

EFFECT OF URBANIZATION ON  
DIURNAL TEMPERATURES

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In this paper several case studies of the effects of urbanization on diurnal temperatures will be described. Although the data presented and the methods used comprise most of the manuscript there are in the closing paragraphs several suggestions, one might say almost predictions, about the uses of such studies. These predictions (or at least they are proposals) might call for a reversal of the title into, "The effect of diurnal temperatures on urbanization."

## Organization of the Temperature Surveys

Each year the Graduate School of Geography opens the Fall semester with a field camp, required of all Master of Arts and Doctor of Philosophy degree candidates who are in residence. A different site is selected each year. Careful consideration of each site's potential physiography, land use, urban and micro-climate problems is given. In addition, plans are made to scatter the sites so that students in residence more than one year receive a maximum of training in the field. Such selection criteria as listed above, especially the new sites, naturally pose as much, perhaps more, challenge to the staff than to the students. A few examples of sites illustrating their diversity are Hartford and New Britain in Connecticut; Lowell, Gardner, Pittsfield, Springfield and Fall River in Massachusetts; the city of Roanoke in Virginia; and this coming fall, Trenton, in the state of New Jersey.

The micro-climate study, really one of temperature patterns at each site, is planned so that it may take place when conditions are ideal. The town or city is chosen and small place maps are secured for each team consisting of two or three students. Usually the graduate group consists of 20 to 30 people, hence teams range in number from 10 to 15. A large scale map of the city is divided into as many sections as there are teams. Each team has the responsibility of cruising through its section of the city, selecting at least ten likely spots for the taking of temperature soundings. This cruising is done in the daytime. Full notes are made of the environmental conditions, physical and cultural, at each point selected. Each section of the large base map is thus covered and annotated. Thermometers are issued, two to a team. The extra thermometer per team is a necessary precaution, for if just one was used and was broken the whole study would be

practically invalidated, or a great deal of interpolating would be necessary later when isotherms were to be drawn on the maps.

The exact moment for the observations is then looked for; a clear, fogless, cloudless, windless night. This is important, since all conditions, except those of urban origin, must be minimized or excluded entirely. To eliminate reflected light rays as well as radiated heat the survey is scheduled for the hour preceding dawn. The teams move to their first stations about one hour before dawn, then travel through it rapidly, swinging the thermometers at the previously chosen stops to get the "true" temperatures. At least ten readings are taken in each section, the last one scheduled for the same spot as the first. Experience has shown that the first reading more than any other is usually too high -- thermometers have been held in cars or have not been swung long enough. Where possible one team overlaps a few soundings of adjacent teams. With the appearance of light in the eastern sky the survey ends. By this time one hundred to two hundred readings are obtained as simultaneously as possible. The temperatures which have been recorded on the map sections then are transferred to a large master map. Notes on each station are turned in for appraisal and to assist in interpreting the finished map.

#### DRAWING THE TEMPERATURE PATTERNS

All the temperatures recorded by all teams are added, divided by the number of soundings and the "norm" figured. This norm, or average temperature, has been found to be most useful in drawing the first isotherm. This isotherm sometimes cuts completely across a city as in the case of Springfield (see figure 1) or it circles the city as a closed isotherm as in the case of New Britain (see figure 2). In Springfield the 40° isotherm was the critical one. In New Britain the 52° isotherm was the critical one. Each opened the door, so to speak for the others.

(Other examples of these tendencies to dissect or enclose are shown on maps displayed on the stage or in the Libbey Library of the School of Geography.) The Gardner survey shows the 40° isotherm roughly bisecting the town north to south. (See maps) Crystal Lake on the east and Parkers Pond on the west suggested that this might be the case.

The Fall River early morning temperature map indicates that the 44° isotherm almost bisects the town midway between the Taunton River on the west side and large Watuppa Pond on the east side. (See maps) The Fall River map seems to verify the assertions made about water influence on isothermal patterns, for the Quequechan River, an arm of Watuppa Pond breaks the 44° isotherm in mid-course.

