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PLANNING & BUILDING

April 9, 2015

Jim Bergman, Planning Director
County of San Luis Obispo
976 Osos Street, Room 200
San Luis Obispo, CA 93401

Re: Las Pilitas Resources Quarry Appeal; DRC2009-00025

Dear Director Bergman:

I am writing to provide you with some additional detail regarding the appeal by Las Pilitas Resources, LLC from the Planning Commission's denial of the proposed Las Pilitas Quarry, which will be heard by the Board of Supervisors on May 12, 2015. As we stated in our appeal form, the Denial Findings that were adopted by the Planning Commission are not supported by substantial evidence in the record and in many cases are directly contradicted by the evidence in the record. The findings are based on conjecture, speculation, and misunderstandings about the project, and cannot be reconciled with the actual facts that are in the record. In addition, the Planning Commission erred by not considering the importance of this aggregate resource to the region as a whole as required by state law, as well as other considerations that are specific to mineral resources and which alter the balance of the traditional Conditional Use Permit findings for projects such as this.

A copy of the Denial Findings is included in this letter as Attachment A, for reference. The specific errors in each of the Denial Findings are summarized below:

1. The proposed project or use is not consistent with the San Luis Obispo County General Plan because:

<u>Denial Finding 1.a:</u>

This Denial Finding alleges that the project should be denied because it is not consistent with certain Visual Resources goals of the Conservation and Open Space Element (COSE) of the General Plan. This finding is erroneous in several respects.

There is no requirement that a project be found consistent with the COSE before it can be approved. Rather, the County Code specifically requires the decision-makers to find that the project is consistent with the *Land Use Element* of the General Plan, not the COSE. (County

Code § 22.62.060(C)(4)(a)) The Las Pilitas Quarry Project is consistent with the Land Use Element, as described in detail below.[1]

i. Consistency With the LUCE and the EX1 Combining Designation

The County's Land Use Element (LUE or LUCE) of the General Plan, as reorganized in 2014, is broken into two parts. Part I is the Framework for Planning, and Part II contains the Area Plans. The LUCE notes that its primary goal is to "achieve internal consistency among the various elements of the county general plan... the LUE complements the other elements by incorporating and implementing their land use concerns and recommendations." (LUCE Part I, 1-10.) "The Land Use Element identifies appropriate locations for different land uses on the basis of minimizing conflicts between them." (LUCE Part I, 3-3.) To that end, the LUCE establishes land use categories as well as special combining designations.

According to the Implementation Chapter of the LUCE, a proposed land use is consistent with the Land Use Element when "the proposed use or division is allowed in the land use category in which the site for the proposed use is located, as shown on the official maps." (LUCE Part I, 8-1.) Here, the underlying land use category for the Las Pilitas Resources Quarry project is Rural Lands, and per Table 2-2 of the LUO, mines and quarries are an "A2: Allowable Use" in that category.

The Las Pilitas Resources Quarry is also being proposed within a special combining designation that specifically allows for quarries. "Combining designations identify areas with characteristics that are either of public value or are hazardous to the public." (LUCE Part I, 7-1.) The Extractive Resource Combining Designation (EX1) was created "to recognize the importance of continuing availability of mineral and energy resources by avoiding land use decisions which may inhibit the continuing viability of energy and extractive operations and result in unnecessary and premature termination of the use of such resources." (LUCE Part I, 7-1.)

Two of the main purposes of the EX1 overlay are "to notify landowners and the general public of the presence or high likelihood of significant mineral deposits," and "to emphasize the conservation and *development* of the mineral deposits... provided that a high level of environmental quality is also preserved and protected through the environmental permitting process." (LUCE Part I, 7-8.) The EX1 overlay applies to all areas that the California Geological

[1] This consistency has important derivative implications because there is a legal presumption that all of the elements of the General Plan are consistent with one another (this is often referred to as horizontal consistency), and therefore if a project is consistent with one element, it is presumably consistent with the others. Because the General Plan is implemented through ordinances, which ordinances must be consistent with the General Plan (referred to as vertical consistency), there is also a presumption that if a project is consistent with the applicable ordinances in the County Code, it is consistent with the General Plan. As discussed under Denial Finding 2.a and 2.b, below, this project is also consistent with the applicable provisions of the Land Use Ordinance (Title 22).

Survey has classified as containing or being highly likely to contain significant mineral deposits. including the proposed project site. (LUCE Part I. 7-2.)

When the EX1 overlay was enacted in 1991. one of the findings was that the enactments "will provide for development that *is compatible with the character of the general area and immediate site vicinity* because they require that in areas of significant mineral resources, land uses which are subject to discretionary land use permits will not adversely affect existing mineral resource extraction uses." (Attachment B. Finding A) In denying the Las Pilitas Resources permit. however. the Planning Commission found that the project was not consistent with the character of the immediate neighborhood and surrounding community. (See Denial Finding 4.) As discussed in more detail later in this letter. that Denial Finding is directly at odds with the enactment of the EX1 overlay.

It was also found that the EX1 combining designations would "not be detrimental to the public health, safety and welfare of area residents because they require that in areas of significant mineral resources, land uses subject to discretionary land use permits be compatible with existing resource extraction operations. . . .The proposed amendments are consistent with the San Luis Obispo County General Plan because in the areas where the proposed EX1 combining designation is to be applied, *mineral resource extraction is an allowable use*. . . . In addition, the proposed amendments. which are intended to emphasize the conservation and development of significant mineral resources, are consistent with the general land use goal which includes conserving nonrenewable resources. . . . ." (Attachment B, Findings C,D.)

The Staff Report that was prepared for the 1991 EX1 overlay enactment stated that the areas identified for the overlay "are areas considered to be available for mining because they contain what the state considers to be compatible land uses. For example, agriculture and very low density development of one dwelling unit per ten or more acres are considered compatible land uses."[2] (Attachment B, Staff Report pg. 5-8)

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[2] Actually. the State Mining and Geology Board's (SMGB) regulations specify an even broader range of development that is deemed compatible with mining. They also define what land uses are presumed incompatible with mining:

"Compatible Land Use. Land uses inherently compatible with mining and/or that require a minimum public or private investment in structures, land improvements, and which may allow mining because of the relative economic value of the land and its improvements. Examples of such uses may include, but shall not be limited to, high density residential, low density residential, geographically extensive but low impact industrial, recreational, agricultural, silvicultural, grazing, and open space." (14 Cal. Code Regs. § 3675.)

"Incompatible Land Use. Land uses inherently incompatible with mining and/or that require public or private investment in structures, land improvements, and landscaping and that may prevent mining because of the greater economic value of the land and its improvements. Examples of such uses may include, but shall not be limited to, high density residential, low density residential with high unit value, public facilities, geographically limited but impact intensive industrial, and commercial." (14 Cal. Code Regs. § 3675.)

The LUCE itself notes that future amendments to the General Plan in the EX and EX1 areas "shall give priority to maintaining land use categories which allow resource extraction and which result in development that is compatible with resource extraction." (LUCE Part I, 7-9.) Specifically, "proposals within the EX or EX1 combining designations which would preclude resource extraction, would allow minimum residential parcel sizes of less than 10 acres or would otherwise be incompatible with resource extraction shall be approved only when the need for the particular use is determined by the Board of Supervisors to outweigh the value of keeping the potential mineral resource available for extraction." (LUCE Part I, 6-10.)

In other words, any new development on less than ten acres that has taken place in the EX1 area since 1991 should be considered incompatible with the proposed project, not the other way around. As can be seen on the chart in Attachment C, this includes most of the surrounding properties.[3] Alternatively, the County could follow the approach of the SMGB, and find that low density residential uses are "inherently compatible" with mining as a matter of law, pursuant to the SMGB regulations.

By its own terms, the LUCE "has been designed to support county land use decisions as part of a dynamic process instead of being a rigid, static plan. To achieve that objective, the LUE has been structured and is used differently than traditional land use plans and zoning. The land use maps illustrate long-term land use and growth policies, and *they are adopted as the official zoning maps and used to evaluate current development proposals*."[4] (LUCE Part I, 1-3.)

The Las Pilitas Resources project is fully consistent with the LUCE and the official zoning maps as they pertain to mining projects. Because the LUCE and maps were deemed consistent with the COSE at the time they were enacted and updated, this project is therefore also consistent with the COSE.[5] To construe the two vague Visual Resources "goals" from the COSE cited in this Denial Finding to trump the overarching consistency of this project with the Land Use Element would allow the vague to trump the specific, would manufacture an internal inconsistency among the County's General Plan documents, and would allow the COSE aesthetic goals to supersede all other General Plan documents, ordinances, and development standards for mining projects that the County has enacted. That is simply not a proper way to interpret or apply the County's planning documents.

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[3] Interestingly, this chart was prepared by one of the groups opposed to the quarry, Margarita Proud, and submitted into the record as part of their comments on the DEIR for the project.

[4] This last part is important because some of the opponents to the Las Pilitas project have claimed that the extractive resource combining designation that applies to the project site and vicinity is not "zoning" and that therefore the site is not "zoned" for mineral extraction. According to the LUCE, however, which created the combining designations, that is exactly what it is.

[5] In fact, when the EX1 overlay was put into place in 1991, it was an amendment to the Land Use Element, the Land Use Ordinances, *and* the Open Space Element. (See Attachment B)

ii. Scenic Corridor Findings

The facts listed regarding scenic resources in support of Denial Finding 1.a are not accurate. The Denial Finding states: "The slopes of the proposed mining area and mining equipment would be visible from SR 58 and would be inconsistent with the rural visual character of the area." It goes on to say that the project should be denied in part because it "would be visible to the public in an area that is predominantly characterized by a natural setting including the riparian corridor surrounding the Salinas River." These statements, however, ignore the fact that the surrounding landscape has already been significantly altered and degraded by the nearby Santa Margarita Quarry, which is highly visible from SR 58 and which has existed for 100 years, and has applied for a permit to mine for another 50 or so years. This existing condition is an important part of the visual baseline, which was not acknowledged in the Staff Report or the EIR.[6]

The language in the Denial Finding would lead the reader to believe that there is currently no mining in this area at all and that this is a pristine viewshed. As can be seen from the photographs in Attachment F, however, that is not at all the case. To the contrary, the mine face of the existing Santa Margarita Quarry just to the west is easily the most dominant feature of the landscape on this quarter mile stretch of public roadway, detracting from any expectation that drivers on SR 58 might have of a pristine vista in this area. The visual impacts of the Las Pilitas Quarry would actually be *consistent* with the existing character of the landscape—as well as the historical character of the landscape, given that the area has experienced active mining for 100 years.

According to the reclamation plans for the two projects, the visible portion of the Las Pilitas Quarry will be fully reclaimed far sooner than the mine face of the Santa Margarita Quarry. Bafflingly, however, the Las Pilitas Quarry was deemed to have significant and unavoidable aesthetic impacts, while the DEIR for the proposed Santa Margarita Quarry expansion (which includes reclamation of the existing mine face) found there would be no aesthetic impacts, in part because the viewshed could not be considered "scenic" due to the historical and existing mining activity.

Despite all this, Denial Finding 1.a claims that the Las Pilitas Quarry project is located in a "corridor which is highly scenic," and that, "although SR 58 [is] not an officially designated scenic highway, Policy VR 4.1 of the COSE indicated that SR 58 will eventually become a scenic corridor. The significant and unavoidable impacts associated with the proposed quarry and the excavated slopes that will be visible to travelers along SR 58 would not be consistent with the identification of SR 58 for designation as a scenic corridor." This statement misrepresents both the scenic roads program set forth in the COSE and the probability that this stretch of SR 58 would ever be made a part of that program.

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[6] According to both the LUCE and the COSE, "the visual character of a planning area is a combination of its natural and built environment." (LUCE Part II, III.3-3)

The COSE, which was updated in 2011,[7] includes the following goal: "Goal 4: Visual resources will be protected within *scenic corridors* along well-traveled highways and roads." (COSE 9.12) Policy 4.1 then states that the County will "designate scenic corridors based on the recommendations for Scenic Corridor Studies, for the candidate roads and highways listed in Table VR-2." (*Id.*) SR 58 is listed as a candidate road in that table, but it is important to note that the candidacy is for *the entire 70-mile stretch of SR 58 in the County*, from almost Highway 101 to the Kern County line. (COSE 9.14)

Upon reading the implementation strategies for this program, it becomes clear that the *entire* 70-mile stretch of SR 58 was never intended to be deemed scenic, or even potentially scenic, by the COSE. The implementation strategies outline a multi-step process for the establishment of a scenic corridor program in the County, and the first step is to put together a priority list and work program to *study* the candidate roads listed in Table VR-2, in order to identify *key scenic resources* along those roads worthy of protection. The studies must: "(a) specify the features that need to be protected through a site-specific analysis of each viewshed; (b) state why it is important to protect those features; (c) where applicable, establish specific mapped boundaries that define the minimum area necessary to protect the identified features; and (d) identify the type of inappropriate development that should be regulated." (COSE 9.12) The studies would then be presented to the Board of Supervisors, who would have the final say on designating any particular road section as scenic. The County must then establish design standards that would be applicable to development in those corridors, without unduly burdening private property.

To date, this "designation of scenic corridors" policy identified in the COSE has not been implemented by the County, and no studies have been done on SR 58. Accordingly, this standard is not applicable to the Las Pilitas Quarry project, and cannot be used as one of the reasons for denying the project. Even were such a program about to be implemented in the County, there is no indication that this particular stretch of SR 58 was the reason for the highway's listing as a candidate road, as opposed to the other, far more scenic, areas that the highway passes through, such as the wildflower areas near Shell Creek Road or the Carissa Plains.

As stated in Implementation Strategy VR 4.1.1, the corridor studies for candidate stretches of road submitted to the Board of Supervisors under this program must focus on *specific features worthy of protection* and include *site-specific analysis*. The facts recited in Denial Finding 1.a fall far short of this standard. In reality, as implied in the DEIR for the Santa Margarita Quarry Expansion (which found that this view was not a "scenic vista"), it is highly unlikely that this area could ever qualify as a scenic road under the County's hypothetical future program, because of the extent to which it has already been impacted by mining activity and other development.

[7] Notably, this was *after* the application for the Las Pilitas Resources Quarry was deemed complete.

Denial Finding 1.b:

This Denial Finding states that the County must evaluate proposed mining operations in areas having open space, scenic, habitat, recreational, or agricultural value by balancing these values against the need for extracting mineral resources from such areas. The Denial Finding then states that while the State of California has recognized the importance of aggregate resources and the need to balance the demand and supply of aggregate materials in the County, the Applicant has not demonstrated that the need for the proposed facility would outweigh the visual and environmental impacts of the project.

As an initial matter, it is questionable whether this balancing test even applies here. COSE Goal MN-1 and Policy MN 1.1 only applies to mining projects in areas having open space, scenic, habitat, recreational, or agricultural value. The current project site does not contain any of these specific values. The site is not zoned open space and does not fit into either of the "distinct categories of open space" identified in the COSE. (COSE, 7.9) As discussed above, the site is not in a scenic area. The EIR found that the site did not contain any meaningful habitat, recreational, or agricultural values that would be disturbed by the mining. Therefore, it would appear that this finding is inapplicable from the outset.

Even if this balancing test does apply to the project, the record shows that the need for these mineral resources far outweighs the other values that the site might possess. The State of California has estimated that this Production-Consumption (PC) Region (which includes San Luis Obispo and Santa Barbara counties) will run out of aggregate by the year 2026 if new reserves aren't permitted. The need for this project is pressing. (See Attachment D: Special Report 215 (2011))

Currently, the only other mining application pending in this County is for the expansion of the Santa Margarita (Hanson) Quarry, and that expansion alone will not meet the projected shortfall of 188 million tons of aggregate that will be needed over the next 50 years. That project, if approved, would only offset the shortfall by 21.5 million tons. One other mining proposal in Santa Barbara County, which would add only another 4 million tons, has been on hold since 2011. No other mining projects are currently proposed in the entire PC Region to meet the demand that has been projected by the State.[8] The need for the Las Pilitas Resources project is critical, from a supply and demand standpoint.

The Las Pilitas Resources Quarry is also needed to foster local price competition and product diversity. Currently, there are only two producers of hard rock aggregate in the North County, which does not give consumers—including the County Public Works Department and Caltrans

[8] It should be noted that the State has been tracking and forecasting aggregate demand since SMARA was enacted in 1975, and the calculations in reports such as Special Report 215 have a proven track record of accuracy. If anything, they are occasionally too conservative—the last estimate of aggregate consumption for San Luis Obispo and Santa Barbara counties ended up being exceeded by 20%.

(who are the two largest consumers of aggregate in this County)—a lot of options. Several speakers at the Planning Commission hearings reported having to wait a week or more just to get a load of decomposed granite delivered. Oftentimes, the products that are being produced at those two quarries are not what are required by the specs for local jobs. Consequently, at least 10% of the aggregate being consumed in this PC Region is imported from outside the Region.

Construction aggregate is quite literally the building block of any economy. Without a plentiful and diverse local supply, prices can soar quickly, affecting everything from the cost of infrastructure maintenance to the price and availability of housing. (The average single family home requires 229 tons of aggregate.) Trucking aggregate from long distances away, as becomes necessary when the local supply is not adequate, has a host of ramifications. As stated in a report by the State Mining and Geology Board:

> For construction minerals to have value, they must be produced near their place of use. This reflects their overall low unit value and high transportation costs due to their bulk and weight. A haul distance of about 25 miles doubles the delivered price of construction aggregate. Shorter haul distances mean lower costs and less environmental impact which results in less fuel use, air pollution, traffic congestion, road wear, tire and equipment wear, and shorter delivery times. Since almost half of construction aggregate is used in public works projects, lower cost aggregate means lower taxes. (Attachment G: A Report of Mineral Land Classification and Designation Under the Surface Mining and Reclamation Act of 1975, page 5.)

The need for this project is therefore critical enough that it should, in theory, be sufficient to outweigh a host of environmental impacts. Fortunately, the impacts of the Las Pilitas Resources project are relatively few. Apart from the "aesthetic impacts," which were discussed above, the only unmitigable impacts are nominal noise level increases (which will only occur during business hours, Monday through Friday) and a contribution to future cumulative traffic volumes at the intersection of Estrada Avenue and El Camino Real, which could be fixed with signalization of that intersection.

The Denial Finding does not explain why these rather small impacts outweigh the significant need for additional aggregate documented in Special Report 215. Nor does the Denial Finding disclose that this deposit of granite was recently deemed by the SMGB to have "regional significance." Under state law, this designation requires the County to undertake an additional balancing step before deciding whether to approve the project. Specifically, state law provides that: "Lead agency land use decisions involving areas designated as being of *regional significance* shall be in accordance with the lead agency's mineral resource management policies and shall also, in balancing mineral values against alternative land uses, consider the importance of these minerals to their market region as a whole and not just their importance to the lead agency's area of jurisdiction." (Pub. Res. Code § 2763(a)) This factor was not addressed by the Planning Commission findings, and consequently Denial Finding 1.b applies an incorrect and incomplete balancing test.

Denial Finding 1.c:

This Denial Finding states that the project would be inconsistent with the Noise Element goals and policies, because the public "will be subject to the harmful and annoying effects of exposure to excessive noise" as a result of truck traffic in the community of Santa Margarita, as well as from blasting noise and vibration. This finding simply cannot be reconciled with the conclusions in the Noise Chapter of the EIR for the project.

i. Truck Traffic Noise

"In most real world situations, people will not perceive an increase in noise levels any less than 3 dBA. For this reason, increases below 4 dBA are usually not considered substantial." (FEIR at 4.8-14.) Even using the extremely high number of 25 hourly truck trips (and assuming that all the trucks would be new or additional, which is not the case), the EIR found that the truck traffic would cause a noise increase of just **1.9 dBA**. (FEIR at 4.8-14 to 4.8-15) The EIR also found that: "Along most segments of SR 58, where existing noise levels are below CNEL 60 dBA, this increase will not cause existing noise levels to exceed this threshold. For the two areas where residences are closer to the road and where existing noise levels are already over 60 dBA, the project traffic will add slightly to these noise levels." (FEIR 4.8-15)

At all the of residences along SR 58 that currently meet the standard, noise levels would remain below the County's standard of 60 dBA even with the project. However, the EIR reasoned that: "It will affect outdoor living areas exposed to traffic noise and the increase in heavy truck traffic may be *perceived* as objectionable. For this reason, the traffic noise increase at these locations is considered a significant impact," notwithstanding the fact that noise levels would still be below the County's threshold and would likely be imperceptible. (FEIR 4.8-15)

At two locations in downtown Santa Margarita (essentially either end of town on El Camino Real), existing noise levels already exceed 60 dBA. For the downtown area then, the EIR concluded that the effects of the project truck traffic noise would be *less than significant*, because, "unlike the quieter neighborhood along J Street, the heavier traffic volume through this downtown portion of Santa Margarita makes the noise of individual vehicles less distinct." (FEIR 4.8-16.)

