ohio
 I. Shedd Aquarium, Chicago, Illinois
 J. Other _____
3. Would you like to visit a aquarium/seaquarium?
 Yes No
If yes, which one(s)? _____
4. If you visited a aquarium/seaquarium, would you?
 A. Drive your car.
 B. Fly and rent a car.
5. If a new aquarium/seaquarium is built and is FABULOUS, how far would you drive to see it?
 A. 100 Miles
 B. 200-300 Miles
 C. Northern Florida
 D. Any distance
6. Which of the following would you like to see at a aquarium/seaquarium? (Check as many as you wish)
 A. Located in the sunny south- open exhibits
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 C. Porpoise, Dolphin and Seal Shows
 D. Whales and Sharks
 E. Deep Sea Fish, Huge turtles, eels.
 F. Kennel for your dog or cat.
 G. Nursery for your small children
 H. Hotels on the site
 I. Limosine service to an airport
 J. Shuttle Bus to entrance gate from parking
7. Your age group please?
 16-25 26-35 36-45 46-55
 56-65 66-75

YOUR OPINION?

This survey will be used to gain information for an architectural research class at Ball State U.

1. If you had more space or money, what would you add to your store? more tanks
2. What is your biggest problem with your store?
 Space Other _____
 Supplies _____
3. Do you feel location is an important factor in your store's success?
 Yes No
4. What is the rarest fish or any type of sealife you have had in your store? Clown trigger
5. What fish/sealife has sold the best in your store? Butterfly's
6. Have you visited any aquariums/seaquariums around the country?
 Yes No
If yes, where? Shed's
If yes, what impressed you the most fish
the least _____
7. Do you feel that Florida has too many aquariums?
 Yes No
8. What would you include in a seaquarium besides fish, sharks, whales, porpoise, dolphin, seals, manatee, dugong, turtles, eels, sea horse?
SEA COW'S
9. Do you feel that aquariums/seaquariums help your business?
 Yes No
10. Anything extra you would like to say, please do!

4 END OF QUARTER

NOV. 9th & 10th
JURIES

104 A

- TARGET - 1 SCHEMATIC DESIGN
- 1. DIAGRAMS - ZONING OF THE BUILDINGS (ACCURATE)
- 2. DIAGRAM - PRIMARY CIRCULATION ENTRY & ACCESS - SERVICE ENTRY
- 3. PLANS - NO BOBBLE DIAGRAMS MARKER DWG.
 - A. CIRCULATION SYSTEM
 - B. SOME INDICATION OF CIRCULATION
 - C. SOME INDICATION OF STRUCT.
 - D. PLANS PORTRAY ACCURATE SPATIAL DEFINITION WHERE WALLS & NOT WALLS SKYLIGHTS, BALCONIES
 - E. SECTIONS - MARKER AT LEAST (2) - THRU SITE & BLDG. & ADJACENT AREA
 - F. MASS MODEL w/ PRIMARY OPENINGS - WHERE DOES FORM BREAK
 - G. 1-pt. perspective sketch portray character of what you're trying to do DO INTERIOR PERSPECTIVE
 - H. PRESENT REVIEW & HISTORY - LAST CRITIC'S WHAT HAPPENED SINCE

Thurs.

