New York Sea Grant Report Series

# THE DEMAND FOR CONSTRUCTION MINERALS IN THE GREATER NEW YORK METROPOLITAN AREA



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## 1. Scope

This report is part of a New York Sea Grant research project entitled "The Impact of Offshore Sand and Gravel Mining on the Availability and Costs of Construction Minerals in the Greater New York Metropolitan Area" (G.N.Y.M.A.). Our study area includes twenty-four counties in New York, New Jersey, and Connecticut as shown in Maps 1, 2, and 3. (1). The purpose of the project is to determine the economic conditions associated with establishing and maintaining an offshore mining industry for construction minerals to serve this region.

The report has three objectives: first, to describe a method for deriving demand for construction minerals using readily available computerized data; second, to present more recent results on the demand for these minerals in the GNYMA (4); and third, to forecast regional demand for construction minerals for the period 1980-2000.

Our work was designed to provide information for planners, coastal managers, and others involved in managing the offshore resources of the GNYMA. The first report in this series described the offshore supply of construction minerals in the GNYMA indicating several geologically suitable areas for offshore mining [6]. This report presents historic demand and forecasts for the future. A subsequent report will match supply and demand "optimally" to determine the potential economic impacts of offshore mining operations for construction minerals.

## II. Background

Urbanization and industrialization create strong demands for mineral resources. The best known are those for metallic ores and petrochemical feed stocks. Less publicized, but still very important for future growth and development, are the demands for construction minerals: sand, gravel, crushed stone, and fill.

The importance of these resources can be illustrated: Construction of the concrete basement for a 30 by 40 ft. house requires 80 tons of aggregates; one mile of four lane highway requires from 60,000 to 100,000 tons; and the Verranzano Narrows Bridge connecting Brooklyn and State Island contains over 1,000,000 tons [4].

Volume demand for construction minerals is greater than that for all other non-fuel and non-metal resources combined. In 1972, the United States consumed 913 million short tons of sand and gravel and 792 million tons of crushed stone. An even greater national demand is projected for the future (Table 1) (8).

Table 1

Projections and Forecasts for U.S. Sand and Gravel and Crushed Stone Demand by End Use, 1972, 1985, and 2000

(Million Short Tons)

| | 1972 | 1985 | 2000 | | |
|---|---|---|---|---|---|
| | | | Forecast Range | | |
| End use | | | Low | High | Probable |
| Sand and gravel | | | | | |
| Construction | | | | | |
| Highway and street construction | 504 | | 1,950 | 2,740 | 2,000 |
| Heavy construction, general bldg. | 341 | | 805 | 1,200 | 1,000 |
| Other end uses | 68 | | 145 | 260 | 200 |
| Total | 913 | 1,700 | 2,900 | 4,200 | 3,200 |
| Crushed and broken stone | | | | | |
| Construction | 723 | | 1,968 | 3,182 | 2,576 |
| Other end uses | 69 | | 142 | 228 | 185 |
| Total | 792 | 1,417 | 2,110 | 3,410 | 2,761 |

The mineral aggregates industry produces a product with a low intrinsic value, and a relatively high unit weight. Dry gravel weighs 100 to 120 pounds per cubic foot, while bituminous coal weighs approximately 84 $lbs/ft^3$ and white pine 27 $lbs/ft^3$. Both of these other materials have higher intrinsic values per ton than construction aggregates. Thus even when hauled considerably farther they can still be economically competitive. Current estimates indicate that hauling aggregates 20 miles by truck doubles delivered costs and that distances of 40 to 60 miles become prohibitive (4). Longer distances are feasible by barge if a suitable route, and docking and unloading facilities exist. Such routes and facilities are limited and often involve unloading in congested urban areas which increase the time involved in subsequent movement of product by truck to the eventual use site and hence increase overall costs.

Construction aggregate resources are common and plentiful. Long Island, New York, alone, probably contains some 250 billion tons of glacially deposited sand and gravel. If these resources were used totally they could supply the region's present and future demand for approximately 22,000 years (8).

The total onshore resource, however, is not available for exploitation. Reserves--resources available for extraction--are severely limited by a number of economic and non-economic factors. Some of these are: urban sprawl, highway construction, land use regulation, restrictive zoning, increased land values, and environmental regulation. These factors have forced producers to seek new extraction sites which are progressively farther from demand sites. For example, while a production site in southern Brooklyn might be ideally located to serve demand, it is highly unlikely that an extraction site could be established there.

The ultimate impact of this situation is in economic terms; increased delivered costs reflecting most strongly increases in hauling costs. The impled costs associated with the prevention of the opening of sites on Long Island have been estimated to increase delivery costs by $12,226,000 and total consumer expenditures by $24,740,000, for fine aggregate alone (5). Using offshore resources may provide a solution. Within our study area, major sites of urban and suburban development are generally near shore. This fact coupled with the economies of scale associated with dredging indicate the possibility for economically viable offshore extraction. Sand has been removed from New York Harbor in the process of shipping channel maintenance for many years. However, the ultimate economic viability of such an operation to provide for major segments of demand has not yet been demonstrated. It is the intention of our ongoing research to delineate and study the conditions associated with establishing such an industry in the GNYMA.

## 3. Procedures

Estimates of demand for mineral aggregate resources may be constructed in two ways. Both assume that the production and consumption of mineral aggregate products will be equal in any annual period. Thus production estimates demand, and demand estimates production.

The most common approach estimates demand by the compilation of producer data for the period of study. This is the method routinely used by the US Bureau of Mines in its annual report in the Minerals Yearbook (12). Production data is requested annually from each producer for each of its operations. This data is then aggregated by state. Similarly, detailed local surveys may be conducted as was done by Evans et al. for the greater Los Angeles, California area in 1976 (9).

These methods were felt to be inadequate for our purposes. The aggregated data collected by the US Bureau of Mines is not amenable to disaggregation into areas as small as individual counties. In addition, individual producers are justifiably reluctant to make a full disclosure of the nature and scope of their operations.

Therefore we have formulated a method for estimating demand based upon the end uses of these minerals. This approach was first promulgated by Bishko, Dunn, and Wallace as part of a US Bureau of Mines study (2).

The first step of this method is to identify the end uses of these materials. Virtually all of the demand for construction minerals can be included in one of the following six categories:

- residential construction
- non-residential construction
- highway maintenance
- highway construction
- public capital projects
- private capital projects

While this categorization does not include all sources of demand (e.g., glass manufacture), it should be noted that historically the first four categories have accounted for approximately 96% of annual demand (4). Our approach determines the "amount" of these activities and, through a knowledge of the technologies involved, the amount of construction minerals need to provide for these activities.

Bishko, Dunn, and Wallace (2) considered residential and non-residential construction, and highway construction and maintenance. For both residential and non-residential construction, "typical" structures were defined and analyzed. These results were used to convert construction activity information into demand estimates. Highway construction and maintenance were similarly considered on a "typical" per mile basis and used to convert available project data.

Bronitsky (4) expanded this "molecular" approach to more accurately estimate demand. His study covered the years 1963, 1966, and 1969. By means of calculations based upon the 1963 Input/Output Study of the US Department of Commerce (15), he constructed a matrix of "technical coefficients" relating tons of sand, gravel, and crushed stone consumed to the dollar value of various types of construction activity (Table 2) (4, Table A-5).

In addition to providing a convenient and direct means for analyzing demand, this analysis is also able to take into account indirect consumption; i.e., the use of intermediate products such as cement blocks.

Demand for construction minerals used in residential and non residential construction was estimated from construction permit activity files. The data was abstracted manually from various sources. Highway data was obtained by survey of the various state, county, and local highway departments. These data were interpreted by means of the appropriate technical coefficients. Additional data for the five counties of New York was obtained by analysis of barge movements of sand and gravel and crushed stone into the area which were estimated to account for 90% of demand. Bronitsky's estimates were validated from producer data and found to be accurate to within 8%.

Computerized analysis has made this approach simpler and more accurate. We have developed a series of computer programs which allow analysis of demand for construction minerals in any area of the United States based upon data which is easy to obtain.

We have again considered only residential and non-residential construction and highway construction and maintenance. Data for capital projects are difficult, if not impossible, to obtain directly. In addition, we believe that capital projects are accurately reflected in construction permit activity data.

3.1 Data Sources (1970-1975)

The demand for construction aggregates in the GNYMA was estimated from the Bureau of the Census data on construction activity. These data were made available to us in the form of computer tapes (16). The information obtained covered the issuance of construction permits and was reported in estimated current dollar value for particular projects. Such data are available, by state, county, and construction type for all areas in the United States.

