San Diego Region Aggregate Supply Study

January 2011

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San Diego Region Aggregate Supply Study

January 2011

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EXECUTIVE SUMMARY

INTRODUCTION

Aggregate materials include sand, gravel, and crushed stone. Aggregate is a key ingredient in concrete and asphalt and is essential for constructing and maintaining the physical framework of buildings and infrastructure for a modern society. In fact, simply stated aggregate is the fundamental building block of society—it is impossible to maintain or build a region without it. For example, aggregate is used as base material under roads and rails to provide a solid foundation, in commercial and residential buildings, new public facilities (such as schools and hospitals), and public works projects (such as sewer and water infrastructure).

According to the California Geologic Survey, aggregate supply sources within the San Diego region have dropped from 48 mines in 1980 to 27 mines in 1995.[1] Since then the number of significant and active mines declined to 16; this decline will likely continue over the next two decades as mining permits expire and/or resources are depleted. The California Geologic Survey projects a 40 percent shortfall in the statewide supply of aggregate material needed to meet demand through 2055. They also project an 83 percent shortfall in the region's supply of aggregate material.[2] As the locally based supply of aggregate decreases, needs are met by importing aggregate from other regions or other countries.

The San Diego region, as well as other areas in California, are experiencing shortages in permitted aggregate resources and are being forced to transport aggregate longer distances, which significantly increases the cost of aggregate. Because aggregate is a high-bulk, low-unit value product, costs can be minimized if the source is located in close proximity to the project, thereby reducing the transport miles by truck. According to the California Geological Survey, the highest-priced aggregate in California is in the San Diego area, where high-quality sand is in very short supply, causing prices to range from $20-$22/ton, compared to $7-$8/ton in other parts of the state. The escalating cost of aggregate in the region for transportation projects has become a critical issue.[3]

While the San Diego Association of Governments (SANDAG) and the California Department of Transportation (Caltrans) District 11 understand the importance of aggregate in meeting regional construction needs, the agencies also have a particular interest in the use of aggregate in transportation projects. In 2004 San Diego region voters approved a 40-year extension of *TransNet*, a half-cent sales tax, which should generate an additional $14 billion for public transit, highways, and local street and road improvements. The construction and maintenance of transportation infrastructure creates a need for basic construction materials such as aggregate.

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1 Department of Conservation, Division of Mines and Geology. (1996). Update of Mineral Land Classification: Aggregate Materials in the Western San Diego County Production-Consumption Region.

2 Department of Conservation, California Geological Survey. (2006). Map Sheet 52: Aggregate Availability in California. Retrieved 12/3/2008 at http://www.consrv.ca.gov/cgs/information/publications/ms/Documents/MS_52_map.pdf.

3 *Ibid*.

This study builds on previous and existing efforts of the GoCalifornia Industry Capacity Expansion (ICE) action plan that is a part of the Governor's Strategic Growth Plan. The ICE effort identified strategies and actions that enable the heavy highway construction industry to better meet Caltrans' future transportation program. A key part of the effort is to create a coordinated statewide strategy to work with communities and other agencies to secure adequate materials, including aggregate, for California's needs and long-term quality of life.

One of the challenges facing the region is how to meet the increasing demand for aggregate at a time when the locally based supply is shrinking, while at the same time preserving environmentally sensitive lands and communities. An area may contain abundant aggregate suitable for mining, but conflicting land uses, zoning, regulations, or citizen opposition may preclude its development and production. Stakeholders have strong and often conflicting views about where and how aggregate is supplied to the region. Many individuals may not be aware of the community's need for aggregate and its regional benefits. These conflicts have resulted in a decrease of local sites, lands not becoming available for mineral extraction, local jurisdiction guidelines that do not fully protect aggregate resources, and a time- and cost-prohibitive permitting process.

PURPOSE AND OBJECTIVES OF THE STUDY

The San Diego Region Aggregate Supply Study is an analysis of aggregate supply in the region. SANDAG, in cooperation with Caltrans District 11, examined the issues regarding the supply of aggregate to provide background information and tools necessary to begin developing a framework to manage aggregate to address future projected shortfalls.

The study contributes to the understanding of aggregate issues and compiles information from many sources and organizes it into one document. The intent of the report is not to make policy recommendations, but rather to identify issues and develop tools that decision makers could use as a starting point in adaptive management strategies. Actual policy-making rests with those agencies that have land use authority. The information, mapping, and tools developed through this process could be used to inform decision makers and offer a pilot approach for other regions of the state that also are grappling with aggregate supply issues.

The objectives of the study are to provide a comprehensive review of aggregate sources in the region, clarify the needs and issues surrounding the supply of aggregates, develop a regional geographic information system (GIS) database that would allow for comprehensive visualization of aggregate sources with informational overlays, and develop tools that local governments could use to identify potential locations of aggregate sites and estimate air-quality impacts.

While the intended objectives were to provide a "comprehensive" review of aggregate sources, the aggregate supply issue proved to be very complex, and there were many challenges obtaining geologic and economic data. The study developed a regional aggregate database as an important baseline tool and developed GIS analysis tools to identify potential sites for aggregate. However, additional groundwork will be required for determining the quality of the aggregate and potential marketability to narrow the number of potential aggregate sites. The study focused on estimating air-quality impacts due to transport. A comprehensive analysis might include a broader look at other environmental impacts. Consultation and coordination with local jurisdictions that have land use authority to look at zoning ordinances and other local policies would be appropriate steps to take in the future to build on the fundamentals documented in this study.

STUDY APPROACH

The study was divided into two phases. The first phase focused on the development of a GIS database to visualize and analyze the location of potential aggregate sources in the region. The second phase focused on the economic and environmental aspects of aggregate supply, including the development of tools for calculating aggregate need for Regional Transportation Plan (RTP) projects and estimating the impacts due to hauling aggregate, such as greenhouse gas emissions. The analysis includes air-quality impacts of several importation alternatives (e.g., importing more aggregate or developing more local resources).

An expert review panel was established to gather data and information and secure technical assistance where needed to improve the study. The expert review panel comprised representatives from environmental and resource agencies, local suppliers of aggregate, importers and transporters of aggregate, and users of aggregate. During meetings and focus group sessions, these representatives identified important issues with respect to aggregate supply and served as an invaluable resource for this study.

SUMMARY OF FINDINGS

The principal findings associated with the information and estimates presented in this study include the following:

Local Aggregate Shortages

- According to reports by the Department of Conservation and discussions with local miners, the San Diego region has ample sources of the necessary rock types to meet the anticipated future aggregate demand, but access is limited as mineral development needs compete with other community needs such as urban areas, open space, environmentally sensitive areas, and military lands with restricted access. Factors that would contribute to an increase in annual production within the region include: (1) increasing annual production limits; (2) extending the permit duration of mines (years); (3) expanding existing permitted mines; and (4) permitting new mines.
- Fine aggregates (i.e., sand) are in short supply in the San Diego region. According to local mining operators, sand makes up approximately 90 to 95 percent of all aggregate imported into the region. Sand is a critical component required to produce portland cement concrete. The sources for sand and gravel are predominantly located in alluvial and river deposits. While these river deposits and drainage systems provide a high quality source of sand and gravel, they may be considered to be environmentally sensitive areas or contain endangered species and habitats, so access is limited.
- The San Diego region has historically produced a sufficient supply of coarse aggregates to meet local demand; however, if no new mines are permitted or permits of existing mines are not extended or expanded, the region will likely face shortages of coarse aggregates.

Environmental Regulatory Challenges

- Many concerns about the complexity of the environmental regulatory process were expressed during the expert review panel meetings. The purpose of the study is not to develop solutions for the environmental permitting process, but rather to document the issues so that policy makers and others are aware of the concerns. While the environmental regulations are important to protect environmentally sensitive lands and endangered species, the permitting process itself is perceived to have inherent inconsistencies that cause time delays and escalate cost. Improving the understanding and communication between industry and regulatory agencies may lead to a more consistent approach to permitting and more certainty in the outcome. The complexity of the permitting process has contributed to larger mine sites in the region.

Identification of Potential Aggregate Supply Sites

- The GIS analysis identified over 1,000 possible aggregate sites of 20 acres or greater in the region. These potential sites are not developed and have not been conserved for environmental reasons. It is important to note that the potential suitability of these sites for construction aggregate cannot be determined by a GIS exercise alone and need to be evaluated on a case-by-case basis. However, local governments could use the GIS tools developed by this study to develop overlays to help focus efforts on potential sites for aggregate development. This evaluation also would need to include the proximity to highways and freeways, proximity to the market, quality of the aggregate, and marketability of the aggregate.
- According to expert review panel representatives, while 20-acre mines do exist, a more ideal size for a mining operation is more likely to be in the 40- to 60-acre range or 100-acre or greater range. These experts commented that often large acreage is needed to accommodate required set-asides for mitigation purposes and to be sure the site will be economically viable. Based on this information, the GIS overlay analysis was repeated for potential aggregate supply sites of 60 acres or more and for supply sites of 100 acres or more. The analysis showed that there are about 550 potential aggregate supply sites of 60 acres or more and 390 potential supply sites of 100 acres or more. Most of the sites are located in the unincorporated parts of the region.
- The study also conducted a GIS spatial analysis to optimize the distance between the potential available aggregate sites and demand points. RTP projects were used as demand points in the analysis. The location of the RTP projects coincides with areas of future growth. The study determined that the point of diminishing marginal benefit—that is, where the largest number of projects can be served with the least additional distance—occurs at the 20- to 25-mile driveshed. As transportation plays a major role in the economic and environmental costs of aggregate, the farther the distance, the higher the costs; an important factor to keeping costs low and reducing CO_2 emissions from hauling aggregate is to reduce haul distance by truck.

Options for Import

- Options for importing aggregate into the region include import from nearby counties by truck, as well as import from distant mines by train, barge, or ship. The region is currently importing aggregate by truck from nearby counties. It also has imported aggregate by truck and by barge from Mexico.
- Importation by rail could be an option for consideration if necessary infrastructure improvements, including a transloading facility, were to be constructed. This option could bring in about one million tons of aggregate annually.
- Importation by ship could be an option for consideration with some access improvements from the Port of San Diego to major freeway distribution corridors and other infrastructure improvements at the Port. The capacity could be about two million tons of aggregate annually.

Fuel Consumption and CO_2 Emissions

- The data emphasize the major role that transportation plays in calculating environmental costs and indicate that the key to reducing CO_2 emissions is to reduce haul distance by truck. Aggregate is a low-unit-value commodity with high transportation costs due to its bulk and weight. Since transportation substantially increases the cost to the purchaser, obtaining aggregate from a source close to the point of use reduces cost. This also reduces other direct costs, such as fuel consumption, as well as the environmental and social costs of air pollution, traffic congestion, and road maintenance associated with truck travel.
- The fuel use and air quality analysis indicates that the transportation of aggregate by truck has the highest fuel consumption and CO_2 emissions per net ton-mile compared to other options of rail, ship, and barge. The lowest fuel consumption and CO_2 emissions per million tons of aggregate result from the transport of aggregate from local aggregate mines located close to projects. Even though ship and rail have lower CO_2 emissions per net ton-mile than truck or barge, the distance traveled is often long and they still have some component of truck travel once the material arrives in the region.

Resource Management Opportunities

- The research and the information and insight of the expert review panel indicate that there is no one solution for managing aggregate in the region, and a number of complementary strategies may be required to address projected shortfalls.

CONCLUSION

Future investments in essential infrastructure, such as new and improved roads, housing and commercial establishments, public facilities, rail links, airport facilities, and water and sewage infrastructure all require aggregate. This analysis is designed to provide background information and tools to assist planners plan effectively, while minimizing negative impacts. It also may help decision makers understand key issues that need to be addressed to build consensus on how to manage aggregate as a strategic asset. Opportunities for effective planning today will help address the availability of aggregate required to meet the region's future needs.

CHAPTER 1
INTRODUCTION

PURPOSE OF THE STUDY

The San Diego Region Aggregate Supply Study is an overview and analysis of the regional aggregate supply. The San Diego Association of Governments (SANDAG), in cooperation with the California Department of Transportation (Caltrans), District 11, examined the issues regarding the supply of aggregate to provide background information and tools necessary to develop a framework to manage aggregate to address future projected shortfalls.

One of the challenges facing this region is how to meet the increasing demand for aggregate at a time when the local supply is shrinking, while at the same time preserving communities and environmentally sensitive lands. This analysis is designed to assist planners by providing tools and approaches to plan effectively, while minimizing negative impacts. It also may help decision makers understand key issues that need to be addressed and reach consensus on strategies for managing aggregate as a strategic asset.

OBJECTIVES AND LIMITATIONS OF THE STUDY

The intended objectives of the study are to provide a comprehensive review of aggregate sources in the region, clarify the issues surrounding the supply of aggregates, develop a regional geographical information system (GIS) database that allows for visualization of aggregate sources with informational overlays, and develop tools that local governments could use to estimate environmental and economic impacts.

However, while recognizing that developing a regional aggregate database is an important baseline tool, it is understood that additional groundwork is required for site-specific aggregate quality analysis. The GIS work performed as part of this study can help provide a starting point for identifying potential sites for aggregate mining, but alone it cannot provide sufficient information for the final identification of specific sites. Site-specific field activities were beyond the scope of work for this study. This database and report were structured to provide data and information that local jurisdictions and government agencies could use in making public policy decisions.

To provide a comprehensive review of aggregate resources, not only is the field work necessary, but so is consultation and coordination with local jurisdictions that have land use authority to look at zoning ordinances and other local policies. These would be appropriate steps to take in the future to build on the fundamentals documented in this study. In addition, the focus of this study is concentrated on select environmental impacts associated with the transportation of aggregate (i.e., fuel consumption and CO_2 emissions), but a comprehensive analysis should include the environmental impacts from extracting or processing aggregate at the mine sites, as well as impact on wildlife habitat and connectivity, endangered species, water resources, water quality, and air.

Challenges obtaining reliable data on local production of aggregate and quantities imported and exported limited the economic analysis. The California Department of Conservation produced an estimate of aggregate demand in the region in its 1996 and 2006 reports; however data on actual quantities of aggregate imported into the region are not known to be collected or reported by a government entity or other organizations.

In addition, the classification of mineral resource zones (a classification system that indicates the known or inferred mineral resource potential of the land) is limited to the Western San Diego Production-Consumption boundary. This boundary was determined by the California Department of Conservation in 1982 to encompass the entire metropolitan area of San Diego County (urbanized areas); areas that were expected to urbanize within the next 10-30 years (urbanizing areas) and any resource areas that provided or were expected to provide aggregate material to these areas in the future. Since the 1982 report, additional mineral resource zones have been classified on a petition basis, but due partially to limited agency resources, no comprehensive effort to expand the classification beyond the western portion of the region has been undertaken. This study also reviewed detailed geology maps to identify any correlations between geologies in the Production-Consumption area and geologies outside of the Production-Consumption area. However, detailed geologic mapping from the U.S. Geologic Survey is available only for selected portions of the region; therefore, the analysis is limited.

While the aggregate supply issue is very complex and many facets surrounding the problem are beyond the scope of this study, this report contributes to the understanding of aggregate issues and compiles information from many sources and organizes it into one document. The intent of the report is not to make policy recommendations, but rather to identify issues and develop tools that decision makers could use as a starting point. Actual policy decisions should come from those agencies that have land use authority. The information, mapping, and tools developed through this process could be used to inform decision makers and offer a pilot approach for other regions of the state that also are grappling with aggregate supply issues.

SCOPE OF WORK

The study is divided into two phases. The first phase focuses on the development of the GIS database to visualize and analyze potential locations of aggregate sources in the region. The second phase focuses on economic and environmental aspects of aggregate supply, including the development of tools for calculating aggregate need for Regional Transportation Plan (RTP) projects and estimating impacts due to hauling aggregate, such as greenhouse gas emissions. The analysis will present the opportunities and limitations of several importation alternatives (e.g., importing more aggregate or developing more local resources). The key tasks are as follows.

- **Research available geologic and geographic information:** Prepare detailed list of available geologic and geographic information.
- **Compile geologic and geographical information:** Design the aggregate geodatabase schema and integrate disparate data formats.
- **Quality assurance:** Resolve discrepancies among various geographic and geologic information and reformat all datasets to a consistent format for the geodatabase.

- **Develop additional geologic and geographic information and identify potential aggregate locations:** Create overlays of existing geographical data (land use, transportation networks, etc.) to produce visualization of aggregate sources with informational overlays, develop repeatable method for identifying potential aggregate locations, and compile offshore data.
- **Estimate aggregate needs for RTP:** Develop an estimate of the aggregate needs for transit and highway projects, including an estimating tool for making calculations in the future.
- **Evaluate future *TransNet* mitigation lands as potential supply of aggregate:** Review potential opportunities and limitations and develop criteria for considering aggregate supply when purchasing mitigation land.
- **Estimate haul distances based on current mine locations:** Estimate haul distances based on current mine locations and location of RTP projects, produce tables detailing haul distances, and analyze at least three importation scenarios.
- **Estimate environmental impacts due to haul:** Estimate the environmental impacts due to haul (i.e., fuel consumption and greenhouse gas and other emissions), and produce an environmental impact assessment tool.
- **Plan and convene focus groups to obtain public input on local sourcing of aggregate supply:** Work with the California Department of Transportation District 11 to hold focus groups to share information on potential economic, social, and environmental impacts of aggregate sourcing and transportation and obtain input. (Focus groups of the expert review panel were conducted.)
- **San Diego Region Aggregate Supply Study documentation and report**: Prepare study documentation and draft and final reports.

EXPERT REVIEW PANEL

An expert review panel was established to gather data and information and secure technical assistance where needed to improve the study. The expert review panel comprised representatives from environmental resource agencies, local suppliers of aggregate, importers and transporters of aggregate, and users of aggregate. During meetings and focus group sessions, these representatives identified important issues with respect to aggregate supply and served as an invaluable resource for this study. Summaries of the issues raised during the focus group sessions are included in this chapter, while a list of the participants and more detailed information is presented in Appendix F.

ORGANIZATION OF THE STUDY

Chapter 2 contains background information to provide context for the Aggregate Supply Study. Chapter 3 provides an overview of aggregate supply and demand. Chapter 4 discusses the results of a tool developed to estimate fuel consumption and CO_2 emissions due to hauling aggregate. Chapter 5 features a GIS overlay and optimization analysis showing potential locations of aggregate sites. Chapter 6 discusses the expressed issues and possible solutions raised by the expert review panel. Case studies and scenarios using the GIS tools are presented in Chapter 7 and highlights of the main findings of the study, and conclusions are in Chapter 8. Technical appendices include a detailed methodology and other supporting documents pertaining to the study. The technical appendices are available on CD.

CHAPTER 2
BACKGROUND AND CONTEXT

Construction aggregate is the largest nonfuel mineral commodity produced in California. Aggregate consists of fragments of rock that are mined or quarried and used in their natural state or after crushing, washing, and sizing. It is essential for constructing and maintaining the physical framework of the buildings and infrastructure of modern society. Demand for aggregate is expected to increase as the state's population continues to grow and more investment is needed for not only the construction of new roads, rail links, airport facilities, homes, and water and sewage facilities, but also the maintenance and improvement of existing infrastructure.

While the demand is expected to increase, according to a 2006 study by the California Geological Survey, an anticipated aggregate supply shortfall is expected in nearly all regions of California. According to the study, existing sources of aggregate in San Diego region will be able to meet only 17 percent of the demand through 2055. The region is expected to use more than a billion tons of aggregate by the end of 2055. Permitted aggregate reserves are estimated to be 198 million tons, resulting in an 83 percent shortfall in meeting the region's needs. The same study projects a 40 percent shortfall in the statewide supply of aggregate material, reflecting the importance of this topic as a statewide concern.[1]

According to reports by the Department of Conservation and discussions with local mining operators, the San Diego region has geologic sources of the necessary rock types to meet the anticipated future aggregate demand, but access to these sources is limited as mineral development competes with other land uses such as urban areas, open space, environmentally sensitive areas, and military lands with restricted access. An area may contain abundant aggregate suitable for mining, but conflicting land uses, zoning, regulations, or citizen opposition may preclude its development and production. Stakeholders have strong and often conflicting views about where and how aggregate is supplied to the region. Many individuals may not be aware of the community's need for aggregate and its regional benefits. According to local operators, obtaining permits to initiate new aggregate operations has become extremely challenging. The aggregate industry faces heavy opposition to opening a new mining operation, especially in areas where aggregate has never been mined. Some residents in the vicinity of the quarries object to the dust, noise, and truck traffic associated with a proposed aggregate operation. Nearby residents may feel these effects more directly, while the benefits of aggregate are dispersed over the entire region. These conflicts have resulted in a decrease of local sites, unavailability of lands for mineral extraction, local jurisdiction guidelines that do not fully protect aggregate resources, and a permitting process that has become time- and cost-prohibitive.

[1] Department of Conservation, California Geological Survey. (2006). Map Sheet 52: Aggregate Availability in California. Retrieved 12/3/2008 at http://www.consrv.ca.gov/cgs/information/publications/ms/Documents/MS_52_map.pdf.

The San Diego region produces approximately 9.2 million tons of aggregate on average each year.[2] According to local mining operators and industry experts, nearly everything that is produced in the region is used in the region. Conversations with local industry experts revealed that due to the closure of many instream mines, sand makes up approximately 90 to 95 percent of all aggregate imported into the region.

The San Diego region, as well as other areas in California, are experiencing shortages in permitted aggregate resources and are therefore transporting aggregate longer distances, which significantly increases its cost. Because aggregate is a high-bulk, low-unit value product, costs can be minimized if the source is located in close proximity to the project, thereby reducing hauling distance by truck. According to the California Geological Survey, the highest-priced aggregate in California is in the San Diego area, where high-quality sand is in very short supply, causing prices to range from $20-$22/ton, compared to $7-$8/ton in other parts of the state. Coarse aggregate is more abundant and averages about $15 per ton, typical of the price throughout much of the state. The escalating cost of aggregate in the region has become a critical issue for transportation projects.[3]

THE IMPORTANCE OF AGGREGATE

Construction aggregate is a category of coarse particulate material, which includes sand, gravel, and crushed stone. Aggregate is a component of composite materials, such as concrete and asphalt. The aggregate serves as reinforcement to add strength to the overall composite material. Sand, gravel, and crushed rock provide essential construction materials for building a modern society. It is impossible to build a city without aggregate. Aggregate is used to build and maintain infrastructure, including industrial and commercial buildings, hospitals, schools, residential homes, sidewalks, highways, railroads, and other public works projects, such as airport runways and bridges. It is essential to the existing and future needs of the San Diego region. Sand and gravel resources mined from local sources have played an important role in the development of the San Diego region, including the building of freeways, such as the recent expansion of Interstate 15 and the construction of State Route 905, the building and expansion of San Diego Trolley lines and the SPRINTER and the COASTER railways, and large San Diego facilities, like Qualcomm Stadium, the Convention Center, and Petco Park. Meeting these needs depends on the availability of large supplies of aggregate.

In addition to the many uses of aggregate in construction projects, crushed stone also has numerous agricultural and industrial uses. Pulverized stone is used in fertilizers and insecticides to enhance the growth of plants; in the manufacture of pharmaceuticals, from antacids to life-saving drugs; and in the manufacture of items as diverse as sugar, glass, paper, plastics, floor coverings, rubber, leather, synthetic fabrics, glue, ink, crayons, shoe polish, cosmetics, chewing gum, and toothpaste. Stone in one form or another is used in practically everything that we touch during the day.[4]

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2 Department of Conservation, Office of Mine Reclamation. Total aggregate production in San Diego County, 1995-2009.

3 Department of Conservation, California Geological Survey. (2006). Map Sheet 52: Aggregate Availability in California. Retrieved 12/3/2008 at http://www.consrv.ca.gov/cgs/information/publications/ms/Documents/MS_52_map.pdf.

4 Langer, William H., Lawrence J. Drew, and Janet S. Sachs. (2004). Aggregate and the Environment. American Geological Institute in cooperation with U.S. Geological Survey.

Aggregate production essentially takes big rocks, turns them into little rocks, and sorts them by size. Quarrying and mining of stone generally requires drilling and controlled blasting before the rock is extracted. Sand and gravel deposits commonly are excavated with conventional earth-moving equipment, such as bulldozers, front-end loaders, and tractor scrapers. Depending on the requirements for the final product, processing of quarried rock may require crushing. After crushing, the aggregate is sorted to size. Silt and clay are removed by washing. At this stage, aggregate is commonly moved by conveyors to bins or stockpiled by size. Finally, aggregate is loaded on trucks, railcars, barges, or ships for transport to the site of use.

Reclamation, returning the land to a beneficial use, is the final step of aggregate production. Reclaimed pits or quarries throughout the nation have been converted to many uses, including residential developments, recreational areas, wildlife areas, wetlands, botanical gardens, golf courses, industrial and commercial properties, storm-water management, office parks, and landfills. Reclamation is commonly planned before mining begins, allowing the pit or quarry to be developed in a manner that facilitates final reclamation.[5] Butchart Gardens in Victoria, British Columbia, is an example that is often cited as a successful reclamation project. Successful projects cited in the San Diego region include California State University at San Marcos that was mined to grading specifications in order to build the university. Another proposed project that has received much attention is the reclamation of the quarry at Mission Valley into a mixed-use development called Civita (formerly known as Quarry Falls). When fully implemented, the Civita plan is to provide public parks, open space and trails, residential units, retail space, and office/business park uses.

Although there are many uses and benefits derived from aggregate mining, it should be noted that the development of a mine changes the topography of a site, and can reduce habitat and biodiversity, and alter the visual scene. Operations associated with extraction and processing include noise, dust, truck traffic near the site, visually disturbing landscapes, and affected surface or groundwater. Planning for growth in the region in an environmentally responsible way is a desirable path. Properly designed and operated aggregate production could keep the impacts on the landscape, wildlife, surface and groundwater, and surrounding communities to a minimum. A number of federal, state, and local regulations are designed to limit environmental impacts of aggregate operations.

Portland cement concrete (PCC)-grade aggregate is the highest grade and is used predominantly to provide the bulk and strength to PCC and asphalt cement (AC). Class II base, sub-base, fill, and riprap (large pieces of rock used to stabilize slopes, shorelines, etc.) require a lesser grade of aggregate. The American Society for Testing and Materials publishes an exhaustive listing of specifications for various construction aggregate products, which by their individual designs, are suitable for specific construction purposes. These products include specific types of coarse and fine aggregate designed for such uses as additives to asphalt and concrete mixes, as well as other construction uses. Several agencies, including the California Department of Transportation, further refine aggregate material specifications in order to tailor aggregate use to the needs and available supply in particular locations. Caltrans has established rigid specifications for PCC and AC to ensure the construction of durable structures. Because of their high standard, PCC or AC aggregate are the scarcest and most valuable form of aggregate. PCC sand is scarce in the San Diego region. The mining of alluvial sand and gravel deposits is limited in large part due to environmental and

[5] *Ibid.*

regulatory constraints of permitting and extracting sand and gravel from instream and floodplain areas.[6]

GEOLOGY AND AGGREGATE IN THE SAN DIEGO REGION

Geological formations appropriate for aggregate in the San Diego region can be classified into several main geologic environments. It is important to note that the suitability for aggregate is not determined by rock type alone. Additional field surveying and further mineral analysis would be required to determine if outcrops of suitable size and quality for aggregate may exist. Figure 2-1 illustrates the location of these geology types.[7]

Quaternary Alluvium

Quaternary alluvial and fluvial deposits are often good sources for sand and gravel, which can be processed for construction materials from this geologic environment. Fluvial deposits are often well sorted and may provide an ideal source for sand. Despite the fact that alluvial fan deposits are usually poorly sorted with a variety of grain sizes, they are often good sources for sand and gravel. Alluvial fan deposits are closer to the source region, with the fluvial deposits being transported farther from the source region. These deposits are predominately located in drainage systems associated with topographic lows. Major drainages within the Western San Diego region are from north to south, Santa Margarita River, San Luis Rey River, Escondido Creek, San Dieguito River and Santa Ysabel Creek (both make up the San Pasqual Valley), Los Peñasquitos Creek, San Diego River, Sweetwater River, Otay River, and the Tijuana River.

Figure 2-2 illustrates the location of these drainages. It is important to note that while these drainage systems potentially provide a good source of sand and gravel, they may be considered environmentally sensitive areas if endangered species and habitats occur there.

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6 County of San Diego, Land Use and Environment Group. (2007, July). Guidelines for Determining Significance and Report Format and Content Requirements: Mineral Resources.

7 Note: Majority of rock type in areas not classified on map are metamorphic rocks with granitic intrusion.

Figure 2-1
Geology of the San Diego Region

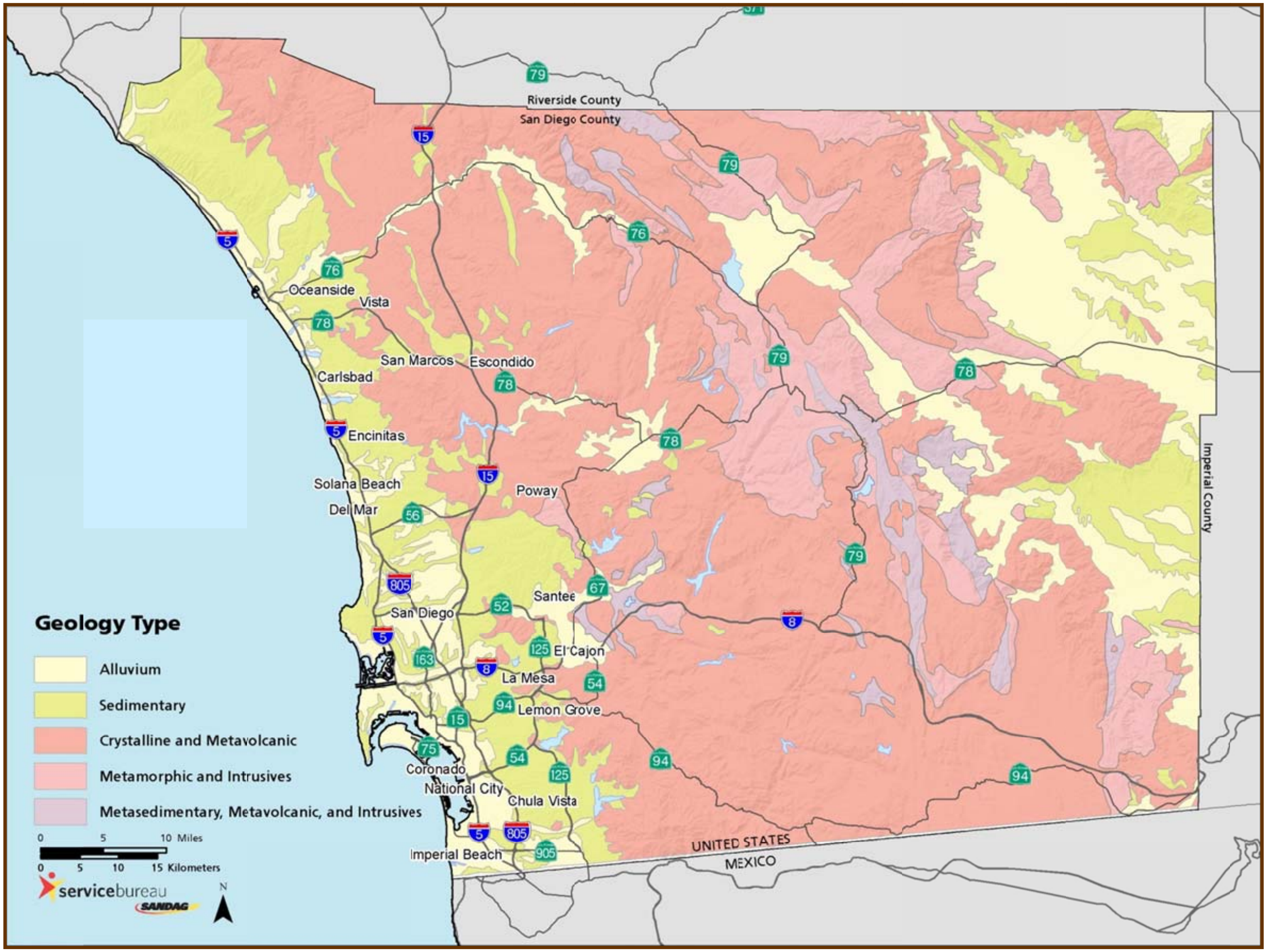
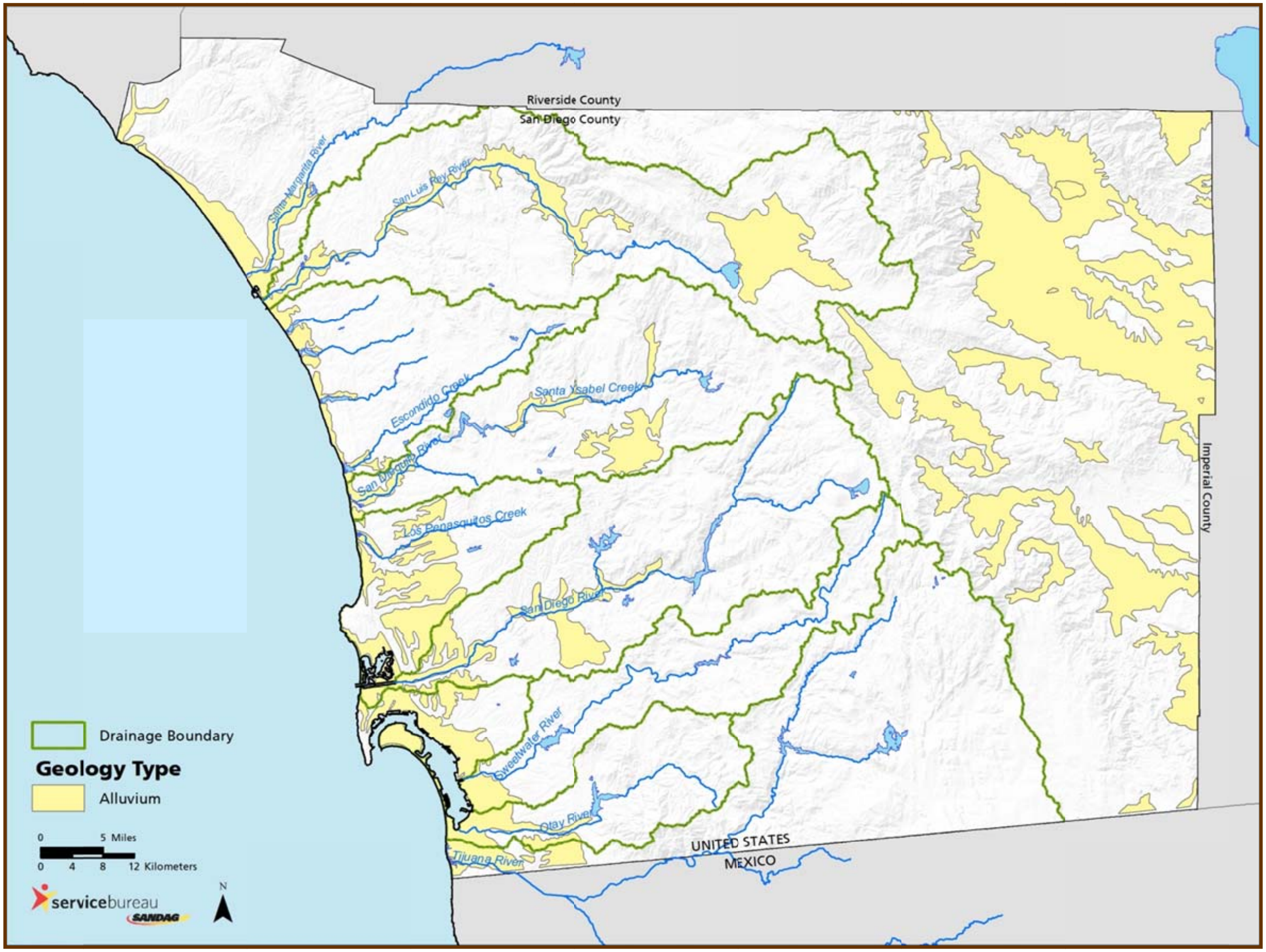


Figure 2-2
Major Drainages in the San Diego Region



Sedimentary Rocks

Sedimentary rocks form from the accumulation and consolidation of particles eroded from metamorphic, igneous, and existing sedimentary rocks. As shown in Figure 2-1, many of the sedimentary rocks along the coastline are marine deposits that have been tectonically uplifted and exposed. The marine sedimentary rocks consist of claystones, siltstones, blocky sandstones, and coarse conglomerates. Coarse-grained sedimentary rocks are excellent sources for aggregate, especially sand and gravel; however, most exposures of marine sedimentary rocks in the region are along the shoreline in densely populated regions. Conversely, the nonmarine poorly to moderately cemented massive cobble conglomerate with sandstone located inland provides an ideal source of aggregate. Siltstones and claystones are, in large part, poor sources for aggregate.

Cretaceous Age Crystalline Rocks and Upper Jurassic Metavolcanics

As shown in Figure 2-1, igneous crystalline rock is the dominant rock type in San Diego region. Granitic rocks and other igneous rocks, such as diorites and gabbro, can be quarried for coarse aggregates that are needed for concrete and riprap (larger pieces of broken rock for breakwaters and bank protection), as well as for decorative and dimension stone from this geologic environment.[8] The rock is typically hard and resistant to erosion and needs to be crushed in order to be used as aggregate material. Granitic rocks are not known to be homogeneous in the region and may be of variable quality from site to site. According to the Department of Conservation, granitic rocks are often capped by a thick layer of weathered material, and getting to the fresh boulders for crushing for PCC-grade aggregate may not be economically viable.[9]

Metamorphic and Intrusives

Some areas in the region are characterized by metamorphosed silicic and intermediate volcanic rocks that are intruded by volcanics—mostly tonalites. Undifferentiatied volcanics, mildly metamorphosed volcanic, and volcaniclastic rocks also are included in this classification. Although metavolcanic rocks with volcanic intrusives can be quarried for coarse aggregates, their lateral variability and differential composition may make these rock types less economically viable as a source of aggregate than more uniform crystalline igneous rocks.

Metasedimentary, Metavolcanic, and Intrusives

The metasedimentary rocks (mostly of Jurassic and Cretaceous age) have undergone different amounts of metamorphism from greenschist facies with interbedded sandstone, siltstone, and shale to schist, quartzite, metabasalt, and metatuff-breccia with gneiss. These metasedimentary and metavolcanic rocks are intruded by fine-grained granodiorites and tonalites. Given the highly variable nature of this classification, these rock types are usually considered low quality as a source of aggregate. Nevertheless, additional field surveying and further mineral analysis would be required in these areas to determine if outcrops of suitable size and quality for aggregate may exist.

[8] County of San Diego, Land Use and Environment Group. (2007, July). Guidelines for Determining Significance and Report Format and Content Requirements. Retrieved on 2/3/2009 at: http://www.co.san-diego.ca.us/dplu/docs/Mineral_Resources_Report_Formats.pdf.

[9] Department of Conservation, Division of Mines and Geology. (1996). Update of Mineral Land Classification: Aggregate Materials in the Western San Diego County Production-Consumption Region.

FEDERAL LAWS APPLICABLE TO AGGREGATE MINING

Numerous federal laws are applicable to aggregate mining. For instance, the Water Quality Act of 1965 and the Federal Water Pollution Control Act Amendments of 1972 (retitled the federal Clean Water Act) were enacted to provide efficient programs for water pollution control. Every major point source (a confined conveyance such as a pipe, drain, or ditch) from which pollution is discharged into U.S. waters requires a joint federal-state permit.

The Air Quality Act of 1967 (amended by the Clean Air Amendments of 1970) gives states and local governments the responsibility to develop and implement plans to address airborne pollution at its source. Sand and gravel mining activities that are covered include dust and exhaust emissions.

Other federal regulations indirectly govern the production of aggregate resources through numerous acts, including the Fish and Wildlife Resource Management Act, the Fish and Wildlife Coordination Act, the Migratory Bird Treaty Act, the Endangered Species Act, the Rivers and Harbors Act, the Coastal Zone Management Act, and the National Environmental Policy Act. Worker health and safety is governed at the federal level by the Mine Safety and Health Administration.[10]

SURFACE MINING AND RECLAMATION ACT

California implemented the Surface Mining and Reclamation Act (SMARA) in 1975. Under SMARA, the California Geologic Survey (formerly the Division of Mines and Geology) is mandated to classify specified lands on the basis of mineral content. SMARA provides decision makers with information for basing land use decisions.[11] SMARA emphasizes the conservation of mineral resources to ensure environmental protection and reclamation of mined lands. In order to assist in the planning for conservation and access to mineral resources, SMARA statutes initiated the mineral land classification program. Mineral land classification by the California Geological Survey and the designation by the State Mining and Geology Board reflect the initial steps in the exploration, development, production, use, and reclamation of lands under SMARA. The primary goal of this aspect of SMARA is to ensure that potential mineral resources are recognized and considered in land use planning process.[12] The California Geological Survey provides objective classification data and projections to the Board, local agencies, and others.

