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PROPOSED EXPANSION OF MORRILL
HALL PARKING AREA AT
MICHIGAN STATE COLLEGE

Thesis for the Degree of B. S.
MICHIGAN STATE COLLEGE

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1949

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Proposed Expansion of Morrill Hall Parking
Area at Michigan State College

A Thesis Submitted to

The Faculty of
MICHIGAN STATE COLLEGE

of
AGRICULTURE AND APPLIED SCIENCE

by

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Candidates for the Degree of

Bachelor of Science

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FOREWORD

The purpose of the Senior Problem or thesis required of all Civil Engineering seniors is the application of knowledge gained in undergraduate courses. Hence, the problem which was most closely related to the greatest number of fields was chosen. Besides furnishing the writers with valuable experience in topographical surveying, drainage, soils, concrete, design and other related fields, it is hoped that this plan for the expansion of off-street parking facilities in the Morrill Hall area may be of some value to Michigan State College.

That the College is aware of a parking deficiency in this area is indicated by the fact that vehicles are allowed to park on the lawn immediately surrounding the lot. Consequent damage to the lawn and general beauty of the campus makes it imperative that some permanent change be made.

While the improvement of this area, as presented by this paper, may seem costly, the added utility and permanence of the installation make the expenditure justifiable. Every attempt has been made to lay out the proposed parking lot for maximum efficiency and minimum congestion while keeping the design, as nearly as possible, in accordance with the surrounding buildings and grounds.

The writers wish to acknowledge the helpful suggestions of Professor Gail C. Blomquist in the formation of this plan and the editorial assistance of Mrs. Clement Laurion in the preparation of the text.

PROPOSED EXPANSION OF MORRILL HALL PARKING
AREA AT MICHIGAN STATE COLLEGE

THE PARKING PROBLEM

The problem of parking is not only an old one, but is one of the most critical and persistent problems encountered in every area where concentrated traffic occurs. There is probably not a city in the United States which does not consider municipal parking one of its constant headaches. Not a single city, village, or confined area has completely solved this problem, although some very noteworthy advances have been made, especially in newly-planned developments. The attempt to include adequate facilities for off-street parking in areas under development is an indication that the problem is being recognized and coped with.

The problem at Michigan State College is accentuated by the boundaries of the campus. The rapid post-war growth in enrollment and subsequent additions to teaching facilities has tended to increase the parking problem in two ways: a) the areas suitable for parking lots have been used instead for the construction of new buildings; b) the construction of these new buildings has increased the parking demand.

One method of combating the problem is to restrict the number of vehicles authorized to use the campus parking facilities. This has already been done at Michigan State College by fair and equitable regulations which prohibit all cars not operated by faculty, administrative workers, and the physically handicapped from using both the off-street lots and the curb facilities.

Another means of easing the situation at this college takes the form of a preventative measure. For with each new building which has

been erected on the campus in the last three years, an attempt has been made to locate a parking area in its immediate vicinity. How much research has been done to determine the required capacity of these lots is not known, but whether or not they accomodate the full parking demand which the new building creates, the lots at least alleviate the parking problem in that specific area.

A third way to alleviate the shortage of parking space is presented in this thesis. It consists of determining by actual count the number of vehicle spaces required in a parking lot to meet the demand placed on that lot. If this number is in excess of the lot's capacity and the physical characteristics of the lot are such as to allow adding to its facilities, the area is redesigned to the capacity required. In so confined an area as a college campus, where space is at a premium, this is a favorable solution to a difficult problem

ANALYSIS OF PRESENT LOTS

The Morrill Hall parking area as it now exists has proven to be inadequate in both capacity and arrangement. Originally planned to accomodate forty-two vehicles on three lots, an average of 83 cars are now parking in this area. Daily counts were taken to establish this figure and are presented in the graph shown. This excess of cars, 98 per cent of design capacity, is being parked on the lawn adjacent to the regular parking area, thereby increasing the capacity of the lot to that needed, but at the expense of increased congestion, unsightliness, and confusion to the drivers.

