Photogrammetry in Highway Planning

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Photogrammetry has two main fields of usefulness in highway planning—preliminary engineering and public relations.

In preliminary engineering, which in Connecticut is a function of planning, photogrammetry is used for determining and weighing alternate lines, and for transmitting the recommended schematic layout for processing through the survey and design stages.

Furthermore, it is used as a base for portraying proposed highway improvements at the public hearings required by federal and state statutes.

● ODDLY enough, the subject of this paper, "Photogrammetry in Highway Planning," makes more sense to the layman than to the professional. That is because most professionals in this field place a different meaning on the word "planning" than does the layman, and the layman's usage is the correct one. The term "planning", as generally used today, came into the highway engineer's lexicon through the State-Wide Highway Planning Surveys initiated by the U.S. Bureau of Public Roads in the late thirties as cooperative ventures with the several states. The planning of these surveys was the gathering of data, which provides the frame of reference for planning, but it was no more planning in itself than the site, which provides a frame of reference for a building, is the building itself.

The activities commonly and erroneously thought of as planning are, in Connecticut, carried on by the Records and Statistics Section which for many years was under the jurisdiction of the Bureau of Business Administration. These activities include gathering the data for recording the physical configuration, or structural arrangement of all road sections on the state system; type and width of pavement and of shoulders, sight distances, alignment, gradient, superelevation, etc. Also forming part of the inventory are data relating to bridge clearances and waterway areas, railroad-highway intersections, whether at grade or separated, school bus and mail routes, etc. Records and Statistics also keeps so-called road life records which are merely the historical data relating to the various road sections. Loadometer and other data-gathering surveys are made by this section which, in the main, has service rather than creative functions. There does not seem to be much need, or even any great area of usefulness, for photogrammetry in the accumulation of statistics.

A highway is an area reality, not a lineal abstraction. It is the recognition of this fact and its translation into the answers for "what, where and how" that constitutes planning. One of the most important aids, from the initial general "look-see" at the area of concern to the completion of the final schematic scaled layout for the survey and design of a particular project, is photogrammetry.

Connecticut is participating, on a continuing basis, with the U.S. Geological Survey in the cost of preparing the USGS quadrangles for the state. Formerly these were based on plane table mapping but in more recent years on aerial photogrammetry. About half of Connecticut's quadrangles are photogrammetric. With the passage of time, and the requirements for revision on a 5-year cycle, the entire state will be covered by maps produced photogrammetrically. These USGS quadrangles are the "work horses" of planning.

The major planning studies currently being made by the Connecticut Highway Department deal with expressway projects. A typical planning study begins with the examination of the area of concern on USGS mapping. This office examination is, of course, supplemented by field investigations. An expressway study is not treated as a lineal problem between two points, but rather, as an area service problem. It is possible to delimit traffic drainage sheds and arrive at likely locations for roadside traffic interview stations, thus programming the various traffic studies largely on the basis of USGS mapping.

This USGS mapping also is useful as both a source and a mapping base for land use information, a necessary factor, along with traffic data, in highway planning.

After, or along with, the compilation of the traffic and land use data relating to a highway project, various alternate locations are studied on USGS mapping to determine feasible routes and the limits of the area in which the new expressway will be located. The desirable scale for the photogrammetric coverage (usually 200 ft to the inch with 5-ft contours) is decided upon and the map sheets for photogrammetry are laid out on USGS mapping and form the basis for dealing with the photogrammetric contractor.

When the preliminary photogrammetric map sheets are received the project engineer proceeds to transfer to them the various alternates, first laid out on the USGS mapping. The better mapping reveals the undesirability, or impossibility, of some part, or all, of various lines and the possibility, or the necessity, of adjusting and refining the others. Also, he is usually able to add new alternates for study to replace those he has been forced to discard.