Our primary source of data on highway construction and maintenance was the SF-15 series of Highway Finance (13). This data covers only the Standard Metropolitan Statistical Areas (SMSA) and is reported in dollars. Secondary sources for areas not within these regions were reported by county supervisors, departments of highways, and state departments of transportation. These data were also reported in dollars. Unfortunately for our purposes, data not available for all counties in our study area. We were forced, in consultation with local planners, to develop judgemental estimates for those counties for the appropriate years. These data, reported directly in tons, are marked with a single asterisk (*) in the summary of results (Table 8). A summary of these judgemental estimates, expressed as percent of total derived demand, is given in Table 9. The impact of a 20% error in these estimates, again expressed as a percent of total derived demand, is also shown.

3.2 Analysis

The data obtained, in the form of dollars, were converted into tons of construction aggregates using the matrix of technical coefficients previously described and shown in Table 2.

We have assumed that these coefficients are still structurally valid, that is, that there has been no fundamental change in the various construction technologies and that the price of aggregates has inflated at a rate approximately in balance with other construction materials. While this assumption seems intuitively correct, we have verified it by examination of the All Construction Materials Index of Construction Review (7). On a national basis, construction aggregates still contribute approximately the same proportion of costs of all materials as they did when the index was last adjusted in 1963.

To appropriately apply the technical coefficients, however, it was necessary to adjust the coefficients to represent the change from "current" dollars to 1963 dollars. This was done for construction by applying three of the Boech construction indicators and the Handy-Whitman indicators to the individual categories of construction. For highway data, the Federal Highway Index (composite) was applied. These indices were normalized to the base year, 1963, and are shown in Table 3.

Applying these indices to the 1963 matrix of technical coefficients, adjusted coefficients for the years 1970-1975 for sand and gravel and crushed stone was obtained (Table 4). Flowchart 1 describes the computation procedures.

The construction permit activity tapes supplied to us contain multiple entries per county for each year in our study period. Since the volume of data was large, a data processing system was developed to generate appropriate reports and create a data file for future analyses. This data processing system was written in ANSI COBOL with the intention to be easily adaptable to other study areas.[1]

Data abstracted from tape are sorted by county and construction type. The result is a report of current dollars of construction activity by type, county, and state. These data are interpreted by means of the technical coefficients described above to provide a second report of tonnage of sand and gravel and crushed stone by type of construction, county and state. Sample pages of these reports for Suffolk County for 1975 are shown below in Tables 5 and 6. Flowchart 2 describes the computation procedures.

Highway data were divided into two components: new construction and highway maintenance. These data, in dollars, were converted using the adjusted technical coefficients. We used a computerized procedure, similar to that for construction. Since there were significantly less data, we used an interactive approach was used to generate a yearly report by county and aggregate type from a computer terminal. This system is written in Fortran IV, and easily adapted to other regions.[1] A sample page of this report for 1975, is shown in Table 7. Flowchart 3 describes the computation procedures.

3.3. Results

Table 8 shows demand in tons of sand and gravel and crushed stone, for each county for the years 1970-1975.

A composite graph of demand for the entire study area is shown in Graph 1. In addition to coarse and fine totals per year, the index of twelve leading economic indicators and total residential fixed investment indicator from the "Business Conditions Digest" (14) are superimposed. The strong "leading"

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[1]Source code and operating instructions are available in a working paper entitled, "System for Estimation of Construction Mineral Aggregates" (7).

nature of our demand graph reflects the delay between initiation and completion of specific projects. Coarse and fine aggregate consumption follow similar profiles due to the fairly constant proportionality of use of these materials over the entire construction industry.

4. Demand of Forecast for Construction Minerals in the GNYMA

To obtain estimates for the demand for sand and gravel and crushed stone for the period 1980 through 2000 a "micro" approach was used. Demand is estimated for the individual counties (the five counties of New York considered together) and an overall forecast calculated by adding the county forecasts.

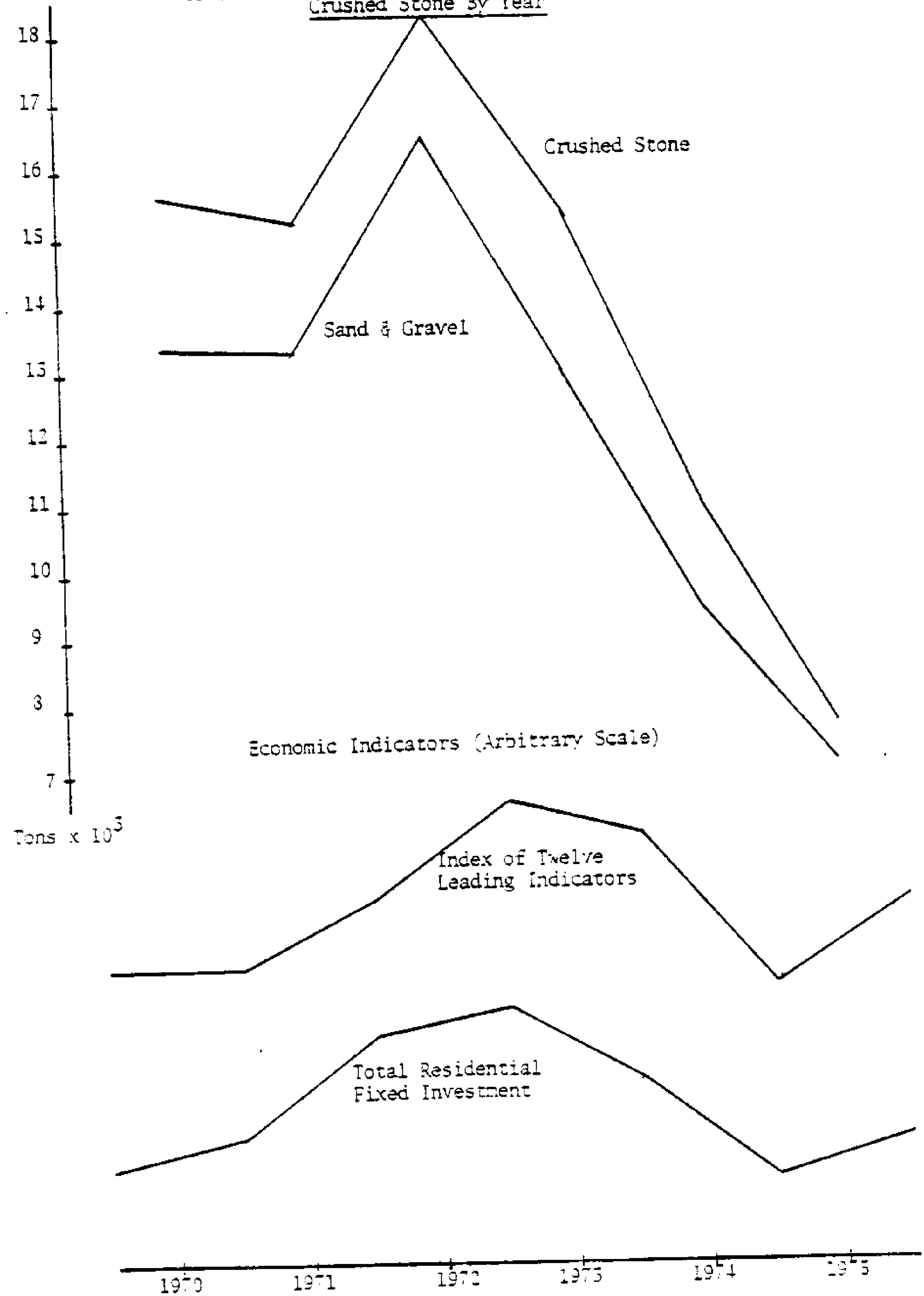
The period 1970-1975 is assumed to include the upper and lower bounds for future demand within each county. This reflects the behavior of the graph of total demand with respect to the two cyclical indicators shown in Graph 1.

These bounds are assumed valid for the following reasons: first, the most recent cycle in construction activity was the most severe since World War II; second, the GNYMA is likely to remain relatively stable overall, experiencing neither great growth nor decline.

The data obtained are insufficient to undertake standard analysis of this cyclical time series. As may be seen in Graph 1 the derived demands encompass not even one complete cycle; several cycles of annual data are needed to estimate the long range trend. Standard statistical analysis of time series data covering less than one complete cycle must also be rejected as yielding a mean and standard deviation not representative of the entire cycle. Thus no account of cyclicity, or trend, is taken. Average demand

Graph 1

Total Derived Demand for Sand and Gravel and Crushed Stone By Year



over the total forecast period is determined based upon the implied cyclical upper and lower bounds.

The primary determinants of construction activity are exogenous to the indsutry itself. Future activity, and hence demand for construction minerals, will be closely tied to the area's overall business and residential climate. The number of factors involved in determining this climate are manifold, e.g. taxation, cost of living, zoning. No accurate means for forecasting these trends exists.

Therefore, to predict trends in consumption of coarse and fine aggregates in the GNYMA for the period 1980-2000, a judgemental approach was used. Judgmental forecasting is, to a certain extent, a seat-of-the-pants approach, relying on the intuition of the forecaster and careful realistic assumptions with regard to macro factors rather than upon formal models. While we recognize the limitations of such forecasts, we feel that such a methodology will provide results which are valid for the policy planning process, particularly since our approach is based upon the determinants of demand for these materials.

