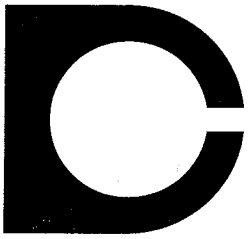
MINERAL LAND CLASSIFICATION: PORTLAND CEMENT CONCRETE AGGREGATE AND ACTIVE MINES OF ALL OTHER MINERAL COMMODITIES IN THE SAN LUIS OBISPO-SANTA BARBARA PRODUCTION-CONSUMPTION REGION

1989

CALIFORNIA DEPARTMENT OF CONSERVATION
DIVISION OF MINES AND GEOLOGY

SPECIAL REPORT 162



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1989

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EXECUTIVE SUMMARY

The San Luis Obispo-Santa Barbara Production-Consumption (P-C) Region, as defined in this report, covers approximately 2,062 square miles and includes the urbanizing portions of San Luis Obispo and Santa Barbara counties. In any urbanizing region it is important that land-use decisions be made with full recognition of the local natural resources. Mineral resources, including construction aggregate, are limited within a given region. This is especially true of Portland cement concrete (PCC) aggregate resources, an indispensable, high-grade construction aggregate which is costly to transport. This report provides information concerning the location, tonnage, and quality of aggregate resources in the San Luis Obispo-Santa Barbara P-C Region and the projected demand for aggregate for the next 50 years. This report also provides information on all other active mines and the mineral deposits being mined within the region.

The loss of regionally significant mineral deposits to land uses that preclude mining is one of the problems that the California Surface Mining and Reclamation Act of 1975 (SMARA) was framed to address. Based on guidelines adopted by the California State Mining and Geology Board (Board), the California Department of Conservation's Division of Mines and Geology (DMG) has classified land for Portland cement concrete (PCC) aggregate resources and all other mineral deposits being actively mined within the San Luis Obispo-Santa Barbara P-C Region. This classification study will assist the Board if a subsequent process, called designation, is initiated. Designation is the formal recognition by the Board of lands containing resources of regional or statewide significance that are needed to meet the demands of the future.

Both processes, classification and designation, require specific mandated actions by the lead agencies having jurisdiction over the resources identified in this report. These actions include:

1. Recognition of the mineral classification information including the classification maps transmitted to the lead agency by the Board.

2. Emphasis on the conservation and development of the identified mineral deposits.

The boundaries of the San Luis Obispo-Santa Barbara P-C Region were defined to include all areas within the two counties where PCC-grade aggregate is produced (the mining sites), and the market area where their product is consumed (the urban centers within the counties). The boundary was subsequently refined so that imports of aggregate from mines outside of the San Luis Obispo-Santa Barbara P-C Region or the adjacent Western Ventura County P-C Region were less than 5 percent of the total consumption (mines in the Western Ventura County P-C Region provide about 10 percent of the San Luis Obispo-Santa Barbara P-C Region demand), and aggregate exports out of the P-C region to more distant markets were less than 1 percent. The P-C region is therefore as near to a closed system as possible, with aggregate production nearly equal to aggregate consumption within it.

DMG has classified the San Luis Obispo-Santa Barbara P-C Region according to the presence or absence of significant sand, gravel, or stone deposits that are suitable as sources of Portland cement concrete aggregate and all other mineral deposits that are actively mined. The land classification within the San Luis Obispo-Santa Barbara P-C Region is presented in the form of Mineral Resource Zones (MRZ) on 41 U.S. Geological Survey topographic quadrangle maps that accompany this report (Plates 1-41) and two generalized MRZ classification maps of the region (Plates 57 and 58).

Mineral Resource Zones for PCC-grade aggregate were established on the basis of a sand, gravel, and crushed stone resource appraisal which included a study of pertinent geologic information, field investigations of mines and quarries, and analyses of water well drilling records. Land is classified MRZ-2 if the area contains a minimum threshold value of $9.2 million (5 million 1978 dollars) of suitable aggregate that can be extracted profitably by current mining technology, or mining technology which can reasonably be expected to exist in the foreseeable future.

Five areas within the San Luis Obispo-Santa Barbara P-C Region are classified as MRZ-2 for PCC-grade aggregate. A portion of one of these - the Sisquoc River area - was previously classified by DMG in response to a petition by Coast Rock Products, Inc. The information in that report - Mineral Land Classification of a Portion of the Sisquoc River, Santa Barbara County, California, for Portland Cement Concrete Aggregate (Cole and Jensen, 1986) - was used in this report with no changes in the boundaries of the area classified as MRZ-2 for PCC-grade aggregate.

Active mines within the P-C region that extract mineral commodities other than PCC-grade aggregate or fill are classified as MRZ-2 if the deposit being mined contains at least the minimum threshold value established by the Board for that commodity. Ten active mining sites are zoned as MRZ-2 for other commodities. Many other mining sites are not zoned MRZ-2 because the quantity of material is below the minimum threshold value. Except for the classification of the ten active mines, the San Luis

Obispo-Santa Barbara P-C Region is not classified for mineral commodities other than PCC-grade aggregate.

In order to organize the volume calculations of the PCC-grade aggregate resources, the State Geologist has developed the concept of "sectors." Sectors identify portions of MRZ-2 areas that have not been urbanized. The geometrical configuration and the geologic continuity of the deposits in each sector are fairly uniform, allowing the calculation of aggregate tonnages with some reliability. Thus, for example, sector boundaries are established between that part of a natural deposit formed on an alluvial fan, and that part within the confines of an adjacent modern stream channel. The sector concept is used for the convenience of arraying resource information, and is intended to convey accurate information regarding the location and approximate tonnage of resources found in non-urbanized areas.

Throughout this report the terms "reserves" and "resources" are used with rigorous definitions. *Reserves* are aggregate deposits that are owned or controlled by a mining company, and that are authorized for extraction by appropriate lead agencies through a valid mining permit. *Resources* are all of the available aggregate deposits within an area, including reserves. The estimated resources of PCC-grade aggregate within the five sectors (A - E) amount to 11,175 million tons. These five resource sectors are shown on Plates 42 through 54. Of the 11,175 million tons of resources, 107 million tons are reserves (as of January 1989). These reserves cover 2.1 square miles, which is less than one percent of the classified area.

The projected aggregate consumption of the San Luis Obispo-Santa Barbara P-C Region to the year 2038 is estimated to be 206 million tons, of which an estimated 76 million tons must be of PCC quality. The projected life expectancy of the present reserves of all aggregate in the P-C region is estimated to be 34 years (depletion by the year 2023).

The projected aggregate consumption for the San Luis Obispo-Santa Barbara P-C Region was obtained by determining an average annual per capita rate of past consumption and multiplying that by the population projected for the next 50 years. The average annual per capita rate was derived by correlating aggregate production and population for the past 28 years (1960-1987). The calculated per capita rate of 6.0 tons per year and the population projected to the year 2038 were used to estimate the consumption within the P-C region for the next 50 years (206 million tons). Should unforeseen events occur, such as massive urban renewal, reconstruction in the wake of a disaster, or a major economic recession, the aggregate demand could change considerably.

In addition to those deposits classified as MRZ-2, areas classified as MRZ-3 within the San Luis Obispo-Santa Barbara P-C Region contain possible alternative sources of aggregate. Too little is known about the quality or quantity of these possible sources to permit even crude resource estimates to be made.

As with many forecasts of economic activity, those generated for this report should not be viewed as offering unqualified predictions of the future. The forecasts in this report are based on assumptions that the data used is accurate, and that the economic and urban development trends of the past three decades will continue for the next five decades.

Based on this study and assuming that the consumption forecast is accurate, the following conclusions were reached:

- The anticipated consumption of aggregate in the San Luis Obispo-Santa Barbara P-C Region through the year 2038 is estimated to be 206 million tons, of which 37 percent or 76 million tons must be of PCC quality.

- About 107 million tons of permitted PCC-grade aggregate and about 25 million tons of permitted aggregate other than PCC grade exist within the P-C region.

- As of January 1989, seven mines operated by five different mining companies are permitted to produce Portland cement concrete aggregate in the P-C region. Six of the seven mines are currently active.

- Unless additional aggregate resources are permitted for mining, or alternative resources are utilized, the present 132 million tons of aggregate reserves, including the 107 million tons of PCC-grade aggregate, will be depleted by the year 2023.

- The 132 million tons of aggregate reserves within the P-C region can provide only 64 percent of the anticipated consumption of all aggregate during the next 50 years. The expected longevity of these reserves is based on the assumption that mining will continue to be permitted until the reserves are depleted.

- 11,175 million tons of PCC-grade aggregate resources (including reserves) have been identified within the San Luis Obispo-Santa Barbara P-C Region. Of this total, 6,119 million tons are crushed stone resources, and 5,056 million tons are sand and gravel resources.

- The San Luis Obispo-Santa Barbara P-C Region covers an area of 2,062 square miles, of which 72 square miles (4 percent of the P-C region) were classified as MRZ-2 for PCC-grade aggre-

gate. Of this area, 57 square miles (3 percent of the P-C region) have been sectorized as having current land uses which do not preclude mining. A little over 2 square miles (less than one percent of the P-C region) of the sectorized areas are permitted for mining of PCC-grade aggregates.

- The 57 square miles of sectorized land considered to be available for providing future PCC-grade aggregate needs of the region may not all be practically available. Local governments may have already committed portions of this sectored land to purposes which preclude aggregate mining. The significance of this is that the estimate of available resources may be optimistic. It is, therefore, important that local governments promptly review the sectorized areas to verify the conclusions in this report.

INTRODUCTION

This study provides information on the estimated availability of, and demand for, Portland cement concrete (PCC) -grade aggregate resources within the San Luis Obispo-Santa Barbara Production-Consumption (P-C) Region. The study area covers 2,062 square miles and includes major portions of western San Luis Obispo and Santa Barbara counties (Figure 1). Approximately 40 percent of San Luis Obispo County and 45 percent of Santa Barbara County have been included within the P-C region and have been classified for PCC-grade aggregate. In this area, as in any urbanizing area, important land-use decisions should be made with full recognition of the region's natural resources. This is particularly important with regard to resources of high-grade construction aggregate used in Portland cement concrete. PCC-grade aggregate is an indispensable building material that is costly to transport. This classification report documents for the San Luis Obispo-Santa Barbara area:

1) the location of PCC-grade aggregate resources;

2) the quantity of PCC-grade aggregate within those deposits;

3) the location of all active mines within the region producing commodities other than fill;

4) the demand for aggregate within the region for the next 50 years.

This study was conducted as specified by the Surface Mining and Reclamation Act (SMARA) of 1975. SMARA was passed by the California State Legislature in response to the loss of significant mineral resources due to urban expansion, the need for current information concerning the location and quantity of essential mineral deposits, and to ensure adequate mined-land reclamation. To address mineral resource conservation, SMARA mandated a two-phase process called classification-designation. The objective of the classification-designation process is to ensure, through appropriate local lead agency policies and procedures, that raw material is available when needed and does not become inaccessible as a result of inadequate information during land-use decision-making actions.

SMARA mandates that guidelines for classification and designation be developed by the State Mining and Geology Board (Board). The Board originally adopted formal SMARA guidelines on June 30, 1978. Section I.1.a of those guidelines requires the State Geologist to classify specified areas into Mineral Resource Zones (MRZ). Classification is the process of identifying lands containing significant mineral deposits, based solely on geologic factors, and without regard to present land use or ownership. The Board recognizes that construction materials (sand, gravel, and crushed stone) are produced regionally, are used in every urban area of the state, and require special classification data. Section I.3 of the guidelines requires that classification reports pertaining to deposits of construction aggregate materials include the following information: (1) the location and estimated total quantity of construction aggregate available for mining; (2) limits of the market (consumption) region that these potential resources would supply; and (3) an estimate of the total quantity of aggregate material that will be needed to supply the consumption region for the next 50 years. This information will assist the Board in determining the statewide or regional significance of these types of deposits. A copy of the guidelines is printed in "California Surface Mining and Reclamation Policies and Procedures" (California State Mining and Geology Board, 1983). While this publication is currently out-of-print and is being revised, a reproduction can be obtained free of charge from DMG.

Overview of Classification

DMG is responsible under SMARA for carrying out the classification phase of the classification-designation process. Classification entails seven distinct but interrelated steps. These seven steps are described below.

1. *Determination* of *Production-Consumption (P-C) Region Boundaries.* The boundaries of the P-C region (Plate 55) are drawn along the limits of the marketing area of the active aggregate operations supplying the urban centers under study. The San Luis Obispo-Santa Barbara area was chosen for study because the State Office of Planning and Research (OPR) determined that it is an expanding urban area. The marketing area of the production sites supplying the San Luis Obispo-Santa Barbara area was determined by interviews with aggregate operators and analysis of transportation rates set by the Public Utilities Commission (PUC).

2. *Establishment of Mineral Resource Zones (MRZ).* All lands within the San Luis Obispo-Santa Barbara P-C Region are assigned Mineral Resource Zone classifications (MRZ-1, MRZ-2, MRZ-3, or MRZ-4, which are defined on pages 9-11) based upon geologic appraisal of PCC-grade aggregate resource

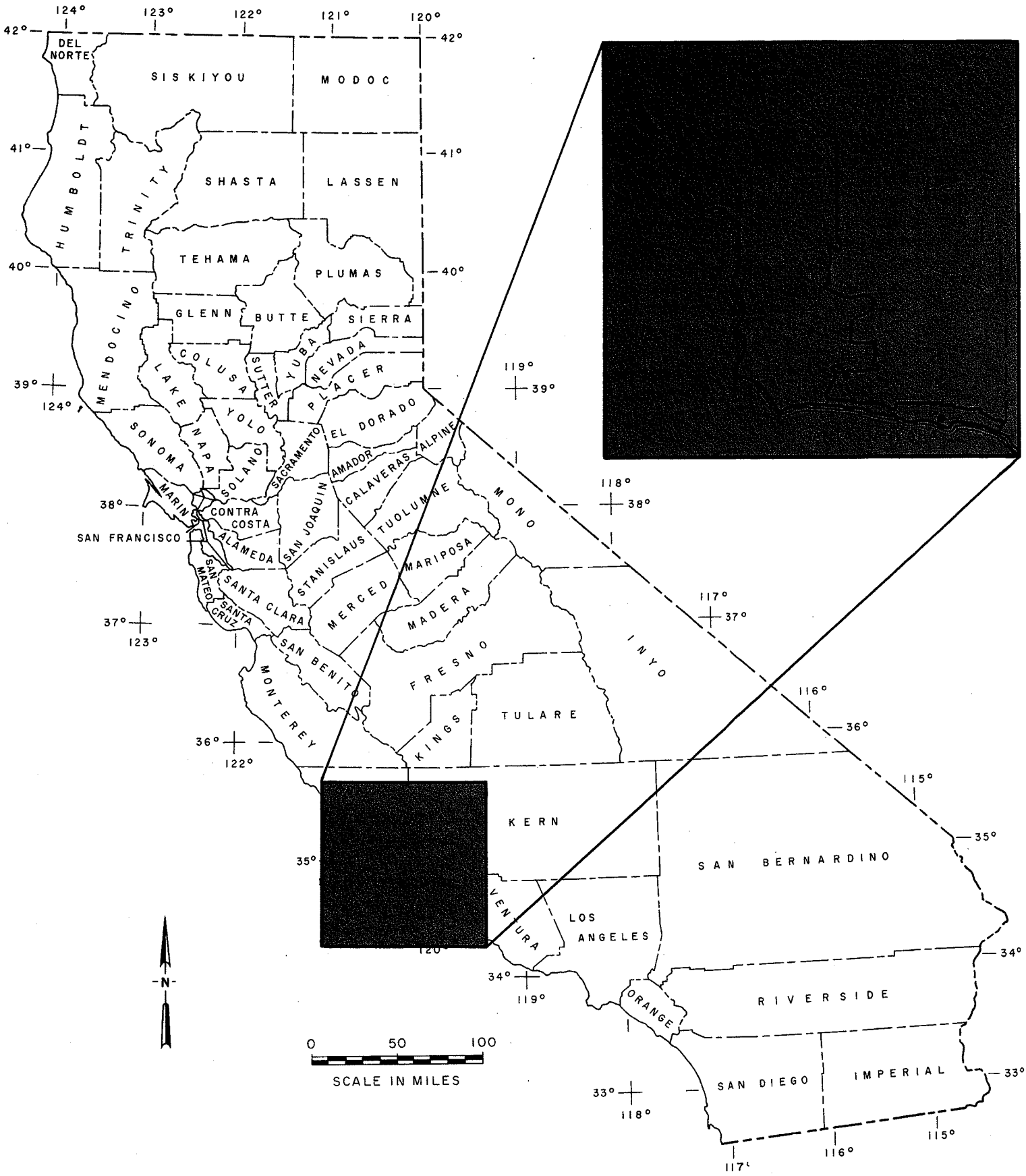


Figure 1. General location of the San Luis Obispo-Santa Barbara Production-Consumption Region.

potential. This mineral land classification is presented on Plates 1-41 and Plates 57 and 58; Figure 2 is an index map showing the coverage of the plates in the P-C region. This appraisal includes study of pertinent geologic reports and maps, field investigation at outcrops and active and inactive pits and quarries, and analyses of water well-logs.