DEPARTMENT OF ARCHITECTURE
COLLEGE OF ARCHITECTURE AND PLANNING
BALL STATE UNIVERSITY
MUNCIE, INDIANA

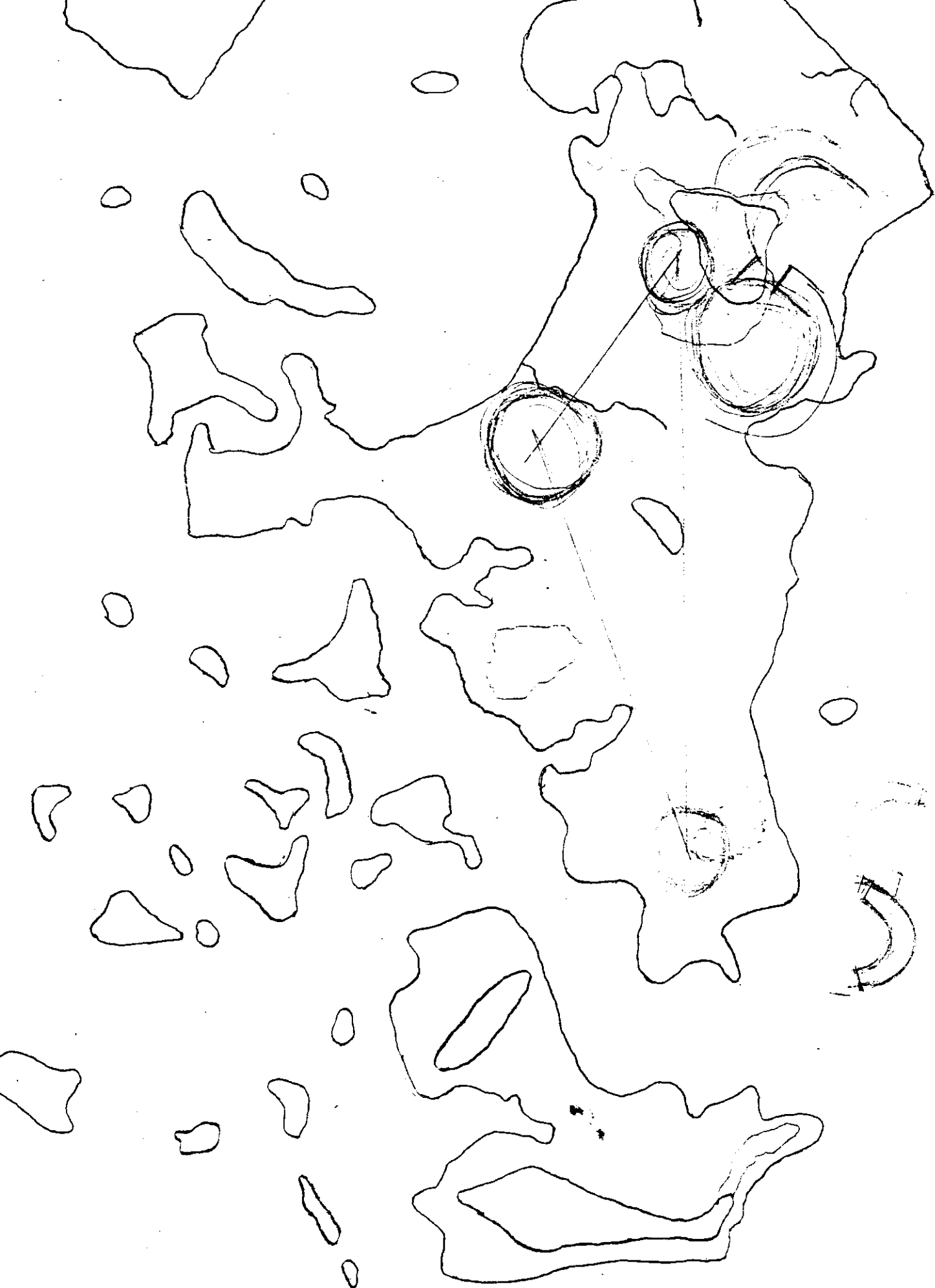
Presentation Requirements and Due Dates

ARCH 405 - Winter Quarter
Fifth Year Thesis Design

1st Week	Individual crits for reassessment and evaluation and begin study model for design development
2nd Week	Individual crits
3rd Week	Individual crits - structural and mechanical systems should be developed by now
4th Week	Individual crits - indication of all major materials should have been made by now Preholiday studio review
5th Week	Individual crits
6th Week	Mid-term review - with all documents and models presented in "hard line" form that will be required at the final presentation during the 10th week. This is a very <u>critical</u> design development week to make any changes or additions to your designs Individual crits
7th Week	Final design development presentation should begin now Individual crits
8th Week	Individual crits
9th Week	Final design development juries, location to be announced
10th Week	Final exam

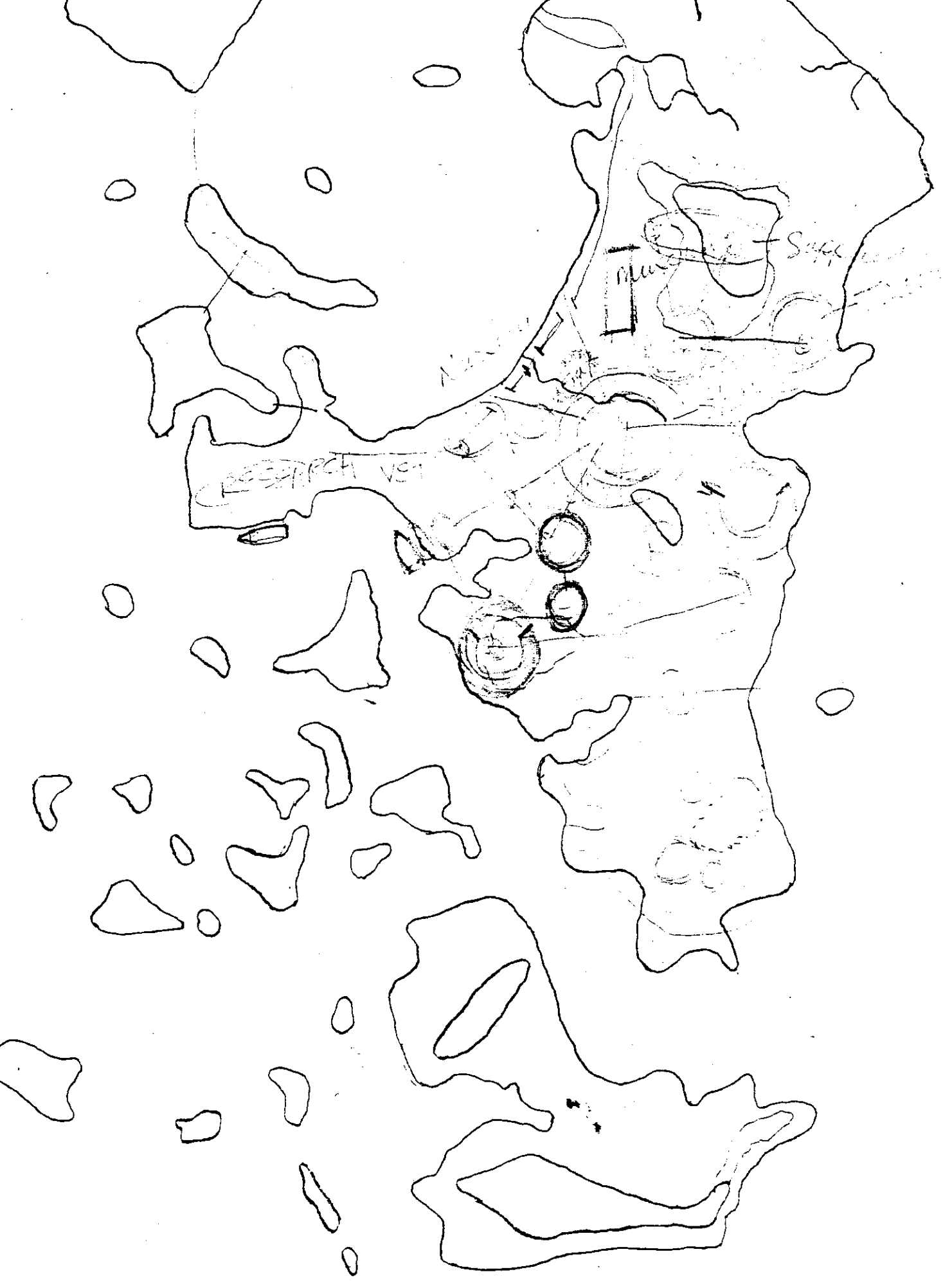
Mid-quarter reviews including study model, plans, sections and elevations should clearly illustrate the following aspects of your project:

1. Site response and development (natural or exploited? contrast or camouflage? etc.)
2. Programmatic response (building type, public vs. private, served vs. service, etc.)