## 4.1 Procedure

First we classified individual counties based upon population forecasts and past population data for the study area. Population forecasts and past data were obtained from the Tri-State Regional Planning Commission (10). We used the following decision rules:

1. If a county's projected growth for the period 1970-2000 was greater than 50%, it was classified as a growth plus county: "G+".
2. If a county's projected growth was greater than 10%, it was classified as a growth county: "G".

3. If a county's projected growth was between -10% and +10%, it was classified as a stable county: "S".

4. If a county's projected growth was less than -10%, it was classified as a declining county: "D".

Upon classification, we made a projection of future levels of demand based upon the following rules:

1. For each county, the 1970-1975 period was examined for the maximum and minimum levels of demand.

2. If a county was classified as growth plus, a projected level of [.9 (max-min) + min] was used to forecast average demand.

3. If the county was classified as growth, a projected level of [.75 (max-min) + min] was used.

4. If the county was classified as stable, a projected level of [.5 (max-min) + min] was used.

5. If the county was classified as declining, a projected level of [.25 (max-min) + min] was used.

6. Two counties, Nassau and Westchester, fell between the stable and growth designations. (S G and G S respectively) For these counties a projected level of [.625 (max-min) + min] was used.

Though the data do not indicate that any county within our study area will fall into "declining" category, we include this category for completeness.

4.2 Results

Our forecasts, by county, of demand for sand and gravel and crushed stone for the period are shown in Table 10.

As noted above, these are estimates of long range average demand, we must also caution the reader that these are largely based upon the projections of planning agencies whose methods of data collection and analysis were not subject to our scrutiny. Thus the data in Table 10 should be considered as "surprise free" projections; in that they implicitly assume that the future will be significantly similar to the recent past. A subsequent report will utilize these data in considering the long range economic viability of an offshore construction aggregates mining industry.

5. Conclusions

The data analysis system discussed in this report has as data inputs the following:

1. US Bureau of the Census construction permit activity (computer) tapes (16) which are available for any area in the country;
2. The SF-15 series of Highway Finance covering highway construction and maintenance for areas within the SMSAs;
3. Reports by local supervisors and highway departments (or available state data);
4. The updated matrix of technic coefficients presented in this paper.

This information is readily available and avoids the necessity for expensive surveys. The computer system described in our working paper (7) is readily usable on most computers with Cobol and Fortran IV capabilities.

Using this system, we have derived the historical demands for construction aggregates for the years 1970-1975. Clearly, this analysis reflects the highly cyclical demand for aggregates. This result was not exhibited in previous work (4), due to fairly stable levels of construction activity over the years studied.

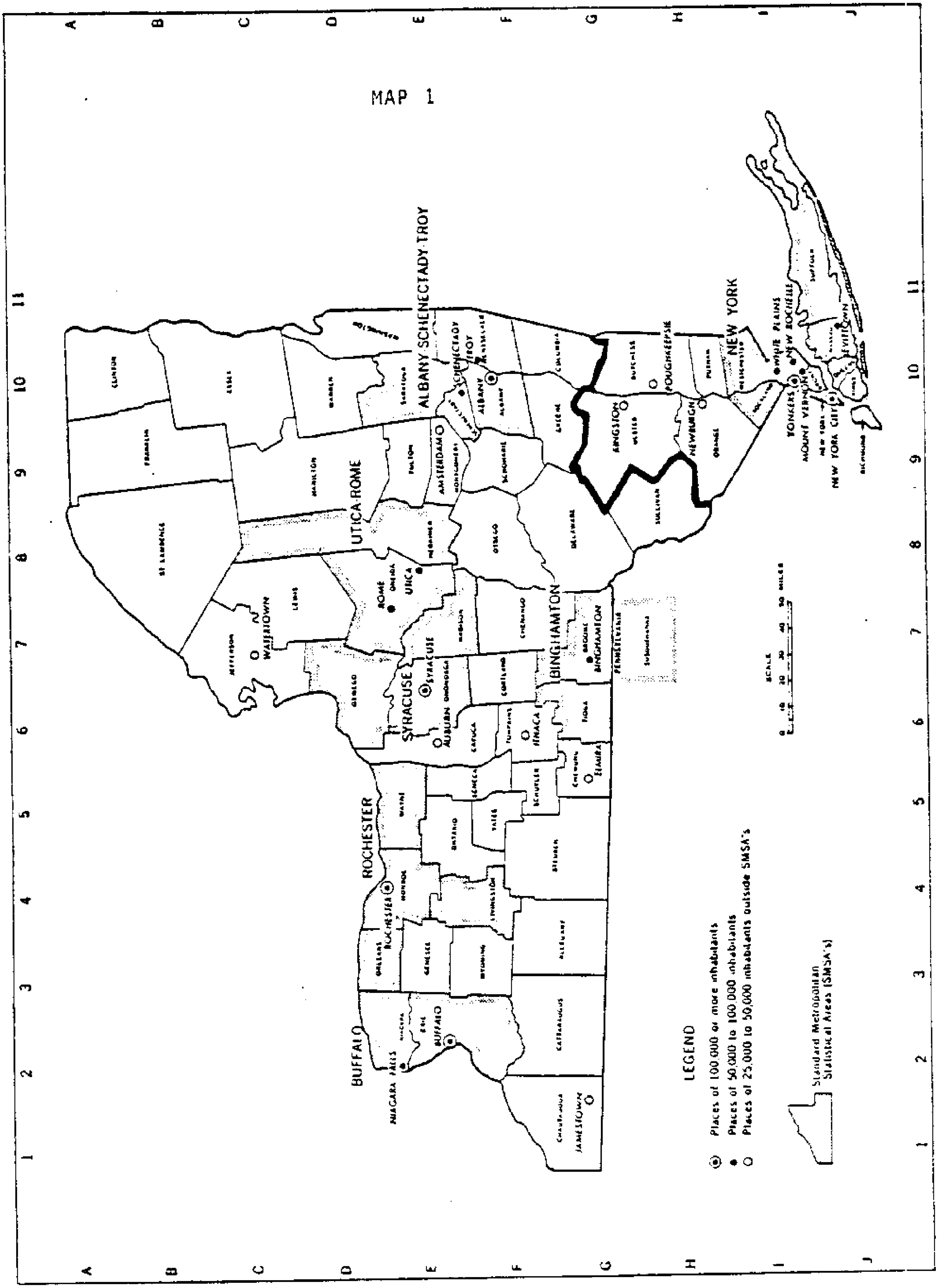
Due to limitations in consistency, quality and availability of current and past data, we feel that a systematic error has been introduced into the estimation procedure, which will tend to cause underestimation of demand. For example, the construction permit activity data used will not report on construction for which no permit was required or on activities where a permit, though required, was not obtained (e.g., patios, porches, stairs). Similarly, highway construction and maintenance data may not include private roads or new streets paved at a developer's expense. As noted before, Bronitsky estimated his total error as below 8%. We believe that, because of the availability of better and more complete data, our accuracy is greater.