3. *Identification of Available Aggregate Resource Areas as Sectors.* Lands known to contain significant deposits of PCC-grade aggregate resources (areas classified as MRZ-2 in step 2) are evaluated to determine whether or not current uses of these lands preclude possible future mining. Areas currently permitted for mining and areas found to have land uses compatible with possible future mining are considered available for mining. MRZ-2 areas which are not yet developed, but which have Specific Plans approved by local governments, were not considered to be available for mining. Sectors which identify available land are delineated on Plates 42-54 and described in detail in this report. Criteria for sectorization of MRZ-2 areas, established by the Board, are given in the Appendix.

4. *Calculation of Resource Tonnages within Sectors.* Investigation and analysis of on-site conditions, measurement of the areal extent of deposits, drill-hole information, waste-material percentages, and deposit densities are used to calculate total tonnages of PCC-grade aggregate reserves (deposits in land owned by an aggregate producer and permitted for mining by local government as of January 1, 1989) and resources (all deposits known to be of PCC grade, including the reserves) within each sector. Calculations reflect conditions of the deposits as of January 1, 1989 and do not include resource depletion since that date.

5. *Forecast of 50-Year Needs and the Life Expectancy of Current Reserves.* The total tonnage of aggregate needed to satisfy the demand in the San Luis Obispo-Santa Barbara P-C Region over the next 50 years is based on multiplying the projected population over that period with the average annual per capita rate of total aggregate consumption from 1960-1987. Even though all identified reserves are of PCC grade, other aggregate commodities are routinely produced and marketed from them. The projected life expectancy of the reserves is based on the assumption that this practice will continue. Results of this forecast are used to determine the life expectancy of the P-C region's current reserves.

6. *Identification of Alternative Resources.* Alternative sources of aggregate to meet the forecasted 50-year demand are identified and briefly considered.

7. *Other Commodities.* Active mines, where commodities other than PCC-grade aggregate are produced, are located and classified MRZ-2 if they meet the minimum threshold value set by the State Mining and Geology Board. Resources at the site are not quantified beyond confirming this minimum value. This classification is site-specific where commercial mineral resource extraction occurs. It is not a classification of the entire P-C region for specific resources other than PCC-grade aggregate.

The Mineral Land Classification of the San Luis Obispo-Santa Barbara Production-Consumption Region was initiated in 1986 by the State Geologist. Portland cement concrete-grade aggregate resources of the area were selected for initial classification. Deposits suitable for PCC-grade aggregate were zoned and the volume of available material within them was quantified. All other known active mines within the P-C region were classified MRZ-2 for their particular product but were not quantified beyond the establishment of a threshold value.

Each PCC-grade aggregate deposit was evaluated separately, and then considered as part of a single production-consumption (P-C) region established on the basis of existing aggregate consumption patterns. The San Luis Obispo-Santa Barbara marketing region is served by one major production district (Sisquoc River) and several smaller production areas in San Luis Obispo County. DMG previously classified the Sisquoc River production area in response to a petition to the State Mining and Geology Board (Cole and Jensen, 1986).

Residents of the San Luis Obispo-Santa Barbara region have been fortunate in having adequate quantities of high-quality aggregate materials either locally or within a moderate distance. However, the amount of these materials available for future development is diminishing as active producers deplete their deposits and land containing suitable sand and gravel resources is utilized for urban development.

Brief Overview of Designation

This report constitutes the classification phase of the two-step process mandated by SMARA. The designation phase follows receipt and approval of this classification report by the State Mining and Geology Board. Designation is the formal recognition by the Board of areas

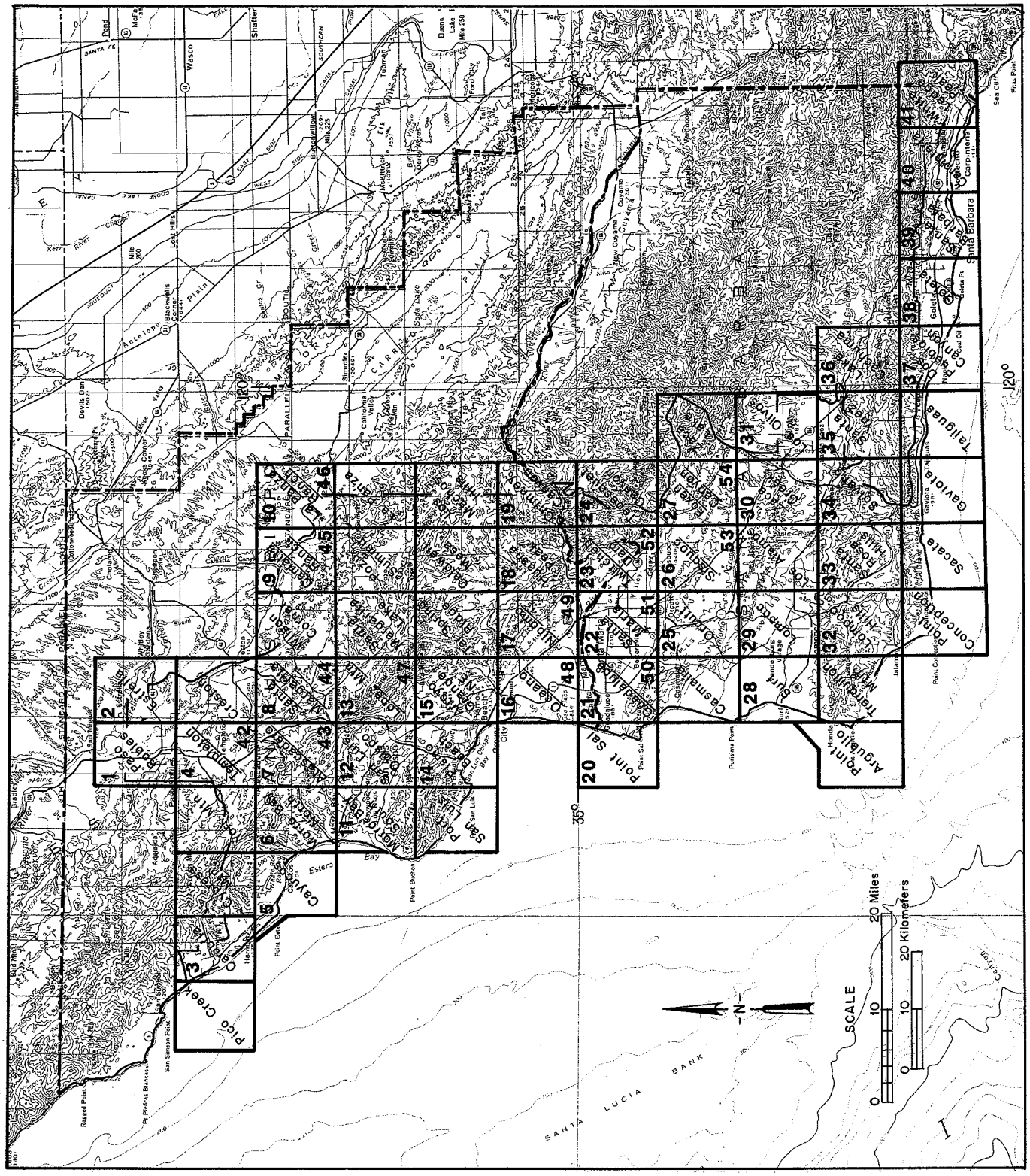


Figure 2. Index map of U.S. Geological Survey 7.5-minute quadrangles covering the San Luis Obispo-Santa Barbara P-C Region.

containing mineral deposits of regional or statewide significance that should be considered by lead agencies for protection from land uses incompatible with mineral extraction. Recognition is achieved by the adoption of regulations which designate certain deposits to be of prime importance in meeting the future needs of the region or the state. Designation is based upon this DMG report and consultation with lead agencies and other interested parties. Procedures for the designation of lands containing significant mineral deposits are specified in Section II.2 of the Board's Guidelines for Classification and Designation of Mineral Lands (California State Mining and Geology Board, 1983, p. 28).

Lead Agency Response to Classification

The State Mining and Geology Board, upon receipt of the classification information from the State Geologist, transmits the classification report to the appropriate lead agencies and makes it available to other interested parties. Within 12 months of receipt of the classification report, each lead agency must develop and adopt mineral resource management policies to be incorporated into its general plan. These policies will:

1. Recognize the mineral classification information, including the classification maps transmitted to the lead agency by the Board.

2. Emphasize the conservation and development of identified mineral deposits.

Overview of Aggregate Uses

Sand, gravel, and crushed stone are "construction aggregates." These commodities, collectively referred to as "aggregate," provide bulk and strength to Portland cement concrete, asphaltic concrete, plaster, and stucco. Aggregate is also used as road base, subbase, railroad ballast, and fill. Aggregate normally provides from 80 to 100 percent of the material volume in the above uses.

Aggregate material is essential to fulfill the needs of a modern society. It is a resource of great importance to the economy of any urbanizing area.

During 1987 over 3 million tons of construction aggregates worth approximately $11 million, were mined from the deposits within the San Luis Obispo-Santa Barbara P-C Region. Nearly 100 percent of this production was consumed within the P-C region boundaries. Approximately 37 percent of the aggregate produced from 1960 to 1987 was used as Portland cement concrete aggregate. This high-quality material was used in such things as concrete highways, dams, canals, airport runways, bridge abutments, buildings and their foundations, and general construction.

In this aggregate resource classification study, special emphasis is given to aggregate that meets the specifications used in making Portland cement concrete. The material specifications for PCC aggregate are more restrictive than the specifications for aggregate used in other applications. Deposits that are acceptable for use as PCC aggregate are the rarest and most valuable of aggregate resources. Aggregate produced from such deposits can be, and commonly is, used in other lower quality products. Because of this versatility, value, importance in construction, and relative scarcity, PCC-grade aggregate deposits are of major concern when planning for future availability of aggregate commodities.

Rarely is in-place aggregate (raw material) physically or chemically suited for every type of aggregate use. Every potential deposit must be tested to determine how much material can meet specifications for a particular use, and what processing is required. Specifications for various uses of aggregate material have been established by several agencies, such as the U.S. Bureau of Reclamation, the U.S. Army Corps of Engineers, and the California Department of Transportation (Caltrans), to ensure that aggregate is satisfactory for specified uses. These agencies and other major consumers of aggregate test aggregate for acceptance by standard test procedures defined by such organizations as the American Society for Testing Materials and the American Association of State Highway Officials.

Most aggregate specifications have been established to ensure the manufacture of strong, durable materials capable of withstanding the physical and chemical effects of weather and use. For example, specifications for Portland cement concrete and concrete products prohibit use of aggregate materials containing gypsum, pyrite, zeolite, opal, chalcedony, chert, siliceous shale, volcanic glass, and some high-silica volcanic rocks. Gypsum lengthens the setting time of Portland cement, pyrite dissociates to yield sulfuric acid and iron oxide stain, and other substances contain silica in a form that reacts with alkali substances in the cement, resulting in cracks and "pop-outs."

Specifications also call for precise particle-size distributions for the various uses of aggregate. Aggregate is commonly classified into two general sizes, coarse and fine. Coarse aggregate is rock retained on a 3/8" or a #4 U.S. sieve. Fine aggregate passes a 3/8" sieve and is retained on a #200 U.S. sieve (a sieve with 200 weaves per inch). For some uses, such as asphaltic paving, particle

shape is specified. The Standard Specifications issued by Caltrans (1988) requires that at least 25 percent by weight of coarse aggregate (1/4" to 3/4" diameter) used as Class 2 aggregate base material shall be crushed particles. Furthermore, aggregate base material used with bituminous binder (commonly called road tar) to form sealing coats on road surfaces shall consist of at least 90 percent by weight of crushed particles. Crushed stone is preferable to natural gravel in asphaltic concrete because asphalt adheres better to broken surfaces, and the interlocking of angular particles strengthens the asphaltic concrete and road base.

The preferred use of one aggregate material over another in construction practices depends not only on specification standards, but also on economic considerations. Alluvial gravel is preferred to crushed stone for Portland cement concrete aggregate because the rounded particles of alluvial sand and gravel result in a wet mix that is easier to work than a mix composed of angular fragments. The workability of a mix consisting of Portland cement with crushed stone aggregate can be improved by adding more sand and water, but more cement must then be added to the mix to maintain concrete durability standards. At the present time, the additional cement amounts to about a quarter of a 94-pound sack per cubic yard of concrete at an additional cost of about $1.00 per yard of mix. Although more care is required in pouring and placing a wet mix containing crushed stone, Portland cement concrete made with this aggregate is as satisfactory as that made with alluvial sand and gravel of comparable rock quality.

In the San Luis Obispo-Santa Barbara area, PCC-grade aggregate sells in bulk for about $5.70 per ton at the plant site (in January 1989.) However, this selling price reflects only part of the cost to the consumer. Transportation cost is a significant part of the final delivery price. In areas lacking nearby aggregate sources, delivery charges alone may be greater than the sale price of the material at the plant site.

Transportation Rates

Because it is a low-value, high bulk weight commodity, a major part of the cost of aggregate to the consumer is for transportation. In fact, transportation cost is the principal constraint defining the market area for a specific production district.

All aggregate marketed in the San Luis Obispo-Santa Barbara P-C Region is transported by truck. Minimum rates for independent aggregate truckers are set by the California Public Utilities Commission (PUC). Rates for the San Luis Obispo-Santa Barbara area are published in "Minimum Rate Tariff 7-A," Sections 2 and 3. Charges are calculated based on either an hourly rate (Table 1) or a distance rate (Figure 3). The minimum hourly rate or the minimum distance rate, whichever is larger, may be charged to the consumer. If the hourly rate is used, the carrier and debtor must enter into a written agreement prior to transport.