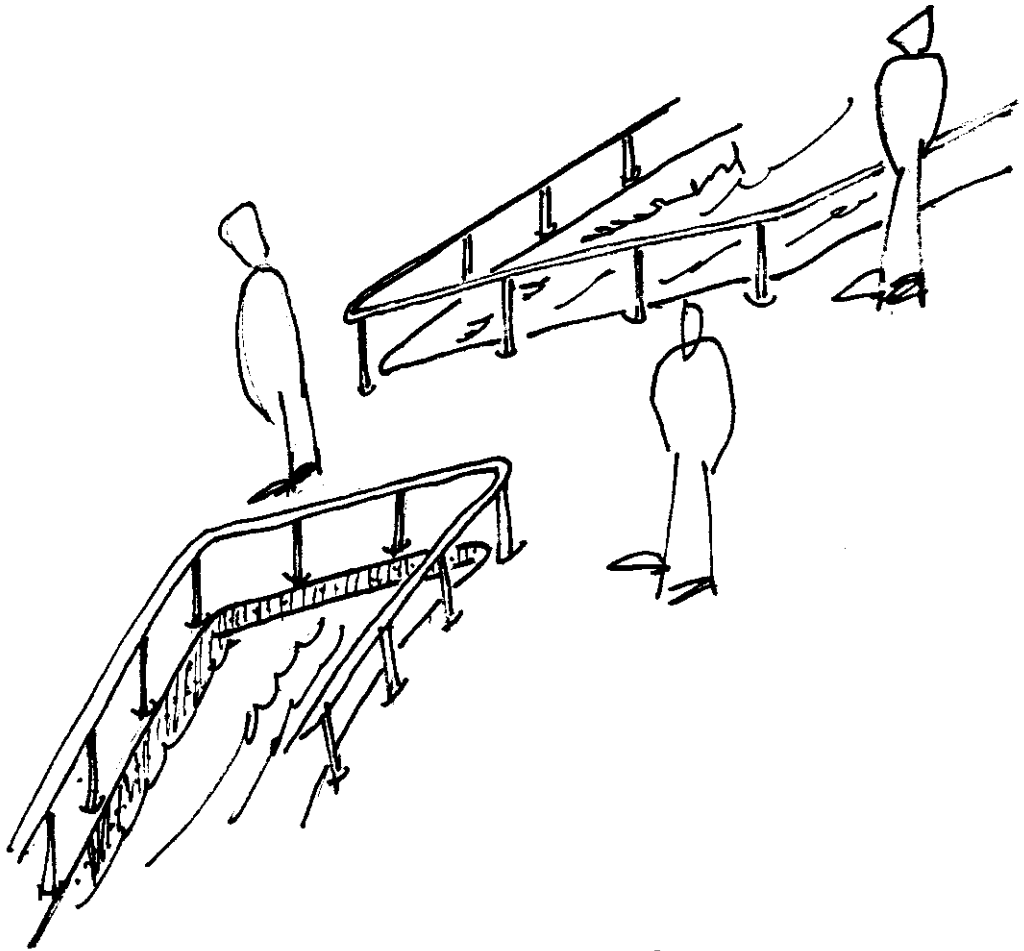
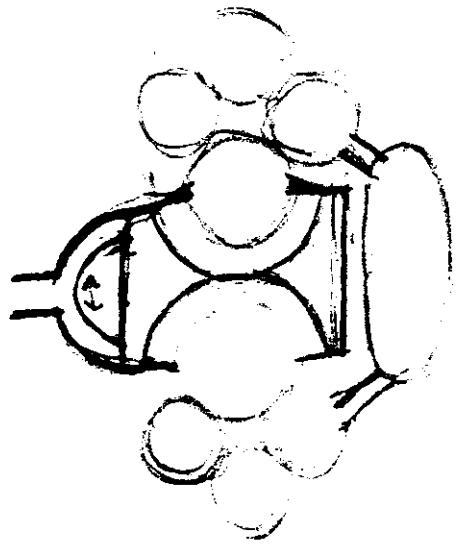












1 PT. PERSPECTIVE - FREE HAND

HOW BLDG WORKS - WHAT IT IS LIKE

2 P. 144 PROCESS - DIAGRAMS
REQ, STRUCT,
(CIRCULATION)

DEVKRE TO ORDER BLDG.

"DOMINANT OR SUBSERVARIANT ROLES

" ISSUES OR FORMS

STRUCTURAL SYSTEM!

3 PRINCIPLES I.E. SQUARE

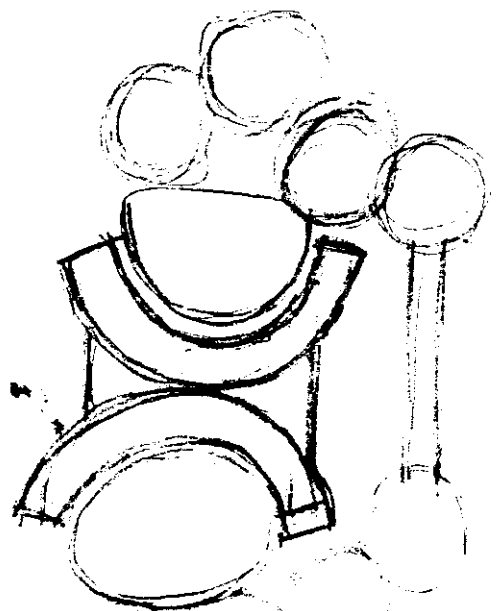
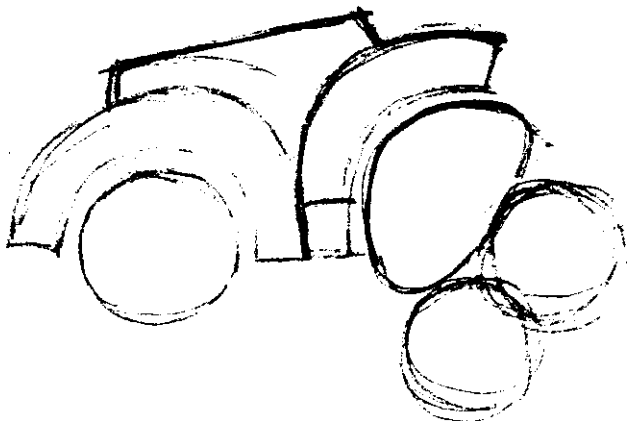
4 SCALE @ HUMAN LEVEL - ENTRY

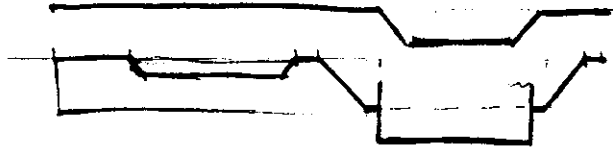
5 DESIGN DEV. STUDY MODELS

PARTS OF BLDGS.