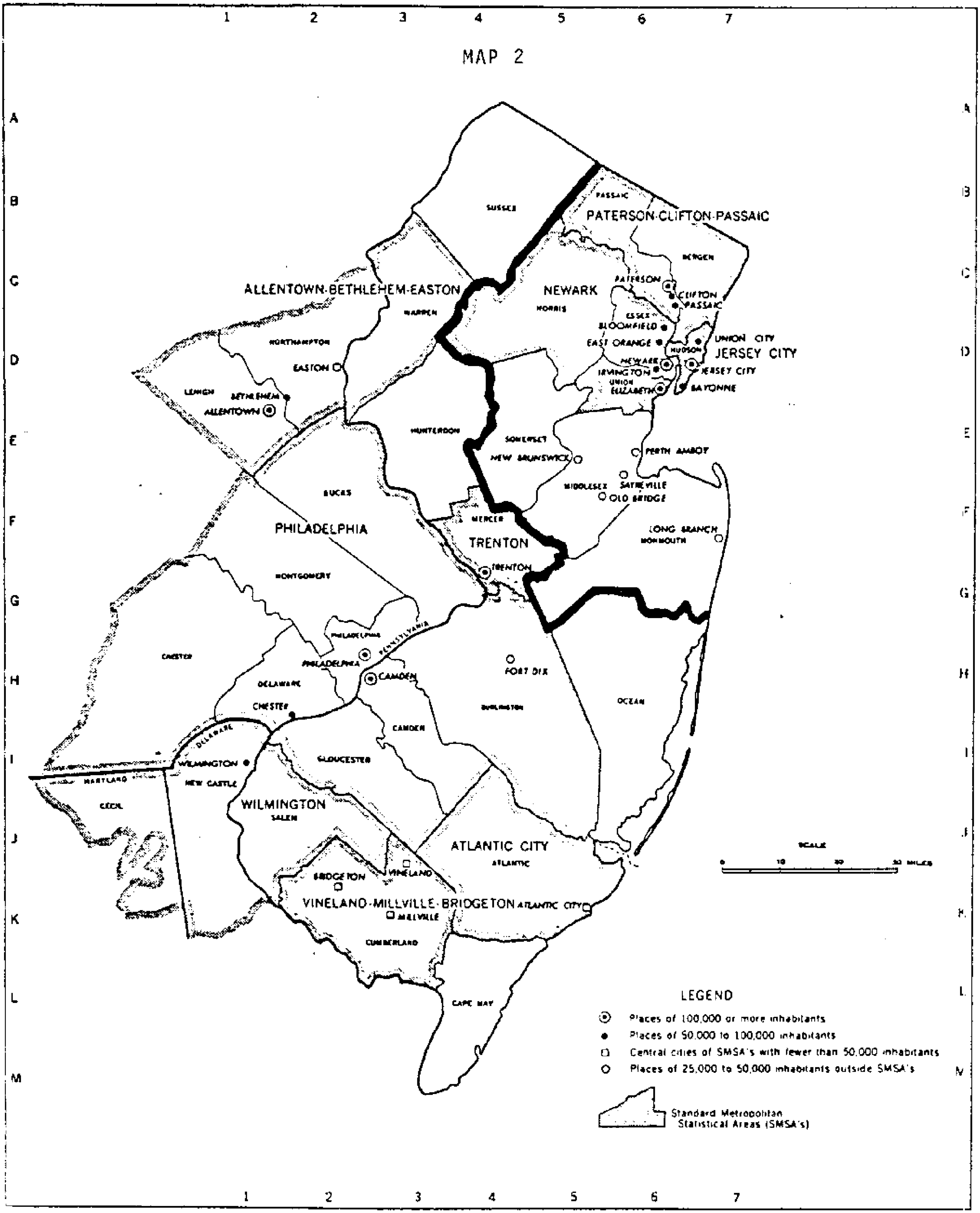
Our forecast method provides a crude estimate of actual annual demand. Our results provide á realistic accurate forecast of long-range average demand.

Perhaps our most dangerous assumption was the "stability" of the GNYMA. This implies both "economic" and technological consistency over time. We believe that we have adequately considered "economic" factors in our methodology. While we have established the consistency of construction technology for the period 1963-1975, we believe that technological changes (possibly brought on by resource or energy considerations) could cause a significant deviation from our forecasts.

Finally, we must emphasize that our forecast method is only one of the many possible methods. The detailed breakdown of past demand by county (Table 6) is included to assist that reader in developing other, or more localized, forecasts.

MAP 1


BUFFALO
ROCHESTER
SYRACUSE
UTICA-ROME
BINGHAMTON
ALBANY-SCHENECTADY-TROY
NEW YORK
LEGEND
Places of 100,000 or more inhabitants
Places of 50,000 to 100,000 inhabitants
Places of 25,000 to 50,000 inhabitants outside SMSA's
Standard Metropolitan Statistical Areas (SMSA's)


MAP 2
ALLENTOWN-BETHLEHEM-EASTON
PATERSON-CLIFTON-PASSAIC
NEWARK
JERSEY CITY
PHILADELPHIA
TRENTON
WILMINGTON
ATLANTIC CITY
VINELAND-MILLVILLE-BRIDGETON
SUSSEX
PASSAIC
BERGEN
MORRIS
ESSEX
HUDSON
UNION
WARREN
NORTHAMPTON
LEHIGH
HUNTERDON
SOMERSET
MIDDLESEX
MONMOUTH
MERCER
BUCKS
MONTGOMERY
CHESTER
DELAWARE
PHILADELPHIA
BURLINGTON
OCEAN
CAMDEN
GLOUCESTER
NEW CASTLE
SALEM
CECIL
ATLANTIC
CUMBERLAND
CAPE MAY
PATERSON
CLIFTON
PASSAIC
BLOOMFIELD
EAST ORANGE
UNION CITY
NEWARK
IRVINGTON
ELIZABETH
JERSEY CITY
BAYONNE
EASTON
BETHLEHEM
ALLENTOWN
PERTH AMBOY
NEW BRUNSWICK
SAYREVILLE
OLD BRIDGE
LONG BRANCH
TRENTON
FORT DIX
PHILADELPHIA
CAMDEN
CHESTER
WILMINGTON
BRIDGETON
VINELAND
MILLVILLE
ATLANTIC CITY
PENNSYLVANIA
DELAWARE
MARYLAND
SCALE
0 10 20 30 MILES
LEGEND
Places of 100,000 or more inhabitants
Places of 50,000 to 100,000 inhabitants
Central cities of SMSA's with fewer than 50,000 inhabitants
Places of 25,000 to 50,000 inhabitants outside SMSA's
Standard Metropolitan Statistical Areas (SMSA's)

MAP 3

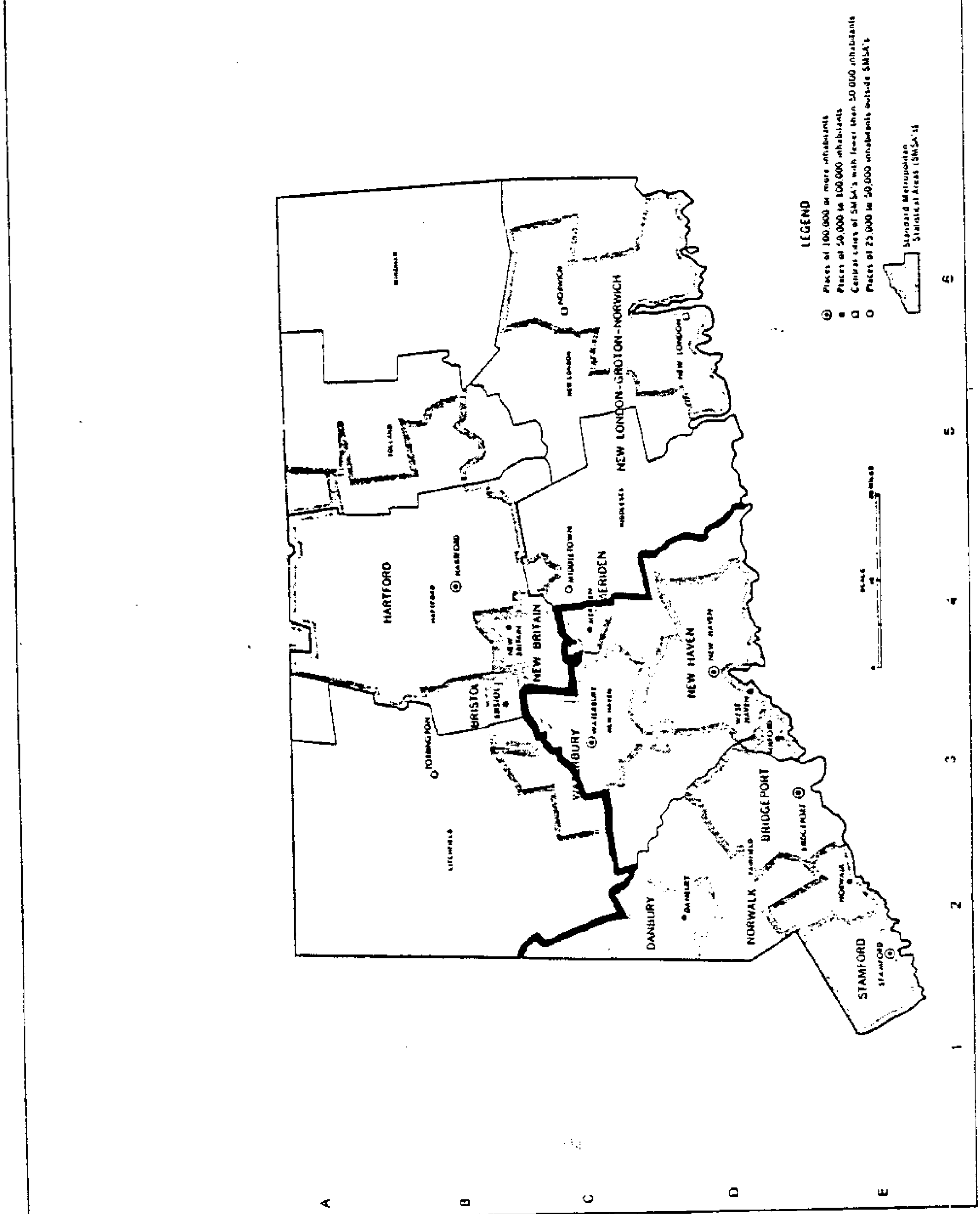

LEGEND
Places of 100,000 or more inhabitants
Places of 50,000 to 100,000 inhabitants
Central cities of SMSA's with fewer than 50,000 inhabitants
Places of 25,000 to 50,000 inhabitants outside SMSA's
Standard Metropolitan Statistical Areas (SMSA's)
HARTFORD
NEW BRITAIN
BRISTOL
WATERBURY
MERIDEN
NEW HAVEN
BRIDGEPORT
NORWALK
STAMFORD
DANBURY
NEW LONDON-GROTON-NORWICH