In California, sand and gravel mining is regulated at the local level by jurisdictions with land use authority. Lead agencies incorporate the information provided by the California Geological Survey and the State Mining and Geology Board into their general plans and are to use it in their land use decisions to protect a 50-year supply of aggregate.

[10] Society for Mining, Metallurgy and Exploration (SME). (2006).

[11] Langer, William H. (2002). USGS Open-File Report 02-415: Managing and Protecting Aggregate Resources.

[12] Note that SMARA, its regulations and guidelines, are described in California Department of Conservation, Division of Mines and Geology. (2000). Special Publication 51.

SMARA Section 2762(a) states:

> *"Within 12 months of receiving mineral information, and also within 12 months of designation of an area of statewide or regional significance within its jurisdiction, every lead agency shall, in accordance with state policy, establish mineral resource management policies, to be incorporated in its general plan."* [13]

In order to protect the future supply of aggregate: (1) lands containing construction aggregate quality resources need to be identified by the California Geological Survey and the State Mining and Geology Board; and (2) the lead agency, through its mineral resource management policies in its general plan, needs to manage the land uses within and surrounding areas of statewide and regional significance to restrict the encroachment of incompatible land uses.

MINERAL LAND CLASSIFICATION

SMARA requires the state geologist to classify lands based on the known or inferred mineral resource potential of that land. Lands are classified on the basis solely of geologic factors and without regard to existing land use and ownership, as one of the following:

- Areas containing little or no mineral deposits
- Areas containing significant mineral deposits
- Areas containing mineral deposits, the significance of which requires further evaluation

The State Mining and Geology Board subsequently defined these categories into mineral resource zones (MRZs). The mineral land classification process identifies lands that contain economically significant mineral deposits. The primary objective of the classification and designation processes is to ensure, through appropriate lead agency policies and procedures, that mineral deposits of statewide or regional significance are available when needed.

The MRZs are established by the California Geologic Survey based on guidelines adopted by the California State Mining and Geology Board and under authority granted by SMARA of 1975. Lands in Western San Diego Production-Consumption (P-C) Region[14] were initially classified in 1982 and subsequently designated by the State Mining and Geology Board in 1985. Additional classified lands were included in a 1996 update and by petition after 1996.

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[13] Public Resources Code, Division 2, Chapter 9, Article 4 State Policy of the Reclamation of Minded Lands, Section 2762(a).

[14] The San Diego Production-Consumption boundary was determined by the California Division of Mines and Geology in 1982 to encompass the entire metropolitan area of San Diego County (urbanized areas); areas expected to urbanize within the next 10-30 years (urbanizing areas); and any resource areas which provided or were expected to provide aggregate material to these areas in the future.

Figure 2-3 illustrates the MRZs in the San Diego region. The definition of each zone is listed below:

MRZ-1: Areas where adequate geologic information indicates that no significant mineral deposits are present or where it is judged that little likelihood exists for their presence.

MRZ-2: Areas underlain by mineral deposits where geologic data show that significant measured or indicated resources are present. A typical MRZ-2 area would include an operating mine or an area where extensive sampling has indicated the presence of a significant mineral deposit.

MRZ-3: Areas containing known mineral deposits that may qualify as mineral resources. Further exploration work within these areas could result in the reclassification of specific localities into other MRZ categories.

MRZ-4: Areas where the geologic information does not rule out either the presence or absence of mineral resources. (Additional information regarding mineral occurrence is needed.)

Mineral land classification of aggregate for the Western San Diego P-C Region was initiated in November 1980 by the state geologist. All major metropolitan portions of San Diego County (urbanized areas); areas that were expected to urbanize within the next 10 to 30 years (urbanizing areas); and any resource areas which currently provided or were expected to provide aggregate in the future were classified in this effort. The region was assigned a high priority because it was undergoing rapid urbanization.

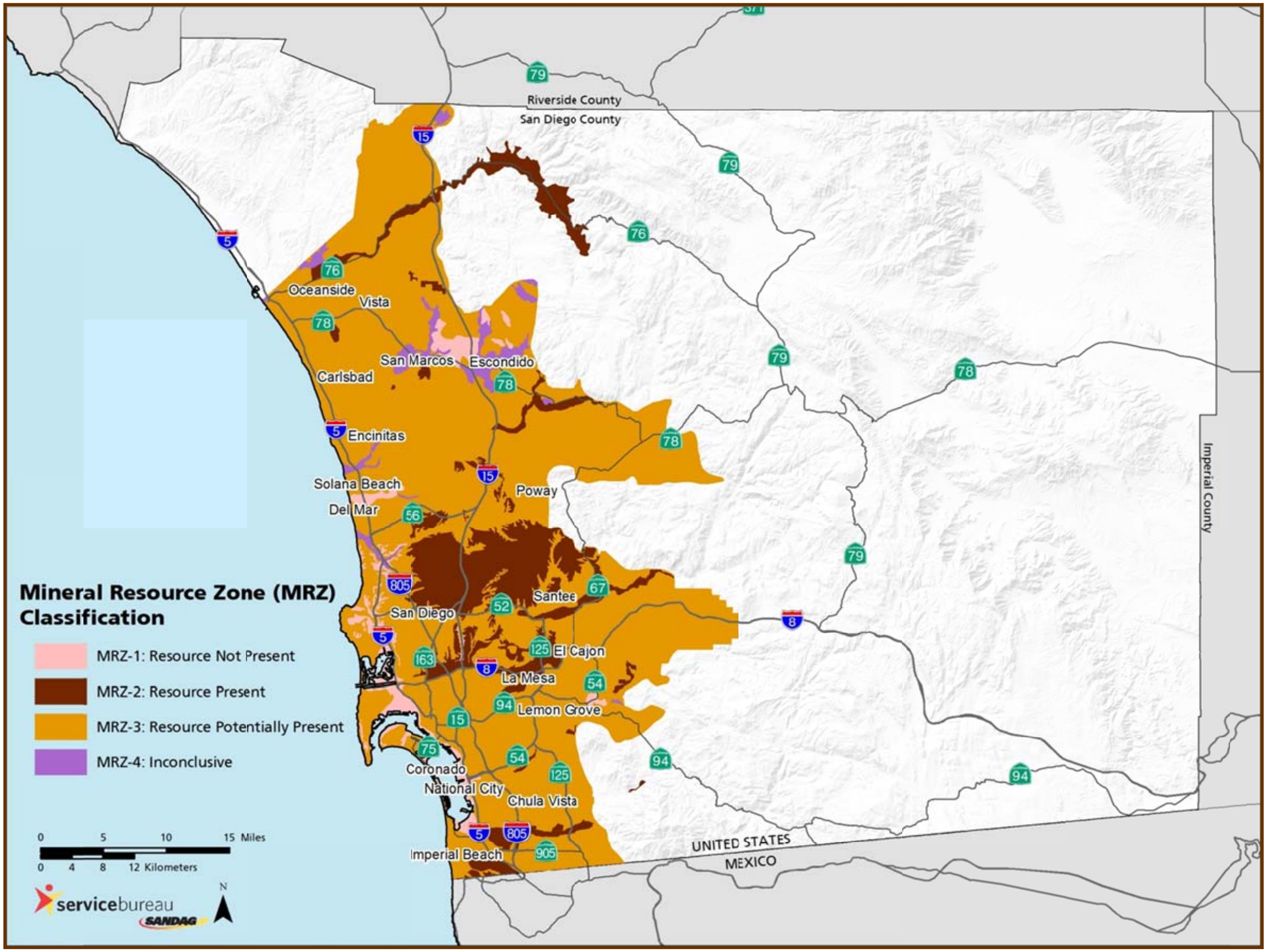
The emphasis in this classification was placed on PCC aggregate. Sand, gravel, and crushed rock are classed as “construction materials” and provide bulk and strength to PCC. The material specifications for PCC aggregate are more restrictive than for other aggregate types; fewer sand and gravel deposits satisfy these specifications, therefore, they are considered scarce resources.[15]

The MRZs are classified on the basis of an aggregate resource appraisal, which includes an analysis of geologic reports and maps, field investigations, an examination of active sand and gravel mining operations, analyses of drill-hole data, interpretation of aerial photographs, and evaluation of private company data. The physical and chemical rock material specifications, as determined by laboratory testing, must be known before any specific geologic deposit is assigned an MRZ-2 classification.[16]

[15] Kohler, Susan L. and Russell V. Miller, Department of Conservation State Mining and Geology Board. (1982). Special Report 153 Mineral Land Classification: Aggregate Materials in the Western San Diego County Production-Consumption Region.

[16] *Ibid*.

Figure 2-3
Mineral Resource Zones in the San Diego Region

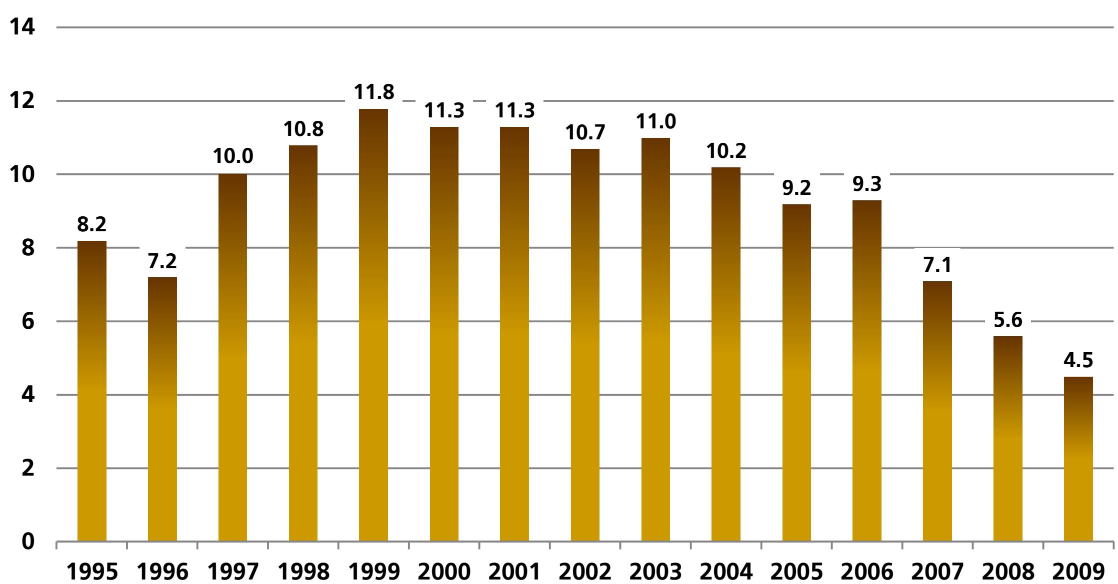


CHAPTER 3
AGGREGATE SUPPLY AND DEMAND

SUPPLY OF AGGREGATE

Aggregate used in the San Diego region is obtained from local reserves and imported from other areas. Permitted aggregate reserves are aggregate deposits that have been determined to be acceptable for commercial use, exist within properties owned or leased by aggregate-producing companies, and have permits allowing mining of aggregate material. Local permitted aggregate reserves were estimated at 198 million tons as of 2006.[1] Figure 3-1 presents annual production data for local mines from 1995 to 2009.[2] The average over this time period is 9.2 million tons annually, which represents approximately 22 years of supply. Annual variations in production result primarily from changes in urban growth, major public construction projects, and changes in interest rates and other economic factors.

Figure 3-1
Construction Aggregate Produced in the San Diego Region 1995 – 2009
(million tons)



Source: California Department of Conservation

1 Department of Conservation, California Geological Survey. (2006). Map Sheet 52: Aggregate Availability in California; most recent figures available.

2 California Department of Conservation. (2010). The California Public Resources Code requires mining owners or operators to report the total production for each mineral commodity produced annually (Section 2207). Included in the estimates are decomposed granite, stone, rock, sand and gravel, fill dirt, silica, specialty sand, and bituminous rock.

Although annual production fluctuates, the number of active permitted mines in the region decreased from 48 in 1980 to 27 in 1995. Much of the decline is due to the closure of instream sand mines (there were 24 in 1980 and only 8 in 1995) and subsequent decline in permitted instream sand reserves (from 121 million tons in 1980 to 55 million tons in 1995).[3] Since then the number of active and significant mines has declined to 16 and is expected to decline in the future as permits expire and/or resources are depleted.[4]

The 1995 to 2009 time period is presented in Figure 3-1 to illustrate production levels subsequent to the sand mine closures in the early 1990s. Much of the decline in production in 2008 and 2009 may be attributed to the recent economic recession that began in December 2007.

Table 3-1 lists the existing mines in the region. They are grouped by mines estimated to close prior to 2030 and those expected to still be operating in 2030 or beyond. Expected closure dates can vary, especially if annual production slows, thereby extending the life of the mine. It is important to note that typically when quarries in an area close, the remaining mine operations increase production to offset the reduction in supply somewhat as long as permitted reserves are available.

Table 3-1
San Diego Region Aggregate Mines and Expected Closure

Mine	Estimated Closure	
	Before 2030	2030 or Later
Carroll Canyon Plant/Hanson	*	
Channel Road	*	
Enniss Enterprises	*	
Hillsdale Granite Pit	*	
Lakeside Sand Pit	*	
Mission Gorge Pit	*	
Sycamore Canyon Landfill	*	
TTT Quarry	*	
Vulcan - Carroll Canyon	*	
Hester's Granite		*
Inland Valley Materials		*
National Quarries		*
Otay Valley Rock		*
Rosemary's Mountain		*
Slaughterhouse Canyon		*
Vigilante Quarry		*

Source: EnviroMINE (based on 2006 estimates); SANDAG

3 Department of Conservation, Division of Mines and Geology. (1996). Update of Mineral Land Classification: Aggregate Materials in the Western San Diego County Production-Consumption Region. Many of these sand mines ceased operation due to their inability to complete new permitting procedures required for regulations associated with instream mining.

4 The estimate of 16 mines is focused on active mining production sites. Plants that are inactive, classified as borrow pits, or mainly engaging in processing were excluded. Sycamore Canyon Landfill was included as a source of aggregate as advised by local mining operators. A full list of mines can be ordered from the Department of Conservation Office of Mine Reclamation Web page at www.conservation.ca.gov.

The local production potential of aggregate is expected to decline over the next few decades as reserves in current quarries are depleted and as operating permits expire without being extended. Figures 3-2 and 3-3 show the location of mines operating in 2010 and 2030. If no mines are permitted or extended, by 2030 the San Diego region could have only seven active mines remaining. San Diego was one of the aggregate study areas with the greatest projected future need for aggregate identified by the California Geological Survey in 2006.

Factors that would contribute to an increase in annual production within the region include: (1) increasing annual production limits; (2) extending the permit length (years); (3) allowing expansion of existing permitted mines; and (4) permitting new mines. The California Geological Survey suggests that non-permitted aggregate resources are the most likely source of construction aggregate to meet California's future demand.[5] However, the permitting process and regulations may restrict the development of aggregate production or the expansion of established mines more than actual resource availability.[6]

Nonpermitted aggregate resources were estimated at 5.7 billion tons in 1995.[7] Nonpermitted resources are defined as deposits that may meet specifications for construction aggregate, are recoverable with existing technology, have no land overlying them that is incompatible with mining, and are not permitted for mining. It is not likely that all of the identified resources will be mined because of social, environmental, or economic factors. For example, aggregate resources located close to urban or environmentally sensitive areas can limit or preclude their development, or resources may be located too far from a potential market to be economically viable.[8]

5 Department of Conservation, California Geological Survey. (2006). Map Sheet 52: Aggregate Availability in California.

6 Langer, William H. (2002). Managing and Protecting Aggregate Resources. USGS Open-File Report 02-415.

7 Department of Conservation, Division of Mines and Geology. (1996). Update of Mineral Land Classification: Aggregate Materials in the Western San Diego County Production-Consumption Region. 1996; most current data available.

8 Department of Conservation, California Geological Survey. (2006). Map Sheet 52: Aggregate Availability in California.

Figure 3-2
San Diego Region Aggregate Mines 2010

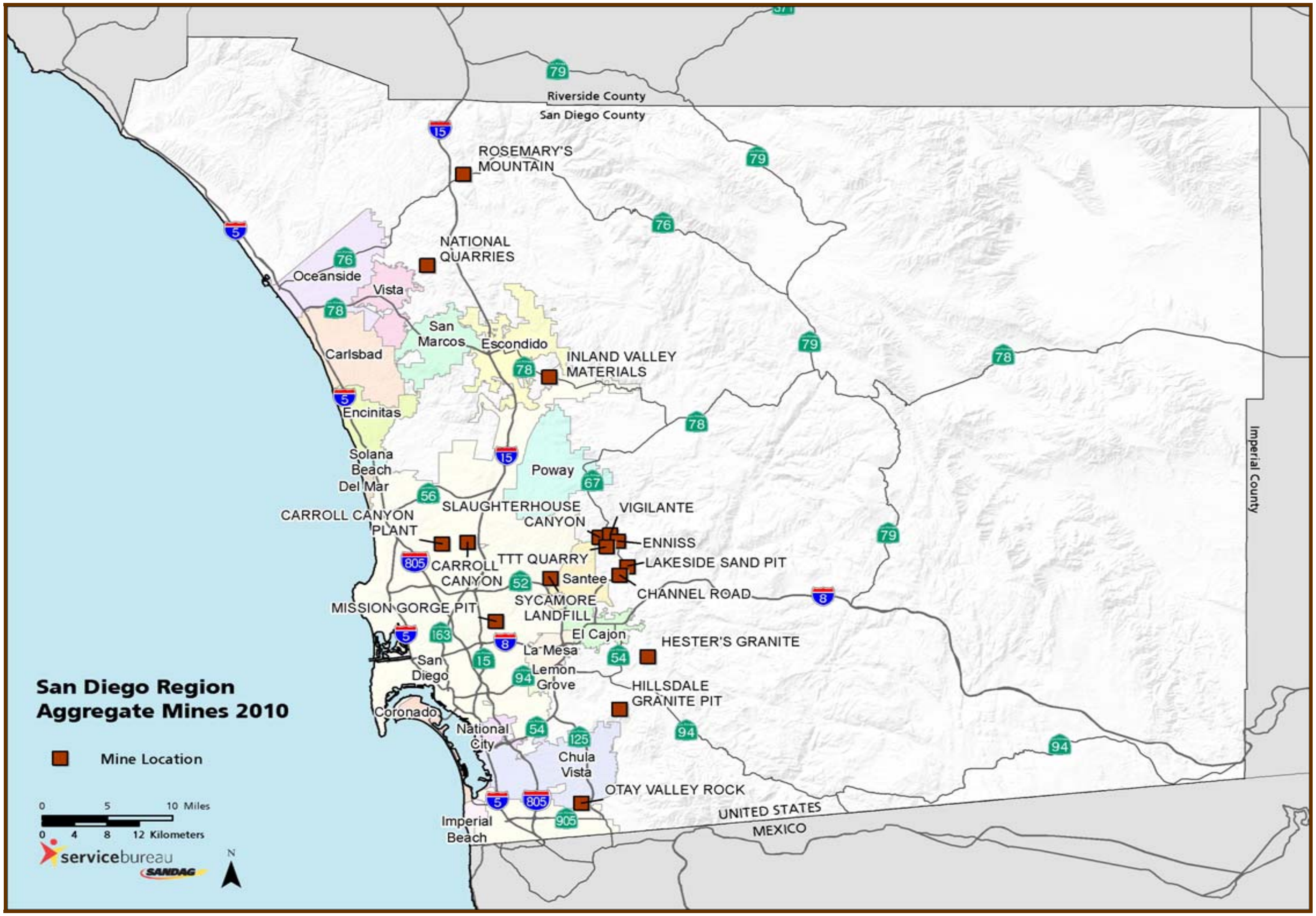
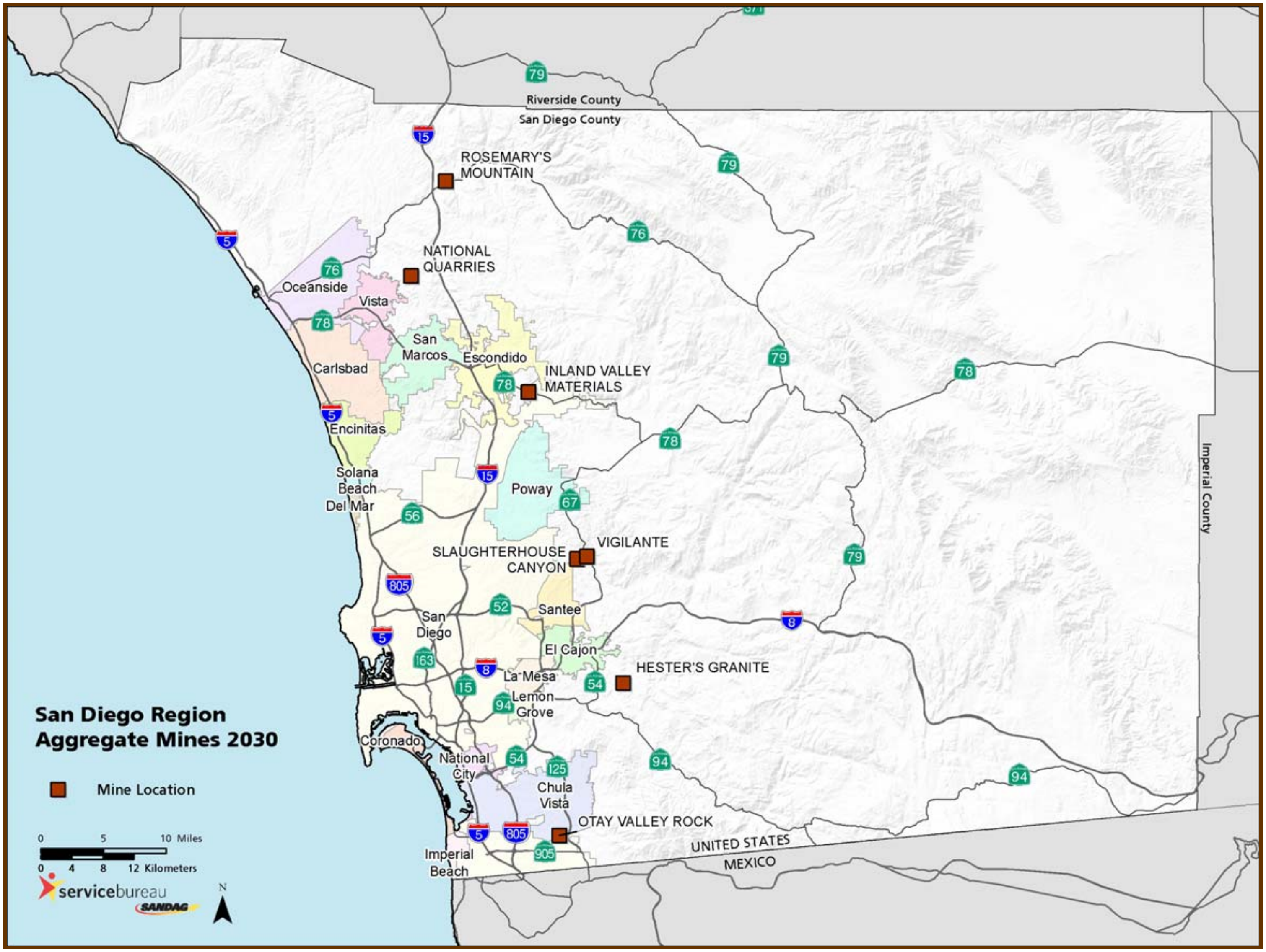


Figure 3-3
San Diego Region Aggregate Mines 2030



Imports

Data on the volumes of sand, gravel, and crushed stone that are imported annually are not known to be collected by any government agency. However, available information indicates that for most years from 1975 through the early 1990s, local production was sufficient to meet local demand.[9] Since the 1990s, however, a portion of the aggregate used within the region has been imported from other California counties and from Mexico. Local mining operators estimate that about 90 to 95 percent of the aggregate imported into the region is sand. The San Diego region imports aggregate from the San Bernardino and San Gabriel Valley areas, as well as from Riverside County. It the past it has received aggregate trucked in from southwest Imperial County and from Mexico by barge.[10] Sand (less than 500,000 tons per year) also has been imported by truck through the Tecate and Otay Mesa international border crossings.[11]

The areas that the San Diego region imports from will eventually experience shortages, limiting future access. Future potential supplies include material from Liberty Quarry, a proposed crushed rock quarry in southwestern Riverside County. The permitting process for this project has begun and, if approved, the quarry could provide up to 4.5 million tons annually. In addition, Eagle Rock Aggregates anticipates extending its shipments of sand and gravel from Vancouver Island, British Columbia, to San Diego; they currently import to the Port of Richmond, San Francisco, and Redwood City.[12]

Offshore, Reservoir, and Riverine Resources

Several known deposits of sand, coarse sand, and gravel lie offshore the San Diego region. In addition to beach sand along most of the coast, sand and gravel deposits have been found along the edge of San Clemente Island and some of its banks, and coarse aggregate has been located near the Tijuana River. The study collaborated with the Scripps Institution of Oceanography, which has provided its database of offshore resources. However, beach and offshore sand may be too fine for construction aggregate.[13]

Sediment removal from reservoirs is another potential source of construction aggregate. This option was recently reviewed by the City of San Diego.[14] Staff found that dredging of the city's reservoirs has potential benefits, including the increase in supply of aggregate and restoration of lost water storage areas (by the removal of sediment buildup). They concluded, however, that the expenses related to the extensive permitting and studies required to dredge in reservoirs that supply drinking water outweighed the benefits. Other opportunities where permitting requirements are not as extensive were noted, such as dredging streams, flood control channels, and lakes that are not used for the storage of drinking water.

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[9] EnviroMINE, Inc. (2007, November). Southern California Construction Aggregates Market Study.

[10] U.S. Geological Survey. (2009). 2006 Minerals Yearbook: California.

[11] EnviroMINE Inc. (2007, November).Southern California Construction Aggregates Market Study.

[12] U.S. Geological Survey. (2010). 2007 Minerals Yearbook: California (Advance Release).

[13] Expert Review Panel. (2010).

[14] Office of the Independent Budget Analyst Report. (2007, October). Removal of sediment from city reservoirs as an aggregate resource.

Another potential source of fine aggregates is the El Monte Valley Mining, Reclamation, and Groundwater Recharge project being pursued by the Helix Water District. The mining component of the proposed project would help re-contour the riverbed for restoration and produce sand and gravel for the region.

Aggregate Recycling

The use of recycled aggregate reduces the need for natural aggregate and lowers transportation costs when it is used on-site in new construction. The variability and quality of recycled aggregate usually limits its use to road base, backfill, and asphalt pavement. In addition, recycled material can only supplement the use of natural aggregates because the available supply is much less than total demand for aggregates. California allows (but does not require) recycled aggregate to supplement natural aggregates in road base applications, backfill, and for portland cement mix.[15] California Department of Transportation contracting procedures provide financial incentives for contractors to use recycled material that meets agency specifications by allowing them to retain a portion of the resultant project cost savings. Within the region, the City of San Diego’s Construction and Demolition Debris Deposit Ordinance requires at least 50 percent of construction debris be recycled, reused, or donated. The ordinance also requires that the majority of construction, demolition, and remodeling projects requiring building and demolition permits pay a refundable recycling deposit.

The Federal Highway Administration notes that the use of recycled aggregate in new concrete pavement has been successful across the United States, citing the Oklahoma Department of Transportation’s (ODOT) use of recycled aggregate for paving one lane of Interstate 35 and natural aggregate for another.[16] After 20 years, ODOT finds no evidence of any difference in quality or longevity between the lanes.

Other Sources

Processes for producing synthetic aggregate have been developed which use industrial wastes, such as coal ash, foundry sand and slag, paper sludge, and clay, as well as quarry fines (small particles and dust).[17] These processes can produce synthetic aggregate, which may replace natural aggregate in road construction or repair. Some synthetic materials have properties of construction aggregate as specified by the American Society for Testing and Materials and American Association of State Highway and Transportation Officials. Although the economic feasibility of using synthetic processes is determined by the availability of the raw materials and transportation costs, their use can reduce environmental impacts and cost.[18] There is no evidence that synthetic aggregate has been used in the San Diego region.

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[15] Wilburn, David R. and Thomas G. Goonan. (1998). Aggregates from Natural and Recycled Sources: Economic Assessments for Construction Applications – A Materials Flow Analysis. USGS Circular 1176.

[16] Vanikar, Suneel N., Jim Grove, and Leif Wathne. (2010, May/June). Leaving a Smaller Footprint. Public Roads. Federal Highway Administration.

[17] See for example Wainwright, P.J., D.J.F. Cresswell and H.A. van der Sloot. (2002). The Production of Synthetic Aggregate from a Quarry Waste Using an Innovative Rotary Kiln. Waste Management Research; A.C. Carpenter and K.H. Gardner. (2008). Use of Industrial by-Products in Urban Transportation Infrastructure: Argument for Increased Industrial Symbiosis. Electronics and the Environment.

[18] Western Research Institute. SYNAG™ Synthetic Aggregate Process. Retrieved May 2010 from www.westernresearch.org.

Fine aggregates such as sand also can be manufactured by crushing or grinding coarse sand or gravel in a mechanical crusher, and then screened. This requires considerably more processing time at the mine than the production of other forms of construction aggregate. Manufactured sand is not known to be produced or imported in the region. At the present time, local aggregate mining firms indicate that it would be more costly to manufacture sand that would meet construction specifications than it is to import natural sand.[19]

DEMAND FOR AGGREGATE

The total quantity of aggregate used (local production plus net imports) in the San Diego region is not known to be recorded or collected annually by a government agency. The California Geological Survey and others have found that population growth is the only factor that exhibits a strong correlation to historical aggregate use, and therefore uses per-capita aggregate production (and population forecasts) to estimate future demand.[20] They note that this method has historically been effective for predicting aggregate demand in major metropolitan areas, with only a 2 percent difference in actual versus predicted demand in the Western San Diego P-C region.[21]

The California Geological Survey estimated average annual demand to be 5.4 tons per person based on 1960 to 1994 production data.[22] This factor was used to estimate future aggregate demand by multiplying population levels forecast for each year,[23] 2010 to 2030, by 5.4 tons per person, and then calculating an average. This resulted in an average annual demand estimate of 19.2 million tons.

Exports

Local producers of aggregate indicate that while there might be some gravel and crushed stone exported to other regions, it is a small amount. Most producers agree that what is produced in the region is used in the region.[24] The California Geological Survey notes that there had been some exportation from northern San Diego County into Riverside County.[25] Data regarding the quantity of exports is not known to be recorded or collected by a government agency.

[19] Expert Review Panel. (2010).

[20] The California Geological Survey cautions that (1) this simple method for projecting aggregate demand does not take into account fluctuations in the economy, either regionally or nationally; (2) is only meant to be a general long-range planning guide for local lead agencies; and (3) may not work well in areas that import or export a large percentage of aggregate (with region exporting 70% to nearby areas given as an example). Department of Conservation, California Geological Survey. (2006). Map Sheet 52 Aggregate Availability in California.

[21] *Ibid*.

[22] Department of Conservation, Division of Mines and Geology. (1996). Update of Mineral Land Classification: Aggregate Materials in the Western San Diego County Production-Consumption Region.

[23] SANDAG. (2010). 2050 Regional Growth Forecast.

[24] Expert Review Panel. (2010).

[25] Department of Conservation, Division of Mines and Geology. (1996). Update of Mineral Land Classification: Aggregate Materials in the Western San Diego County Production-Consumption Region.

SUPPLY AND DEMAND FOR AGGREGATE

Comparing the estimated annual average production from mines in the San Diego region over the next 20 years to lower and upper bounds of estimated future demand provides an idea of the potential gap. Future production is an average annual volume of 9.2 million tons (described earlier in this chapter). Future demand is estimated for two annual per-capita rates: (1) per-capita average for 1995 to 2009 (5.4 tons), and (2) per-capita aggregate required for only maintenance and repair, (3.0 tons).[26] This is equivalent to a lower bound of 10.6 million tons and upper bound of 19.2 million tons annually. If local mines produce an average of 9.2 million tons annually and demand reaches the upper bound of 19.2 million tons, there could be a shortfall of 10 million tons. By contrast, if demand is at the lower end, 10.6 million tons, there could be a shortfall of 1.4 million tons. These shortfall estimates may be conservative if sand is not produced locally.

OVERVIEW OF PRICE AND RELATED ECONOMIC CONSIDERATIONS

The price of construction aggregate varies considerably depending on location, quality, and supply. For example, some of the least expensive portland cement concrete (PCC)-grade aggregate in California averages about $7 to $8 per ton in the Yuba City-Marysville region of California due to relatively abundant supplies, while in the San Diego region, the limited PCC-grade sand ranges from $20 to $22 per ton.[27] The region has larger supplies of coarse PCC-grade aggregate, which as a result averages about $15 per ton, typical of the price throughout much of the state.

Transportation

Transportation plays a major role in the cost of aggregate to the purchaser. The transportation mode used depends upon the distance moved, volume of material, and availability of unloading facilities. The unloading and storage of aggregate transported by rail, barge, and other ocean vessels requires special facilities and the material will have a final movement by truck. At longer distances, movement by rail and ocean vessels become less expensive than by truck, making them the preferred method for importation of aggregate over longer distances. A major component in determining the mode used is the distance of the final truck trip for delivery to the point of use.

When aggregate is transported by truck to the point of use, the price of the material increases about 15 cents per ton for every mile hauled.[28] For example, for 10,000 tons to be hauled 40 miles the transportation cost would be $60,000, or an additional $6 per ton. Since transportation substantially increases the cost to the purchaser, obtaining aggregate from a source close to the point of use minimizes cost. Furthermore, this also reduces other direct costs, such as fuel consumption, as well as the environmental and social costs of air pollution, traffic congestion, and road maintenance associated with vehicle travel.

[26] Midpoint of 2.5 to 3.5 ton per capita range provided by John Clinkenbeard, California Geological Survey, personal communication. (2010, February).

[27] Department of Conservation, California Geological Survey. (2006). Map Sheet 52 Aggregate Availability in California.

[28] *Ibid.* This assumes a straight haul with minimum traffic; heavy traffic, toll roads and bridges, road conditions and elevation can increase price.

If all the demand can be met by local quarries, it is unlikely that seaborne or rail importation options could compete. However, as the demand begins to exceed supply, some quarries may not be able to meet demand and aggregate may thus need to be trucked from other quarries farther away. When this occurs, the overall price usually equalizes at a level near the highest truck transportation costs and importation options from rail or ocean vessels can become competitive. Rail and seaborne importation could be less expensive than moving large volumes by truck over longer distances.

The ability of the region to supply its needs locally, and the possible requirement for imports if these demands cannot be met, will ultimately determine the price of aggregate and the mode of transport.

CHAPTER 4
FUEL USE AND CO_2 EMISSIONS FROM TRANSPORT

GENERAL ENVIRONMENTAL IMPACTS OF AGGREGATE

The opening of a new site for aggregate mining, the process of extracting the mineral, and transporting it to where it is to be used all affect the environment, albeit in different ways. The development of a mine changes the land use, and oftentimes topography of a site, and can result in a reduction of habitat and biodiversity, as well as changing the visual scene. When development impairs species that are threatened or endangered, it can diminish the long-term viability of those species, as well as others on which they depend (for habitat or food, for example). Habitat loss is the most widespread cause of species endangerment in the United States.[1] This is particularly important in the San Diego region, which has a greater number of threatened and endangered species than anywhere else in the continental United States.[2] It is one of two counties in the nation that are considered "hot spots" for biodiversity, with high concentrations of endangered species.[3]

Environmental effects of mine operation include noise, vibration, and dust from blasting rock. Aggregate is commonly transported from the mining face to the plant either by truck or conveyer, and there it is processed by crushing, screening, and washing. After stockpiling, it is loaded onto trucks.[4] Geologic properties of the aggregate, in addition to operational conditions (e.g., the location and type of the mine, mining techniques, processing techniques, type and effectiveness of regulations), influence the environmental impacts that might result from mining the resource.

Aggregate is usually transported from mines to the point of use by truck. It also may be imported from distant mines by train, barge, or ship (and then by truck). Truck transport results in added traffic and noise on roadways, perhaps most noticeable in the neighborhoods or other areas through which the truck must travel from the mine to get to major streets and highways. Trucking also may accelerate roadway deterioration, particularly because aggregate is a heavy payload. All transport modes — rail, ship, barge, as well as truck — consume fuel and emit pollutants into the air. Major pollutants emitted by vehicles and regulated by the U.S. Environmental Protection Agency under the Clean Air Act include nitrogen oxides, volatile organic compounds, carbon monoxide, carbon dioxide, particulates, and hydrocarbons.

1 Wilcove, D.S. and Master, L.L. (2005, October). How Many Endangered Species Are There in the United States? Frontiers in Ecology and the Environment, Vol. 3, No. 8, pp. 414-420.

2 San Diego County. (1998, August). Final Multiple Species Conservation Program/MSCP Plan. The region contains over 200 plant and animal species that are federally and/or state listed as endangered, threatened, or rare; proposed or candidates for listing; or otherwise considered sensitive.

3 Dobson, A.P., Rodriguez, J.P., Roberts, W.M., Wilcove, D.S. (1997, January 24). Geographic Distribution of Endangered Species in the United States. Science, Vol. 275. The other county identified as a hot spot is Santa Cruz, California.

4 Langer, William H. and Arbogast, Belinda F. (2002). Environmental Impacts of Mining Natural Aggregate. In: Deposit and Geoenvironmental Models for Resource Exploitation and Environmental Security, Proceedings of the NATO Advanced Study Institute, A.G. Fabbri et al., eds.

FUEL AND CARBON DIOXIDE EMISSIONS FOCUS

A comprehensive review and estimation of the environmental consequences associated with aggregate mining and transport within the region, such as the impacts on wildlife habitat and connectivity, endangered species, water resources, water quality, and air, would be a valuable study. However, that level of analyses is beyond the scope of this report, which is limited to assessment of fuel consumption and carbon dioxide (CO_2) emissions associated with the transport of aggregate.

This chapter estimates fuel consumption and CO_2 emissions for several modes of transport and uses the estimates to analyze impacts for potential future supply options (local mines and various import modes). Fuel consumption is correlated with transport cost and thus the total cost of the material to the purchaser, and involves the use of fossil fuels, which are nonrenewable natural resources. Carbon dioxide is a major greenhouse gas, and reducing greenhouse gas emissions is the subject of recent California legislation. California Assembly Bill 32 (Global Warming Solutions Act, 2006) requires that greenhouse gas emissions in California be reduced to 1990 levels by 2020. Region-wide, this means a 33 percent reduction from projected "business-as-usual" 2020 levels and for heavy-duty trucks such as those used to transport aggregate, a 22 percent reduction from projected 2020 levels.[5] On average, CO_2 represents about 95 percent of the greenhouse gas emissions from vehicles.[6]

TRANSPORT OPTIONS AND CONSEQUENCES

Most construction aggregate used within the San Diego region is transported to the point of use by truck. It may originate from a mine within the region or from another county. Alternatively, it can be transported from another county, state or country by rail, barge or ship, then transferred ("transloaded") to a truck for delivery to the point of use. At present, the region has limited rail and maritime capacity due to infrastructure constraints, particularly limited storage facilities.

One component of this study was to develop an environmental impact assessment tool to estimate the fuel consumption and emissions of alternate transport options at a regional level. A fuel consumption and emissions estimator tool was developed (detailed in Appendix A on the CD accompanying this report) for this purpose. The tool could be used to estimate a variety of mode options and scenarios. This chapter uses the tool to assess the following five transport mode options.

[5] Energy Policy Initiatives Center and University of San Diego. (2008, September). San Diego County Greenhouse Gas Inventory: An Analysis of Regional Emissions and Strategies to Achieve AB 32 Targets.

[6] U.S. Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2001. Other greenhouse gases include methane and nitrous oxide emissions from the tailpipe as well as hydrofluorocarbon emissions from leaking air conditioners.

The aggregate is:

1 Transported by truck from current local mine locations to project sites (no imported aggregate).

2[7] Imported by truck from outside the San Diego region to project sites.

3 Imported by rail, then transported by truck from rail yard to project sites.

4 Imported by barge, then transported by truck from the Port of San Diego to project sites.

5 Imported by ship from outside the San Diego region, then transported by truck from the Port of San Diego to project sites.

For each mode option, fuel consumption and CO_2 emissions are estimated per million tons of aggregate transported.[8] In addition, an estimate is made for the 19-million-ton level, which represents an approximation of the region's average annual aggregate demand between 2010 and 2030, calculated at 5.4 tons per capita (see Chapter 3 for additional details). Emissions within the San Diego region, as well as outside the region, were estimated based on average transport distance by mode.