Eventually there result from two to five or more alternates on photogrammetry. These alternates are developed to fully engineered and scaled schematic layouts on the photogrammetry. Centerlines are shifted around until the most acceptable profile appears; the possibility of separated roadways in likely areas is investigated and decision reached, conformity with alignment and gradient criteria can now be assured; interchanges are engineered to scale and the treatment of intersected roads shown. It is now possible to make comparable cost estimates for both right-or-way and construction for the several alternates which, used in conjunction with the traffic operations data assembled by the project engineer, permit the computation of benefit-cost ratios.

After the several alternates are developed they go through channels for review and decision. The atlas containing the several alternate layouts for Interstate 91, between New Haven and Meriden, had 32 full photogrammetric map sheets. Figure 1 shows a section of the index map for this atlas and the wide area of necessary coverage. The tendency would have been to skimp, had old line methods of mapping been employed.

Figure 2 is an interchange developed on 200-scale photogrammetry for the intersection of Connecticut 8 with Interstate 84 in Waterbury. If the mapping had been obtained by old line methods, it is highly unlikely that the coverage would have been wide enough for a satisfactory solution. The problems were:

1. Full interchange had to be provided between two expressways and between the expressways and the local street system.
2. The traffic volumes were very heavy.
3. The heavily industrialized area to the east of the Naugatuck River had to be spared.
4. The Naugatuck River itself; and
5. The area available to the west of the river was steeply sloping.

The highway planner is working in three dimensions, as is clearly evident, and contoured photogrammetry most conveniently provides the base he needs.

The photogrammetry surcharged with the carefully engineered schematic layouts for the various alternates then serves as a basis for discussion of the several alternates: (a) with the several levels of decision within the department, (b) with other affected agencies of the state, (c) with local public and/or semi-public agencies, and (d) with the Bureau of Public Roads. After study of the several alternates, not only from the strictly engineering and cost standpoints but also from the standpoint of effect on the traversed communities and on local area planning objectives, decision is reached as to the general line location.

The chosen alternate is carefully refined to provide as complete a guide as possible for the ground survey and design at 40 scale. The survey is usually the transit and tape variety, although it seems probable that photogrammetry will claim an increasing share of this field. Figure 3 is a typical planning map completed by the Planning Division and forwarded for survey and design. It is a section of sheet No. 1 of 3 for the relocation of route Connecticut 12 in Killingly. The centerline for the expressway is shown by a single heavy line. Where separated roadways are specified by planning