Figure 3 illustrates how the PUC rates increase with distance as specified in Minimum Rate Tariff 7-A. For example, hauling aggregate from the Sisquoc River production area to Santa Maria (approximately 11 miles) results in an additional cost of $2 per ton over the cost of the same material purchased F.O.B. mine site. To haul aggregate to Santa Barbara from the Sisquoc River production area would increase its cost by approximately $8-9 per ton, demonstrating the economic importance of maintaining accessible local sources.

Table 1. Minimum hourly rates for transport of aggregate in the San Luis Obispo-Santa Barbara area. From California Public Utilities Commission, 1987. Minimum Rate Tariff 7-A (current rates as of August 1, 1987).

TYPICAL TONS PER LOAD	NO. OF AXLES PER UNIT OF EQUIPMENT	*HOURLY RATES ($)	$/HR/TON
10	2	42.23	4.22
15	3	47.90	3.19
24	4	50.47	2.10
26	5+	53.33	2.05

*Rates are higher for work done on holidays and weekends

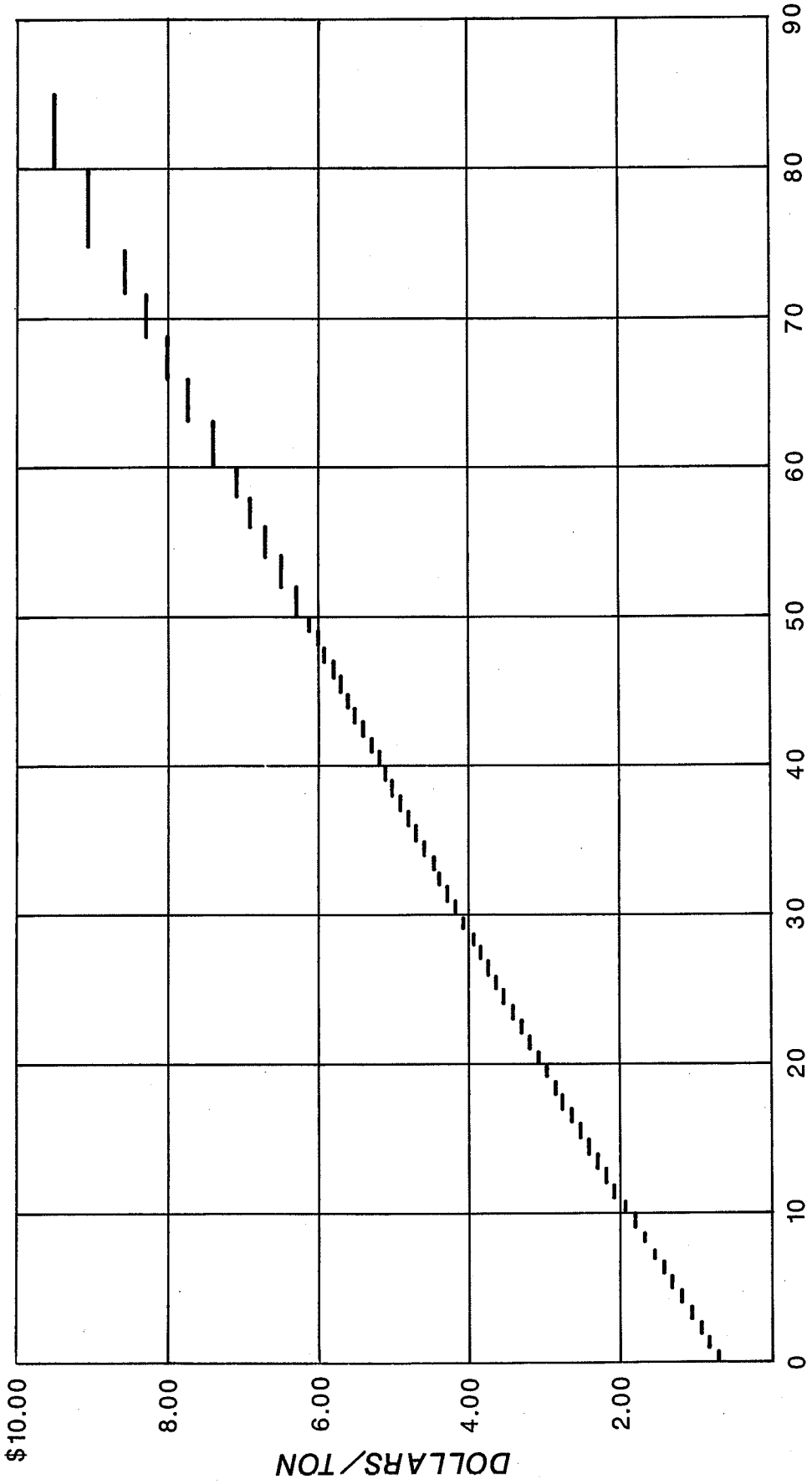


Figure 3. Minimum distance rates for trucking aggregate within the San Luis Obispo-Santa Barbara P-C Region.

DETERMINATION OF THE SAN LUIS OBISPO-SANTA BARBARA PRODUCTION-CONSUMPTION REGION

Initially, the city of Santa Barbara and the adjoining urban areas were targeted by the Office of Planning and Research (OPR) as areas experiencing significant urban expansion, and were scheduled by the State Mining and Geology Board for a SMARA classification study. Subsequently, the Board included the urban centers in San Luis Obispo County and northern Santa Barbara County in the list of areas to be classified under SMARA. Although San Luis Obispo and Santa Barbara counties were considered as separate production-consumption (P-C) regions at the outset of the study, preliminary work demonstrated that all of the major urban areas within the two counties should be included in a single P-C region.

The boundary of the study area (P-C region) was delineated to include the urban and urbanizing areas targeted by OPR and the Board, and the high-grade aggregate production districts supplying those areas. This initial target was updated and enlarged through consultation with local lead agencies and examination of their General Plans, so that all areas in the path of urban expansion were included within the P-C region. The boundary includes most of the population which consumes the aggregate mined from the production districts, even if this population is located outside the target areas. Less than 1 percent of the output of the production districts is exported for consumption outside of the P-C region. The boundary of the study area was drawn using the General Plans of the lead agencies and observations of current land-use patterns.

The San Luis Obispo-Santa Barbara P-C Region is served by one major and five smaller production areas which supply Portland cement concrete aggregate. The major production district is located on the Sisquoc River east of the city of Santa Maria. This district produces nearly 80 percent of the PCC aggregate for the region. The five smaller production areas, all within San Luis Obispo County, are located east of Atascadero in Rocky Canyon, northeast of the community of Santa Margarita next to the Salinas River, northeast of Cambria along San Simeon Creek, along Navajo Creek in northeastern San Luis Obispo County, and along Pine Canyon near the Cuyama River.

The cities of Santa Barbara and Carpinteria and the surrounding urban areas are also supplied with aggregate from producers within the adjacent Western Ventura County P-C Region. Although the amount of aggregate imported is only about 10 percent of the total demand for the San Luis Obispo-Santa Barbara P-C Region, it is an important source for the Santa Barbara area. The closest production district within the P-C region which can supply PCC aggregate is about 75 miles away - the Sisquoc River production district. The cost of transporting aggregate from the Sisquoc River area to the Santa Barbara area is about twice as much as importing it from the Western Ventura County P-C Region.

The area in and around the city of Paso Robles receives PCC aggregate from a production district in Fresno County near the town of Coalinga. This imported material makes up but a small fraction of the total consumption for the San Luis Obispo-Santa Barbara P-C Region.

Table 2. Lead agencies (county and incorporated city governments and military bases) located within the San Luis Obispo-Santa Barbara P-C Region.

City of Arroyo Grande	City of San Luis Obispo
* +City of Atascadero	City of Santa Barbara
City of Carpinteria	+City of Santa Maria
City of Grover City	+City of Solvang
City of Guadalupe	* +County of San Luis Obispo
City of Lompoc	* +County of Santa Barbara
City of Morro Bay	United States Air Force, Vandenberg Air Force Base
* +City of Paso Robles	
City of Pismo Beach	

+Agencies that have land classified as MRZ-2 for PCC-grade aggregate or other commodity within their jurisdiction.

* Agencies that have active aggregate operations within their jurisdiction.

Agencies with sectors within their jurisdiction are underlined.

The production-consumption region was delineated to encompass: 1) the metropolitan areas of the 13 incorporated cities; 2) outlying communities such as Santa Margarita, Nipomo, and Goleta, and those areas which are anticipated to urbanize within the next 50 years; 3) rural areas and small towns that, although not anticipated to urbanize in the foreseeable future, collectively consume a significant percentage of the region's aggregate production; and, 4) the production districts identified in this study. The P-C region boundary was, in many places, located along the most suitable census tract boundary to allow use of existing population data for forecasting. Lead agencies with jurisdiction within the P-C region are shown in Table 2.

ESTABLISHMENT OF MINERAL RESOURCE ZONES

DMG has classified 2,062 square miles of land in the San Luis Obispo-Santa Barbara P-C Region according to the presence or absence of significant PCC-grade aggregate deposits. The land classification is presented in the form of Mineral Resource Zones, or MRZ's. Directions for the identification of Mineral Resource Zones are set forth in DMG's Special Publication 51 in the section "Guidelines for Classification and Designation of Mineral Lands" (California State Mining and Geology Board, 1983). The guidelines for establishing the Mineral Resource Zones are as follows:

MRZ-1 Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence. This zone shall be applied where well-developed lines of reasoning, based upon economic-geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is nil or slight.

MRZ-2 Areas where adequate information indicates that significant mineral deposits are present, or where it is judged that a high likelihood for their presence exists. This zone shall be applied to known mineral deposits or where well-developed lines of reasoning, based upon economic-geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is high.

MRZ-3 Areas containing mineral deposits, the significance of which cannot be evaluated from available data.

MRZ-4 Areas where available information is inadequate for assignment to any other MRZ.

Mineral Resource Zones in the San Luis Obispo-Santa Barbara P-C Region are presented on forty-one 1:48,000 reductions of U.S. Geological Survey 7.5-minute topographic quadrangle maps (Plates 1–41). Figure 2 shows the quadrangle maps that cover the San Luis Obispo-Santa Barbara P-C Region.

Mineral Resource Zones within the San Luis Obispo-Santa Barbara P-C Region were established on the basis of an aggregate appraisal that included the following tasks for assessing the quantity, quality, and extent of the aggregate deposits:

1. Examination and compilation of relevant geologic maps, aerial photos, geologic literature, aggregate industry data (some of which is proprietary), and aggregate engineering test data. The geologic maps used in classification of the San Luis Obispo-Santa Barbara P-C Region are indicated on Figure 4. Plate 56 shows the generalized geology and geologic columns of the San Luis Obispo-Santa Barbara area.

2. Interviews with aggregate operators and company geologists.

3. Compilation and analysis of subsurface water well-log data and drilling records.

4. Field investigation of active and depleted aggregate quarries and the geologic formations which could contain aggregate resources.

Areas Classified as MRZ-1

Areas classified as MRZ-1 were judged, on the basis of available data, to have little likelihood of containing significant deposits of PCC-grade aggregate. Deposits that have excessive amounts of clay, silt, organic matter, absorptive rock, alkali-reactive rock, platy rock, or soft rock are unsuitable for use in PCC aggregate. Areas containing such deposits are classified MRZ-1.

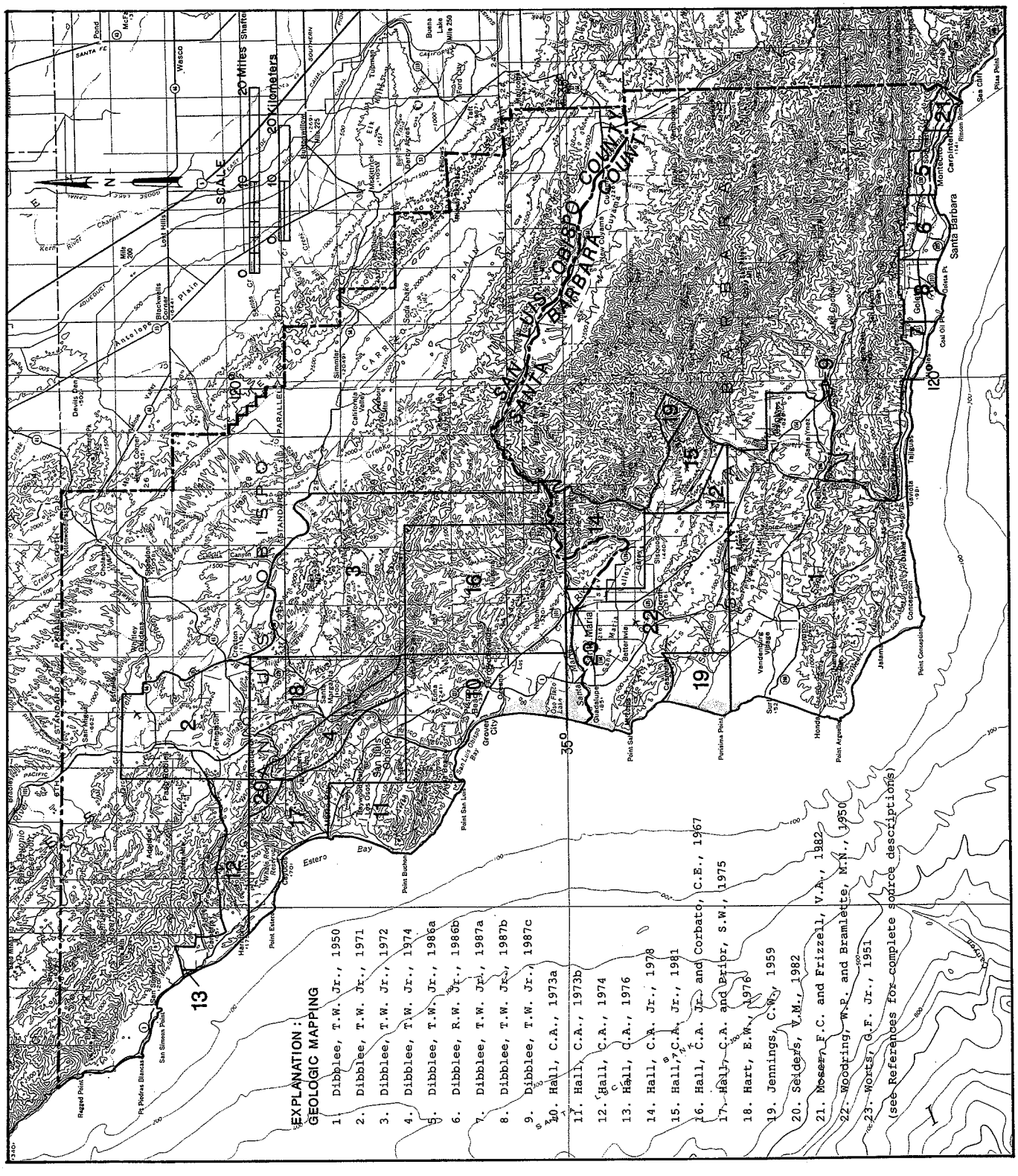


Figure 4. Index to geologic mapping used in the classification of the San Luis Obispo-Santa Barbara P-C Region.