Assumptions

The average distances, emissions rates, and fuel efficiencies used in the model and analysis are shown in Tables 4-1 through 4-3. Table 4-1, Average Transport Distances by Mode Option, presents the average distances for each transport mode option and the basis for the mileage assumptions.

In Transport Mode Option 1, aggregate is transported by truck from current mine locations to project sites; no aggregate is imported from outside the San Diego region. The distance between each existing mine in the region (shown in Chapter 3) and each future San Diego Regional Transportation Plan (RTP) project was calculated and the average distance of 26 miles used in this analysis.

In Transport Mode Option 2, aggregate is transported by truck from locations outside the San Diego region to project sites. The cities from which San Diego has been known to import aggregate include Thermal, Lake Elsinore, Rialto, Corona, Irwindale, and Ocotillo.[9] To calculate the driving distance, first the distance between each of these cities and the closest (northern or eastern) county line was calculated. The average of 45 miles was used as the average truck distance outside of the region for this analysis. Second, the distance from the northern county line to each RTP project via Interstate (I-) 5 or I-15, or the distance from the eastern county line to each RTP project via I-8, was calculated and the average of 55 miles used in this analysis to represent the average truck distance

7 Aggregate (up to 1 million tons annually) is permitted for transport across the U.S.-Mexico border by conveyer belt east of the Calexico II Port of Entry to Aggregate Products, Inc. in Imperial County. A separate transport option for this mode is not listed, but since the material could be transported by truck from the San Diego/Imperial County line to project sites, emissions and fuel consumption would be comparable to the results for Mode Option 2. (Source: Finding of No Significant Impact and Summary Environmental Assessment, 67 Federal Register 79228-79231).

8 The emissions associated with transloading are not included. Trucking emissions from transloading have been found to be about 5 percent of total emissions. (Greenhouse Gas Calculator Emissions Factors, CN Railway, Retrieved 12/20/2010 at www.cn.ca.en/greenhouse-gas-calculator-emission-factors.htm.)

9 EnviroMINE, Inc. (2007, November). Southern California Construction Aggregates Market Study.

within the region. Aggregate from Thermal, Lake Elsinore, Rialto, and Corona was assumed to be transported via I-15, aggregate from Irwindale via I-5, and aggregate from Ocotillo via I-8.

Table 4-1
Average Transport Distances by Mode Option

Mode Option / Average Miles by Mode	Basis for Mileage
1. Local Mine	
Truck/26	Average distance between existing mines and future San Diego RTP projects
2. Import: Truck	
Truck outside Region/45	Average distance from known import locations and northern/eastern county line
Truck within Region/55	Average distance from northern/eastern county line to RTP projects via I-5, I-15, & I-8
3. Import: Rail and Truck	
Rail Outside Region/140	Estimate of distance from Cushenbury to San Diego County line
Rail Within Region/60	Distance from northern San Diego County line to rail yard at Port of San Diego
Truck/20	Average distance between rail yard at the Port of San Diego and RTP projects
4. Import: Barge and Truck	
Barge Outside Region/66.45*	Approximate distance from Port of Ensenada to San Diego waters
Barge Within Region/3.45*	Waters within state jurisdiction (3 nautical miles)
Truck/20	Average distance between Port of San Diego and RTP projects
5. Import: Ship and Truck	
Ship Outside Region/1536.55*	Distance from Vancouver Island to Port of San Diego
Ship Within Region/3.45*	Waters within state jurisdiction (3 nautical miles)
Truck/20	Average distance between Port of San Diego and RTP projects

* Statute miles (converted from nautical miles).
Source: SANDAG, BNSF 2010, CSL International.

In Transport Option 3, aggregate is imported by rail, and then transported by truck from a rail yard to project sites. The distance between Cushenbury (in San Bernardino County), California, and the rail yard at the Port of San Diego was used because Cushenbury is one of the farthest points from which a major local rail carrier currently believes aggregate could realistically be transported.[10] For this analysis, 140 track miles from Cushenbury to the northern San Diego County line represents the rail miles outside the region, and 60 track miles from the county line to the rail yard at the Port of San Diego represents the rail miles within the region. Aggregate is then transloaded to a truck for delivery to project sites. The distances between the rail yard at the Port of San Diego and each RTP project were estimated and the average of 20 miles used in this analysis.

[10] BNSF Railway. Personal communication on August 2, 2010.

It should be noted that in Chapter 6 the expert review panel suggests that transporting aggregate by rail may be a viable option depending on economic conditions and other factors. In order for this to occur, investment in infrastructure, including a transloading facility, would be required. As this type of facility is not currently available, the existing rail yard was used as a proxy for transport Mode Option 3.

In Transport Mode Option 4, aggregate is imported by barge and then transported by truck from the Port of San Diego to project sites. The San Diego region has been known to import from Mexico by barge, so the 70-mile distance from the Port of Ensenada, Mexico, to the Port of San Diego was used for the analysis. Because the state of California has jurisdiction over waters 3.45 miles (3 nautical miles) from shore, that distance was used in this analysis to represent the transport distance within the region and the remaining 66.55 miles as the transport distance outside the region. Aggregate is then transloaded to a truck for delivery to project sites. The distances between the Port of San Diego and each RTP project were estimated and the average of 20 miles used in this analysis.

In Transport Mode Option 5, aggregate is imported by ship from outside the San Diego region and then transported by truck from the Port of San Diego to project sites. Although aggregate is not currently imported by ship to the region, Eagle Rock Aggregates is planning to extend its shipments of sand and gravel from Canada to San Diego using large vessels carrying up to 79,200 tons of aggregate.[11] The 1,540-mile (1,339-nautical-mile) distance from Vancouver Island to the Port of San Diego was used in this analysis. As in the previous option, because the State of California has jurisdiction over waters 3.45 miles (3 nautical miles) from shore, that distance was used in this analysis to represent the transport distance within the region by barge and the remaining 1,536.55 miles as the transport distance outside the region by ship. Aggregate is offloaded from the ship to a storage facility and then onto a truck for delivery to project sites. The distances between the Port of San Diego and each RTP project were estimated and the average of 20 miles used in this analysis.

For the five transport mode options, the locations of all San Diego RTP projects were used as a proxy for the areas where future development is likely to occur within the region and for average truck-miles in Table 4-1. To illustrate the correlation between future projected growth and RTP projects, both population and housing forecasts were mapped with RTP projects. Figure 4-1 illustrates the San Diego region population change between 2008 and 2030, while Figure 4-2 illustrates the accompanying housing change for the same time period. The figures show that the locations of RTP projects coincide with areas of future growth, and thus, locations of potential future construction aggregate demand.

For all import mode options, the transport distance is calculated from the loading site (mine, rail yard, or port) outside the region, not from any previous travel to that point. This is because information on the mileage and vehicles used to move aggregate to all rail yards or ports not within the San Diego region is not available for all transport options, nor is information that would permit reasonable assumptions.

[11] U.S. Geological Survey. (2010). 2007 Minerals Yearbook: California (Advance Release).

Figure 4-1
San Diego Region Population Change 2008 – 2030

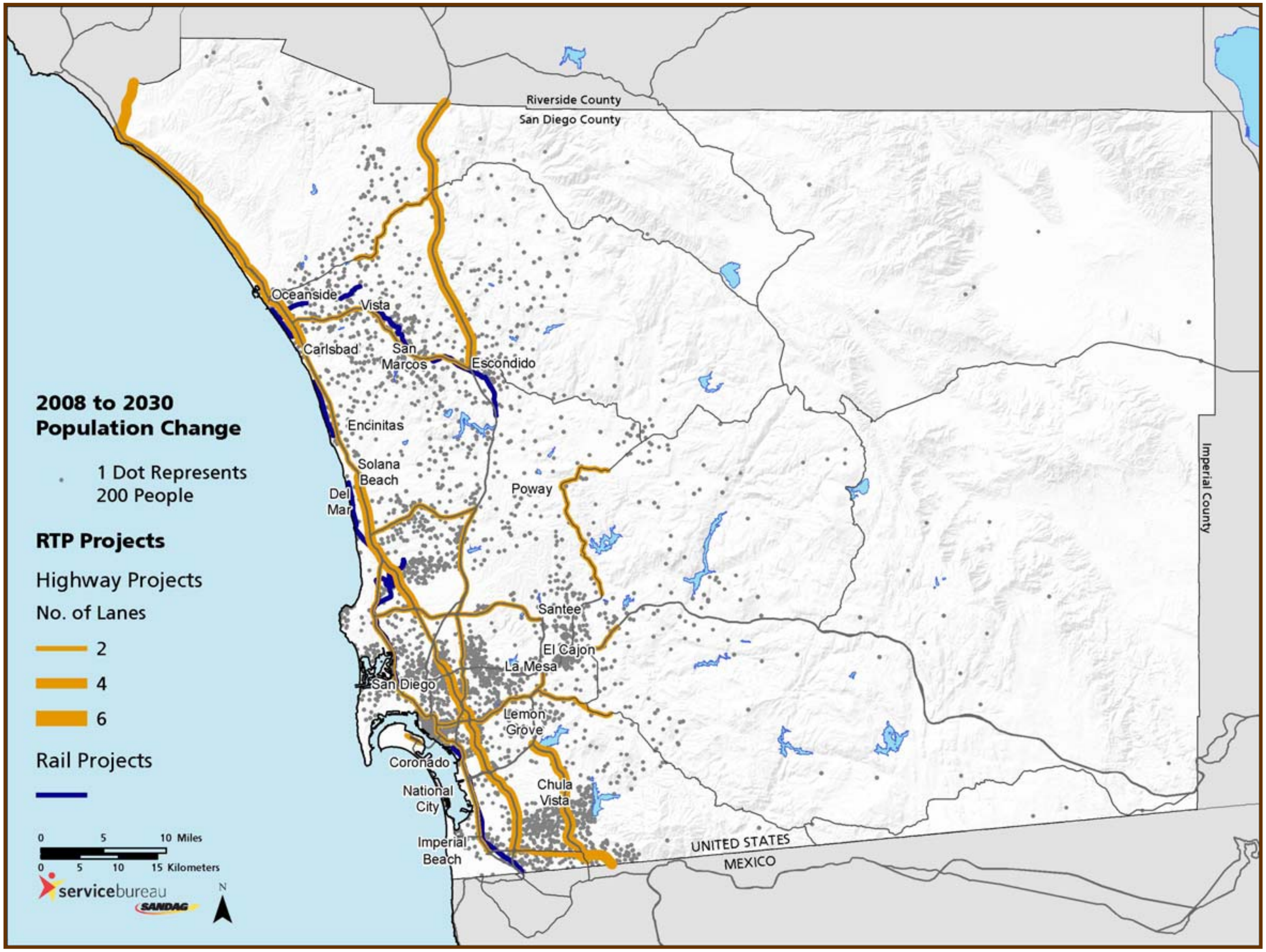
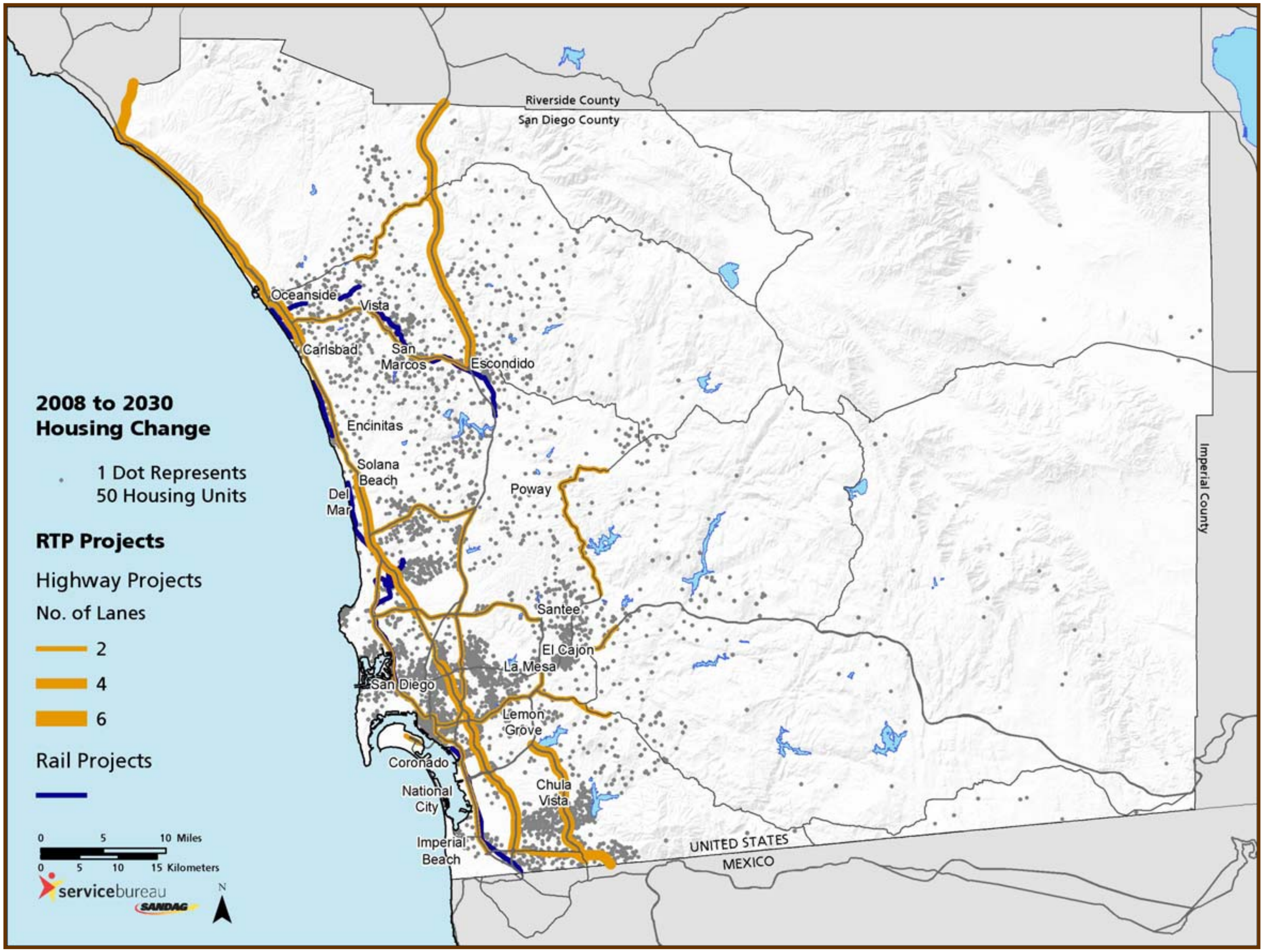


Figure 4-2
San Diego Region Housing Change 2008 – 2030



Fuel Consumption and CO_2 Emissions

Fuel consumption and CO_2 emissions were estimated based on round-trip travel, with aggregate transported to the point of use and the vehicle returning empty.[12] Estimates were developed by the California Air Resources Board (CARB) for:

- Truck classes typically used for hauling aggregate – medium-heavy-duty diesel trucks and heavy-heavy-duty diesel trucks, model year 2010. Trucks are assumed to weigh 12.5 tons empty, with a payload of 25 tons.
- Short-haul, uncontrolled locomotives manufactured before 2001. Rail cars are assumed to weigh 30 tons empty, with a maximum capacity of 100 tons per hopper car.
- Lighter Aboard SHip (LASH) barges built between 1979 and 1983. Barges are assumed to weigh 412 tons empty, with a maximum capacity of 1,500 tons.

CARB provided per-mile fuel consumption rates for the typical vehicles described above based primarily on data made available in their Documentation of California's Greenhouse Gas Inventory. Rates were supplied for vehicles with and without payload. This allowed an estimation of the gallons of fuel used to transport a given quantity of aggregate a specified distance. From this estimate of total fuel use, CO_2 emissions were calculated using CARB and U.S. Environmental Protection Agency data for the CO_2 content per gallon of fuel.

Additionally, CSL International, the manufacturer of the typical vessel intended for importing aggregate to the region, provided estimates for the CSL Acadian. This ship is classified as a dry bulk carrier capable of carrying up to 80,000 tons. It was built in 1982, with the forebody rebuilt in 2006 as a self-unloader. For this analysis an average load of 72,786 tons was used.

The fuel consumption and CO_2 emissions rate assumptions for each transport mode are presented in Tables 4-2 and 4-3 for transporting aggregate. Detailed information regarding the transport vehicle assumptions used to develop fuel consumption and emissions rates may be found in Appendix A.

[12] This simplifying assumption will overstate total emissions and fuel consumption if, for example, a portion of the aggregate is delivered *en route* to the San Diego region or the transport vehicle does not return to the point of origin.

Fuel Consumption

Table 4-2 presents fuel consumption rates for each aggregate transport mode. These rates are in miles per gallon, gallons per mile, and gallons per net ton-mile, assuming the payload for each mode shown in the table. Rates would be different for empty vehicles and for vehicles hauling a different amount of aggregate. These figures indicate that transporting aggregate by truck or rail would use about the same amount of fuel per mile. However, these rates apply to distinctly different payloads, a locomotive hauling 100-ton hopper cars compared to a truck hauling 25 tons, so rail would use substantially less fuel per ton-mile of aggregate hauled. The barge carrying 1,500 tons and ship with 72,786 tons use less fuel per net ton-mile than a truck.

Table 4-2
Fuel Consumption for Aggregate Transport, With Payload

	Fuel Consumption			
Mode	(miles/gallon)[13]	(gallons/mile)	(gallons/ net ton-mile)[14]	Payload
Truck	4.7	0.214	0.0086	25 tons
Rail	4.8	0.210	0.0021	100 tons/hopper car
Barge	0.10	10.18	0.0068	1,500 tons
Ship	0.03	31.8	0.0004	72,786 tons

Source: CARB 2010 and CSL International 2010; rates per nautical mile converted to statute mile.

Fuel Consumption Estimates per Million Tons of Aggregate

Using the average transport distances by mode option presented in Table 4-1 and fuel consumption equations provided in Appendix A, fuel use per million tons of aggregate can be estimated for the five transport mode options in Table 4.3.

[13] Inverse of fuel consumption in gallons per mile.

[14] Fuel consumption in gallons per mile divided by payload; includes weight of transporting vehicle/vessel plus payload.

Table 4-3
Fuel Consumption for Transport Mode Options
Estimates Per Million Tons of Aggregate
(thousand gallons)

Option	Total Fuel	Fuel Outside Region	Fuel Within Region
1. Truck[15]	296	N/A	296
2. Import: Truck	1,138	512	626
3. Import: Rail & Truck	788	392	396
4. Import: Barge & Truck	804	548	256
5. Import: Ship & Truck	1,406	1,176	230

Source: CARB 2010, CSL International 2010 and SANDAG.

CO_2 Emission Rates

CO_2 emission rates for each aggregate transport mode are presented in Table 4-4. These rates are in grams per net ton per mile hauled, assuming the payload for each mode shown in the table. Rates would be different for empty vehicles, and for vehicles hauling a different amount of aggregate. These data indicate that truck transport results in the highest CO_2 emissions per net ton-mile, and ship the lowest. Emissions from hauling by barge are about 20 percent lower than truck transport, and rail emission rates are about one-fourth that estimated for truck.

Table 4-4
CO_2 Emissions From Aggregate Transport, With Payload

Mode	CO_2 Emissions (grams/ net ton-mile)	Payload
Truck	86.9	25 tons
Rail	21.4	100 tons/rail car
Barge	69.6	1,500 tons
Ship	5.34	72,780 tons

Source: CARB 2010 and CSL International 2010.

[15] Sample calculation: 1,000,000 tons aggregate / 25 tons per truck = 40,000 truck trips * 26 miles per trip = 1,040,000 truck miles each way * (0.071 + (0.0057 * 25 tons aggregate per truck)) = 222,040 gallons of fuel one way loaded. (0.071 * 1,040,000 truck miles each way) = 73,840 gallons of fuel one way empty. 222,040 + 73,840 = 295,880 gallons total for 1,000,000 tons aggregate. See Appendix A for sample calculations of other mode options.

CO_2 Emissions Estimates per Million Tons of Aggregate

Using the average transport distances by mode option presented in Table 4-1 and CO_2 emission rate equations provided in Appendix A, CO_2 emissions per million tons of aggregate can be estimated for the five transport mode options. These results are shown in Table 4.5.

Table 4-5
CO_2 Emissions for Transport Mode Options
Estimates Per Million Tons of Aggregate
(metric tons)

Option	CO_2 Total Emissions	CO_2 Emissions Outside Region	CO_2 Emissions Within Region
1. Truck [16]	3,000	N/A	3,000
2. Import: Truck	11,537	5,192	6,345
3. Import: Rail & Truck	7,985	3,974	4,011
4. Import: Barge & Truck	8,210	5,612	2,598
5. Import: Ship & Truck	16,703	14,363	2,340

Source: SANDAG estimates based on CARB 2010 and CSL International 2010 data.

Table 4-5 shows that:

- The lowest total CO_2 emissions, 3,000 metric tons, are estimated for Transport Mode Option 1 – aggregate transported by truck from current mine locations to project sites.
- The highest total CO_2 emissions, 16,703 metric tons, are estimated for Mode Option 5 – aggregate transported by ship from Canada and then transported by truck from the port to project sites. This is primarily due to the higher CO_2 emissions outside the region as the transport distance is over 1,500 miles.
- The second highest total CO_2 emissions, about 11,500 metric tons, are estimated for Transport Option 2 – aggregate imported by truck from locations outside the San Diego region to project sites (this option assumes the greatest trucking distance).

Table 4-5 also shows emissions outside the San Diego region and within the region. Note the emissions in the "within region" column are slightly higher for Transport Mode Option 3 (Import: Rail and Truck) than for Option 1 because the aggregate travels an additional 60 miles by rail within the region (Table 4-1). In contrast, aggregate delivered by ship only travels 3.45 miles within the region before being transloaded to truck, which explains the difference in emissions within the region between Options 5 and 3. The lowest CO_2 emissions within the San Diego region per million tons of aggregate are estimated for Transport Mode Options 4 and 5; most of those emissions are from truck travel.

[16] Sample Calculation: 295,880 gallons of fuel * 10,138 grams CO_2 per gallon of fuel = 2,999,631,440 grams CO_2 /1,000,000 grams per metric ton = 3,000 metric tons. See Appendix A for sample calculations of other mode options.

SAN DIEGO SUPPLY OPTIONS

Fuel Use and CO_2 Estimates

The average distances, fuel consumption, and emissions rates were applied to five future supply scenarios using the 2010 through 2030 average annual regional demand estimate of 19 million tons (see Chapter 3). The fuel consumption and emissions estimator tool could be used for any number of scenarios. The supply scenarios used in this report are based on these estimates:

A. All aggregate supplied by local mines and transported to project sites by truck (19 million tons),

B. Local mines supply 9 million tons (average annual regional supply estimate for 2010 to 2030) and the balance (10 million tons) imported by truck,

C. Local mines supply 16 million tons and the balance imported by rail and ship,

D. Local mines supply 9 million tons, ship and rail supply potential future capacity of 2 million tons and 1 million tons, respectively, and the remaining 7 million tons imported by truck, and

E. All aggregate is imported: 16 million tons by truck, 2 million tons by ship, and 1 million tons by rail.

It should be noted that Supply Scenarios B and D are based on an estimate of future potential annual production of 9 million tons that assumes regional mines are able to continue to supply about the same quantity as between 1995 and 2009. The local aggregate production assumed for Supply Scenarios A and C (19 and 16 million tons, respectively) exceeds annual production levels during the same time period (see Chapter 3). It assumes that existing permits were extended, mines were expanded, or new mines were opened.

Approximately half a million tons of aggregate per year has been received through the Port of San Diego in recent years, but if infrastructure improvements occur, such as transload/storage facilities and access improvements from the port to the major freeway connectors, this study assumes that about 2 million tons annually could be accommodated. Current rail infrastructure and lack of a transloading facility are among the major constraints to rail imports. This study assumes some improvements could be achieved, enabling about 1 million tons of aggregate per year to be imported by rail.

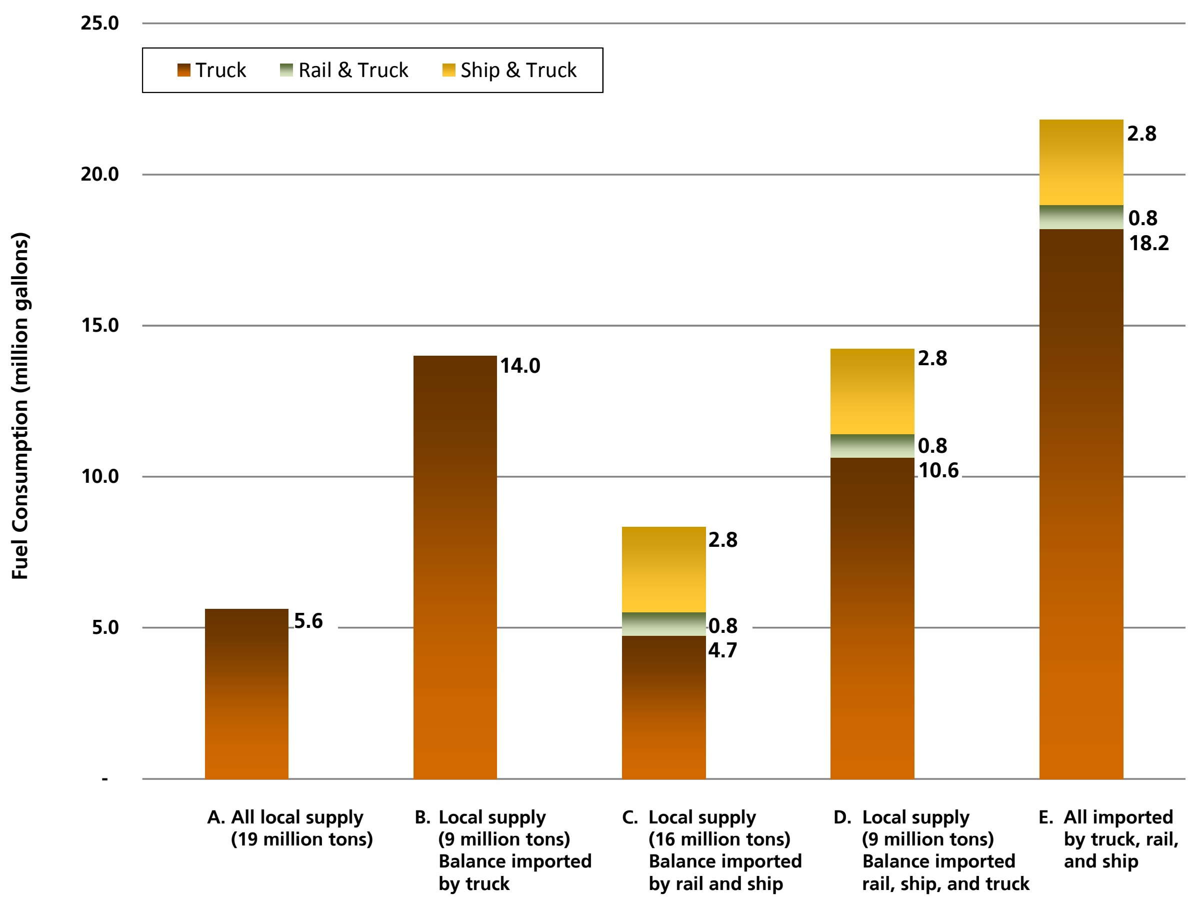
Fuel Use

Table 4-6 presents fuel consumption estimates for each supply scenario. Scenario A, the local provision of the estimated aggregate needed over the next 20 years, would result in the lowest total fuel consumption. Scenarios B and D, local mines supplying 9 million tons with the balance imported, would require more than twice the quantity of fuel. Scenario C, local mines supplying 16 million tons with the balance imported by truck, would result in the second-lowest fuel use. The highest level of fuel use would occur under Scenario E, 16 million tons of aggregate imported by truck with the remainder imported by ship and rail. Figure 4-3 illustrates the quantity of fuel attributable to each transport mode by supply scenario.

Table 4-6
Fuel Consumption for San Diego Supply Scenarios
19 Million Ton Average Annual Estimated Demand 2010 to 2030

Supply Option	Total Fuel Consumption (million gallons)	Fuel Consumption Outside Region	Fuel Consumption Within Region
A. All aggregate supplied by local mines via truck	5.6	N/A	5.6
B. Local mines supply 9 million tons, balance of 10 million tons imported via truck	14.0	5.1	8.9
C. Local mines supply 16 million tons, 1 million tons via rail and 2 million tons via ship	8.3	2.7	5.6
D. Local mines supply 9 million tons, 7 million tons imported via truck, 1 million tons via rail and 2 million tons via ship	14.2	6.3	7.9
E. All aggregate imported: 16 million tons by truck, 1 million tons via rail and 2 million tons via ship	21.8	10.9	10.9

Figure 4-3
San Diego Supply Scenarios With Quantity of Fuel Consumed Attributable to Each Transport Mode



CO_2 Estimates

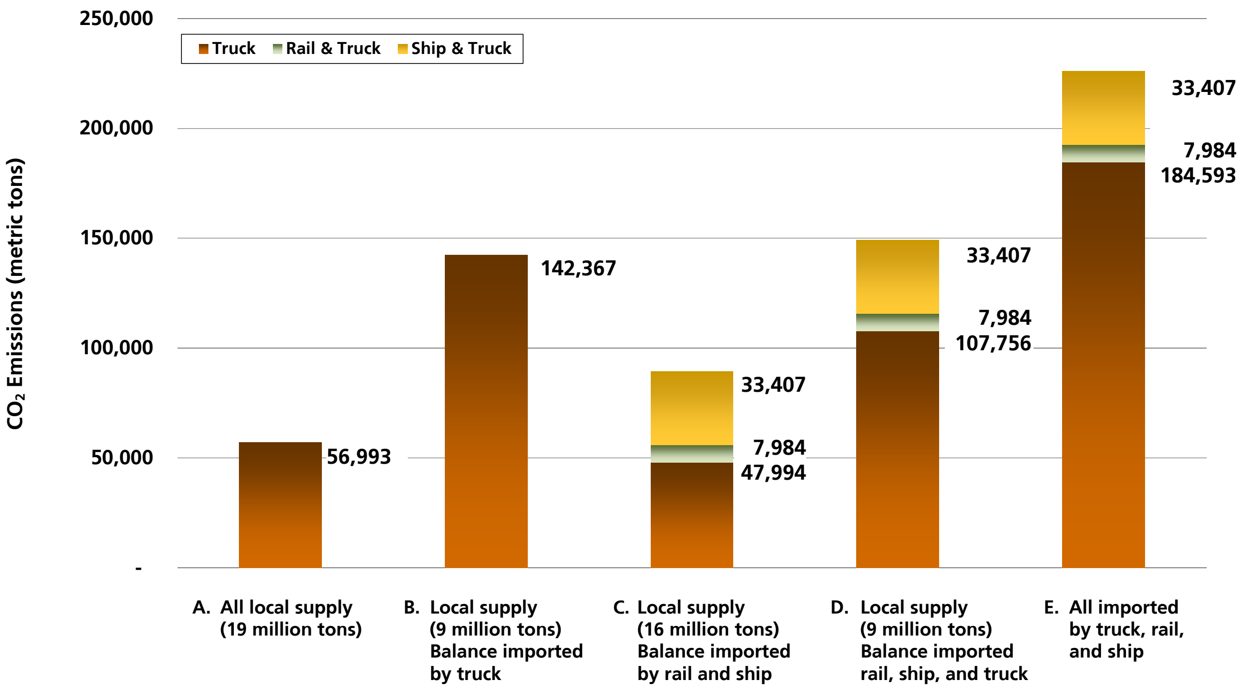
Table 4-7 presents CO_2 emissions estimates for each supply scenario. Since emissions are largely a function of fuel consumption (rates differ by fuel type, which differs by mode), the relative ranking of results is the same as above. Scenario A, the local provision of the projected aggregate need 2010 to 2030, would result in the lowest total CO_2 emissions. In Scenarios B and D, local mines supplying 9 million tons and the remaining 10 million tons imported, emissions would more than double. Emissions are second lowest under Scenario C, local mines supplying 16 million tons with the balance imported by rail and ship. Scenario E would result in the greatest emissions. By importing 16 million tons by truck and the balance by ship and rail at their potential future capacity, emissions under Scenario E would be about 50 percent more than in Scenarios B or D. Despite the fact that ship and rail have lower CO_2 emissions within San Diego region, in Supply Scenario E all aggregate is imported, which increases the truck import by 6 million tons (compared to Scenario B), thus outweighing the benefit of having 3 million tons imported by ship and rail.

Table 4-7
CO_2 Emissions for San Diego Supply Scenarios
19 Million Ton Average Annual Estimated Demand 2010 to 2030

Supply Option	CO_2 Total Emissions (metric tons)	CO_2 Emissions Outside Region	CO_2 Emissions Within Region
A. All aggregate supplied by local mines via truck	56,993	N/A	56,993
B. Local mines supply 9 million tons, balance of 10 million tons imported via truck	142,367	51,917	90,450
C. Local mines supply 16 million tons, 1 million tons via rail and 2 million tons via ship	89,385	32,701	56,684
D. Local mines supply 9 million tons, 7 million tons imported via truck, 1 million tons via rail and 2 million tons via ship	149,147	69,043	80,104
E. All aggregate imported: 16 million tons by truck, 1 million tons via rail, and 2 million tons via ship	225,984	115,768	110,216

Figure 4-4 illustrates the CO_2 emissions attributable to each transport mode by supply scenario.

Figure 4-4
San Diego Supply Scenarios With Portion of CO_2 Emissions Attributable to Each Transport Mode



Even though fuel consumption and CO_2 emissions for import options utilizing rail and ship are lower per million tons of aggregate imported than those relying on truck imports (Tables 4-3 and 4-5), the potential future capacity for rail and ship limits their share to about 15 percent (3 out of 19 tons) of projected future demand. Therefore the balance will need to be transported by truck, resulting in greater fuel use and CO_2 emissions (attributable to truck transport) in Scenarios D and E.

Since truck transport is required for all supply options, fuel consumption and emissions depend to a large extent on the distance between the production or transloading point and the point of use. Thus, actions that reduce this distance would decrease these aspects of transportation. These could include: (1) establishment of mines closer to projected areas of need; (2) improved truck fuel efficiency; (3) lower truck emissions per mile; and (4) establishment of rail distribution centers near projected areas of need.

ACTIONS THAT COULD REDUCE FUTURE AIR EMISSIONS

A number of factors, such as technological improvements and regulations over the next decade could influence fuel use and emissions. In May 2010 the United States Environmental Protection Agency announced that it will initiate a new rulemaking (with the National Highway Traffic Safety Administration) to improve fuel efficiency and reduce greenhouse gas emissions for commercial trucks,[17] such as those used for hauling aggregate. They anticipate that the joint rulemaking for new heavy-duty engines and vehicles would be proposed in the fall of 2010, finalized by July 2011, and begin with model year 2014. It is expected that these new regulations, when implemented, would reduce the total CO_2 emissions estimated for each option.

Recent advances in locomotives could also benefit the transportation of aggregate. In April 2010 the San Diego & Imperial Valley Railroad announced their purchase of two new locomotives that generate fewer emissions.[18] These locomotives run on ultra-low-sulfur diesel and reduce nitrogen oxide and particulate emissions by up to 90 percent compared to the 1950s locomotives they replaced. The new locomotives are quieter than the older models and have average fuel savings of 25 percent.

[17] U.S. Environmental Protection Agency. (2010, May). EPA and NHTSA to Propose Greenhouse Gas and Fuel Efficiency Standards for Heavy-Duty Trucks; Begin Process for Further Light-Duty Standards.

[18] Lee, Mike. (2010, April 1). 2 New Trains on Track to Cut Pollution. San Diego Union-Tribune.

CHAPTER 5
GIS OPTIMIZATION AND OVERLAY ANALYSIS

One of the key objectives of the study is to review the aggregate sources in the region and develop a regional geographic information system (GIS) database that allows for the visualization of aggregate sources with informational overlays. This objective included the goal of developing a modeling approach that could be employed by regional and local agencies to assess potential aggregate source sites in other areas of the state. A three-pronged approach for the GIS analyses was developed. The following steps were employed:

- Step 1: Identify potential aggregate supply sites
- Step 2: Identify Regional Transportation Plan (RTP) aggregate demand points
- Step 3: Optimize distance between demand points and supply sites

STEP 1: IDENTIFY POTENTIAL AGGREGATE SUPPLY SITES

The first step in the GIS optimization analysis is to identify the potential available lands for aggregate based on land use constraints. In this approach, lands that already have been developed and lands that have been identified as environmentally constrained were removed from the analysis. Developed lands were removed because extraction of aggregate resources is usually precluded if permanent structures such as roads, houses, or other buildings are built over them. Once urban development has occurred, it will likely permanently prevent any further development of aggregate at that location. Aggregate extraction would not be allowed on lands that have been conserved for environmental purposes. Basically, the analysis begins with a GIS layer of the region and subtracts out developed lands and environmentally conserved lands to arrive at "unconstrained lands." Then small areas (less than 20 acres) and areas where no mineral resource is present are removed to arrive at the potential aggregate supply sites. Figure 5-1 illustrates the steps in the GIS analysis model.

Figure 5-1
GIS Model for Identifying Potential Aggregate Supply Sites

San Diego Region

+ Mineral Resource Zones
-- Developed Land
-- Conserved Lands (or lands identified for conservation at 90 percent)

Unconstrained Areas

-- Less than 20 Acres
-- MRZ-1 (no resource present)

A description of the process follows. The associated maps illustrating the GIS layers are shown in Figures 5-2, 5-3, and 5-4 at the end of this section. Figure 5-5 shows the potential available lands after developed and conserved land layers are removed.

Mineral Resource Zones

Beginning with the San Diego region, the first task is to overlay the mineral resource zone (MRZ) layer. The definitions of MRZs are described in detail in Chapter 2. Briefly, lands are classified into MRZs by the California Department of Conservation. MRZ-1 areas are those areas where no significant mineral deposits are present or where it is judged that there is little likelihood of their presence. MRZ-2 areas are those where geologic information indicates that significant mineral deposits are present or where it is judged that there is high likelihood of their presence. MRZ-3 areas contain mineral deposits, but the significance to the region or the state cannot be evaluated due to the lack of detailed data. MRZ-4 areas are where the geologic information does not rule out either the presence or absence of mineral resources.

Electronic layers of the MRZs were obtained from the County of San Diego and modified to include new areas subsequently classified as MRZ-2. Other regions in the state seeking to do a similar analysis would need to contact the Department of Conservation California Geologic Survey to obtain either printed or electronic maps. At the time of this study, digitized MRZ maps were not available from the California Geologic Survey. However, the agency has recently begun to devote resources toward the development of electronic layers for all regions in the state.

Developed Land Use Layer

The next step in the GIS model is to examine the land use information. The 2008 SANDAG Land Use Layer is used for this analysis. SANDAG's Land Use Layers are created for use in the agency's Regional Growth Forecast. Many of these datasets are built from the San Diego Geographic Information Source (SanGIS) landbase. The SANDAG land use information has been updated on a regular basis since 2000 using aerial photography, the County Assessor Master Property Records file, and other ancillary information. As part of this process, the local jurisdictions and the County of San Diego review the land use information to ensure its accuracy.

The model eliminates areas as potential candidates for aggregate supply if the areas overlap with developed land use types classified in the 2008 SANDAG Land Use Layer categories shown in Table 5-1. (Refer to Appendix D, for a complete list of all SANDAG land use codes.)

Table 5-1
Land Use Types Considered to be "Developed"

Land Use Type	SANDAG Land Use Code[1]
Residential	1100, 1110, 1120, 1190, 1200, 1280, 1290
Mobile Home Park	1300
Group Quarters	1400, 1401, 1402, 1403, 1404, 1409
Hotels/Motel/Resort	1500, 1501, 1502, 1503
Heavy/Light Industry	2001, 2100, 2101, 2103, 2104, 2105
Airports	4101, 4102, 4103, 4104
Transportation	4110, 4111, 4112, 4113, 4114, 4115, 4116, 4117, 4118, 4119, 4120
Commercial	5000, 5001, 5002, 5003, 5004, 5005, 5006, 5007, 5008, 5009
Office	6000, 6001, 6002, 6003
Public Services	6100, 6101, 6102, 6103, 6104, 6105, 6108, 6109
Hospital	6500, 6501, 6502, 6509
School	6800, 6801, 6802, 6803, 6804, 6805, 6806, 6807, 6809
Commercial Recreation	7200, 7201, 7202, 7203, 7204, 7205, 7206, 7207, 7208, 7209, 7210, 7211
Parks	7600, 7601, 7603, 7604, 7605, 7606, 7607, 7609
Under Construction	9500, 9501, 9502, 9503, 9504, 9505, 9506, 9507
Water	9200, 9201, 9202
Military Use	6700, 6701, 6702, 6703
Mixed Use	9700

Note: Lands classified as Military Use were considered to be developed. Marine Corps Air Station Miramar has worked with SANDAG to provide more detailed land use information. Thus this study was able to show detailed land uses at Miramar while it was not able to do so at other bases located in the region.