These extremely conservative conclusions are a far cry from the language used in Denial Finding 1.b, which states that sensitive receptors would be subjected to the "harmful" and annoying effects of exposure to "excessive noise" as a result of truck traffic within the community of Santa Margarita. There is simply no evidence to support the findings that traffic noise would be harmful and excessive, given that, even under the worst case scenario, the noise level increase would be less than 2 dBA—not perceptible to the normal human ear—and noise levels would remain below the County's threshold at all but two locations in Santa Margarita, which two locations are already over the threshold even without the project.

Moreover, it should be remembered that the truck traffic noise will only be experienced Monday through Friday between 7 am and 5 pm, when ambient noise levels are generally much louder than the combined 24-hour day/night average that was used in the EIR, and when many of the residents may not be home or using their outdoor living areas (the noise levels at the indoor living areas would remain below the County's thresholds in all cases).

Finally, it bears repeating that the trucks going through downtown will not all be "new" or additional. Most of the trucks that would go to the Las Pilitas Quarry are currently hauling in and out of the Santa Margarita Quarry, and thus are already traveling along El Camino Real and are already part of the baseline noise levels in the downtown area. Therefore, the noise levels are unlikely to change in the downtown at all as a result of this project.

ii. Operational Noise

Operational noise impacts from the project are similarly overstated. Noise modeling done for the EIR shows that the County's threshold for hourly noise may be exceeded by 1.7 to 2.9 dBA at the two nearest residences during the first two phases of quarry operations. (FEIR, 4.8-19, Table 4.8-9.) Again, this type of increase is not likely to be perceptible to the average human ear, and would normally not be considered significant. The EIR modeling is based on the reasonably foreseeable worst case scenario, and does not take into account possible mitigation measures. The EIR notes that: "Several measures can be undertaken to ensure that the stationary noise source standard … is met by quarry operations." (FEIR 4.8-20) For instance, all heavy equipment can be fitted with mufflers or other noise reducing equipment, operating multiple pieces of equipment at one time can be discouraged, and stockpiles can be strategically located as noise barriers. These measures alone can lead to reductions of 1-2 dBA or more, which may be sufficient to ensure that hourly noise levels at the nearest residences are not increased. (FEIR, 4.8-21.) If these measures do not work (based on noise monitoring that will be done), then noise barriers and other shielding measures can be employed. "Such shielding and temporary barriers can typically provide an additional 5 dBA of noise reduction and more may be possible." (FEIR, 4.8-21.) If these mitigation measures are employed, no violations of the County's stationary noise standard will occur.

Nevertheless, the EIR observed that: "Even if the project complies with the requirements of Section 22.10.120, however, it may still cause some disturbance or adverse noise effects at the nearest residences during construction, from the perception of backup alarms, or from other disruptions such as loud dumping noises. The only way to avoid operational noise effects completely would be to prohibit this project and restrict all quarry projects to areas that are located at even greater distances from residential areas, about 3,000 feet."[9] (FEIR, 4.8-21.) For this reason, the EIR deemed operational noise an unmitigable impact.

[9] It should be noted that backup alarms are legally exempt from the noise standards; however, in this instance, the Applicant has volunteered to use "white noise" backup alarms instead of the traditional

The fact that some residences might still be able to *hear* some quarry operational noises during daytime hours, even when reduced to legally-acceptable levels, does not make those noises "harmful" or "excessive" to the point of justifying denial of the project. During public comment on the project, several residents along Digger Pine Road reported that they can hear the Santa Margarita Quarry operations regularly, but that such noises do not interfere with their daily life or enjoyment of their property. It is impossible to mitigate all noises from a quarry, or even any other type of land uses, which is why the County has set standards in its Noise Ordinance, as opposed to prohibiting *any* audible off-site noises.

In addition, most of the permits that have been pulled for the two properties that would experience the operational noises impacts were issued after the EX1 overlay was put in place. The nearest lot is actually flagged "mine buffer area" in the County's PermitView system. Denying the Las Pilitas Resources Quarry on the grounds that operational noises could be heard from these residences would violate the entire purpose of the EX1 overlay, which is to put property owners on notice of the potential for mining in the area, and to ensure that residential uses don't encroach and hinder the ability to extract the rock in the future.

In short, the worst-case scenario operational noise impacts identified in the EIR, which can and will be mitigated to acceptable levels, do not support Denial Finding 1.c. Denying this project on the basis that nearby residences *may* be able to *hear* the quarry would be antithetical to the entire purpose of the EX1 overlay and the State's classification and designation of the rock in this area.

iii. Blasting Noise and Vibration

The EIR's conclusions about blasting and vibration do not support Denial Finding 1.c. Per the project description, blasting would occur 20 times a year, or less than twice per month. Each blasting event would last less than 2 seconds (FEIR, 4.8-23), meaning that any noise effects attributable to blasting would occur for a maximum of 4 seconds in a given month, or for less than 40 seconds out of the entire year. According to the EIR, "the noise is more like a wave crashing on the beach rather than like a bomb explosion." (FEIR, 4.8-23)

Nevertheless, the EIR deemed the noise impacts from blasting to be significant because, for those 2 seconds during a blasting event, the blasting noise on certain benches of the quarry might exceed the County's maximum threshold of 70 dBA. (For comparison purposes, 70 dBA is also the level of the typical television audio in a living room.) The EIR admitted, "It is possible that the predictive model used is overly conservative, and that the FHWA empirical value and results may be more accurate, in which case the predicted Lmax values would comply with the standard. Since the result is uncertain based on these two methods, the EIR conclusion will adopt the more conservative and assume that the impact will be significant." (FEIR, 4.8-23 to 24.)

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beeping alarms. This mitigation measure will further reduce the perception of operational noises from off site, as they generally cannot be heard from more than 200 feet away.

Thus, although blasting noise was determined to be a significant and unavoidable impact, this was based on a conservative estimate, and will occur less than twice a month, for less than two seconds. The quarry will be required to provide extensive advanced notice to all neighbors prior to blasting, and to monitor the level of the blasting noise, which should further reduce the impact on the lives and activities of nearby residents. It is worth noting that the nearby Santa Margarita Quarry has been utilizing blasting for years without any harmful effects on nearby land uses or residents.

With regard to ground vibration effects from blasting and heavy equipment use, the EIR concluded that these "are not expected to pose a significant effect. Significant vibration from these types of operations is limited to within a few hundred feet of the source, and all of the nearby residences are over 1,000 feet from where quarry operations are proposed.... While perceptible, [the modeled vibration] levels are considered very low and are not expected to cause any damage to normal structures and are substantially lower than the typical standards cited in the blasting plan. Therefore, ground vibration from the project operations and blasting is not expected to be a significant impact." (FEIR, 4.8-24 to 25.)

Again, this conclusion is at odds with the statements in Denial Finding 1.c., which suggest that both "blasting noise *and vibration*" that will be experienced adjacent to the project site warrant denial of the project. This Denial Finding is not factually correct or supported by any evidence, particularly with regard to vibration, which was clearly and unequivocally deemed a less than significant impact in the EIR.

Denial Finding 1.d:

This Denial Finding states that denial of the Las Pilitas Resources project does not preclude or set precedence for future mining projects within the EX1 combining designation. Yet that is exactly what it does.

One of the main purposes of the EX1 combining designation—and in fact SMARA itself—is to ensure that incompatible land uses don't encroach on classified and designated rock areas, to the point where it later becomes difficult to extract the rock because of neighborhood objections. Yet all of the reasons cited for denying the project hinge on perceived land use incompatibilities and neighborhood objections. Denying this project on the grounds cited in these Denial Findings allows the surrounding uses, many of which have developed in the years since the EX1 overlay was put in place, to effectively override and outweigh the EX1 zoning, to the point of rendering any rock deposits along SR 58 incapable of being accessed.

As can be seen on the map for Special Report 215 (Attachment E, which shows in green areas of known mineral deposits in the County) a significant portion of this granitic deposit can only be accessed along SR 58 or 229, or by otherwise going through the town of Santa Margarita (since the trucks will still need to ultimately get to Highway 101 to service their market). In order to access the remainder of the deposit, which lies in between the existing Rocky Canyon and Santa Margarita quarries, any new project would have to cross the Salinas River, would likely be visible from Highway 101, and would impact the much more densely populated areas of South Atascadero. And, as this map clearly shows, there is no other deposit from which to obtain aggregate in North County, except the Salinas River channel, which has limitations that should be self-evident.

There is nothing unique about the Class I impacts of the Las Pilitas Resources project: aesthetics, noise, and truck traffic contributions. Every hard rock mining operation will alter the landscape, will create noise, and will involve truck traffic. (In actuality, the Las Pilitas Resources project has fewer significant impacts than most mining projects, and the impacts that it will have are largely overstated in the EIR.) If the view of a quarry from a public road, noise experienced by neighbors, and truck traffic are legitimate reasons to deny a quarry, then no new quarry projects will ever be approved. Relying on the continued expansions of the two existing quarries (which is the only other option for meeting future demand) does nothing to foster price competition or diversity of supply, and presumes that these quarries will not encounter political opposition in their neighborhoods or run up against environmental constraints in expanding (such as endangered species or habitats, which is always a big *if,* until biological studies have been completed).

Looking at the State's map, it is difficult to imagine another quarry proposal that would be as close to the market and Highway 101 while impacting as few immediate neighbors as the proposed quarry. In other words, if this quarry cannot be approved, likely no new quarries can be approved in this deposit, and there is nowhere else to get aggregate in North County.

2. The proposed project does not satisfy all applicable provisions of Title 22 of the County Code because:

<u>Denial Finding 2.a:</u>

This Denial Finding states that the project is inconsistent with the County noise ordinance (County Code § 22.10.120) because project-generated noise will cause exceedances of the 60 dBA standard along roadways, the 50 dBA hourly Leq standard at nearby residences, and the 70 dBA standard for Lmax during blasting events. Again, this finding misstates the conclusions in the EIR.

i. Roadway Noise

The County standard for transportation-related noise is 60 dBA in outdoor living areas, as averaged over a 24-hour period. The Denial Finding states that the project will result in exceedances of this standard along the haul route. As stated in the EIR, however, even at 25 truck trips per hour (which is a very high number) and assuming that all of those trips would be new, the project traffic noise <u>would not</u> exceed 60 dBA at any of the sensitive receptors from the intersection of Estrada Avenue and El Camino Real out to the quarry site. (FEIR 4.8-15, Table 4.8-7) Within the downtown area, the project would increase traffic noise by 1.9 dBA at the east end of town, and by 0.7 dBA at the west end of town. (*Id.*) However, these areas are *already* *over* the 60 dBA threshold today, even without the project. Because the project's 1.9 and 0.7 dBA increase would not be perceptible in these areas given the existing traffic noise, the EIR deemed these impacts less than significant. (FEIR, 4.8-16) Thus, according to the EIR itself, the project will not *cause* any exceedances of the noise standards along the haul route. Under the worst-case scenario, it will add an imperceptible amount of noise in areas where the noise level is already over 60 dBA. There will be no "new" noise exceedances anywhere along the haul route as a result of the project.

More importantly, the Noise Ordinance itself exempts "traffic on public roadways... to the extent regulation thereof has been preempted by state or federal law." (County Code § 22.10.120.A.9) In this instance, the source of the noise is heavy truck traffic along a state highway, and regulation of trucks on a state highway is preempted by the California Vehicle Code. The Vehicle Code comprehensively regulates the use of the state's roads and highways and, as part of its scheme, expressly preempts local regulation of truck traffic. Vehicle Code § 21 states that:

> Except as otherwise expressly provided, the provisions of this code are applicable and uniform throughout the State and in all counties and municipalities therein, and no local authority shall enact or enforce any ordinance on the matters covered by this code unless expressly authorized herein.

The Vehicle Code regulates truck size, weight, tire size, speed limits, engine power, road surfacing, and all of the other things that contribute to the noise a truck makes on the road. Accordingly, *any* regulation of truck traffic on a state highway would likely encompass a matter covered by the Vehicle Code, and would therefore be preempted, including restrictions involving truck noise. This is exactly why the County Noise Ordinance contains an exemption for traffic noise in such cases. The County may enforce its Noise Ordinance, for instance, to ensure that new residential construction along a state highway contains adequate noise mitigations to protect the health and welfare of the home's occupants (such as design features listed in the County Noise Element), but the County may not use the Noise Ordinance to regulate truck traffic on a state highway.

Instead, this finding should properly note that, whether or not it is significant, truck traffic noise along SR 58 is exempt from the County's Noise Ordinance under Section 22.10.120.A.9.

ii. Operational Noise

The County standard for stationary sources affecting nearby residences is 50 dBA, as measured over one hour. For residences where the ambient noise level already exceeds 50 dba, the threshold is one plus the existing noise level. (County Code § 22.10.120.B.2) The studies in the EIR showed that several of the nearest residences already experienced ambient noise levels over 50 dBA making the applicable threshold the ambient noise level plus 1 dBA. (FEIR, 4.8-19, Table 4.8-9B) During the first phases of operations, the quarry would cause increases of 1.7 dBA and 2.9 dBA at the two nearest residences (as well as up to 5.1 dBA at the nearest parcel of vacant land). However, the EIR went on to say that, by applying certain available mitigation measures, the Applicant could likely achieve up to 7 dBA of noise reductions. (FEIR, 4.8-20 to 21) This would bring the noise levels back within acceptable levels at these residences.

Given minor noise level increases and the availability of mitigation measures to reduce that noise, there is no reason to think that the project will not be able to comply with the County's noise standards once operational. Rather than deny the project on the grounds that it might violate the Noise Ordinance, a better approach would be to simply impose a Condition of Approval requiring the quarry to demonstrate compliance with the Noise Ordinance via its Mitigation Monitoring and Reporting Plan.

iii. Blasting Noise

The County's standard for a maximum noise event experienced by nearby residences is 70 dBA. The EIR was ambivalent about whether the project blasting events, which would occur for less than 2 seconds, twenty times per year, would exceed this standard. Blasting data provided by the Federal Highway Administration, when applied to this project, showed that the maximum noise levels from blasting at the nearest residences would range from 61.9 to 64.5 dBA, well under the 70 dBA threshold. On the other hand, predictive modeling estimated noise levels at 78.7 to 80.1 dBA at the nearest residences during the 2 seconds of blasting. The EIR concluded: "It is possible that the predictive model used is overly conservative, and that the FHWA empirical value and results may be more accurate, in which case the predicted Lmax values would comply with the standard." (FEIR, 4.8-23 to 24)

Mitigation Measure Noise-3a in the EIR requires the Applicant to prepare a blasting management plan for approval by the County that would include advance notification to neighbors, and a monitoring program that would allow computation of resulting noise levels at nearby residences. Therefore, once the project is operational, the monitoring program will establish whether the applicable noise levels are being exceeded or not. Rather than deny the project outright under the assumption that the conservative model is more accurate and noise levels will be unlawfully exceeded, again, a better approach would be to simply impose a Condition of Approval requiring the quarry to demonstrate compliance with the Noise Ordinance during blasting events.

In sum, the project's truck traffic noise will not violate the County's Noise Ordinance, and such traffic is exempt from the Noise Ordinance in any event. For operational and blasting noise, the EIR included mitigation measures that would allow the project to demonstrate compliance with the Noise Ordinance. It is simply incorrect for Denial Finding 2.a to state that the County noise standards "cannot be met".

Denial Finding 2.b:

This finding states that the project will not be consistent with Title 22 because the requirements of Section 22.36.040.E of the County Code won't be met. That section, which is part of the County's local SMARA Ordinance, requires, among other things, that mining projects: "(3) Incorporate adequate mitigation measures to mitigate the probable significant adverse environmental effects and operational visual effects of the proposed operation.... and (5) Demonstrate that the uses proposed are not likely to cause public health and safety concerns."

The first part of this Denial Finding, regarding the visual impacts of the operation, is addressed in the response to Denial Finding 1.a, above. The second part of this Denial Finding, regarding potential public health and safety concerns, is addressed in great detail in the responses to Denial Findings 3.b and 3.c, below.

3. The establishment and subsequent operation or conduct of the use will be, because of the circumstances and conditions in this case, detrimental to the health, safety, and /or welfare of the general public and/or persons residing and/or working in the neighborhood of the use, and/or be detrimental and/or injurious to property and/or improvements in the vicinity of the use because:

Denial Finding 3.a:

This finding alleges that "sensitive receptors will be subject to the harmful and annoying effects of exposure to excessive noise" as a result of truck traffic noise, operational noise, blasting and vibrations, and exceedances of applicable noise standards which cannot be mitigated. A detailed response to these statements is included in the response to Denial Findings 1.c and 2.a, above.

Denial Finding 3.b:

This finding claims that the "project would result in land use compatibility conflicts between truck traffic, bicyclists, pedestrians, and school children." This statement is completely at odds with the conclusions in the EIR on these topics, and is not supported by any evidence in the record.

i. Pedestrian Crossing at Encina Avenue

Denial Finding 3.b states that the project truck traffic will contribute towards potential conflicts with pedestrian movements across El Camino Real at Encina Avenue, and for that reason must be denied. The EIR studied this issue, however, and found that "the potential effects of the project related traffic on the pedestrian crossing at Encina" were "mitigable through improvements that will increase pedestrian safety." The EIR requires the Applicant to "construct a pedestrian refuge island on SR 58 at the intersection of Encina Avenue, or other related pedestrian safety improvement consistent with the Santa Margarita Design Plan, as approved by the County Department of Public Works and Caltrans." (FEIR, 4.11-27, MM Traffic-2b)

In addition, the project's contribution to downtown truck traffic at this intersection should be put into context. Caltrans estimates that approximately 447 daily truck trips pass through this portion of downtown Santa Margarita, on average. (FEIR 4.11-21) Recent traffic counts done for the Santa Margarita Quarry expansion application show that, on an average weekday, heavy truck traffic comprises 4-5% of the total traffic going through downtown.[10] The Santa Margarita Quarry is allowed under its CUP to send up to 588 one-way trips through downtown Santa Margarita (there is no limitation on the CUP on how many of those trucks can turn north versus south on El Camino Real). Although the actual number on an average day is much less, there have been times when that maximum limit has been hit. In short, there is currently already a large volume of heavy trucks passing through this intersection on a regular basis, and there has not been a single accident or incident involving a truck at this intersection.

The Las Pilitas Resources EIR estimated the existing percentage of heavy truck traffic through downtown to be 3% of total traffic, and noted that "the proposed project truck traffic will not completely add on to existing aggregate truck traffic in the region—it will displace at least some of it. The overall percentage of heavy truck traffic on SR 58 and area roadways is expected to remain in the existing three percent range." (FEIR, 4.11-30) In other words, the Las Pilitas Resources project will not add a statistically significant amount of new trucks to the road.

Given the lack of accidents involving trucks at this intersection, the fact that most of the truck traffic will not be "new," and the conclusions in the EIR that any concerns about pedestrian safety can be mitigated by additional improvements, there is no factual evidence in the record to support this Denial Finding.

ii. Elementary School Crossing

Denial Finding 3.b next refers to the "vertical curve" on SR 58 near the elementary school crossing which obscures driver views of the crossing, as well as alluding to general safety concerns for school children along the haul route, as grounds for denying the project. Scientific data and information in the record shows that these concerns are completely unfounded.

The EIR studied this crosswalk as well as the effect of the "vertical curve" on drivers, and found that, although the crest does obscure views of the crosswalk for car drivers, "this effect does not occur with heavy truck drivers, however, since their driving position is much higher above the street surface than that of automobile drivers. Truck drivers can see the crossing from about 350 feet away." (FEIR, 4.11-25) The EIR went on to note that the crosswalk was designed and built in accordance with all applicable Caltrans standards for crossings on a state highway, including a pedestrian-activated beacon to warn drivers of the presence of a person or child in the crosswalk. The EIR concluded that "the potential interference with visibility at the school crossing is considered a less than significant impact," and required no mitigation. (FEIR, 4.11-25, 27)

[10] This includes both trucks associated with the existing quarry, and also with the construction of the solar farm projects that was occurring at the time.

Empirical data supports this conclusion. For 19 years, from 1992 until 2011, the Mike Cole Farms trucking operation was based off of SR 58, a short distance from the proposed quarry. At the height of operations, 17 trucks were dispatched from that location, six days per week. Based on dispatch logs, Mike Cole Farms estimates that its trucks have made over 200,000 trips along this haul route and past the school, without incident.[11]

In addition, data obtained from the National Highway Traffic Safety Administration (NHTSA) shows that the stopping distance for a fully loaded truck at 25 mph (the speed limit in the school zone) is nearly as good as a car. (See Attachment H at page 16, showing test result data for an older semi-truck with an unbraked trailer loaded to a MGVWR of 85,000 lbs., and Attachment I, showing data for the average passenger car.) In reality, trucks traveling to or from the quarry will likely not be able get above 20 mph going past the school, due to the stop sign, railroad tracks, and intersection with El Camino Real at one end of this stretch, and the sharp 90-degree turn at J Street at the other end, making the stopping distance for the loaded trucks *better* than the passenger cars, who may or may not be obeying the school zone speed limit.[12]

Safety at the school crossing and for children and pedestrians in general along the haul route is a paramount concern for Las Pilitas Resources. Therefore, Las Pilitas Resources has volunteered to take a number of precautionary measures, even though the EIR did not find it necessary. First, Las Pilitas Resources will work with the Atascadero Unified School District each year to prepare a Traffic Control and Management Plan (TCMP), in order to ensure that trucks arriving at or leaving the quarry reduce conflicts with peak pick-up and drop-off times at the school. The TCMP will be modeled after the ones required of First Solar and SunPower for the solar farms' construction, which was deemed to be a successful mitigation measure, according to the staff planner in charge of mitigation monitoring for those projects.[13]

In addition, Las Pilitas Resources has volunteered to pay for a motion-generated flashing light system to be embedded in the crosswalk pavement, to ensure greater pedestrian safety, especially during hours when crossing guards may not be present. Although this mitigation measure has been volunteered for the school crossing, if the community so desired, it could be installed at El Camino Real and Encina, instead, which has a higher rate of pedestrian usage.