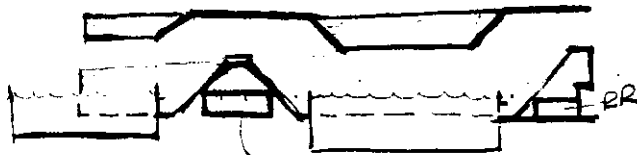
PRIMARY SPACES

SUNSHINE ROLL ON PERSPECTIVE



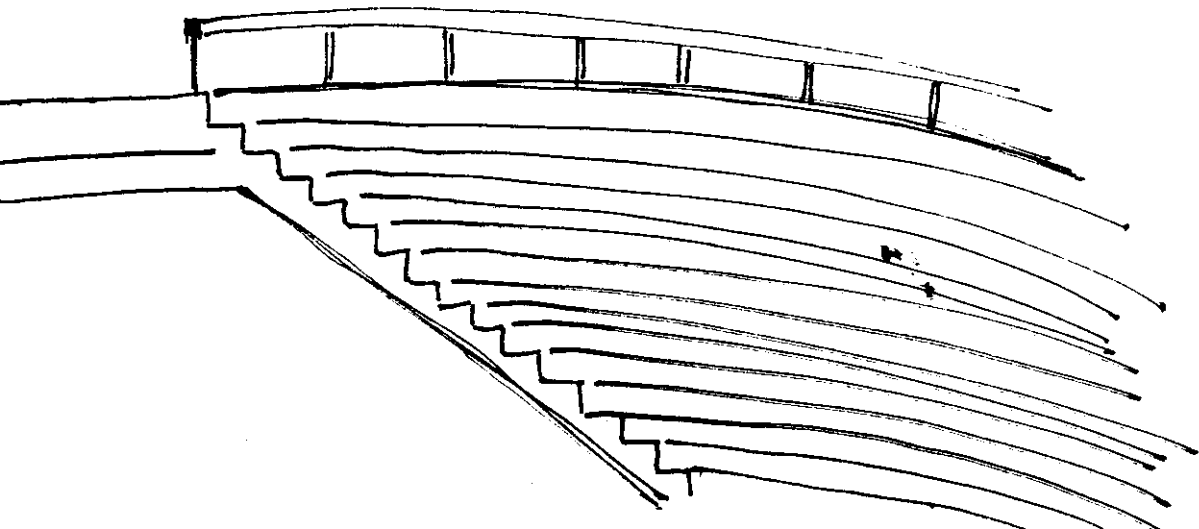


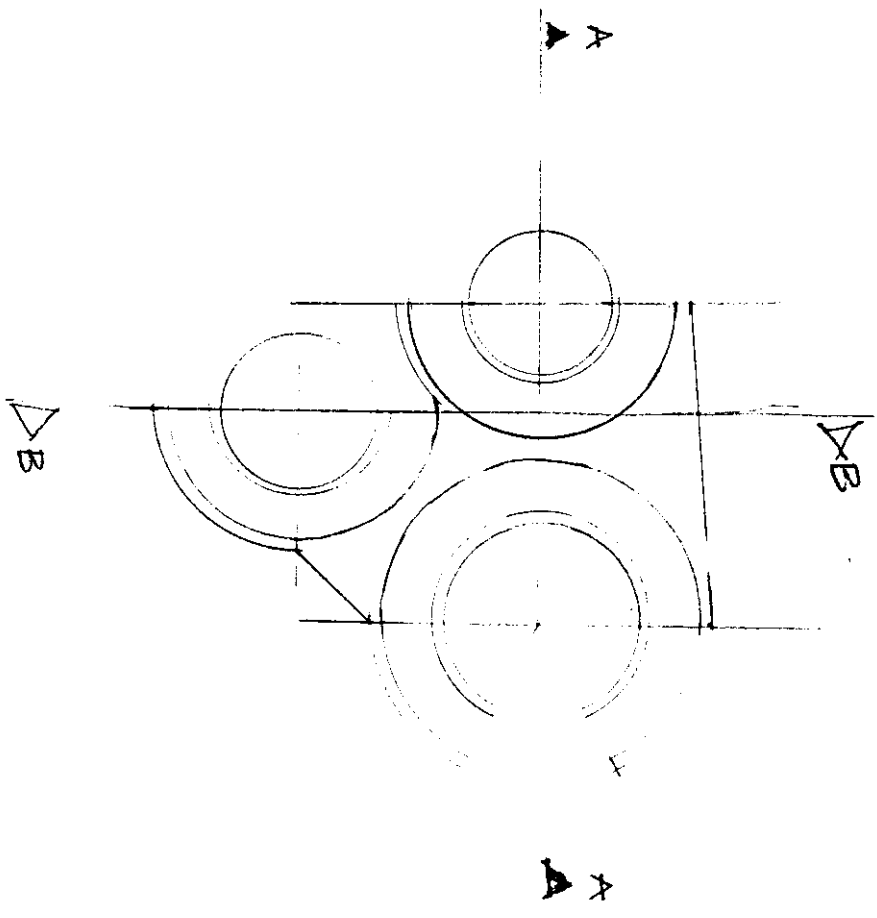
B - B



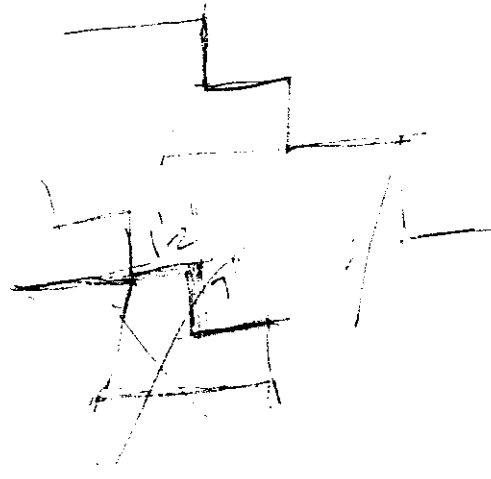
WATER
EMISSIONS

A - A

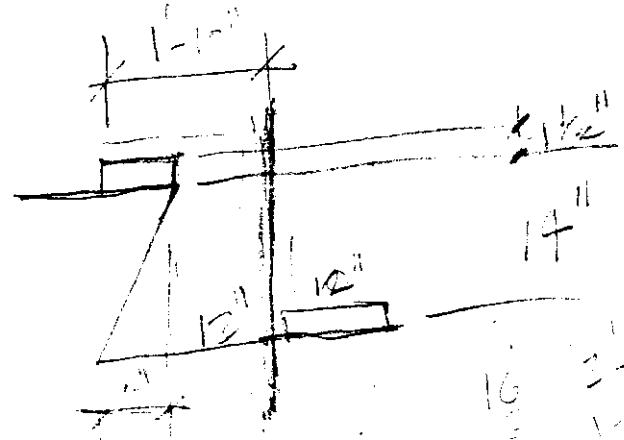
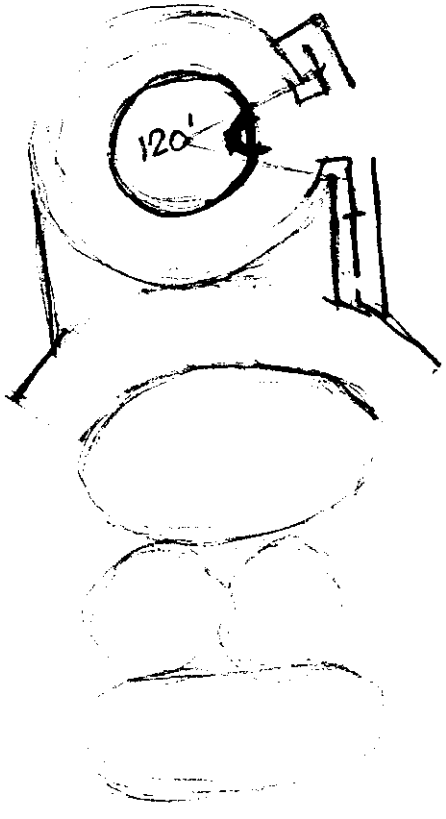




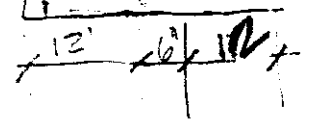
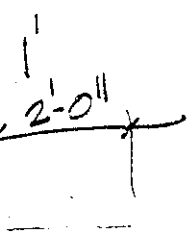
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12' 1/2
10' 1/2

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suggesting fish roe, composing them (*see* OÖLITE). also available on tropical coasts in the form of coral-coral-like origin, and of coquina if composed of shell

quantity used as building stone is sandstone. It ranges in color from white through buff, red and dark brown. Its grains are cemented with silica, calcium carbonate or iron oxide. The porosity of certain sandstones makes them subject to weathering and spalling. As coarseness increases sandstone becomes more friable and finally conglomerate (cemented gravel). Sandstone is widely quarried for building, especially in western North America (Ohio, New York, Wisconsin, Pennsylvania, New Jersey). Unlike limestone, it serves little use except in glass and refractories.

Granite in quantity used is granite (*q.v.*), a term inaccurately applied to most light-colored, coarsely crystalline igneous rocks. Granite is highly useful for crushed stone and for monuments and decoration. Its great variety of colors—from white through gray, pink, greenish and black—and of coarseness of grain make it much in demand. Productive localities include especially the Scandinavian countries, Canada and New England.

Dark-colored igneous rocks (gabbro, andesite, basalt, etc.) are collectively sold as trap and used chiefly in crushed aggregate. Typical localities of production are in the western United States and Washington, Oregon and western Scotland, and Washington, Oregon and New Jersey in the United States.

Marble is a recrystallized and commonly beautifully banded metamorphic rock. Its original layers may be greatly contorted, or shatter-cemented, resulting in strikingly contrasting colors. Its chief use is for decoration—mainly indoors—and for sculpture. Famous sources are Italy, Greece, Egypt and Tennessee.