[1] The four-digit land use coding system is used for the SANDAG land information inventory. The detailed land use definitions are included in Appendix D.

Land was considered as a potential aggregate site if it was classified as:

- Vacant: 9101
- Surface Parking Lot: 4114
- Agriculture: 8000, 8001, 8002, 8003
- Extractive Industry: 2201
- Spaced Rural Residential: 1000

Note: Spaced Rural Residential is defined as density equal to one house per ten acres or more.

Areas with a land use classification of "open space" were handled separately. The open space lands were eliminated as potential candidates for aggregate supply if they overlapped with environmental areas that already were conserved or identified for conservation at the 90-percent level in the following databases:

- SANDAG Conserved Lands Database
- South County Multiple Species Conservation Program (MSCP) designated preserve areas (MSCP South, Final)
- North County MSCP (MSCP North, Draft Version 8)
- Multiple Habitat Conservation Program (MHCP)

The MSCP Pre-Approved Mitigation Area land and MHCP soft line (preserve area is less than 90 percent) were not eliminated as potential candidates of aggregate supply since these lands are allowed to be developed at some extent, usually up to 25 percent.

After completing this analysis it was learned that the Marine Corps Air Station Miramar Integrated Natural Resources Management Plan (2006-2010) identifies selected lands as environmentally sensitive. Some representatives of the expert review panel suggested these lands should be considered to be conserved as part of this study. If these lands were excluded, it would have reduced the number of potential aggregate sites by 11. It is not likely that the results of the GIS exercise would change with the exclusion of these 11 sites. The sites could be removed in future studies and analyses.[2]

All remaining lands at this point are referred to as "Unconstrained Lands."

[2] Marine Corps Air Station Miramar, Environmental Management Department. MCAS Miramar Integrated Natural Resources Management Plan (2006 - 2010). 2006. Lands identified as Level I – Vernal pools and associated watersheds; Level II – Non vernal pools threatened/endangered species; and Level III – Habitat linkages/riparian vegetation could be considered to be conserved and removed from the potential aggregate sites in subsequent analyses.

Small Areas and MRZ-1

Two additional tasks were employed in order to arrive at the “potential aggregate supply sites.” Lands less than 20 acres were eliminated because they were deemed to be of insufficient land size for a long-term mining operation as advised by the staff at the County of San Diego familiar with mining operations and geology. In addition, MRZ-1 was eliminated since geologic information indicates no significant mineral deposits are present.

Potential Aggregate Supply Sites

All remaining lands are identified as potential aggregate supply sites, completing Step 1 of the GIS model. A total of 1,159 sites are identified as potential aggregate supply sites. These areas do not meet the definition of a developed land use type, and they have not been conserved for environmental reasons nor identified for conservation at a 90-percent level. Each of the 1,159 sites are 20 acres or more. (The potential areas are not parcels but rather contiguous areas formed after the land use constraints were applied. One area could contain multiple parcels.) Figure 5-5 shows the location of the 1,159 potential aggregate supply sites and the MRZ classifications.

It is important to note that the potential suitability of these sites for construction aggregate will need to be evaluated on a case-by-case basis. The GIS analysis shows potential sites, but does not take into consideration the suitability and marketability of the sites for aggregate. This is a step that would need to be incorporated.

Table 5-2 shows the potential aggregate supply sites by size category. Out of the 1,159 potential sites, over half are smaller than 100 acres.

Table 5-2
Potential Aggregate Supply Sites by Size

Size (Acreage)	Number of Sites
20 to 59	606
60 to 99	163
100 to 499	279
500 to 999	50
1,000 to 9,999	47
10,000 to 15,000	14
	Total 1,159

Figure 5-2
Mineral Resource Zones Map

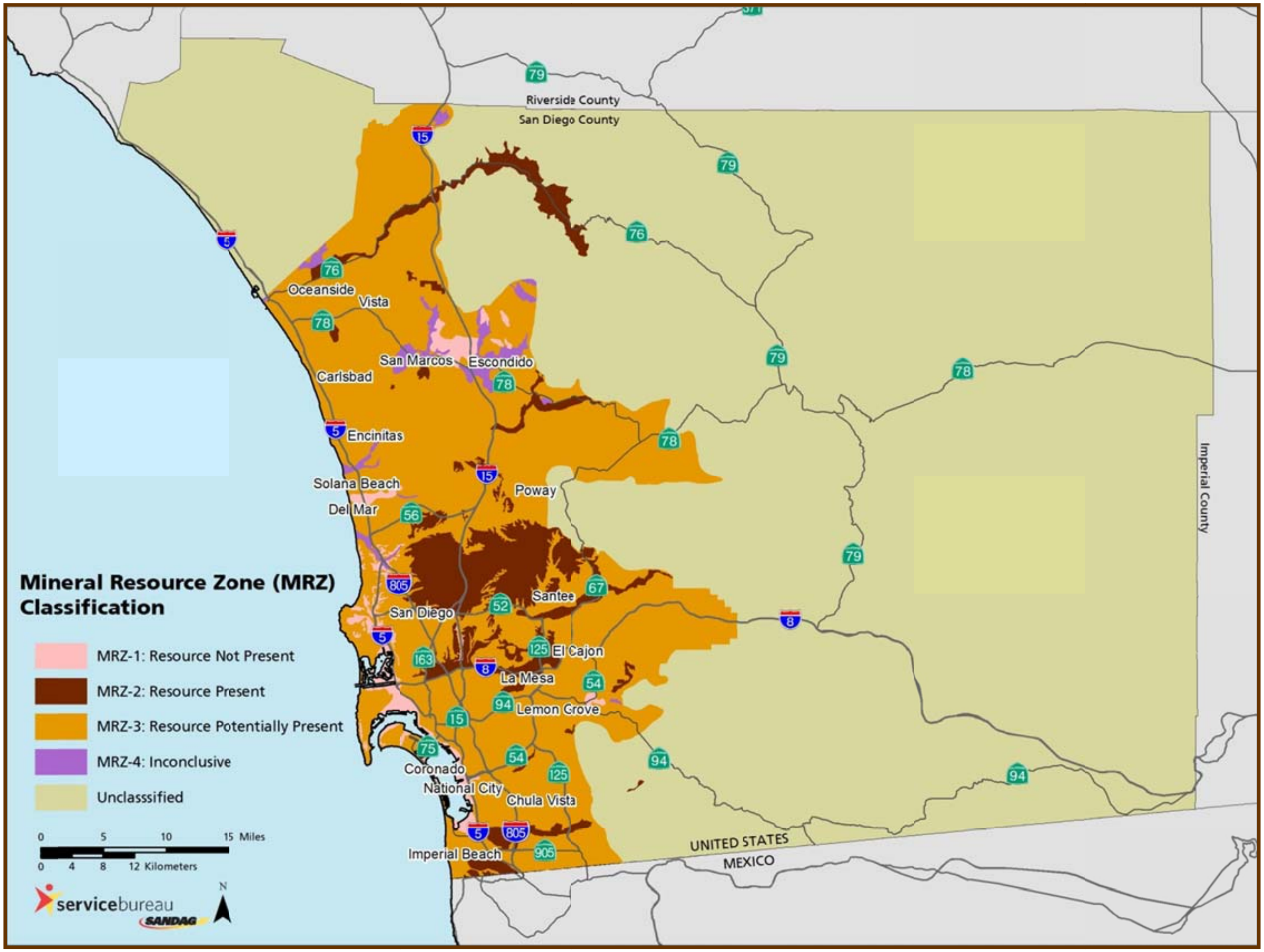
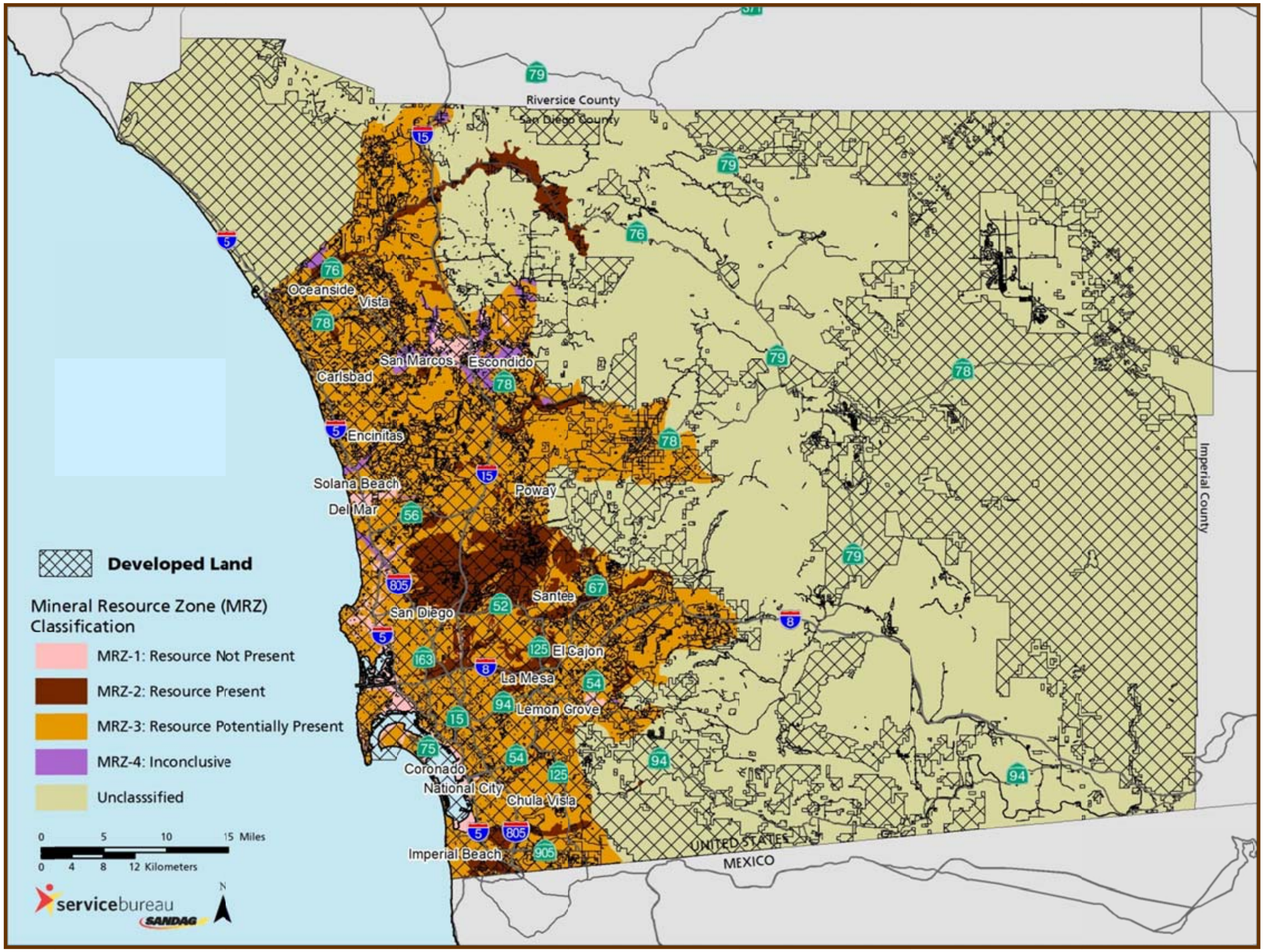


Figure 5-3
San Diego Region Developed Land



Note: In this study, developed land includes national, state, and local parks.

Figure 5-4
San Diego Region Conserved Land (or Land Identified for Conservation at 90% to 100%)

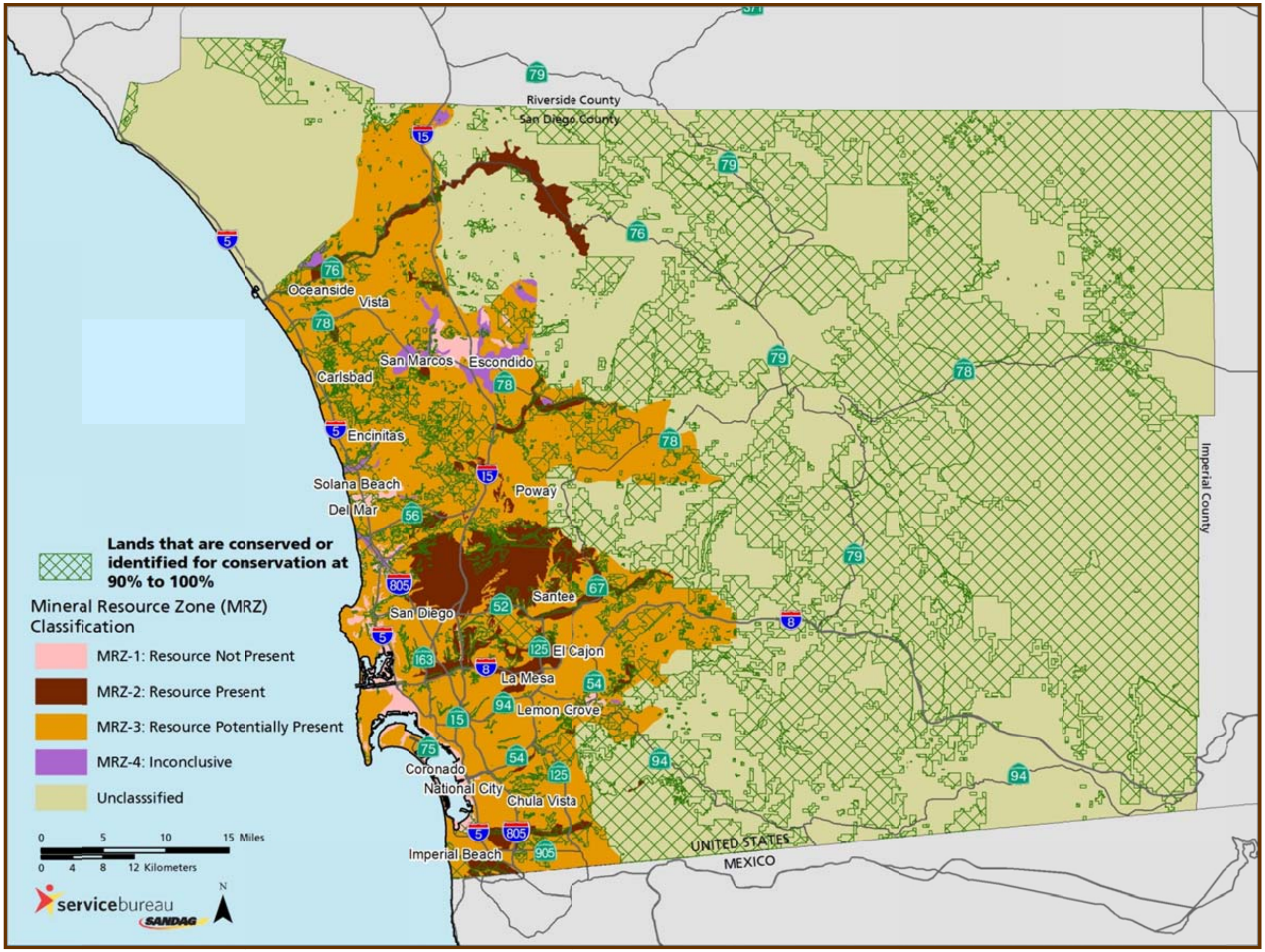
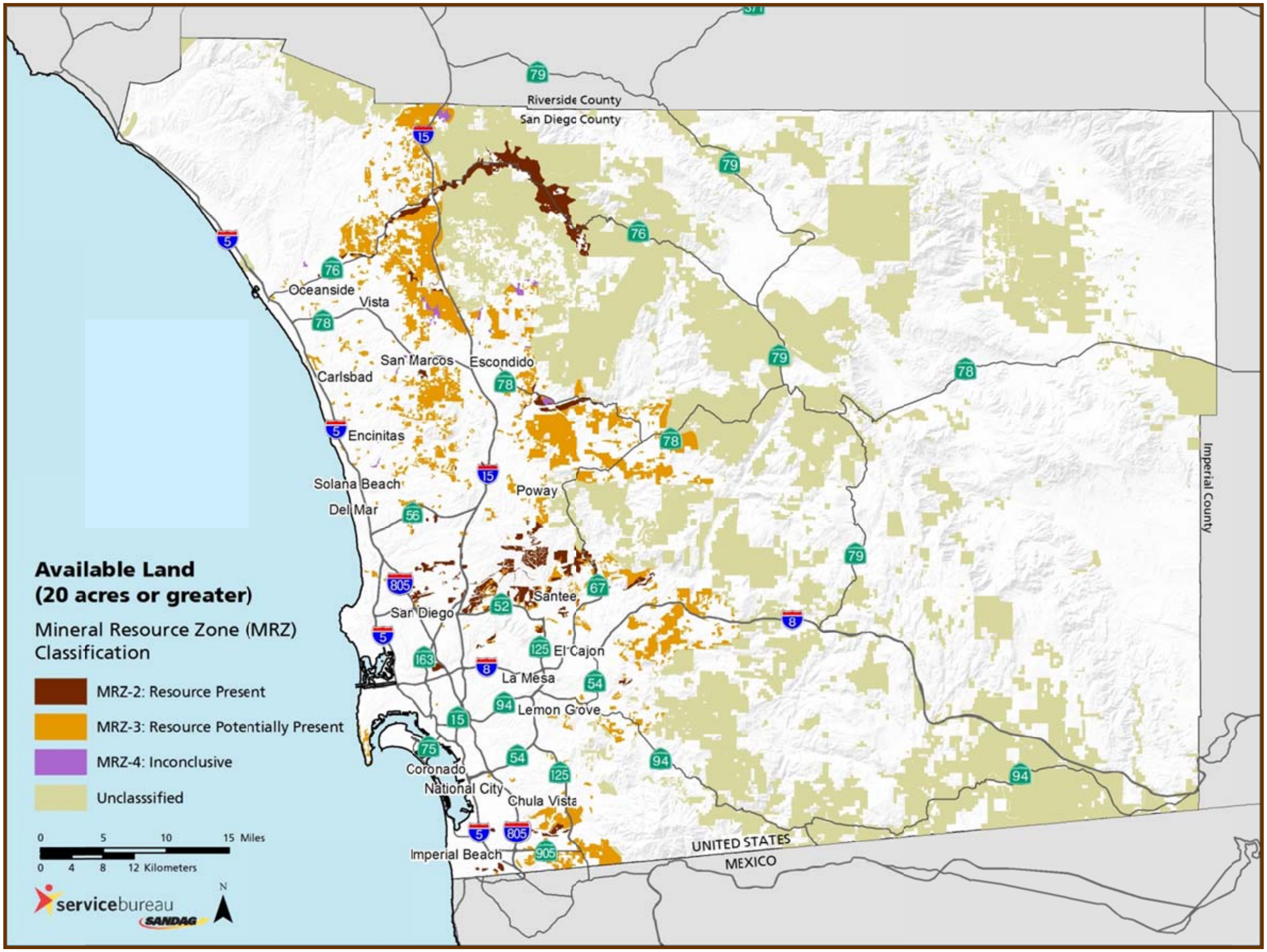


Figure 5-5
Potential Aggregate Supply Sites



This GIS overlay analysis was completed using ESRI ArcGIS 9.3.1. The developed land types were queried from the SANDAG Land Information System database and then exported to a single layer "DevelopedLand." Two ArcGIS models were developed to complete this analysis. As shown in Figure 5-6, the model "FindEnvironUnconstrainedLand" was used to find the nonenvironmentally constrained lands. South County MSCP, North County MSCP, and MHCP (hardline area) layers were first combined as a single layer using the "UNION" tool. The output layer was then eliminated from the County layer using the "ERASE" tool. The output multipart features were separated into single-part features as the final output layer from this model.[3]

Figure 5-6
"FindEnvironUnconstrainedLand" Model Diagram

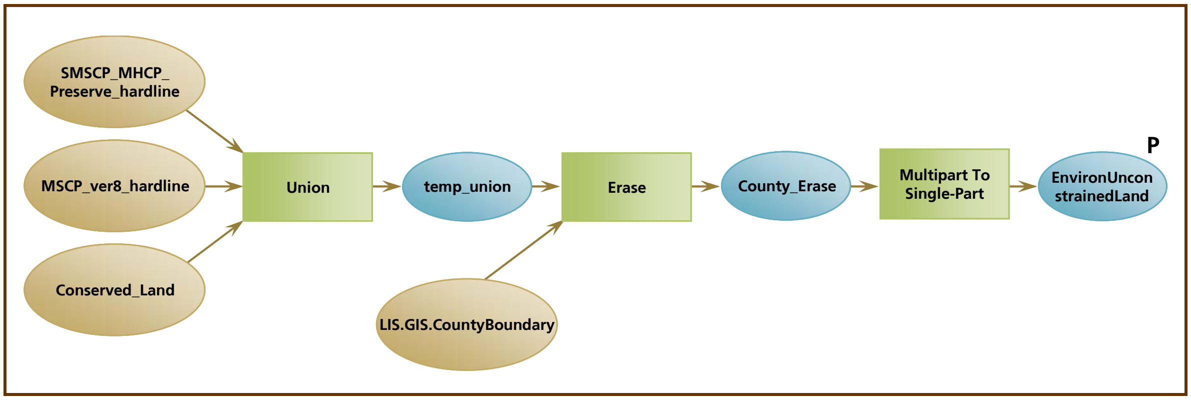
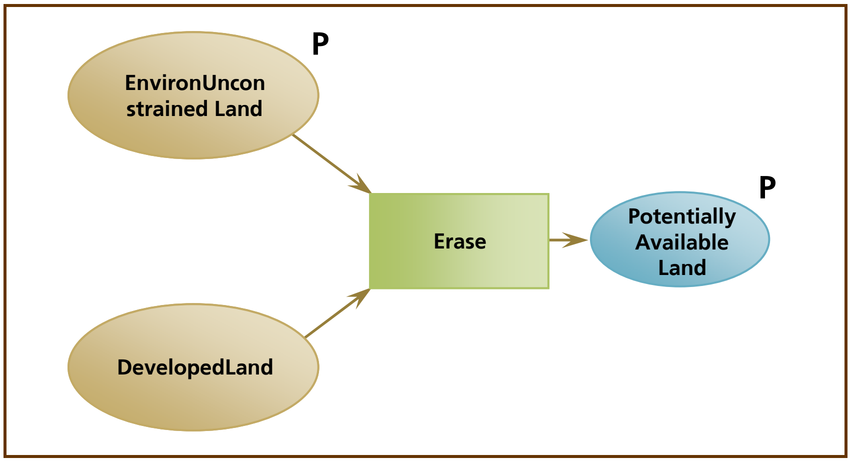


Figure 5-7 illustrates the second model "FindEnvironUnconstrainedUndevelpedLand," which was used to eliminate the "DevelopedLand" layer from the "EnvironUnconstrainedLand" layer using the ERASE tool. The output layer "Potentially Available Land" consists of lands that are not classified as developed and not classified as environmentally constrained (conserved or identified for conservation at the 90-percent level).

[3] Figures 5-6 and 5-7 show certain symbols that are particular to GIS model documentation. The "P" represents model parameter, which allows the user to specify its value in the model tool dialog box.

Figure 5-7
"FindEnvironUnconstrainedUndevelpedLand" Model Diagram



STEP 2: IDENTIFY RTP AGGREGATE DEMAND POINTS

The second step in the GIS optimization analysis is to identify RTP highway and transit projects scheduled for completion in 2015, 2020, and 2030. These projects were included in the 2030 SANDAG RTP. They include highway and transit projects approved by the region's voters in 2004 as part of the *TransNet* Extension. SANDAG is currently developing its 2050 RTP, and the phasing of these projects may change.

Tables 5-3 and 5-4 group the RTP projects by completion year. There are 38 transportation projects and 8 transit (rail) projects included in the analysis. Those RTP projects that were completed or were already underway at the time of this study were excluded from the analysis in order to focus the analysis on future demand for aggregate. Direct access ramps are included as part of the transportation projects and are not shown as separate projects. In addition, the transit projects include those involving rail and do not include bus projects or bus stations. Note that this analysis is designed to be repeatable and could be used for any set of projects.

In order to incorporate the projects into the optimization analysis, each project first needs to be divided into aggregate demand points. Several options were considered. One option was to convert each project into one demand point, but this is unreasonable as most projects are many miles in length. Another option was to look at each project segment by segment using the transportation network, but this yielded too many points for this type of analysis. In the end sections of the RTP projects were divided based on experience from previous highway project phases. This approach more clearly reflected the concept of "aggregate mixing points" that are often utilized in large highway projects.

A centroid point for each project was identified as the aggregate demand point using the "Feature Vertices to Points" tool in ArcGIS. The 46 RTP projects were divided into 77 demand points. Figure 5-8 shows the location of the projection on the map, and Figure 5-9 shows the location of the 77 aggregate demand points.

Table 5-3
RTP Transportation Projects by Completion Year

Year Built By	Freeway	From	To	Existing	Improvement
2015	I-5	La Jolla Village Drive	I-5/I-805 Merge	8F/14F	8F/14F + 2HOV
2015	I-5	I-5/I-805 Merge*	Vandegrift Boulevard*	8F/14F	8F/14F + 4ML
2015	SR 11	SR 905	Mexico	--	4T
2015	I-15**	SR 94	SR 163	6F/8F	8F + 2HOV
2015	I-15	SR 163	SR 56	8F + 2ML (R)	10F + 4ML/MB
2015	SR 52	I-805	SR 125	4F/6F	6F + 2ML (R)
2015	SR 76	Melrose Drive	I-15	2C	4C
2015	SR 94	I-5	I-805	8F	8F + 2HOV
2015	SR 241	Orange County	I-5	--	4T
2015	I-805	Palomar Street	SR 94	8F	8F + 4ML
2015	I-805	Carroll Canyon Road	I-5	8F	8F + 4ML
2020	I-805	SR 94	I-8	8F	8F + 4ML
2020	I-5	I-5/I-805 Merge	Vandegrift Boulevard	8F/14F	8F/14F + 4ML
2020	I-15	SR 78	Riverside County	8F	8F + 4T
2020	SR 52	I-5	I-805	4F	6F
2020	SR 56	I-5	I-15	4F	6F
2020	SR 67	Mapleview Street	Scripps Poway Parkway	2C/4C	4C
2020	SR 94	I-805	SR 125	8F	8F + 2HOV
2020	I-805	I-8	SR 52	8F	8F + 2HOV
2020	I-805	SR 52	Carroll Canyon Road	8F	8F + 4ML
2020	SR 125	SR 94	I-8	8F	8F + 2HOV
2030	I-5	SR 905	SR 54	8F	8F + 2HOV
2030	I-5	SR 54	I-8	8F	8F + 2HOV
2030	I-5	J Street	Sea World Drive	8F	Access Improvements (2 lanes)
2030	I-5	I-8	La Jolla Village Drive	8F/10F	8F/10F + 2HOV
2030	I-5	Vandegrift Boulevard	Orange County	8F	8F + 4T
2030	I-8	2nd Street	Los Coches	4F	6F
2030	SR 67	Scripps Poway Parkway	Dye Road	2C/4C	4C
2030	SR 78	I-5	I-15	6F	6F + 2HOV
2030	SR 125	Telegraph Canyon	San Miguel Road	4T	8T
2030	SR 125	San Miguel Road	SR 54	4F	8F
2030	SR 241*	Orange County	I-5	4T	4T/6T
2030	I-805	SR 905	Palomar Street	8F	8F + 4ML
2030	I-805	Mission Valley Viaduct		8F + 2HOV	8F + 4ML
2030	I-805	I-8	SR 52	8F + 2HOV	8F + 4ML
2030	SR 75/282	Glorietta Boulevard	Alameda Boulevard	6C	6C+2TU (PE only)
2030	SR 905	I-805	Mexico	6F	8F
2030	SR 94	SR-125	Avocado/Steele Canyon	4F/2C	6F/4C

*selected segments

Source: SANDAG, Regional Transportation Plan Reasonably Expected Revenue Scenario

Abbreviations

- F – Freeway Lanes
- C – Conventional Highway Lanes
- T – Toll Road
- HOV – High Occupancy Vehicle
- ML – Managed Lane
- ML (R) – Managed Lane (Reversible)
- TU – Tunnel

Note: List includes those projects not currently under construction at time of study.

Table 5-4
RTP Transit Projects by Completion Year

Year Built By	Freeway	From	To
2015	Mid-Coast Trolley	Old Town	University Town Center
2015	COASTER Double Track	Carlsbad	Oceanside
2020	SPRINTER Double Tract	Escondido	Oceanside
2020	San Diego Trolley South Line Rehab	San Ysidro	National City
2030	SPRINTER Westfield Expansion	Escondido	Westfield Mall
2030	Mid-Coast Trolley Expansion	UTC	Sorrento Valley
2030	COASTER Rose Canyon Tunnel	Near I-5 and Clairemont	–
2030	COASTER Del Mar Tunnel	Del Mar	–

Figure 5-8
Location of 2030 RTP Projects

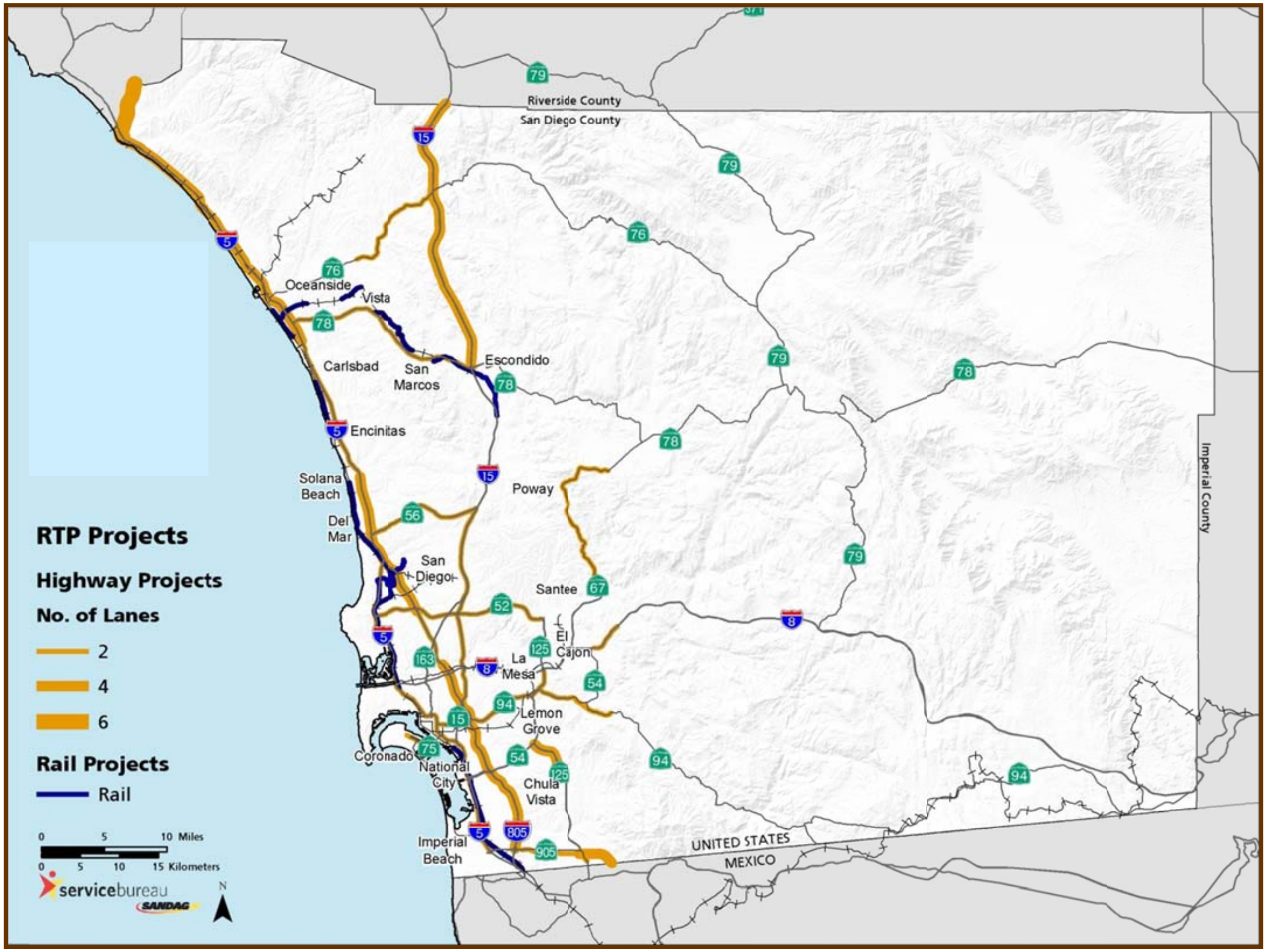
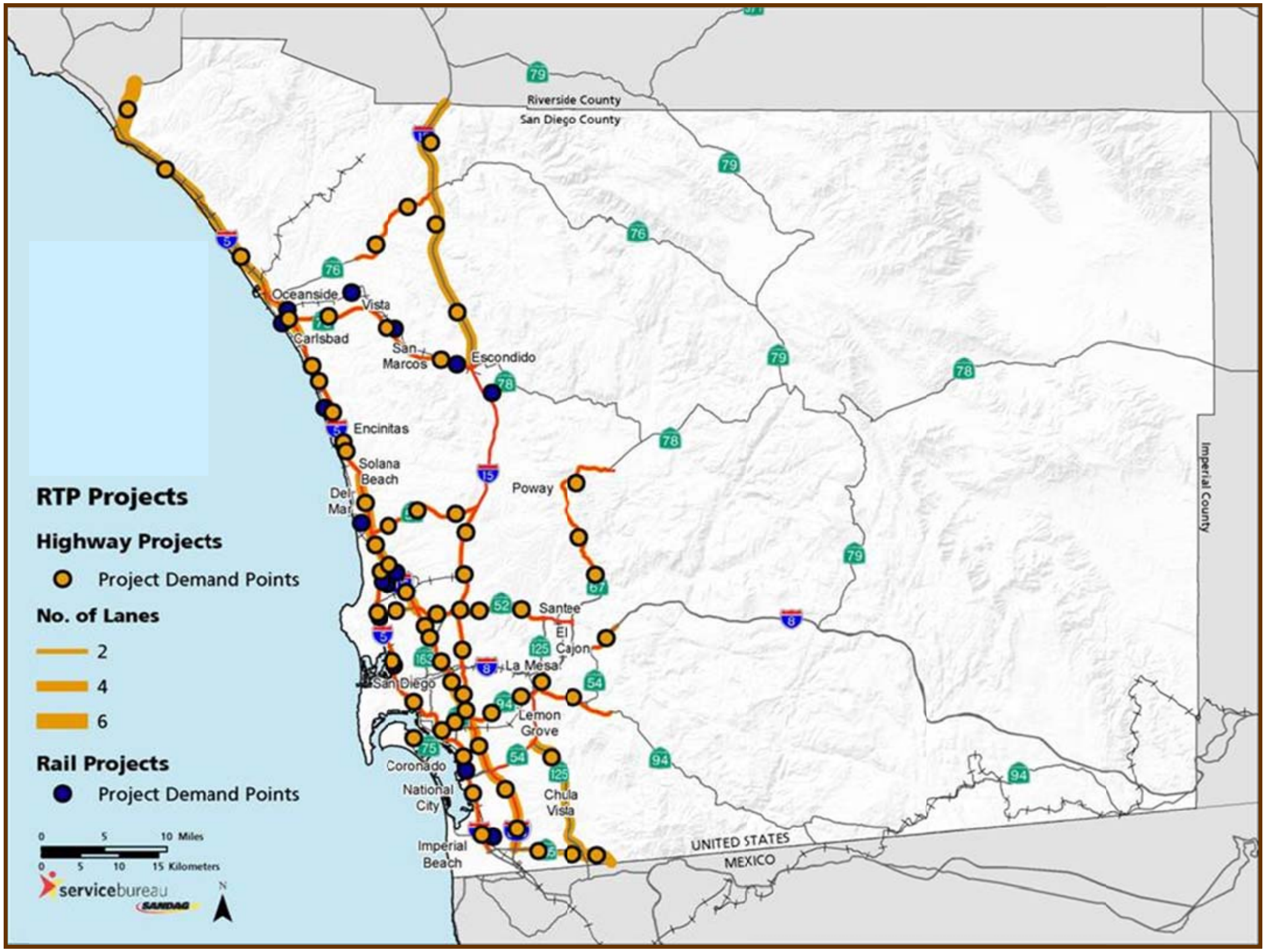


Figure 5-9
Location of RTP Aggregate Demand Points



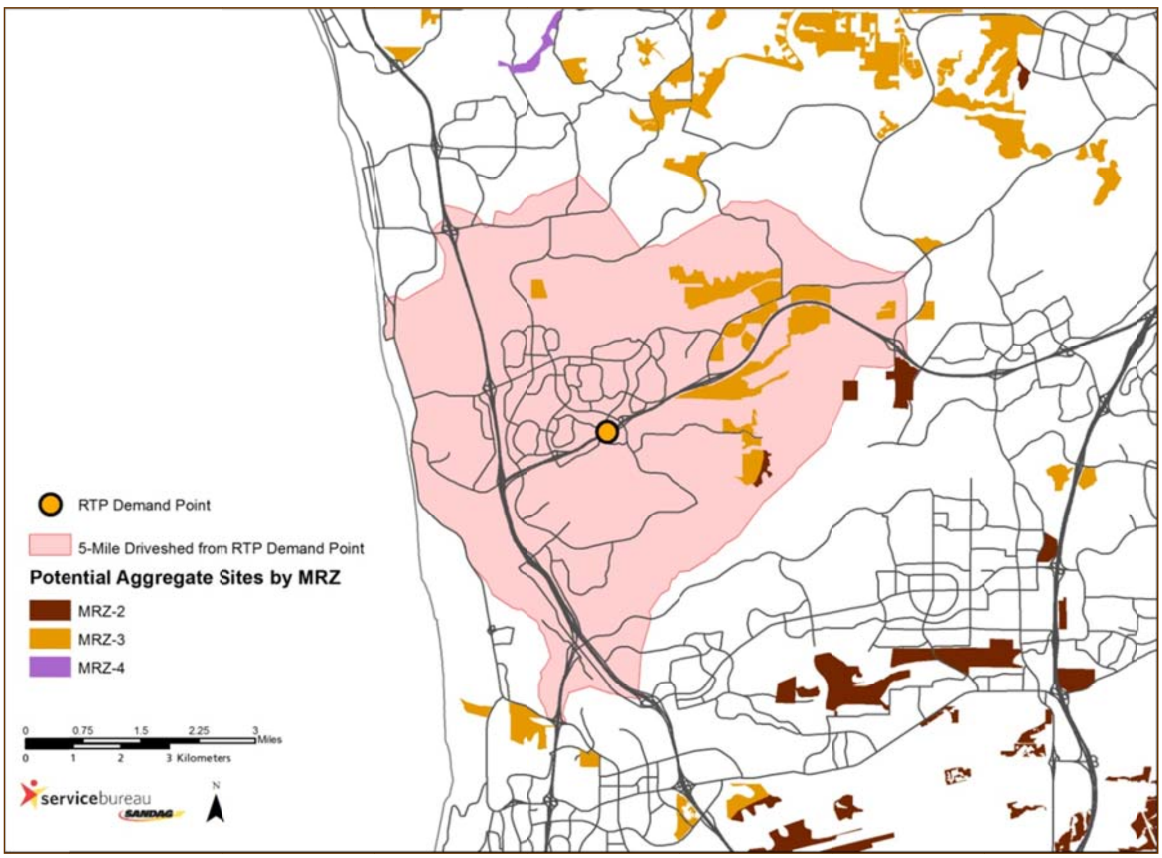
STEP 3: OPTIMIZE DISTANCE BETWEEN DEMAND POINT AND SUPPLY SITE

Potential aggregate supply sites were determined in Step 1. The RTP demand points were determined in Step 2. In Step 3 the model optimizes the driving distances between the potential available aggregate supply sites and the aggregate demand points.

Using ArcGIS Network Analyst, various drivesheds (driving areas) from each aggregate demand point were generated based on the SANDAG road network at 5-, 10-, 15-, 20-, 25-, 30-, 35-, and 40-mile driving distances. Each driveshed defines an area that encompasses all accessible roads, streets, and highways that lie within the specific distance. For instance, the 5-mile driveshed for each RTP project includes all streets that can be reached within a 5-mile distance from that project.

The potential aggregate supply sites were identified for each RTP aggregate demand point in drivesheds at different distances using the INTERSECT tool in ArcGIS. For example, Figure 5-10 shows the 5-mile driveshed for one particular RTP demand point. As shown in the figure, 13 potential sites can reach this RTP demand point within a 5-mile driving distance.