The area lies in a position most favorable to expansion and rearrangement. It lies between Morrill Hall and Olin Memorial Hospital

and off the campus circular drive.

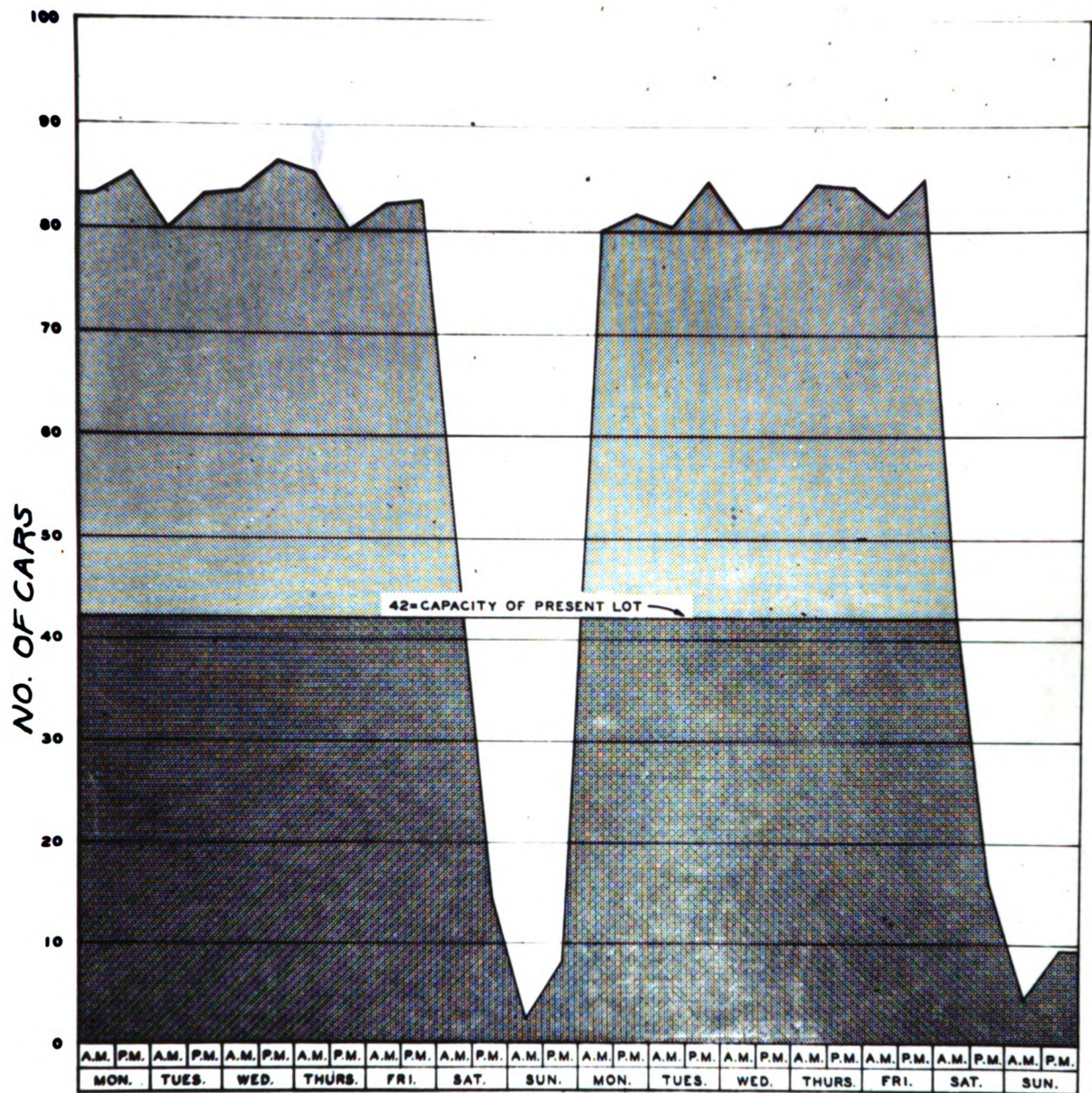
A topographical map of the original Morrill Hall parking area is shown on page 5. The map was drawn on a plane table with an alidade and is sufficiently accurate for the purposes intended. The map shows the existing parking lots, vegetation, drains, lighting and general layout of the area. This map, along with firsthand observations of the area, detailed soil and drainage investigations are the bases for the proposed new designs suggested later in the report.