Areas Classified as MRZ-2

Five areas are classified as MRZ-2 for PCC-grade aggregate in the San Luis Obispo-Santa Barbara P-C Region. These are areas for which data indicate that there is a high likelihood that significant deposits of PCC-grade aggregate exists.

SMARA guidelines set forth two requirements to be used to determine if land should be classified MRZ-2:

1. The deposit must be composed of material that is suitable as a marketable commodity.

2. The deposit must meet the threshold value. The projected value (gross selling price) of the deposit, based on the value of the first marketable product, must be at least $9,200,000 (which equates with 5 million 1978-dollars).

Areas classified MRZ-2 for PCC-grade aggregate contain resources that are either proven PCC grade or highly probable to be PCC grade. Some of the aggregate in the MRZ-2 areas have not been identified as PCC-grade aggregate through formal engineering tests. Aggregate deposits in untested, unproven areas identified as MRZ-2 are believed to contain PCC-grade aggregate for either of the following reasons:

- The aggregate in unproven areas is similar in age, lithology, and depositional environment to that in areas containing proven PCC-grade aggregate.

- The unproven deposit is a lateral extension of an alluvial formation from which PCC-grade aggregate has been produced.

Seventy-two square miles have been classified as MRZ-2 for PCC-grade aggregate in the San Luis Obispo-Santa Barbara P-C Region.

Areas Classified as MRZ-3

Areas classified as MRZ-3 contain aggregate deposits, the significance of which cannot be evaluated from available data.

Coarse-grained sedimentary units and igneous rock types are often included in this category. Evidence obtained from geologic literature or petrologic field investigations that show a rock unit to contain abundant, hard, durable material without excessive amounts of deleterious materials is necessary for it to be considered a suitable candidate for an MRZ-3 classification. Additional information, including engineering test data on physical and chemical quality, regarding the material in these areas could either upgrade the classification to MRZ-2 or downgrade the classification to MRZ-1.

Some alluvial deposits are also classified MRZ-3. In the Santa Maria Valley and in several active stream channels such as the Sisquoc River there are areas for which too little information is available to classify as either MRZ-2 or MRZ-1, although well-log information indicates that aggregate resources are present.

Areas Classified as MRZ-4

Areas classified as MRZ-4 are those for which available information is lacking or incomplete for assignment into the other MRZ categories. No areas were classified as MRZ-4 in the San Luis Obispo-Santa Barbara P-C Region.

EVALUATION OF PCC-GRADE AGGREGATE IN THE SAN LUIS OBISPO-SANTA BARBARA P-C REGION

An assessment of aggregate resources in the San Luis Obispo-Santa Barbara P-C Region is presented in this section of the report. The assessment was conducted on the basis of a quantitative evaluation of suitable aggregate resources classified as MRZ-2.

Concepts Used in Identifying Available Aggregate Resource Areas

The State Geologist is responsible for calculating aggregate resources for those areas classified as MRZ-2 for PCC-grade aggregate. Recognizing that there are lands within MRZ-2 areas that have already been urbanized and therefore have a limited opportunity for mineral resource conservation and extraction, the State Geologist has limited the calculation of aggregate resource tonnages to areas classified as MRZ-2 for PCC-grade aggregate that have not been urbanized.

For purposes of classification, incompatible uses of land are defined as improvements of high cost, such as high-density residential developments, intensive industrial developments, commercial developments, and major public facilities (see Appendix). In addition, lands for which the lead agency has approved a tract map or issued an approved Specific Plan are treated as having uses that are incompatible with mining. Lands that have compatible uses are defined as those that are nonurbanized or that have very low density residential development (one unit per ten acres), land that does not have high-cost improvements, and lands used for agriculture, silviculture, grazing, or open space.

For this report, determination of use of lands classified as MRZ-2 for PCC-grade aggregate was based upon conditions of the lands at the time of the study (1986 through 1989). The use of the lands was determined after review of data from lead agencies, reference to aerial photographs and photo-revised topographic maps, and field reconnaissance.

SECTORS

Sectors are areas that have been classified as MRZ-2 for PCC-grade aggregate by the State Geologist and are deemed to be available for mining based upon criteria for compatibility provided by the State Mining and Geology Board and outlined above.

A sector is an area in which the geometrical configuration of the deposit is sufficiently regular to permit reliable calculation of the tonnage of the mineral resource present. For example, sector boundaries would be established between that part of a natural deposit formed on a fan, and that part within the confines of an adjacent modern stream channel and its floodplain. Sectors are often divided into subsectors to exclude major pipelines, transmission lines, canals, and roads. These sectors and subsectors have been employed to focus the attention of land-use planners and local governments on areas that remain accessible for mineral extraction. Mineral land classification, which is done without regard for current land uses, by itself, does very little to put into perspective the resource base that is available to meet the future needs of a region. The State Geologist calculates the available resources of each sector and identifies the amount of remaining resources that have been permitted for mining. A more specific term for these permitted resources is *reserves*. The resources present in non-sectorized MRZ-2 areas are not calculated because they are regarded as unavailable.

The calculated reserves and resources of all sectors in a region are compared with the State Geologist's forecast of the 50-year needs of that region. The comparison of regional needs with available reserves and resources provides the opportunity to focus attention on the mineral resource issues confronting the region, such as the need to plan carefully for the use of any lands containing mineral resources, and the need to consider the permitting of additional mining operations in the region as currently mined deposits are depleted.

Each sector meets or exceeds the Board's threshold values for deposits of significant size, and each sector may be considered for designation as an area of regional or statewide significance by the State Mining and Geology Board, pursuant to Section 2790 of SMARA. Areas that have not been sectorized by the State Geologist are not considered for designation by the Board.

Although the classification by the State Geologist and the designation by the Board are actions explicitly provided for by SMARA, and although the results of such actions yield reports that must be acted upon by affected local governments, the sectorization and sector maps do not of themselves carry specific obligations imposed on local governments by SMARA. The maps and resource base calculations, however, do contain the essential facts that are needed to focus the attention of planners on the mineral availability problems and the alternative sources of aggregate to meet the mineral resource needs of the region. Without the sector maps and the accompanying

calculations, the primary objectives of SMARA could not be achieved.

The Board's criteria for sectorization focus on the apparent suitability of the land for mining and do not take into account conflicting commitments that may restrict the suitability of some sectors for mining. It is possible that the available resource base as calculated by the State Geologist may be an overestimation and the problems confronting local government may be understated. Considering these possibilities, it becomes important for local governments to carefully review the sectors and estimate resources to ensure that planning decisions are made using a correct perspective on available resources.

Calculation of Available Resources

RESERVES AND RESOURCES

In this report, *reserves* are calculations of tonnages of aggregate that have been determined to be acceptable for commercial use, that exist within properties owned or leased by aggregate producing companies, and for which permits have been granted to allow mining and processing of the material. *Resources* include reserves as well as all potentially usable aggregate materials that may be mined in the future, but for which no permit allowing mining has been granted, or for which marketability has not been established.

FACTORS CONSIDERED IN CALCULATIONS

The resource calculations given here are limited to those PCC-grade aggregate resources present in resource sectors which are, as explained in the previous section, the nonurbanized portions of the areas classified as MRZ-2 for PCC-grade aggregate. The resource sectors defined in this study are shown on the sector maps (Plates 42-54) that accompany this report. Deposits where mineral resources other than PCC-grade aggregate are currently mined have also been classified, but are not quantified beyond establishment that they exceed threshold value. These deposits have not been sectorized since their regional significance has not been studied.

Each sector is identified by a capital letter and represents a resource area or a portion of a resource area which appears to have a fairly consistent geometrical configuration and identical geologic parameters. The sectors are subdivided into numbered subsectors to exclude the locations of existing freeways, other major roads, canals, bridges, dams, major power lines, and major pipelines. These criteria allow for the calculation of realistic resource tonnages.

The following factors were used to determine the areal extent and tonnage of PCC-grade aggregate resources within the sectors:

1. Sector resource tonnage calculations were based on measurements taken from base maps that have a scale of 1:24,000 or maps obtained from aggregate companies with varying scales.

2. Even in proven PCC-grade aggregate deposits, a small percentage of the aggregate cannot be used in concrete and is referred to in this study as "waste." Waste includes pit-run and production waste, both of which may be utilized in non-PCC uses, primarily fill. Known waste percentages were extrapolated to deposits in untested sector areas from proven, nearby PCC-grade aggregate deposits.

3. Thicknesses of PCC-grade aggregate deposits were determined through analysis of water well-log data, examination of active aggregate pits and natural outcrops, and other information provided by persons who have knowledge concerning aggregate deposits in this region.

4. A standard setback of 100 feet from utility and rail lines and urban developments was used in determining the areal limits of sectors that border areas not available for mining.

5. Side slopes were generally calculated to have a 1:1 gradient, or, if the deposit was permitted for mining, the side slopes of the mining plan.

6. In-place densities of 0.055 and 0.060 tons per cubic foot were assumed in calculating alluvial resources, and .084 tons per cubic foot was assumed in calculating the granitic, crushed stone resources.

7. Overburden, if present, was subtracted from the thickness of the deposit.

Resource Sector Descriptions

Five resource sectors (A - E) have been identified in the San Luis Obispo-Santa Barbara P-C Region. The total area of the resource sectors in the P-C region is 57 square miles, of which 2.1 square miles are currently permitted for mining PCC-grade aggregate.

Resource Sector A is located along the Salinas River near the cities of Paso Robles and Atascadero; Sector B is located in Navajo Creek, about 20 miles east of Santa Margarita; Sector C covers part of the La Panza granitics

east of Atascadero and Santa Margarita; Sector D covers a large part of the Santa Maria River near the city of Santa Maria; and Sector E covers the Sisquoc River.

The aggregate resources in these five sectors consist of alluvial channel, floodplain, and crushed stone deposits. The estimated total PCC-grade aggregate resources in all of the sectors is 11,175 million tons. The reserves and resources for the individual sectors are shown on Tables 3 - 7. The parameters used in calculating these figures include: slopes of 1:1 gradient, in-place densities of 0.055 and 0.060 tons per cubic foot for alluvial deposits (depending on site specific conditions), and 0.084 tons per cubic foot for the crushed stone deposits, waste percentages varying from 3 to 55 percent, and a setback of 100 feet from roads and other development features.

Two areas that contain PCC-grade aggregate resources have not been sectorized. The San Simeon Creek and Pine Canyon deposits each contain less than the threshold value of aggregate material and have been classified as MRZ-3.

SECTOR A - SALINAS RIVER

Sector A includes the recent river channel deposits and parts of the adjacent floodplain deposits along about 14 miles of the Salinas River, from the southeastern boundary of the city of Atascadero to the southern boundary of the city of Paso Robles. Sector A includes three subsectors which together cover an area of 2,014 acres. The alluvium in the Salinas River generally consists of an upper layer of mostly sand and a lower section of one or more gravel layers separated by clayey layers. The upper sand deposit varies in thickness from 15 to 35 feet and the lower gravelly section ranges in thickness from 20 to 50 feet. The total depth of the alluvium is from 50 to 80 feet. The well-log data are sparse upstream of Sector A, but the logs of two wells about one mile upstream indicate that the overburden of soil and fine material is much thicker and the gravel layer is very thin. Downstream, or north of the sector, well-log data indicate that there are several clayey layers in the alluvium underlying much of the floodplain. The older floodplain underlying the terraces along this part of the river, and the most recent stream channel may have fewer clayey layers, but not enough data are available to delineate such areas.

Goldman (1968) reported that the gravel in the Salinas River consists of 31 percent sedimentary rocks, 21 percent granitic rocks, 27 percent volcanic and fine-grained igneous rocks, 13 percent quartz and quartzitic rocks, 7 percent shale from the Monterey Formation, and 1 percent metamorphic rocks. The pieces of shale from the Monterey Formation are reactive in concrete and are therefore considered to be deleterious. The removal of shale fragments from the aggregate material must be accomplished to make it acceptable for Portland cement concrete.

The first sand and gravel plant in this area was built near Templeton in 1915. In the years since, there have been at least a dozen aggregate pits operating along the Salinas River within or near Sector A. Currently there are six producers of aggregate in Sector A; The Dirtman, Salinas Sand Company, Slash Bar G Dump Truck and Loader Service, Steve Schmidt, Union Asphalt Inc., and Weyrick Sand and Gravel.

Although the deposits in Sector A are classified as MRZ-2 for Portland cement concrete aggregate, aggregate that meets the specifications for use in PCC is not being produced at present by any of the operators in the sector. Concrete sand and gravel have been produced in the past (Goldman, 1968) but they probably would not have met present day specifications for PCC aggregate without additional processing. However, testing at two locations in the sector indicates that the aggregate material in the Salinas River can be processed to yield PCC-grade sand. It is estimated by an operator in the Salinas River that as much as 45 percent of the sand can be used, after processing, for Portland cement concrete aggregate. Most of the remainder of the material can be used as other grades of construction aggregate. Because the aggregate from the permitted mines in Sector A is not currently processed for use in PCC, the reserves for PCC-grade aggregate from those mines are defined to be zero.

The sand deposits in this part of the Salinas River are significant because of their proximity to the growing urban areas in the northern part of the San Luis Obispo-Santa Barbara P-C Region. At present, some PCC aggregate is being imported to this part of the region from near Coalinga in Fresno County. The two crushed stone quarries that serve the northern part of the region (Union Asphalt, Inc, Rocky Canyon Quarry and Southern Pacific Milling Company Santa Margarita Quarry) can produce a "rock dust" sand, but a source of natural sand of PCC quality in the same area would be important to augment the crushed stone products of the two quarries. The other nearest significant sources of PCC-grade sand are Navajo Creek, about 20 miles east of Atascadero, and the Sisquoc River, about 55 miles to the south.

It is anticipated that beneficiation of sand from the Salinas River to meet PCC specifications will probably occur in the foreseeable future.

Table 3. PCC-grade sand resources in Sector A.

SUB SECTOR	TOTAL ACRES	ACRES PERMITTED FOR PCC-GRADE	THICK-NESS (feet)	PERCENT PCC GRADE	PCC-GRADE RESERVES (tons)	PCC-GRADE RESOURCES (tons)
A-1	752	0	30	45	0	21,600,000
A-2	717	0	30	45	0	20,600,000
A-3	545	0	30	45	0	15,700,000
SUBTOTALS	2,014	0			0	57,900,000

SECTOR B - NAVAJO CREEK

Sector B covers 135 acres of the active channel and floodplain of Navajo Creek, beginning one-and-a-half miles south of the Highway 58 crossing and extending for about two miles upstream. The area classified as MRZ-2 is entirely within the lease boundary of the Navajo Rock and Sand Company. The alluvial deposit is 42 feet thick and is composed of about 60 percent sand and 40 percent gravel. The gravel consists mainly of quartzite cobbles with some granitic rocks. The maximum size of the cobbles is about 10 inches. A waste factor of 15 percent and a density of 0.055 tons per cubic foot were used in calculating the reserves and resources in the sector.

Upstream of the sector the amount of alluvium deposited in the canyon is too small to be economically minable. Downstream of the sector there is little information available as to the quality of the material; but, from field observations, the material appears to be finer-grained, to have a higher clay content, and to have a higher content of deleterious shale fragments from the Monterey Formation.

Mining in this area first began in the 1800's when the alluvium was placer mined for gold. A gold placer operation was reported on Navajo Creek in 1925. Sand and gravel mining did not start on Navajo Creek until 1976.