Figure 5-10
5-Mile Driveshed for RTP Demand Point and Potential Sites



Figures 5-11 through 5-18 show the number of potential aggregate sites that could serve each RTP demand point in several drivesheds at established 5-mile increments.

The location of the 77 RTP aggregate demand points is included in each of the figures. At the 5-mile driveshed (Figure 5-11) the dots are small, meaning there are not many aggregate supply sites that intersect with the demand points. As the driveshed is expanded, more aggregate supply sites intersect with the RTP demand points, and the size of the RTP demand points (dots) becomes larger, meaning there are more potential sites that could serve each demand point.

Figure 5-11
Number of Potential Aggregate Sites for Each RTP Demand Point Within a 5-Mile Driveshed

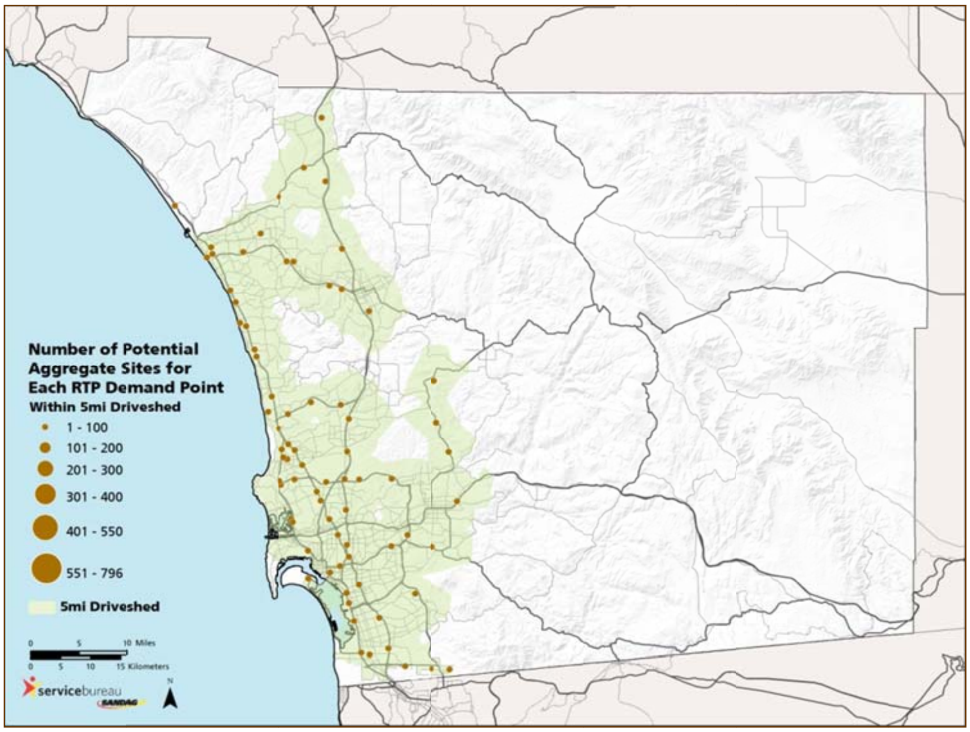


Figure 5-12
Number of Potential Aggregate Sites for Each RTP Demand Point Within a 10-Mile Driveshed

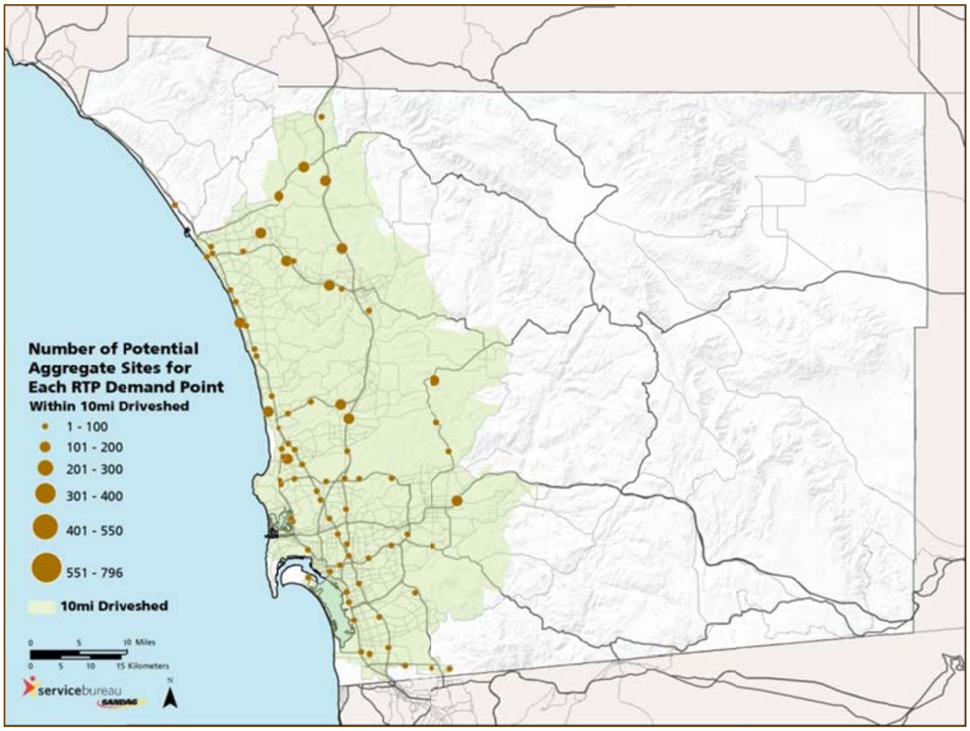


Figure 5-13
Number of Potential Aggregate Sites for Each RTP Demand Point Within a 15-Mile Driveshed

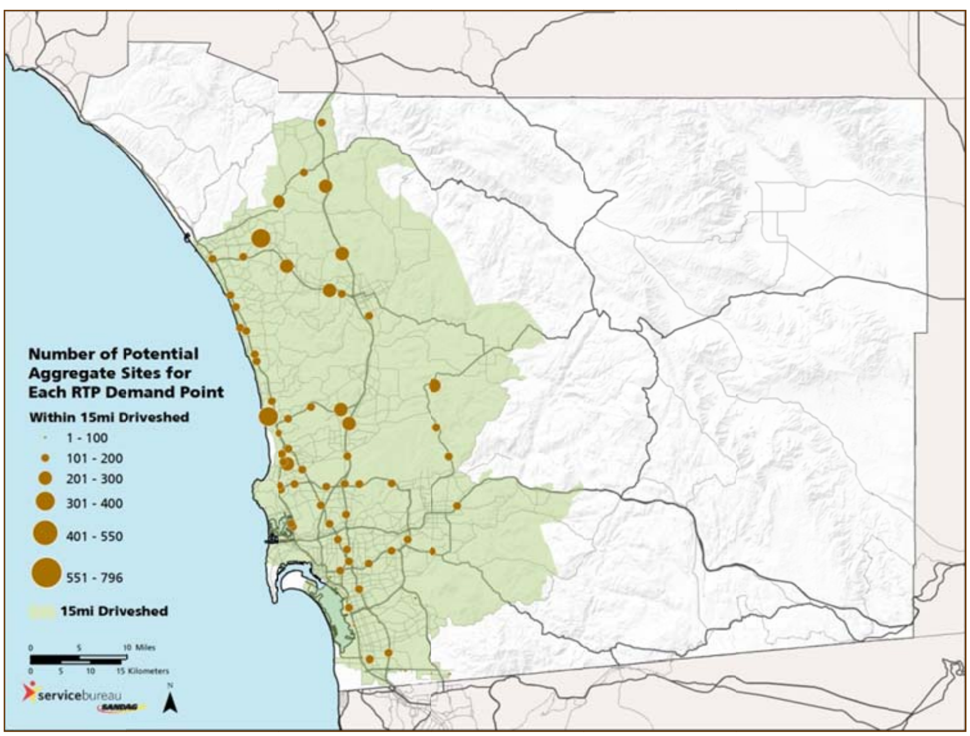


Figure 5-14
Number of Potential Aggregate Sites for Each RTP Demand Point Within a 20-Mile Driveshed

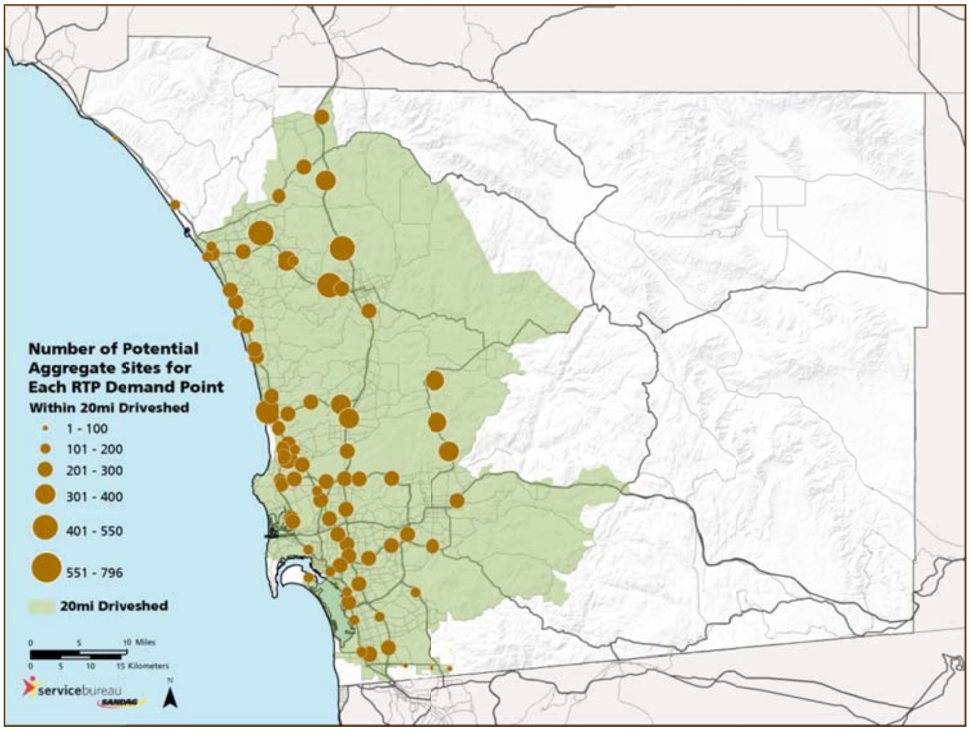


Figure 5-15
Number of Potential Aggregate Sites for Each RTP Demand Point Within a 25-Mile Driveshed

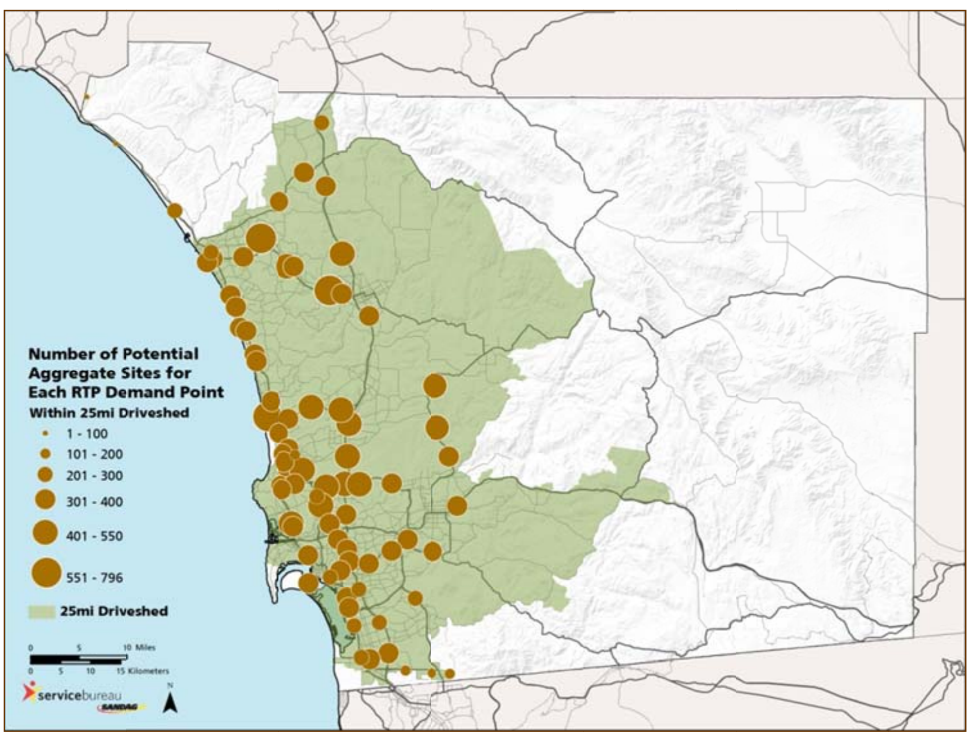


Figure 5-16
Number of Potential Aggregate Sites for Each RTP Demand Point Within a 30-Mile Driveshed

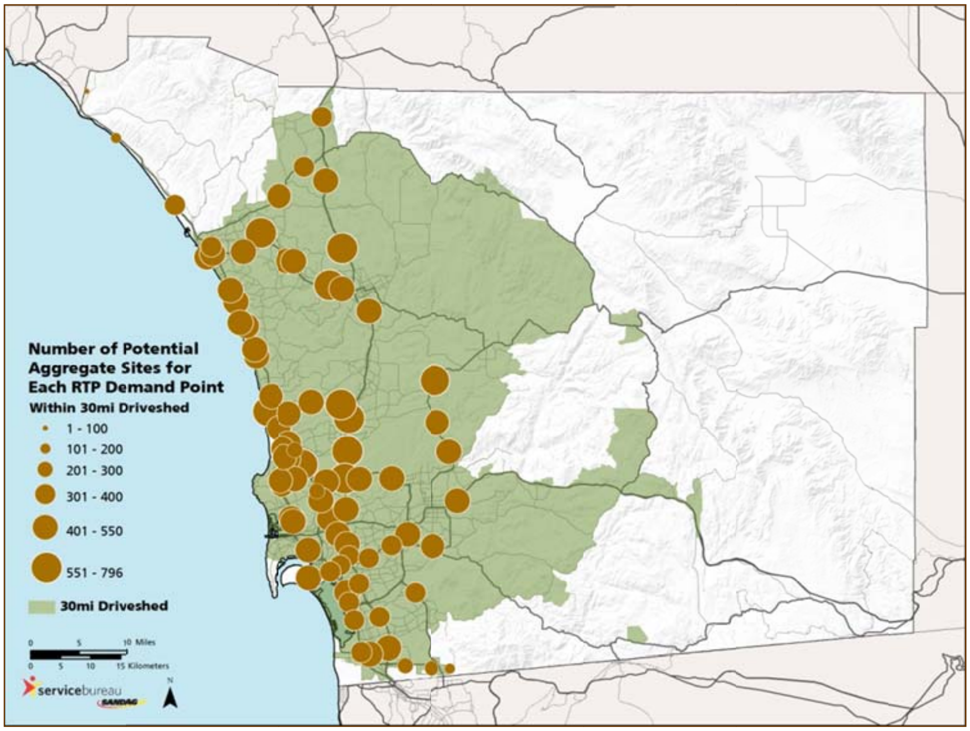


Figure 5-17
Number of Potential Aggregate Sites for Each RTP Demand Point Within a 35-Mile Driveshed

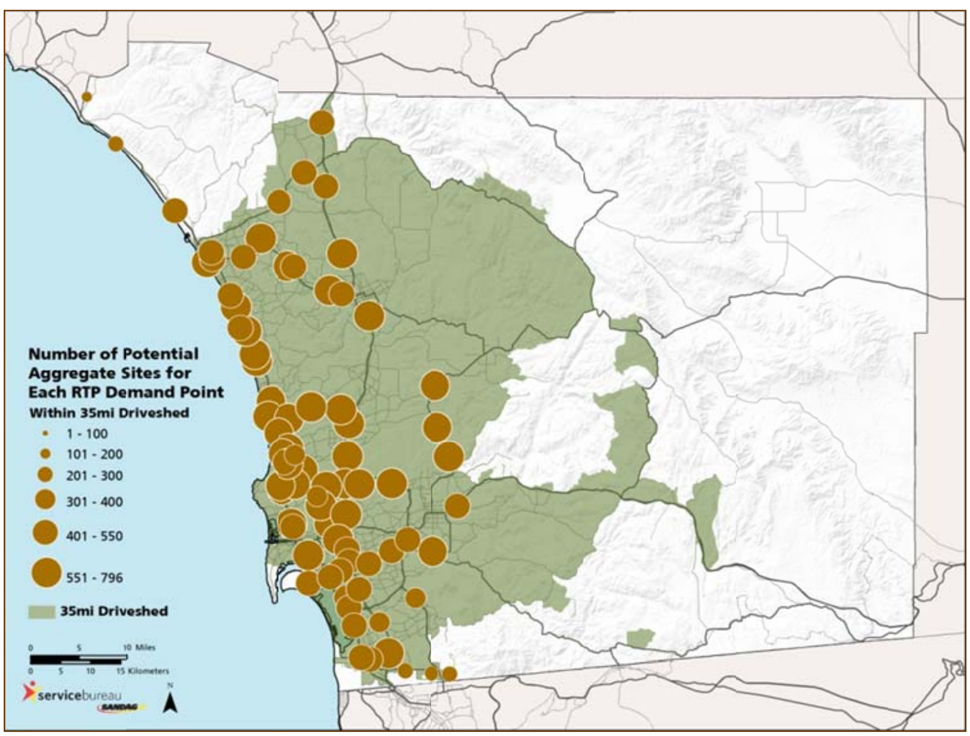
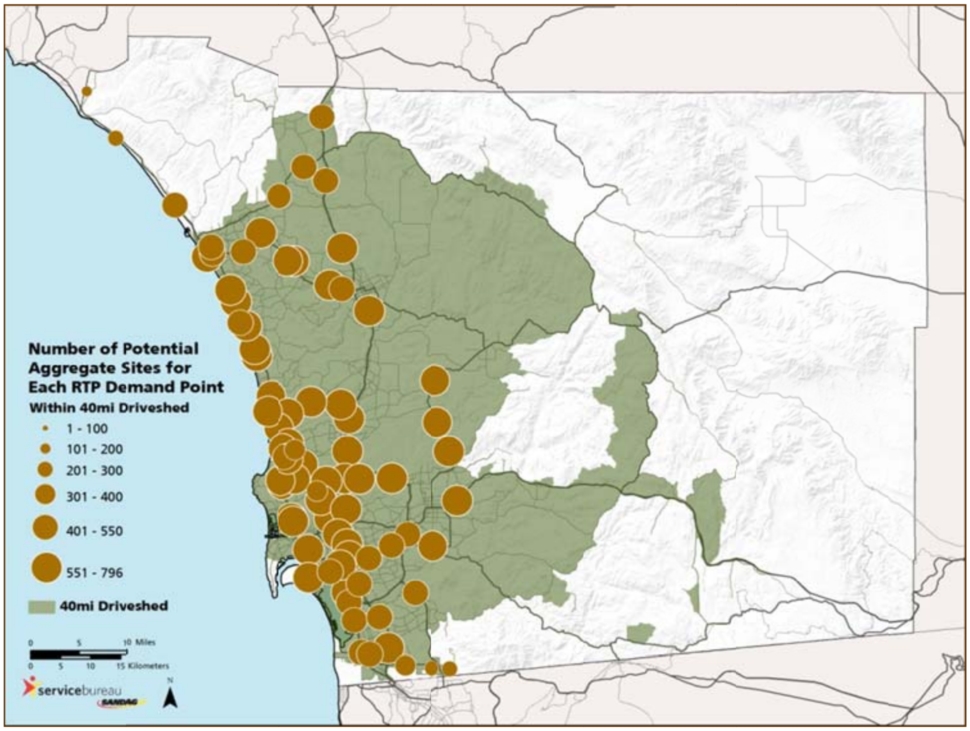


Figure 5-18
Number of Potential Aggregate Sites for Each RTP Demand Point Within a 40-Mile Driveshed

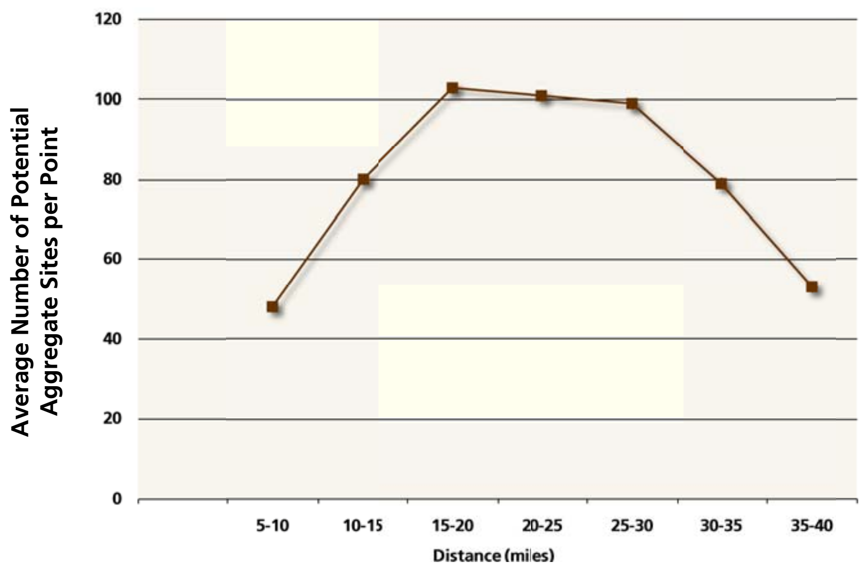


Marginal Benefits

As shown in the previous figures, as the driveshed is expanded, more aggregate supply sites intersect with the RTP demand points. As the driveshed is expanded, the marginal benefit of going out farther increases up to a certain point and then begins to diminish. Determining the point of diminishing marginal benefit is key to identifying the optimal driveshed where the largest number of projects can be served with the least additional distance.

To illustrate the marginal benefit, Figure 5-19 on the next page shows the change in average number of potential aggregate sites per demand point within each driveshed. The slope (rate of change) increases from the 5- to 10-mile driveshed to the 15- to 20-mile driveshed. At the 15-20 mile driveshed, the inflection point is reached, and the rate of increase tapers off slightly. The marginal benefit begins to diminish slightly after the 20-mile driveshed is reached. The marginal benefit of going out another five miles brings diminishing returns rather than increasing returns.

Figure 5-19
Change in Average Number of Potential Sites for RTP Demand Points



Source: SANDAG

The same analysis is repeated separately for the RTP projects scheduled for completion by 2015, 2020, and 2030. This introduces time into the model in addition to distance. Figures 5-20, 5-21, and 5-22 show the change in the average number of potential sites for each demand point for the specific time periods.

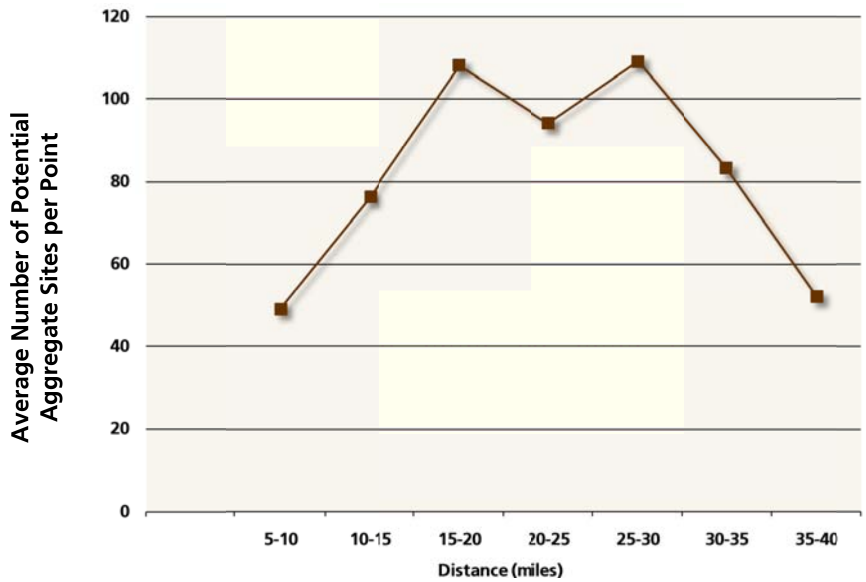
Figure 5-20 shows the results of the analysis for the RTP projects scheduled for completion in 2015. In this analysis the slope for the average number of potential sites reaches the first high point in the 15- to 20-mile driveshed. The slope declines after the 20-mile driveshed and then returns to the previous high point in the 25- to 30-mile driveshed.

In Figure 5-21 for the 2020 projects the greatest change occurs in 15- to 20-mile driveshed. The rate of change remains stable in the 20- to 25-mile driveshed. The slope declines after the 25-mile driveshed.

In Figure 5-22 for the 2030 projects, the maximum rate of change occurs in the 20- to 25-mile driveshed. The marginal benefit falls off after the 25-mile driveshed is reached.

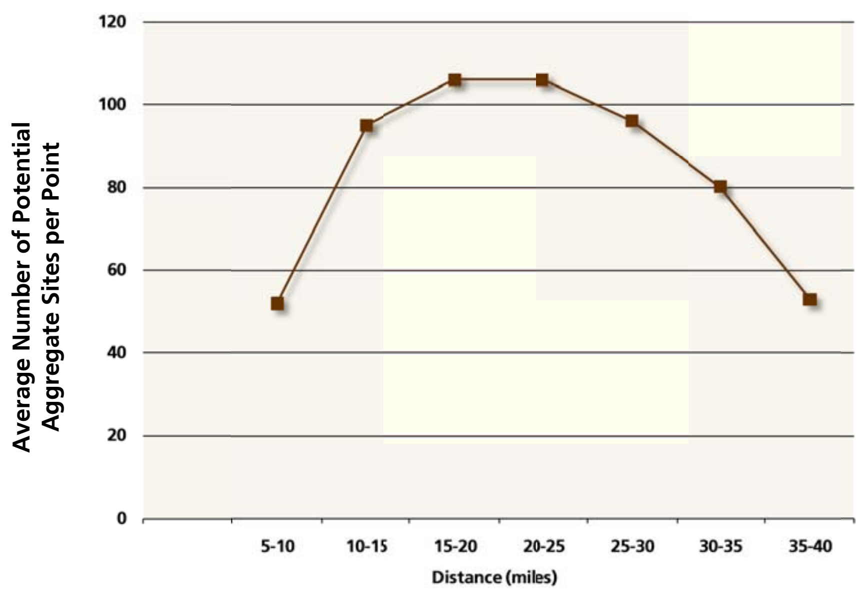
The results are fairly consistent. Each time the optimization analysis is conducted for the RTP demand points, the point of marginal benefits are maximized when the 20-mile driveshed or the 25-mile driveshed is reached. The 20- to 25-mile driveshed encompasses the range of distances in all time periods. The GIS optimization analysis demonstrates that the optimal driving distance between the RTP demand points, and the potential available supply sites occurs in the 20- to 25-mile driveshed. After the 20- to 25-mile driveshed, the number of potential new sites diminishes for increased distance traveled.

Figure 5-20
Change in Average Number of Potential Sites for 2015 RTP Demand Points



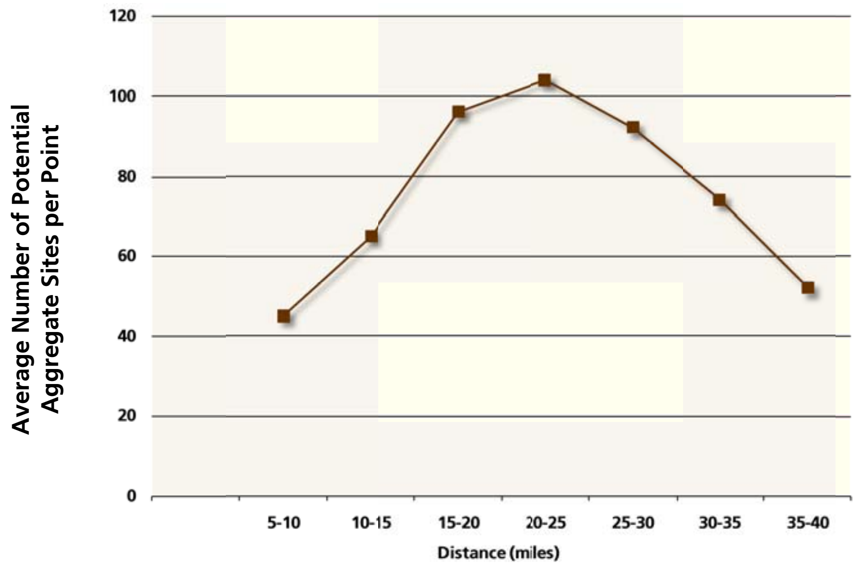
Source: SANDAG

Figure 5-21
Change in Average Number of Potential Sites for 2020 RTP Demand Points



Source: SANDAG

Figure 5-22
Change in Average Number of Potential Sites for 2030 RTP Demand Points



Source: SANDAG

In Step 1 over 1,000 potential aggregate supply sites were identified. The optimization approach uses GIS and marginal benefits analysis to help focus the potential sites to those where the marginal benefits are maximized. The analysis is performed using RTP demands points. The demand points coincide with areas of future population growth, and thus, locations of potential future construction aggregate demand. (This is illustrated in Figure 4-1 in Chapter 4.) Local suppliers participating in the expert review panel commented that a 25-mile travel distance seemed to make sense from an economic standpoint, as well since the cost of aggregate increases if sourced beyond a reasonable distance of about 25 miles.

This optimization exercise reduces the number of potential aggregate supply sites from 1,159 to 788 sites within the 25-mile driveshed.

CHAPTER 6
EXPERT REVIEW PANEL EXPRESSED ISSUES AND EXPRESSED POTENTIAL SOLUTIONS

The San Diego Aggregate Expert Review Panel was established to acquire input and feedback regarding aggregate supply issues, the GIS and optimization analysis, and other technical aspects of the study. The expert review panel includes representatives from different aspects of aggregate, from resource agencies to suppliers and users of aggregate. These representatives identified issues regarding aggregate in light of potential economic, social, air quality, and environmental impacts.

PROCESS FOR OBTAINING INPUT AND FEEDBACK

The expert review panel kick-off meeting was held on January 14, 2010. During this meeting, SANDAG staff informed the participants that feedback and input would be solicited through focus group discussions and a topic-based meeting. The attendees were asked to volunteer for one of four focus groups that were held in February 2010. The focus groups included agencies/organizations of similar interests as follows:

- Environmental/resource agencies
- Local suppliers
- Importers/transporters
- Users of aggregate

A summary of the issues and concerns expressed during the four focus group sessions was organized by key topic areas. This summary was provided as background information and used to generate discussion items for the topic-based meeting. The summary is provided in Figure 6.1, and more details are provided in Appendix F.

Each focus group selected two representatives and one alternate to participate in a topic-based meeting. The topic-based meeting was held on March 4, 2010. Participants representing a cross-section of interests discussed the issues and concerns that were raised at the individual focus groups and contributed new ideas based on the current discussion. The goal of this method was to take key aggregate supply issues identified during the individual focus groups to a topic-specific meeting. At the topic-specific meeting, the individuals representing various interests tried to work together to build pathways to connect these issues and concerns. Part of the approach was for them to listen to the ideas voiced and try to determine where inroads could be made.

A summary of the detailed discussion items is provided in meeting notes included in Appendix F.

EXPRESSED ISSUES

Major Issues Identified During the Focus Group Sessions

The four focus groups were held in February 2010. A number of issues were identified in each of the focus groups. Issues were recorded and then grouped by the common themes below:

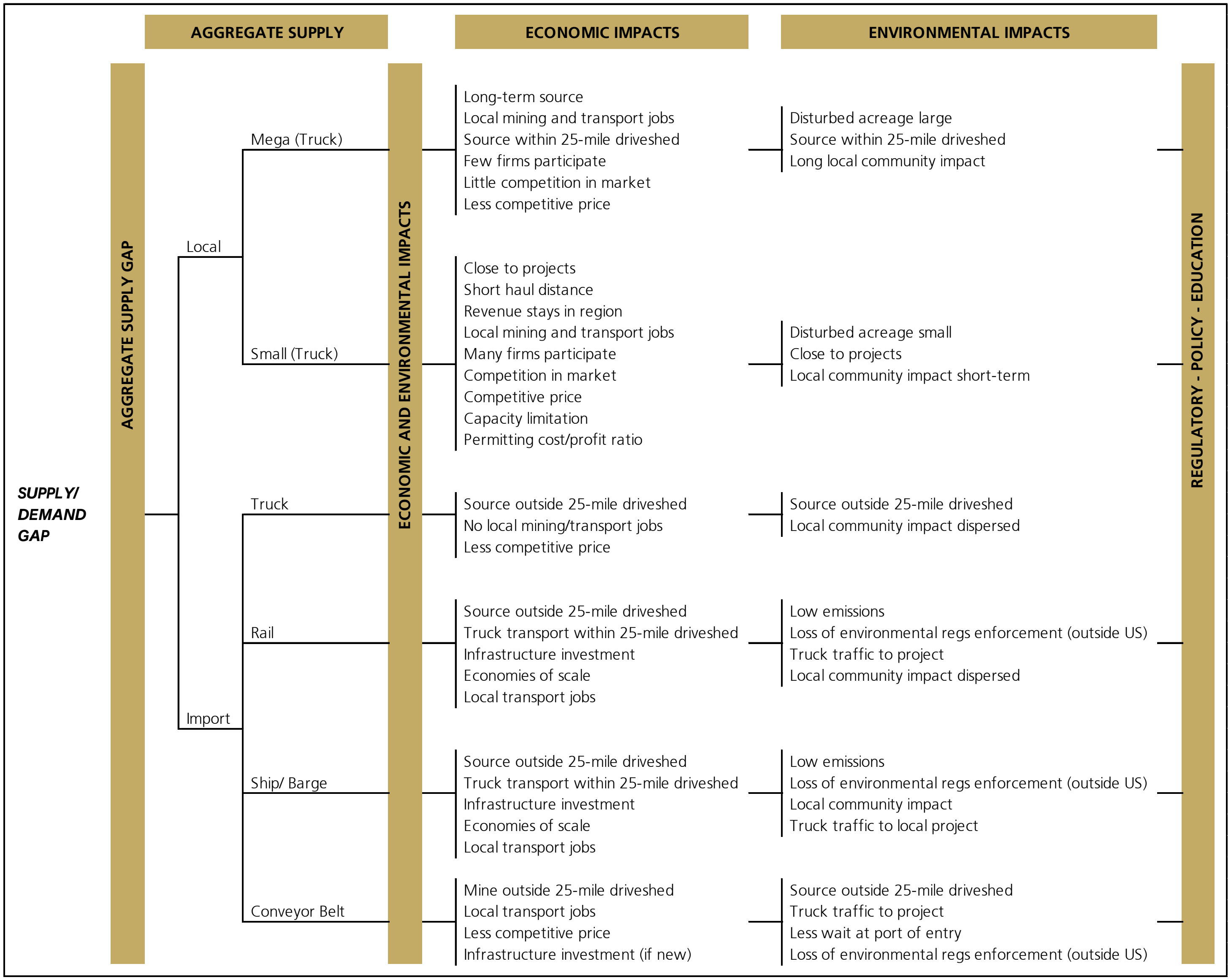
- Supply (supply and demand of aggregate, quality of aggregate)
- Impact (environmental and economic costs, including local community impact)
- Regulatory (permitting process, environmental permitting process)
- Policy (managing aggregate as a strategic asset)

Figure 6-1 illustrates the four themes and related issues. The themes connect vertically and horizontally. The aggregate supply issue is extremely complex. Figure 6-1 is not meant to oversimplify, but rather to build a broad framework within which policymakers can increase their understanding of the key issues.

It is important to note that many concerns and issues were identified during the focus group sessions. While the scope of the study includes documenting the issues surrounding aggregate, it does not include the in-depth analyses and follow-up that would be required to develop potential solutions for resolving many of the aggregate issues. For instance, one key issue that was raised during each of the focus groups was the complexity of the regulatory permitting process. While the environmental regulations are an important vehicle to protect environmental lands and endangered species and habitats, the permitting process itself is perceived to have inherent inconsistencies that cause time delays and increased cost. Further consideration of these issues and a more in-depth discussion about the federal, state, and local regulatory processes for mining aggregate is needed in order to propose specific recommendations for improvement. This is beyond the scope of this study. The study intends to document the concerns raised and compile them into one report so that policymakers and others are more informed about the challenges. The environmental issues are not highlighted in Figure 6-1, but those issues and ideas expressed during the focus groups are summarized in this chapter listed and in more detail in Appendix F.

In addition, the expert review panel emphasized their view that specific policies addressing aggregate mineral resources should be developed as an outcome of this study. Policy recommendations are beyond the scope of this study. However, the study intends to document issues and facts surrounding aggregate in order to help policy makers make informed decisions about the supply of aggregate mineral resources.

Figure 6-1
Summary of Expert Review Panel Expressed Issues



Major Issues Identified During the Topic-Based Sessions

The expert review panel representatives attending the topic-based discussion included at least two individuals from each of the focus groups. While the focus groups included agencies and organizations of similar interests, the topic-based meeting included a cross section of interests. These individuals discussed the issues and concerns that were raised at the individual focus groups and contributed new ideas based on the current discussion. Framing the discussion were the following topics:

- Is a balanced approach with local and import sources the solution?
- How does the region balance growth and environmental concerns?
- What are new strategies to manage the gap between aggregate supply and demand?

Is a balanced approach with local and import sources the solution?

The expert review panel was presented with figures and data on the local supply and demand of aggregate. The information described a shortage that could continue to increase if no new mines or mine extensions/expansions were permitted. The expert review panel agreed that managing this gap is an important issue for the region. From the local suppliers' point of view, the San Diego region contains the mineral resources, including fine aggregates (i.e., sand), to produce enough aggregate to meet the demand if permits could be obtained. The San Diego region accommodated its aggregate needs without importation in the decades before the early 1990s. Twenty-six sand and gravel mines closed since the California Department of Conservation's 1982 mineral classification report was published. Many of these were sand mines in the major rivers (San Luis Rey, San Dieguito, San Diego, Sweetwater, Otay River, and Tijuana River), resulting in a shortage of sand in the region.[1] As existing mines are expected to deplete resources and as mining permits expire, San Diego region will likely be facing a much larger aggregate gap.

According to the local suppliers of aggregate, a slow and complex regulatory process is seen as part of the reason the region is facing shortages. They stated that only one new mine (Rosemary's Mountain) had been permitted in the past 20 years. These same suppliers also feel that although the Department of Conservation identified many lands as containing important mineral resources, these lands haven't been protected to the extent possible in local general plans and are no longer available for mining purposes. Finding suitable lands near population and market areas has become challenging. Importers of aggregate commented that the difficulties obtaining a local mining permit have opened the door to importation.

While there was not unanimous agreement among members of the expert review panel, there did seem to be some agreement that the San Diego region will need both local production and importation of aggregate materials to meet the future needs of the region. It is worth repeating that some representatives strongly emphasized that if access to permits could be obtained, the region could meet all of its aggregate needs without importation. Highlights expressed during the meeting include:

[1] California Department of Conservation, Division of Mines and Geology. (1996). DMG Open-File Report 96-04. Update on Mineral Land Classifications: Aggregate Materials in the Western San Diego County Production-Consumption Region.

- All aggregate material resource types exist in the region, but some materials are located in environmentally sensitive areas, so there are restrictions on extracting it.
- Infrastructure improvements would be needed at the Port of San Diego to enable shippers to import large volumes of aggregate materials into the San Diego region. The volume could be approximately two million tons per year. It is important to note that waterfront activities impact the local community, especially trucks passing through local neighborhoods. Infrastructure improvements that minimize the local community impact are an important part of this supply option. (A dredging project was completed recently so the water depth at Tenth Avenue Marine Terminal could be able to accommodate direct offloading of aggregate from ships.)
- Although the San Diego region has two rail yards (San Diego Rail Yard, near the Tenth Avenue Marine Terminal and San Ysidro Rail Yard, near the U.S.-Mexico International Border), it lacks a rail distribution facility for receiving and handling aggregates and other commodities. It was noted that a rail distribution center should be located within the optimized 20- to 25-mile driveshed. It was indicated that although an ideal site for a rail distribution center is 100 acres, an efficient center could be designed on a 20- to 40- to 60-acre site along a main line. Infrastructure improvements would be needed for the option to be realized. The volume could be approximately one million tons per year.

How does the region balance growth and environmental concerns?

The expert review panel agreed that it is important to plan for growth in the region and to do so in an environmentally responsible way. There is an understanding that the environmental regulations are important to protect communities, habitat, and species. However, frustration was expressed about what some representatives considered to be a lack of a standardized approach to the permit process.