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[11] For rough verification purposes, this figure can be arrived at by multiplying the 17 trucks by 2 (assuming each truck made a minimum of one round trip, or two one-way trips per day), and then multiplying that result by 307 (the approximate number of days per year if one excludes Sundays and 5 days for the major holidays), and then multiplying that by 19 years. Although in the early years there were fewer than 17 trucks being dispatched, each truck also generally made more than the one round trip daily that is being used in this example, making this estimate overly conservative, if anything.

[12] Moreover, the trailers used to haul gravel, such as bottom dumps and transfer trailers, have brakes on each axle, which will yield better stopping distances than even the ones cited in the NHTSA report, which used an unbraked trailer for the tests.

[13] Indeed, construction traffic for the solar farms had to pass by *four* elementary schools: Santa Margarita Elementary, Carrisa Plains Elementary, McKittrick Elementary, and Buttonwillow Elementary.

Las Pilitas Resources also approached the Atascadero Unified School District, and offered to fund the cost of a crossing guard, annually, for the downtown.[14] The School District could choose to use this money to put an additional crossing guard at the crosswalk at H Street (which is currently manned by one guard during peak hours), or to put a guard at another location downtown, such as the Encina crosswalk, which is currently unmanned.

Las Pilitas Resources will also be providing the crossing guards with two-way radios to the scale house, so that the truck dispatcher and the crossing guards will be in direct communication, and trucks can be held as needed to avoid conflicts with school traffic and pedestrians. This direct communication will ensure accountability, and that the TCMP is being fully adhered to.

Las Pilitas Resources will require all drivers hauling to and from the quarry to abide by posted speed limits at all times, and will educate all drivers regarding the school zone, applicable speed limits, and restrictions on the use of engine brakes. Violations of these requirements will not be tolerated. To this end, Las Pilitas Resources will establish a toll-free hotline which members of the public may use to report any truck drivers who were observed exceeding the speed limits or driving unsafely. This mitigation was employed for the solar farms as well, and the feedback on its efficacy was positive, according to the Planning Department.

Finally, Las Pilitas Resources has volunteered to install speed bumps or other traffic calming measures along H Street and I Street in Santa Margarita, in order to respond to residents' concerns that drivers who get frustrated following large trucks into town may attempt to get around the trucks by driving down those streets instead. Las Pilitas Resources will leave that offer open for three years following the opening of the quarry, in order to give residents time to assess whether this is actually a problem that needs addressing.

With all of these measures in place, as well as the data from the EIR and other sources, the public can be assured that the truck traffic will not pose a concern for school children. No evidence was introduced during the Planning Commission hearings to the contrary. Unsubstantiated fears or unfounded perceptions are not a legitimate basis for denying the project.

During the Planning Commission hearings, an additional concern was raised regarding truck safety at the railroad crossing near Estrada and El Camino Real, and specifically that there was not enough clearance between the railroad tracks and the stop sign for a full length truck. Again, this concern is unfounded. As noted in the EIR, the distance from the railroad crossing arm to the stop line is approximately 75 feet. "This distance is sufficient for trucks to stop between the tracks and El Camino Real without extending into the latter." (FEIR, 4.11-18) The legal length

[14] Representatives of Las Pilitas Resources have presented details on the project and school-related mitigation measures to the Atascadero Unified School Board, and have also met separately with the School Superintendent, in order to ensure that all concerns about the project have been addressed to the School District's satisfaction.

of a truck in California is 65 feet, with certain exceptions.[15] (Vehicle Code § 35401) As can be seen in the photograph in Attachment J, there is sufficient room for a gravel truck to stop behind the stop line at this intersection and be clear of the railroad tracks.

iii. Bicyclist Concerns

Denial Finding 3.b also lists incompatibility with bicyclists on SR 58 as one of the reasons for denying the project. Specifically, the finding notes that "there is no dedicated bike land [sic: lane] on SR 58, which leaves little room for bicyclists and truck traffic to share the road which could result in a lessening of their perceived experience cycling on the roadway. This perception could result in a disincentive for bicyclist [sic] to use SR 58 during operational hours of the quarry."

The EIR considered the impact of truck traffic on bicyclists, but concluded that the impact was less than significant. (FEIR 4.10-5 to 6; 4.11-21 to 23) It found that the issue was primarily a recreational one, not a traffic or safety one. Nearly all of the cyclists who may use SR 58 do so for recreation—few, if any, cyclists commute along this stretch of SR 58. "Based on the information provided by Caltrans, the information contained on the Highway Capacity Manual, and discussions with industry professionals; the County has determined that 'Bicycle Level of Service' more appropriately describes the bicyclist's perception of the recreational experience they would perceive along a segment of roadway." (FEIR, 4.11-23) The EIR stated that the "Bicycle Level of Service" (BLOS) on this stretch of SR 58 is already considered an "F," and that it would remain an LOS F with or without the project. To put it another way, bicycle riders are already disincentivized from using SR 58 and have poor experience on this roadway, due to the lack of shoulders and the traffic. To paraphrase one avid cyclist who spoke at the Planning Commission hearings in support of the project: "Any bike rider who rides Highway 58 is out of their mind."

From a safety standpoint, there is no indication that heavy trucks cannot safely share this road with those bicyclists who choose to use it. As noted above, the trucks belonging to Mike Cole Farms have make around 200,000 trips along this exact stretch of road without any incidents—bicycle related or otherwise. Construction of the solar farms placed an incredible amount of traffic on SR 58 over a 3-4 year period without resulting in any bike-related incidents.[16] On any given day, any number of large vehicles, including horse trailers, hay trucks, cattle trucks, RVs, and grape trucks, use this portion of SR 58 without issue.

The County has previously approved projects with large trucking components that would have had a much greater effect on bicyclists. Apart from the solar farms, the Cold Canyon Landfill

[15] None of these exceptions, which allow certain combinations of trucks and tandem trailers to extend up to 75 feet, would apply to trucks hauling aggregate, which need to be as short as possible for weight purposes. The length of a standard double transfer truck used for aggregate is 65 feet.
[16] It was estimated in the EIRs that the First Solar project would generate 290 trips per day and that the SunPower project would have 800 trips per day (though some of these trips used the east end of SR 58).

expansion stands as one such example. Arguably, far more bicyclists use SR 227, for both commuting and recreation, than have ever used SR 58. The Cold Canyon project included up to **860** proposed daily trips, many by large trucks or vehicles hauling trailers. The EIR for that project used the following threshold of significance: "An impact to pedestrians and bicyclists would be considered significant if implementation of the proposed project would conflict with existing or planned bicycle facilities, or would generate pedestrian and bicycle demand without providing adequate and appropriate facilities for safe, non-motorized mobility." The EIR then merely stated that, because SR 227 was not a designated bikeway and because there were no pedestrian facilities in the vicinity of the landfill, the impacts of the traffic on bicyclists and pedestrians would be less than significant. (Cold Canyon Landfill Expansion FEIR, page V-244) Here, no portion of SR 58 along the haul route is designated or proposed as a bikeway in the SLO County Bikeways Plan.

The Staff Report for the Planning Commission hearings mentioned the newly-enacted "3-foot" law as an additional reason for denying the project—stating that gravel trucks would be unable to give bicyclists 3 feet of passing space along this road, as is newly mandated by law. If that is the case, however, then *all* trucks and large vehicles should be banned from using SR 58, as that spatial phenomenon would not be unique to just trucks hauling aggregate, but would apply equally to trucks hauling grapes, hay, or cattle.

In any event, the 3-foot rule (Vehicle Code § 21760) must be read in harmony with the other provisions of the Vehicle Code. Bike riders on public roads must abide by all the traffic laws that apply to cars. (Vehicle Code § 21200) This includes the requirement of riding as far as possible to the right edge of the road if the bicyclist is unable to travel at the speed of traffic. (Vehicle Code § 21654) On two lane highways where passing is unsafe, a bicyclist behind which five or more vehicles are formed in a line must turn off the road at the nearest safe opportunity (such as a driveway or other turnout) and allow the vehicles to pass. (Vehicle Code § 21656) One would hope that the law-abiding cyclist on SR 58 would do just that—and that the courteous cyclist would pull over for even one car or truck stuck behind him/her for any length of time, if it was safe to do so.

Bicycle riders have a right to ride their bikes along most any State or County road that they choose, but that does not mean that the State or County, or individual project applicants, have a commensurate obligation to put Class I bike lanes on *all* roads, or to defer using the roads for legitimate transportation purposes in order not to interfere with the "recreational experience" of bicyclists.

Furthermore, it could be argued that the quality of the experience of a recreational bicyclist on a state highway is not within the purview of the Planning Commission or the Board of Supervisors, at least not when ruling as a quasi-adjudicatory body on a land use application. This is particularly true when no land use or planning document identifies this as a County bikeway, but where numerous laws and planning documents promote the development and conservation of mineral resources in this area. Caltrans, SLOCOG, and the Department of Public Works are all much better positioned to work towards improving the experience of bicyclists in this County—it should not be done via ad-hoc decisions on individual land use applications, along roads that are not even identified as bikeways.

For future planning purposes, approving this project is actually in the best interests of bicyclists in this County. The County does need far more Class I and II bike lanes in commuter areas in order to make bicycling a safe and viable alternative to traditional modes of transportation. One mile of Class II bike lane (3 foot wide) on each side of the road takes approximately 3,200 tons of aggregate to construct. The aggregate for all the planned bike lanes and trails in this County must come from somewhere. It would be cognitively dissonant for the County and SLOCOG to continue to plan and budget for bike lanes in future public works and regional transportation projects, yet deny this project on the grounds that it could interfere with the "perceived experience" of recreational cyclists on SR 58.

Denial Finding 3.c:

This Denial Finding merely states that "public concerns have been expressed regarding the potential health risks of the project including emissions associated with the truck traffic..." There is no mention of the fact that the EIR studied this exact issue, and found it insignificant.

Appendix D of the EIR contains what is known as a Health Risk Assessment (HRA), which included the immediate project vicinity, residences on Parkhill Road, and the community of Santa Margarita within its study area. The HRA evaluated the potential risks of diesel particulate matter (DPM) and other toxic air contaminants emanating from both the haul route and the quarry itself, including the risk for cancer. (FEIR, 4.3-32). The potential health risks, even using highly inflated truck numbers, were found to be far below the APCD's thresholds even without mitigation, with the exception of one residence across from the quarry that might be exposed to fugitive dust, and that risk was mitigable via the APCD's measures for dust control. In fact, the Air Quality chapter of the EIR, which was prepared with the collaboration of the APCD, found that all air-related impacts of the project were either less than significant, or could be mitigated to acceptable levels, and thus this project has no Class I Air Quality impacts.

Appendix D to the EIR contains evidence showing that approving this project could actually be beneficial for regional air quality.[17] The demand for aggregate is inelastic, and thus the addition of new aggregate resources in a given market does not result in increased use of aggregate. Rather, the addition of a new aggregate quarry to a market will decrease haul distances, and thus will decrease emissions from trucks, rather than increase them. According to the Caltrans analysis included in Attachment K, if the average haul route for aggregates in the State of California could be decreased by just 15 miles round trip, it would reduce truck emissions statewide by about 22,436 tons per year. Although the haul distance for this project would be

[17] A copy of the relevant documents from Appendix D of the EIR has been attached to this letter as Attachment K, for your ease of reference.

little different than hauling out of the Santa Margarita Quarry for most local consumers, this project has the potential to displace aggregates that are currently being imported from outside the County, or that are being trucked to San Luis Obispo from the Santa Maria area. This would result in a significant decrease in haul distances and truck emissions overall.

4. The proposed project or use will not be consistent with the character of the immediate neighborhood and the character of the community of Santa Margarita and/or its orderly development because:

As an initial matter, it should be noted that the above statement differs slightly from the actual required CUP findings contained in Section 22.62.060(C)(4) of the County Code, in that it adds "the community of Santa Margarita" to the finding. The standard CUP findings applied to all other projects in this County only address whether the proposed project or use will be consistent with the character of the "immediate neighborhood." The reason for altering the standard findings in this manner was not explained, but it likely relates to the truck traffic and the fact that SR 58 passes through Santa Margarita, despite the fact that the project itself is located several miles out of town. We were unable to find any other project where the land use compatibility analysis had been extended so far out from the project site. Regardless, as discussed below, the subfindings are not supported.

Denial Finding 4.a:

This Denial Finding again cites that the project would not be consistent with rural and "highly scenic" character of the area, and that the excavated slopes would be visible to the public and certain residences on SR 58 prior to reclamation. A detailed response to this finding is included in the response to Denial Finding 1.a, above.

Denial Finding 4.b:

This Denial Finding replicates Denial Findings 1.c and 2.a by stating that the project will expose sensitive receptors to harmful and excessive noise. A detailed response to this finding can be found in the responses to Denial Findings 1.c and 2.a, above.

Denial Finding 4.c:

This Denial Finding states that: "Truck traffic generated from the proposed quarry will pass through the residential neighborhood along Estrada Avenue and through downtown Santa Margarita along SR 58 which would compromise the small town, rural character of this historic community."

This Denial Finding is really an objection to the location of SR 58, a state highway which travels through Santa Margarita, not the project itself. Furthermore, by inferring that truck traffic is inconsistent with the character of Santa Margarita, this finding overlooks some key context. As stated by several local residents during the Planning Commission hearings: "We are a trucking town." Current businesses in the downtown district that are dependent on large trucks include two trucking companies, a lumber yard, a diesel repair shop, a fuel distributor, a feed store, a sawmill, a gas station, and a beverage distributor. In addition, the handful of restaurants and mini-marts in the downtown regularly receive deliveries of food and beverages via large truck. And, as noted, the Santa Margarita Quarry has been operating just outside of town for nearly a century, and has a permit to run as many as 588 truck trips per day through downtown. Caltrans estimates that, on average, 447 trucks per day pass through Santa Margarita.

Even the EIR states: "Currently, large trucks regularly travel through the downtown center of Santa Margarita.... Large truck traffic along this stretch is common, due to the existence of a local trucking company and a truck repair operation, as well as trucks servicing the nearby Hanson quarry and other businesses. Passenger trucks hauling livestock trailers are also common along this stretch due to the rural and agricultural nature of the area." (FEIR 4.14-8) Because the demand for aggregate is inelastic and determined by market forces, not supply, "the proposed project truck traffic will not completely add on to existing aggregate truck traffic in the region—it will displace at least some of it. *The overall percentage of heavy truck traffic on SR 58 and area roadways is expected to remain in the existing three percent range.*" (FEIR, 4.11-30 (italics added for emphasis)) There is simply no foundation for the idea that this project is going to suddenly and grievously escalate the number of trucks in Santa Margarita, or compromise its small town, rural character (which has, incidentally, coexisted with mining for over 100 years).

The EIR also noted that: "Truck traffic will occur only on SR 58, a state-owned and maintained highway. As such, the County has no authority to limit truck trips on this route." (FEIR, 4.14-8) The County's inability to regulate truck traffic on a state highway was addressed in the response to Denial Finding 2.a. Denying a project simply because it will send trucks down a state highway is a de facto regulation of trucks on a state highway. The County does not have the legal authority to determine, for instance, that current truck uses are fine but no additional ones should be approved, or that the capacity of the state highway for trucks has been reached. Under state law, if the highway is truly unsuitable for heavy trucks, then *all* trucks of that particular class/weight must be banned, not just trucks originating from a particular project. To do otherwise would be a violation of equal protection. The fact that trucks will travel through Santa Margarita on their way to or from the project is not a legally valid reason for denying the project.

5. The proposed project or use may generate traffic conditions beyond the safe capacity of certain roads that provide access to the project because:

Denial Finding 5.a:

This Denial Finding replicates Denial Finding 3.b, citing perceived "land use compatibility conflicts between truck traffic, bicyclists, pedestrians, and school children." A detailed response to these concerns was provided in the response to Denial Finding 3.b, above. A few additional relevant points are addressed in the response to Denial Finding 5.b, below.

<u>Denial Finding 5.b:</u>

This Denial Finding states that the project should be denied because of uncertainty regarding the approval of needed traffic improvements in downtown Santa Margarita, which would lead to significant and unavoidable impacts to transportation and circulation. This Denial Finding is misleading, and several of its statements are factually incorrect.

First, the statement in this Denial Finding that the "project would reduce LOS various SR intersections within the Community of Santa Margarita," is directly at odds with the findings of the EIR. The EIR studied the traffic volumes, safety, and levels of service in detail, and—even using implausibly high numbers for the truck trips— found that the project would not have any significant impact on current traffic or levels of service. Specifically, the EIR found that "the project will cause increases in traffic volumes on local roadways, but will not substantially reduce the Level of Service at intersections, freeway ramps, or on U.S. Highway 101, when added to existing traffic volumes. The project effects on other roadways and intersections are considered less than significant." (FEIR, 4.11-17)

The EIR also considered the impact of the project truck traffic on roadway pavement conditions. This was done using a standard Caltrans methodology for analyzing impacts called the Traffic Index (TI). The current TI for SR 58 is 10. Impacts are considered significant if a project would change the existing TI by 1.5 or more (a standard threshold used in EIRs throughout the state), which numerical change would represent a significant shortening of the lifespan of the pavement. Even using hugely inflated truck trip numbers and assuming maximum production for the entire life of the mine, the EIR found that the project would not change the TI by more than 1.0 on any segment of the haul route. The EIR concluded that "the truck trips generated by the project would cause *incremental* damage and wear to roadway pavement surfaces [but] … based on the significance criteria established for this EIR, the project would have a less than significant impact to the roadway condition of SR 58."[18] (FEIR, 4.11-21)

The EIR did determine that the project would have one significant traffic impact: its contribution to *cumulative* traffic volumes at the intersection of Estrada and El Camino Real, looking out some 15 years into the future. Specifically, the EIR found that, by the year 2030, assuming full build-out of the Santa Margarita Ranch and other reasonably foreseeable development, traffic levels at the intersection of Estrada and El Camino Real would have reached the point of

[18] Notwithstanding the fact that the analysis determined the pavement impacts to be less than significant, the EIR still required as "mitigation" that the Applicant undertake a significant pavement monitoring program, including the posting of a "repair bond," or else agree to fund a fair share of impacts to SR 58. Las Pilitas Resources has repeatedly and respectfully objected that this mitigation measure is unlawful, since the County lacks authority to impose and collect fees for impacts to a state highway, and because the trucks already pay enormous weight and licensing fees to the state for the express purpose of compensating for the wear and tear those trucks may have on state highways. Las Pilitas Resources reiterates that objection here for the record. That said, Las Pilitas Resources has no objection to paying a fee directly to the County to mitigate for the project's impacts on *County roads*, as required by County Code 22.36.110, so long as the fee is fairly calculated and bears a rough proportionality to the actual impacts of the project, as required by Government Code § 66000 et seq. and CEQA Guidelines § 15126.4.

requiring signalization, *with or without the project*. (FEIR, 4.11-31) Should the project be approved, it would be just one factor contributing towards those 2030 traffic volumes. But then again, it is important to remember that these traffic volumes will likely be reached by 2030 even if the project is denied—so the project is not the cause of them.

The EIR found that the 2030 traffic volumes would be reduced to less than significant levels if the intersection were signalized—specifically, that the "installation of traffic signals would provide LOS B during the A.M. peak period and LOS A during the P.M. peak period for the 2030 plus project scenario." (FEIR, 4.11-32) Accordingly, the EIR requires the project to contribute a fair share (currently estimated at 8.1%) toward the future signalization of this intersection. If the signal is installed when needed, the traffic impacts of this project would be fully mitigated.