Soil Investigation

Due to the fact that this is not to be a structure of great weight, requiring any deep foundation work, the soil investigations made were of the preliminary type. A log of borings covering the area under consideration is shown on page 7. The typical river-bed, sandy clay soils found in these investigations is common to this part of Michigan. While not providing the ideal sub-grade for a concrete slab, the inclusion of a 12 inch cinder or sand cushion under the wearing course will give more than sufficient sub-grade support. That the soil in the area is capable of supporting the load of a parking lot is pointed up by the fact that parking of cars on the lawn for the past three years has resulted in no excessive rutting or other ground failure.

Drainage

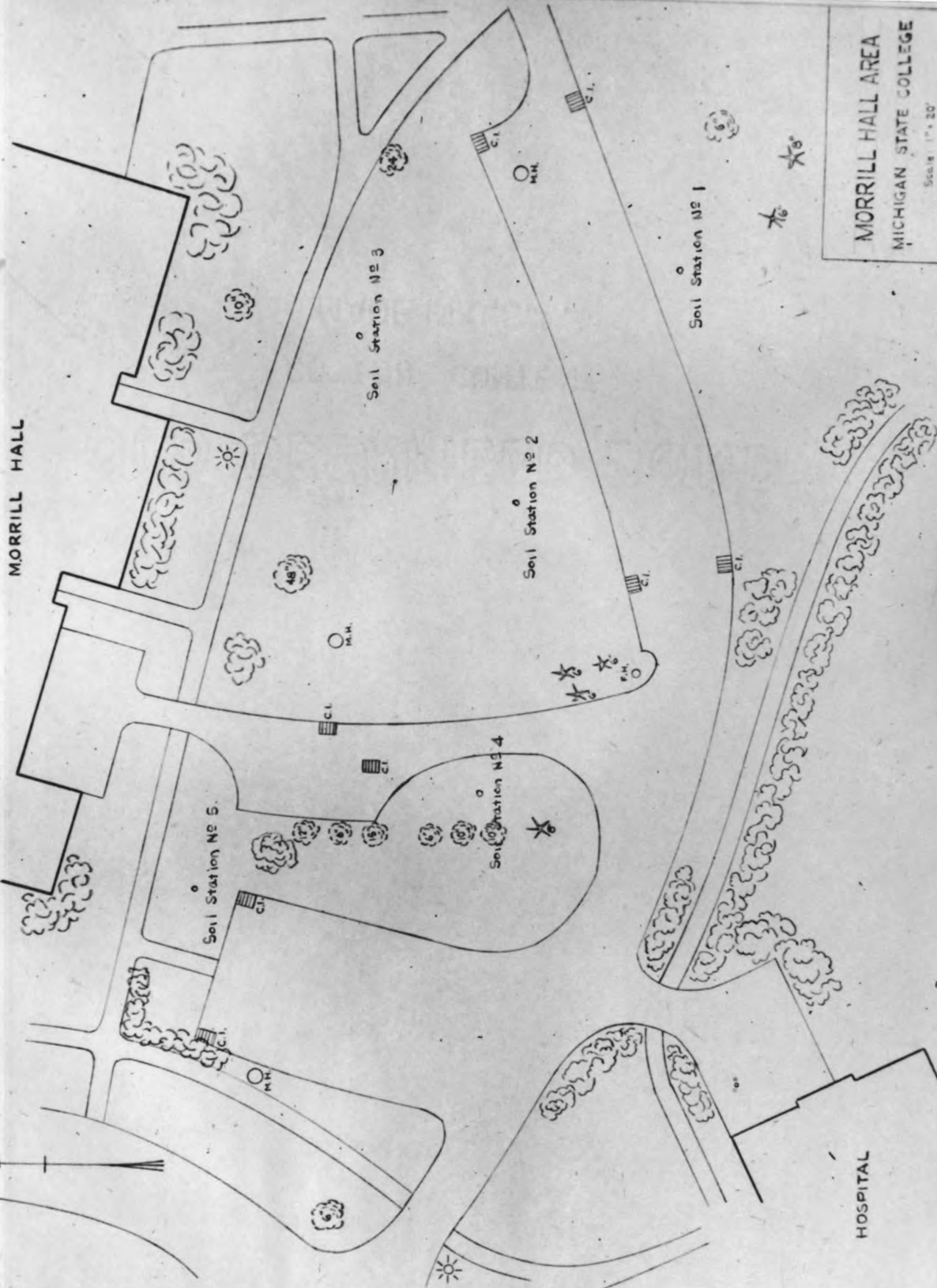
The existing drains and inlets are marked on the map of the area. These drains are adequate for the present lots, but additional curb inlets will be required for the proposed expansion. The drains are all located at strategic positions to carry off the storm water. They