The Pittsfield early morning temperature pattern reveals similar influences of water, although there is shown a peripheral isotherm of 33°F enclosing a small central urban area. Nevertheless, Pontoosuc Lake on the north, Onota Lake on the west, along with Silver Lake,

Morewood Lake and Goodrich Pond on the east all exert influence at the time of year of survey (October) in their tendency to shatter the peripheral aspects of land-encircled cities.

#### FURTHER INTERPRETATIONS OF TEMPERATURE PATTERNS

There is always the danger of reading too many phenomena from too little criteria, and the writer recognizes that these are "one-shot" studies. Nevertheless, it would seem that cities along water bodies, large lakes or rivers, have the "dissecting isotherm" and the cities with just land on all sides have the "peripheral isotherm". The cities with many lakes within their city limits become challenging temperature mapping problems. Relief too, as we shall see later, looms large in the mapping problems.

Recently Pierre Dansereau in his book "Biogeography - An Ecological Perspective" stated that, "Urbanization is the ultimate replacement of all natural elements (soil, hydrologic system, vegetation, and fauna) by man-made ones: roadway, sewage network, lighting and heating apparatus, living and working constructions."\*

One must agree, of course, that these visible objects are removed or altered, but the climate, the water bodies, and relief (certainly these are natural elements) remain. Dansereau continues by saying, "the natural order has been so far disrupted that the recurrent menace from weeds, trees and animals is very remote." Again I acquiesce with this as far as it goes, but the "recurrent menace" and benefits of temperature, precipitation, and topography still must be reckoned with because they are in proximity all the time.

Naturally as one works with these surveys his "appetite grows with eating" and he wants more and more of them. Satiation of this yearning was attempted in two instances. One, an afternoon temperature study, was made in New Britain on the same day as the early morning temperature survey. It was done to see exactly what parts heated up the most. This was attempted even though a slight breeze set in from the west. Our first glance at the resulting afternoon temperature map seemed to reveal little. (see figure 3). On closer observation it was noted that tongues or islands of colder air were on the western side and that islands or trailing edges of warm air were on the eastern side and southward facing slopes. The latter with their higher temperatures might be explained on the basis of exposure, the former to the easterly drifting of warm air from the urban center. One can see readily that the urge comes to do another study with an east, a south and a north wind -- on and on until a whole year's plottings could be made. Then the real interpretation

\* Dansereau, Pierre, "Biogeography - An Ecological Perspective". The Ronald Press, New York, pp. 263.

would be most challenging.

Another attempt to satiate the appetite with this kind of fare was done with Hartford as the test site. On October 9, 1952 early morning temperature readings were taken at 130 stations. (see figure 4) The isothermal pattern bears out earlier conjectures but some new things are added. The figure shows a peripheral isotherm (37°F) for downtown Hartford. There is also a dissecting isotherm (35°F) roughly paralleling the Connecticut River. The interesting new thing about the map, however, is the sharp drop in temperature from the central business core (41°) to the river (35°). The Central business district is on higher ground. A second interesting new thing is the intrusion of cold air in the parkland areas on the north and south sides.

Two years later, almost to the day, conditions seemed ideal to repeat the survey (see figure 5). The air mass was considerably colder, but the resulting pattern bears out in a remarkable way the results of the first survey. Again the urban core stands out; the dissecting isotherm this time is 32°F. The isotherms are crowded from the core to the river; the parkland influence is evident.

#### EFFECTS OF DIURNAL TEMPERATURE ON URBANIZATION

Now we come to the point where the title of the paper may be changed to read, "Effects of Diurnal Temperature on Urbanization". Another way to state the title might be simply this, "What good is such a study?" One of the responses to this question of course would be that

- (a) it provides practice in cooperative research for the graduate groups involved,
- (b) develops skill in drawing isotherms, which really lays the groundwork for other isarithmic drawings, and
- (c) the surveys also provide vehicles for writing about relationships of simple weather, relief, elevation, water, and urban patterns. Even writing about the lack of relationships offers some training.

Admittedly, there has been a paucity of evidence submitted here, but let us remember how one scientist when asked about his research and its usefulness replied with this question, "What good is a new born baby?" The writer asks your indulgence as he submits suggestions and proposals which might represent what these "new born babies" might grow up to be.