Greenstone is a gray to red, green, mottled or black stone marked by irregularly bedded and splitting cleavage planes. It is used chiefly for blackboards, switchboards and partitions, but also as a building stone. Outstanding producing regions are Wales, France, Switzerland, Belgium, and the eastern United States (Virginia, New York, Vermont and Maine). Similar foliated rocks with wavy cleavage, called schists, are locally used.

Opal and related types veined with white calcite (opal-antique) are massive and greenish, generally ranging in color from light chartreuse to olive. They are used for counters and jewelry. Although widespread, large deposits are rare. Travertine, a calcium carbonate deposit, usually porous, and onyx, generally a precipitated deposit, are other decorative stones. See separate articles on varieties of stone, as GRANITE; MARBLE; SLATE, etc.; and references under "Stone" in the

MINERALOGY.—Oliver Bowles, *The Stone Industries* (1934), general mineralogy, economics; American Institute of Mining, Metallurgical and Petroleum Engineers, Committee on industrial minerals *Industrial Minerals and Rocks*, 3rd ed. (1960), sections dealing with materials, crushed stone, dimension stone, granules, sand and gravel, slate; G. P. Merrill, *Stones for Building and Decoration* (1907), thorough but somewhat outmoded treatment; J. Hirschwald, *der Bautechnischen Gesteinspruefung* (1921), numerous technical tests; U.S. Bureau of Mines, *Minerals Yearbook* (annual publication, trade, uses, and technology). (C. H. BE.)

STONE AGE: *see* FLINT AND OTHER STONE TOOLS; ARCHAEOLOGICAL HISTORY; PALEOLITHIC; MESOLITHIC; NEOLITHIC.

STONE CARVING: *see* SCULPTURE; SCULPTURE TECHNIQUE.

STONEHENGE, a circular setting of large standing stones arranged by an earthwork about 8 mi. (13 km.) N of Salisbury, Wiltshire, Eng., was built during Late Neolithic to Early Bronze Age (c. 2500–1400 B.C.). Among the earliest references to it is that of Geoffrey of Monmouth, who related in *Historia regum Britanniae* (c. 1136) the legend that the stones were magically transported from Ireland by Merlin (*q.v.*). This legend perhaps entered the folk memory of the bringing from Pembrokeshire of the stones which form part of the monument. The supposed connection of Stonehenge with the Druids, which, though without scientific basis, has held the public imagination since the 17th century,

originated with John Aubrey (1626–97), and was more particularly elaborated by William Stukeley in 1740 (*see* DRUIDISM). The modern interpretation of the monument is based chiefly on excavations carried out by the Society of Antiquaries of London from 1919.