SURVEY OF MORRILL HALL OFF-STREET PARKING LOT

(APRIL 4, 1949 TO APRIL 17, 1949)

MORRILL HALL



HOSPITAL

MORRILL HALL AREA
MICHIGAN STATE COLLEGE

Scale 1" = 20'
Date: April 9, 1929

Charles A. Morgan - 1144 S. S. Schumaker

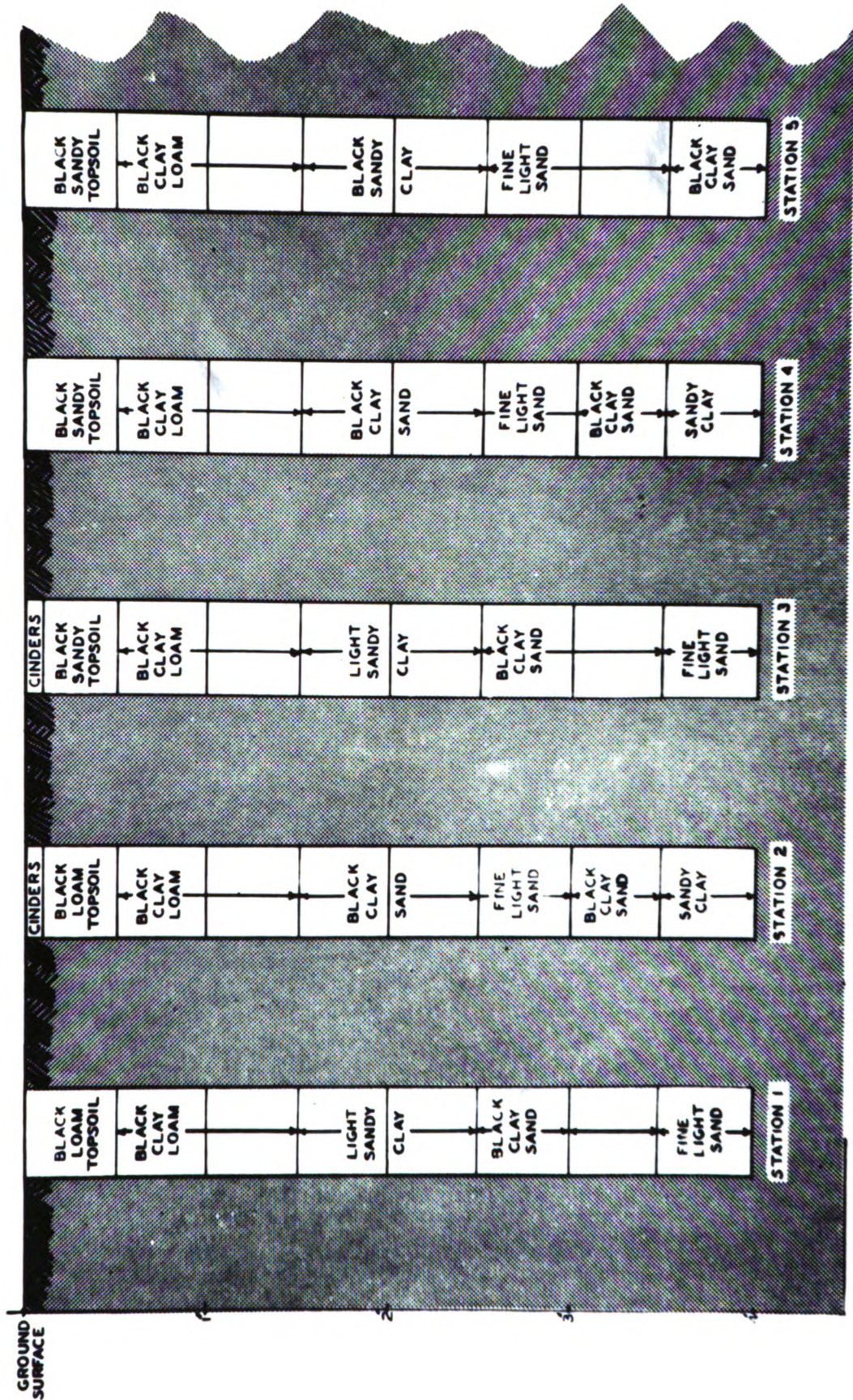
are 12 by 24 inch grill opening drains, that lead directly into the College sewer lines, which, in turn, lead to the disposal plant south of the Red Cedar River and west of Harrison Road. There is practically no danger of the drains backing up or not carrying off the expected waterfall.