The reserve and resource data for this sector are proprietary. The reserve total for Sector B is included with the P-C region total on Table 7.

SECTOR C - LA PANZA GRANITICS

Sector C, which covers 12,238 acres, is underlain by granitic rocks of granodioritic and quartz monzonitic composition. Sector C lies southeast of the city of Atascadero. There are up to 700 feet of topographic relief in the sector. Sector C is separated into three subsectors, C-1, C-2, and C-3. Parts of subsector C-1 are leased by Union Asphalt, Inc., a subsidiary of Coast Rock Products, Inc., and Southern Pacific Milling Company (formerly Kaiser Sand and Gravel Company). After stripping off the weathered surface material, which can be as thick as 50 feet, the underlying fresh, hard rock is quarried and crushed for aggregate. Aggregate production began at the Union Asphalt, Inc. Rocky Canyon quarry in 1983. Crushed stone for aggregate and riprap has been intermittently quarried at the Southern Pacific Milling Company Santa Margarita Quarry since the early 1920's. There is a third small quarry, the Davis Quarry, immediately south of the Rocky Canyon Quarry in subsector C-1. The Davis Quarry intermittently produces road base from the weathered surface material of the granitics.

In calculating the reserves and resources for Sector C, the quarrying procedures presented in the County of San Luis Obispo's Reclamation Plan Guidelines were followed for benching configurations. A density factor of 0.084 tons per cubic foot and a waste percentage of 3 percent were used to calculate total tonnages. These two factors were derived from company data. The resources of crushed stone available in Sector C are calculated to total 6,119 million tons. The reserve total for Sector C is confidential but is included with the P-C region total on Table 7.

SECTOR D - SANTA MARIA RIVER

Sector D includes 17,758 acres (27.7 square miles) of land in the river channel and floodplain of the Santa Maria River. The area includes lands in both San Luis Obispo and Santa Barbara counties. The sector extends

from the confluence of the Sisquoc and Cuyama rivers, about 6 miles east of the community of Sisquoc, to one-half-mile east of Highway 1, about 4 miles from the coast.

Sector D contains the largest resources of PCC-grade aggregate in the San Luis Obispo-Santa Barbara P-C Region. Sector D, with its 37 subsectors, contains 4,528 million tons of PCC-grade aggregate resources. Eighty-nine percent of the available alluvial sand and gravel resources in the P-C region is contained in this one sector.

Five companies mine aggregate from the Santa Maria River channel. Four of them are located north of the city of Santa Maria and do not produce PCC-grade aggregate. They are River Sand and Gravel, Inc., in subsectors D-8 and D-13, Sanchez and Sons, Inc., in subsector D-13, Santa Maria Sand Company in subsector D-8, and Troesh Ready-Mix Company in subsectors D-7 and D-8. The fifth, Coast Rock Products, Inc., southeast of Santa Maria, produces PCC aggregate from property in subsector D-13. The reserves of PCC-grade aggregate in Sector D are confidential, but are included in the total on Table 7.

Water-well logs in the Santa Maria River, from the confluence of the Sisquoc and Cuyama rivers to about 8 miles downstream, all in subsector D-13, show a persistent clay layer in the lower part of the unstratified surface layer. The unstratified surface layer of sand and gravel in this area ranges in thickness from 65 to 100 feet. In the broad floodplain of the Santa Maria River, south of the recent channel in subsectors D-10 through D-32 (excluding subsector D-13), there are discontinuous layers of clay and clayey strata in the upper 100 to 150 feet of sand and gravel. In areas where these clayey layers are predominant enough to make mining of the alluvium uneconomical, they have been classified as MRZ-1. In areas where well-log data indicate a pattern of both economical and uneconomical deposits, but with no clear dividing lines between them, they have been classified as MRZ-3.

West of the city of Santa Maria (subsectors D-1 through D-14), clay layers are more numerous and continuous in the upper part of the alluvium; the upper layer of alluvium is predominantly sand and is generally from 20 to 45 feet in thickness. Even though this aggregate is more difficult to mine than deposits to the east, it can still be used to make PCC. The cross sections on Plates 59 and 60 may be referred to for the subsurface geology of Sector D.

Table 4. PCC-grade crushed stone resources in Sector C.

SUB-SECTOR	TOTAL ACRES	ACRES PERMITTED FOR PCC-GRADE	THICK-NESS (feet)	PERCENT PCC-GRADE	PCC-GRADE RESERVES (tons)	PCC-GRADE RESOURCES (tons)
C-1	6,734	212	200-700	97	*	3,367,000,000
C-2	2,274	0	200-400	97	0	1,137,000,000
C-3	3,231	0	200-500	97	0	1,615,000,000
SUBTOTALS:						
	12,239	212			*	6,119,000,000

* Proprietary data

Table 5. PCC-grade aggregate resources in Sector D.

SUB SECTOR	TOTAL ACRES	ACRES PERMITTED FOR PCC-GRADE	THICKNESS (feet)	PERCENT PCC GRADE	PCC-GRADE RESERVES (tons)	PCC-GRADE RESOURCES (tons)
D- 1	938	0	90	90	0	190,400,000
D- 2	1,667	0	80	90	0	305,900,000
D- 3	466	0	70	90	0	74,100,000
D- 4	1,138	0	100	90	0	259,800,000
D- 5	337	0	120	90	0	87,800,000
D- 6	599	0	110	90	0	144,800,000
D- 7	390	0	130	90	0	109,800,000
D- 8	127	0	130	90	0	34,100,000
D- 9	300	0	25	90	0	17,400,000
D-10	781	0	120	90	0	207,400,000
D-11	1,313	0	130	90	0	383,800,000
D-12	27	0	100	90	0	5,100,000
D-13	2,385	409	130	90	*	678,800,000
D-14	152	0	140	90	0	42,200,000
D-15	277	0	80	90	0	49,400,000
D-16	394	0	90	90	0	78,600,000
D-17	51	0	210	90	0	15,400,000
D-18	414	0	130	90	0	117,500,000
D-19	16	0	240	90	0	2,900,000
D-20	1,063	0	150	90	0	356,200,000
D-21	424	0	120	90	0	109,900,000
D-22	57	0	200	90	0	19,900,000
D-23	249	0	110	90	0	58,900,000
D-24	1,058	0	120	90	0	283,200,000
D-25	137	0	130	90	0	35,500,000
D-26	48	0	180	90	0	14,700,000
D-27	39	0	180	90	0	12,300,000
D-28	346	0	90	90	0	68,000,000
D-29	255	0	160	90	0	85,700,000
D-30	96	0	200	90	0	36,700,000
D-31	199	0	115	90	0	48,400,000
D-32	612	0	130	90	0	176,500,000
D-33	75	0	120	90	0	18,400,00
D-34	24	0	100	90	0	50,900,000
D-35	205	0	75	90	0	34,400,000
D-36	971	0	130	90	0	280,100,000
D-37	128	0	130	90	0	33,100,000
SUBTOTALS						
	17,758	409			*	4,528,000,000

* Proprietary data

SECTOR E - SISQUOC RIVER

Sector E consists of four subsectors totaling an area of 3,742 acres of the river channel and floodplain of the Sisquoc River. Sector E extends along the Sisquoc River from a point 7 miles east of the community of Sisquoc, downstream to the confluence of the Cuyama River. Sector E contains 470 million tons of PCC-grade aggregate resources.

The Sisquoc River area was previously classified by DMG in response to a petition. The information in that report (Cole and Jensen, 1986) was used in this report with no changes in the boundary of the area classified as MRZ-2 for PCC-grade aggregate.

Sector E contains the largest reserves of PCC-grade aggregate in the region even though Sector D contains a far greater tonnage of aggregate resources. Two mining companies, Coast Rock Products, Inc., (subsectors E-1, E-3, and E-4) and Kaiser Sand and Gravel Company (subsectors E-1 and E-2), have large holdings along the Sisquoc River. These companies are presently mining aggregate from the active river channel, but they have also mined aggregate from the floodplain south of the active river channel.

Mining of aggregate in the Sisquoc River area was reported as early as 1924 (Tucker, 1925). Coast Rock Products, Inc., has been mining aggregate here since 1957. Kaiser Sand and Gravel Company took over the property of Southern Pacific Milling Company in 1980 and has been mining here since that time. Distribution of PCC aggregate from these two plants reaches as far as the community of Goleta, 70 miles to the south and the city of Cambria, 75 miles to the north.

The rock types recognized within the river channel deposits mined include well-lithified sedimentary conglomerate and breccia, coarse-grained arkosic and lithic sandstone, fine- to medium-grained quartzose sandstone, volcanic breccia, quartzite, basic igneous rock, fine- to medium-grained plutonic rock with a silicic to intermediate composition, chert, and tuffaceous and porcelaneous shale. The shale makes up about 5 to 20 percent of the alluvial material and must be removed during the processing of the PCC aggregate. The shale is removed by using a heavy media separator and a sand sorter and is marketed separately as chip seal.

Water-well logs in the Sisquoc River indicate that the upper portion of the alluvium consists of a relatively unstratified layer of sand, gravel, and boulders. The thickness of this surface layer varies from about 25 feet in the upstream end to about 70 feet near the Cuyama River. Below this relatively unstratified layer are alternating stratified layers of sand, sandy clay, gravel, and clay which typically range in thickness from 1 to 10 feet.

Table 6. PCC-grade aggregate resources in Sector E.

SUB-SECTOR	TOTAL ACRES	ACRES PERMITTED FOR PCC-GRADE	THICK-NESS (feet)	PERCENT PCC-GRADE	PCC-GRADE RESERVES (tons)	PCC-GRADE RESOURCES (tons)
E-1	1,663	298	70	95	*	269,600,000
E-2	94	0	85	95	0	17,900,000
E-3	1,265	221	50	95	*	144,400,000
E-4	720	63	25	95	*	38,300,000
SUBTOTALS						
	3,742	582			*	470,200,000

*Proprietary data

Table 7. Total PCC-grade aggregate resources in the San Luis Obispo-Santa Barbara P-C Region.

SECTOR	TOTAL ACRES	ACRES PERMITTED FOR PCC-GRADE	PCC-GRADE RESERVES (tons)	PCC-GRADE RESOURCES (millions of tons)
A	2,014	0	0	58 (sand)
B	135	135	*	* (sand and gravel)
C	12,239	212	*	6,119 (crushed stone)
D	17,758	409	*	4,528 (sand and gravel)
E	3,742	582	*	470 (sand and gravel)
GRAND TOTALS	35,888	1,338	107	11,175 **

* Proprietary data.
** Does not include resources in Sector B

PCC-grade Aggregate Deposits below Minimum Threshold Value

SAN SIMEON CREEK

Although Morro Rock and Sand Company actively mines PCC aggregate in San Simeon Creek, the deposit has been classified as MRZ-3. The amount of aggregate resources available here has been determined to be below the minimum threshold value as required by the State Mining and Geology Board. Even though the deposit does not meet this criterion of regional significance, the deposit is locally important to the Cambria area. PCC aggregate not supplied to the Cambria area by the San Simeon Creek deposit must be hauled 70 miles from the Sisquoc River.

The California Department of Fish and Game limits mining on San Simeon Creek to the gravel bars above the low water line. Therefore, the supply is dependent on replenishment by flooding in the creek.

The maximum size of the aggregate in the creek channel is about 6 inches in diameter and there are abundant cobbles over 2 inches in diameter. About 70 percent of the material is gravel-sized with the remainder being sand. The most abundant rock types represented in the gravels are graywacke and greenstone. There are also fragments of chert, serpentine, siltstone, sandstone, and schist; however the deposit does not require extensive processing or flotation to remove deleterious clasts.

PINE CANYON

The streambed of Pine Canyon contains aggregate material of PCC quality. However, the quantity of resource that is known to be available here does not meet the minimum threshold value as set by the Board.

The known deposit extends from the mouth of Pine Canyon, at the Highway 166 crossing, to about 1 mile upstream. While no mining is currently taking place, mining of aggregate, including small amounts of PCC aggregate, has taken place in this area since the late 1970's. Pine Canyon Rock, Inc., was the last company to mine here. The depth of mining in this deposit is limited by a major pipeline, buried at a depth of 15 feet, which crosses the canyon about one-quarter mile upstream of the canyon mouth.

The maximum size of the aggregate is about 1 foot in diameter and the average size is about 3 to 4 inches in diameter. The rock types of the cobbles commonly are sandstone, limestone, and quartzite.

CLASSIFICATION OF ACTIVE MINES PRODUCING OTHER MINERAL COMMODITIES

The entire P-C region has been classified for PCC-grade aggregate. Additionally, during this study, sites of active production of other commodities were encountered. It was decided that deposits which contain active mining operations, regardless of the type of mineral commodity produced, would also be classified as MRZ-2. The reserves and resources at most of these sites have not been quantified beyond ensuring that they exceed the minimum threshold value established by the State Mining and Geology Board for each category of commodity. However, the reserves of those mines which are actively producing other construction aggregates were calculated for inclusion in the final estimate of total aggregate reserves for the region, to be compared with the total aggregate demand of the region for the next 50 years. It is important to note that the classification of deposits which contain active mine sites is not to be construed as a classification of the entire region for these commodities, but solely a classification of individual deposits where commercial extraction of a mineral resource occurs. Because no attempt was made to determine the regional significance of these individual deposits, they have not been sectorized as candidates for designation by the Board.

The San Luis Obispo-Santa Barbara P-C Region has ten deposits currently being mined for commodities other than PCC-grade aggregate which are classified as MRZ-2 as shown on Plates 1 - 41. These deposits are mined by ten different companies, but are not completely correlated to the deposits on a one-to-one basis. One company mines two different deposits and two companies mine within the same deposit. The commodities mined are aggregate base from recent alluvium, diatomite and decorative stone from Miocene marine sediments, asphaltic aggregate from recent stream channel alluvium, specialty sands from Tertiary sediments and coastal dunes, and riprap from Cretaceous sandstone.

Upper Cretaceous sandstone, exposed in a ridge about 3 miles south of Cambria on the west side of Highway 1, in San Luis Obispo County, is classified as MRZ-2 for riprap.

- Cambria Radar Station Quarry, operated by Negranti Construction Company, is located on the west side of Estrada Ridge. The property covers 57 acres at the north end of the ridge, all of which have been classified as MRZ-2 for riprap (Plate 3). Mining began at this site in about 1925. The material mined is a hard feldspathic graywacke and arkosic wacke of Upper Cretaceous age. The sandstone is highly fractured and is composed mostly of quartz (50-70 percent). The deposit is classified for riprap because the bulk of the produced material is sold for that use, and test data to substantiate PCC quality were lacking.

The sand dunes along the coast are mined at two locations within the P-C region for specialty sands. These two properties are classified as MRZ-2 for specialty sands.

- Oceano Sand Company operates a sand mine in the coastal dunes just south of Oceano in San Luis Obispo County (Plate 16). Specialty sand has been produced from this 30-acre property since before 1920. Recent production has been used in golf course sand traps.

- Gordon Sand Company mines specialty sand on a 27-acre parcel about 1 mile south of the mouth of the Santa Maria River in Santa Barbara County (Plate 20). The windblown dune sands are processed for use in sand blasting.

Aggregate subbase material is mined from recent alluvium along Alamo Creek in San Luis Obispo County. This property is classified as MRZ-2 for subbase.