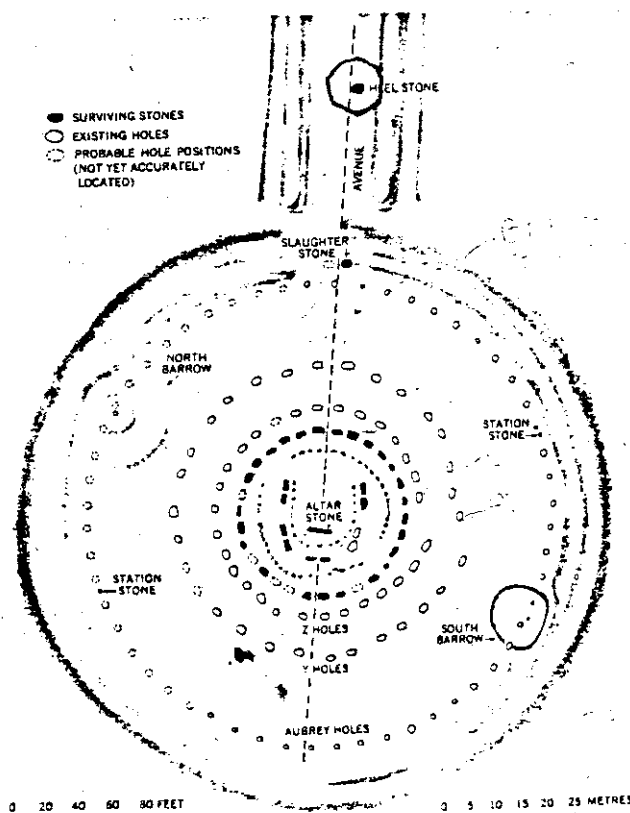
The monument consists of a number of structural elements, mostly circular in plan. On the outside is a circular ditch, broken by an entrance gap on the northeast, with a bank immediately within it.

Inside the bank is a ring of 56 pits, known after their discoverer as the Aubrey holes. Between these and the stones in the center are two further rings of pits, now invisible on the surface, known as the Z and Y holes. The stone setting consisted of two circles (the outer of sarsen [Tertiary sandstone], the inner of bluestone) and two horseshoes of uprights (the outer of sarsen, the inner of bluestone), the outer circle and the outer horseshoe being capped by stone lintels. Additional stones include the Altar stone, lying on the axis southwest of the center; the Slaughter stone inside the entrance of the earthwork; two Station stones just within the bank on the northwest and southeast; and the Heel ("Hele") stone, standing on the Avenue outside the entrance and surrounded by a narrow circular ditch.

Similar ditches enclose two flat areas on the inner edge of the bank, known as the North and South barrows, with empty stone-holes at their centers.

Excavations between 1950 and 1964 suggested three main periods of building (Stonehenge I, II and III), the last of which can be divided into three phases (Stonehenge IIIa, IIIb, and IIIc).

Stonehenge I (built in the Late Neolithic about 1800 B.C.) comprised the circular ditch and bank, the Aubrey holes, and the Heel stone. There may have been some structure of stone or timber at the center of the circle, but little or nothing of it is likely to have survived disturbance by treasure hunters. The bank, now reduced by weathering to a height nowhere more than 2 ft., has a mean diameter of 320 ft. (98 m.), and was broken by an entrance gap 35 ft. (10.7 m.) wide on the northeast side. It



ADAPTED, BY PERMISSION, FROM MINISTRY OF PUBLIC BUILDING AND WORKS PLAN
STONEHENGE PLAN SHOWING STONES, EXCAVATED STRUCTURES, AND THE
SOLSTITIAL ALIGNMENT OF THE AXIS OF SYMMETRY

alk rubble quarried from the surrounding ditch. Regular in plan and depth, and consists of a series of pits up to 7 ft. (2.1 m.) deep, with steep sides. The pits form a circle 288 ft. in diameter (87.8 m.). The pits are up to 6 ft. (1.8 m.) in diameter and 4 ft. deep, with steep sides and flat bottoms. They appear to have been deliberately filled soon after their excavation. Many of them contain cremated human bones, inserted later as secondary deposits, though still in the phase of the monument's history. Similar cremations form a cemetery of about 30 burials in the eastern part of the monument and the silting of the ditch.

One of the 35-ton blocks of sarsen 16 ft. (4.9 m.) high, which formed the entrance of the earthwork, but not on its axis. West of it, astride this axis, four large postholes mark the site of a former timber gateway. A pair of stones, which appears to have stood centrally in the gap in the ditch, are the present position of the Slaughter stone.

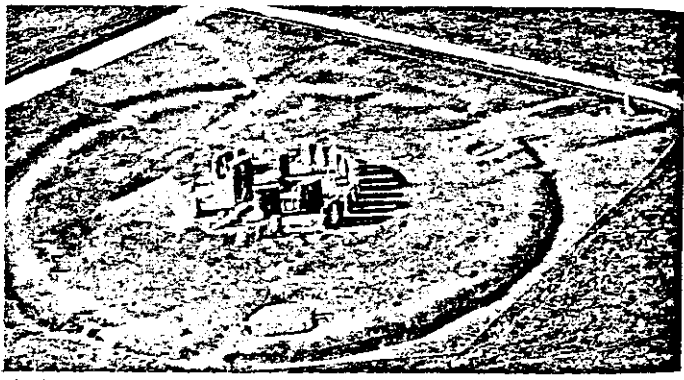
In phase II (probably 17th century B.C.) the entrance was widened on the east side, and was joined to the ditch (about 2 mi. [3.2 km.] to the east) by the traditional way marked by parallel banks and ditches. The Heel stone, which was now symbolically propping, and immediate refilling, of the ditch that at the same time a number of natural slabs and rocks (diabase, rhyolite, and volcanic ash) called the Prescelly Mountains in southwest Wales, and erected in the centre of the concentric circles about 74 ft. and 86 ft. (22.6 m. diameter). Each radial pair of these stones stood on an elongated stone-hole straddling the line later the bluestone circle (erected in period IIIc). The earliest setting of bluestones was marked by additional pairs, and was aligned approximately upon the summer solstice, the alignment being continued by Avenue nearest Stonehenge. The double circle was then designed to contain about 40 pairs of stones, completed and was dismantled in the next phase. It has been shown that at least a quarter of its circle west side was still unfinished when the stones were dismantled. The work of this period is attributed to the Beaker people of the Late Neolithic: *Archaeology: Middle and Late Neolithic*. In phase IIIa (soon after 1600 B.C.) the monument was transported about 20 mi. (32 km.) to the north and the circle of 30 uprights capped by a continuous ring enclosing a horseshoe of five trilithons, each of uprights supporting a lintel. The four Station stones (which have vanished), and the Slaughter stone and companion, also of sarsen, appear to belong to this

structure is unique among the megalithic monuments. Its stones are of exceptional size, up to 30 ft. and 50 tons in weight. Their visible surfaces have been dressed smooth by pounding with stone hammers; and was used to form the mortise-and-tenon joints which are held on their uprights, and the tongue-and-groove by which the lintels of the circle fit together. The stones have been carefully shaped to a trapezoidal

European megalithic architecture, these refinements are supported by carvings of Bronze Age weapons and on four of the sarsen stones. Most of these representations of Early Bronze Age axesheads of a type known between 1600 and 1400 B.C.; but there is also a hilted dagger that can best be matched in the shaft graves of Mycenae. This identifica-

tion (though a matter of opinion) is supported by the presence of objects of Mediterranean origin in many of the rich barrow burials of the Early Bronze Age that cluster densely around Stonehenge. On this evidence the building of the sarsen structure may be assigned to the earlier half of the 16th century B.C., broadly confirmed by a radiocarbon estimate giving a probable range of 2000 to 1400 B.C. (see RADIOCARBON DATING).