Marking and Lighting

Firsthand observations of the present parking lots show that the area is not suitably lighted or marked for either daytime or nighttime use. Although daytime traffic volume dictates the size of the facilities, there is enough nighttime use to warrant better lighting and marking. Observation has shown that visitors to Olin Memorial Hospital use the lot during the evening visiting hours. The majority of this nighttime traffic is made up of people from off-campus, who are generally not familiar with the parking layout. The existing signs and markings are not equal to the requirements for safety under these conditions.

Entrances and Exits

One opening to the circular campus drive serves as both entrance and exit to the parking area. This 20 foot driveway is capable of handling the interchange of vehicles between these two points. The low volume of cars using the lot at any one time makes this double lane drive more than adequate.



LOG OF BORINGS **SOIL INVESTIGATION OF MORRILL HALL AREA** **MICHIGAN STATE COLLEGE**

ANALYSIS OF PROPOSED EXPANSION

A composite map of the Morrill Hall Parking Area after the proposed expansion is shown on page 9. The expanded parking facilities have been shown on a copy of the original survey. The capacity of the lot after improvement according to this plan is 96 cars, or 15.7 per cent in excess of the maximum demand of a typical school day. The dimensions of the increased and added lots along with their capacities are as follows: (See Topographical Map of proposed improvements.)

Lot No.	Original Dimensions	Original Capacity	Proposed Dimensions	Proposed Capacity
I	0	0	144' x 20'	16
II	175' x 20'	19	153' x 20'	17
III	0	0	150' x 60'	30
IV	45' x 20'	5	100' x 20'	11
V	81' x 52'	18	100' x 60'	22
		<u>42</u>		<u>96</u>

Besides providing orderly accommodations for all cars authorized to park in the area, the plan does away with the depreciation of the surrounding grounds and the general confusion that is the result of too little space and too many cars.