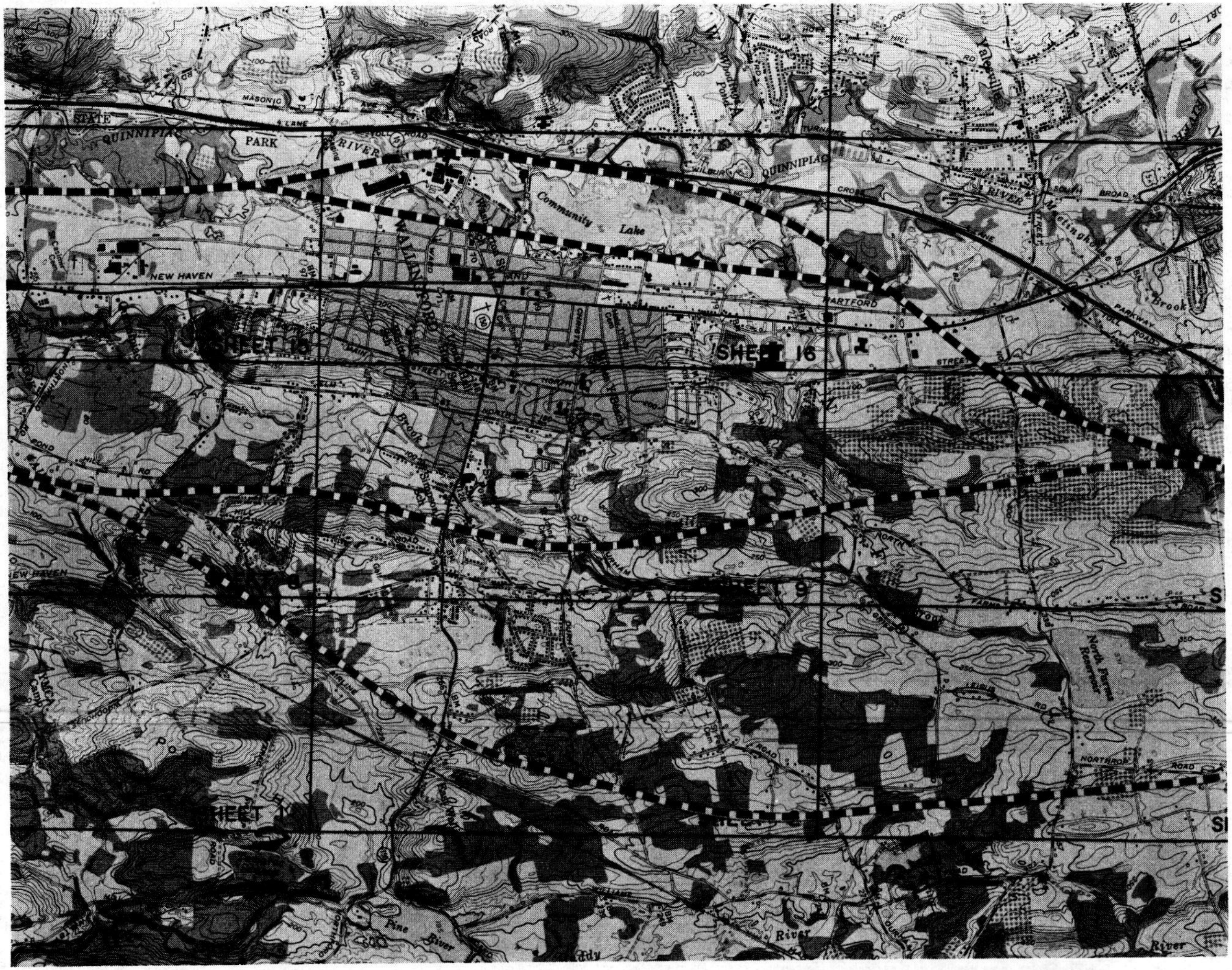

MASONIC
STATE
QUINNIPIAC
PARK
RIVER
Community Lake
QUINNIPIAC
RIVER
NEW HAVEN
HARTFORD
SHEET 15
SHEET 16
WALLINGFORD
Brook
SHEET 9
North Farms Reservoir
NORTHROP
Pine River
River

Figure 1.