In Stonehenge IIIb, which probably followed immediately after phase II, about 20 bluestones were selected from the dismantled components of Stonehenge II and dressed to shape with stone hammers. These were erected in an oval setting, largely coincident with the line of the present inner horseshoe of bluestones. This arrangement contained at least two bluestone trilithons with mortise-and-tenon



AERIAL VIEW OF STONEHENGE. SEEN FROM THE SOUTH: HEEL STONE AT RIGHT CORNER

joints, and a pair of contiguous pillars joined by a vertical tongue-and-groove. It seems to have been the intention to erect the remaining bluestones in the two circles of Y and Z holes, which are roughly concentric with the sarsen circle; but this plan clearly was never carried out. The holes on the southeast side were never completed; both circles were left open to silt up over the succeeding centuries.

The abandonment of this plan marks the end of phase IIIb and was probably followed at once by the final period of building (Stonehenge IIIc) likely to have been completed before the end of the Early Bronze Age about 1400 B.C. The phase IIIb oval structure of dressed and jointed bluestones in the centre was dismantled; and its bluestones, as well as those lying on or near the site since the dismantling of the phase II circles during phase IIIa, were rearranged into the bluestone circle and horseshoe whose remains can be seen today. Most of the components of the dismantled oval were reused as uprights in the final horseshoe, perhaps after some reshaping to give a sequence of straight-sided square pillars alternating with flatter, tapering obelisks. The Altar stone (of micaceous sandstone from the shores of Milford Haven in Pembrokeshire) apparently stood as a pillar at the focal point of the horseshoe, subsequently falling to cover its own stone-hole.

It is generally and probably rightly assumed that Stonehenge was constructed as a place of worship; but in the absence of contemporary documentary evidence the nature of the religion it served must remain conjectural. The solstitial alignment of the axis of symmetry of the sarsen structure (Stonehenge IIIa) has long been recognized, and is now known to have perpetuated a similar alignment in the earlier double circle of bluestones (Stonehenge II). In 1963 the existence of additional alignments of significant risings and settings of the sun and moon was suggested independently by C. A. Newham in England and by G. S. Hawkins in the U.S. These suggestions undoubtedly reinforce the popular belief that Stonehenge was a temple for sky worship, but should be considered with caution since most Christian churches are likewise astronomically orientated.

Hawkins also suggested that the circle of 56 Aubrey holes could have been used as a counting device for predicting significant risings of the moon, and eclipses of the moon and sun. The possibility cannot be denied, but its likelihood is open to question if only because the Aubrey holes (refilled very soon after they

were opened) would have been covered over several centuries. This represents a culture far more advanced than that of the later Stone Age. Between 1918 (when the monument was restored) and 1964 more stones were restored or straightened, including stones that fell from the monument. See also AMESBURY; RADIOCARBON DATING.

BIBLIOGRAPHY.—R. J. C. Atkinson, *Archaeology of the Stonehenge* (1964); G. S. Hawkins, *Stonehenge: a New*

STONY POINT, a town in the scenic highlands of New Jersey, about 38 mi. (61 km) from New York City. Stony Point derives its name from a point of land on the Hudson. A part of Paul Kean's estate. At the town's center is the heavy chain stretched across the river during the Revolution to prevent British ships from sailing while at the southern shore. The house where General Mifflin's army met on Sept. 21, 1780, was destroyed. Stony Point to the British. A successful and daring attack on Stony Point by General Mifflin's hand-picked American forces killed and 83 wounded and captured 543 British. As the fort was in ruins, however, it was surrendered to the British thereupon. The British thereupon destroyed it late in Oct. 1781. Stony Point was a safe for the Americans.

Major products include iron, steel, and machinery. Stony Point is governed by a mayor and two justices of the peace. For comparative population, see POPULATION.

STOPES, MARIE, a pioneer of the birth control movement in Scotland, on Oct. 15, 1880. She was a student at the University of Edinburgh and at the University of Manchester. Her work on problems of coal mining and her academic reputation were both annulled in 1916, following her work on birth control as a means to save women from the ravages of venereal disease. In 1918, she helped her husband, Dr. Humphrey Verdon Roe, in his work on birth control. In 1918, she had many editions of her book *Contraception: Its History and Practice*. In 1921 it was the most widely read book on birth control. The fervour of Marie Stopes' work on birth control, especially her work on birth control, as reflected in her conferences. After her work on birth control in Far Eastern countries, she died on Oct. 2, 1958. See K. Briant, *Passion and Power*. **STORACE, ST**, introduced the class

would have been ill-adapted as permanent markers for centuries. They also belong to the first Stonehenge, a culture and technology markedly more primitive than the later stages of construction.

In 1883 (when the monument was presented to the British people) more than half the surviving sarsen pillars were whitened, and consolidated in concrete foundations, and those that fell accidentally in 1797, 1900, and 1963. **WILTSHIRE; WILTSHIRE.**

—R. J. C. Atkinson, *Stonehenge*, 2nd ed. (1960, with principal publications to 1959); S. Piggott, article on Stonehenge in *The New Scientist* (July 30, 1959); C. A. Newham, *Yorkshire Post* (March 16, 1963), *The Enigma of Stonehenge*; G. S. Hawkins, "Stonehenge Decoded," *Nature* (Oct. 26, 1964); "Stonehenge: a Neolithic Computer," *Nature* (June 27, 1964). (R. J. C. A.)