1. First of all there might be the installation of thermographs at strategic locations throughout a city. From these, continuous records would be compiled and many maps drawn. Installation of these thermographs might be in police call stations or at fire stations. What good would such temperature data be?

Let us imagine that the weather forecasts are for freezing rain or snow. Instantaneous checks could be made on the temperature. When a section of the city experienced a temperature of say 33° all the sanding equipment or snow removal equipment could be massed and operated in that section. Who knows, but we may be wrong in clearing central city streets first, perhaps we should let the urban center's temperature do a little work for us. (Such a procedure might be better than what one wag has suggested — to turn the hot air of the City Council onto the streets!)

To be serious again — do we really know what parts of a city to tackle first — or do we have to try all of it at once and every time? The price of 20 thermographs is a lot less than the cost of one complete plowing or sanding. It should not be too difficult to give certain sections of a city priority on the bases of temperatures and slope and exact location.

2. With such continuous records, sections of a city might be found where the "optimum" temperature (if there is such a thing) for living conditions might be found. One would hope that if such places were to be located they would not be classed as residential zone A. If this were done then the temperature survey would do the greatest good for the fewest number instead of the greatest.

3. Another conjecture is this. What happens temperature-wise when large slum areas are cleared; when parking lots are built? Do the heating bills of the adjacent property owners near these now cold areas go up in winter, and do their air conditioning bills go up likewise near these hot spots in summer. Fuel and air conditioning costs perhaps go up; certainly the taxes on the property near the "improvements" go up. In other words, what is the real cost of slum clearance?

4. In the light of the afternoon temperature survey made in New Britain we might go on with our proposals or questions. Should industrial plants be located on the eastern sides of towns as many of us have been led to believe? With the controls today over industrial smoke why not plan new plants on the west, then our prevailing westerly winds would bring heat to an urban community.

5. Some of these plants in winter might consider fan installation to flood night-time surplus heat out over a parking lot laid out on the eastern side of the plant. It may not be too fantastic to carry the fan installation idea for a whole community.