However, because the design and installation of a proper signal at this intersection requires the coordination and approval of a number of agencies (County Public Works, Caltrans, and Union Pacific Railroad) and has some geometric characteristics that will make the design process challenging, the EIR concluded that it would be improper to rely on the signal being installed in time to alleviate future traffic congestion at this intersection. (FEIR, 4.11-33) Specifically, the EIR says that, although signalization "would reduce impacts to the extent possible, due to the uncertainty regarding Caltrans approval of improvements within their jurisdiction, and uncertainty regarding right-of-way acquisition, in [sic: it] cannot be assured that all improvements would be feasibly constructed prior to the time when they are needed. As a result, cumulative traffic impacts would remain significant and unavoidable." (FEIR, 4.11-34)

This contribution to the 2030 traffic volumes in the community is the only significant traffic impact identified in the EIR. This may be a significant impact from a CEQA perspective, but there are several reasons why this is not a proper reason for denying the project from a CUP perspective. The purpose of CEQA is to inform the public of the likely physical effects a project will have before it is approved. CEQA is also required to evaluate the reasonably foreseeable worst case scenario. Therefore, it is arguably appropriate for an EIR to inform the public that they may suffer some significant and unavoidable delays at an intersection in the event that the responsible agencies take some time to put in a signal, since that is a reasonable worst-case scenario, given what is known about governmental bureaucracy. But it should also be remembered that, once the signal is installed, levels of service at this intersection will be above acceptable levels. In other words, this impact is fully mitigable if the government agencies do what they are supposed to do, when they are supposed to do it.

From the standpoint of granting the CUP, the following factors need to be considered: First, there is a presumption that governmental agencies will discharge their duties properly, or at least that they will not unreasonably delay in doing so. Therefore, regardless of the worst case scenario in the EIR, it is reasonable for the Board of Supervisors to presume that the signal will be installed when needed, particularly if there is funding for it. As noted in the EIR, approving the Las Pilitas Resources project is one of the best ways to ensure that there will be funding available for the future signalization of Estrada and El Camino Real. Without the proposed project, traffic amounts will still increase to unacceptable levels by 2030, and the only project definitively on the hook to pay for improvements will be the Santa Margarita Ranch development, and it cannot be required to pay more than its fair share—the rest will be on the taxpayers. (See FEIR, 4.11-33 to 34) If traffic levels are going to increase anyway, it would be in the public's best interest to have more than one project on the hook to pay for improvements. Thus, future traffic congestion at this intersection is a reason for *approving* this project, not denying it.

Finally, where the cumulative impacts of a project can be mitigated with a particular traffic improvement, and the project applicant has agreed to fund a fair share of that improvement, it is fundamentally unfair to deny the project on the grounds that the improvement might not be timely built because of something outside the applicant's control. Here, Las Pilitas Resources will do everything it can to ensure timely construction of the improvement that would solve the problem. If the mitigation measure cannot feasibly be built, that is one thing. But the government should not deny a project where the applicant has pledged a fair share toward the solution, only because it is anticipating its own inefficiencies in implementing that solution.

In sum, it simply cannot be said that this project will generate traffic beyond the safe capacities of the roads serving it. The EIR looked at these issues and found that project truck traffic would not result in any unsafe conditions nor decreased levels of service. By the year 2030, traffic may have increased to the point that the intersection of Estrada and El Camino Real will require additional improvements, but this would occur even without the proposed project, and thus is not a direct result of the proposed project, and Las Pilitas Resources has agreed to fund a fair share cost of the improvements that would fix this problem. The statements in Denial Finding 5.b cannot be reconciled with the actual evidence in the record.

6. Environmental Determination

This Denial Finding (which contains no sub findings) states, in sum, that the Final EIR for the project has provided evidence to support denial of the project. As detailed above, however, most of the Denial Findings are directly at odds with, or misstate, what is in the EIR. The factual evidence in the record for this project does not support the Denial Findings that were approved by the Planning Commission.

7. There are insufficient specific, overriding economic, legal, social, technological, or other benefits of the project that outweigh the significant effects on the environment . . . .

This Denial Finding does not list, or even consider, the economic, legal, social, technological, or other benefits of the project, it simply assumes that they are not enough to overcome the Class I impacts of the project. The Class I impacts of this project, however, are few. According to the EIR, they are Aesthetics (2), Noise (3), and Traffic (1) (cumulative impacts only).

As discussed above, two of the noise impacts (operations and blasting) can be mitigated via a Condition of Approval requiring the project to demonstrate compliance with the County's Noise Ordinance as part of its Mitigation Monitoring and Reporting Program (MMRP). This is the vehicle by which any approved project in the County must show that it is abiding by its mitigation measures and conditions of approval.

The cumulative traffic impact can be overridden by finding that the project will not be the direct cause of the decreased LOS at Estrada and El Camino Real—as this would happen even without the project—and that the project has agreed to fund a fair share of the traffic signal, which will help ensure that the improvement will happen in a timely manner. This is actually a public benefit of the project.

That leaves the aesthetic impacts and truck traffic noise impacts, which were largely overstated in the EIR, as discussed above. The Supervisors may disagree with the conclusions in the EIR, if such disagreement is based on substantial evidence in the record. Here, substantial evidence shows that the project will not affect a "scenic vista," despite what was stated in the EIR. With regard to truck traffic noise, the Board of Supervisors could similarly find that the impact would not be significant since the increase would be less than 2 dBA, imperceptible to the human ear.

Even if the Board agrees that these are significant impacts, they are not so significant as to outweigh the economic, legal, and social benefits of this project. As set forth Special Report 215 in Attachment D, the need for additional aggregate in this County is approaching critical levels. Unless new sources are permitted, the current supply is expected to run out in 2026. That is because the resources are being consumed at a far greater rate than they are being permitted. The State Mining and Geology Board recently designated this granite deposit as one of regional significance, which requires the County to consider the importance of the aggregate to the region as a whole when evaluating this mining application.

The project is centrally located to serve the entire County, and will ensure a competitively-priced and diverse supply of aggregate in this region. Because the largest single consumers of aggregate in this County are the County Department of Public Works and Caltrans, every taxpayer will ultimately benefit from having this additional competition and supply in the local aggregate market. The project can also reduce regional greenhouse gas emissions by reducing the need to import aggregate from outside of the County. Having a reliable supply of local aggregate is vital to achieving the environmental goals of both AB 32 and SB 375.

Other benefits of the project are community-specific. The project will create jobs, will contribute toward pedestrian safety improvements on SR 58 (which are needed even without the project), and will provide the local school district with an annual donation to fund the cost of a crossing guard, which will make the local streets safer for children. Taken together, these community and County-wide benefits are sufficient to outweigh the impacts that the project will have on aesthetic resources and traffic noise.

For all of these reasons, we hope that the Board of Supervisors will see fit to uphold our appeal and approve this project, for the long-term benefit of all citizens in this County.

Respectfully,

Ken Johnston
Project Manager
Las Pilitas Resources

DENIAL FINDINGS – EXHIBIT A

Conditional Use Permit (Land Use Ordinance Section 22.62.060C.4.)

1. The proposed project or use is not consistent with the San Luis Obispo County General Plan because:

   a. The Conservation and Open Space Element (COSE) includes Goal VR-1 and VR-2 which respectively state, "Through the review of proposed development, encourage designs that are compatible with the natural landscape and with recognized historical character, and discourage designs that are clearly out of place within rural areas" and "the natural and historic character and identity of rural areas will be preserved." The slopes of the proposed mining area and mining equipment would be visible from SR 58 and would be inconsistent with the rural visual character of the area. The project is located in a transition zone between the semi-rural upper Salinas River Valley (the Santa Margarita area) and the rural and steeply sloped oak woodland and chaparral covered hillsides adjacent to the Salinas River corridor which is highly scenic. The project's excavated slopes associated with the quarry operations would be visible to the public in an area that is predominately characterized by a natural setting including the riparian corridor surrounding the Salinas River. Due to the length of time before restoration would occur, the time for vegetation to mature, and the uncertainty of successful revegetation on the excavated slopes; the project would be visible for over 25 years until planted vegetation associated with the proposed reclamation plan matures and meets the success criteria established in the reclamation plan and the SMARA guidelines. Although SR 58 not an officially designated scenic highway, Policy VR 4.1 of the COSE indicates that SR 58 will eventually become a scenic corridor. The significant and unavoidable impacts associated with the proposed quarry and the excavated slopes that will be visible to travelers along SR 58 would not be consistent with the identification of SR 58 for designation as a scenic corridor.

   b. Conservation and Open Space Element (COSE) Goal MN-1 and Policy MN 1.1 require the County to evaluate proposed mining operations in areas having open space, scenic, habitat, recreational, or agricultural value by balancing these values against the need for extracting mineral resources from such areas. While the State of California has recognized the importance of aggregate resources and the need to balance the demand and supply of aggregate materials in the San Luis Obispo – Santa Barbara production consumption region; the Applicant has not demonstrated that the need for the proposed facility would outweigh the visual and environmental impacts of the project including significant and unavoidable impacts to Aesthetics and Visual Resources, Noise, and Transportation and Circulation.

   c. The project would be inconsistent with Noise Element Goals and Policies because sensitive receptors will be subject to the harmful and annoying effects of exposure to excessive noise as result of truck traffic within the community of Santa Margarita and as a result of operation activities and blasting noise and vibration adjacent to the proposed project site; including exceedances of the noise standards which represent maximum acceptable noise levels which cannot not be feasibly mitigated to acceptable levels.

   d. Denial of the proposed project does not preclude or set precedence for future mining projects within the EX1 combining designation area. This project was evaluated independently based on the currently proposed project characteristics. Future mine projects in this area will be evaluated based on proposed project characteristics at that time.

2. The proposed project does not satisfy all applicable provisions of Title 22 of the County Code because:

    a. Noise Ordinance – Section 22.10.120 (Noise Standards) cannot be met, which states, "This Section establishes standards for acceptable exterior and interior noise levels and describe how noise shall be measured. These standards are intended to protect persons from excessive noise levels, which are detrimental to the public, health, welfare and safety and contrary to the public interest because they can: interfere with sleep, communication, relaxation and full enjoyment of one's property; contribute to hearing impairment and a wide range of adverse physiological stress conditions; and adversely affect the value of real property." The proposed project will result in exceedances of the 60 dBA Ldn standard due to roadway noise generated by the proposed projects truck traffic. The proposed project will result in exceedances of the 50 dBA daytime hourly Leq standard for point source project noise as a result of quarry operations. The proposed project will result in exceedances of the 70 dBA standard for Lmax associated with blasting noise associated with quarry operations.

    b. Surface Mining and Reclamation – Section 22.36.040E. cannot be met because the project will result in significant and unavoidable impacts to aesthetic and visual resources which cannot be mitigated. The slopes of the proposed mining area and mining equipment would be visible from SR 58 and would be inconsistent with the rural visual character of the area. The project is located in a transition zone between the semi-rural upper Salinas River Valley (the Santa Margarita area) and the rural and steeply sloped oak woodland and chaparral covered hillsides adjacent to the Salinas River corridor which is highly scenic. The projects excavated slopes associated with the quarry operations would be visible to the public in an area that is predominately characterized by a natural setting including the riparian corridor surrounding the Salinas River. Due to the length of time before restoration would occur, the time for vegetation to mature, and the uncertainty of successful revegetation on the excavated slopes; the project would be visible for over 25 years until planted vegetation associated with the proposed reclamation plan matures and meets the success criteria established in the reclamation plan and the SMARA guidelines. Although SR 58 not an officially designated scenic highway, Policy VR 4.1 of the COSE indicates that SR 58 will eventually become a scenic corridor. The significant and unavoidable impacts associated with the proposed quarry and the excavated slopes that will be visible to travelers along SR 58 would not be consistent with the identification of SR 58 for designation of SR 58 as a scenic corridor. Additionally, public concerns have been expressed regarding the safety of the truck traffic which would include approximately 35 peak hour truck trips through the community of Santa Margarita and along the proposed haul routes including the school crossing at the intersection of SR 58 and H Street, conflicts with bicyclist along SR 58, and the pedestrian crossing at El Camino Real and Encina Avenue, and the potential health risks of the project including emissions associated with the truck traffic. As indicated by these concerns, the project is incompatible with the community of Santa Margarita.

3. The establishment and subsequent operation or conduct of the use will be, because of the circumstances and conditions in this particular case, detrimental to the health, safety and / or welfare of the general public and / or persons residing and / or working in the neighborhood of the use, and / or be detrimental and / or injurious to property and / or improvements in the vicinity of the use because:

    a. Sensitive receptors will be subject to the harmful and annoying effects of exposure to excessive noise as result of truck traffic within the community of Santa Margarita and as a result of operational activities and blasting noise and vibration adjacent to the proposed project site; including exceedances of the noise standards which represent maximum acceptable noise levels which cannot not be feasibly mitigated to acceptable levels.

b. The project would result in land use compatibility conflicts between truck traffic, bicyclists, pedestrians and school children. The project will contribute approximately 35 peak hour truck trips through the community of Santa Margarita, and will contribute towards potential conflicts with pedestrian movements across El Camino Real at Encina Avenue. There is a crest vertical curve on Estrada Avenue (SR 58) south of H Street, which is the location of the Santa Margarita Elementary School crossing. This crest obscures driver views from the south of the school pedestrian crossing. SR 58 also passes directly through the "business district" of the community of Santa Margarita, and within close proximity of the Santa Margarita Elementary School. Children walking to and from school regularly cross SR 58 via a designated crossing at the intersection of SR 58 and H Street. In addition, bicyclists would be required to share SR 58 with the truck traffic generated by the proposed project. There is no dedicated bike land on SR 58, which leaves little room for bicyclists and truck traffic to share the road which could result in a lessening of their perceived experience cycling on the roadway. This perception could result in a disincentive for bicyclist to use SR 58 during operational hours of the quarry. Each of these concerns reflects an incompatibility with land use with the community of Santa Margarita.

c. Public concerns have been expressed regarding the potential health risks of the project including emissions associated with the truck traffic which would include approximately 35 peak hour truck trips through the community of Santa Margarita and along the identified haul routes as a result of the proposed project.

4. The proposed project or use will not be consistent with the character of the immediate neighborhood and the character of the community of Santa Margarita and / or its orderly development because:

a. The natural and historic character and identity of the rural areas will not be preserved because the excavated slopes of the proposed mining area and mining equipment would be visible from SR 58 and would be inconsistent with the rural visual character of the area. The project is located in a transition zone between the semi-rural upper Salinas River Valley (the Santa Margarita area) and the rural and steeply sloped oak woodland and chaparral covered hillsides adjacent to the Salinas River corridor which is highly scenic. The proposed project's excavated slopes associated with the quarry operations would be visible to the public and numerous residences in the vicinity of the proposed project site that is predominately characterized by a natural setting including the riparian corridor surrounding the Salinas River. Due to the length of time before restoration would occur, the time for vegetation to mature, and the uncertainty of successful revegetation on the excavated slopes; the project would be visible for over 25 years from locations in the vicinity of the proposed project site until planted vegetation associated with the proposed reclamation plan matures and meets the success criteria established in the reclamation plan and the SMARA guidelines.

b. Sensitive receptors will be subject to the harmful and annoying effects of exposure to excessive noise as result of truck traffic within the community of Santa Margarita and as a result of operational activities and blasting noise and vibration adjacent to the proposed project site; including exceedances of the noise standards which represent maximum acceptable noise levels which cannot not be feasibly mitigated to acceptable levels.

c. Truck traffic generated from the proposed quarry will pass through the residential neighborhood along Estrada Avenue and through downtown Santa Margarita along SR 58 which would compromise the small town, rural character of this historic community.

5. The proposed project or use may generate traffic conditions beyond the safe capacity of certain roads that provide access to the project because:

   a. The project would result in land use compatibility conflicts between truck traffic, bicyclists, pedestrians and school children. The project will contribute approximately 35 peak hour truck trips through the community of Santa Margarita, and will contribute towards potential conflicts with pedestrian movements across El Camino Real at Encina Avenue. There is a crest vertical curve on Estrada Avenue (SR 58) south of H Street, which is the location of the Santa Margarita Elementary School crossing. This crest obscures driver views from the south of the school pedestrian crossing. SR 58 also passes directly through the "business district" of the community of Santa Margarita, and within close proximity of the Santa Margarita Elementary School. Children walking to and from school regularly cross SR 58 via a designated crossing at the intersection of SR 58 and H Street. In addition, bicyclists would be required to share SR 58 with the truck traffic generated by the proposed project. There is no dedicated bike land on SR 58, which leaves little room for bicyclists and truck traffic to share the road which could result in a lessoning of their perceived experience cycling on the roadway. This perception could result in a disincentive for bicyclist to use SR 58 during operational hours of the quarry.

   b. The proposed project would create significant and unavoidable impacts to transportation and circulation due to the lack of certainty regarding Caltrans approval of needed improvements and the uncertainty of timing of the needed improvements which may never be fully realized due to the lack of other contributors and funding. The project would reduce the LOS at various SR 58 intersections within the Community of Santa Margarita. This would result in delays for residents of the community of Santa Margarita and other users of SR 58 and result in increased traffic congestion at the identified intersections. The necessary improvements to SR 58 would require the approval of Caltrans as well as the California Public Utilities Commission (due to the proximity to the railroad crossing) at the El Camino Real / Estrada Avenue (SR 58) intersection. It is not known if or when those improvements would be approved by Caltrans and if additional funding would be available to pay for the improvements. Due to this uncertainty, it can be assumed that the improvements may not be implemented.

Environmental Determination

6. The Environmental Coordinator, after completion of the initial study, found that there is evidence that the project may have a significant effect on the environment, and therefore a Final Environmental Impact Report (FEIR) was prepared (pursuant to Public Resources Code Section 21000 et seq., and CA Code of Regulations Section 15000 et seq.) for this project. The Final EIR focuses on the following issues: Aesthetics and Visual Resources, Agricultural Resources, Air Quality, Green House Gas Emissions, Biological Resources, Geology, Hazards and Hazardous Materials, Noise, Public Services and Utilities, Recreation, Transportation and Circulation, Wastewater, Water Quality and Supply, and Land Use. The EIR also considers alternatives in addition to the "No Project" alternative. While an EIR has been prepared, per the Public Resources Code 21080(b)(5) and CEQA Guidelines, CEQA does not apply to projects which a public agency rejects or disapproves. However, the FEIR has provided evidence and information

to support this denial, including an evaluation of the significant and unavoidable environmental impacts of the proposed project.

7. There are insufficient specific, overriding economic, legal, social, technological, or other benefits of the project that outweigh the significant effects on the environment, as would be required to approve the project pursuant to Public Resources Code section 21081.

PLANNING COMMISSION
COUNTY OF SAN LUIS OBISPO, STATE OF CALIFORNIA.

April 11, 1991

PRESENT: Commissioners Shirley Bianchi, Don Keefer, Susan Ostrov, Fabian Romano, and Chairman Ken Schwartz

ABSENT: Commissioner David Oakley

RESOLUTION NO. 91-32
RESOLUTION RECOMMENDING AMENDMENT OF THE LAND USE ELEMENT OF THE SAN LUIS OBISPO COUNTY GENERAL PLAN AND THE SAN LUIS OBISPO COUNTY LAND USE ORDINANCE

The following resolution is now offered and read:

WHEREAS, State Law requires that a General Plan be adopted; and

WHEREAS, the Land Use Element of the San Luis Obispo County General Plan was adopted by the Board of Supervisors on September 22, 1980, and is a proper element of the General Plan; and

WHEREAS, Public necessity, convenience and general welfare requires that the elements of a General Plan be amended from time to time; and

WHEREAS, the Planning Commission of the County of San Luis Obispo held a public hearing on April 11, 1991, to consider proposed amendments to the Land Use Element of the San Luis Obispo County General Plan and the San Luis Obispo County Land Use Ordinance; and

WHEREAS, the Planning Commission, at the conclusion of the public hearing, adopted findings for those amendments recommended for approval.

NOW, THEREFORE, BE IT RESOLVED that the San Luis Obispo County Planning Commission recommends to the Board of Supervisors of the County of San Luis Obispo, State of California, that the Land Use Element and

B-8 (1-B)

Open Space Element of the County General Plan and the San Luis Obispo County Land Use Ordinance be amended as follows:

1. Amend the El Pomar-Estrella, Huasna/Lopez, Las Pilitas, Salinas River, Shandon-Carrizo, and South County Area Plans and Framework for Planning-Inland Portion, of the Land Use Element, and the Land Use Ordinance as appears on the exhibit which are listed below, and which are expressly referred to and incorporated herein as though fully set forth.

    a. Exhibit G890015N:1A-1E County of San Luis Obispo

    b. Exhibit G890015N:2 (Revised 4-11-91) County of San Luis Obispo

    c. Exhibit G890015N:3 and 3A County of San Luis Obispo

    d. Exhibit G890015N:4 through 9 County of San Luis Obispo

2. Approve the attached Findings which are expressly referred to and incorporated herein as though fully set forth.

3. Approve the Negative Declaration in accordance with the applicable provisions of the California Environmental Quality Act, Public Resources Code Section 21000 et seq.

On motion of Commissioner Keefer, seconded by Commissioner Bianchi, and on the following roll call vote, to wit:

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2

AYES: Commissioners Keefer, Bianchi, Ostrov, Romano, Chairman Schwartz

NOES: None

ABSENT: Commissioner Oakley

the foregoing resolution is hereby adopted.