The expert review panel noted that the time and cost required to comply with environmental regulations contributed to the development of very large mines in this region (mega mines). Larger firms (national or international firms) have monetary resources to endure a multiyear permit process. If a firm is going to invest a large amount of money to get a permit, then the expectation is that the mine will be operational for a long period of time in order to recoup costs and generate profits. The expert review panel stressed that long and challenging permit processes make it difficult for the smaller mines to establish a new site. It was noted that permitting difficulties/costs are a deterrent to establishing smaller sites, but standardized regulatory processes could help make smaller sites economically feasible.[2] A better understanding of the permitting process and how private sector and resource agencies could coordinate may lead to more certainty in the outcome.

[2] The expert review panel used the following definitions for the size of a mine: Generally speaking a small mine yields less than 500,000 tons/year, a medium mine yields 500,000 to 1½ million tons/year, and a large mine yields 1½ million tons/year and greater.

Highlights expressed during the meeting are listed below:

- Managed production of fine aggregate sites could help satisfy local demand and be done in such a way that it also could benefit the environment. Alluvial deposits along rivers and streams are a key source for fine aggregates. These areas also may be considered environmentally sensitive areas. There are examples around the state and nation of managed resource plans where extraction and restoration work together to benefit communities and the environment. These types of plans could offer ideas for solutions in this region.

- Extraction of sand from the reservoirs could be an opportunity if the sand is the right type and the habitat could be protected. It was mentioned that El Capitan Reservoir could have several million tons of sand. The extraction of sand from the reservoir could benefit the region by expanding the capacity of a water resource. The challenge would be working together to extract the sand, protect the habitat, and increase the region's water supply.

- Limited staffing and resources of the regulatory agencies is a challenge. It was emphasized that regulatory agencies, such as the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, California Department of Fish and Game, and Regional Water Quality Control Board, should be fully engaged in the process and work through the pre-design process together with industry. However, limited resources often prevent this from occurring. For instance, the federal resource agencies are obligated to review projects to determine compliance with the National Environmental Policy Act (NEPA). They may not have sufficient staffing level to also review local agency and California Environmental Quality Act documents earlier in the process. So, a project often gets all the way to the NEPA stage without any type of review by federal resource agencies, and then concerns are identified.

- State and local public agencies have the ability to enter into reimbursable contracts with regulatory agencies to ensure their projects receive timely environmental review. There is no method for resource agencies to enter into similar agreements from private parties to facilitate early and ongoing review.

What are new strategies to manage the gap between aggregate supply and demand?

The expert review panel suggested a variety of strategies that could be considered for future exploration. Highlights expressed during the meeting are listed below:

- ***Public Education and Outreach***

  - Increase understanding of the impacts (both positive and negative) of improving freight-related infrastructure in order to develop policies and services that address relevant economic and environmental concerns.

  - Increase public awareness of the trade-offs and impacts when importing aggregate into the region, including the increased cost, which could affect people's attitude about local aggregate operations and lead to more acceptability of aggregate mines.

  - Highlight examples of successful mine reclamation efforts so the public can imagine what "could be" after a mining operation closes.

- Provide facts about the need for aggregate and implications of alternate supply sources that local leaders and decision makers could cite when addressing community concerns about the opening or expansion of mines or the infrastructure improvements for importation.
- Engage users of aggregate, including state and local government, to offer support by speaking about the need for and importance of aggregate in the region (not targeted toward a specific project, but general need for aggregate).
- Consider and increase the use of recycling as an important source of base materials for freeway construction projects and other projects.

Resource Management

It was suggested that a systematic and comprehensive approach could help streamline the permit process and help ensure that planning for the region's aggregate needs is done in a responsible way (e.g., protects environmental lands and communities). Various types of resource management plans were discussed.

- Explore the creation of a mineral resource management plan for the region, similar to the multiple habitat conservation plans under development in the region. This approach could identify lands containing high-quality construction aggregate and plan for managing it as a strategic asset. This could include lands that already have been officially classified as MRZ-2 and also other lands identified through this study and/or other efforts.
- Explore the possibility of developing a broader comprehensive approach that addresses both local supply and importation of aggregate. It could benefit the region to view the supply of aggregate as a regional system—not project by project. This type of approach could involve the resource agencies early on, and it could include various techniques like a programmatic environmental impact report. (The San Diego County Water Authority did this successfully presenting water management as a system.) Another example that was mentioned was a specific area management plan (SAMP). A SAMP is a comprehensive plan designed to achieve a balance between economic development and aquatic resource protection. It was indicated that an effective SAMP could reduce problems associated with the traditional case-by-case review and involve the federal regulatory agencies during the initial stages.

Streamline the Permitting Process

- Consider opportunities for streamlining the permitting process. For instance, jurisdictions or other government entities may consider using the GIS overlay analysis and tools developed through this study as a starting point to establish mineral resource layers and offer a streamlined permitting process for new mines or mine extensions that are located within them. The current model does not take into consideration local zoning, topography, or other factors that jurisdictions could incorporate. In addition, some representatives from the environmental agencies noted that from a resource management standpoint, the expansion of existing mines and the extension of existing permits likely have fewer negative impacts to the environment and, therefore, could be more desirable than establishing new mines. Regulatory agencies expressed a willingness to consider a streamlined permitting process to facilitate the expansion of existing mines.

- Consider researching the viability of establishing smaller aggregate sites within local market areas that might be easier for the public to accept. These small mines could require fewer trucks and a shorter life span (two to ten years). Restoration may be less complicated because of the smaller size. A streamlined permit process could be developed for those mines willing to operate for a shorter time period. It is important to note that more research is needed to determine if small mines would be economical for the operator as the cost of permitting and capital equipment are high. It was mentioned that it could be possible to tie this to future transportation or other development projects (e.g., to mine the area according to a grading plan for the future development).

EXPRESSED POTENTIAL SOLUTIONS

The expert review panel suggested further exploration and/or consideration be given to the following ideas:

- Explore the mutual benefits sand extraction could have on the environment in the long run when using specific extraction methods. It may be possible to meet sand needs while improving habitat along the rivers in the region. The expert review panel suggested that examples of successful resource management plans exist and may offer ideas for balancing environmental and industrial resources.

- Explore the creation of a mineral resource management plan for the region, similar to the multiple habitat conservation plans under development. In these plans high-priority habitat areas are designated and protected, while urban development is allowed for less-sensitive areas in accordance with guidelines established in the plans. The expert review panel suggested that a similar type of comprehensive, long-term plan for the protection of mineral resource lands may be an important consideration.

- Explore opportunities for collaboration. Despite what could at times seem like opposing interests, opportunities for collaboration exist. The expert review panel suggested that by developing a resource management plan, industry, government, and regulatory agencies could better plan together for the benefit of future generations and mitigate potential future harmful effects that could threaten the region's natural environment, quality of life, and the health of its residents.

- Explore ways for government and industry to work together to increase public outreach and education on the need for and supply of aggregate.

- Work toward improving understanding and communication between industry and regulatory agencies. Increased understanding by industry of what the regulatory agencies need in the permitting process may lead to more certainty in the outcome. For example, sometimes when a permit for a mine is submitted, a resource agency might comment that the applicant didn't look at enough sites. A reasonable range of locations should be considered for the mine that minimizes adverse environmental disturbances. Regulatory agency staff emphasized that permit applications need to be high quality, with adequate baseline information provided for consideration during the permitting process.

- Look for opportunities to expand existing mines or extend existing permits. Environmental agencies noted that the expansion of existing mines had fewer negative impacts to the environment and, therefore, could be more desirable than establishing new mines. Regulatory agencies expressed a willingness to consider a streamlined permitting process to facilitate the expansion of existing mines.

CHAPTER 7
CASE STUDIES AND SCENARIOS—USING THE TOOLS

One of the objectives of this study is to develop a geographic information system (GIS) mapping and analysis tool that could be used by other regions and local governments facing aggregate supply shortages. A standard GIS overlay tool offers a starting point to help local governments focus their efforts on potential aggregate supply areas. It is important to note that while GIS mapping and analysis provides an important baseline tool; it is understood that additional groundwork will be required for site-specific suitability and aggregate quality analysis. This chapter presents various ways of using the GIS tool. In all cases presented in this chapter, the user must go to the next level and examine local zoning and set back requirements, slope of available land, the presence of natural habitats and species, the economic viability of the site, and other local factors.

CONSIDERATIONS FOR USING FUTURE *TransNet* MITIGATION LANDS AS POTENTIAL SUPPLY OF AGGREGATE

The *TransNet* Extension Ordinance and Expenditure Plan, approved by the voters of the San Diego region in November 2004, includes the Environmental Mitigation Program (EMP), which provides funding to mitigate habitat impacts from regional transportation projects by directing transportation project mitigation land purchases to areas that are designated as open space preserves in the region's habitat conservation plans. The EMP includes a funding allocation for habitat acquisition to offset the direct impact on upland and wetland habitat from regional and local transportation projects. The early acquisition of land for multiple projects allows large blocks of land to be acquired in advance of the traditional, project-by-project mitigation. The funding allocation also includes management and monitoring activities to help implement the regional habitat conservation plans. The allocation is tied to mitigation requirements and the environmental clearance approval process for projects outlined in the Regional Transportation Plan (RTP).

All areas of the San Diego region have been included into one of four habitat conservation plans. The Multiple Species Conservation Program (MSCP) South was adopted in 1997, covering the southern portion of the region. The Multiple Habitat Conservation Program (MHCP), completed in 2003, covers the seven jurisdictions in the north coastal San Diego region. Two plans are being prepared in the unincorporated areas of the region: the MSCP North, covering the inland areas of northern San Diego County, and the MSCP East, which extends east to the San Diego/Imperial counties border. These habitat plans provide the policy framework that allows the jurisdictions to identify how their local land use authority will be used for the continued preservation of open space and natural resources in the San Diego region.

Under the *TransNet* EMP guidelines, SANDAG and California Department of Transportation (Caltrans) staff will pursue mitigation opportunities consistent with the strategies agreed to by SANDAG, Caltrans, U.S. Fish and Wildlife Service, and California Department of Fish and Game. Existing criteria for *TransNet* EMP mitigation are as follows:

- **RTP Mitigation**: The property will satisfy one or more RTP projects as identified in *TransNet* EMP memorandum of agreement (MOA). Mitigation opportunities to meet other RTP project and local street and road projects will be considered under the term of the MOA. Certain assurances by the environmental regulatory agencies will be met.

- **Jurisdictional Land Use Plans:** Use of the site as habitat mitigation/open space is consistent with the long-range land use and transportation policies of the local jurisdiction or the jurisdiction does not object to the site being purchased for mitigation.

- **Willing Seller:** Owner of the property is a willing seller with clear title to the property, and any hazardous material identified in a Phase I environmental site assessment has been evaluated and addressed.

- **Appraisal:** The property must be appraised by a qualified, licensed appraiser in accordance with established acquisition and appraisal standards, and the first written offer will reflect the fair market value of the property.

- **Promotes Natural Community Conservation Plan (NCCP):** The proposed mitigation will contribute to the success of the San Diego regional NCCP by acquiring and restoring unique habitat areas, key populations of endangered species, and lands adjacent to existing conserved habitat lands by promoting wildlife linkages with the goals of establishing mitigation ratios in subsequent agreements pursuant to the adopted habitat conservation plans.

- **Owner/Manager:** Perpetual ownership of the land has been identified, as well as a qualified land manager. The identified owner is willing to provide a conservation easement or deed restriction to SANDAG or Caltrans upon transfer of title that contains a reversionary clause back to SANDAG or Caltrans if the land is not being managed and monitored pursuant to a resource management plan acceptable to the wildlife agencies. SANDAG, Caltrans, and the land manager have agreed upon the annual cost to manage the land and the method for funding the annual management costs.

This study explored the use of future *TransNet* mitigation lands as potential supply of aggregate. A list of factors was developed to consider the possibility of aggregate supply as a secondary result when mitigation lands are purchased. Although the EMP program is specific to SANDAG and the San Diego region, the considerations are broad and could be used by other agencies engaged in purchasing mitigation lands.

SANDAG staff consulted with the expert review panel to understand the parameters that should be considered when evaluating secondary benefits of aggregate supply. The expert review panel included environmental resource agencies, such as the U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, and U.S. Fish and Wildlife Service. Two scenarios were discussed during the expert review panel focus group meetings that included the above-mentioned agencies, as well as representatives from Caltrans, San Diego Endangered Habitats League, California Air Resources Board, and California Geological Survey. In addition, the scenarios were reviewed in separate focus groups of local suppliers of aggregate, importers/transporters of aggregate, and users of aggregate. Insight and feedback were used to develop a list of factors that could be used for considering opportunities to increase aggregate supply when purchasing mitigation lands through the SANDAG EMP.

When considering the purchase of a property for mitigation, SANDAG may wish to consider the following factors identified by the expert review panel to determine if there are opportunities for increasing the regional supply of aggregate as a secondary consideration when purchasing or restoring mitigation lands.

Under what conditions could this occur?

- **On a Case-by-Case Basis:** As SANDAG seeks opportunities to secure lands for conservation, it could consider if there is a potential for increasing the region's supply of aggregate. Decisions would be case-sensitive.
- **Pristine or Disturbed Habitat Land:** Is the desired mitigation land considered to be "disturbed?" Disturbed in this sense means altered from its original or a naturally functioning condition. If so, the land may require restoration to return the land to a previously functioning state and in so doing, there may be possibilities for increasing aggregate supply in the restoration process. Questions to ask include:
  - Is the land in a natural state?
  - Does the land suffer from natural or human disturbance that limits environmental processes?
  - Would grading and/or removal of aggregate sand and gravel restore the area to previously functioning natural state?
  - Would grading and/or removal of aggregate sand and gravel on lands cause a negative environmental impact?
- **Project Purpose:** All elements of the project must be specified in the project purpose. Questions to ask include:
  - Does the project purpose specify restoration?
  - Is the aggregate extraction needed for the project?
- **Other Considerations:** Topography, geology, and other site-specific factors also must be considered, particularly the biological resources of the area. Related questions include:
  - What types of natural vegetation communities are present?
  - What plant species does the area support? Are they natural or exotic? Are they special status species (i.e., listed as threatened, endangered, candidate or of special concern by the federal government or State of California)?
  - What animal species does the area support? Are they native or nonnative? Are they special-status species?
  - Is the area a biological resource core area? Is it part of a regional linkage or corridor?
  - Are there jurisdictional wetland or nonwetland waters (i.e., within the jurisdiction of the U.S. Army Corps of Engineers)?
  - Are there vernal pools present?

Not all actions require mitigation. If the action has no adverse environmental impacts, no mitigation is necessary. Lands meeting the above-mentioned factors could be consistent with the *TransNet* EMP strategy, and the use of *TransNet* mitigation dollars for purchasing and/or restoring the land may be appropriate.

This topic was discussed in the expert review panel focus group meetings with local suppliers, users of aggregate, and importers and transporters of aggregate. An evaluation of the economic feasibility of the situation would need to be considered to determine if this could be a viable opportunity from the local mining operators' perspective. The focus group participants indicated that the following factors should be considered:

- **Quality of Materials:** Material to be extracted is either usable in the existing or a nearby project or suitable for sale. Materials used in state transportation projects must meet Caltrans' aggregate specifications.

- **Storage and Processing of Materials:** Materials could be processed and stockpiled at the site as transporting back to the mine could be cost prohibitive. The extraction of materials, if used in a state or local government project, could be subject to SMARA regulations and require the operation to be on the Assembly Bill 3098 list and meet the necessary provisions. This would be an important factor to consider as it could mean the operation may need a mining permit and an approved reclamation plan, which could be a time-consuming process.[1]

- **Long-Term Perspective:** The demand for aggregate is market driven, so a long-term perspective of at least ten years is needed.

- **Economical:** The situation would have to make sense economically for the mining operator. Proximity to local roadways and quality and marketability of materials should be taken into account.

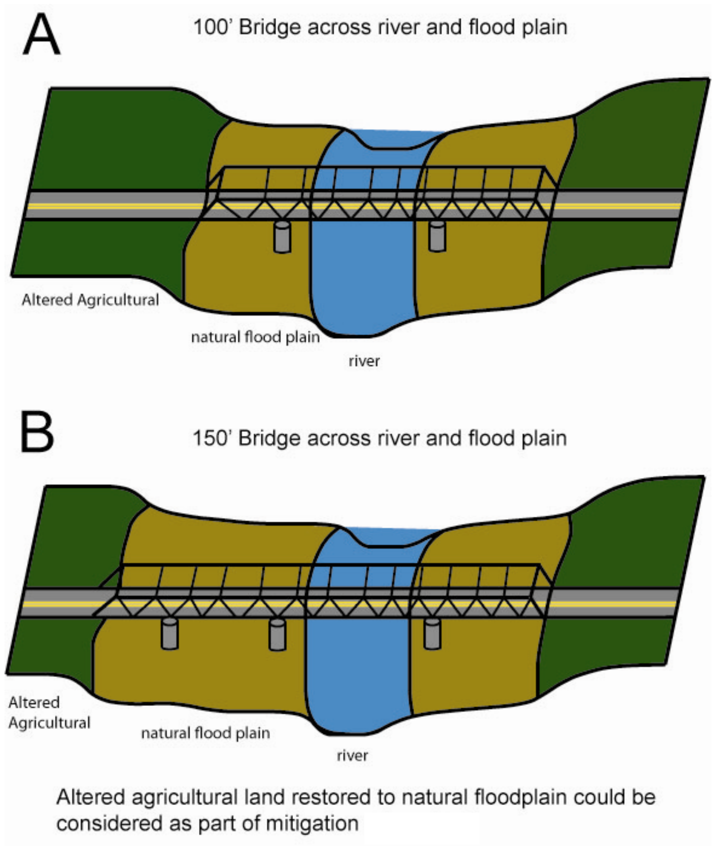
Two hypothetical situations were discussed during the expert review panel focus groups to illustrate policy implications: a Riverbed Opportunistic Scenario and an Upland Opportunistic Scenario. It is important to note that the following discussion focuses on environmental considerations. An evaluation of the economic viability of the situation would need to be considered before any conclusions could be drawn.

Riverbed Opportunistic Scenario

The project purpose is to expand the bridge and restore the flood plain. The bridge spans a river and flood plain. Land surrounding the bridge has been altered by agricultural uses. In order to expand the bridge, the project requires some of the altered land to be removed. In addition, sediment is removed to restore the flood plain to a previous natural state. Aggregate materials could be used in the project and the surplus used to supplement regional supply.

[1] Assembly Bill (AB) 3098 list includes all mining operations that are authorized to sell sand, gravel, aggregates or other mined materials to state or local agencies. Mining operations included on the list must have an approved reclamation plan and financial assurances (or an appeal pending with respect to the reclamation plan and financial assurances). The Department of Conservation, Office of Mine Reclamation publishes this list.

Figure 7-1
Riverbed Opportunistic Scenario



Factors to consider when determining if there are opportunities for increasing the regional supply of aggregate as a secondary consideration when purchasing or restoring mitigation lands include:

- Pristine or Disturbed Habitat Land

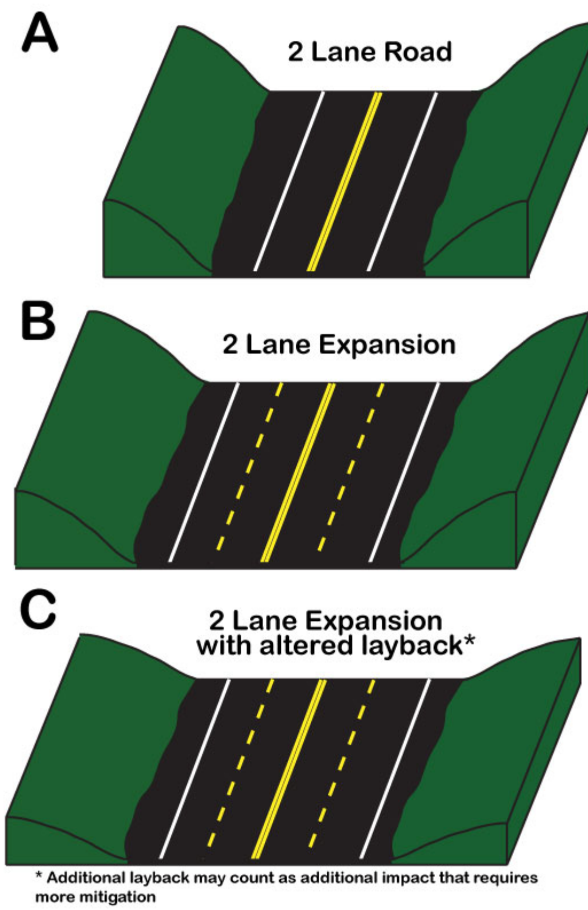
1. Is the land in a natural state?	☐ Yes	☒ No
2. Does the land suffer from natural or human disturbance that limits environmental processes?	☒ Yes	☐ No
3. Would grading and/or removal of aggregate sand and gravel help restore the area to previously functioning natural state?	☒ Yes	☐ No
4. Would grading and/or removal of aggregate sand and gravel on the land cause an adverse environmental impact?	☐ Yes	☒ No

- Project Purpose
  1. Does the project purpose specify restoration? ☒ Yes ☐ No
  2. Is the aggregate extraction needed for the project? ☒ Yes ☐ No
- Biological Resources
  1. Are sensitive species present? ☐ Yes ☒ No
  2. Are the vegetation communities and/or geology known to support sensitive species? ☐ Yes ☒ No
  3. Are vernal pools present? ☐ Yes ☒ No

Upland Opportunistic Scenario

The project purpose is to expand the freeway. The project is a two-lane expansion of a freeway (A) to freeway (B). One may want to lay back the slope even flatter (C) and use the aggregate in the project.

Figure 7-2
Upland Opportunistic Scenario



Factors to consider when determining if there are opportunities for increasing the regional supply of aggregate as a secondary consideration when purchasing or restoring mitigation lands include:

- Pristine or Disturbed Habitat Land
  1. Is the land in a natural state? ☒ Yes ☐ No
  2. Does the land suffer from natural or human disturbance that limits environmental processes? ☐ Yes ☒ No
  3. Would grading and/or removal of aggregate sand and gravel help restore the area to previously functioning natural state? ☐ Yes ☒ No
  4. Would grading and/or removal of aggregate sand and gravel on lands cause a negative environmental impact? ☒ Yes ☐ No
- Project Purpose
  1. Does the project purpose specify restoration? ☐ Yes ☒ No
  2. Is the aggregate extraction needed for the project? ☐ Yes ☒ No
- Biological Resources
  1. Are sensitive species present? ☐ Yes ☒ No
  2. Are the vegetation communities and/or geology known to support sensitive species? ☐ Yes ☒ No
  3. Are vernal pools present? ☐ Yes ☒ No
  4. Are there jurisdictional wetland or non-wetland waters? ☐ Yes ☒ No

Discussion of Scenarios

In the Riverbed Opportunistic Scenario, the project requires the removal of some agricultural land. The aggregate materials extracted would be used in the bridge expansion project, and grading/dredging for the project would result in helping to restore the area to its previously functioning state as a flood plain. The Clean Water Act, National Environmental Policy Act, and California Environmental Quality Act (CEQA) require that potential adverse environmental impacts be avoided, minimized, or mitigated (in that order). In this case, the impact would be positive so the expansion of the bridge would not require additional mitigation.

In the Upland Opportunistic Scenario, the project purpose does not specify additional grading for layback in a pristine area. The additional layback to the slope to obtain more aggregate would be considered an additional impact requiring mitigation.

Expert review panel representatives suggested that if the project purpose specified freeway expansion and provided aggregate to supplement the regional supply and if the extra layback would be the least environmentally damaging alternative for obtaining aggregate (compared to transporting aggregate from another location, for example), and would be in the public's best interest, then the project could potentially proceed. These decisions would need to be determined on a case-by-case basis.

The above-mentioned factors could be considered when evaluating aggregate supply possibilities when purchasing mitigation lands; however, the economic viability from the operator standpoint should be taken into consideration as well.

CASE STUDY: USING GIS TOOLS TO IDENTIFY FUTURE *TransNet* MITIGATION LANDS AS POTENTIAL SUPPLY OF AGGREGATE

According to the Department of Conservation, the highest-priced aggregate in California is in the San Diego area where portland cement concrete (PCC)-grade sand is in very short supply.[2] So there is a need to identify sources of aggregate sand. This study explores an opportunity for linking an existing effort, such as buying and restoring of mitigation lands as in the *TransNet* EMP, with efforts to identify potential areas for aggregate sand. Although the *TransNet* EMP is specific to the San Diego region, the approach used in the case study can be repeated in other California regions to test similar scenarios.

Figure 7-3 illustrates the flowchart outlining the case-study approach. The case study builds on the GIS standard overlay analysis. It uses the GIS overlay model to identify areas that may be suitable for mitigation lands and that also may be suitable for sand extraction if needed as part of a restoration process. The GIS layers and filters used in the case study area:

- Include California Geologic Survey mineral resource zone (MRZ) areas MRZ-2 and MRZ-3, plus correlated MRZ areas for zones 2 and 3 developed in this study (explanation below;
- Include all lands inside the designated preserve area;
- Include all lands outside the designated preserve area;
- Exclude developed lands; and
- Exclude military and tribal lands as purchase of these lands is not permitted under the EMP.

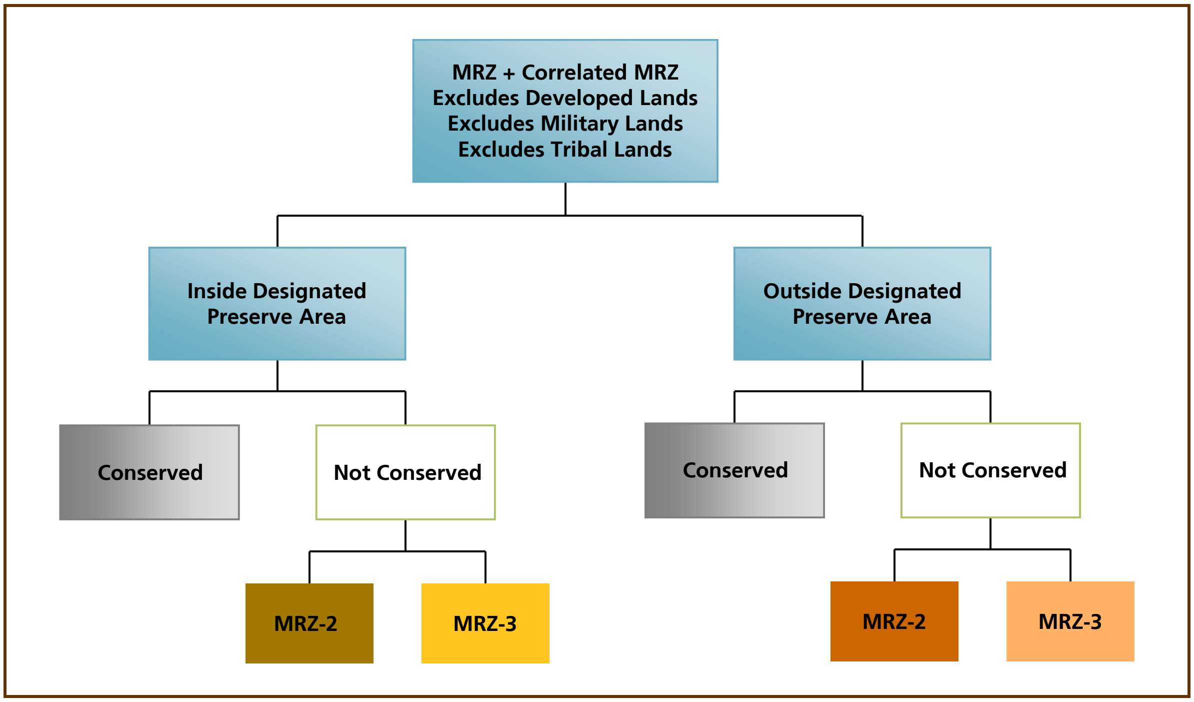
Designated preserve areas are areas that have been identified for open space conservation by local jurisdictions and wildlife agencies in habitat conservation plans. The lands are not yet conserved. Conserved lands are areas that already have been conserved for open space conservation by local jurisdictions and wildlife agencies in habitat conservation plans.

MRZ-2 and MRZ-3 lands are classified by the California Department of Conservation. MRZ-2 areas are those where geologic information indicates that significant mineral deposits are present or where it is judged that there is high likelihood for their presence. These areas typically have data from an old or existing mine or from drill holes to determine if the area is of regional or statewide significance in terms of supplying the market. MRZ-3 areas contain mineral deposits, but the significance to the region or the state cannot be evaluated due to the lack of data.

[2] California Department of Conservation, California Geological Survey. (2006). Map Sheet 52: Aggregate Availability in California, p. 14.

Another filter used in this case study is referred to as correlated MRZ-2 and correlated MRZ-3. Correlated areas have similar rock type as included in the Department of Conservation's MRZ-2 and MRZ-3. They were developed through this study with the assistance of geologists at the Scripps Institution of Oceanography. The areas are based on similar geology types as identified in available United States Geological Survey 7.5-minute quadrangle geologic maps for the San Diego region and correlated to similar rock types identified as MRZ-2 and MRZ-3 by the Department of Conservation. See Appendix C for a detailed explanation and associated maps.

Figure 7-3
Case Study Flowchart



Conserved lands have certain restrictions due to the title of ownership and, therefore, were not considered in the final steps of the case study.

Figure 7-4 illustrates the result of these GIS layers and filters. The map includes MRZ-2 and MRZ-3 lands that are either inside or outside the designated preserve areas. (Conserved areas are not included.) Three areas, outlined in red, show a concentration of MRZ-2 lands. These areas may represent opportunities for combining the purchase and restoration of mitigation lands and secondary benefits of aggregate sand extraction.

It is important to understand the results presented in Figure 7-4 are based solely on a GIS overlay analysis. Evaluating the opportunities and constraints of restoring the mitigation lands and possibly extracting aggregate requires additional research and local knowledge of the geography, habitat, and political considerations of the areas.

For instance, the southern-most circled area on the map in Figure 7-4 has a concentration of MRZ-2 lands. Several active mines are located in the circled area along State Route 67 including, Channel Road, Lakeside Sand Pit, Slaughterhouse Canyon, TTT Quarry, Vigilante Quarry, and Ennis. This case study is focused on restoration and sand extraction. Several of the mines listed above are rock quarries and do not supply natural fine aggregates from alluvial riverbeds. Channel Road does produce PCC-grade sand; however, industry reports show it is scheduled to close around 2014. Reports by the Department of Conservation also have listed Ennis and Lakeside Sand to be located on land with geology suitable for producing PCC-grade sand. Also located within the circled area is El Monte Valley, which is the location of a proposed mining, reclamation, and groundwater recharge project by the Helix Water District. The district is pursuing a new, permanent water supply source by augmenting water in the El Monte Valley underground basin with highly purified, recycled water. The district is studying various options, including a sand mining component to offset costs of the project and restore critical habitat and enhance recreational activity.

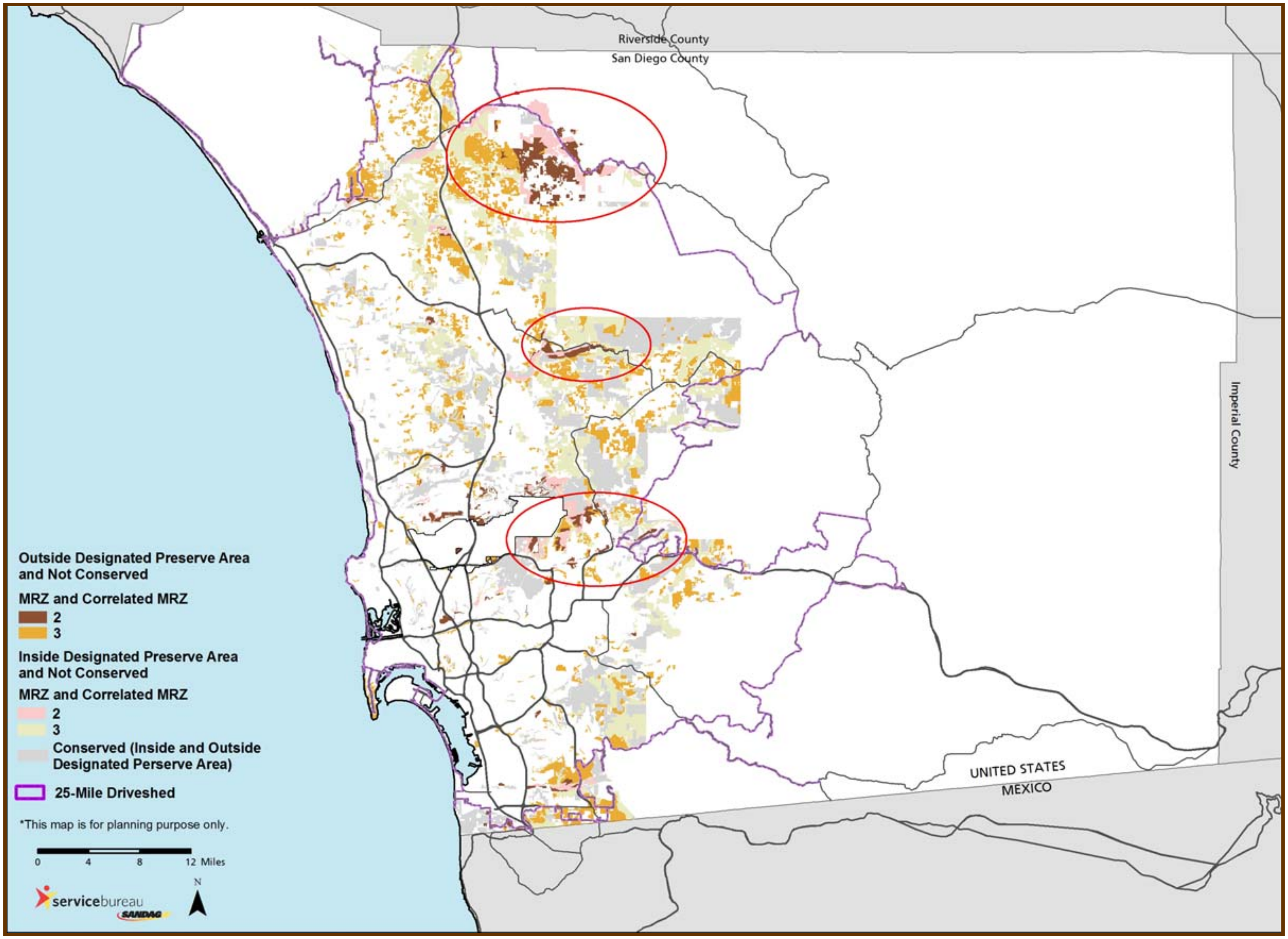
It is important to note that although this particular case study is focused on restoration and secondary benefits of sand mining, there are several mines located in the area, and since environmental agencies have indicated that potential environmental impacts may be less for expansion of an existing mine versus establishing a new mine, it may prove to be worth the effort to explore opportunities for increasing sources of aggregate by expanding the size of existing quarries in areas that already are known for mining activities. The existing mines are on lands designated as MRZ-2 areas, so these potential mineral resources lands should be recognized and considered in San Diego County's land use planning process.

The smallest circle on the map, east of Interstate 15, is San Pasqual Valley. Some of the land is inside the preserve and some outside the preserve, and both contain lands classified as MRZ-2. This area runs along the San Dieguito River and, potentially, it could be used as wetlands mitigation if it were to be restored. Restoration of this area may require the removal of sand and, therefore, may present opportunities for realizing a secondary benefit of a sand-supply aggregate. This site would be worth additional research to determine its full potential. One active mine is located within the circled area (Inland Valley Materials), but it is a rock quarry and not a source for natural sand.

The circled area farthest north on the map is the San Luis Rey River. Some of the land is inside the preserve and some outside the preserve, and both contain lands classified as MRZ-2. Some land surrounding the area is owned by tribal governments. This area used to have several active sand mines, but virtually all were close during the early 1990s. One active mine opened recently in the general area (Rosemary's Mountain), but it is a rock quarry and not a source for natural sand.

The idea in this case study is to explore opportunities for linking existing efforts such as buying and restoring mitigation lands as in the *TransNet* Program, with efforts to identify potential areas for aggregate sand. The GIS overlay analysis in the case study helps focus the user to identify areas that may be suitable for mitigation and also have a potential for aggregate sources. But the GIS model approach cannot answer all questions. Further research beyond the scope of this study is needed to determine the full potential of these areas. Research should include field studies, local knowledge of the area, soil sampling to determine grain size and quality of sand, environmental species and habitat constraints, and other project constraints, to name a few. In addition, the quality and marketability of the aggregate must be factored into the evaluation to ensure a successful match.

Figure 7-4
Potential Areas for Mitigation and Aggregate Supply



SCENARIOS FOR USING THE TOOLS FOR POLICY-MAKING CONSIDERATIONS

Opening a new aggregate operation is a complicated process that can cost millions of dollars and take many years. Aggregate producers invest a great deal of time and money locating potential aggregate resources and determining the quantity and quality of the aggregate, the feasibility of production, identifying potential environmental impacts, obtaining necessary permits, and conforming to relevant laws. Preliminary GIS investigations might identify potential areas at a high level, but field reconnaissance studies, sampling, and other exploration are often employed to help define the opportunities and the limitations of the potential sources of aggregate.

These considerations are important in making land use decisions as well. The GIS overlay analysis tool can be used as a starting point to evaluate different options for local land use planning scenarios. A couple of scenarios are presented in this chapter to illustrate how the tool could be used. The following maps explore various assumptions about the size of available lands for a mining operation, mitigation of adverse impacts such as noise, and proximity to infrastructure.

Variation in Acreage of Available Land

In identifying potential available lands for aggregate, this study relied on the assumption that a minimum of 20 acres is needed to accommodate a mine. This assumption was used throughout the study in order to keep the largest number of options open to policy makers. According to several experts in the field, while 20-acre mines do exist, a more ideal size for a mining operation is more likely to be in the 40- to 60-acre range or 100-acre or greater range. These experts commented that often a large acreage is needed to accommodate required set-asides for mitigation purposes and to be sure the site will be economically viable. (The San Diego region has mining sites at various acre sizes, from about 20 acres to more than 500 acres. The average acreage for active mining sites in the San Diego region is 150 acres, including undisturbed lands and setbacks.)

For the purpose of illustrating how the GIS tool could be used, several maps showing variation in acreage are illustrated. Figure 7-5 shows the potential aggregate supply sites for areas 20 acres or greater. Figure 7-6 illustrates the potential lands for areas 60 acres or greater. Figure 7-7 is based on the idea of a super operation, where a limited number of large sites serve as the suppliers for the entire region. The minimum number of acres for this super operation is 100. Several scenarios were run for these three sizes (20 acres, 60 acres, and 100 acres).

These potential aggregate supply sites, referred to as available lands on the figures, are areas that are not developed and have not been conserved for environmental reasons nor identified for conservation at a 90-percent level.