Table 2

Tons of Sand and Gravel and Crushed Stone Consumed per $1,000 of Construction Type

(1963 Dollars)

| Construction Type | Total Consumed Directly and Indirectly | |
|---|---|---|
| | Sand and Gravel | Crushed Stone |
| Single Family Houses | 4.651 | 2.498 |
| 2-4 Family Houses | 3.855 | 2.331 |
| 5 or more Family Houses | 6.283 | 2.789 |
| Additions or Alterations Residential | 1.349 | 0.690 |
| Hotels and Motels | 3.750 | 1.873 |
| Religious Buildings | 4.567 | 2.649 |
| Industrial Buildings | 4.826 | 2.843 |
| Parking Garages and Service Stations | 4.081 | 1.300 |
| Hospitals | 4.422 | 3.656 |
| Office and Professional Buildings | 3.558 | 2.125 |
| Stores and Restaurants | 5.300 | 3.424 |
| Schools and Dormitories | 4.677 | 3.208 |
| Public Works and Utility Buildings | 4.046 | 2.299 |
| Other Non-Residential Buildings | 4.474 | 2.004 |
| Other Non-Buildings | 4.269 | 4.101 |
| Additions and Alterations Non-Residential | 3.744 | 4.206 |
| Highways | 22.626 | 21.757 |
| Repair and Maintenance Highways | 56.142 | 37.240 |

Table 3

Normalized Construction Indices
(1963 = 1.000)

| Index | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 |
|---|---|---|---|---|---|---|
| B1 | 1.4384 | 1.5599 | 1.7123 | 1.8699 | 2.0240 | 2.1558 |
| B2 | 1.4608 | 1.5836 | 1.7065 | 1.8072 | 1.9761 | 2.1706 |
| B3 | 1.4555 | 1.5788 | 1.7123 | 1.8253 | 2.0223 | 2.2329 |
| HW | 1.3387 | 1.4839 | 1.6129 | 1.7581 | 2.1290 | 2.3710 |
| FHI | 1.4544 | 1.5248 | 1.6000 | 1.7648 | 2.3360 | 2.3600 |

Legend:

B1: Residential (BOECKH)
B2: Apartments (BOECKH)
B3: Commercial (BOECKH)
HW: Public utilities (Handy-Whitman)
FHI: Federal highway index (Composite)

Table 4

Tons of Sand and Gravel (S&G) and Crushed Stone (CS) Consumed Per $1000 of Construction Type

| | Normalized Index Applied | 1970 S&G | 1970 CS | 1971 S&G | 1971 CS | 1972 S&G | 1972 CS | 1973 S&G | 1973 CS | 1974 S&G | 1974 CS | 1975 S&G | 1975 CS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Single Family | B1 | 3.233 | 1.737 | 2.982 | 1.601 | 2.716 | 1.459 | 2.487 | 1.336 | 2.298 | 1.234 | 2.157 | 1.159 |
| Two Family | B2 | 2.639 | 1.596 | 2.434 | 1.472 | 2.259 | 1.366 | 2.133 | 1.290 | 1.951 | 1.180 | 1.776 | 1.074 |
| 3 & 4 Family | B2 | 2.639 | 1.596 | 2.434 | 1.472 | 2.259 | 1.366 | 2.133 | 1.290 | 1.951 | 1.180 | 1.776 | 1.074 |
| 5 or More Family | B2 | 4.301 | 6.210 | 3.968 | 5.729 | 3.682 | 5.316 | 3.477 | 5.020 | 3.179 | 4.591 | 2.895 | 4.179 |
| Hotels & Motels | B2 | 2.567 | 3.849 | 2.368 | 3.551 | 2.197 | 3.295 | 2.075 | 3.111 | 1.898 | 2.846 | 1.728 | 2.591 |
| Other (e.g. camps) | B2 | 2.567 | 3.849 | 2.368 | 3.551 | 2.197 | 3.295 | 2.075 | 3.111 | 1.898 | 2.846 | 1.728 | 2.591 |
| Additions (Residential) | B2 | .923 | 1.395 | .852 | 1.288 | .791 | 1.195 | .746 | 1.128 | .683 | 1.032 | .621 | .939 |
| Single Family (Public) | B1 | 3.233 | 1.737 | 2.982 | 1.601 | 2.716 | 1.459 | 2.487 | 1.336 | 2.298 | 1.234 | 2.157 | 1.159 |
| Two Family (Public) | B2 | 2.639 | 1.596 | 2.434 | 1.472 | 2.259 | 1.366 | 2.133 | 1.290 | 1.951 | 1.180 | 1.776 | 1.074 |
| 3 & 4 Family (Public) | B2 | 2.639 | 1.596 | 2.434 | 1.472 | 2.259 | 1.366 | 2.133 | 1.290 | 1.951 | 1.180 | 1.776 | 1.074 |
| 5 or More Family (Public) | B2 | 4.301 | 6.210 | 3.968 | 5.729 | 3.682 | 5.316 | 3.477 | 5.020 | 3.179 | 4.591 | 2.895 | 4.179 |
| Amusements | B2 | 3.304 | 5.250 | 3.047 | 4.843 | 2.828 | 4.494 | 2.670 | 4.244 | 2.442 | 3.881 | 2.223 | 3.533 |
| Religious | B2 | 3.126 | 4.940 | 2.884 | 4.557 | 2.676 | 4.229 | 2.527 | 3.993 | 2.311 | 3.652 | 2.104 | 3.324 |
| Industrial | B3 | 3.316 | 5.269 | 3.057 | 4.857 | 2.818 | 4.479 | 2.644 | 4.202 | 2.386 | 3.792 | 2.161 | 3.435 |
| Parking Garages | B3 | 2.804 | 3.697 | 2.585 | 3.408 | 2.383 | 3.143 | 2.236 | 2.948 | 2.018 | 2.661 | 1.828 | 2.410 |
| Garages (Residential) | B2 | .923 | 1.395 | .852 | 1.288 | .791 | 1.195 | .746 | 1.128 | .683 | 1.032 | .621 | .939 |
| Service Stations | B3 | 2.804 | 3.697 | 2.585 | 3.408 | 2.383 | 3.143 | 2.236 | 2.948 | 2.018 | 2.661 | 1.828 | 2.410 |
| Hospitals | B2 | 3.027 | 5.530 | 2.792 | 5.101 | 2.591 | 4.734 | 2.447 | 4.470 | 2.238 | 4.088 | 2.637 | 3.722 |
| Banks | B2 | 2.436 | 3.890 | 2.247 | 3.589 | 2.085 | 3.330 | 1.969 | 3.145 | 1.801 | 2.876 | 1.639 | 2.618 |
| Public Works | H.W. | 3.022 | 4.740 | 2.727 | 4.276 | 2.509 | 3.934 | 2.301 | 3.609 | 1.900 | 2.980 | 1.706 | 2.676 |
| Schools & Dormitories | B2 | 3.195 | 5.398 | 2.947 | 4.979 | 2.735 | 4.621 | 2.582 | 4.363 | 2.361 | 3.990 | 2.150 | 3.633 |
| Stores & Restaurants | B3 | 3.642 | 5.994 | 3.357 | 5.526 | 3.095 | 5.095 | 2.904 | 4.779 | 2.621 | 4.314 | 2.374 | 3.907 |
| Other Non-Residential | B3 | 3.074 | 4.451 | 2.834 | 4.103 | 2.613 | 3.783 | 2.451 | 3.549 | 2.212 | 3.203 | 2.004 | 2.901 |
| Other Structures | B3 | 2.933 | 5.751 | 2.704 | 5.301 | 2.493 | 4.888 | 2.339 | 4.586 | 2.111 | 4.139 | 1.912 | 3.748 |
| Additions (Non-Residential) | B3 | 2.572 | 5.462 | 2.371 | 5.035 | 2.187 | 4.643 | 2.051 | 4.355 | 1.851 | 3.931 | 1.677 | 3.560 |
| Highway Construction | FHI | 15.557 | 14.959 | 14.839 | 14.269 | 14.141 | 13.598 | 12.821 | 12.328 | 9.686 | 9.314 | 9.587 | 9.219 |
| Highway Maintenance | FHI | 38.601 | 25.605 | 36.819 | 24.423 | 35.089 | 23.275 | 31.812 | 21.102 | 24.033 | 15.942 | 23.789 | 15.779 |