/s/ Kenneth Schwartz
Chairperson of the Planning Commission

ATTEST:

/s/ Diane R. Tingle
Secretary of the Planning Commission

1246-1

B-8(1-B)
3

FINDINGS

A. The proposed amendments will provide for development that is compatible with the character of the general area and immediate site vicinity because they require that in areas of significant mineral resources, land uses which are subject to discretionary land use permits will not adversely affect existing mineral resource extraction uses.

B. The proposed amendments will provide for development that is consistent with public service capabilities because proposed new mining operations will be responsible for impacts to roads and other public services through compliance with Land Use Ordinance Sections 22.8.180 et seq. regarding surface mining and reclamation and through the required Development Plan approval process.

C. The proposed amendments will not be detrimental to the public health, safety and welfare of area residents because they require that in areas of significant mineral resources, land uses subject to discretionary land use permits be compatible with existing resource extraction operations. In addition, proposed new mining operations require Development Plan approval, for which findings must be made that the proposed development will not be detrimental to the health, safety or welfare of persons residing or working in the neighborhood of the use.

D. The proposed amendments are consistent with the San Luis Obispo County General Plan because in the areas where the proposed EX1 combining designation is to be applied, mineral resource extraction is an allowable use in Table O, Framework for Planning - Inland Portion, Part I of the Land Use Element and is permitted by existing or proposed planning area standards in the applicable area plans of the Land Use Element. In addition, the proposed amendments, which are intended to emphasize the conservation and development of significant mineral resources, are consistent with the general land use goal which includes conserving nonrenewable resources, as described in Framework for Planning - Inland Portion.

E. The proposed amendments are appropriate because they are needed to comply with the Surface Mining and Reclamation Act of 1975, which requires that the county General Plan include policies which recognize areas classified by the State as containing significant mineral deposits and which emphasize the conservation and development of those mineral deposits.

F. On the basis of the Initial Study and all comments received, there is no substantial evidence that the project will have a significant effect on the environment.

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5-1

Staff Report

San Luis Obispo County Planning Department

I. PROJECT SUMMARY

FILE NO: G890015N   **AGENDA DATE:** MARCH 28, 1991

APPLICANT/AGENT: COUNTY OF SAN LUIS OBISPO

APPROVAL(S) REQUESTED: GENERAL PLAN/LAND USE ORDINANCE AMENDMENTS

ENVIRONMENTAL DETERMINATION: NEGATIVE DECLARATION 3/15/91

STAFF RECOMMENDATION: RECOMMEND TO THE BOARD OF SUPERVISORS APPROVAL OF THIS GENERAL PLAN AND LAND USE ORDINANCE AMENDMENT BASED ON THE RECOMMENDED FINDINGS AND EXHIBITS

PROJECT DESCRIPTION:

This project consists of proposed amendments to the Land Use Element of the County General Plan and the Land Use Ordinance in order to recognize and protect various areas of the county for mining. This proposal is intended to comply with the State Mining and Reclamation Act of 1975 by addressing areas classified by the State as containing or being highly likely to contain significant mineral resources. The specific proposed amendments are as follows:

1) Amend Framework for Planning - Inland Portion, Part I of the Land Use Element (LUE) by a) establishing a new Extractive Resource Area (EX_1) combining designation to reflect areas classified by the State as containing or being highly likely to contain significant mineral deposits - primarily Portland cement concrete aggregate. The purpose of the EX_1 combining designation is to recognize the significant mineral resources identified by the State and to emphasize the conservation and development of those resources; b) revising an objective of the existing Energy or Extractive Area (EX) combining designation regarding amending the LUE to apply the EX designation to the sites of approved resource extraction projects; c) establishing a guideline for land use category amendments in Chapter 7 which calls for consideration of the importance of maintaining mineral resources available for extraction;

2) Amend the El Pomar-Estrella, Huasna/Lopez, Las Pilitas, Salinas River, Shandon-Carrizo, and South County Area

B-8(1-B)
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S-8

the site should not receive special protection for resource extraction. Nevertheless, the existing mining operation can continue if it is in compliance with Sections 23.09.010 et seq. and 23.08.180 et seq. of the Coastal Zone Land Use Ordinance regarding nonconforming uses and surface mining and reclamation.

2. Mineral Resources in the Inland Area

In the inland area, the State has classified five areas in MRZ-2. Four of the five areas, which comprise nearly all of the acreage within MRZ-2, are classified for P.C.C.-grade aggregate. Those areas are also identified by the State as "sectors," which are areas considered to be available for mining because they contain what the State considers to be compatible land uses. For example, agriculture and very low density development of one dwelling unit per ten or more acres are considered compatible uses. In contrast, residential areas, commercial and industrial development, major public facilities, and certain institutional uses are considered to be incompatible uses for the purpose of identifying an MRZ-2 as a "sector." The following describes the four sectors and the other area in an MRZ-2. The locations of those areas are shown in Exhibits G890015N: 1A, B, C, D, and E.

a. Santa Maria River channel. This area consists of approximately 1,866 acres in and adjacent to the river channel. It extends from a point approximately 3.3 miles west of Highway 101 to the southern tip of the county, all within the South County Planning Area. The area is part of a much larger sector which extends into Santa Barbara County and contains the largest resources of P.C.C.-grade aggregate and almost 90 percent of the available alluvial sand and gravel resources in the San Luis Obispo-Santa Barbara County region. Four companies mine aggregate from the river channel for use as subbase and fill sand. However, they do not produce P.C.C.-grade aggregate.

The State has actually included a much more extensive area in an MRZ-2 and a sector for P.C.C.-grade aggregate. That area extends from the Santa Maria River to the Nipomo Mesa. Unfortunately, that area contains the rich, irrigated croplands in the Santa Maria Valley, which are found mostly on prime and Class III soils. The area is among the most productive agricultural land in the county and is largely under Land Conservation Act contracts. Giving special protection to that area for resource extraction could conflict with the Land Use Element goal of encouraging the protection of agricultural land for the production of food, fiber and other agricultural commodities. Furthermore, a planning area standard (South County Agriculture standard No. 5) for the Nipomo and Santa Maria Valleys precludes resource

B-8(1-5)
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Figure MP4.14-2 Parcel Map overlaid onto Area Map (orange = one mile (5280') from scale house @ proposed quarry operation.

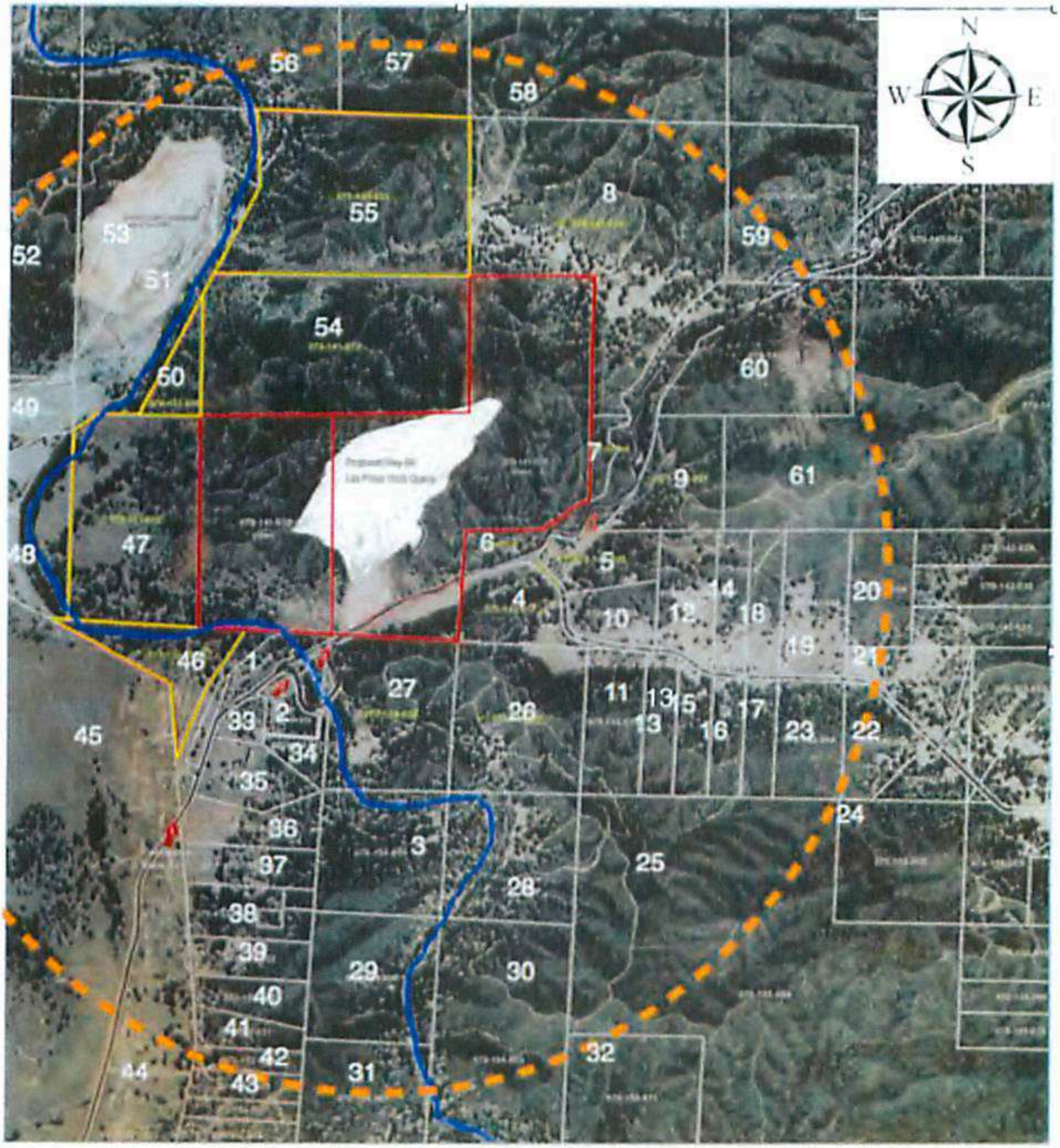

Table MP4.14-1 Parcel Inventory

Inventory of parcels, the parcel size, if a building permit has been issued for the parcel since the EX1 Combining Designation has been in place, associated land-use classification and other location information within the one mile radius defined in Figure MP 4.14-2

#	APN	Parcel Size	Permit issued since EX1	LUC	Location Notes
1	070-154-032	12 ac	Not in EX1	RR	adjacent to 070-141-070
2	070-154-009	5 ac	yes	RR	6755 Hwy. 58
3	070-154-005	40 ac	yes	RL	
4	070-142-017	26 ac	yes	RR	SW corner Parkhill/58
5	070-142-032	14 ac	yes	RR	NE corner Parkhill/58
6	070-142-016	2.4 ac	yes	RR	adjacent to 070-141-071
7	070-142-026	3.3 ac	vacant	RR	adjacent to 070-141-071
8	070-141-059	> 40 ac	yes	RL	adjacent to 070-141-071
9	070-142-027	27 ac	yes	RR	Hwy. 58
10	070-142-033	10 ac	yes	RR	6450 Parkhill Rd.
11	070-142-015	23 ac	yes	RR	6445 Parkhill Rd.
12	070-142-024	14 ac	yes	RR	6428 Parkhill Rd.
13	070-142-020	11 ac	yes	RR	6395 Parkhill Rd.
14	070-142-025	14 ac	yes	RR	6352 Parkhill Rd.
15	070-142-022	10 ac	yes	RR	6375 Parkhill Rd.
16	070-142-021	10 ac	yes	RR	6355 Parkhill Rd.
17	070-142-019	10 ac	yes	RR	6321 Parkhill Rd.
18	070-142-007	10 ac	yes	RR	6324 Parkhill Rd.
19	070-142-008	19 ac	yes	RR	6318 Parkhill Rd.
20	070-142-009	< 20 ac	yes	RR	Parkhill Rd.
21	070-142-011	6.5 ac	yes	RR	Parkhill Rd.
22	070-142-065	14 ac	no	RR	Parkhill Rd.
23	070-142-064	18 ac	yes		Parkhill Rd.
24	070-155-005	40 ac	no	RL	Parkhill Rd.

#	APN	Parcel Size	Permit issued since EX1	LUC	Location Notes
25	070-155-004	320 ac	NA	RL	BLM Land
26	070-154-001	40 ac	yes	RL	
27	070-154-024	39 ac	yes	RL	
28	070-154-002	40 ac	no	RL	
29	070-154-006	40 ac	no	RL	
30	070-154-003	120 ac	no	RR	
31	070-154-007	40 ac	no	RL	
32	070-155-011	40 ac	no	RL	
33	070-154-018	5 ac	yes	RR	6795 Hwy. 58
34	070-154-017	5 ac	yes	RR	
35	070-154-019	13 ac	yes	RR	6835 Hwy. 58
36	070-154-022	14 ac	yes	RR	Digger Pine Rd.
37	070-154-021	14ac	yes	RR	Digger Pine Rd.
38	070-152-033	16 ac	yes	RR	Digger Pine Rd.
39	070-152-032	10 ac	yes	RR	Digger Pine Rd.
40	070-152-022	10 ac	yes	RR	Digger Pine Rd.
41	070-152-021	10 ac		RR	Digger Pine Rd.
42	070-152-005	6 ac		RR	Digger Pine Rd.
43	070-152-006	7 ac		RR	Digger Pine Rd.
44	070-091-023				now part of parcel 45
45	070-091-037	1697 ac	NA	AG	Major Domo LLC (SMR) Access road into Hanson follows northern boundary of this parcel.
46	070-154-033	17 ac	NA	RL/RR	Kaiser (mining buffer parcel) adjacent to Oster

#	APN	Parcel Size	Permit issued since EX1	LUC	Location Notes
47	070-131-020	79 ac	NA	RL	Kaiser (mining buffer parcel) adjacent to Oster
48	070-131-021	73 ac	NA	RL	Kaiser
49	070-131-018	8 ac	NA	RL	SMR LLC
50	070-141-008	5 ac	NA	RL	Kaiser (mining buffer parcel)
51	070-141-006	40 ac	NA	RL	Mission Lakes LLC (SMR) Hanson Quarry operations
52	070-131-003	171 ac	yes	RL	Dkf LLC (SMR) Hanson expansion site
53	070-141-054	115 ac	NA	RL	Mission Lakes LLC (SMR) Hanson Quarry operations
54	070-141-072	80 ac	NA	RL	Kaiser (mining buffer parcel) adjacent to Oster
55	070-141-053	64 ac	NA	RL	Kaiser (mining buffer parcel)
56	070-141-001	160 ac	no	RL	
57	070-141-041	363 ac	no	RL	
58	070-141-061	404 ac	no	RL	
59	070-141-060	40 ac	no	RL	
60	070-141-049	50 ac	no	RL	
61	070-141-039	360 ac	no	RL	BLM Land
62					

SPECIAL REPORT 215

UPDATE OF MINERAL LAND CLASSIFICATION: CONCRETE AGGREGATE IN THE SAN LUIS OBISPO-SANTA BARBARA PRODUCTION-CONSUMPTION REGION, CALIFORNIA

By

Lawrence L. Busch

PG #6440

and

Russell V. Miller

PG #3331

2011

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888 Figueroa Street, Suite 475
Los Angeles, CA 90017
(213) 239-0878

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Sacramento, CA 95814-3531
(916) 445-5716

Bay Area Regional Office
345 Middlefield Road, MS 520
Menlo Park, CA 94025
(650) 688-6327

STATE OF CALIFORNIA, NATURAL RESOURCES AGENCY EDMUND G. BROWN, JR., GOVERNOR

STATE MINING AND GEOLOGY BOARD

DEPARTMENT OF CONSERVATION

801 K Street • Suite 2015 • Sacramento, California 95814

PHONE: 916 / 322-1082 • FAX: 916 / 445-0738 • TDD: 916 / 324-2555 • INTERNET: conservation.ca.gov/smgb

March 19, 2012

Department of Planning & Building Director
County of San Luis Obispo
976 Osos Street, Room 300
San Luis Obispo, CA 93408

Re: Transmittal of California Geological Survey's Special Report 215 on Update of Mineral Land Classification: Concrete Aggregate in the San Luis Obispo – Santa Barbara Production-Consumption Region, California

To Whom It May Concern:

At its Regular Business Meeting held on March 8, 2012, the State Mining and Geology Board (SMGB) accepted California Geological Survey's Special Report 215 on Update of Mineral Land Classification: Concrete Aggregate in the San Luis Obispo – Santa Barbara Production-Consumption Region, California.

The above referenced report is being transmitted to your office pursuant to Public Resources Code Article 2, Sections 2761 and 2762, for establishment of Mineral Resource Management Policies (MRMP) to be subsequently incorporated in your general plan. The SMGB looks forward to the opportunity to review and comment on your proposed MRMP.prior to adoption.

Please do not hesitate to contact me should you have any questions.

Sincerely,

Stephen M. Testa
Executive Officer

cc: Dr. John Parrish, State Geologist and Director of the California Geological Survey
John Clinkenbeard, Minerals Resources Unit, California Geological Survey

Mission of the State Mining and Geology Board is to Represent the State's Interest in the Development, Utilization and Conservation of Mineral Resources; Reclamation of Mined Lands; Development of Geologic and Seismic Hazard Information; and to Provide a Forum for Public Redress

EXECUTIVE SUMMARY

This report updates the mineral land classification for concrete aggregate in the San Luis Obispo-Santa Barbara Production-Consumption Region. The mineral land classification of the area was previously described in California Department of Conservation's Division of Mines and Geology (now California Geological Survey) Special Report 162 – *Mineral Land Classification: Portland Cement Concrete Aggregate and Active Mines of All Other Mineral Commodities in the San Luis Obispo-Santa Barbara Production-Consumption Region* – published in 1989. Special Report 162 emphasized the classification of portland cement concrete-grade aggregate resources, but also classified active mines of other mineral commodities such as asphaltic concrete aggregate, base, subbase, fill, and diatomite that were being mined in the region at that time.

This report presents a reevaluation and update of concrete (portland cement concrete-grade and asphaltic concrete-grade) aggregate resources in the San Luis Obispo-Santa Barbara Production-Consumption Region for the benefit of local lead agencies in the region. Deposits that meet the specifications for concrete aggregate are among the scarcest and most valuable construction aggregate resources. The broader category of "construction aggregate" includes materials that meet the specifications for concrete aggregate but also includes lower grade materials that are used in products such as base, subbase, and fill.

This report also provides an updated 50-year projection of construction aggregate needs for the San Luis Obispo-Santa Barbara Production-Consumption Region through the year 2060. This report does not update or alter the status of other mineral resources previously classified in Special Report 162.

In this update report, the following conclusions are reached:

- The 75 million tons of currently permitted construction aggregate reserves are projected to last through the year 2026, 16 years from the present (2010).
- In this update report, an additional 2,991 acres of land containing concrete aggregate resources are identified in areas in and near the San Luis Obispo-Santa Barbara Production-Consumption Region.
- The anticipated consumption of construction aggregate in the San Luis Obispo-Santa Barbara Production-Consumption Region for the next 50 years (through the year 2060) is estimated to be 263 million tons, of which 137 million tons must be concrete-grade. This is 57 million tons more than the prior 50-year projection made in 1989.
- An estimated 10,700 million tons of concrete aggregate resources are identified in the San Luis Obispo-Santa Barbara Production-Consumption Region.