Figure 7-5
Available Land (20 acres or greater)

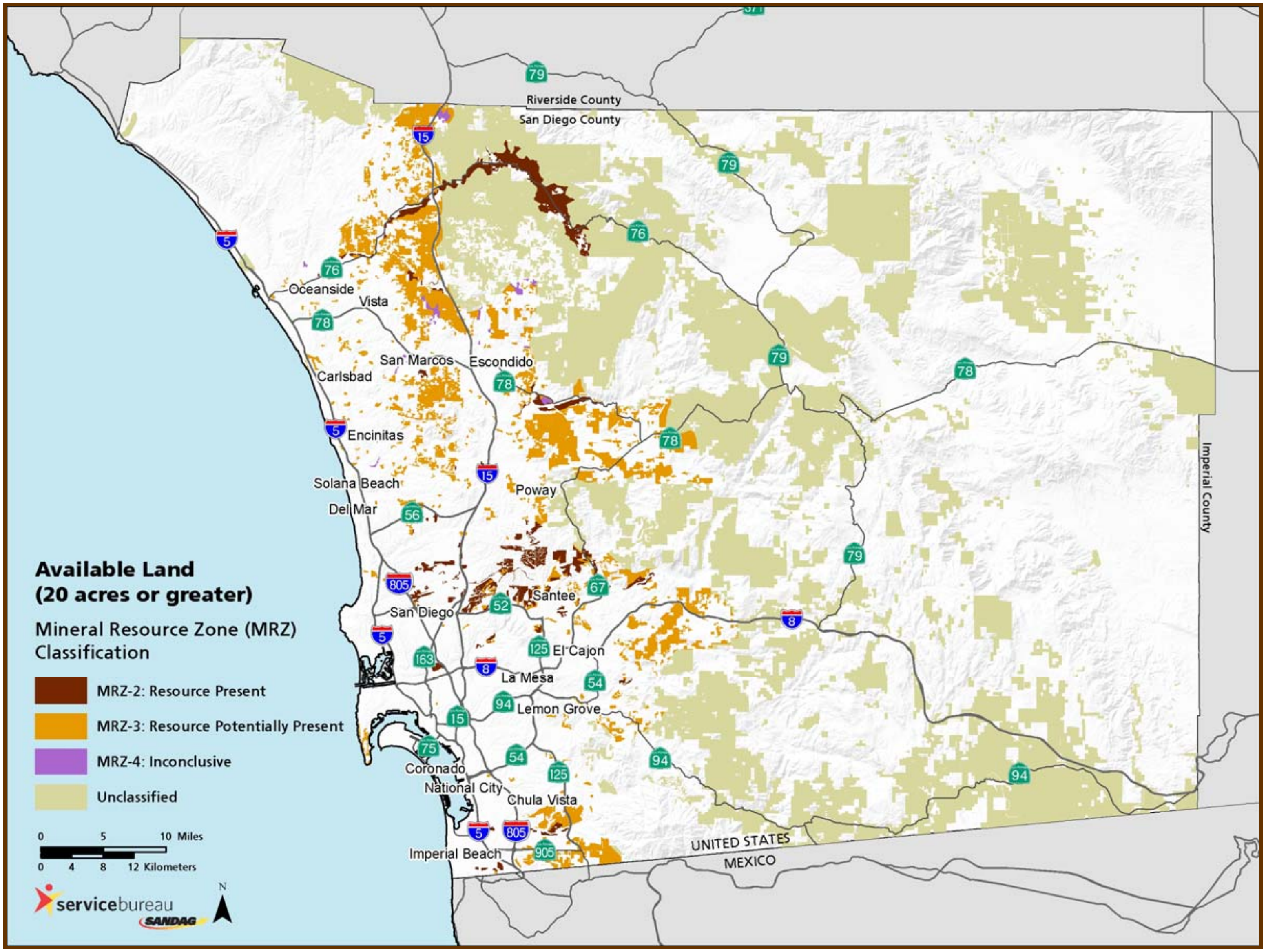


Figure 7-6
Available Land (60 acres or greater)

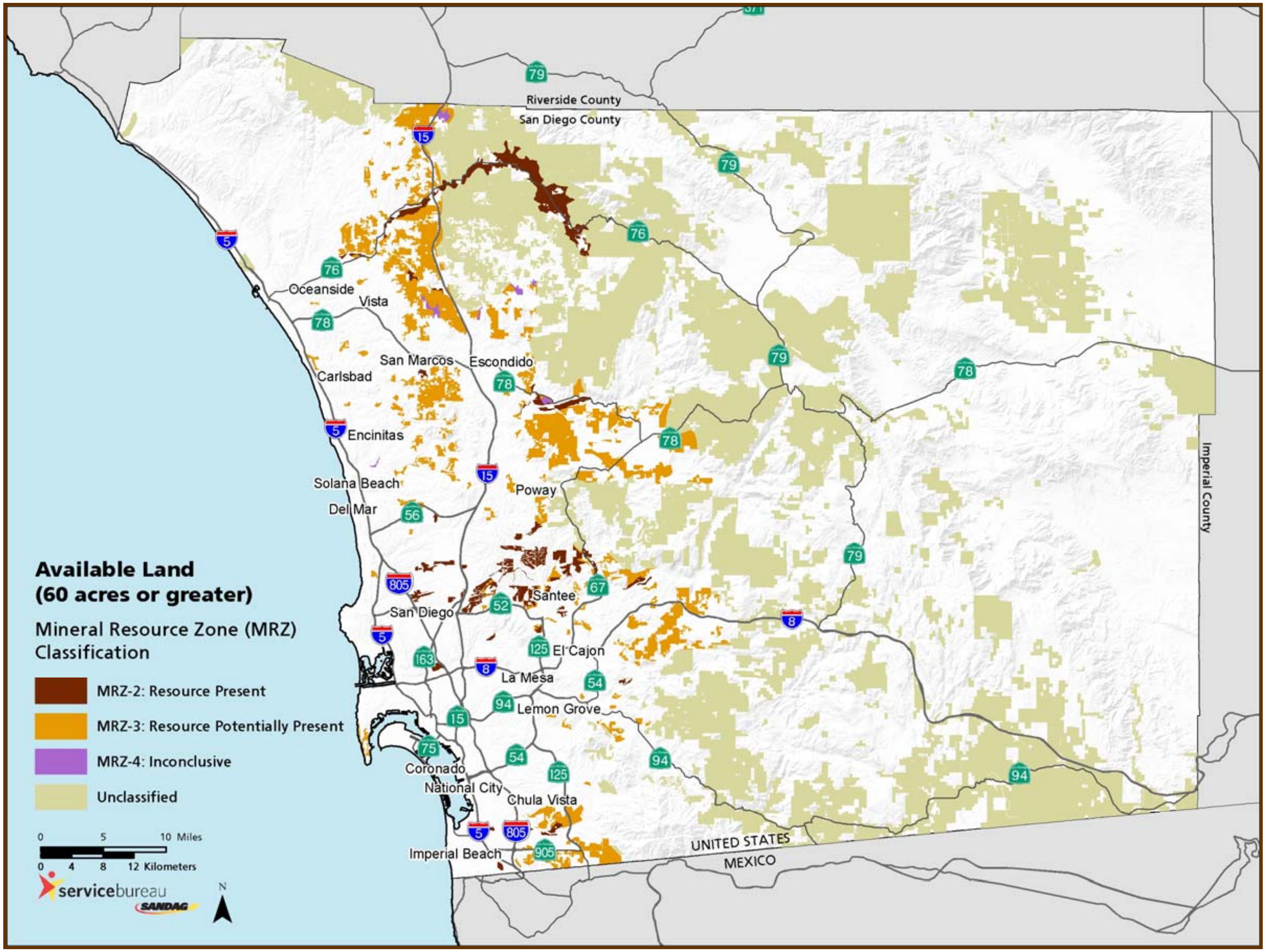
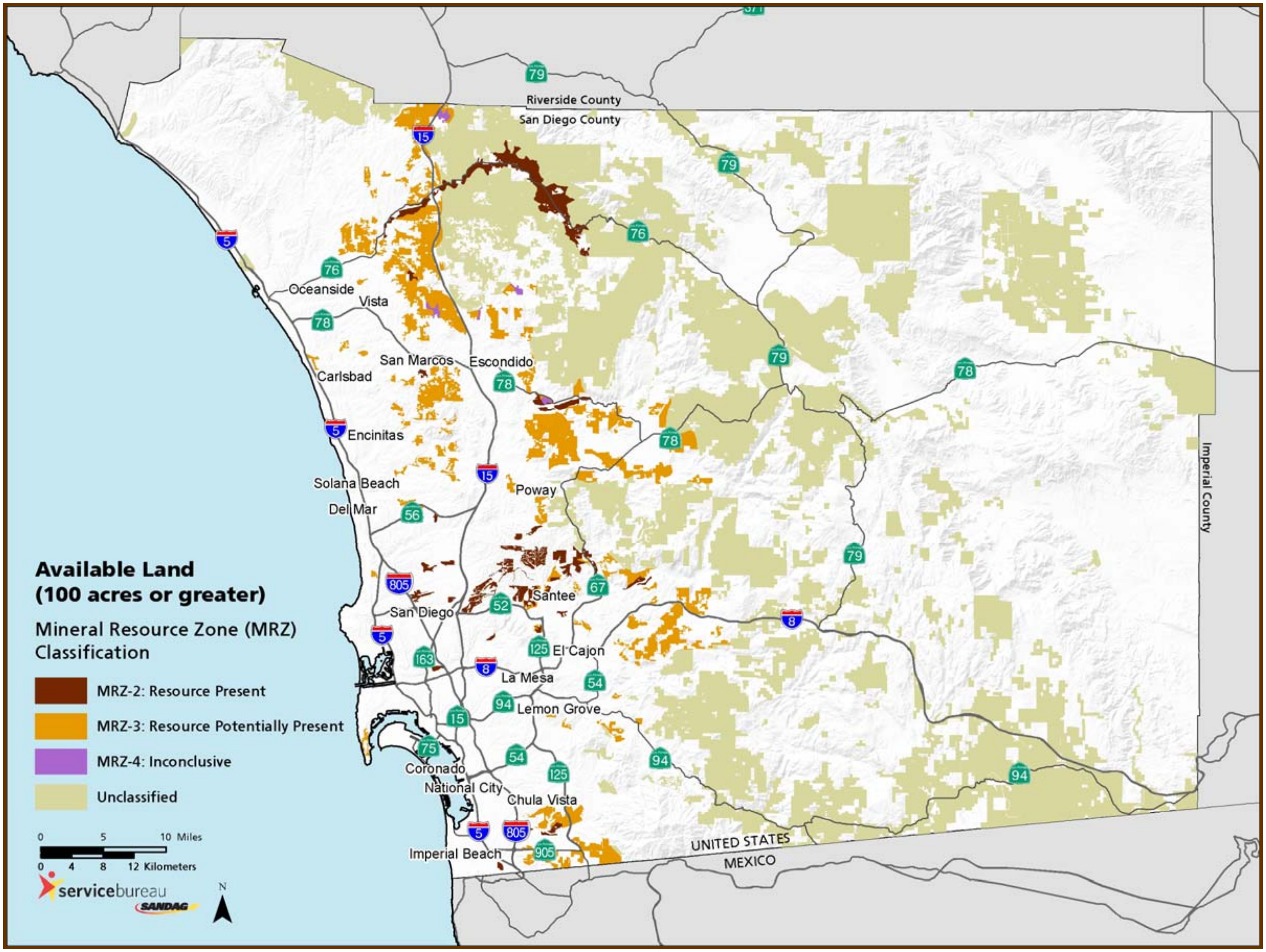


Figure 7-7
Available Land (100 acres or greater)



Proximity to Existing Residential Land Uses

In addition to other factors for locating a mining operation, proximity to certain land uses also plays a role. Zoning statutes or CEQA requirements could cite setbacks from residential areas to mitigate undesirable byproducts of the aggregate extraction process. Setback requirements will likely vary across jurisdictions. A 1,300-foot setback from residential areas is considered in the County of San Diego's mineral resource evaluation methodology guidelines to mitigate noise.[3] To illustrate different scenarios, the blanket 1,300-foot setback was applied from all residential land uses, including low-density, (less than 1 dwelling unit per 10 acres) rural, single-family areas. While these rural single-family areas are included in the potential aggregate sites inventory, when introducing the setback idea, it was determined that it should be applied from these areas as any effort to site a mine would have to address noise concerns of residents. It should be noted that the 1,300-foot setback is not an absolute requirement, and proper mitigation would be decided on a site-by-site basis. Other mitigation factors, such as topography, noise-reduction technology, or landscape design, could be used in place of setbacks, depending on the site. The 1,300-foot setback in this assumption is used to highlight areas where mitigation of impacts to local residents would be less of a concern and, therefore, potentially easier to locate a mining operation.

The following scenarios illustrate the remaining number of potential aggregate sites after a 1,300-foot setback from existing residential land uses is applied. Figure 7-8 illustrates those areas with 20 or more remaining (effective) acres after the 1,300-foot setback is applied. For this analysis, the map continued to show the entire potential aggregate site unless the encroachment from the 1,300-foot setback resulted in a potential aggregate site being reduced to less than 20 acres. The idea was that with 20 acres or greater, there may be options for locating the mining operation where impacts to local residents would be less of a concern. This same technique was used in preparing the related maps for 60 or more acres and 100 or more acres. Potential aggregate sites with 60 or more effective acres are shown in Figure 7-9, and potential sites with 100 or more effective acres are shown in Figure 7-10.

These potential aggregate supply sites, referred to as available lands on the figures, are areas that are not developed and have not been conserved for environmental reasons or identified for conservation at a 90-percent level.

[3] County of San Diego, Department of Planning and Land Use, Department of Public Works. (2007). County of San Diego Guidelines for Determining Significance and Report Format and Content Requirements: Mineral Resources.

Figure 7-8
Available Land (20 acres or greater after 1300' setback from existing residential land)

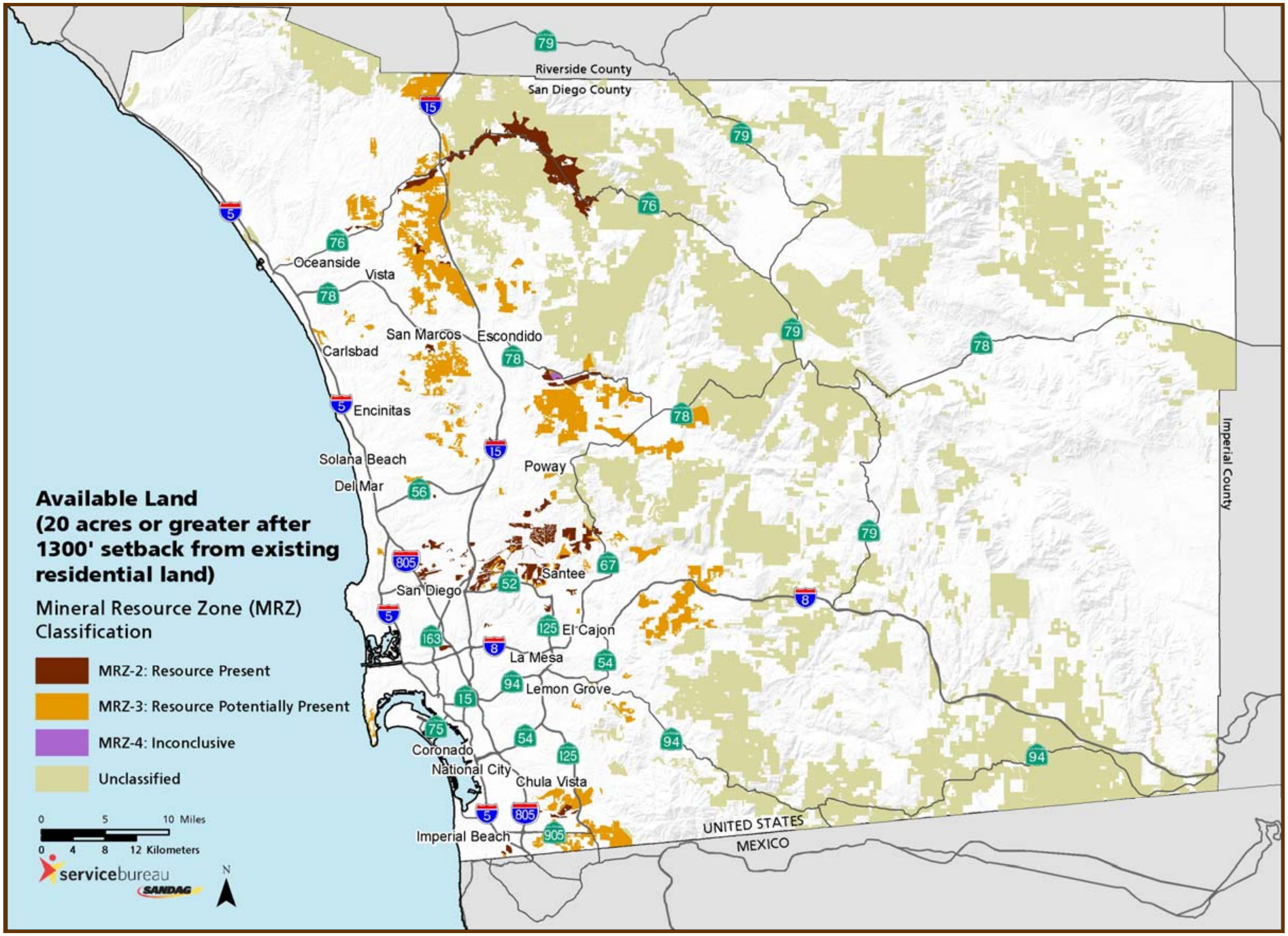


Figure 7-9
Available Land (60 acres or greater after 1300′ setback from existing residential land)

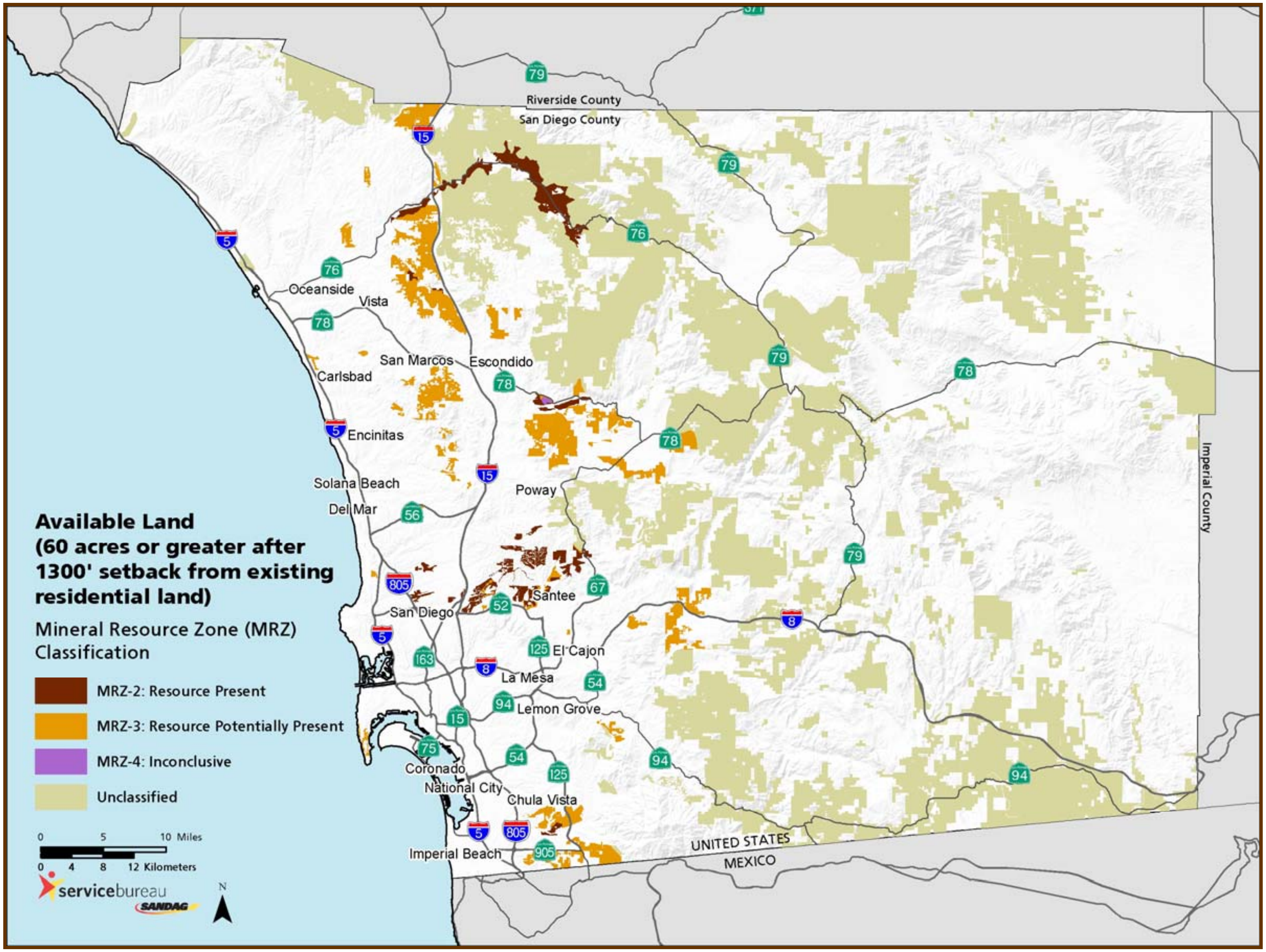
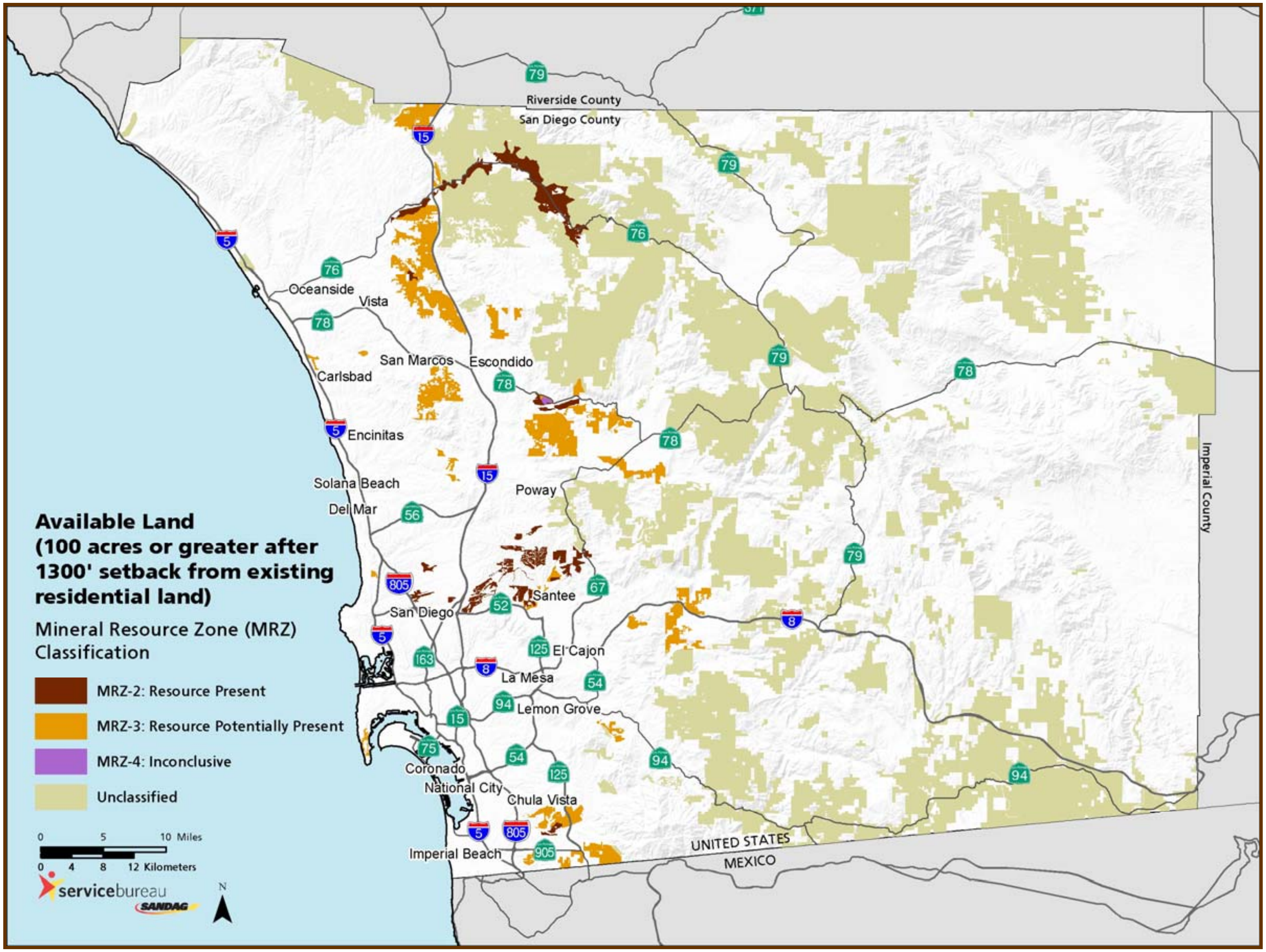


Figure 7-10
Available Land (100 acres or greater after 1300′ setback from existing residential land)



Proximity to 2050 Planned Residential Land Uses

The process was then repeated based on planned 2050 residential land uses. For this assumption a blanket 1,300-foot setback was applied from all planned residential land uses in 2050. Figure 7-11 illustrates those areas with 20 or more remaining (effective) acres after the 1,300-foot setback is applied. Potential sites with 60 or more effective acres are shown in Figure 7-12, and potential aggregate sites with 100 or more effective acres are shown in Figure 7-13.

Although detailed information about existing residential land use on tribal reservations is included in the SANDAG land use database and has been validated through aerial imagery, the same level of detail is not available for planned residential land use on the tribal reservations. Planned land use is coded as "tribal reservations" and does not include the detailed information about location of residential units. Therefore, the maps likely show more land as potential aggregate sites than actually exists.

These potential aggregate supply sites, referred to as available lands on the figures, are areas that are not developed and have not been conserved for environmental reasons or identified for conservation at a 90-percent level.

Figure 7-11
Available Land (20 acres or greater after 1300' setback from 2050 planned residential land)

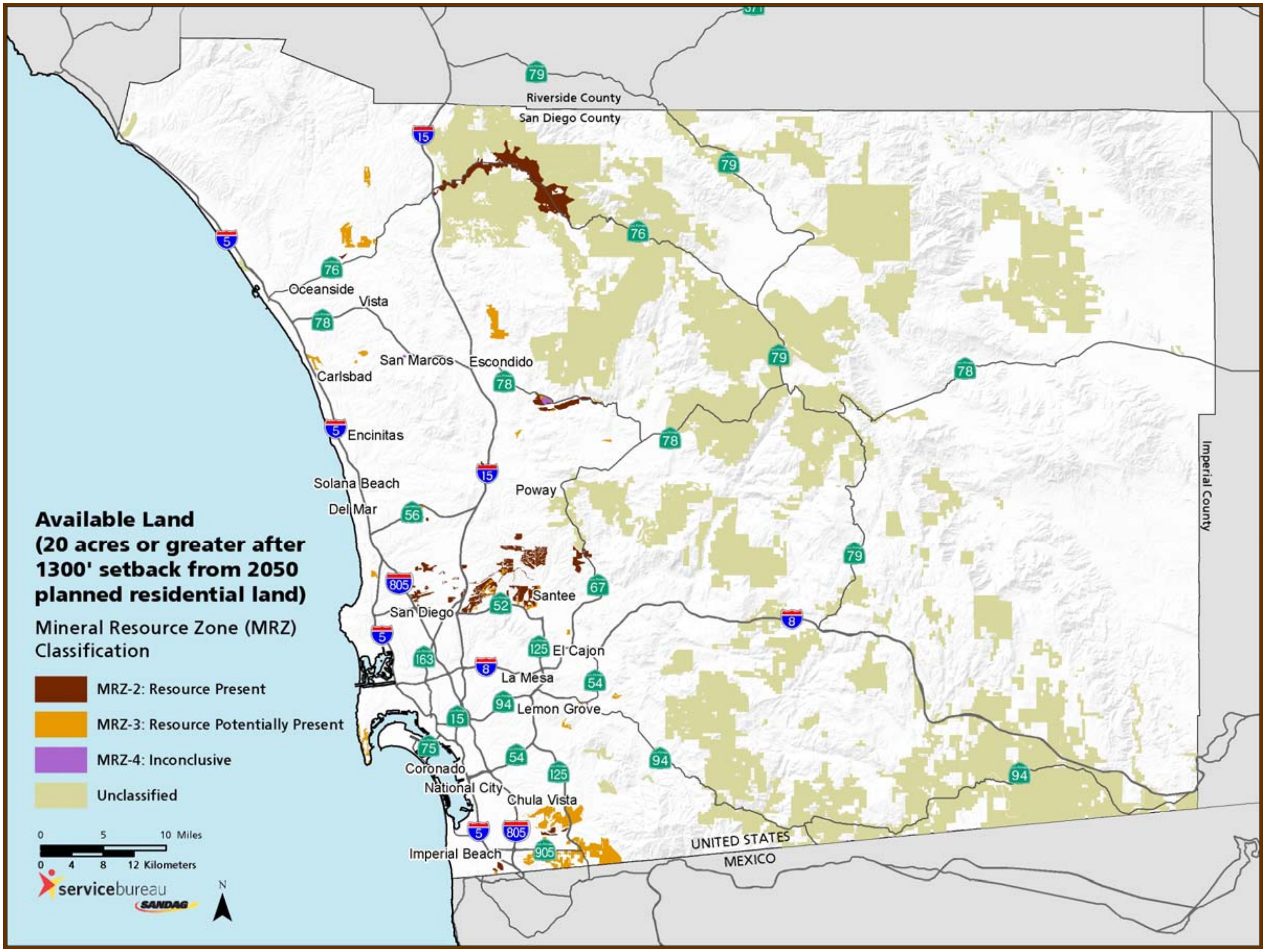


Figure 7-12
Available Land (60 acres or greater after 1300′ setback from 2050 planned residential land)

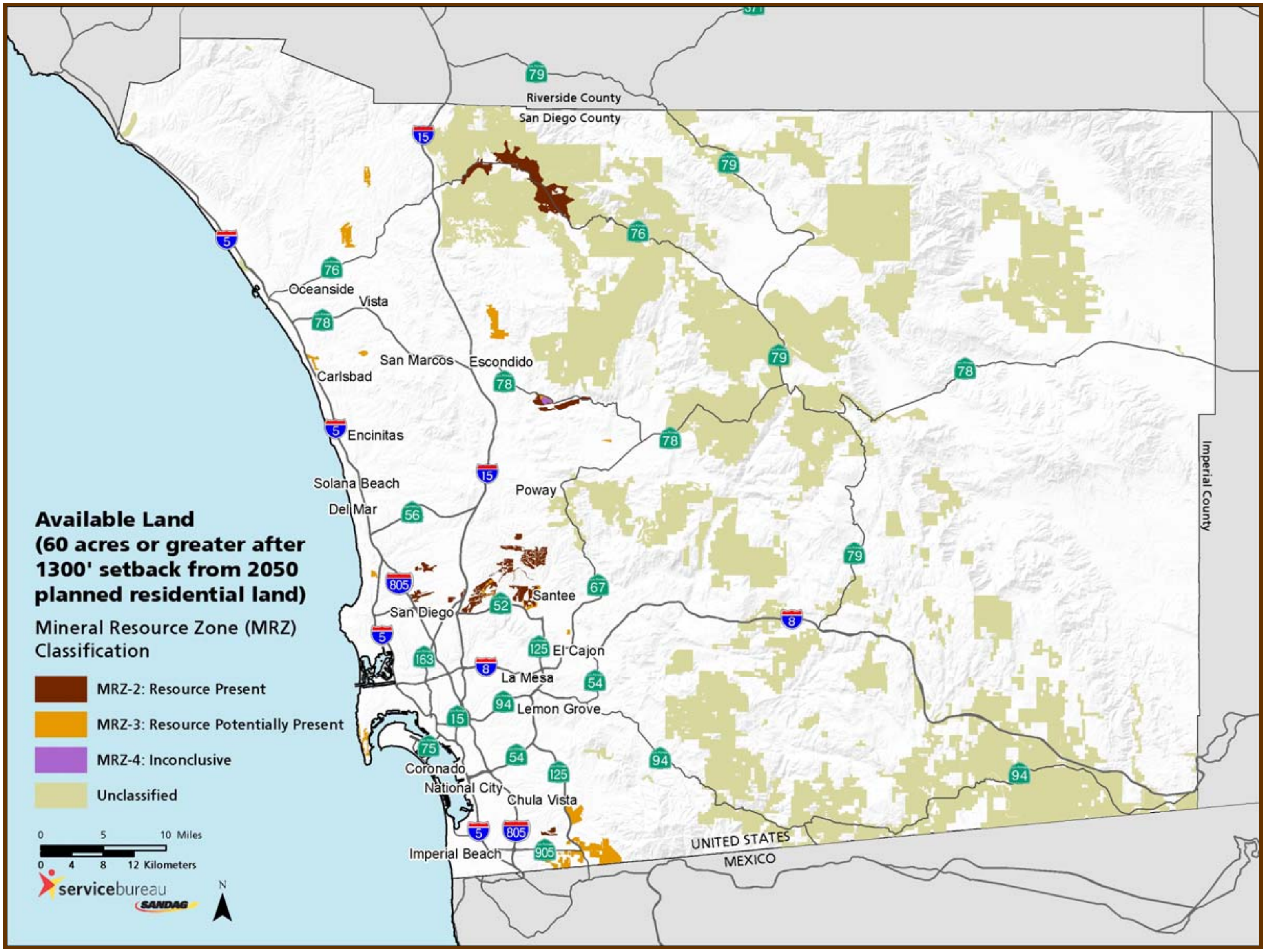
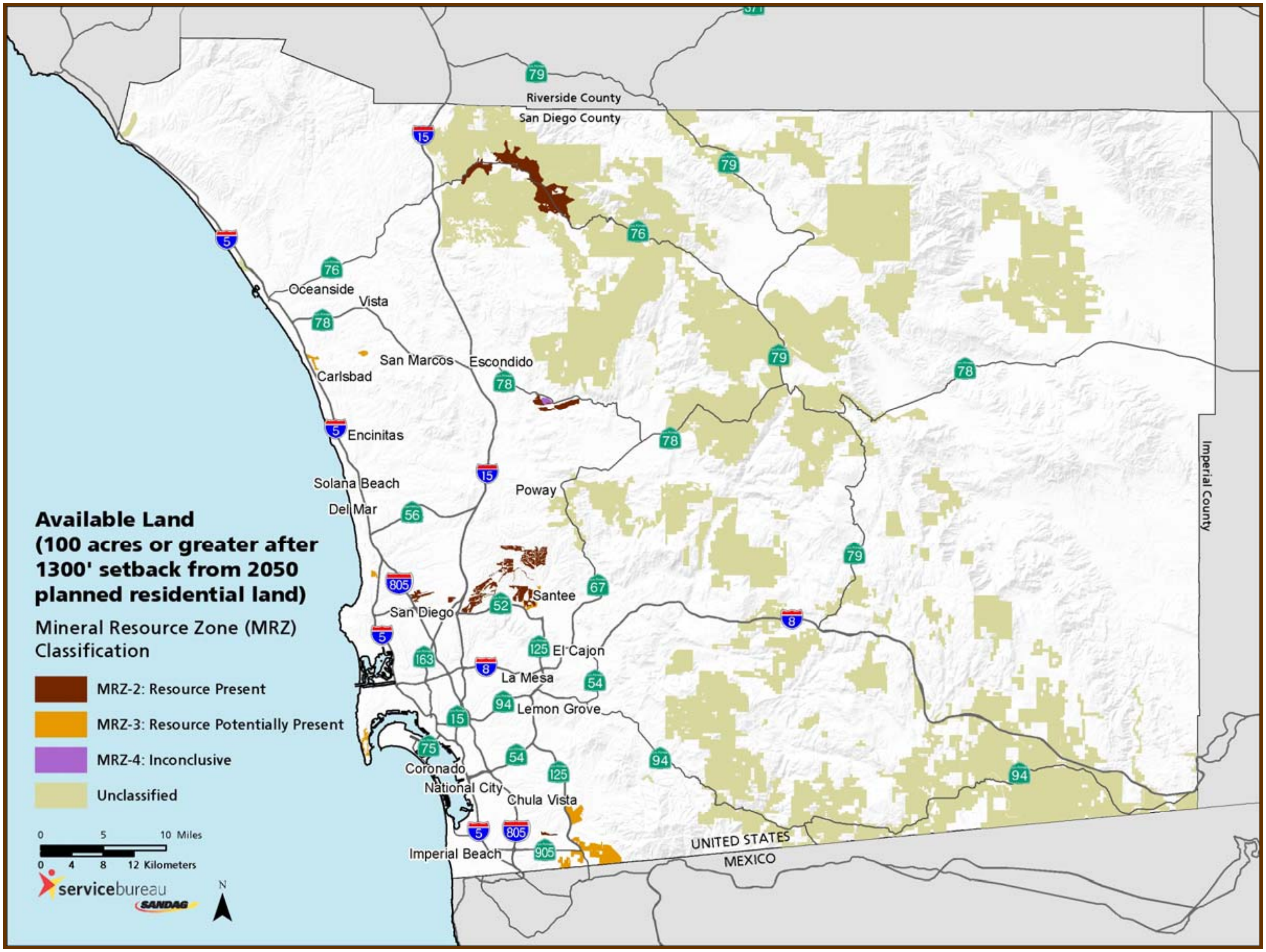


Figure 7-13
Available Land (100 acres or greater after 1300' setback from 2050 planned residential land)



Summary Residential Land Use Scenarios

Table 7-1 summarizes the number of available lands before and after the 1,300-foot setback based on existing and planned residential land use. This GIS exercise uses a blanket setback of 1,300 feet. Actual setback requirements vary by jurisdiction and by the specific circumstances surrounding the mine. Nonetheless, the results are revealing. The total number of available lands is reduced from 1,159 potential aggregate sites to 234 sites with the 2050 planned residential land use setback. It is important to remember that potential sites are defined as areas that are not developed and that have not been conserved for environmental reasons or identified for conservation at a 90-percent level. Mineral resource classification has not been identified for many of these lands. The potential suitability of the sites for construction aggregate will need to be evaluated on a case-by-case basis.

This exercise demonstrates how the GIS overlay tool could be used to explore scenarios. From a long-term planning perspective, it is important to consider the 2050 land use plans and the location of mineral resources, which supply the aggregate needed to build the infrastructure. Planning decisions that do not take this into account could result in costly alternatives of importing aggregate from outside or pushing aggregate mines farther east, resulting in higher transportation and environmental costs and translating into higher construction costs.

Future housing and investment in essential infrastructure, such as new and improved roads, rail links, hospitals, schools, airport facilities, and water and sewage facilities, all require aggregate. Opportunities for effective planning today will help address the availability of construction aggregate required to meet the region's needs in the future.

Table 7-1
Number of Available Lands by Size Before and After Setback

Size (Acreage)	No Setback	Existing Land Use 1300' Setback	2050 Land Use 1300' Setback
20 to 59	606	223	92
60 to 99	163	76	44
100 to 499	279	154	63
500 to 999	50	30	15
1,000 to 9,999	47	26	18
10,000 to 15,000	14	3	2
Total	**1,159**	**512**	**234**

GIS LAYERS WITH JURISDICTIONAL BOUNDARIES

Other standard GIS layers could be added to visualize different scenarios. The following maps repeat maps showing potential aggregate supply sites at the 20-, 60-, and 100-acre sizes, but in these maps, the overlay of municipal and tribal boundaries is included. As shown in Figures 7-14, 7-15, and 7-16, the majority of available aggregate sites fall within the unincorporated areas of the region.[4]

[4] At the September 21, 2010 Board meeting, the Southern California Tribal Chairmen's Association approved including boundaries of Federally Recognized Indian Reservations on maps.