- Alamo Rock and Sand Company mines sand and gravel along Alamo Creek, about 2 miles north of Highway 166, 8 miles northwest of Santa Maria (Plate 18). Alluvial material is skimmed from the creek bed and processed for use as subbase.

Decorative stone is mined from the siliceous shales of the Monterey Formation along Tepusquet Canyon in Santa Barbara County. The quarry is classified as MRZ-2 for decorative stone.

- Antolini and Sons quarries decorative stone at two locations in Santa Barbara County, the Santa Maria Quarry and the Colson Summit Quarry. The Colson Summit Quarry is outside of the P-C region. At the Santa Maria Quarry, about 25 miles east of Santa Maria, siliceous shale from the Miocene-age Monterey Formation is mined for use as building stone (Plate 24).

Diatomite is mined from Miocene rocks south of Lompoc in Santa Barbara County. The diatomite mines here are the largest in the world. There are four separate properties that are classified as MRZ-2 for diatomite.

- Manville Corporation has two properties south of Lompoc which have nearly 3,000 acres underlain by reserves of diatomite (Plates 29, 32, and 33). The diatomite operation here is the largest in the world. The diatomite from this quarry is used in the filtration of beer, wine, cooking oils, and many other liquids.

- Grefco, Inc. operates the second largest diatomite quarry in the Lompoc area. From the two properties controlled by Grefco, Inc., diatomite is mined for use in filtration and as paint extender (Plates 32 and 33).

Asphaltic aggregate and other construction aggregate materials are mined from the active stream channel of the Santa Ynez River near Buellton in Santa Barbara County. Because of the information that is available concerning the geology of the alluvial deposits along the Santa Ynez River, a large area of the river channel outside of the property boundaries of the two active mines was also classified as MRZ-2 for asphaltic aggregate. Geologic mapping by the U.S. Geological Survey (Wilson, 1959) and drill logs were used to classify the deposit.

- Buellflat Rock Company mines alluvium from the Santa Ynez River next to the city of Solvang (Plate 34). A wide range of aggregate products including asphaltic aggregate and chipseal (surface coating for streets) are sold here. Because both the sand and gravel fractions of the deposit contain large amounts of Monterey shale fragments, the material cannot meet the quality standards for Portland cement concrete aggregate.

- Granite Construction Company operates a sand and gravel mine - the Gardner Pit - along the Santa Ynez River between Buellton and Solvang (Plate 34). The plant produces road building materials that are used over a large part of Santa Barbara County. As in all of the alluvial deposits along the Santa Ynez River, there are too many shale fragments to permit the material to be used as Portland cement concrete aggregate.

Sand is mined from a Tertiary marine formation near Santa Barbara. The mine property and an adjacent part of the same formation have been classified as MRZ-2 for specialty sand.

- Santa Barbara Sand and Topsoil Company mines sand from the Vaqueros Formation in Ellsworth Canyon, about 5 miles west of Goleta in Santa Barbara County (Plate 37). The material is sorted for sand and sold for use in house pads and foundations, trench filling, and landscaping. Although this is a low-grade deposit, the contribution it makes to the construction aggregate needs of the urban area in and around the city of Santa Barbara is important. All other construction aggregate must be transported from either the Buellton area or from Ventura County.

Other Active Mines Not Classified as MRZ-2

Besides the ten deposits that have been classified as MRZ-2 for commodities other than PCC-grade aggregate, there are several active or intermittently active deposits that have less than the threshold value of resources available. The majority of these deposits are mined for road base materials (road base, subbase, and class III aggregate base) and are located in San Luis Obispo County. The San Luis Obispo County Engineering Department prefers to have a source for class III aggregate base available along each county-maintained dirt road. This is to avoid the haulage of road material over paved highways. These quarries are generally located in the Franciscan Formation and are termed "red rock" quarries because of the reddish color of the material. The Franciscan Formation is a disorderly assemblage of various rocks that have undergone unsystematic disturbance. This heterogeneous mixture of rock material is called a "melange." The desired material for road base is generally found as small pods of hard rock within this melange. Although, as has been mentioned, none of these deposits have threshold amounts of material, as a group they constitute an important source of construction aggregate for the region. Table 8 is a listing of these and other small mines. Their locations are plotted on Plate 55.

Table 8. Active mines with less than threshold value of commodities other than PCC-grade aggregate.

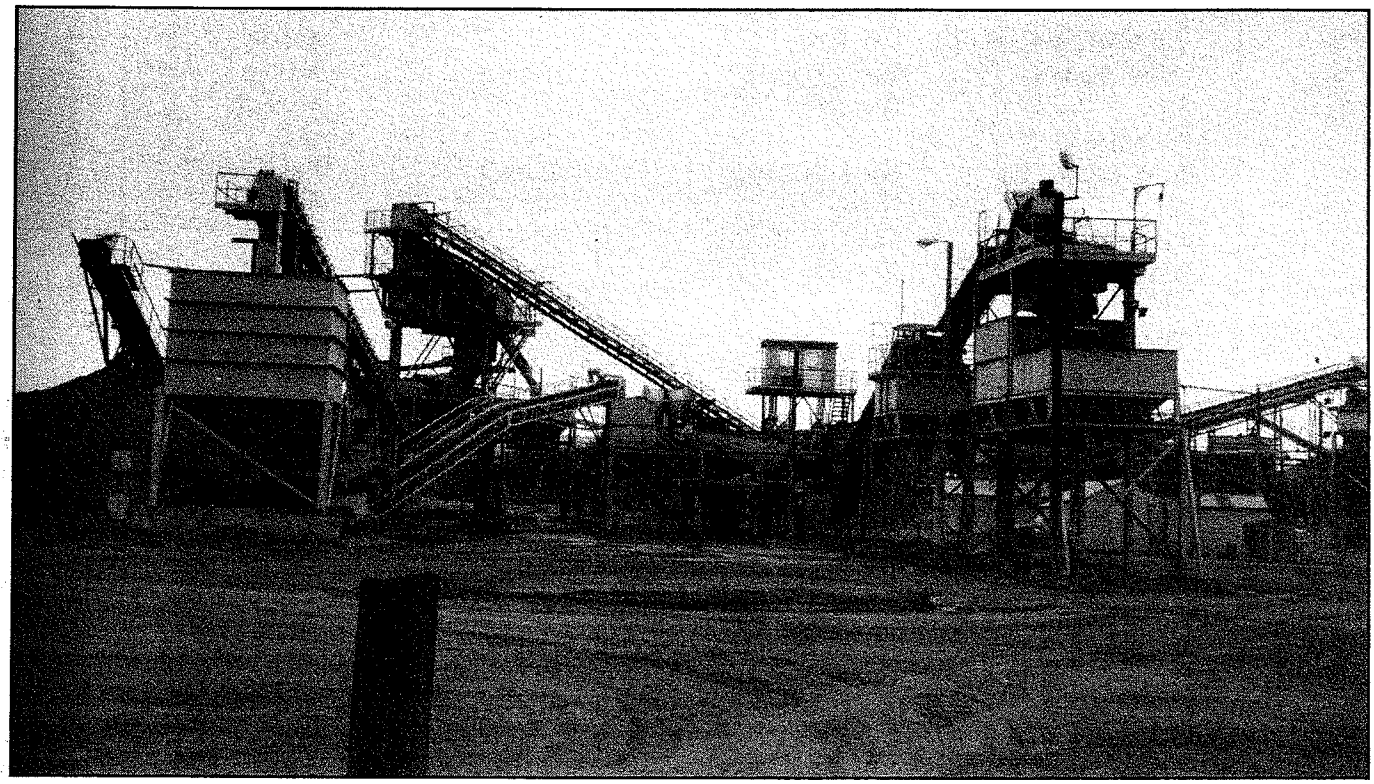
MINE NAME (ALTERNATE NAME*)	COUNTY AND (7.5' QUADRANGLE)	PRIMARY COMMODITY	GEOLOGIC FORMATION
Acin Quarry	Santa Barbara (Lompoc)	decorative stone	Monterey Formation
Alberti Ranch Quarry	San Luis Obispo (San Luis Obispo)	base aggregate	Franciscan Formation
Beecham Pit (Red Rock Pit)	San Luis Obispo (Morro Bay South)	Class III aggregate	Franciscan Formation
Biagginni Pit	San Luis Obispo (Cayucos)	Class III aggregate	Franciscan Formation
Brughelli Pit	San Luis Obispo (San Luis Obispo)	Class III aggregate	Franciscan Formation
Domenghini Pit	San Luis Obispo (Morro Bay North)	Class III aggregate	Franciscan Formation
Froom Ranch Pit	San Luis Obispo (San Luis Obispo)	Class III aggregate	Franciscan Formation
Guerra Quarry	San Luis Obispo (Morro Bay North)	subbase	Franciscan Formation
Hartzell Pit (Cienega Creek Quarry)	San Luis Obispo (York Mountain)	Class III aggregate	Franciscan Formation
Hawley Rock Quarry (El Jaro Quarry)	Santa Barbara (Santa Rosa Hills)	riprap	Monterey Formation
Hedges Pit (Ormond Road Pit)	San Luis Obispo (Arroyo Grande NE)	fill sand	Pismo Formation
Homeplace Pit	San Luis Obispo (San Luis Obispo)	Class III aggregate	Franciscan Formation
Huasna River Pit	San Luis Obispo (Huasna Peak)	Class III aggregate	Recent alluvium
Land Mine (Land Red Rock Pit)	San Luis Obispo (Cypress Mountain)	road base	Franciscan Formation
Las Cruces Quarry	Santa Barbara (Santa Rosa Hills)	decorative stone	Monterey Formation
Live Oak Shale Quarry	Santa Barbara (Solvang)	subbase	Sespe Formation
Miguelito Canyon Quarry	Santa Barbara (Lompoc Hills)	road base	Monterey Formation
Millhollin Pit	San Luis Obispo (Atascadero)	road base	Atascadero Formation
Mountain Springs Quarry	San Luis Obispo (Paso Robles)	road base	Monterey Formation
Nicholson Red Rock Pit	San Luis Obispo (Morro Bay North)	Class III aggregate	Franciscan Formation
North River Road Pit	San Luis Obispo (Paso Robles)	Class II aggregate	Quaternary alluvium

Table 8. (continued)

MINE NAME (ALTERNATE NAME*)	COUNTY AND (7.5' QUADRANGLE)	PRIMARY COMMODITY	GEOLOGIC FORMATION
Ole Viborg Salinas River Pit	San Luis Obispo (Paso Robles)	fill sand	Recent alluvium
Parker Red Rock Pit	San Luis Obispo (San Luis Obispo)	Class III aggregate	Franciscan Formation
Patchett Pit	San Luis Obispo (Arroyo Grande NE)	Class III aggregate	Pismo Formation
Sanford Quarry	Santa Barbara (Tranquillon Mtn.)	decorative stone	Monterey Formation
Serrano Pit	San Luis Obispo (Morro Bay South)	Class III aggregate	Franciscan Formation
Sheehy Pit (Dana Ranch Pit)	San Luis Obispo (Nipomo)	Class III aggregate	Franciscan Formation
Signorelli Quarry	Santa Barbara (Tranquillon Mtn.)	decorative stone	Monterey Formation
Solvang Sand Pit	Santa Barbara (Zaca Creek)	fill sand	Careaga Formation
Stornetta Pit	San Luis Obispo (Arroyo Grande NE)	Class III aggregate	Franciscan Formation
12th Street Pit	San Luis Obispo (Paso Robles)	fill sand	Recent alluvium
V.J. Rock Transport Sand Pit	Santa Barbara (Lompoc)	fill sand	Recent alluvium
Valley Trucking Sand Pit (Lompoc Sand and Gravel Pit)	Santa Barbara (Lompoc)	fill sand	Recent alluvium
W. W. Warren Pit	San Luis Obispo (Cayucos)	Class II aggregate	Franciscan Formation
Whale Rock Pit	San Luis Obispo (San Luis Obispo)	Class III aggregate	Franciscan Formation

* Mine name in list of Mining Operations Subject to SMARA (MOSS) if different. The MOSS list is a Division of Mines and Geology internal information file.

Aerial view of Manville Corporation diatomite plant at Lompoc.



Coast Rock Products, Inc. aggregate plant on the Sisquoc River.

ESTIMATED 50-YEAR CONSUMPTION OF AGGREGATE

Basis of 50-Year Forecast

The State Mining and Geology Board, as specified in its "Guidelines for Classification and Designation of Mineral Land" (California State Mining and Geology Board, 1983, Part II) requires that mineral land classification reports for regions containing construction materials classified as MRZ-2 include "An estimate of the total quantity of each such construction material that will be needed to supply the requirements of both the county and the marketing region in which it occurs for the next 50 years. The marketing region is defined as the area within which such material is usually mined and marketed. The amount of each construction material mineral resource needed for the next 50 years shall be projected using past consumption rates adjusted for anticipated changes in market conditions and mining technology." In the guidelines the Board also specifies that these estimates be reviewed periodically (every 10 years or fewer).

A 50-year forecast of PCC aggregate needs in the San Luis Obispo-Santa Barbara P-C Region was made on the basis of reported aggregate production during the years 1960-1987. The P-C region boundary is defined to ensure that no more than one percent of the PCC aggregate produced in the San Luis Obispo-Santa Barbara area is delivered outside of the P-C region, and that imports of PCC-grade aggregate from outside the P-C region or the neighboring Western Ventura County P-C Region, are less than 5 percent. Mines in the Western Ventura County P-C Region supply about 10 percent of the aggregate demand in the San Luis Obispo-Santa Barbara P-C Region.

Correlations between Aggregate Production and Consumption

Past studies of marketing regions in California have shown that there is a strong correlation between the amount of aggregate produced and the population in a given aggregate production-consumption region (Anderson and others, 1979.) On this basis, aggregate production and population figures in the San Luis Obispo-Santa Barbara P-C Region were correlated for the years 1960-1987 (Table 9). Correlations between the annual aggregate production records and the population statistics were used to compute historic annual per capita consumption rates of aggregate in the study area. This annual per capita consumption figure is for all aggregate, not just PCC aggregate. The historical aggregate production data for the study area were obtained from mining records of the U.S. Department of the Interior, Bureau of Mines and the aggregate companies. The Bureau of Mines' records are compiled from responses to voluntary questionnaires that are sent annually or semi-annually to all known mining operators. Each producer is requested to divulge the production from each of his producing properties for the preceding year. It is important to note that the degree of accuracy of these statistics depends entirely on the producer's response. Although compliance is usually good, the DMG staff did not verify production data in the Bureau of Mines' files. Historical population data for the San Luis Obispo-Santa Barbara P-C Region were received from the California Department of Finance and the U.S. Department of Commerce (1970 and 1980).

The average per capita consumption rate in the San Luis Obispo-Santa Barbara P-C Region has been 6.0 tons of aggregate per year over the period 1960-1987 (Table 9). Due to the erratic variations in aggregate production from year to year, a three-year moving average of the annual aggregate production was used in conjunction with population statistics to compute the per capita consumption rates for the P-C region (Figures 5, 6, and 7). The moderate consumption rates in the San Luis Obispo-Santa Barbara area appear to be characteristic of aggregate marketing regions in which the overall population density is relatively low and the rate of urban development is moderate. For example, the Simi Valley P-C Region (Ventura County) and the Western San Diego County P-C Region were both found to have consumption rates of 5.5 tons per person per year.