POINT, a town of Rockland County, N.Y., U.S., lies on the highlands along the west shore of the Hudson River about 61 mi. (61 km.) from midtown New York City. Stony Point gets its name from the rocky promontory jutting into the water at Palisades Interstate Park lies within the town. The town's northern point was anchored one end of a dike stretched across the Hudson during the American Revolution to prevent the British fleet from ascending further, and the southern limits stood the Treason (Joshua Hett Rensselaer where Gen. Benedict Arnold and Maj. John André met on Sept. 21, 1780, to arrange for Arnold's betrayal of West Point to the British. At midnight on July 16, 1779, occurred the daring storming of the strong British fortifications by the army led by Gen. Anthony Wayne and about 1,350 gallant American troops. Wayne's feat, with a loss of 15 men killed and 54 wounded as against 63 British killed and 70 wounded, and the loss of 543 of the garrison, was a severe setback to the British. The fort was undefendable against river bombardment, and it was speedily dismantled and evacuated on July 17, 1779, whereupon it was reoccupied a second time but abandoned in Oct. 1779, and the upper Hudson was thereafter controlled by the Americans.

Products include chemicals, traprock, and gypsum. The town is governed by a town board consisting of a superintendent, two justices of the peace, and two councilmen.

Statistical population figures see table in NEW YORK: (M. D. H.)

MARIE CARMICHAEL (1880-1958), British birth control movement, was born in Edinburgh, Scotland, on Oct. 15, 1880. She graduated in botany and geology at University College, London, in 1903, obtained a doctorate in botany at the University of Munich in 1904, and became a lecturer in botany at the University. A specialist on fossil plants and coal mining, she had established a considerable reputation when the failure of her first marriage, which ended in 1916, focused her thought on problems of marriage, and she turned to birth control as an aid to marriage fulfillment and as a way to free women from the burdens of excessive childbearing.

Verdon Roe, the aircraft pioneer, whom she married in 1917, helped her in the crusade which she now began. Her *Love and Wise Parenthood*, both of which appeared in many editions and translations. In 1921 Marie Stopes opened the United Kingdom's first birth control clinic. When her book *Reasons: Its Theory, History and Practice* appeared in 1924, it was the most comprehensive work of its kind.

Four of Marie Stopes's writings and speeches evoked opposition, especially from Roman Catholics, which gave publicity to her movement and to herself. She did most to lay the foundation for the Church of England's change of stand on birth control, as reflected in the reports of successive Lambeth Conferences. After World War II she worked to promote birth control in Far Eastern countries, and continued her interest in birth control. She died at Norbury Park, near Dorking, Surrey, on Oct. 10, 1958. See also BIRTH CONTROL.

CE, STEPHEN (1762-1796), English composer who introduced the classical Italianate style of Vienna into English

opera, was born in London on April 4, 1762. The son of an Italian double-bass player resident in Britain and of an English mother, he was trained at the S. Onofrio conservatory in Naples. From 1785 he periodically joined his sister, the singer Ann Selina (Nancy) Storace (1765-1817) in Vienna and took lessons there from Mozart. His first two operas, *Gli sposi malcontenti* (1785) and *Gli equivoci* (1786), were given in Vienna and later in Leipzig, Dresden, and other cities in Germany. The latter, the score of which survives, has an excellent libretto by Lorenzo da Ponte, based on Shakespeare's *The Comedy of Errors*.

In 1786 Nancy Storace created the part of Susanna in Mozart's *Nozze di Figaro*, and the family then returned to London, where Stephen spent the rest of his short life writing English operas for Drury Lane, in which his sister sang the lead. His masterpiece, *The Pirates* (1792), on a Neapolitan plot by James Cobb, is Mozartean in scale and sometimes in style. Of his other full-length operas the most successful was *The Haunted Tower* (1789), with a "Gothic" plot that anticipated the novels of Mrs. Radcliffe. *Dido, Queen of Carthage* (1792) was written in emulation of T. A. Arne's *Artaxerxes*. All Storace's other English operas have spoken dialogue. Of his afterpieces the most successful was *No Song, No Supper* (1790, reprinted, *Musica Britannica*, vol. xvi, 1959, edited by R. Fiske). Storace also published two early examples of the piano quintet, three Mozartean piano trios, and some songs. His anthology, *Storace's Collection of Original Harpsichord Music* (1787-89), includes many works he brought back from Vienna, and he was the first to publish Mozart's piano trio in G (K. 564). Storace's sound training and unrivaled knowledge of the continental repertory gave his music a style and professionalism lacking in that of his English contemporaries. He died in London on March 19, 1796.

See R. Fiske, "Stephen Storace," in *Proceedings of the Royal Musical Association*, 86th session (1959-60). (R. E. F.)

STORAGE BATTERY: see BATTERY.

STORK, a large, long-legged, long-necked, large-billed bird related to the heron and ibis and placed with them in the order Ciconiiformes. The 17 species of true storks, which constitute the family Ciconiidae, include the white stork of popular fable, a bird that brings good luck and little babies.

In storks the voice box, or syrinx, is poorly developed, but many species are able to emit low grunts and hisses; they also clatter their bills. They fly with much soaring, the neck and legs being stretched to their limits. Storks feed during the day, mainly on small aquatic animals caught in marshes; some, like the marabou stork of Africa and the adjutant bird of India, feed primarily on carrion. Storks are found in flocks except during the breeding season when they pair off. The nest, a large twig platform built by both sexes, is constructed in trees, on rock ledges, or, in the case of the white stork, on rooftops and chimneys, often in colonial groupings. Three to six chalky white eggs are incubated by both parents for a month or more; the down-clad young birds are cared for in the nest.

The white stork (*Ciconia ciconia*) breeds across Europe and Asia and winters south to the Cape of Good Hope. It is a stately bird, three to four feet long, with black flight feathers, a dark red bill, and reddish legs. To attract these harbingers of good fortune, the townspeople often put up ready-made platforms on their rooftops. The black stork (*C. nigra*), about the size of its congener and with red bill and legs, is black except for a white belly patch. It is more wary of man and nests in marshes and forest. Like the white stork, its population is decreasing, partly due to continuing destruction of its habitat by man.

The adjutant bird (*Leptoptilus dubius*) is distinguished by its dull plumage, black scabrous head, and enormous breast pouch; the last is of doubtful function, connected with the respiratory system. The bird is about 5 ft. tall. Related species are the lesser adjutant (*L. javanicus*), of southeast Asia, and the African adjutant, or marabou stork (*L. crumeniferus*). The original marabou feathers of commerce were the undertail coverts of the latter bird, but the name has come to be applied to large downy feathers of other birds as well.

The jabiru (*Jabiru mycteria*), an American stork found from