Stabilization of the Sub-grade

The log of borings made covering the area under consideration shows the sub-soil to be a member of the Allendale Series as described

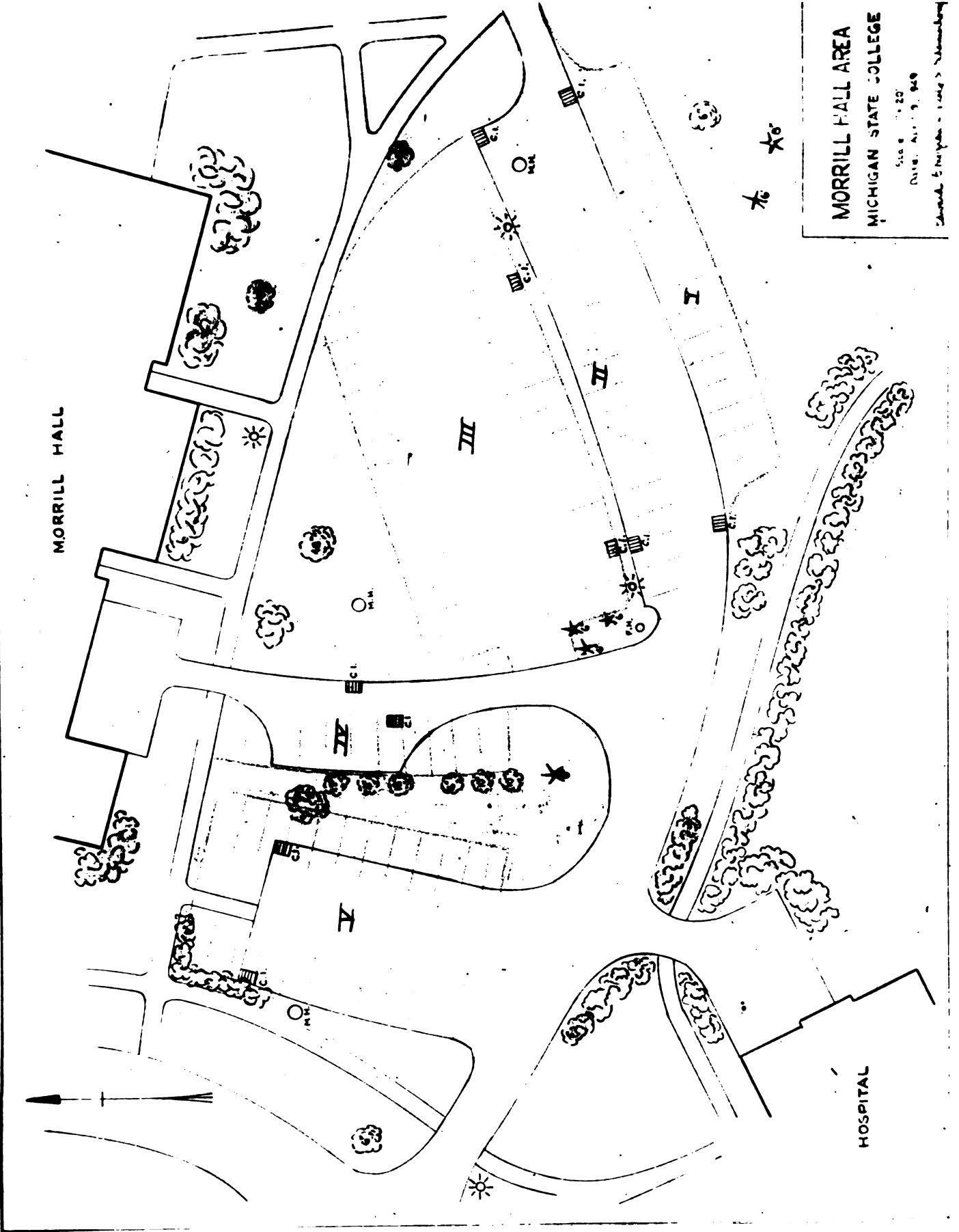
MORRILL HALL

MORRILL HALL AREA
MICHIGAN STATE COLLEGE

Scale 1" = 20'
Date: April 9, 1949

Source: Photograph - 1947 & 1948

HOSPITAL



in the "Field Manual of Soil Engineering for Michigan". This series is characterized by the presence of strata of impervious clay. The natural drainage through these strata is poor with ground water standing near the surface during the wet season. Clay soils, when dry and compacted, give excellent subgrade support. However, in service, clay subgrades may soften and lose some of their supporting value when wet. Therefore, to assure adequate drainage and suitable subgrade support, a 12 inch cushion of coarse sand will be specified for the sub-base of the concrete slabs. This will give a modulus of subgrade reaction (k) of 200, to be used in computing the slab thickness.

Drainage

With only one exception, the curb inlets now located in the general area are capable of handling the increment of runoff which will result from the improvement. The exception is in the case of the largest slab proposed. Reference to the map of the improved area shows the location of the added (two) curb inlets. Positioning of these added inlets adjacent to the island separating the two lots insures against inconvenience of standing water in the path of foot traffic flow. Also, the location of the curb inlets at this point is in the interest of economy.

Connection of the curb inlets to the sewer is made by means of a standard Y which has the side outlet at an angle of about 45 degrees.

Slab Design

All improvements in the area are in the form of simple slabs. Those standards governing Design of Cross-Section for Secondary or Country Trunk Route or Residential Street as presented in Portland Cement Association's "Concrete Pavement Design", are used throughout. As all factors

of design are common to each of the separate slabs, only one set of computations are presented here.

This work will consist of a single course of Portland cement concrete with reinforcement, constructed on the prepared subgrade. (See Stabilization of Sub-grade).

A standard Michigan State Highway concrete mix will be used.

Approximate proportions by volume =	1:2-1/4:3-1/2
Compressive strength at 28 days, psi, min.	3,500
Modulus of rupture, psi, min.	
At 7 days	550
At 28 days	650
Estimated cement, bbl. per cu. yd. of concrete	1.375

Air-entrained cement will be used to reduce bleeding, give greater impermeability, and improve workability of the mix.