A moderate consumption rate will most likely continue in the foreseeable future. As the population density of the region is so low, the point of urban maturity, wherein all available open land is urbanized, probably will not be reached in the next 50 years. If this point of urban maturity were reached, then a decrease in the annual per capita consumption rate would be expected.

Projected Population and Per Capita Consumption through the Year 2038

A simple analysis of the historical aggregate production and past population statistics and population projections for the future was made to forecast the rate of aggregate consumption within the San Luis Obispo-Santa Barbara P-C Region through the year 2038. The total aggregate needs of the study area through the year 2038 were calculated on the basis of two factors: (1) the past average

Table 9. Population, aggregate consumption (tons), and per capita consumption (tons) in the San Luis Obispo-Santa Barbara P-C Region during the years 1960-1987. (All figures are rounded to the nearest 1,000).

YEAR	POPULATION	AGGREGATE CONSUMPTION (tons)	3-YEAR AVERAGE OF CONSUMPTION (tons)	ANNUAL PER CAPITA CONSUMPTION (tons)
1960	237,000	1,546,000		
1961	248,000	1,838,000	1,728,000	7.0
1962	260,000	1,800,000	1,682,000	6.5
1963	272,000	1,407,000	1,821,000	6.7
1964	284,000	2,256,000	1,788,000	6.3
1965	295,000	1,700,000	2,032,000	6.9
1966	307,000	2,139,000	1,812,000	5.9
1967	319,000	1,597,000	1,884,000	5.9
1968	331,000	1,917,000	1,649,000	5.0
1969	342,000	1,434,000	1,554,000	4.5
1970	354,000	1,310,000	1,571,000	4.4
1971	361,000	1,968,000	1,753,000	4.9
1972	367,000	1,981,000	2,100,000	5.7
1973	374,000	2,339,000	2,155,000	5.8
1974	385,000	2,146,000	2,298,000	6.0
1975	392,000	2,409,000	2,422,000	6.2
1976	401,000	2,711,000	2,550,000	6.4
1977	409,000	2,531,000	2,581,000	6.3
1978	416,000	2,501,000	2,337,000	5.6
1979	424,000	1,978,000	2,116,000	5.0
1980	434,000	1,869,000	2,147,000	4.9
1981	441,000	2,593,000	2,329,000	5.3
1982	451,000	2,524,000	2,658,000	5.9
1983	463,000	2,858,000	2,985,000	6.4
1984	476,000	3,574,000	3,356,000	7.1
1985	491,000	3,636,000	3,509,000	7.1
1986	507,000	3,318,000	3,434,000	6.8
1987	522,000	3,349,000		

Average annual per capita consumption for 1960-1987 is 6.0 tons.

Table 10. Projected aggregate consumption through the year 2038 for the San Luis Obispo-Santa Barbara PCC Region . Five-year per capita consumption = 30.0 tons/person. One-year per capita consumption = 6.0 tons/ person.

YEARS	PROJECTED AVERAGE YEARLY POPULATION*	PROJECTED AGGREGATE CONSUMPTION ALL AGGREGATE (million tons)	PROJECTED AGGREGATE CONSUMPTION PCC AGGREGATE (million tons)**
1989-1993	532,352	16.0	5.9
1994-1998	572,724	17.2	6.4
1999-2003	608,734	18.3	6.8
2004-2008	640,334	19.2	7.1
2009-2013	671,699	20.2	7.5
2014-2018	703,063	21.1	7.8
2019-2023	734,427	22.0	8.2
2024-2028	765,792	23.0	8.5
2029-2033	797,155	23.9	8.8
2034-2038	828,520	24.9	9.2
TOTALS		205.8	76.2

* Population projections for the years 1989-2020 are from the California Department of Finance (1986). Population data for the years 2021-2038 are linear projections from the Department of Finance data.

** This figure is based on the fact that 37 percent of the aggregate consumed from 1960 to 1987 was used in PCC (Table 11).

annual per capita consumption rate of 6.0 tons (the average annual per capita consumption rate for the years 1960-1987) and (2) the projected population of the region through the year 2038 (Table 10). The total PCC aggregate demand through the year 2038 is based on historic PCC aggregate consumption. The average percentage of total aggregate consumption used as PCC aggregate was calculated using data from the years 1960-1987. For the San Luis Obispo-Santa Barbara P-C Region, the average historic percentage of PCC aggregate use has been 37 percent of the total aggregate consumption (Table 11).

Population projections for the years 1988 to 2020 (Figure 8) were obtained from the California Department of Finance (1986). To project the population of the area for the years 2021-2038, the Department of Finance projections to the year 2020 were extended in a straight line to the year 2038. The results of these projections, combined with the calculated per capita consumption rate, show that an estimated 206 million tons of aggregate will be needed to satisfy the future demand through the year 2038 in the San Luis Obispo-Santa Barbara P-C Region. Of this total, 37 percent, or 76 million tons must be of PCC grade.

Factors Affecting Per Capita Consumption Rates

The wide variations from year to year in the per capita consumption rate (Figure 7) probably reflect to a large degree, changes in urban growth rates and intermittent large construction projects (for example: freeways, dams, and canals). In part, these variations also result from incompleteness and inaccuracies in the production records supplied by the Bureau of Mines. Certainly the economic climate is a powerful variable that influences the annual per capita consumption rates for aggregate. Very high interest rates, for example, such as existed in California in 1979 and 1980, tended to lower the amount of new construction and consequently lower the demand for aggregate. High consumption of aggregate occurred in the region in the mid-1960's due to construction on Highway 101, and in the mid-1980's as the construction industry rebounded after an economic recession in the early 1980's.

At some point in the future the average annual per capita consumption rate of 6.0 tons for the San Luis

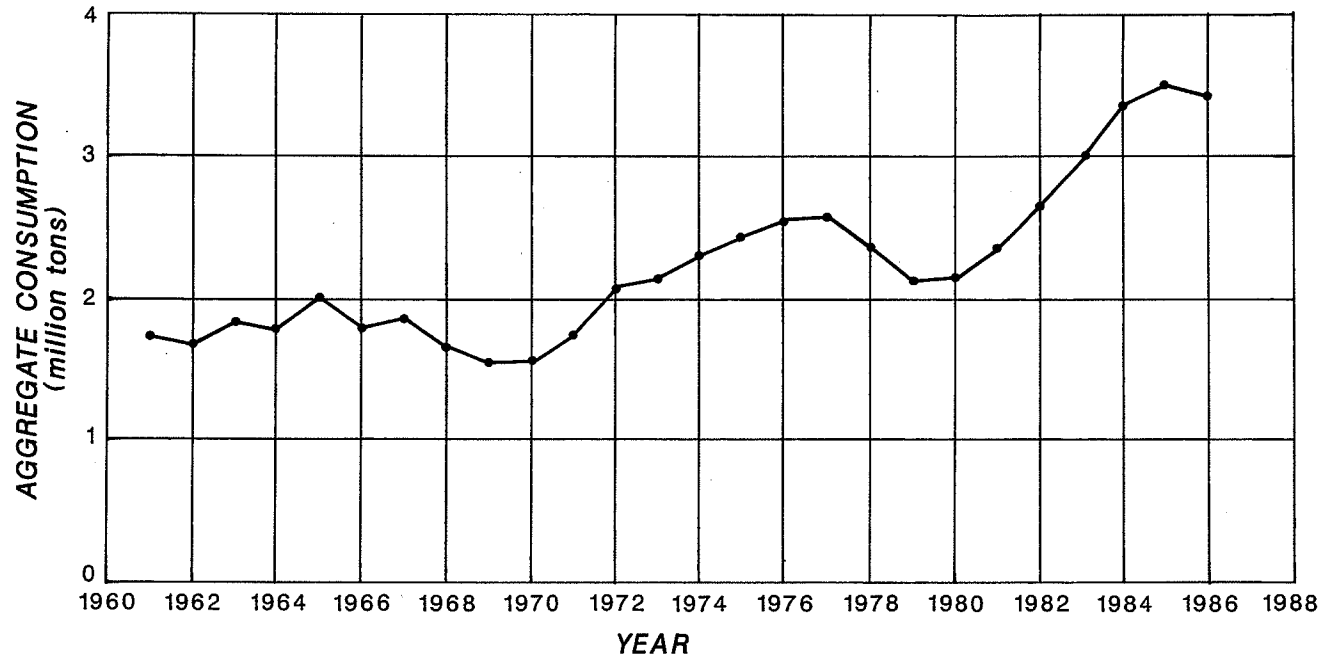


Figure 5. Aggregate consumption (3-year averages) in the San Luis Obispo-Santa Barbara P-C Region, 1961-1986.

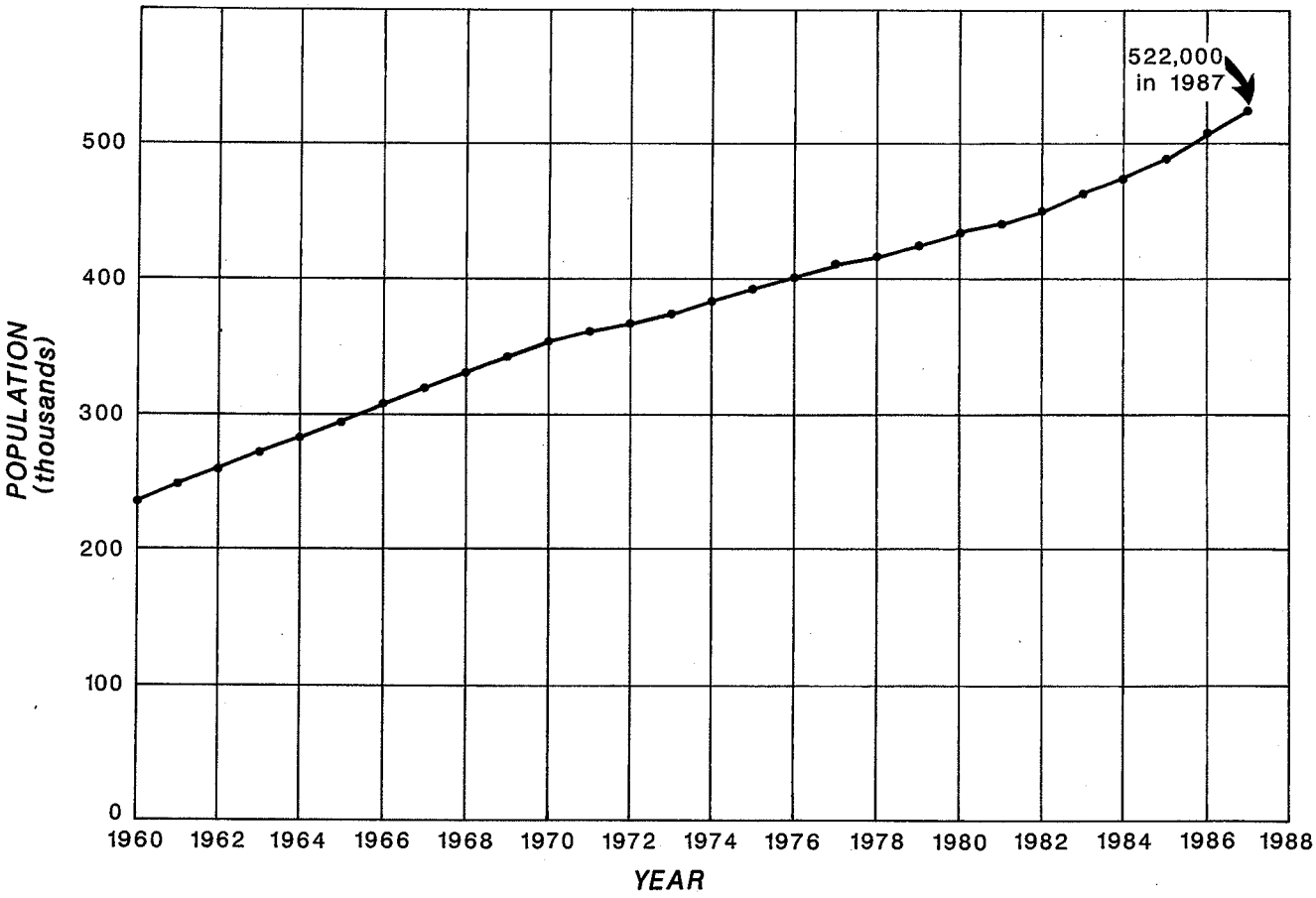


Figure 6. Population in the San Luis Obispo-Santa Barbara P-C Region, 1960-1987.

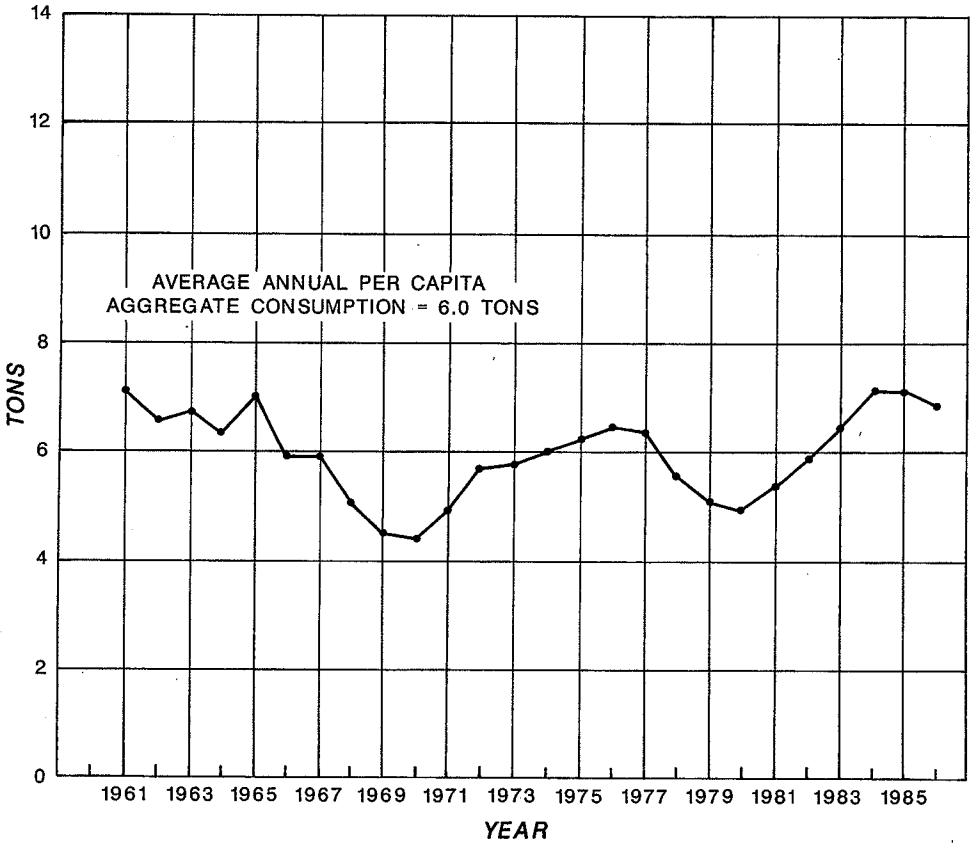


Figure 7. Annual per capita consumption of aggregate in the San Luis Obispo-Santa Barbara P-C Region, 1961-1986.