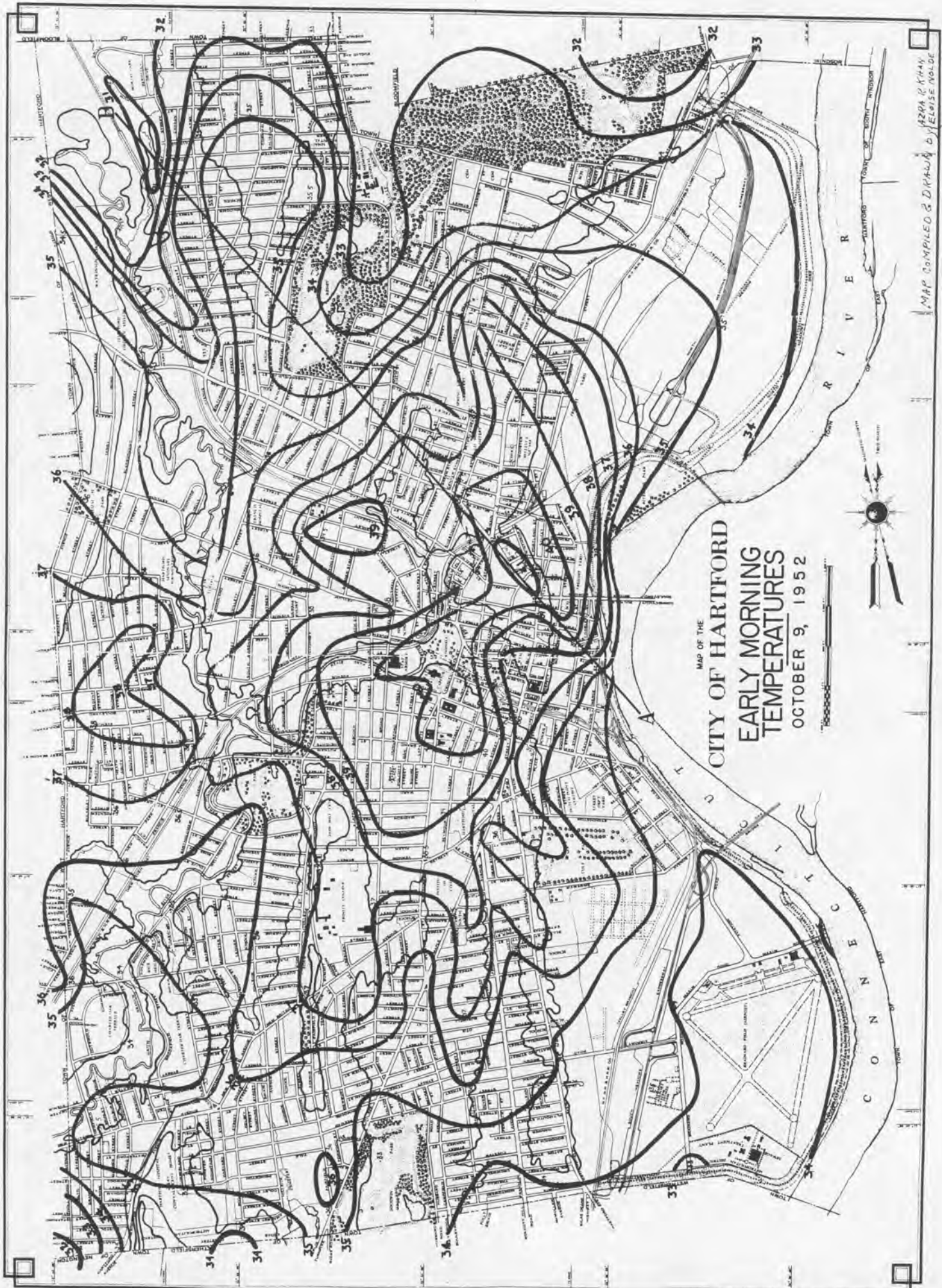
6. Then, too it has been the custom not to build too near water. Perhaps we should build right over it. The cooling effects in summer and the retention of heat by water in winter might offer big

savings in yearly operating costs.

Let us look beyond the New England sites and cities. The patterns may change; in fact one would certainly expect them to be different in the southern states. But just what are the patterns of temperature? What are the temperature patterns of interior, western or west coast cities? To find out requires little output of money and labor.

7. In closing permit me to throw out what might be the "craziest" idea of all. During the last war we experienced "blackouts". Perhaps in the next war, if there is one, we will be experiencing "cold-outs". Intercontinental missiles are "zeroed in" on temperature and pressure conditions. It may be necessary to flatten off the temperatures of cities to the same level as the surrounding open territory. A "cold out" order of 35 degrees for a city's inhabitants may be accompanied by a "warm up" order for rural establishments.