Thickness: Traffic in this area is restricted to passenger vehicles, therefore, the maximum wheel loads to be considered in the design of the slabs will not exceed 400 pounds. Taking the ultimate strength of the concrete to be 600 psi and using a safety factor of 2, Older's formula for slab thickness,*

$$d = \sqrt{\frac{2W}{S}}$$

W = Load, pounds
S = Ultimate strength of concrete, psi

gives a thickness value of 5.2 inches. This agrees favorably with Westergaard's value of 5.5 inches for the same load and with a modulus
+
of subgrade reaction (k) of 200 psi per inch. To accomodate the steel reinforcement to be used, the thickness will be specified as 6 inches.

Reinforcement: Research has shown that the most economical designs are those which contain steel. Although there are many divergent views on the using of steel in concrete slabs, it is generally

* Highway Engineering - Bateman - Page 230.

+ Concrete Pavement Design - Portland Cement Association - Page 92.

agreed that the distributed steel in the form of bar mats or wire mesh does not increase the resistance of an unbroken slab to flexural stress or add to its strength in any way. Its sole function is to hold together the fractured faces of the slabs after cracks have formed so as to aid in load transmission at these points and to prevent the infiltration of incompressible material into the crack. The economy of steel use is in added pavement life and minimum attention needed for upkeep.

The area of steel required in 1-ft. width of slab is computed from the formula:

$$a = \frac{LfW}{2S}$$

Where: a = Steel area in direction of L (inches square per foot of slab)
 L = Distance between transverse or longitudinal joints (feet)
 f = Coefficient of friction, between slab and sub-grade (1 to 2) (assume 1-1/2)
 W = Weight of 1 square foot of slab (assume 75 psf)
 S = Allowable working stress in steel (assume 30,000 psi)

Each slab is 20 feet in width, therefore, the steel required in the transverse direction is 0.0375 inches square per foot of slab. In the longitudinal direction, weakened plane joints will be placed every 30 feet, therefore, the steel required in this direction will be 0.05625 inches square per foot of slab. A welded steel mesh of 1/4 inch round bars with 12 inch center to center spacing in the 20 foot direction and 10 inch center to center spacing in the 30 foot direction will provide adequate reinforcement. Placement of the steel mesh will be accomplished by roughly striking off the concrete about 2 inches below the finished pavement surface, placing the steel on it, and then placing the concrete

for the remainder of the slab thickness.