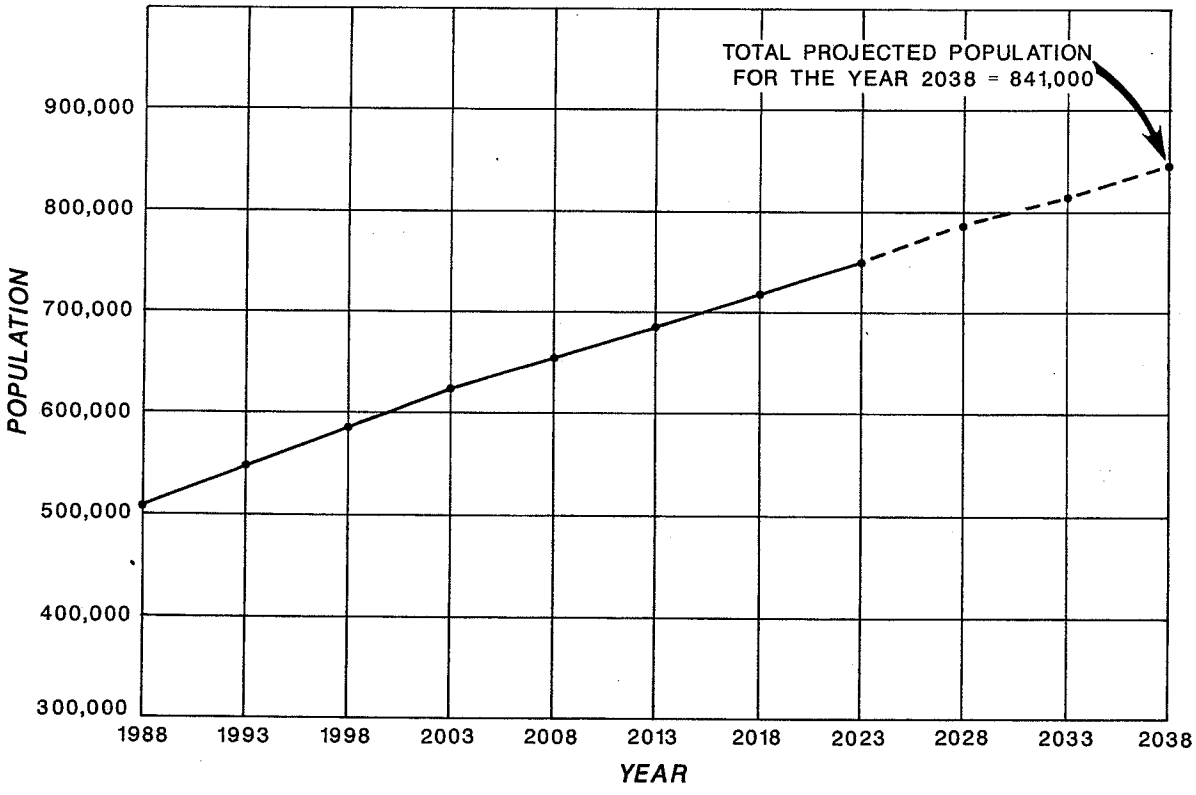


Figure 8. Projected population of the San Luis Obispo-Santa Barbara P-C Region for the years, 1988-2038.

Table 11. Percentage of total aggregate consumption used for Portland cement concrete (PCC) aggregate in the San Luis Obispo-Santa Barbara P-C Region during the years 1960-1987. (All figures rounded to nearest 1,000.)

YEAR	TOTAL AGGREGATE CONSUMED (tons)	PCC AGGREGATE CONSUMED (tons)	PERCENT OF TOTAL AGGREGATE CONSUMPTION USED AS PCC AGGREGATE
1960	1,546,000	773,000	50
1961	1,838,000	859,000	47
1962	1,800,000	695,000	39
1963	1,407,000	587,000	42
1964	2,256,000	914,000	41
1965	1,700,000	887,000	52
1966	2,139,000	576,000	27
1967	1,597,000	563,000	35
1968	1,917,000	587,000	31
1969	1,434,000	479,000	33
1970	1,310,000	521,000	40
1971	1,968,000	863,000	44
1972	1,981,000	826,000	42
1973	2,339,000	774,000	33
1974	2,146,000	796,000	37
1975	2,409,000	712,000	30
1976	2,711,000	846,000	31
1977	2,531,000	849,000	34
1978	2,501,000	880,000	35
1979	1,978,000	558,000	28
1980	1,869,000	522,000	28
1981	2,593,000	799,000	31
1982	2,524,000	1,042,000	41
1983	2,858,000	1,043,000	36
1984	3,574,000	1,362,000	38
1985	3,636,000	1,435,000	39
1986	3,318,000	1,346,000	41
1987	3,349,000	1,218,000	36
TOTALS	63,229,000	23,285,000	

Average percentage of total aggregate consumption used as PCC aggregate = 37 percent.

Table 12. Summary of aggregate resources and 50-year demand for the San Luis Obispo-Santa Barbara P-C Region.

PCC-grade aggregate resources (includes PCC-grade aggregate reserves)	11,175,000,000 tons
PCC-grade aggregate reserves	107,000,000 tons
All aggregate reserves	132,000,000 tons
50-year demand, PCC aggregate	76,000,000 tons
50-year demand, all aggregate	206,000,000 tons

Obispo-Santa Barbara P-C Region will probably decrease with the onset of urban maturity and stabilize at a lower rate. This probably will not occur during the next 50 years due to the large areas of developable land available within the region. Also, major unforeseen events such as disaster reconstruction in the wake of an earthquake or a major economic recession would cause the per capita consumption rate of aggregate to change radically.

Comparison of the 50-Year Aggregate Demand with Current Reserves

The total PCC-grade aggregate reserves for the San Luis Obispo-Santa Barbara P-C Region were calculated to be 107 million tons. And the total aggregate reserves, including reserves of construction aggregates other than PCC grade, were estimated to be 132 million tons (these figures do not reflect reserve depletion since January 1, 1988). At the average rate of historic aggregate consumption in the region (6.0 tons per person per year), the total reserves are theoretically sufficient to last 34 years, until 2023.

According to the U.S. Bureau of Mines aggregate production statistics, confirmed by aggregate operators in the P-C region, for the years 1960 to 1987, 37 percent of the total aggregate consumed in the region was used for PCC (Table 10). This equates to 76 million tons of PCC aggregate that will be needed within the next 50 years. If the 107 million tons of PCC-grade aggregate reserves were used exclusively for PCC aggregate, the supply would theoretically last more than 50 years. In reality, much of the PCC-grade aggregate reserves will be used for other products, and a depletion date of 2023 is more likely. Table 12 is a summary of present aggregate resources and future aggregate demands for the San Luis Obispo-Santa Barbara P-C Region.

ALTERNATIVE SOURCES OF AGGREGATE

Potential sources of Portland cement concrete aggregate, in addition to the deposits classified as MRZ-2, exist within and near the San Luis Obispo-Santa Barbara P-C Region. These potential alternative sources include areas within the region that are classified as MRZ-3 and production areas in adjacent regions. These alternative sources are discussed in the following paragraphs.

Potential Sources of Aggregate within the San Luis Obispo-Santa Barbara P-C Region

Other than the large areas classified as MRZ-2 for Portland cement concrete (especially the La Panza granitics and the alluvium of the Santa Maria River), there are few promising sources for future PCC-grade aggregate in the region. Potential sources of Portland cement concrete aggregate of some note, that have been classified as MRZ-3, include Quaternary river terrace deposits, recent stream channel deposits, Mesozoic granitic rocks, and Mesozoic metamorphic rocks.

The older river terrace deposits along the Salinas River have been a source of concrete aggregate in the past, but all of the material may not be able to meet modern test standards for Portland cement concrete aggregate quality and waste percentages may be excessive. These terrace deposits are primarily in the area between the cities of Atascadero and Paso Robles, and north of Paso Robles.

The eastern parts of the La Panza granitics may contain unweathered material that is economically minable as crushed stone. The thickness of the weathered surface layer is the critical factor. Although the La Panza granitics are mined for aggregate at two locations in the western part which has been classified as MRZ-2, the overburden of weathered rock there is about 50 feet thick. In the eastern area of the granitics the topography is gentler, allowing for less erosion of weathered surface material; thus the PCC-grade stone may be overlain by a thicker layer of unsuitable material. Extensive geologic evaluation of site-specific areas would be necessary in the La Panza granitics.

The alluvium in the channel of the Cuyama River may be suitable for PCC aggregate. Material carried by the Cuyama River is mixed with sand and gravel from the Sisquoc River at the confluence of the two rivers near Fulger Point. The mixed material from these two rivers is mined for PCC aggregate by Coast Rock Products, Inc. It is possible, then, that material from the Cuyama drainage may be suitable for PCC aggregate. There are no data on the thickness of the alluvium in the bed of the Cuyama River; although it looks, from field observation, to be thin in several areas.

Although no aggregate of PCC quality has been mined from the Franciscan Formation in the region, there may be bodies of hard graywacke or metavolcanics within the

formation that would be suitable. The Franciscan Formation within the P-C region has never been a source for PCC aggregate.

Potential Sources of PCC-Grade Aggregate outside of the P-C Region

PCC-grade aggregate is being imported for use in the San Luis Obispo-Santa Barbara P-C Region from the lower Santa Clara River production area in the adjacent Western Ventura County P-C Region. Part III of Special Report 145 (Anderson and others, 1981) reported that the Western Ventura County P-C Region had a calculated 13 years of aggregate reserves as of the publication of that report. It is likely then that the reserves in the lower Santa Clara River will not be a source of PCC aggregate over a long period of time. And, because of the shortage of aggregate reserves in the Western Ventura County region, future decisions by lead agencies in that region may not take into account the needs of the Santa Barbara area.

It is possible that the Simi P-C Region could supply aggregate to the Santa Barbara area should the Western Ventura County region become depleted or unable to support exports to the San Luis Obispo-Santa Barbara region. Although the producers in the Simi region are much farther from Santa Barbara than the producers in the lower Santa Clara River, they are closer to Santa Barbara than the producers in the Sisquoc River production area.

Small amounts of PCC aggregate are being imported to the Paso Robles area, in the northern part of the San Luis Obispo-Santa Barbara P-C Region, from near the town of Coalinga in Fresno County. Producers in this part of Fresno County may be able to continue supplying northern areas of the P-C region with limited amounts of aggregate as the distance of this area from Paso Robles is about the same as from the Sisquoc River production area. Although there are large reserves of crushed aggregate closer to urban areas in the northern part of the P-C region (Union Asphalt, Inc. Rocky Canyon Quarry and Southern Pacific Milling Company Santa Margarita Quarry) for contractors who prefer to use rounded alluvial gravel in making Portland cement concrete, Navajo Creek, Sisquoc River, and Coalinga are the closest production areas.

Streambed deposits along the upper Nacimiento River in Monterey County, about 20 miles north of the San Luis Obispo-Santa Barbara P-C Region, have been reported to contain aggregate material possibly of PCC grade (Goldman, 1964). Data are lacking on the thickness of the deposit to evaluate the quantity available, and tests of the reactivity of the material have not been recorded to determine quality.

CONCLUSIONS

Within the San Luis Obispo-Santa Barbara P-C Region, five resource sectors were identified as containing significant resources of PCC-grade aggregate. These areas contain an estimated total of 11,175 million tons of PCC-grade aggregate resources of which 6,119 million tons are crushed stone resources and 5,056 million tons are sand and gravel resources. There are 107 million tons of PCC-grade aggregate reserves, including both sand and gravel and crushed stone.

Based upon available production data and population projections, the San Luis Obispo-Santa Barbara P-C Region will need 206 million tons of aggregate during the next 50 years. Of this projected demand, approximately 37 percent (76 million tons) must be suitable for Portland cement concrete. There are 107 million tons of PCC-grade aggregate reserves and another 25 million tons of lower-grade aggregate reserves calculated to exist within the P-C region. This total of 132 million tons of aggregate is approximately 64 percent of the projected aggregate demand over the next 50 years. Unless new resources are permitted for mining, or alternative resources are utilized, existing reserves will be depleted by the year 2023. If a major earthquake or similar unforeseen catastrophic event strikes the P-C region and necessitates reconstruction, existing reserves will be depleted sooner.

Ten deposits currently being mined within the region for commodities other than PCC aggregate were found to meet the criteria for classification as MRZ-2. These deposits produce aggregate base, diatomite, decorative stone, asphaltic aggregate, specialty sand, and riprap.

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APPENDIX

Interim Criteria for Sectorization of MRZ-2 Areas for Aggregate

The purpose of sectorizing MRZ-2 areas is to provide a semi-quantified estimate of construction aggregate resources which are likely to be available to satisfy society's needs during the next 50 years. This estimate, when compared to DMG-projected needs for the next half-century, provides the context for communities to plan for future availability in their land-use policies. The determination of sectors is intended for the use of the State Mining and Geology Board (Board) in identifying areas which are candidates for designation under SMARA. The development of sectors provides a perception of future mineral resource availability in the face of future needs and also portrays where these available minerals are generally located. This information is distributed by the Board to all affected lead agencies to provide them with the data necessary to plan for future resource availability in their land-use policies.

All areas within MRZ-2 classifications are sectorized if they have current land uses which are similar to those in areas which have undergone mineral extraction in the past. Areas within MRZ-2 classifications which have generally not been available for surface mining in the past for specified social or economic reasons are not sectorized. Since such areas are unlikely to be used for surface mining during the foreseeable future, their inclusion in estimates of future resource availability would be misleading.

The estimation of future mineral resource availability in sectors is not a precise analysis, but rather the best general estimate which can be made with the data presently available. Areas within and without sectors can be used for mining or other land uses at the discretion of the local governments which are charged with responsibility for making land-use decisions. Establishment of sectors in no way infringes on this authority. Rather, it provides a perception of future mineral resource availabilities in the face of future needs and also portrays where these minerals are generally located.

The following criteria were used by DMG in identifying mineral resource areas which are available for future use. These criteria, in conjunction with the geologic and geometric characteristics of specific mineral deposits were used in sectorizing MRZ-2 areas. Use of these criteria assures that sectors contain geologically homogeneous mineral deposits which, based upon current land use, will be available for future use.

The following specific land uses are considered to be generally incompatible with mining and have been excluded from sectored lands. Mineral resource areas containing land uses not specifically listed will be considered for sectorization. The criteria are to be applied only to lands classified as MRZ-2.

There are two general categories of exclusion: I) Economic Exclusion, and II) Social Exclusion.

I) Economic Exclusion
Specific excluded land uses are:
1) Residential areas
2) Commercial areas with land improvements (buildings)
3) Industrial areas (buildings and adjacent needed storage and parking facilities), and
4) Major public or private engineering projects, including:
   a) canals
   b) freeways
   c) bridges
   d) airports and associated developments such as parking lots
   e) dams
   f) railroads
   g) major pipelines
   h) major power transmission lines

II) Social Exclusion
Specific excluded land uses are:
1) Cemeteries
2) Geologic Scientific Zones
3) Public parks, developed historical sites and structures, and public recreation areas of all types
4) Public or private schools, institutions, hospitals, and prisons, including adjacent grounds and related structures, and
5) Military bases and reservations

MINERAL LAND CLASSIFICATION: PORTLAND CEMENT CONCRETE AGGREGATE AND ACTIVE MINES OF ALL OTHER MINERAL COMMODITIES IN THE SAN LUIS OBISPO-SANTA BARBARA PRODUCTION-CONSUMPTION REGION - 1989

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