Table 5
Sample Page Construction Activity Report 1 Suffolk County 1975

CENSUS BUREAU CONSTRUCTION PERMITS DATA (1975)

| Construction Type | Cost (Dollars) | # of Buildings | # of Units |
|---|---|---|---|
| Single Family Houses . . . . . . . . . . . . . . . . . . | 125399558 | 6916 | 6916 |
| Two Family Houses . . . . . . . . . . . . . . . . . . | 528883 | 17 | 34 |
| Three and Four Family Houses . . . . . . . . . . . . . . | 3335295 | 64 | 199 |
| Five or More Family Houses . . . . . . . . . . . . . . . | 17401966 | 124 | 1154 |
| Hotels and Motels . . . . . . . . . . . . . . . . . . | 622000 | 4 | |
| Other (Camps and Lodges) . . . . . . . . . . . . . . . . | | | |
| Additions and Alterations (Residential) . . . . . . . . | 16839008 | | |
| One Family Houses (Publicly Owned Data) . . . . . . . . | | | |
| Two Family Houses. . . . . . . . . . . . . . . . . . . | | | |
| Three and Four Family Houses . . . . . . . . . . . . . . | | | |
| Five or More Family Houses . . . . . . . . . . . . . . . | | | |
| Amusement and Recreation Buildings . . . . . . . . . . . | 458060 | 12 | |
| Religious Buildings . . . . . . . . . . . . . . . . . . | 287000 | 4 | |
| Industrial Buildings . . . . . . . . . . . . . . . . . | 47400809 | 68 | |
| Parking Garages (Public) . . . . . . . . . . . . . . . . | 20306 | 3 | |
| Garages (Residential) . . . . . . . . . . . . . . . . . | 1737401 | 597 | |
| Service Stations and Repair Garages . . . . . . . . . . | 77600 | 2 | |
| Hospitals . . . . . . . . . . . . . . . . . . . . . . | 1937832 | 7 | |
| Banks and Professional Buildings . . . . . . . . . . . . | 4155104 | 38 | |
| Public Works and Utilities . . . . . . . . . . . . . . . | 2549803 | 10 | |
| Schools and Dormitories . . . . . . . . . . . . . . . . | 40600 | 2 | |
| Stores and Restaurants . . . . . . . . . . . . . . . . . | 15159777 | 149 | |
| Other Non Residential Buildings . . . . . . . . . . . . | 5207745 | 699 | |
| Structures-Other-Than-Buildings . . . . . . . . . . . . | 7613913 | 2530 | |
| Additions and Alterations (Non-Residential) . . . . . . | 7636409 | | |

Table 6
Sample Page Construction Activity Report 2 Suffolk County 1975

CENSUS BUREAU CONSTRUCTION PERMITS DATA (1975)

| Construction Type | Tons Sand & Gravel | # of Buildings | # of Units |
|---|---|---|---|
| Single Family Houses | 270542 | 6916 | 6916 |
| Two Family Houses | 939 | 17 | 34 |
| Three and Four Family Houses | 5924 | 64 | 199 |
| Five or More Family Houses | 50372 | 124 | 1154 |
| Hotels and Motels | 1075 | 4 | |
| Other (Camps and Lodges) | | | |
| Additions and Alterations (Residential) | 10465 | | |
| One Family Houses (Publicly Owned Data) | | | |
| Two Family Houses | | | |
| Three and Four Family Houses | | | |
| Five or More Family Houses | | | |
| Amusement and Recreation Buildings | 1018 | 12 | |
| Religious Buildings | 604 | 4 | |
| Industrial Buildings | 102448 | 68 | |
| Parking Garages (Public) | 37 | 3 | |
| Garages (Residential) | 1080 | 597 | |
| Service Stations and Repair Garages | 142 | 2 | |
| Hospitals | 3948 | 7 | |
| Banks and Professional Buildings | 6811 | 38 | |
| Public Works and Utilities | 4351 | 10 | |
| Schools and Dormitories | 87 | 2 | |
| Stores and Restaurants | 35983 | 149 | |
| Other Non-Residential Buildings | 10435 | 699 | |
| Structures-Other-Than-Buildings | 14557 | 2530 | |
| Additions and Alterations (Non-Residential) | 12804 | | |
| Total Tons of Sand and Gravel | 533622 | | |

Table 7

Sample Page Highway Construction and Maintenance Activity Report 1975*

HIGHWAY DATA ESTIMATES SAND & GRAVEL YEAR 1975

| County | Tons (Capital) | Tons (Maintenance) | Tons |
|---|---|---|---|
| New York | 648350 | 15154 | 663503 |
| Nassau | 149217 | 18199 | 167415 |
| Suffolk | 131413 | 47935 | 179348 |
| Rockland | 51637 | 12894 | 64531 |
| Westches | 270687 | 47578 | 318265 |
| Dutchess | 56901 | 42820 | 99721 |
| Putnam | 11035 | 15534 | 26569 |
| Orange | 0 | 0 | 0 |
| Ulster | 0 | 0 | 0 |
| Bergen | 97014 | 39371 | 136385 |
| Essex | 419703 | 21220 | 440922 |
| Hudson | 75893 | 10443 | 86336 |
| Passaic | 15896 | 18532 | 34427 |
| Union | 106860 | 23575 | 130435 |
| Richmond | 0 | 0 | 0 |
| Morris | 100695 | 56761 | 157456 |
| Somerset | 10613 | 42868 | 53481 |
| Middlesex | 56153 | 51313 | 107466 |
| Monmouth | 95480 | 70653 | 166133 |
| Fairfiel | 0 | 0 | 0 |
| N Haven | 12272 | 70178 | 82449 |
| Grand Total | 2914835 | | |

*Note: Counties requiring judgemental estimates produce no entries in this report.

Table 8

Derived Demand for Sand and Gravel by County

| Year | New York+ | Nassau | Suffolk | Rockland | Westchester | Dutchess | Putnam |
|---|---|---|---|---|---|---|---|
| | Highway | | (Sand & Gravel | Tons x $10^3$) | | | |
| 70 | 77.9 | 200.6 | 658.7 | 76.6 | 696.5 | 70* | 30* |
| 71 | 1071.7 | 86.8 | 235.0 | 16.7 | 190.2 | 70* | 30* |
| 72 | 1688.1 | 139.6 | 560.1 | 35.6 | 760.8 | 670.7** | 30* |
| 73 | 441.4 | 403.3 | 79.3 | 97.4 | 364.4 | 76.1 | 21.1 |
| 74 | 484.0 | 190.7 | 150.3 | 46.0 | 354.6 | 86.9 | 45.5 |
| 75 | 663.5 | 167.4 | 179.3 | 64.5 | 318.3 | 99.7 | 26.6 |
| | Construction | | | | | | |
| 70 | 2350.0 | 367.7 | 985.0 | 154.6 | 415.0 | 85.1 | 38.9 |
| 71 | 2106.4 | 452.1 | 1630.2 | 252.0 | 496.1 | 158.5 | 46.7 |
| 72 | 2418.5 | 351.6 | 954.4 | 180.2 | 379.2 | 140.8 | 60.4 |
| 73 | 2462.9 | 280.0 | 963.3 | 128.9 | 496.3 | 205.4 | 76.3 |
| 74 | 1350.6 | 244.4 | 595.4 | 81.1 | 429.1 | 178.4 | 41.6 |
| 75 | 432.9 | 171.0 | 533.6 | 53.3 | 280.1 | 79.9 | 29.3 |
| | Total | | | | | | |
| 70 | 2427.9 | 568.3 | 1643.7 | 231.2 | 1111.5 | 155.1 | 68.9 |
| 71 | 3178.1 | 538.9 | 1865.2 | 268.7 | 686.3 | 228.5 | 76.7 |
| 72 | 4166.6 | 491.2 | 1514.5 | 215.8 | 1140.0 | 811.5*** | 90.4 |
| 73 | 2904.3 | 683.3 | 1042.6 | 226.3 | 860.7 | 281.5 | 97.4 |
| 74 | 1834.6 | 435.1 | 745.7 | 127.1 | 783.7 | 265.3 | 87.1 |
| 75 | 1096.4 | 338.4 | 712.9 | 117.8 | 598.4 | 179.6 | 55.9 |

+Includes Five Counties   *Judgemental Estimate   **Reflects non-Recurring Highway Construction