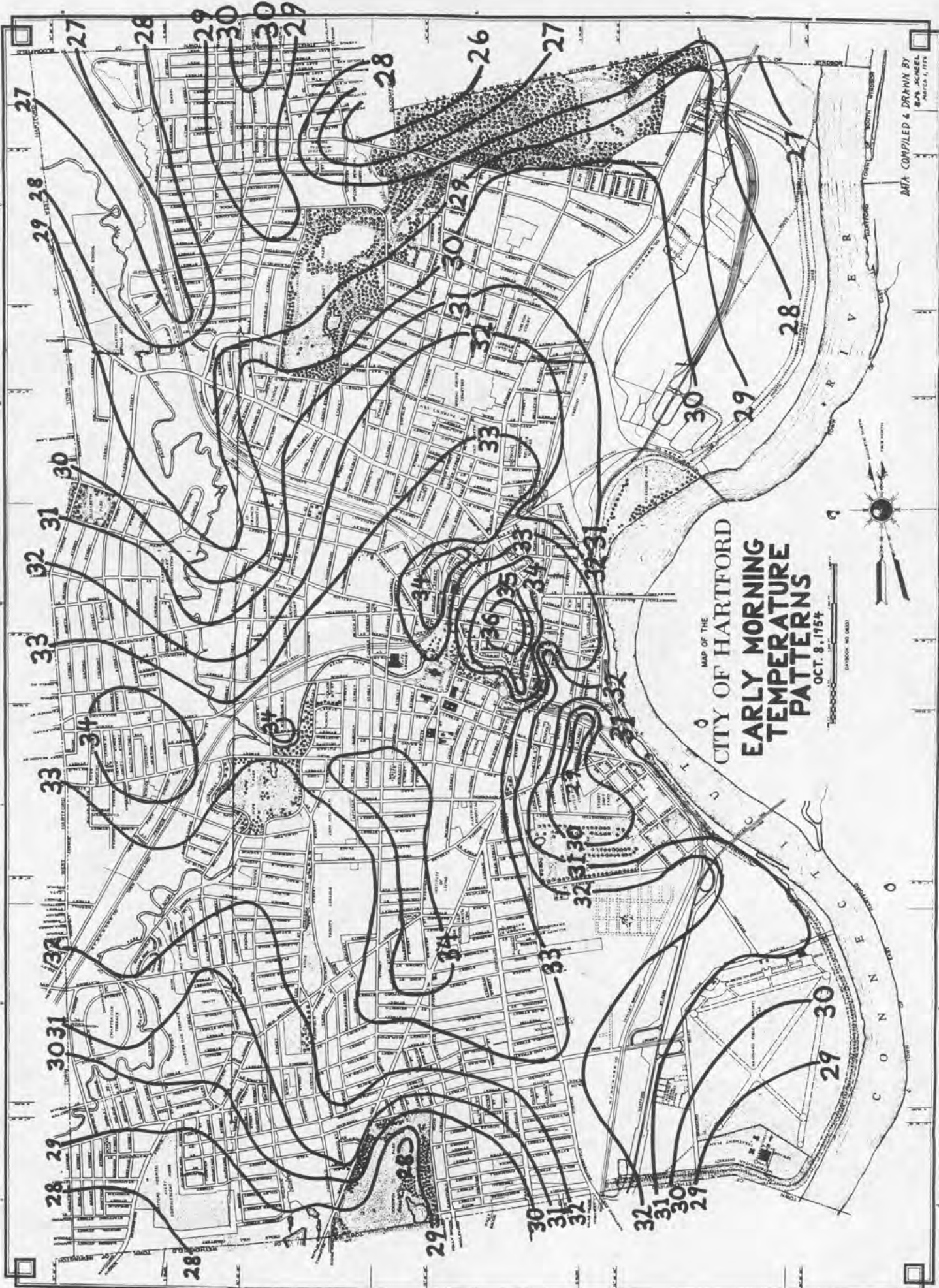
Let us hope we do not come to this stage -- but let us hope too that we are not second best in what may be called the "art of atmospheric camouflage!"