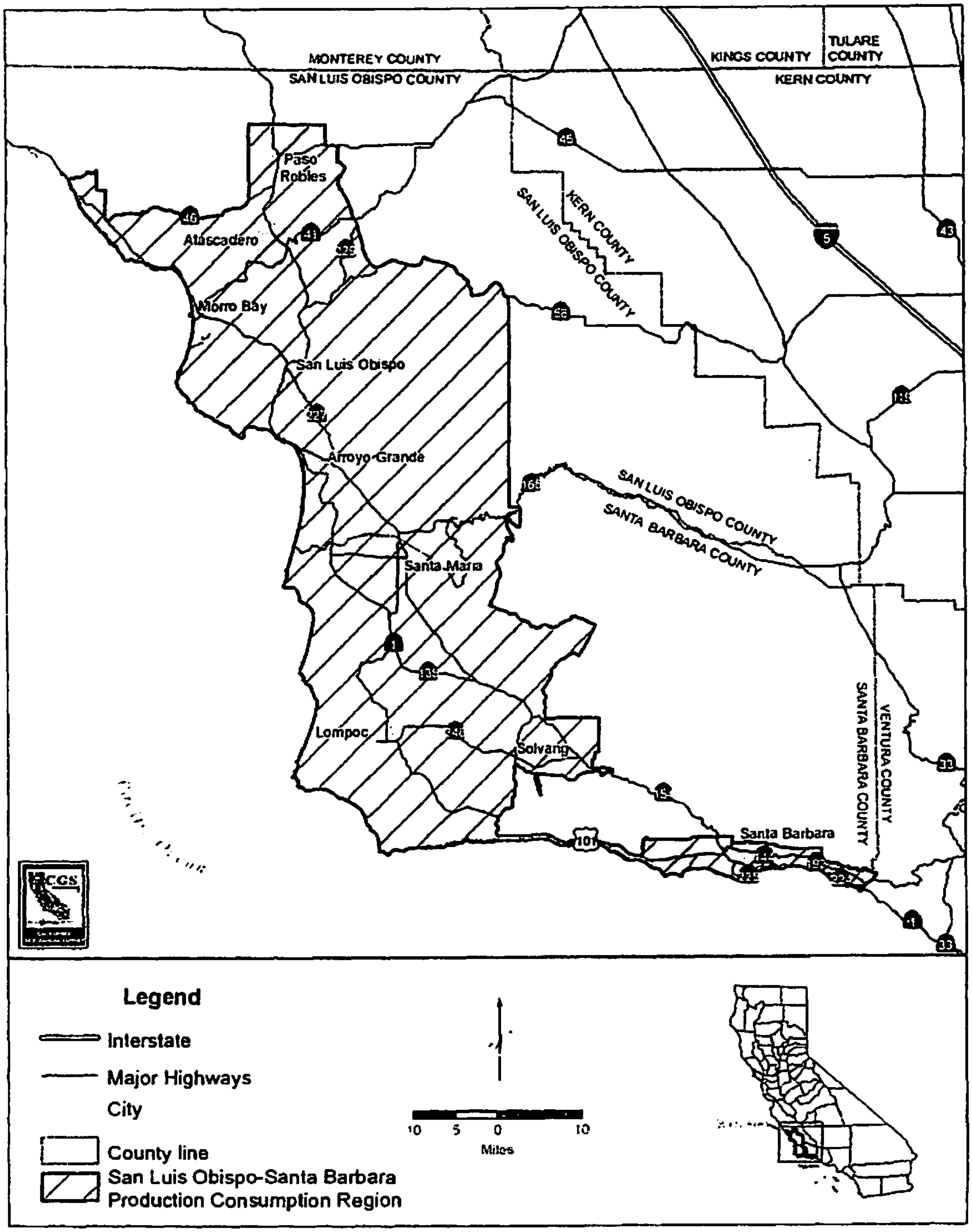


Figure 1. General location map of the San Luis Obispo-Santa Barbara P-C Region.

material percentages, and deposit densities are used to calculate total tonnages of aggregate *reserves* and *resources* within each Sector. Reserves are deposits permitted for mining; resources are all aggregate deposits identified by Sectors, including the permitted reserves.

5. Forecast of 50-Year Needs and the Life Expectancy of Current Reserves: The total tonnage of aggregate needed to satisfy the demand in the study area over the next 50 years is estimated by multiplying the projected population over that period with the average annual per-capita rate of total aggregate consumption derived from historic population and production data. Results of this forecast are used to estimate the date of depletion of current reserves in the Region.

6. Identification of Alternative Resources: Alternative sources of aggregate are identified and briefly discussed.

When the determination of the study boundary for the San Luis Obispo-Santa Barbara P-C Region originally was made in the mid-1980s, the region produced about 90 percent of the aggregate consumed within the Region. Information provided by the aggregate producers indicates that in 2009, imports of aggregate from outside of the Region were still approximately 10 percent of the total aggregate consumed in the region.

OVERVIEW OF DESIGNATION

This update report contains the classification step of the classification-designation process provided for in SMARA. The designation phase follows the receipt and acceptance of this classification report by the Board. *Designation* is the formal recognition by the Board, after consultation with lead agencies and other interested parties, of areas containing mineral deposits of regional or statewide economic significance. Procedures for the designation of lands containing significant mineral deposits are specified in Section II.2 of the Board's Guidelines for Classification and Designation of Mineral Lands (California State Mining and Geology Board, 2000).

LEAD AGENCY RESPONSE TO CLASSIFICATION

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

1. Recognize the mineral land classification information, including the Mineral Land Classification Maps transmitted to the lead agency by the Board.

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

Lead agencies that have land-use jurisdiction within the San Luis Obispo-Santa Barbara P-C Region are shown in Table 1. The information in this update and the revised projection of aggregate needs in the region should be used by the lead agencies in evaluating the effectiveness of their current mineral resource management policies and in planning for future construction aggregate demands in their jurisdictions. These plans should be updated if necessary.

Table 1. Lead agencies in the San Luis Obispo-Santa Barbara P-C Region (County and incorporated city governments).

LEAD AGENCY	Lead agencies with active aggregate operations within their jurisdiction	Lead agencies with land classified as MRZ-2 for concrete-grade aggregate within their jurisdiction
County of San Luis Obispo	•	•
City of Arroyo Grande		
City of Atascadero	•	•
City of Grover City		
City of Morro Bay		
City of Paso Robles	•	•
City of Pismo Beach		
City of San Luis Obispo		
County of Santa Barbara	•	•
City of Buellton		•
City of Carpinteria		
City of Goleta		
City of Guadalupe		
City of Lompoc		
City of Santa Barbara		
City of Santa Maria		•
City of Solvang		•

RoXsand, Inc. (formerly Troesh Ready Mix, Inc.) operates a sand and gravel pit in the Santa Maria River north of the City of Santa Maria. They produce PCC-grade aggregate.

AGGREGATE PRODUCTION DATA

Aggregate production data for the San Luis Obispo-Santa Barbara P-C Region for the years 1990 through 2009 were derived from annual mine production data collected by the California Department of Conservation's Office of Mine Reclamation. Production figures for 1987 were gathered from producers by CGS in 1987; the production figures for 1988 and 1989 were extrapolated from 1987 and 1990 data.

As shown in Table 3, aggregate consumption in the San Luis Obispo-Santa Barbara P-C Region has ranged from 5.5 million tons (2003 and 2005) to 2.5 million tons (2009)—the last year production figures are available. Since the time of the original report (SR 162, 1989) nearly 90 million tons of aggregate have been consumed in the Region. This represents an average annual aggregate consumption rate of 6.6 tons per capita.

Table 3. Population, Estimated Construction Aggregate Consumption (all grades), and Per Capita Consumption in the San Luis Obispo-Santa Barbara P-C Region 1988-2009.

Year	Population	Estimated Annual Consumption (tons)*	Per Capita Consumption (tons/person)
1988	553,165	3,241,000	5.9
1989	558,764	3,241,000	5.8
1990	564,363	3,592,000	6.4
1991	569,962	2,878,000	5.0
1992	575,561	3,230,000	5.6
1993	581,160	2,756,000	4.7
1994	586,759	3,235,000	5.5
1995	592,358	3,717,000	6.3
1996	597,958	3,537,000	5.9
1997	603,557	4,243,000	7.0
1998	609,156	4,777,000	7.8
1999	614,755	5,255,000	8.6
2000	620,354	4,784,000	7.7
2001	627,951	5,042,000	8.0
2002	635,509	5,221,000	8.2
2003	641,719	5,541,000	8.6
2004	647,604	4,843,000	7.5
2005	652,677	5,533,000	8.5
2006	656,829	4,762,000	7.3
2007	661,584	4,040,000	6.1
2008	667,941	3,823,000	5.7
2009	673,551	2,532,000	3.8
		Total 89,823,000	**Average 6.6**

* Consumption = regional production + net imports/s. Aggregate consumption figures are rounded to the nearest 1,000 tons.

PART IV – UPDATED ESTIMATE OF 50-YEAR CONSUMPTION OF AGGREGATE IN THE SAN LUIS OBISPO-SANTA BARBARA P-C REGION

The Board, as specified in its guidelines for classification and designation of mineral land (California State Mining and Geology Board, 2000), requires that mineral land classification reports for regions containing construction materials classified as MRZ-2 include "An estimate of the total quantity of each such construction material that will be needed to supply the requirements of both the county and the marketing region in which it occurs for the next 50 years. The marketing region is defined as the area within which such material is usually mined and marketed. The amount of each construction material mineral resource needed for the next 50 years shall be projected using past consumption rates adjusted for anticipated changes in market conditions and mining technology." This section contains the revised estimate of aggregate needs for the San Luis Obispo-Santa Barbara P-C Region, projected through the year 2060.

CORRELATION BETWEEN AGGREGATE CONSUMPTION AND POPULATION

Past studies of production-consumption regions in California have shown a correlation between the amount of aggregate consumed and the population of the market area (Anderson and others, 1979). An aggregate report for Los Angeles County (Miller, 1994) includes a statistical analysis of aggregate consumption versus population suggesting that roughly two-thirds of the variation in aggregate consumption could be attributed to population variance. The fact that large market regions such as Los Angeles County show a correlation between aggregate production and population indicate that population is a major factor in determining aggregate consumption in many areas. Other factors, such as major public construction projects can randomly add large amounts of aggregate to consumption figures. The economy also has a strong influence on aggregate demand, but the simple factor of population was selected because it most influences aggregate demand over long periods of time.

A comparison of the projected aggregate demand for the San Luis Obispo-Santa Barbara P-C Region from SR 162 (1989) and actual production data for the period of 1988 to 2009 is shown in Figure 2. Using an annual per capita consumption rate of 6.0 tons, SR 162 projected that the demand for aggregate in the San Luis Obispo-Santa Barbara P-C region for 1988-2009 would be 75 million tons. Actual aggregate consumption in the San Luis Obispo-Santa Barbara P-C Region for 1988-2009 was approximately 90 million tons. The difference between projected demand and actual consumption—15 million tons—was 20 percent greater than projected. This difference was likely caused by slightly greater population growth than previously projected and also by higher rates of construction during the 1995-2005 time period.

Population data for the San Luis Obispo-Santa Barbara P-C Region for the years 1988 to 2009 were obtained from census tract data from the U.S. Census Bureau (2010) for the 1990 and 2000 censuses. The populations of complete census tracts within the P-C Region were summed with the partial populations of partial tracts. The population of partial tracts was estimated based on the percentage of the included area. Population for each year between the decennial census years was interpolated. The average per capita aggregate consumption rate for the years 1988 through

2009 was 6.6 tons per person per year (Table 3). This rate was used for projecting future aggregate demands within the P-C Region.

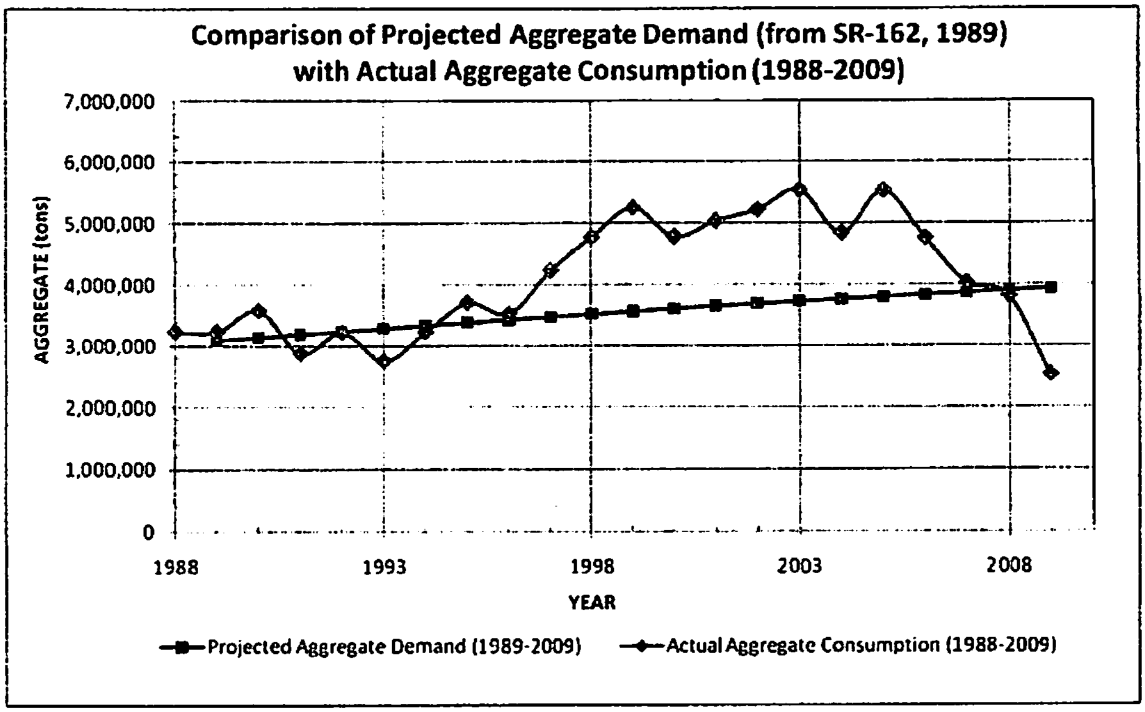


Figure 2. Comparison of projected demand in the San Luis Obispo-Santa Barbara P-C Region with recorded aggregate consumption, 1988-2009.

POPULATION PROJECTION FOR THE SAN LUIS OBISPO-SANTA BARBARA P-C REGION THROUGH THE YEAR 2060

The year-2000 population for the census tracts within the P-C Region was divided by the total year-2000 population of San Luis Obispo and Santa Barbara counties. The resulting ratio was used to estimate the San Luis Obispo-Santa Barbara P-C Region's future population for the years 2010, 2020, 2030, 2040 and 2050.

The population projection for the San Luis Obispo-Santa Barbara P-C Region was derived from official projections for counties published by the California Department of Finance's Demographic Research Unit (California Department of Finance, 2010) and the population percentage factor for the P-C Region, cited above. Report 06 P-1(on the California Department of Finance's website) provides population projections for counties in California for the years 2010, 2020, 2030, 2040 and 2050. Yearly population estimates were interpolated from the bracketing 10-year projected population numbers and extrapolated for the years 2051 through 2060. The population of the San Luis Obispo-Santa Barbara P-C Region is projected to increase from 684,127 in 2011 to 912,003 in 2060, an increase of about 33 percent.

PROJECTED AGGREGATE DEMAND FOR THE SAN LUIS OBISPO-SANTA BARBARA P-C REGION THROUGH THE YEAR 2060

An analysis using projected population and annual per capita consumption rate, derived by methods described in preceding sections, was used to forecast the aggregate demand of the San Luis Obispo-Santa Barbara P-C Region through the year 2060. The calculated annual per capita consumption rate of 6.6 tons (from Table 3) was multiplied by the projected annual population for each year through the year 2060 to produce the projected aggregate demand shown in Table 4.

The result of this projection shows that an estimated 263 million tons of aggregate will be needed to satisfy future demand in the San Luis Obispo-Santa Barbara P-C Region through the year 2060. Of this total, it is estimated that approximately 52 percent, or 137 million tons, will be used in PCC and AC, with the remainder being used in other construction aggregate products. This percentage is based on estimates by the producers of current aggregate usage. This updated 50-year demand for the period 2011 to 2060 is nearly 30 percent higher than the 50-year demand projected in 1989 to 2038 in SR 162.

COMPARISON OF THE 50-YEAR AGGREGATE DEMAND WITH CURRENT CONCRETE-GRADE AGGREGATE RESERVES

The total concrete-grade aggregate reserves of 75 million tons (see Table 2) in the San Luis Obispo-Santa Barbara P-C Region are projected to last 16 years (into the year 2026, see Figure 3). If all of the concrete-grade aggregate reserves were to be used exclusively as concrete aggregate, the supply would theoretically last 30 years (into 2041). In reality, 48 percent of the concrete-grade aggregate reserves likely will be used for other lower grade aggregate products such as base and subbase, and a depletion date of 2026 is considered more realistic. However, even this date may be optimistic. An important consideration is that not all of the aggregate reserves may be minable under existing permits because of operating restrictions or because of expiration dates that may not allow reserves to be completely mined.

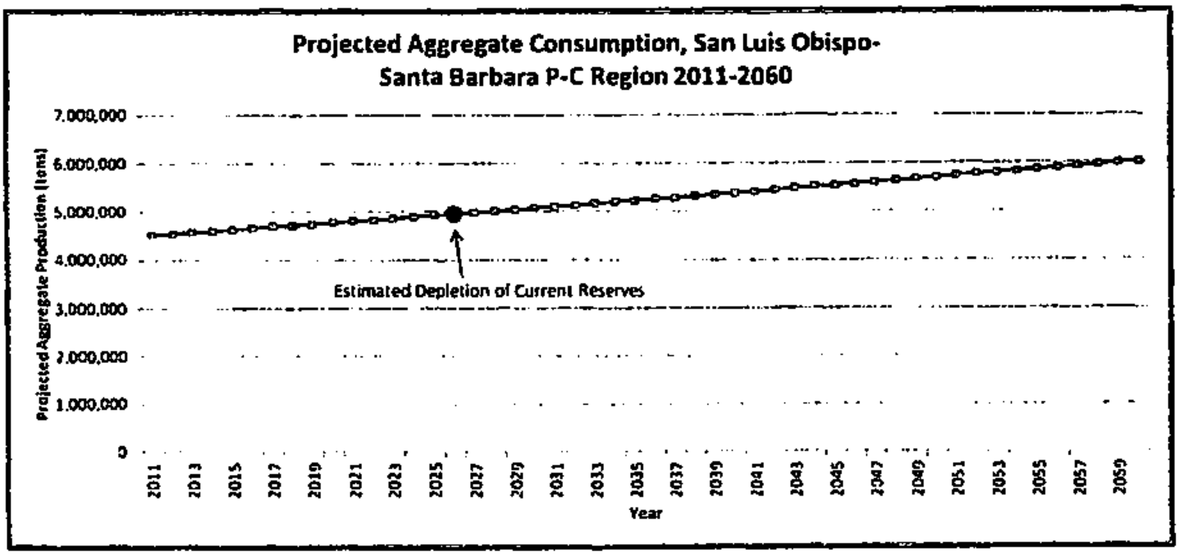


Figure 3. Projected construction aggregate demand in the San Luis Obispo-Santa Barbara P-C Region 2011-2060.

Comparing regional needs to available reserves and resources demonstrates the construction aggregate resource issues confronting the P-C Region. This includes the need to plan carefully for the use of lands containing these resources and the need to consider the permitting of additional aggregate resources in the region before currently permitted deposits are depleted.

Table 5 summarizes the identified aggregate resources and estimated future aggregate demands for the San Luis Obispo-Santa Barbara P-C Region. The projected lifespan of the aggregate reserves assumes that mining of these reserves will continue until the reserves are depleted. In addition, should unforeseen events occur, such as massive urban renewal, infrastructure projects, reconstruction in the wake of a disaster, or major economic recession, the demand for construction aggregate in the San Luis Obispo-Santa Barbara P-C Region may change considerably, which could alter the lifespan of the aggregate reserves.

Table 5. Summary of concrete-grade aggregate reserves, projected 50-year demand, and depletion date for the San Luis Obispo-Santa Barbara P-C Region.

Estimated Concrete-Grade Aggregate Resources	**10.7 Billion Tons**
Concrete-Grade Aggregate Reserves	**75 Million Tons**
Projected 50-Year Construction Aggregate Demand (all aggregate grades)	**263 Million Tons**
Projected 50-Year Demand for Concrete-Grade Aggregate	**137 Million Tons**
Estimated Years Until Depletion of Current Concrete-Grade Aggregate Reserves	**16 Years**
Estimated Depletion Date of Concrete-Grade Aggregate Reserves	**2026**

SPECIFIC PLANS IN THE SAN LUIS OBISPO-SANTA BARBARA P-C REGION

San Luis Obispo and Santa Barbara counties have taken an important step in their planning process that is intended to ensure future access to a large part of their concrete-grade aggregate resources. Both counties have adopted Specific Plans designed to serve as the primary land use and regulatory guides for mining and reclamation in the Plan areas. The overall goals of these plans are to provide for the long term production and conservation of aggregate resources in a manner compatible with existing surrounding land use, while minimizing adverse impacts to the environment. A 12-mile section of the Santa Maria and Sisquoc rivers is covered by a Specific Plan (Santa Barbara County, 1997; and San Luis Obispo County, 1998) adopted by both counties, and the Rocky Canyon Quarry area is included in a Specific Plan (San Luis Obispo County, 1998) adopted by San Luis Obispo County.

The plans set forth goals, objectives, and policies for resource utilization and protection, and environmental protection, as well as operation, reclamation, and monitoring criteria. All actions taken by the regulatory agencies involving plan review and approval for mining and reclamation within the Plan area must be consistent with these Plans. These specific plans represent significant additions to the mineral management policies of the two counties, as they include parts of the two largest PCC-grade aggregate resource areas in the P-C Region.

POTENTIAL ALTERNATIVE SOURCES OF AGGREGATE FOR THE SAN LUIS OBISPO-SANTA BARBARA P-C REGION

Potential sources of concrete aggregate, in addition to the deposits classified MRZ-2 in this update, exist within and near the San Luis Obispo-Santa Barbara P-C Region. The potential sources within the region are in areas that are classified as MRZ-3 and include areas underlain by Holocene alluvial deposits, Tertiary sedimentary deposits, and crystalline rocks. Too little is known about these deposits to allow more than a general description. SR 162 contains a description of these deposits in the section titled "Alternative Sources of Aggregate."

Potential sources outside of the San Luis Obispo-Santa Barbara P-C Region include the production areas in the Simi Valley and San Fernando P-C regions to the southeast. Both of these regions presently provide some aggregate to the Santa Barbara City area.