***Not used in Forecast

Table 8 - (cont'd)

| | Orange | Ulster | Bergen (Sand and Gravel) | Essex Tons $\times 10^3$ | Hudson | Passaic |
|---|---|---|---|---|---|---|
| 70 | 150* | 30* | 463.8 | 539.1 | 59.1 | 458.0 |
| 71 | 150* | 30* | 425.6 | 456.0 | 82.1 | 308.1 |
| 72 | 150* | 30* | 160.8 | 401.4 | 164.2 | 206.7 |
| 73 | 150* | 30* | 225.5 | 322.5 | 143.4 | 185.0 |
| 74 | 150* | 30* | 171.0 | 373.6 | 47.2 | 81.6 |
| 75 | 150* | 30* | 136.4 | 440.9 | 86.3 | 34.4 |
| | | | | | | |
| 70 | 130.2 | 28.2 | 494.0 | 286.8 | 140.0 | 170.8 |
| 71 | 148.5 | 46.8 | 485.1 | 263.7 | 158.5 | 132.9 |
| 72 | 208.0 | 57.2 | 586.4 | 222.0 | 198.4 | 199.2 |
| 73 | 158.2 | 58.4 | 516.7 | 245.7 | 250.4 | 182.3 |
| 74 | 105.4 | 18.3 | 326.1 | 160.4 | 197.7 | 138.2 |
| 75 | 110.9 | 33.2 | 244.4 | 135.8 | 108.6 | 107.5 |
| | | | | | | |
| 70 | 280.2* | 58.2 | 957.8 | 825.9 | 199.1 | 628.8 |
| 71 | 298.5 | 76.8 | 910.7 | 719.7 | 240.6 | 441.0 |
| 72 | 358.0 | 87.2 | 742.2 | 623.4 | 362.6 | 405.9 |
| 73 | 308.2 | 88.4 | 742.2 | 568.2 | 393.8 | 367.3 |
| 74 | 255.4 | 48.3 | 497.1 | 534.0 | 244.9 | 219.8 |
| 75 | 260.9 | 63.2 | 380.8 | 576.7 | 194.9 | 141.9 |

Table 8 (cont'd)

| | Union | Morris | Somerset | Middlesex | Monmouth | Fairfield | New Haven | Total |
|---|---|---|---|---|---|---|---|---|
| | | | | (Sand and Gravel | | Tons x $10^3$) | | |
| 70 | 132.3 | 450.6 | 70* | 300* | 300* | 300* | 160* | 5473 |
| 71 | 142.1 | 550* | 70* | 350* | 300* | 400* | 160* | 5124 |
| 72 | 160.2 | 652.8 | 70* | 491.9 | 300* | 400* | 179.3 | 7742 |
| 73 | 223.9 | 339.8 | 76.4 | 331.3 | 376.2 | 400* | 154.6 | 4442 |
| 74 | 288.2 | 226.5 | 74.2 | 166.4 | 333.0 | 400* | 139.2 | 3842 |
| 75 | 130.4 | 157.5 | 53.5 | 107.5 | 166.1 | 300* | 82.4 | 3395 |
| 70 | 238.0 | 388.8 | 132.8 | 316.4 | 280.8 | 395.6 | 507.7 | 7857 |
| 71 | 193.6 | 306.8 | 120.6 | 369.6 | 370.8 | 575.2 | 441.6 | 8156 |
| 72 | 162.0 | 293.2 | 320.7 | 388.1 | 405.6 | 620.0 | 464.5 | 8671 |
| 73 | 148.3 | 299.9 | 249.3 | 246.9 | 504.4 | 588.4 | 504.4 | 8536 |
| 74 | 108.1 | 182.7 | 221.6 | 361.4 | 211.5 | 384.7 | 254.6 | 5591 |
| 75 | 82.7 | 175.2 | 121.8 | 223.5 | 163.0 | 362.3 | 221.5 | 3670 |
| 70 | 370.3 | 839.4 | 202.8 | 616.4 | 580.8 | 695.6 | 667.7 | 13330 |
| 71 | 335.7 | 856.8 | 190.6 | 719.6 | 670.8 | 975.2 | 601.6 | 13280 |
| 72 | 322.2 | 946.0 | 390.7 | 879.0 | 705.6 | 1020.0 | 643.8 | 16413 |
| 73 | 372.2 | 639.7 | 325.7 | 578.2 | 880.6 | 988.4 | 659.0 | 12978 |
| 74 | 396.3 | 409.2 | 295.8 | 527.8 | 544.5 | 784.7 | 393.8 | 9433 |
| 75 | 213.1 | 332.7 | 175.3 | 331.0 | 329.1 | 662.3 | 303.9 | 7065 |

Table 8

Derived Demand for Crushed Stone by County

(Crushed Stone Tons x $10^3$)

| Year | New York[+] | Nassau | Suffolk | Rockland | Westchester | Dutchess | Putnam |
|---|---|---|---|---|---|---|---|
| | Highway | | | | | | |
| 70 | 51.6 | 170.2 | 602.2 | 64.9 | 645.9 | 60* | 25* |
| 71 | 1014.3 | 76.1 | 210.0 | 11.4 | 166.4 | 65* | 25* |
| 72 | 1616.9 | 125.8 | 516.9 | 28.1 | 709.7 | 625.1 | 25* |
| 73 | 419.9 | 381.4 | 59.4 | 89.1 | 334.2 | 58.3 | 15.5 |
| 74 | 461.1 | 178.1 | 131.4 | 40.5 | 327.9 | 71.5 | 42.5 |
| 75 | 633.5 | 155.6 | 158.1 | 58.2 | 291.9 | 83.1 | 20.9 |
| | Construction | | | | | | |
| 70 | 3551.4 | 514.7 | 1135.8 | 183.6 | 550.9 | 85.7 | 32.4 |
| 71 | 3114.8 | 616.2 | 1065.2 | 303.1 | 668.8 | 182.0 | 37.8 |
| 72 | 3626.7 | 464.2 | 936.0 | 197.7 | 498.5 | 151.2 | 58.8 |
| 73 | 3743.7 | 391.9 | 1070.9 | 136.1 | 697.2 | 228.8 | 81.1 |
| 74 | 1972.3 | 337.3 | 645.9 | 86.2 | 597.4 | 217.1 | 39.9 |
| 75 | 642.6 | 230.9 | 562.0 | 60.6 | 373.2 | 76.5 | 25.3 |
| | Total | | | | | | |
| 70 | 3603 | 684.9 | 1738.0 | 248.5 | 1196.8 | 145.7 | 57.4 |
| 71 | 4129.1 | 692.3 | 1275.2 | 314.5 | 835.2 | 247.0 | 62.8 |
| 72 | 5243.6 | 590.0 | 1452.9 | 225.8 | 1208.2 | 776.3*** | 83.8 |
| 73 | 4163.6 | 773.3 | 1130.3 | 225.2 | 1031.4 | 287.6 | 96.6 |
| 74 | 2433.4 | 515.4 | 777.3 | 126.7 | 925.3 | 288.6 | 82.4 |
| 75 | 1276.1 | 386.5 | 720.1 | 118.8 | 665.1 | 159.6 | 46.2 |

Table 8 (cont'd)

| | Orange | Ulster | Bergen (Crushed Stone | Essex Tons x $10^3$) | Hudson | Passaic |
|---|---|---|---|---|---|---|
| 70 | 140* | 25* | 432.0 | 512.2 | 53.0 | 434.0 |
| 71 | 140* | 25* | 401.1 | 434.8 | 76.7 | 292.5 |
| 72 | 140* | 25* | 149.3 | 378.8 | 153.5 | 191.1 |
| 73 | 140* | 25* | 208.0 | 306.0 | 135.5 | 173.6 |
| 74 | 140* | 25* | 154.6 | 354.1 | 42.8 | 73.7 |
| 75 | 140* | 25* | 119.4 | 417.7 | 79.9 | 27.6 |
| | | | | | | |
| 70 | 145.0 | 36.1 | 676.3 | 438.6 | 206.7 | 242.7 |
| 71 | 140.2 | 42.2 | 639.3 | 386.4 | 246.1 | 163.4 |
| 72 | 212.7 | 59.9 | 781.3 | 310.0 | 287.7 | 272.6 |
| 73 | 150.3 | 64.9 | 685.4 | 355.6 | 384.3 | 249.7 |
| 74 | 110.7 | 13.0 | 449.6 | 234.4 | 300.3 | 206.8 |
| 75 | 138.0 | 37.8 | 327.9 | 191.2 | 166.2 | 154.8 |
| | | | | | | |
| 70 | 285.0 | 61.1 | 1108.3 | 950.8 | 259.7 | 676.7 |
| 71 | 280.2 | 67.2 | 1040.4 | 821.2 | 322.8 | 455.9 |
| 72 | 352.7 | 84.9 | 930.6 | 688.8 | 441.2 | 463.7 |
| 73 | 290.3 | 89.9 | 893.4 | 661.6 | 519.8 | 423.3 |
| 74 | 250.7 | 38.0 | 604.2 | 588.5 | 343.1 | 280.5 |
| 75 | 278.0 | 62.8 | 447.3 | 608.9 | 246.1 | 182.4 |

Table 8 (cont'd)