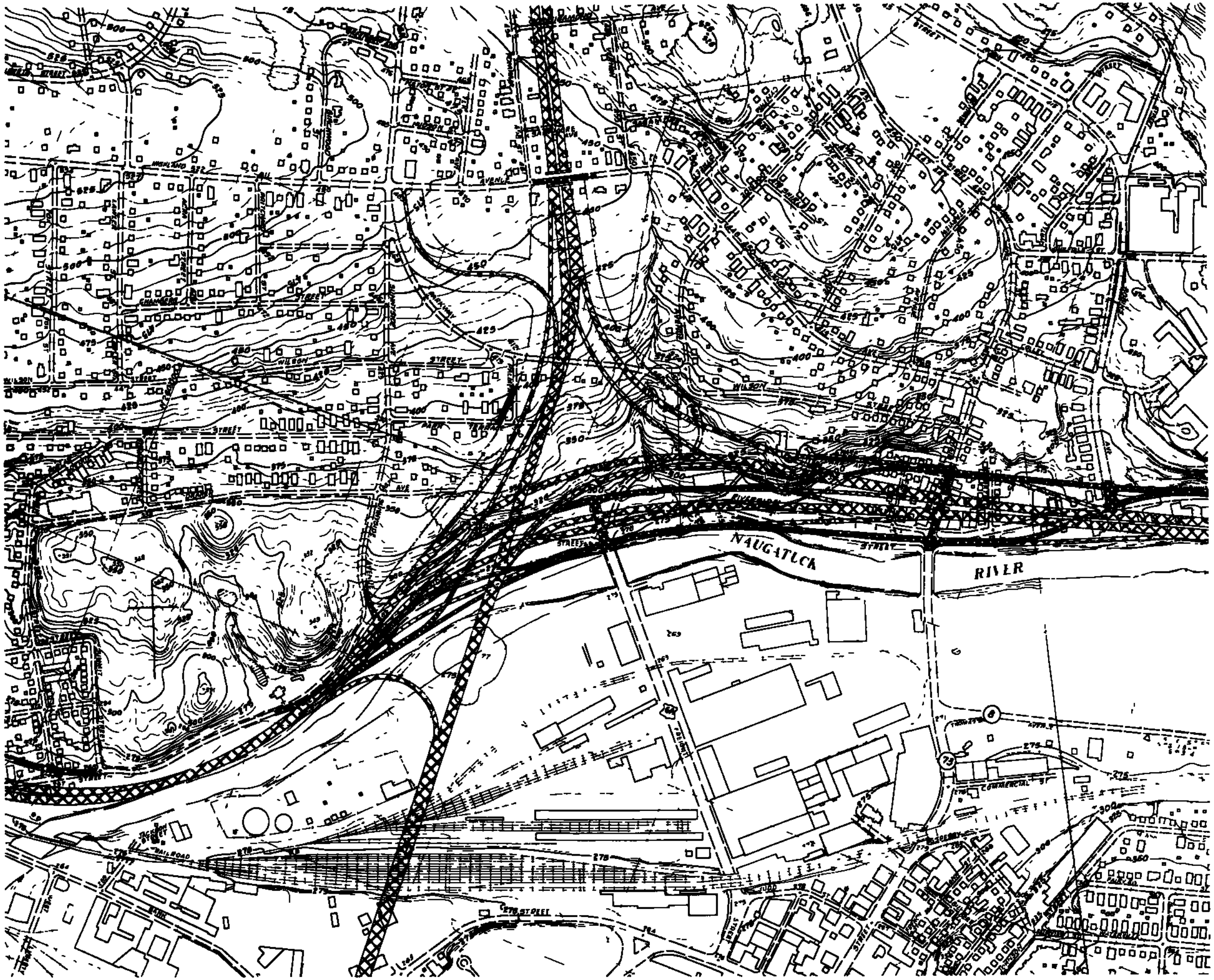
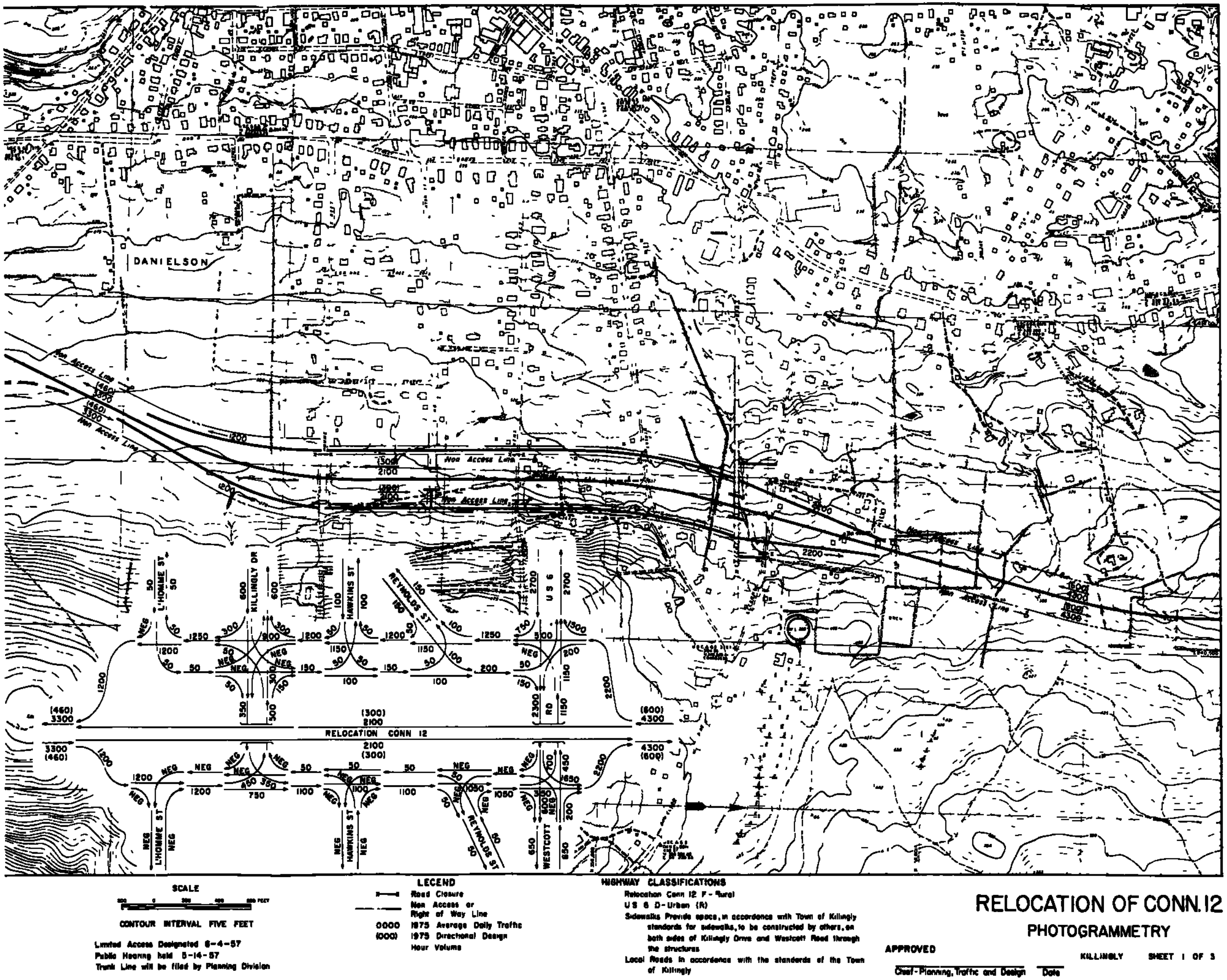