MAP OF THE  
**CITY OF HARTFORD**  
**EARLY MORNING**  
**TEMPERATURES**  
OCTOBER 9, 1952

MAP COMPILED BY D. HALLAM & E. W. HAY  
BY ELOISE NOLDE

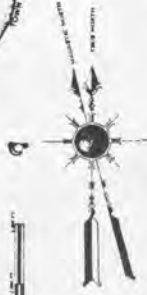


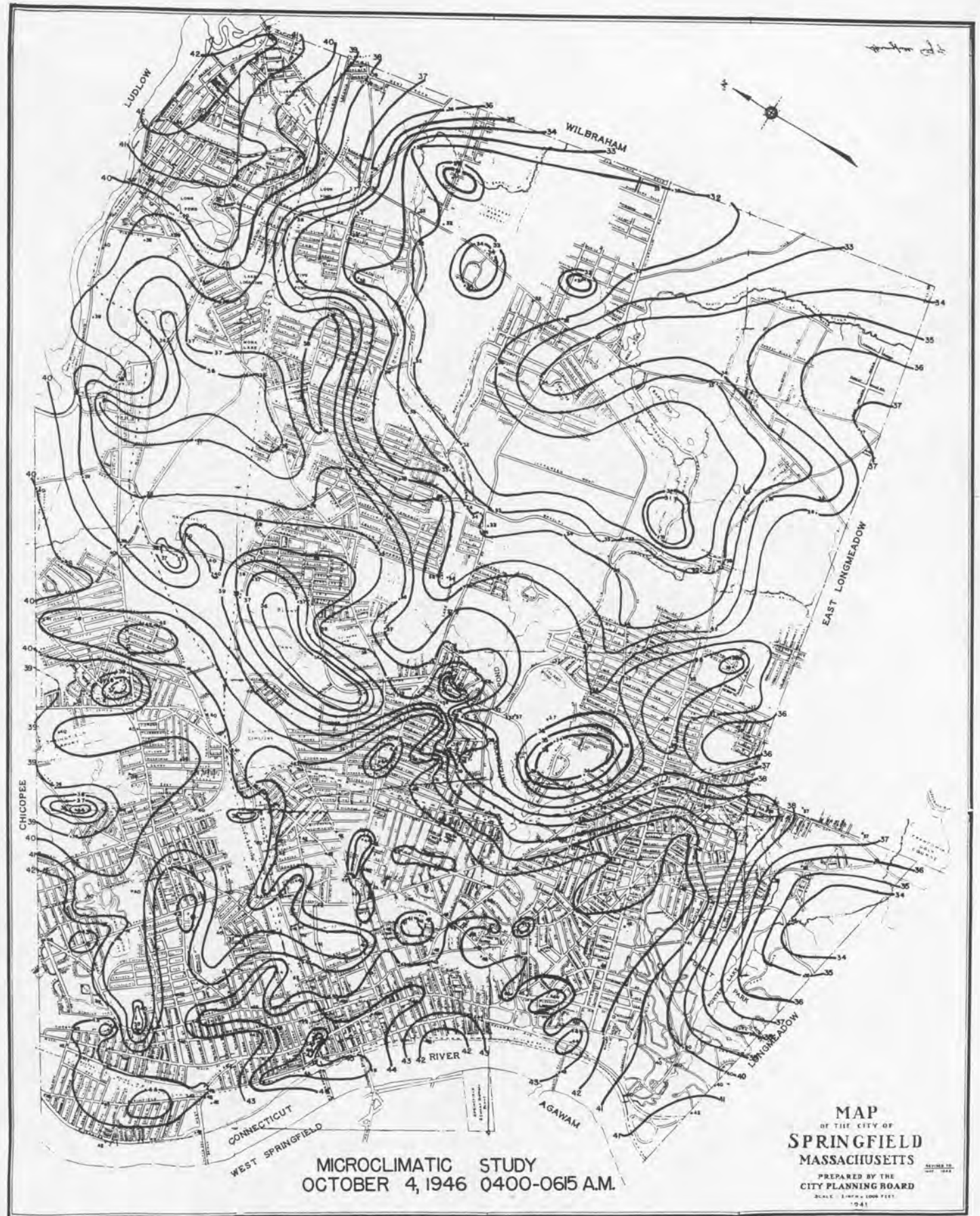


MAP OF THE  
**CITY OF HARTFORD**  
**EARLY MORNING**  
**TEMPERATURE**  
**PATTERNS**  
OCT. 8, 1954

DATA COMPILED & DRAWN BY  
E. W. SCHUBEL  
MARCH 1, 1955

CATSKOPE AND GIBBY





MICROCLIMATIC STUDY  
 OCTOBER 4, 1946 0400-0615 A.M.







MAP  
 OF THE CITY OF  
**SPRINGFIELD**  
 MASSACHUSETTS  
 PREPARED BY THE  
 CITY PLANNING BOARD  
 SCALE 1:10000  
 1941