Figure 7-14
Available Land With Jurisdictional Boundaries (20 acres or greater)

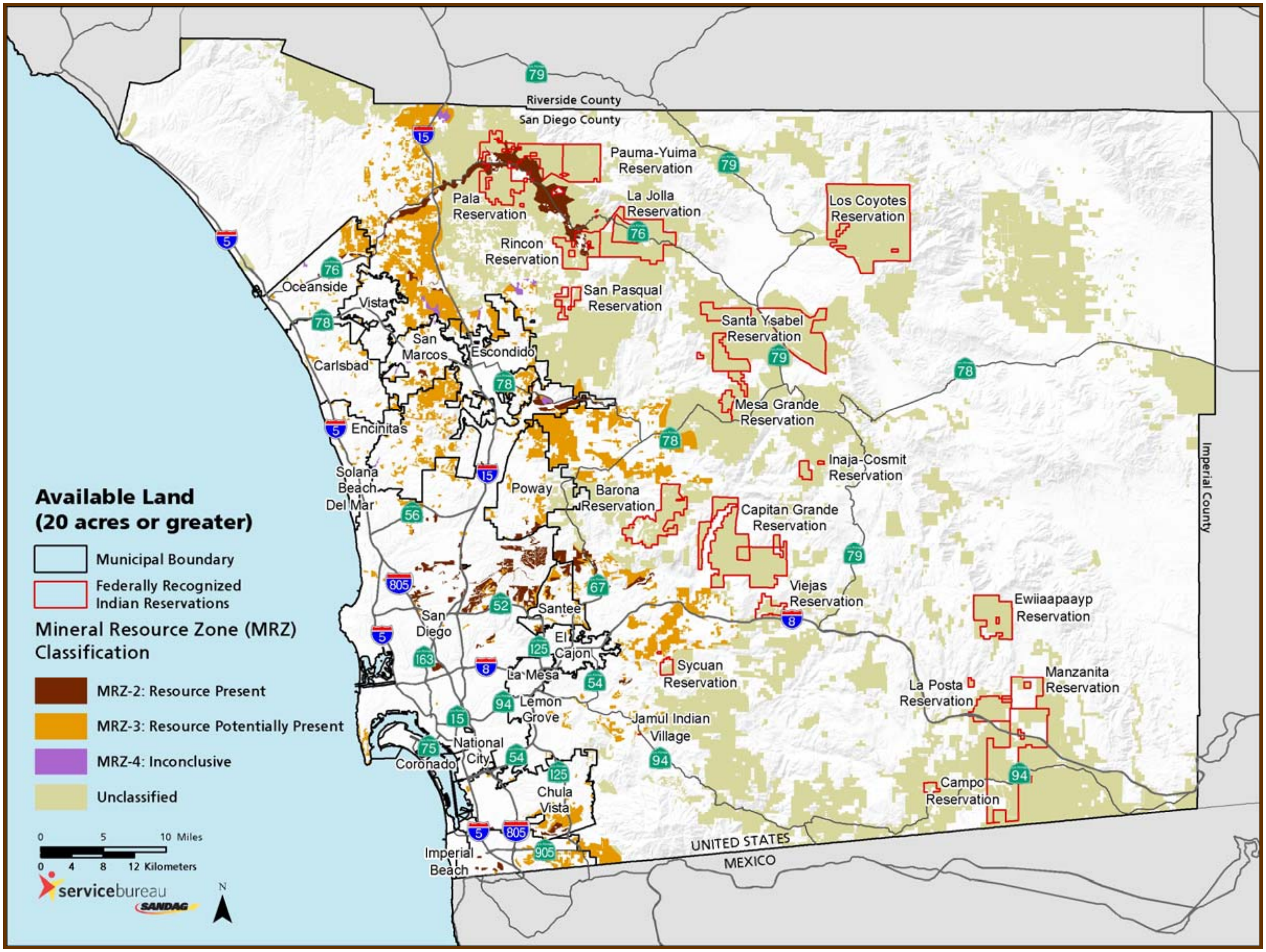


Figure 7-15
Available Land With Jurisdictional Boundaries (60 acres or greater)

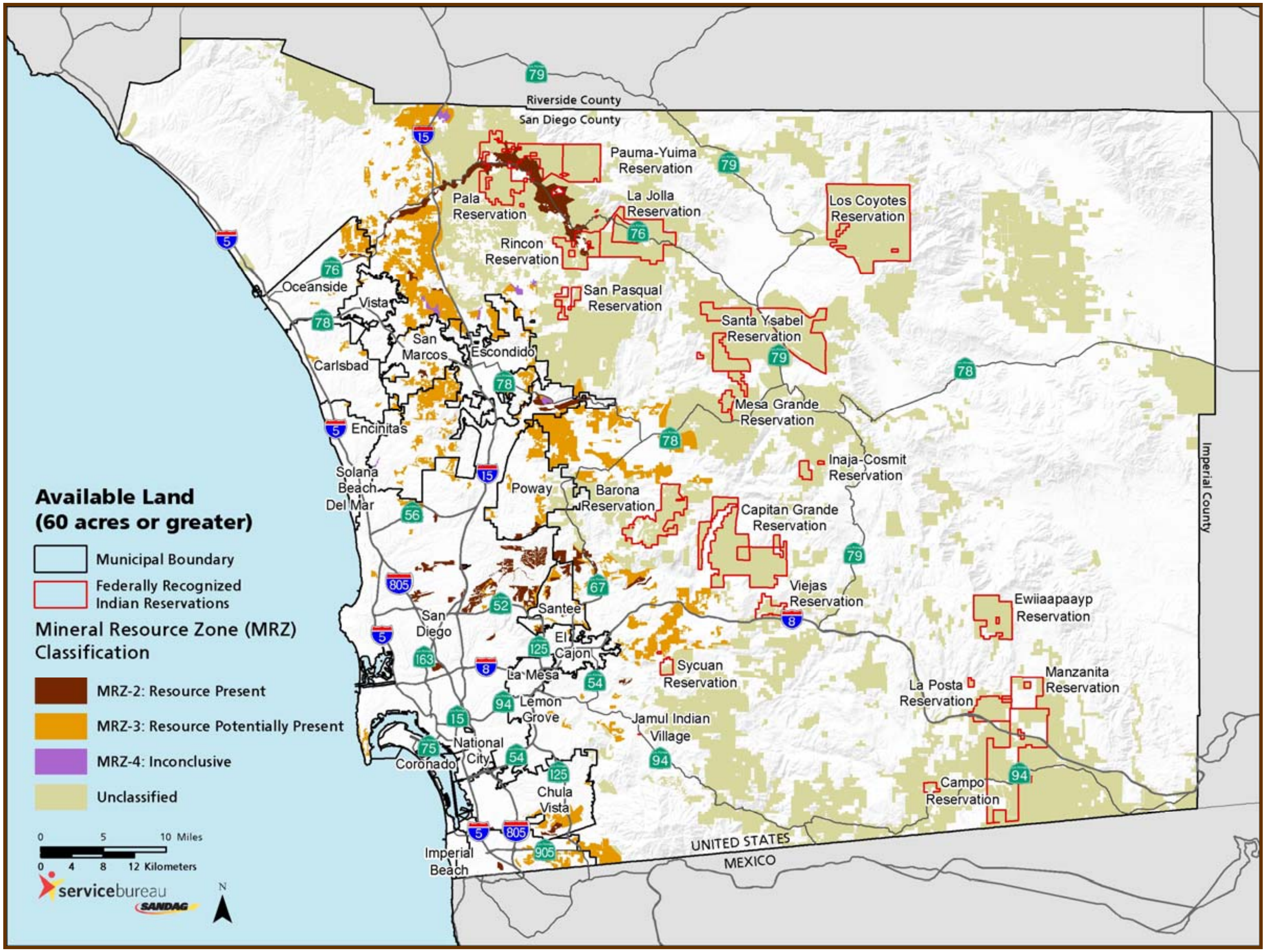
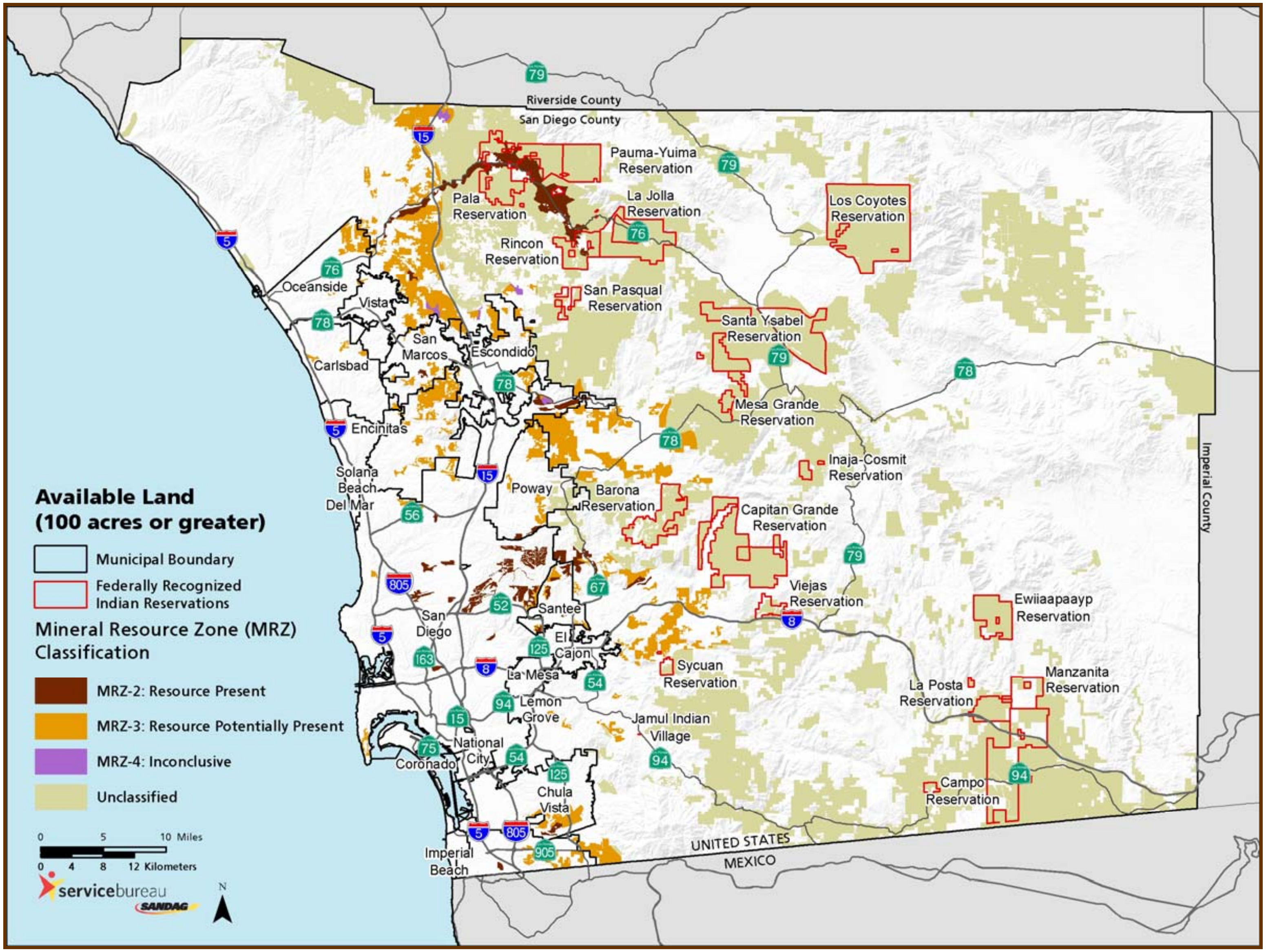


Figure 7-16
Available Land With Jurisdictional Boundaries (100 acres or greater)



RAIL DISTRIBUTION CENTER

An important element to consider when exploring aggregate supply is the viability of importing aggregate materials into the region. When using the GIS tools to look at aggregate supply options, one topic to consider is the potential location of a rail distribution center. During the expert review panel meetings, it was noted that adequate rail mainline access is available in the region, but that a rail distribution facility is needed to make this a viable option for aggregate importation. An investment in infrastructure, such as double-tracking and establishing a distribution center, would be needed.

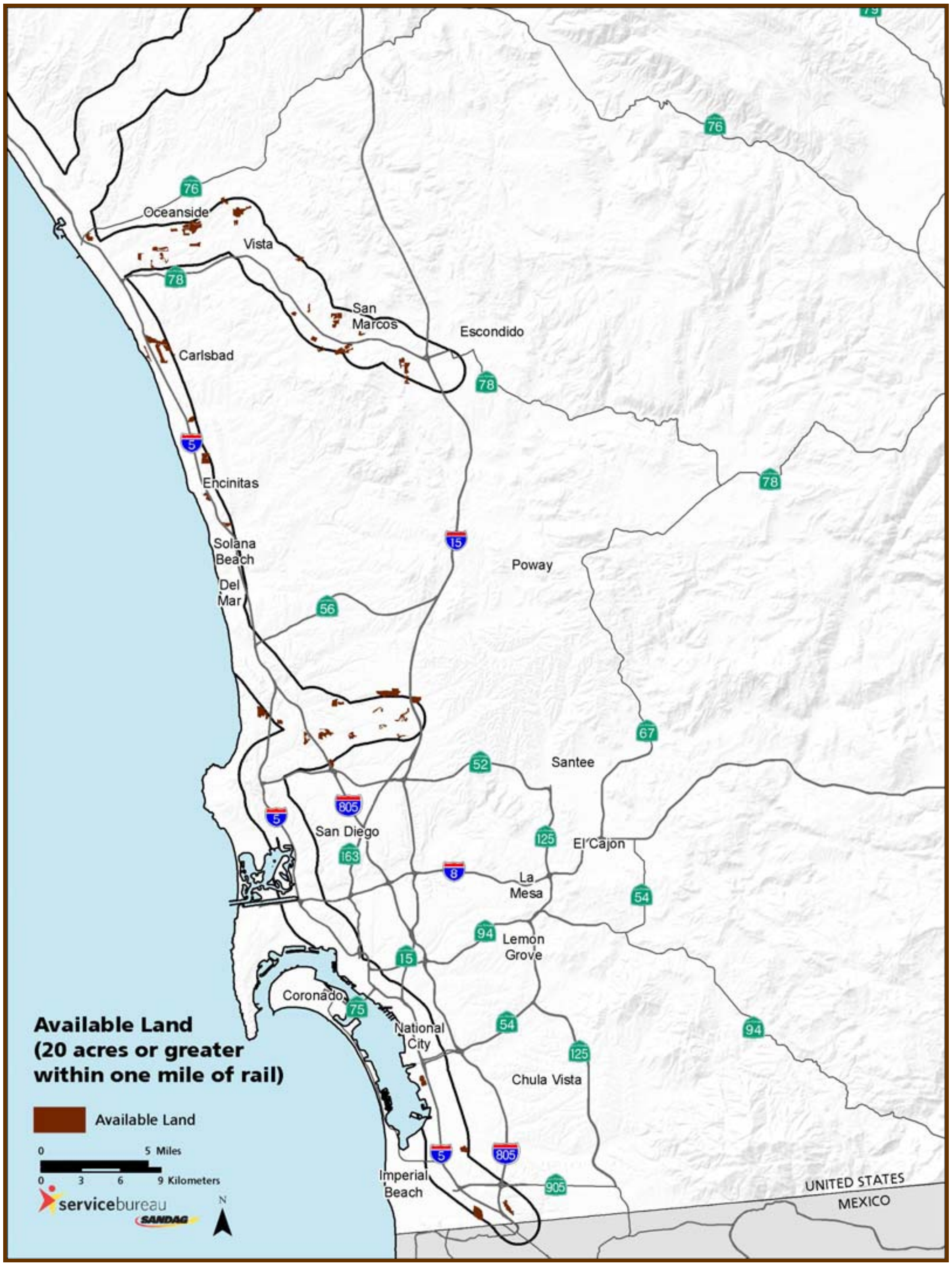
Several participants suggested that establishing a rail distribution center and making other improvements was worth investigating as it could bring in aggregates to help reduce the supply gap and benefit other goods-movement efforts. It was indicated that the ideal size for a rail distribution center is 100 acres, but an efficient center could be designed on a 40- to 60-acre site along a main line. (The expert review panel mentioned that a 20-acre site could be a possibility; however, it would require the materials to be moved by truck almost immediately, while a 40- to 60-acre site could accommodate the stockpile of materials.)

As shown in Figure 7-17, the GIS overlay analysis identified several available lands[5] that are 20 acres or more and located within one mile of an existing railway. Some of these sites are located near residential areas, some near marshes or lagoons, while others are coded as agricultural lands (considered available in this study). The sites would need to be evaluated on a case-by-case basis involving experts in land use, engineering, and environmental fields. Other sites that could be considered for this purpose are industrial lands located near an existing railway, such as selected sites near State Route 78. Also, there are several existing concrete batch plants located in industrial areas near railways.

The feasibility of making the infrastructure improvements and establishing a distribution center to deliver aggregate via a rail line to one or more sites may be a worthwhile endeavor. According to the expert review panel, a train of 60 hopper cars holding 100 tons of aggregate per railcar could deliver approximately one million tons of aggregate annually (one shipment three times a week) to the San Diego region and help reduce the supply gap. If the demand for aggregate cannot be met by local sources, importation by rail may become a viable option. The expert review panel noted that while generally speaking for carload service, a distance of 400 to 500 miles is the typical break-even point because aggregates are a heavy-bulk commodity that would most likely be handled in a unit train service (where the railcars are shipped from the same origin to the same destination), rail could potentially compete on a smaller distance of even 50 miles with the proper loading and unloading facilities.

[5] The definition of “available lands” is provided in Chapter 5. Essentially it excludes lands coded as developed in SANDAG land use codes and excludes environmental lands coded as conserved or identified for conservation at the 90 percent level.

Figure 7-17
Available Land Within One Mile from Existing Railway (20 acres or greater)



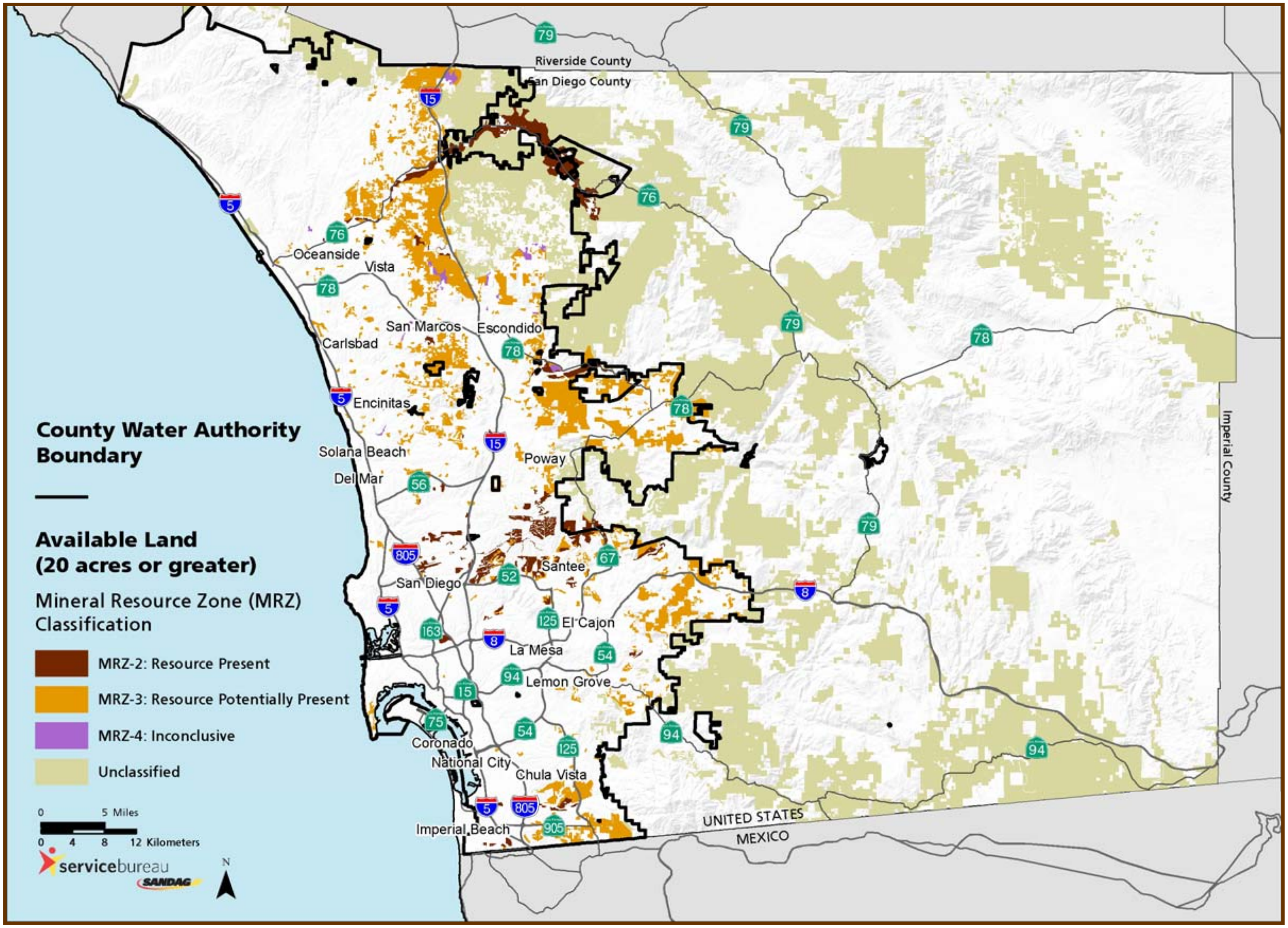
WATER INFRASTRUCTURE

The processing of construction aggregate typically requires a great deal of water. This requires the availability of water infrastructure, or well water extraction (which could be cost-prohibitive). The availability of water infrastructure can be defined in terms of the service areas of the member agencies of the County Water Authority. Figure 7-18 illustrates the overall County Water Authority boundary overlaid with available aggregate sites 20 acres or greater to show which sites have access to water infrastructure.

SUMMARY

This chapter illustrates several ways that the GIS tools could be used to begin exploring different options for increasing the supply of aggregate. Again, it is important to note that the GIS tools represent a starting point. In all cases presented in this chapter, the user must go to the next level and examine local zoning and setback requirements, slope of available land, sensitive habitat lands, and other local factors. The economic viability of the site for mining must be included in this evaluation.

Figure 7-18
Available Land With County Water Authority Overlay (20 Acres or Greater)



CHAPTER 8
DISCUSSION AND FINDINGS

The objectives of the study are to provide a review of aggregate sources in the region, clarify the needs and issues surrounding the supply of aggregates, develop a regional geographic information system (GIS) database that would allow for the visualization of aggregate sources with informational overlays, and develop tools that other local governments can use to estimate air-quality impacts due to transport. The information, mapping, and tools developed through this process could be used to inform decision makers and offer a pilot approach for other local governments that have aggregate shortages.

SUMMARY OF TOOLS DEVELOPED

The methods used to develop the tools that are a part of this study were designed to be repeatable so that other governmental agencies could use them to study aggregate supply. The tools developed include the following.

GIS Overlay Analysis

A standard GIS overlay analysis was used to identify potential aggregate supply sites based on local land use constraints. The overlay analysis identified 1,159 potential aggregate supply sites in the San Diego region. Other local government agencies may use these layers as a starting point and then add land use constraints that are specific to these individual jurisdictions. The GIS tool can help decision makers focus on potential geographies, but additional field work is needed to produce options that fit within the guidelines and ordinances of each local jurisdiction and make sense from an economic standpoint. Several scenarios were explored in Chapter 7, Case Studies and Scenarios, to demonstrate how the GIS overlay tool could be used.

GIS Optimization Analysis

A standard GIS overlay analysis was used to identify potential aggregate supply sites based on land use constraints. The GIS optimization analysis model builds on the overlay analysis to determine the optimal distance for locating an aggregate mine. The model optimizes the driving distances between the potential aggregate supply sites to the aggregate demand points (Regional Transportation Plan (RTP) project points). The optimization analysis provided an objective and repeatable approach to examine the relationship between driveshed, potential aggregate sites, and demand points. It reduced the potential available sites in the entire region (over 1,159 potential sites) to 788 sites within the optimal driveshed of 25 miles.

Estimating Tool for Determining Aggregate Need for Transportation and Rail (Transit) Projects

A spreadsheet tool was developed to broadly estimate the aggregate tons per lane- or track-mile needed on freeway, highway, and rail projects. The tool was developed based on engineers' experience of estimating needs for transportation projects. The tool calculated that approximately 19,000 tons of aggregate per lane-mile are needed in freeway projects, 11,750 tons of aggregate per lane-mile in highway projects, and 10,100 tons of aggregate per track-mile in rail projects (for transit). The tool factors in the use of recycled materials. Additional information on the estimating tool can be found in Appendix A.

Fuel Consumption and Emissions Estimator Tool

An air-quality impact model was developed for evaluating the fuel consumption and emissions impact of transporting bulk construction aggregate materials for various modes. The California Air Resources Board provided estimates of emission factors for each transport mode (truck, rail, and barge). Additionally, CSL International, the manufacturer of the vessel proposed for importing aggregate to the region, provided estimates for the ship. The estimates were used in the creation of a spreadsheet model that could be used to evaluate the air-quality impact of various modes of aggregate transportation. The tool was used to develop several import scenarios described in Chapter 4, Fuel Use and CO_2 Emissions from Transport. Additional details on the tool are found in Appendix A.

RESOURCE MANAGEMENT OPPORTUNITIES

The Aggregate Study Expert Review Panel encouraged a regional approach to managing aggregate to address future projected shortfalls by deploying a range of tools and strategies in a coordinated manner. Through this research effort and the feedback and insight of the expert review panel, it is clear that there is no one solution for managing aggregate in the region, and a number of complementary strategies may be required to address projected shortfalls. For example, the strategies a region might employ for sand mining might not be the same strategy used for establishing new mines or extending the life or expanding the size of existing mines. There might be other strategies for addressing the importation of aggregate. Some ideas for consideration are outlined below.

Restoration and Sand Mining

The lack of permitted mines for fine aggregate (i.e., sand) has resulted in a shortage in the San Diego region, so most is imported. Although it is possible to manufacture sand, there are additional processing costs involved, and depending on the use, it may not be as desirable as a natural product. Alluvial sand and gravel are often preferred to crushed stone because it has better workability than manufactured sand that *is* made from angular particles. However, deposits along rivers are often deemed to be in environmentally sensitive areas due to the endangered species and habitat that may exist, thereby restricting access.

Opportunities may exist for restoring the river areas to a previously functioning state and in doing so, removing material such as sand. One approach to the aggregate supply shortage could be to look for restoration opportunities that also realize secondary benefits of aggregate supply. Sand and gravel mining operating under guidelines established through a cooperative effort could restore altered river channels through selected aggregate removal and grading. As previously mentioned, these opportunities would be evaluated on a case-by-case basis in order to carefully protect the local habitat and endangered species. A current example of this is a potential local effort to develop a new, permanent water supply source by augmenting water in the El Monte Valley underground basin with highly purified, recycled water. This project also will restore critical habitat and protect cultural resources along a stretch of the San Diego River in El Monte Valley, leveraging revenues from related mining activities to support the project.

Opportunities may exist for an agency like SANDAG to explore these potential opportunities as part of its existing work on the Environmental Mitigation Program (EMP). Chapter 7, Case Studies and Scenarios—Using the Tools, presented some factors that SANDAG could use for considering opportunities for increasing aggregate supply when purchasing mitigation lands through the EMP.

As suggested by the expert review panel, a more systemwide approach could be employed, and other resource management plans that have had success in other parts of the state or nation could be examined. The most relevant practices of various plans could be compiled to help develop a comprehensive resource management plan that could meet the supply needs and protect the environment in the San Diego region.

A more detailed analysis of these options is beyond the scope of this study; however, it should be noted that these are often costly to implement and require long-term commitment from industry, agencies, and other partners.

Local Aggregate Resource Development

Transportation plays a major role in the economic and environmental cost of aggregate, and the farther the distance, the higher the costs. Transportation of aggregate by truck has the highest grams of CO_2 per net ton-mile and the highest fuel consumption rate compared to the other options of rail, ship, and barge. Chapter 4 presents several scenarios that show that air-quality impacts can vary considerably depending on mode option used to supply aggregate. The data emphasize the major role that transportation plays in calculating air-quality impacts and indicate that the key to reducing CO_2 emissions is to reduce haul distance by truck.

Because of the important role that transportation plays in the cost of aggregate, locating aggregate mines close to market areas helps to reduce the cost to the consumer and the impact to the environment. As stated in Chapter 3, the California Geological Survey estimates that the price of aggregate increases about 15 cents per ton for every mile hauled by truck.[1] Importing aggregate by truck from distant sources outside the San Diego region results in higher cost per ton and higher CO_2 emissions and fuel consumption.

1 Department of Conservation, California Geological Survey. (2006). Map Sheet 52: Aggregate Availability in California. This assumes a straight haul with minimum traffic; heavy traffic, toll roads and bridges, road conditions and elevation can increase price.

The region may want to consider policies that encourage the expansion of the number of local aggregate mines. This could be in the form of extending or expanding existing mine sites and/or establishing new sites. For instance, the region could explore the possibility of developing a broader, more comprehensive approach that addresses both local supply and importation of aggregate. It could benefit the region to view the supply of aggregate as a regional system—not just project by project. In such a regional approach, resource agencies could be involved early on, and it also could include various strategies like programmatic environmental impact reports.

The region could consider opportunities for streamlining the permitting process. For instance, jurisdictions or other government entities could use the GIS overlay analysis and tools developed through this study as a starting point to establish mineral resource layers and use the layers to offer a streamlined permitting process for new mines or mine extensions in those areas.

In addition, some representatives from the environmental agencies noted that from a resource management standpoint, the expansion of existing mines and the extension of existing permits have fewer negative impacts to the environment and, therefore, could be more desirable than establishing new mines. Regulatory agencies expressed a willingness to discuss a streamlined permitting process to facilitate the expansion of existing mines.

Although not directly related to local resource development, policies or requirements aimed at increasing the use of recycled aggregates, such as construction and demolition waste to reduce the need for natural aggregate, could be explored further. For instance, the California Department of Transportation's (Caltrans') contracting procedures provide financial incentives for contractors to use recycled material by allowing the contractor to retain a portion of the resultant project cost savings. These efforts alone, however, will not likely reduce the projected supply shortfall. Given the potential shortfall, the development of new mines or expansion of existing mines or importation by truck from outside the region will still be required. It is important to note that some mining operations outside of the region are expected to experience resource shortages in the future.

One of the proposed goals of the SANDAG 2050 RTP is to develop transportation improvements that respect and enhance the environment. An important factor in this objective is to reduce greenhouse gas emissions and improve air quality. Senate Bill 375 mandates that regions reduce greenhouse gas emissions from passenger vehicles and light trucks. It also requires that MRZs be included in local sustainable community strategies so that they may be considered in the decision-making process for future projects. This could help increase the awareness of this important resource.

Rail Importation of Aggregate

Another strategic opportunity identified though the research and the expert review panel is the importation of aggregate by rail. The air-quality analysis in Chapter 4 indicates that the importation of aggregate by rail has a lower CO_2 emission rate (grams/net ton-mile) compared to the barge and truck modes. The region currently lacks a rail distribution or transloading facility and according to rail experts, this type of facility is needed for this to be a viable option. Constructing a rail distribution facility at one or two sites located close to where construction aggregate is needed (in order to limit truck distances between the distribution center and market) could make importation by rail a viable option.

According to the expert review panel, a train of 60 hopper cars holding 100 tons of aggregate per railcar could deliver approximately 1 million tons of aggregate annually (one shipment three times a week) to the San Diego region and help reduce the supply gap. If the demand for aggregate cannot be met by local sources, importation by rail may become a viable option. Generally speaking, for carload service, a distance of 400 to 500 miles is required for rail to be competitive. Aggregates, however, are a heavy bulk commodity that would most likely be handled in a unit train service (where the railcars are shipped from the same origin to the same destination), which could make rail competitive for smaller distances about 50 miles with the proper loading and unloading facilities.[2]

One of the proposed mobility objectives of the SANDAG 2050 RTP is to expand goods movement options and enhance goods movement to support economic prosperity. The RTP proposes a proactive approach to addressing the impacts of goods movement that includes a regional freight system design that would avoid community, health, and environmental impacts, as well as remove existing impacts wherever possible. Selected projects for increasing rail capacity to improve goods movement such as double-tracking, expansion of sidings for freight, and rail yard facilities that could serve as possible transloading facilities are planned for inclusion in the SANDAG 2050 RTP. The feasibility of making the infrastructure improvements and establishing a distribution center to deliver aggregate via a rail line to one or more sites may be a worthwhile endeavor to consider.

Ship/Barge Importation of Aggregate

Another strategic opportunity identified though the research and the expert review panel is the importation of aggregate by ship or barge through the San Diego Unified Port. The fuel consumption and CO_2 emissions analysis in Chapter 4 indicates that the importation of aggregate by ship has the lowest CO_2 emissions rate (grams per net ton-mile) and the lowest fuel consumption rate (gallons per net ton-mile) compared to other modes of transport. As noted in Chapter 3, Aggregate Supply and Demand, Eagle Rock Aggregates is considering extending its shipments of sand and gravel from Canada to San Diego using large ships carrying up to 79,200 tons of aggregate.[3] The ships (CSL's Acadian) emit 13 times less CO_2 emissions than a typical barge (5 grams per net ton-mile compared to 70 grams per net ton-mile) and have nearly 50 times the capacity. If necessary improvements are made at the port, such as development of a transloading and storage facility and access improvements from the port to major distribution freeway corridors, the capacity of supplying aggregate through the port could be two million tons per year according to Eagle Rock representatives. (Dredging to accommodate large ships at the Tenth Avenue Marine Terminal has already been completed.)

Together with the Port of San Diego, the region could consider options for importing aggregate into the region through the port with the needed infrastructure improvements and efforts to mitigate any negative impacts to the local community. Access improvements to the Tenth Avenue Marine Terminal are planned for inclusion in the Goods Movement Action Plan as part of the SANDAG 2050 RTP as it would benefit goods movement in general. These improvements plus other internal improvements at the port could facilitate aggregate supply.

2 BNSF representatives, personal communication, August 2010.

3 U.S. Geological Survey. (2010). 2007 Minerals Yearbook: California (Advance Release).

KEY FINDINGS

Local Aggregate Shortages

According to reports by the Department of Conservation and discussions with local miners, the San Diego region has ample sources of the necessary rock types to meet the anticipated future aggregate demand, but access is limited as aggregate needs compete with other community needs such as urban areas, open space, environmentally sensitive areas, and military lands with restricted access. Factors that would contribute to an increase in annual production within the region include: (1) increasing annual production limits; (2) extending the permit duration of mines (years); (3) expanding existing permitted mines; and (4) permitting new mines.

Fine aggregates (i.e., sand) are in short supply in the San Diego region. According to local mining operators, sand makes up approximately 90 to 95 percent of all aggregate imported into the region. Sand is a critical component required to produce portland cement concrete. The sources for sand and gravel are predominantly located in river deposits. It is important to note that while these river deposits and drainage systems provide a high-quality source of sand and gravel, they may be considered environmentally sensitive areas or contain endangered species and habitats.

The San Diego region has historically produced a sufficient supply of coarse aggregates to meet local demand; however, if no new mines are permitted or permits of existing mines are not extended or expanded, the region could likely face shortages of coarse aggregates as well. According to a 2006 study by the California Geological Survey, existing sources of aggregate in San Diego region will be able to meet only 17 percent of the demand through 2055. The region is expected to demand (or use) more than a billion tons of aggregate by that year. Permitted aggregate reserves are estimated to be 198 million tons, resulting in an 83 percent shortfall in meeting the region's needs.

Environmental Regulatory Challenges

Many concerns about the complexity of the environmental regulatory process were expressed during the expert review panel meetings. The purpose of the study is not to develop solutions for the environmental permitting process, but rather to document the issues so that policy makers and others are aware of the concerns. While the environmental regulations are important to protect environmentally sensitive lands and endangered species, the permitting process itself is perceived to have inherent inconsistencies that result in time delays and increased costs. Improving the understanding and communication between industry and regulatory agencies may lead to a more consistent approach to permitting and more certainty in outcome. The complexity of the permitting process has contributed to large mine sites in the region as it is perceived to be costly, especially for establishing new smaller mines.

Identification of Potential Aggregate Supply Sites

Multiple potential aggregate sites were identified for consideration. Through a GIS analysis, it was determined that over 1,000 potential aggregates sites of 20 acres or greater exist in the region. These potential sites are not developed and have not been conserved for environmental reasons nor identified for conservation at a 90-percent level.[4] The potential suitability of these sites for construction aggregate cannot be determined by a GIS exercise alone and will need to be evaluated on a case-by-case basis. However, local governments could use the GIS tools developed by this study to add a number of overlays to help focus efforts on available sites for aggregate development. This evaluation also needs to include the proximity to highways and freeways, proximity to the market, quality of the aggregate, and marketability of the aggregate.

According to expert review panel representatives, while 20-acre mines do exist, a more ideal size for a mining operation is more likely to be in the 40- to 60-acre range or 100-acre or greater range. These experts commented that often large acreage is needed to accommodate required set-asides for mitigation purposes to be sure the site will be economically viable. Based on this information, the GIS overlay analysis was repeated for potential aggregate supply sites of 60 acres or more and for supply sites of 100 acres or more. The analysis showed that there are 553 potential aggregate supply sites of 60 acres or more and 390 potential supply sites of 100 acres or more. Most of the sites are located in the unincorporated parts of the region.

The study also conducted a GIS spatial analysis to optimize the distance between the potential available aggregate sites and demand points. The SANDAG RTP projects were used in this analysis as the demand points as the location of RTP projects coincide with areas of future growth in the region. The analysis generated various drivesheds (driving areas) in five-mile increments from each RTP aggregate demand point. The analysis showed that as the driveshed is expanded, more aggregate supply sites intersect with the RTP demand points, and the marginal benefit increases up to a certain point. Determining the point of diminishing marginal benefit is key to identifying the optimal driveshed where the largest number of projects can be served with the least additional distance. This point occurs at the 20- to 25-mile driveshed. As transportation plays a major role in the economic and environmental cost of aggregate, the farther the distance, the higher the costs; therefore, an important factor to keeping costs low and reducing CO_2 emissions from hauling aggregate is to reduce haul distance by truck.

Options for Importing

Options for importing aggregate into the region include import by truck from nearby counties. It also may be imported from distant mines by train, barge, or ship. The region is currently importing aggregate by truck from nearby counties. It also has imported aggregate by barge from Mexico. Importation by rail could be an option for consideration if necessary infrastructure improvements, including a transloading facility, were to be constructed. This option could bring in about a million tons of aggregate annually. Importation by ship could be an option with some access improvements from the Port of San Diego to major distribution freeway corridors and other infrastructure improvements at the Port. The capacity could be about two million tons of aggregate annually.

[4] The MSCP Pre-Approved Mitigation Area (PAMA) land and MHCP soft line (preserve area is less than 90%) were not eliminated as potential candidates of aggregate supply since these lands are allowed to be developed to some extent, usually up to 25 percent, in accordance with guidelines established in the plans. In addition, environmentally sensitive lands at Marine Corps Air Station Miramar were not eliminated. Removing these sensitive areas at Miramar reduces the number of potential sites from 1,159 to 1,148.

Fuel Consumption and CO_2 Emissions

The data emphasize the major role that transportation plays in calculating environmental costs and indicates that the key to reducing CO_2 emissions is to reduce haul distance by truck. Aggregate is a low-unit-value commodity with high transportation costs due to its bulk and weight. Since transportation substantially increases the cost to the purchaser, obtaining aggregate from a source close to the point of use reduces cost. This also reduces other direct costs, such as fuel consumption, as well as the environmental and social costs of air pollution, traffic congestion, and road maintenance associated with truck travel.

The fuel use and air-quality analysis indicates that the transportation of aggregate by truck has the highest fuel consumption and CO_2 emissions per net ton-mile compared to other options of rail, ship, and barge. The lowest fuel consumption and CO_2 emissions per million tons of aggregate result from the transport of aggregate from local aggregate mines located close to projects. Even though ship and rail have lower CO_2 emissions per net ton-mile than truck or barge, the distance traveled is often long, and they still have some component of truck travel once the material arrives in the region.

POSSIBLE NEXT STEPS

The information, mapping, and tools developed through the San Diego Region Aggregate Supply Study are designed to be used to inform decision makers and offer a pilot approach for other local governments that also are grappling with aggregate supply issues. The tools developed as part of this study can help focus efforts and provide a starting point for identifying potential sites for aggregate mining, but the tools alone cannot provide sufficient information for the final identification of specific sites. Site-specific field activities were beyond the scope for this study. This database and report were structured to provide data and information that local jurisdictions and government agencies could use to help with public policy decisions. Some of the next steps that could be considered in the future include:

- Incorporate the study's tools and findings into the SANDAG Regional Comprehensive Plan so that aggregate supply issues can be considered in future planning efforts.
- Seek potential opportunities for linking restoration projects with possible secondary benefits of aggregate extraction. For SANDAG, this could include exploring opportunities for linking an existing effort, such as buying and restoring mitigation lands as in the *TransNet* program, with efforts to identify potential areas for aggregate sand.
- Research mineral resource plans in other parts of the state or nation to provide a better understanding of the policies that work and those that do not. The information could be used as the basis for managing aggregate resources to avoid shortages.
- Establish criteria to narrow the list of potential aggregate supply areas. Local jurisdictions, policy makers, and others could work collaboratively to agree on and establish criteria that could consider factors such as distance to market, distance to major access route, distance from other land uses, local zoning ordinances and set-back requirements, and access to power and water. Narrowing the focus could help identify higher priority lands because they meet desired criteria for developing a quarry.

- Share tools and information with local jurisdictions so that they may consider incorporating them into their future planning efforts. This could include using the tools to establish mineral resource layers for protection of mineral resource lands. Tools could be provided to help enhance the technical capabilities of local jurisdictions to better plan for aggregate resources in their jurisdiction.

- Share tools and information with Caltrans' districts and other state agencies dealing with aggregate supply issues.

- Consider opportunities to encourage development of more detailed geologic data for the San Diego region from the United States Geologic Survey (USGS). Available copies of USGS 7.5-minute quadrangle geologic maps had limited coverage for the San Diego region. Future research efforts on aggregate supply issues could benefit from more coverage at this detailed level. Other parts of the state could benefit from the additional coverage as well.

- Consider opportunities to encourage the classification of more lands into MRZs by the Department of Conservation, California Geologic Survey. The existing classification is largely limited to the urban areas in the western part of the region. Resources for this effort are scarce; however, local agencies could better plan for and protect these important mineral resource areas with expanded classification.

CONCLUSIONS

The objectives of the San Diego Region Aggregate Supply Study were to provide a review of aggregate sources in the region, clarify the needs and issues surrounding the supply of aggregates, develop a regional GIS database that would allow for the visualization of aggregate sources with informational overlays, and develop tools that other local governments could use to estimate air-quality impacts due to transport. The information, mapping, and tools developed through this process could be used to inform decision makers and offer a pilot approach for other local government that have aggregate shortages.

The aggregate supply issue is complex. Although the study does not make recommendations for policy considerations, it compiles information from various sources into one document so that decision makers can start to understand the complexities and importance of this mineral resource and its connection to modern society.

Future investment in essential infrastructure, such as new and improved roads, housing and commercial establishments, hospitals and schools and other buildings, rail links, airport facilities, and water and sewage facilities all require aggregate. In fact, it is impossible to build a region without aggregate. Opportunities for effective planning today will help address the availability of aggregate required to meet the region's future needs.

San Diego Region Aggregate Supply Study

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