(Crushed Stone Tons x $10^3$)

| | Union | Morris | Sommerset | Middlesex | Monmouth | Fairfield | New Haven | Total |
|---|---|---|---|---|---|---|---|---|
| 70 | 119.0 | 416.2 | 65* | 285* | 285* | 285* | 150* | 5040 |
| 71 | 131.9 | 525* | 65* | 335* | 285* | 380* | 150* | 4180 |
| 72 | 144.8 | 608.1 | 65* | 451.1 | 285* | 380* | 149.2 | 7220 |
| 73 | 210.2 | 315.8 | 63.7 | 306.9 | 346.6 | 380* | 127.4 | 4097 |
| 74 | 271.6 | 204.2 | 60.6 | 147.1 | 303.7 | 380* | 115.1 | 3527 |
| 75 | 118.4 | 134.5 | 38.6 | 88.0 | 138.7 | 285* | 58.4 | 3072 |
| | | | | | | | | |
| 70 | 347.8 | 412.1 | 161.5 | 406.1 | 337.3 | 434.3 | 670.8 | 10570 |
| 71 | 286.7 | 331.4 | 125.3 | 465.7 | 375.3 | 680.7 | 537.5 | 10408 |
| 72 | 219.0 | 322.4 | 440.5 | 495.8 | 432.5 | 772.7 | 570.0 | 11051 |
| 73 | 203.6 | 355.1 | 312.7 | 293.2 | 576.9 | 630.0 | 640.1 | 11252 |
| 74 | 157.4 | 211.2 | 309.0 | 522.1 | 251.7 | 449.3 | 302.6 | 7414 |
| 75 | 179.8 | 188.7 | 80.8 | 286.6 | 184.7 | 388.6 | 264.4 | 4561 |
| | | | | | | | | |
| 70 | 466.8 | 828.3 | 226.5 | 691.1 | 622.3 | 719.3 | 820.8 | 15610 |
| 71 | 418.6 | 856.4 | 190.3 | 800.7 | 660.3 | 1060.7 | 687.5 | 15218 |
| 72 | 363.8 | 930.5 | 505.5 | 946.9 | 717.5 | 1150.7 | 719.2 | 18270 |
| 73 | 413.8 | 670.9 | 376.4 | 600.1 | 923.5 | 1010.0 | 767.5 | 15348 |
| 74 | 429.0 | 415.4 | 369.6 | 669.2 | 555.4 | 829.3 | 417.7 | 10940 |
| 75 | 298.2 | 323.2 | 119.4 | 374.6 | 323.4 | 673.6 | 322.8 | 7633 |

Table 9

Summary of Judgmental Estimates and Their Potential Impact* Upon Derived Demand by Year

| | | Sand & Gravel | | Crushed Stone | |
|---|---|---|---|---|---|
| Year | Number of Counties Estimated | % Total Derived Demand | Impact | % Total Derived Demand | Impact* |
| 1970 | 9 | 10.6 | 2.1 | 8.5 | 1.7 |
| 1971 | 10 | 15.9 | 3.2 | 13.1 | 2.6 |
| 1972 | 6 | 6.0 | 1.2 | 5.0 | 1.0 |
| 1973 | 3 | 4.5 | .9 | 3.6 | .7 |
| 1974 | 3 | 6.2 | 1.2 | 5.0 | 1.0 |
| 1975 | 3 | 6.8 | 1.4 | 5.9 | 1.2 |

*Impact of a 20% error in these estimates, expressed as percent of total derived demand.

Table 10

Forecasted Average Annual Demand by County and Total Annual Demand for Sand and Gravel and Crushed Stone for 1980-2000 Tons x $10^3$

| County | Growth Type | Sand and Gravel | Crushed Stone |
|---|---|---|---|
| New York | S | 2630 | 3260 |
| Nassau | S->G | 550 | 630 |
| Suffolk | G+ | 1550 | 1640 |
| Rockland | G+ | 250 | 290 |
| Westchester | G->S | 940 | 1000 |
| Dutchess | G | 260 | 260 |
| Putnam | G+ | 90 | 100 |
| Orange | G | 330 | 330 |
| Ulster | G | 80 | 80 |
| Bergen | G | 810 | 940 |
| Essex | S | 680 | 770 |
| Hudson | S | 290 | 390 |
| Passaic | G | 510 | 550 |
| Union | S | 300 | 380 |
| Morris | G | 790 | 780 |
| Somerset | G | 340 | 410 |
| Middlesex | G | 740 | 800 |
| Monmouth | G | 740 | 770 |
| Fairfield | G | 850 | 1030 |
| New Haven | G | 570 | 700 |
| Total | | 13320 | 15110 |

FLOWCHART 1 - Calculation of Adjusted Technical Coefficients for Each Year in the Study Period

START

↓

Read technical coefficients in tons of sand and gravel or crushed stone used per 1000 of value (1963 dollars)

↓

Read cost indices for 1963, 1970-75 (B1, B2, B3, HW, FHI)

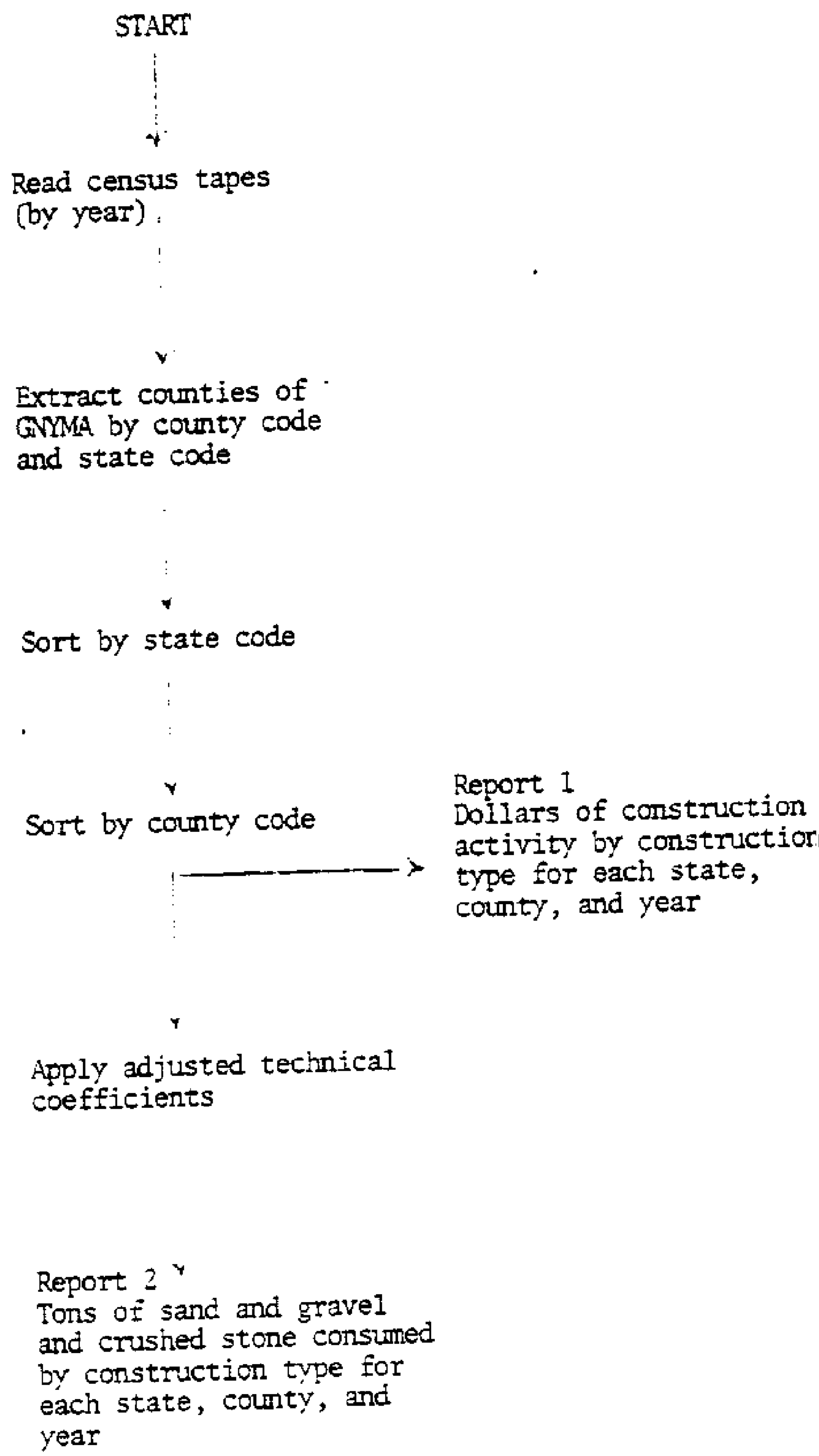
↓

Adjust Coefficients for 1970-75 by application of the appropriate index to individual indices

↓

Write adjusted coefficients, by year

FLOWCHART 2 - Evaluation of Construction Permit Activity Data



FLOWCHART 3 - Evaluation of Highway Construction And Maintenance Data (By Year)

START

Read construction and maintenance data (in dollars) by county

Apply adjusted technical coefficients

Report 3
Tons of sand and gravel and crushed stone consumed for construction and for maintenance by county for one year

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