Figure 2.



CONTOUR INTERVAL FIVE FEET

Limited Access Designated 6-4-57
Public Hearing held 5-14-57
Trunk Line will be filed by Planning Division

LEGEND

⊢—⊣	Road Closure
— · —	Non Access or Right of Way Line
0000	1975 Average Daily Traffic
(000)	1975 Directional Design Hour Volume

HIGHWAY CLASSIFICATIONS
Relocation Conn 12 F - Rural
U S 6 D - Urban (R)
Sidewalks Provide space, in accordance with Town of Killingly standards for sidewalks, to be constructed by others, on both sides of Killingly Drive and Westcott Road through the structures
Local Roads in accordance with the standards of the Town of Killingly

RELOCATION OF CONN. 12
PHOTOGRAMMETRY

APPROVED

Chief - Planning, Traffic and Design   Date

KILLINGLY   SHEET 1 OF 3

Figure 3.

the centerlines for both roadways are shown. Interchange ramp centerlines are shown, and the positioning of the bridge rails indicates whether planning intends an intersecting road to overpass or underpass the expressway. Frontage roads, road closures, cul-de-sacs, and non-access lines are also shown. Traffic volumes for the design target year, both as ADT's and DDHV's, where necessary, are shown both on the line portrayal and on separate traffic diagrams on those portions of the sheet where the base coverage is expendable. In the 3-in. margin at the bottom of the sheet are notes advising of the status of the limited-access designation, trunkline filing and the public hearing. Also noted, are the highway classifications applicable to all of the roads involved in the proposed improvement on this map sheet. Other information may be included, such as sidewalk calls, commitments, and special notes. Also, each map sheet is approved by the Chief of Planning, Traffic and Design. The intent is to give the Surveys Section all the information necessary to make the ground survey and to give the Design Division all the information necessary for agreements with local bodies and to prepare the contract drawings. The planning maps do not, of course, include any drainage information or directives.