RECYCLED AGGREGATE

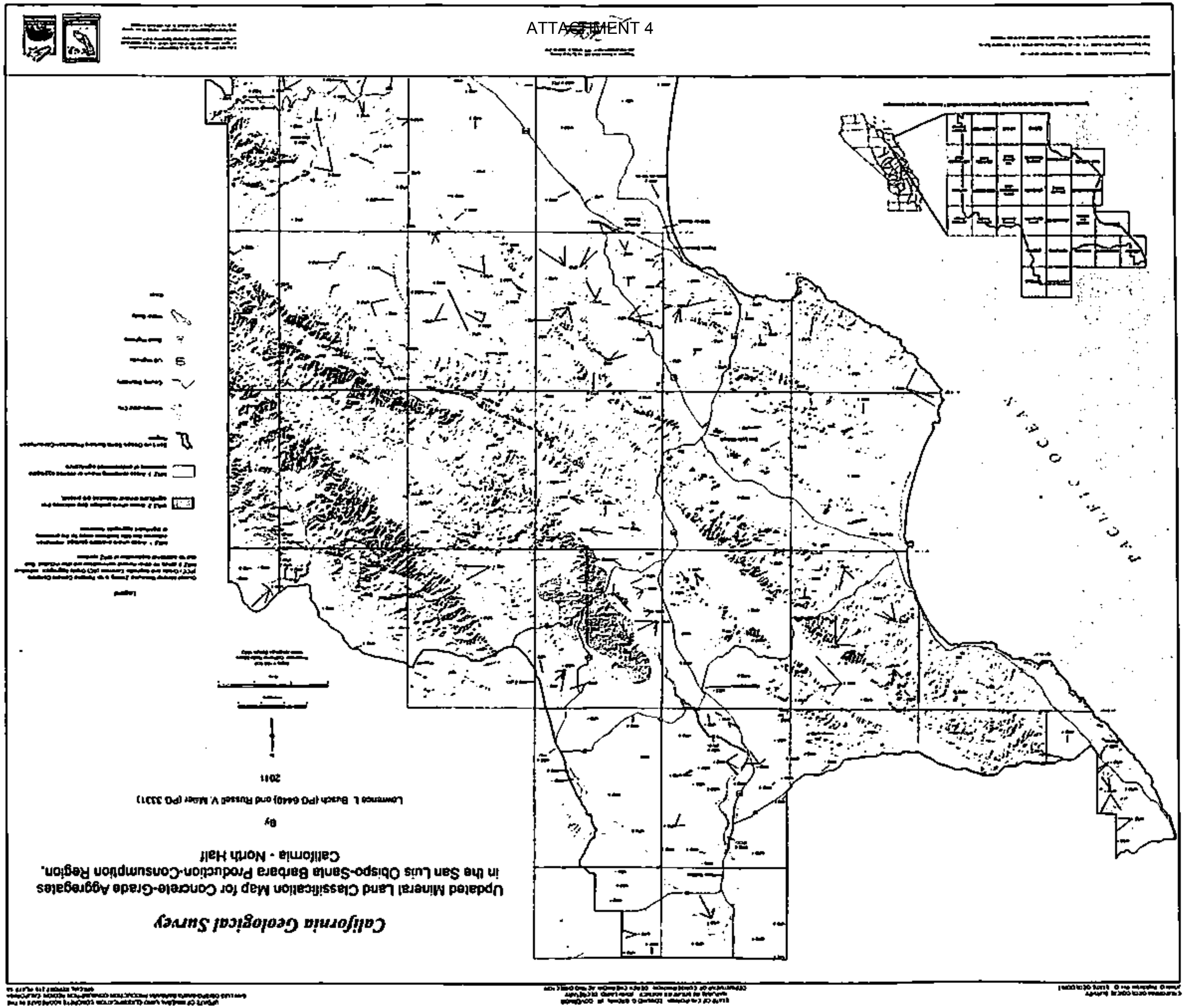
During the past three decades, the use of recycled inert demolition debris such as concrete rubble and slab asphalt rubble has steadily increased in California. The most recycled materials in California, by tonnage, are asphalt and concrete. Recycling programs that recover demolition rubble, such as asphalt and concrete, significantly reduce the waste-stream going into landfills and also extend the life of existing aggregate mines. However, recycled aggregate generally is not suitable for use as PCC aggregate, although some is used in AC aggregate. The bulk of recycled aggregate is used as base materials.

In the San Luis Obispo-Santa Barbara P-C Region, the rate of recycling of demolition waste is high. Based on recycler estimates, roughly 250,000 tons of recycled aggregate was reclaimed from demolished construction materials in the P-C Region in 2009. This figure will vary, depending on amounts available and demands for the products. Unless there is a large change in the use of recycled material for aggregate, there will not be a significant effect on the mining of new aggregate deposits and the projection of future demand for raw aggregate materials will not change significantly.

PART VI - CONCLUSIONS

Reevaluation and recalculation of the concrete aggregate (PCC and AC) resources in this study concludes that the San Luis Obispo – Santa Barbara P-C Region contains about 10.7 billion tons of concrete aggregate resources. This number is slightly less than the 11.2 billion tons of PCC-grade aggregate resources identified by SR 162 in 1989. The updated figure includes a decrease of about 788 million tons of concrete-grade aggregate resources (approximately 90 million tons of production, 273 million tons due to land use changes since 1989, and 425 million tons due to a change in waste factors used). Also included are the additions of about 280 million tons of AC-grade aggregate resources along the Santa Ynez River; about 5 million tons of AC-grade resources in an area along Huerhuero Creek at the northestern boundary of the P-C Region; and the PCC-grade limestone deposits at Bee Rock. The resources identified along the Cuyama River were not included in the resource base for the P-C Region at this time as that area is not currently serving the P-C Region.

Based on available historic population and production data, and population projections, the San Luis Obispo-Santa Barbara P-C Region will need 263 million tons of aggregate during the next 50 years. Of this projected demand, it is estimated that 52 percent, or 137 million tons, must be suitable for use in PCC or AC. The presently permitted concrete-grade (PCC and AC) aggregate reserves of 75 million tons represent less than 30 percent of the projected construction aggregate demand of the next 50 years. These permitted reserves are projected to last until the year 2026, 16 years from the present. If a major earthquake or similar unforeseen catastrophic event strikes the region and necessitates reconstruction, existing reserves may be depleted sooner. A comparison of the results of the current study with those of the 1989 study is presented in Table 6.


California Geological Survey
Updated Mineral Land Classification Map for Concrete-Grade Aggregates
in the San Luis Obispo-Santa Barbara Production-Consumption Region,
California - North Half
By
Lawrence L. Busch (PG 6440) and Russell V. Miller (PG 3331)
2011
PACIFIC OCEAN

Las Pilitas Resources, LLC

Commitment · Integrity · Responsibility

Figure 4.1-2a	Existing Conditions
URS	Oster/Las Pilitas Quarry EIR San Luis Obispo County

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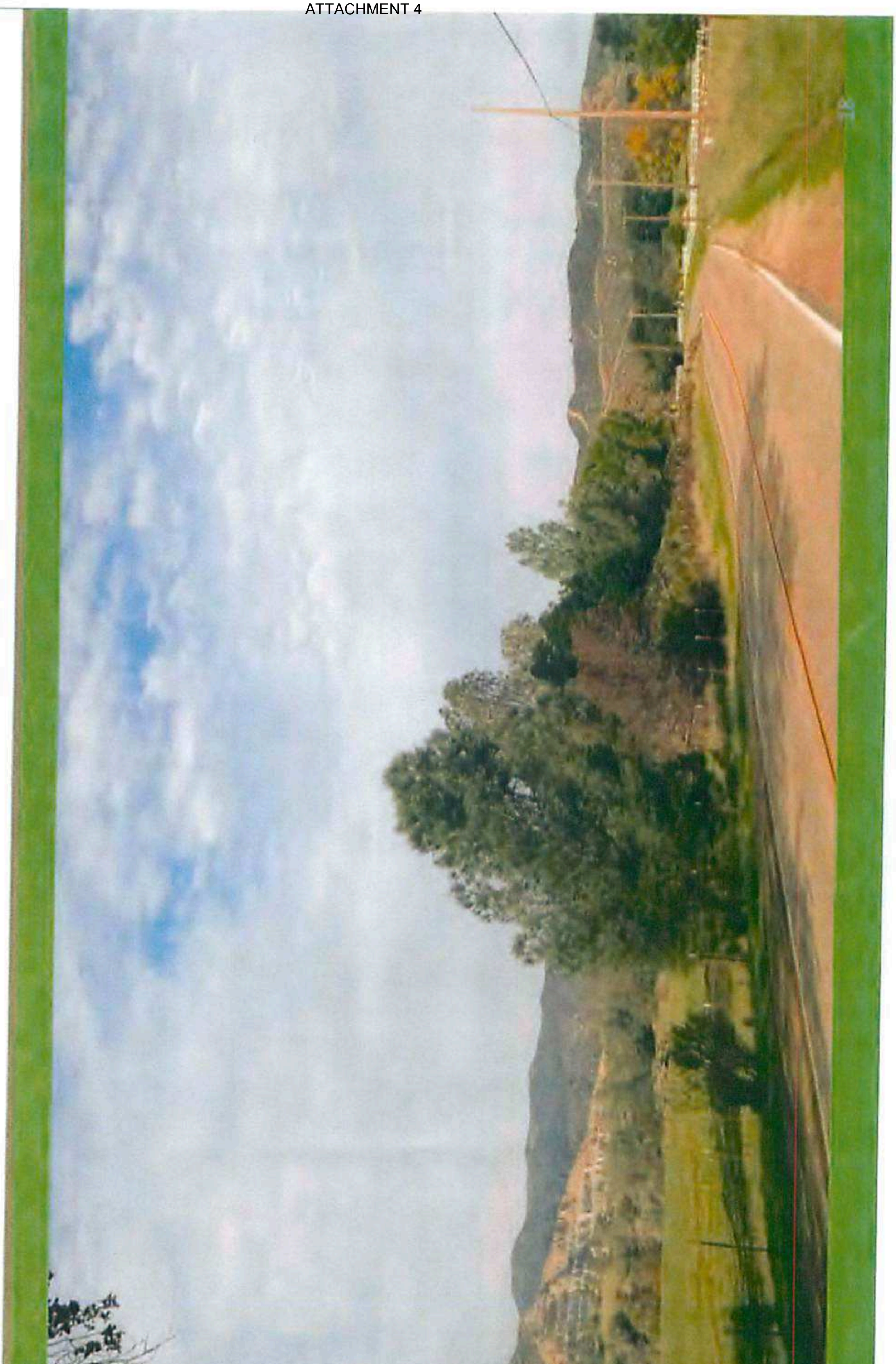

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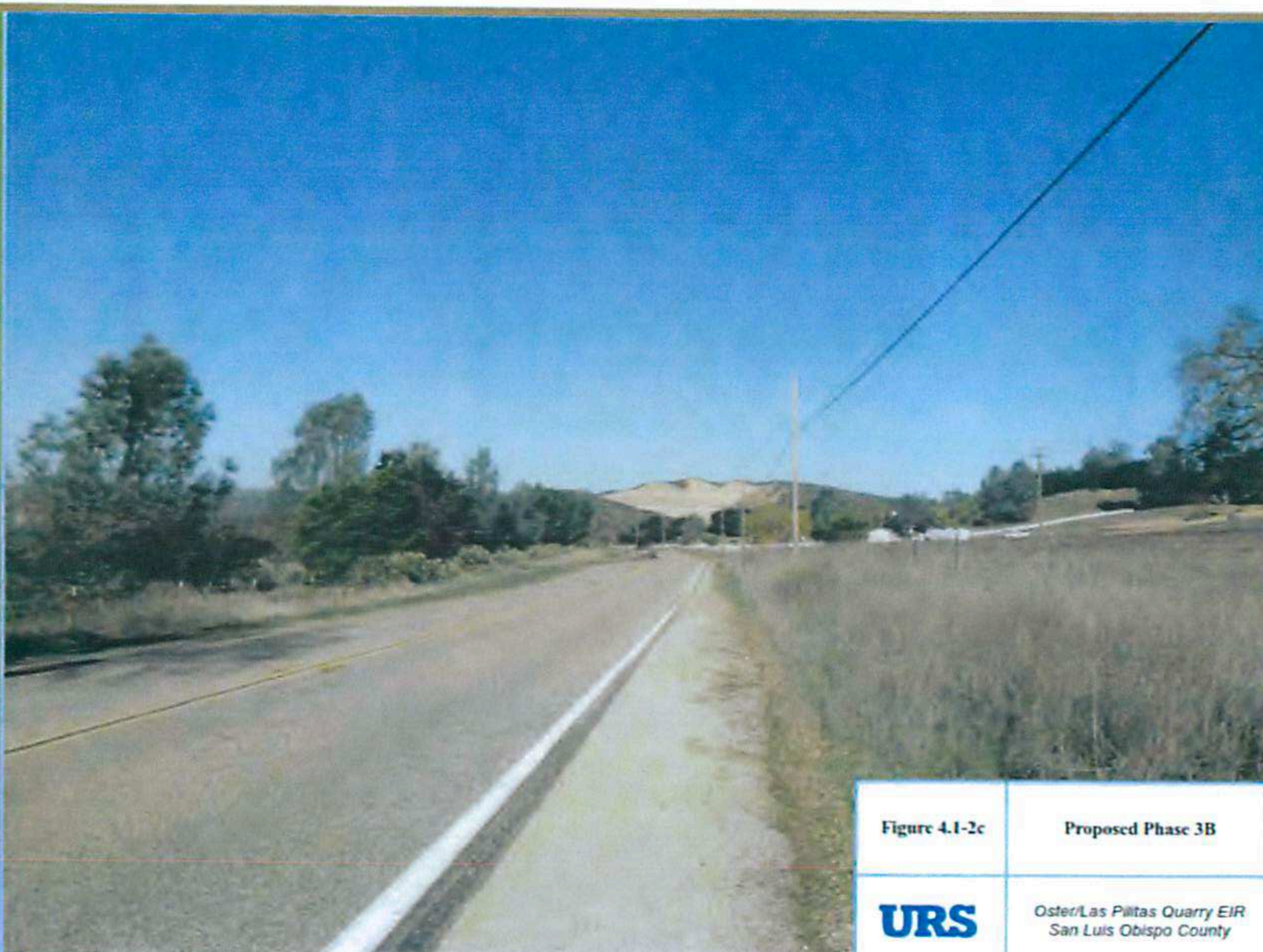

Figure 4.1-2c	Proposed Phase 3B
URS	Oster/Las Pilitas Quarry EIR San Luis Obispo County

Las Pilitas Resources, LLC

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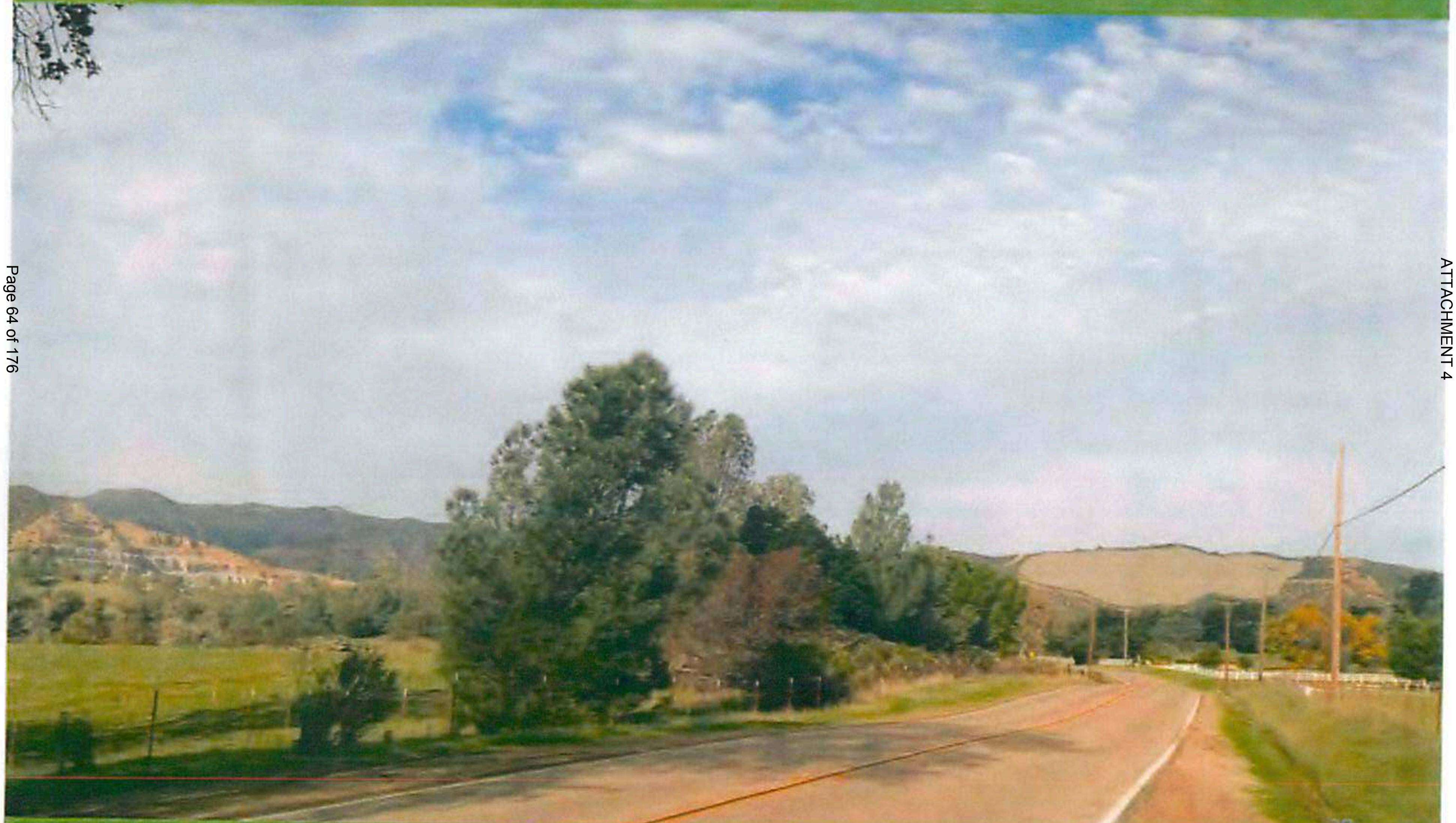

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SMGB Information Report 2008-05

STATE MINING AND GEOLOGY BOARD

A Report of Mineral Land Classification and Designation Under the Surface Mining and Reclamation Act of 1975

Department of Conservation
Resources Agency

July 2008

**This Information Report No. 2008-05
of the State Mining and Geology Board was presented, in part,
at its Regular Business Meeting
held on May 10, 2007.**

**This report does not set forth policy, but rather presents information
that the SMGB considers in setting policy.**

STATE MINING AND GEOLOGY BOARD

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A Report on Mineral Land Classification and Designation Under the Surface Mining and Reclamation Act of 1975

Stephen M. Testa[1] and David J. Beeby[2]

ABSTRACT

Mineral Land Classification by the California Geological Survey (CGS) and Designation by the State Mining and Geology Board (SMGB) reflect the initial steps in the exploration, development, production, use and reclamation of lands under the Surface Mining and Reclamation Act of 1975 (SMARA). The primary goal of this aspect of SMARA is to ensure that the mineral resources potential of lands in California are recognized and considered in the land-use planning process. Mineral Land Classification is very dependent on staffing and funding, and a substantial increase and long-term funding source is needed to restore the effectiveness of this program. Designation by the SMGB has been deferred since 1990, with 14 Production-Consumption Regions awaiting designation. A summary of these two programs in regards to their respective legislative history, methodology and current status is provided. Recommendations, and further considerations for policy decisions, are also provided.

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INTRODUCTION

Mineral Land Classification by the California Geological Survey (CGS) and Designation by the State Mining and Geology Board (SMGB) reflect the initial steps in the exploration, development, production, use and reclamation of lands under the Surface Mining and Reclamation Act of 1975 (SMARA). The primary goal of this aspect of SMARA is to ensure that the mineral resources potential of lands in California are recognized and considered in the land-use planning process.

The primary role of CGS in this process is to provide objective classification data, including forecasting, to the SMGB, lead agencies, and others, in an easily understood format. The role of the SMGB is to conduct public hearings in compliance SMARA to determine which resources areas identified by CGS are of statewide or regional significance, and "Designate" those areas. Lead Agencies subsequently incorporate the information provided by CGS and the SMGB into their general plans and use it in their daily land-use decisions to protect a 50-year supply of aggregate.