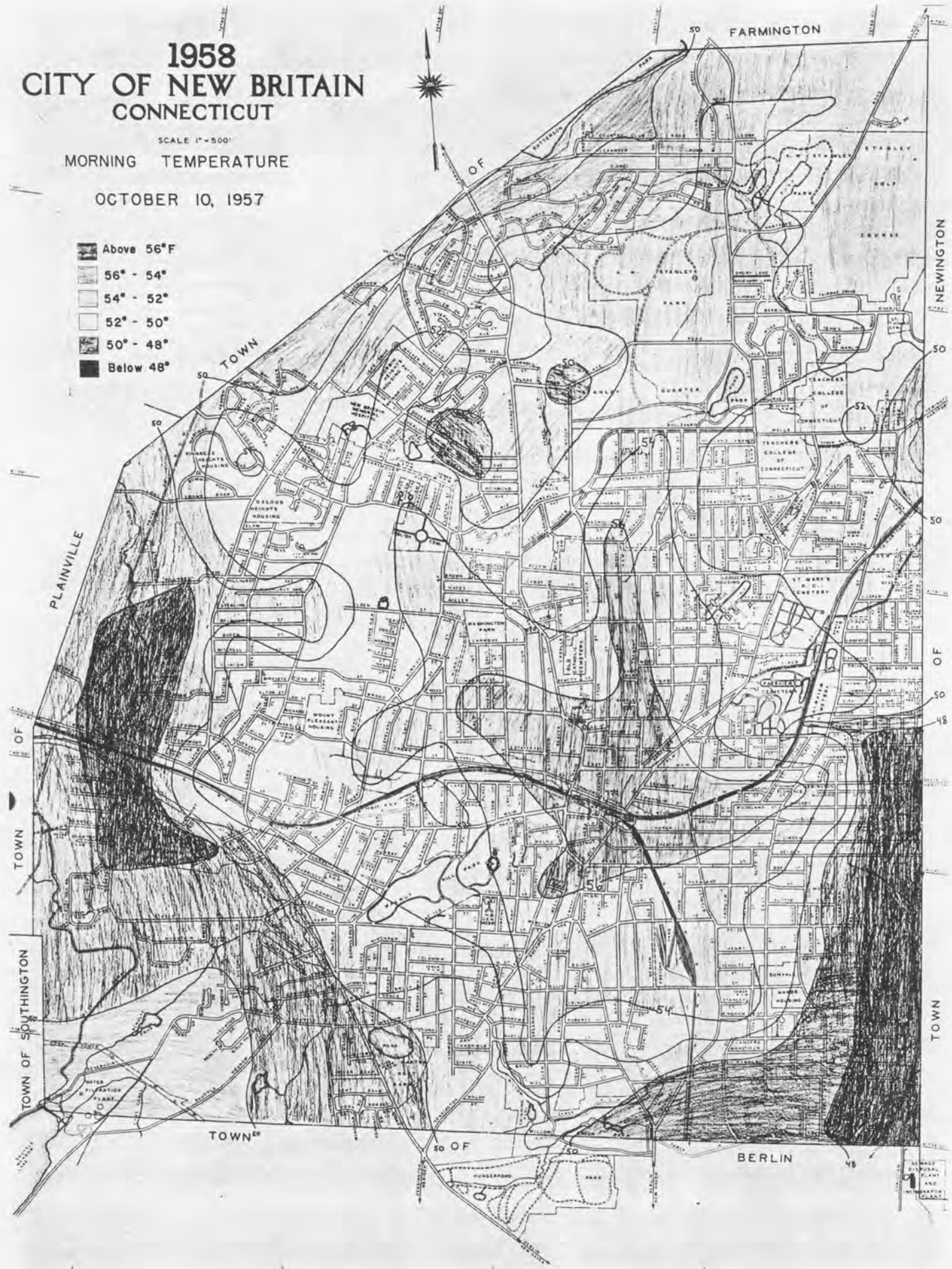
# 1958 CITY OF NEW BRITAIN CONNECTICUT

SCALE 1"=500'

MORNING TEMPERATURE

OCTOBER 10, 1957

-  Above 56°F
-  56° - 54°
-  54° - 52°
-  52° - 50°
-  50° - 48°
-  Below 48°



# 1958 CITY OF NEW BRITAIN CONNECTICUT

SCALE 1" = 500'

AFTERNOON TEMPERATURE

OCTOBER 10, 1957

Above 68°F

68° - 66°

66° - 64°

64° - 62°

Below 62°