The trunkline filing maps, necessary for legal reasons, are filed with the local municipal clerks, after completion of the planning stage, on photogrammetry used as the base mapping.

Photogrammetry in the field of planning is particularly useful in public relations. Of all phases of highway engineering, planning is most affected by, and responsive to, public opinion. Both state and federal statutes require the holding of public hearings for all but the routine type of highway improvement. These hearings are generally held in each town traversed by the proposed improvement. Although, in rare cases, one hearing may serve more than one town, in no case are county lines crossed.

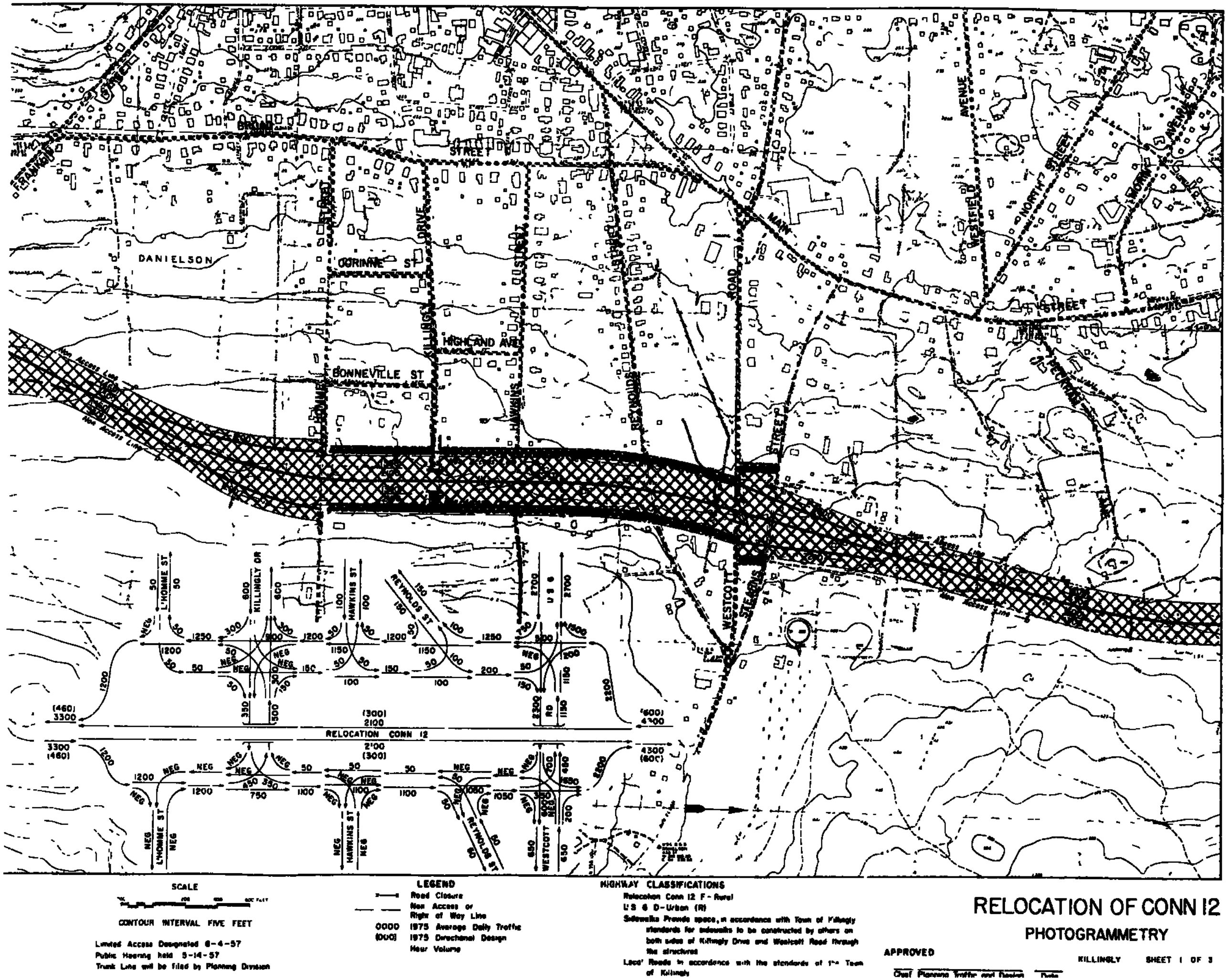
A few weeks before the date of the public hearing a set of the planning maps is sent to the municipal officials showing the proposed highway improvement through that town, for public display in the town or city hall. The right-of-way requirements, between the non-access lines, are colored with a yellow wash on this set of prints. As the map base of these planning layouts is photogrammetric, townspeople inspecting the display can see if they are affected. Also, the relationship of the proposal to the existing street system is readily apparent, even to the layman.