Jointing: a. Transverse Expansion Joints - As a concrete pavement dries out or cools, it tends to contract, or become shorter. It is not free to move, however, because of the frictional resistance offered by the subgrade, and tensile stresses, therefore, are set up within the slab. When the tensile strength of the concrete is exceeded, a crack is formed. A critical time for crack formation occurs during the period after the concrete has been placed and drying of the slab has begun, because during this period the tensile strength of the concrete is low. The formation of these cracks is controlled by constructing contraction joints at those points where cracking is expected.

The least expensive type of joint for this purpose is the hot-poured bituminous joint. It is installed by inserting a form in the pavement which is removed after the concrete has hardened, the resulting depression is then filled with a non-extrusive bituminous material. Favorable load transfer characteristics between the two parts of the cracked slab are maintained because the filler material excludes any foreign incompressible matter from lodging in the crack, allowing maximum aggregate interlock action.

Jointing: b. Longitudinal Joints:- Longitudinal joints between adjacent slabs reduce transverse warping and transfer loads from one section of the pavement to the adjacent section. Proper use of dowels permits the joint to open and close while maintaining the slabs on each side of the joint as nearly as possible at the same elevation. Thus, the deflection of one slab under load is resisted (through the dowel) by the other slab which in turn is caused to deflect also and to carry a portion of the load imposed upon the first slab.

Freedom of movement of the dowels is secured by painting and greasing the ends of the bars to prevent bond with the concrete and by so placing short metal sleeves at one or both ends that end movement of the dowels is possible.

Closeness of spacing of dowel bars across longitudinal joints has not been shown to be necessary, and a spacing of 60 inches is common. Dowel bars are generally 1/2 inch in diameter and 4 feet long. Placing of the dowel bars will be accomplished when the steel mesh is laid.

Curbing

To carry off surface water and to provide a pleasing border between the paved lots and surrounding lawns, the entire area will be provided with a standard 6 inch combination curb and gutter. This curbing will also serve to retain parking traffic to the authorized spaces.

Marking and Lighting

As mentioned previously in the Analysis of the present lots, the lighting and markings are inadequate.

To provide more light for the nighttime use of the parking areas, it is suggested two more lights be installed on the island in the middle of the proposed parking area. The design of the lights will be the same as that of the existing campus lighting facilities. Location of the added light posts at either end of the central island should provide sufficient illumination for safe nighttime operation of the lot. (See topographical map of proposed lot for suggested location of the lights).

The necessity for properly designated stall areas cannot be emphasized too strongly. A good grade of highway yellow paint should be used to designate these stalls. The decrease in congestion and increase in efficiency of the lots realized from proper maintenance of the stall markings is necessary.

CONCLUSION

The value of this thesis is that it may serve to bring to the attention of the proper authorities, the magnitude of the parking problem in this one area of Michigan State College. The worth of the suggested solution is, of course, debatable, a more practical and economical approach to the problem might be presented by a more experienced engineer. But, the figures quoted showing the discrepancy between car space supply and demand are irrefutable and would be much the same determined by anyone.

With continuing increases in vehicle registration every year, the traffic problem, of which the parking problem is an important part, shows no sign of lessening. Immediate recognition of the existing problem is the first essential to satisfactory solution.

It is suggested that more work be done on the many traffic problems to be found on the campus of Michigan State College. Other inadequate parking lots, awkward routing of traffic, and insufficient entrances and exits from the academic campus provide a wealth of material for further study.

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