Figure 4 shows a photogrammetric-based display map such as used at public hearings. For some hearings various types of data charts may also be used to bring out pertinent points, but generally these map sheets are the only displays, and in all cases, they are the "heart" of the hearing. A series of such map sheets, from one end of the included area to the other, is mounted on easels and the departmental spokesman describes, on the basis of these maps, the entire improvement and answers all questions from the floor. After the formal part of the hearing people come up to the display maps and search out their homes or businesses and ask informal questions with reference to the map to indicate their area of concern. Figure 4 shows a section of Interstate 84 at the Danbury-Bethel town line. Proposed new construction was colored red, as were also those sections of the local system which will be rebuilt. Existing roads, not to be rebuilt, were shown in black. Existing US 6 has been split into two one-way frontage roads on either side of Interstate 84 and the addition of ramps has produced a basket-type interchange.

Figure 5 shows another type of portrayal of hearings information on a photogrammetric map base. This is the same project as in Figure 3. For the purpose of presentation at the hearing that same sheet was rendered in color to make the improvement clear to the audience. Yellow wash was used to delineate the areas required in the right-of-way for the expressway; red wash, the right-of-way requirements of related improvements that will be constructed by the state and deeded to the town, such as the frontage roads to be constructed initially on either side of the expressway between L'Homme Street and Westcott Road. A brown wash was used to show the relationship of, and adjustment in, streets of the existing road network in the area. The severance and preservation of local streets in the vicinity of the frontage roads tells the audience, and the hearings official in his presentation to the audience, the effect of the expressway on this neighborhood. Local landmarks, such as the standpipe north of Stearns Street, were also colored to aid in orientation.


FOUNDATION
FOUNDATION
435
450
427
425
435
425
375
400
415
MT VIEW
RD
400
TERRACE
385
700
4650
3550
1100
7000
7000
2350
400
375
365
350
700
375
3550
425
450
550
375
350
5900
1100
355
365
700
290
300
1950
340
318
4400
1350
3300
300
285
419,000
330
325
315
325
350
365
420,000
375
479
475
SWAMP BROOK

Figure 4.


DANIELSON
BROAD STREET
MAIN STREET
CORINNE ST
HIGHLAND AVE
BONNEVILLE ST
L'HOMME ST
KILLINGLY DRIVE
HAWKINS ST
REYNOLDS ST
WESTCOTT ROAD
STEARNS STREET
WESTFIELD AVENUE
NORTH STREET
LAKE
Non Access Line
RELOCATION CONN 12
US 6
NEG
SCALE
CONTOUR INTERVAL FIVE FEET
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KILLINGLY
SHEET 1 OF 3

Figure 5.

With such a presentation, it is evident that highway planning has now matured to an independent discipline in which purely technical considerations form only a part of the pertinent criteria. It is not a coincidence that this maturing of highway planning as a discipline coincides so closely in time with the use of photogrammetry as a planning tool. It is even doubtful that this maturity would have come about without the aid of a quick, low-manpower, low-cost method of mapping coverage, such as that provided by photogrammetry.