At its September 14, 2006, meeting the SMGB's Minerals and Geologic Resources Committee (Committee) received from staff a presentation regarding the State's Mineral Resources Management Program. Staff offered a review of 1) the current status of the SMGB's effectiveness in reviewing Mining Ordinances, Mineral Resource Management Policies (MRMP), and California Environmental Quality Act (CEQA) documents under the SMARA Mineral Resource Management Program, and 2) the state of compliance by local governments in adopting Mining Ordinances and incorporating MRMPs into their general plans, pursuant to Public Resources Code (PRC) Sections 2762 and 2763, and Title 14 California Code of Regulations (CCR) Sections 3675 and 3676. Several recommendations were offered. In addition, a report on the State's overall Mineral Land Classification and Designation program was requested for discussion at a future meeting. The report on Mineral Land Classification and Designation under SMARA contained herein has been prepared in response to the Committee's request. The report is divided into seven parts:

- A Primer on the Economics of Construction Aggregates
- SMARA History
- SMARA Methodology
- SMARA Current Status and Chronology

- Legislative History and Resources
- Observations
- Recommendations

INTRODUCTION ON THE ECONOMICS OF CONSTRUCTION AGGREGATES

Mineral Land Classification by CGS and Designation by the SMGB, are the first links in the SMARA chain. The primary goal of the mineral resource classification and designation program is to ensure that the mineral resource potential of lands in California is recognized and considered in the land-use planning process.

Construction aggregate is the most important mineral commodity produced in California (Figure 1). It forms the physical foundation of our societal infrastructure. It is effectively irreplaceable, and cannot be economically imported and distributed. Produced in every county except San Francisco, and used in all, it is the cheapest commodity produced per unit volume while being the highest overall value commodity mined in California. There are two types of construction aggregate which are largely interchangeable: sand and gravel (natural aggregate) and crushed stone (rock). These materials have many uses (Figure 2), and from increasingly tougher specification to lesser performance expectations, include:

- Portland-Cement-Concrete Aggregate (PCC-grade aggregate)
- Asphaltic-Concrete Aggregate (AC-grade aggregate)
- Road Base
- Railroad Ballast
- Rip-Rap
- Fill
- Others

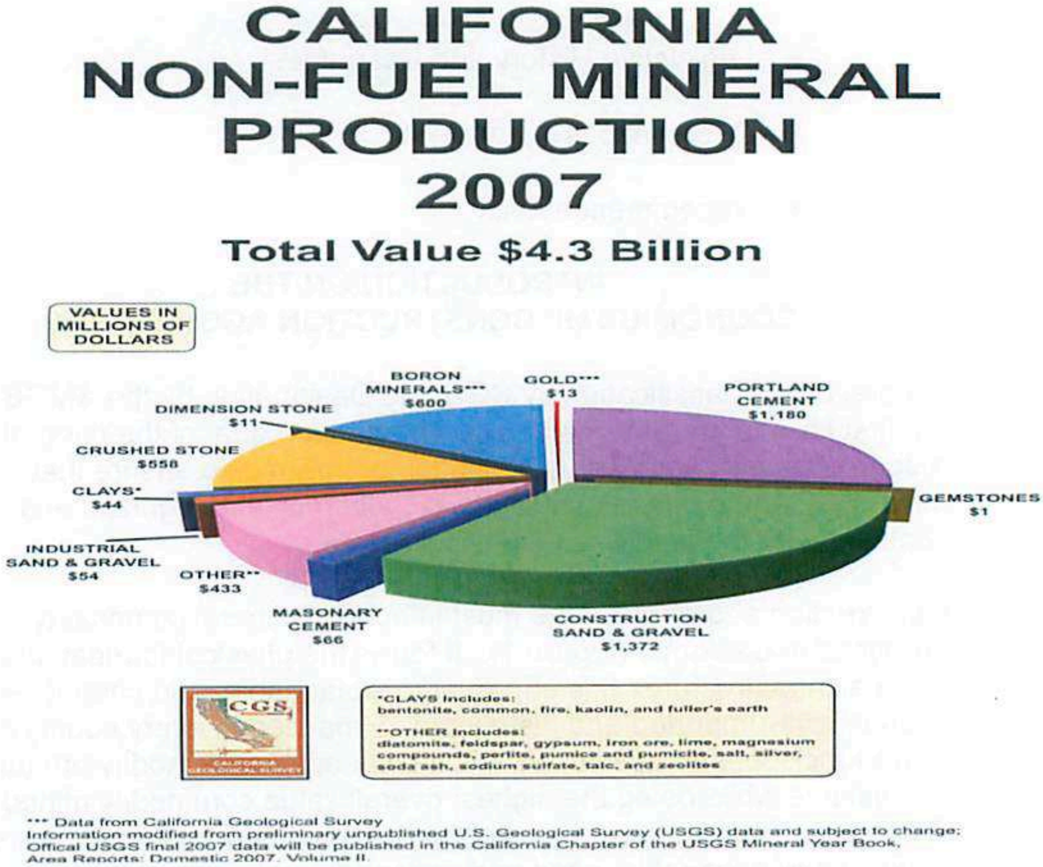


Figure 1. California Non-Fuel Mineral Production for Year 2007 (California Geological Survey, 2008).

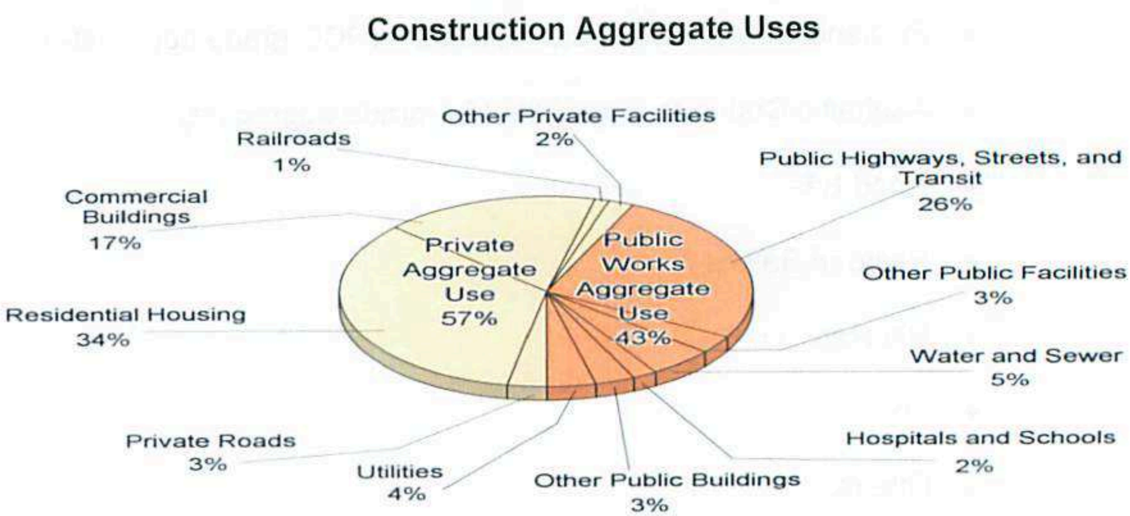


Figure 2. Construction Aggregate Uses (modified after Coopers and Lybrand, 1998).

Construction aggregate is vital to maintain and expand the State's infrastructure and economy. Aggregate accounts for $163 billion (44% of the value) of California's total 2005 mineral production. In regards to usage, in 2005 176.4 million tons of sand and gravel, and 58.9 million tons of crushed stone were used (a total of 255.3 million tons), by a state comprised of 36,100,100 people. Essentially, the annual per capita consumption is on the order of 7.1 tons per person per year. According to the American Geological Institute (AGI, 2004), about 229 tons of aggregate is used for a typical 1,000 square foot ranch house, or a 2,000 square foot two-story house (Figure 3).

Figure 3. Illustration showing the amount of aggregate used in one house. Not included is the capita share of the library, school, church, power Plant, airport, dam, freeways, shopping centers, hospitals, firehouses, etc. (modified after AGI, 2004).

For construction minerals to have value, they must be produced near their place of use. This reflects their overall low unit value and high transportation costs due to their bulk and weight. A haul distance of about 25 miles doubles the delivered price of construction aggregate. Shorter haul distances mean lower costs and less environmental impact which results in less fuel use, air pollution, traffic congestion, road wear, tire and equipment wear, and shorter delivery times. Since almost half of construction aggregate is used in public works projects, lower cost aggregate means lower taxes.

Land values in the urban and suburban areas of the state are high, so it is always in the economic self-interest of the mine operator to reclaim their mines. Thus, lack of reclamation and abandoned aggregate mines are rarely issues in California, and local sources of construction aggregate are in the society's best interest. When a mine is too near its market, problems can develop forcing premature closure and the sterilization of its resources. Unplanned development allows residential growth to engulf and strangle mines to the detriment of society.

Wise and effective land-use planning by local government is essential because of a universal "Not in my Backyard" (NIMBY) syndrome. While aggregate deposits may be geographically widespread, they are not universally present or economically recoverable. A single local jurisdiction may control land-use permitting for aggregate deposits that serve the needs of an entire metropolitan region. Like gold, suitable aggregate deposits are where you find them. They cannot be moved to a convenient place to be mined.

SMARA HISTORY

Enactment of SMARA took years of effort beginning in the 1960s. The SMGB played a very significant role in the development of SMARA, working directly with the California Legislature and the Resources Agency Secretary.

In 1967, the California Legislature through a Senate Resolution requested a review for uniform controls and standards for surface mining. The Senate Committee on Natural Resources and Wildlife subsequently requested that the SMGB review the resolution and advise the Legislature as to the nature of the problem and the need for legislation. The SMGB suggested that a state review of surface mining would be of value and advanced that proposal via Resolution to the Resources Agency Secretary.

In November of 1968, the Resources Agency Secretary requested seven representatives of industry, state and local government, and the academic community to undertake an inquiry to determine "*such regulations as may be needed to avoid collision between urbanization and the mining industry*". The group became know as the "Surface Mining Committee" or "Blue-Ribbon Task Force" and worked for two years holding a series of hearings throughout the state. Their final report was completed in October 1970 and adopted by the SMGB in November 1970. An ad hoc Committee of SMGB Members was appointed, and they presented a "State Mining and Minerals Policy", along with a proposed "Act on Mining and Mined Land Reclamation" to the SMGB on September 14, 1971. That Act was presented to the Governor's Cabinet prior to the 1972 session for introduction to the Legislature, where it resulted in Senate Concurrent Resolution 89 on October 8, 1971.

In 1973, The Urban Geology Master Plan – CGS Bulletin 198, documented that "*the identification and protection of mineral resources* *had the highest cost-benefit ratio (1:176) of any geologic issue in California.*" It forecast that California would face a $17 Billion loss of aggregate resources by the year 2000 if then-current land-use practice continued. This publication was not specifically focused on ongoing SMARA discussions in the Legislature, but was instrumental in its passage. SMARA remained deadlocked for three years in the Legislature between the aggregate industry, local government, and the environmental community. A compromise was finally reached by assuring cities and counties local land-use authority and by strengthening the elements addressing "mine reclamation" in addition to "mineral land classification". The Act was passed as SMARA in 1975.

Before SMARA the landmark publication on sand and gravel resources in California was the 1968 statewide three-part CGS Bulletin 180 (Parts A, B and C), authored by Hal Goldman. This publication became a vital data source for all subsequent SMARA work.

With the passage of SMARA, three pilot studies were undertaken by CGS to develop methodology:

- <u>Stanislaus River Study</u> (OFR 77-16 authored by Rapp et al, 1977), which included a three-dimensional analysis based on drill log data.

- <u>Los Angeles Basin Study</u> (SR 139 authored by Evans et al, 1979), which characterized aggregate production districts.

- <u>San Francisco Bay Study</u> (unpublished, authored by Stinson and Manson), which discussed active mines and marketing.

Concurrently, the SMGB was working with the State Geologist to develop policy and pass regulations to implement SMARA. Specifically, these elements consisted of:

- Policy development;

- Regulations (April 28, 1977, CCR Section 3500 et seq.);

- Guidelines for Classification and Designation of Mineral Lands (CGS SP 51);

- Approval of Classification priorities; and

- Guidance and Assistance for Lead Agencies.

Parts of all three pilots were ultimately used, but the Los Angeles Basin study was selected as the basic model for future classification work. A classification study of the entire Los Angeles Basin was begun by Tom Anderson and Marge Bushnell, but after a year was abandoned as being too broad in scope. This effort resulted in SR 143, Part 1. The Los Angeles Basin was subsequently subdivided into "Production – Consumption Regions", and work began in the San Fernando Valley (SR 143, Part II, 1979). This effort was interrupted to work in Western Ventura County and the Simi Valley (SR 145, 1981) at the direction of the SMGB, but later resumed.

In 1980, an amendment to SMARA authorized the beginning of Mineral Land Classification in non-urban areas of the state and established the SMARA Account as a funding source. It restricted the use of SMARA funds to be used only for Mineral Land Classification, Mined Land Reclamation, and the SMARA activities of the SMGB. Two SMARA Classification Programs were started in 1980-81, both under the direction of Rudy Strand and later by John Alfors:

- Urban SMARA; led by David Beeby
- Country SMARA; led by Tom Anderson

Urban SMARA addressed areas threatened by urbanization, beginning in the Los Angeles and Ventura Basins, and the San Francisco Bay area. The Urban SMARA program was purely data driven, without regard to current land-use.

At is outset the Urban SMARA program dealt strictly with construction aggregate, initially Portland Concrete Cement (PCC) and Asphaltic Cement (AC) grade aggregate. It would subsequently expand to include all construction and industrial minerals, in addition to all other active mines. Information collected was almost all published as Special Reports, and incorporated forecasting aggregate need for "the foreseeable future", petitions for Classification, Designation by the SMGB, and mandatory 10-year re-mapping and forecast updates.

The Country SMARA program addressed non-urban areas threatened by development or Federal land withdrawal. This program began in the Mother Lode and Sierra regions, and in the Mojave Desert (RARE I and II, CDCA, proposed parks). Initially focused on gold and precious metals, it would subsequently include everything except Construction Aggregate and Clay. No local market data was compiled, and almost all of the information was published as Open-File Reports, instead of Special

Reports. The Country SMARA program also did not incorporate Petitions or Designations as "Regionally Significant" by the SMGB. Between 1981 and 1994, 29 study areas were established, covering 15% of the state's area and incorporating 5% of its population (Figure 4).

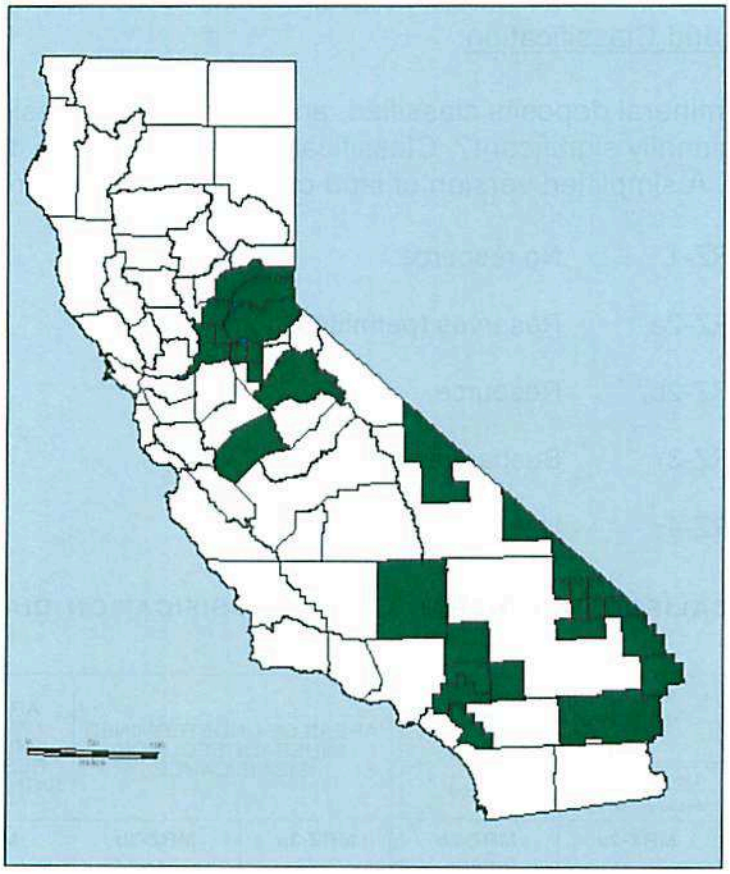


Figure 4. Illustration showing progress of the former County SMARA program from 1981 through 1994. The 29 studies areas are shown in green.

The reports set a new quality standard for wilderness mapping but were almost entirely ignored in withdrawal decisions. Various desert and wilderness Federal land withdrawals eventually took place with the passage by Congress of the "California Desert Protection Act" on October 31, 1994. This Act almost entirely ignored mineral resources mapping of the Country SMARA program. After the withdrawals, Country SMARA ceased to serve an immediate purpose of aiding the land withdrawal decision process.

The Urban and Country SMARA programs were reintegrated into a single Classification Program in 1995 with a focus on all mineral commodities in areas threatened by urbanization, or by any incompatible land use. Staff remained in both northern (SMARA North) and southern (SMARA South)

California to maintain close ties and working relationships with local government, but the distinction was informal.

SMARA METHODOLOGY

<u>Mineral Land Classification</u>:

How are mineral deposits classified, and how are they designated as being regionally significant? Classification categories are illustrated in Figure 5. A simplified version of land classification categories include:

MRZ-1	No resource
MRZ-2a	Reserves (permitted)
MRZ-2b	Resource
MRZ-3	Suspended resource
MRZ-4	Unknown

CALIFORNIA MINERAL LAND CLASSIFICATION DIAGRAM

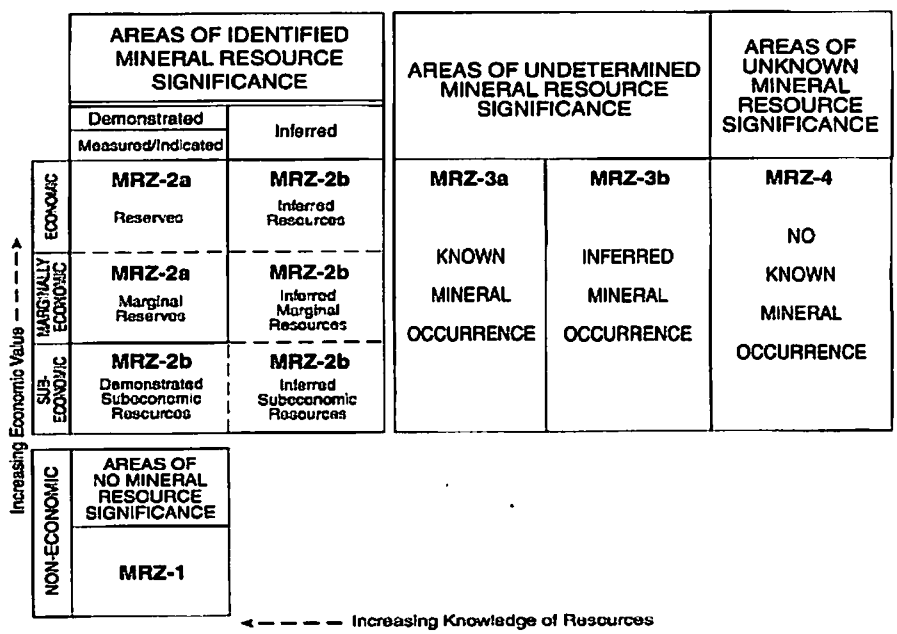


Figure 5. California Mineral Lands Classification diagram showing the various categories of resources (modified after U.S. Bureau of Mines and U.S. Geological Survey, 1980).

Classification methodology is divided into two categories: geologic and economic. Classification studies involve geologic mapping, review of historic and existing mine records, subsurface data, aggregate test data, extrapolation of data, identification of Mineral Resource Zones, and 10-year re-mapping. Economic factors include determination of P-C Regions, market study, quantification of reserves and resources, per capita use, forecasting and publication. The process is purely objective and scientific, is not based upon land ownership or land use, is non-political, and advocates the mineral resources as opposed to the mine. The purpose of the 10-year re-map program is to keep the information current.

SMARA Petitions:

If an applicant could convince the SMGB that they had a mineral deposit that was threatened and could be lost if not classified immediately, they could petition the SMGB for immediate classification ahead of the remaining P-C Regions, provided that 1.) they controlled the land, 2) they would provide adequate data and access for an MRZ-2 Classification and 3) they would pay for the cost of the classification effort. Possible reasons for a SMARA petition included:

- The area had not been previously classified;
- The area had not been previously threatened;
- New data indicating a deposit was MRZ-2 had become available in a previously classified area;
- Improved processing technique made a sub-economic deposit economic; or
- A previously classified area had been mined out.

Between 1980 and 2006, 35 petitions encompassing 34 properties and one County (Sonoma in 2005) were completed. The locations of Classification petitions are shown on Figure 6.

The Number of Classification petitions completed since 1980 are illustrated in Figure 7. The first SMARA classification petition (Pfizer) was completed in 1980. There has been an average of two per year between 1980 and 1994, with none between 1995 and 1999, and less than one per year, on average, from 1999 through 2005. Staff reductions resulted in a temporary hold on petitions between 1995 and 2000. Two petitions have been received since 2005.

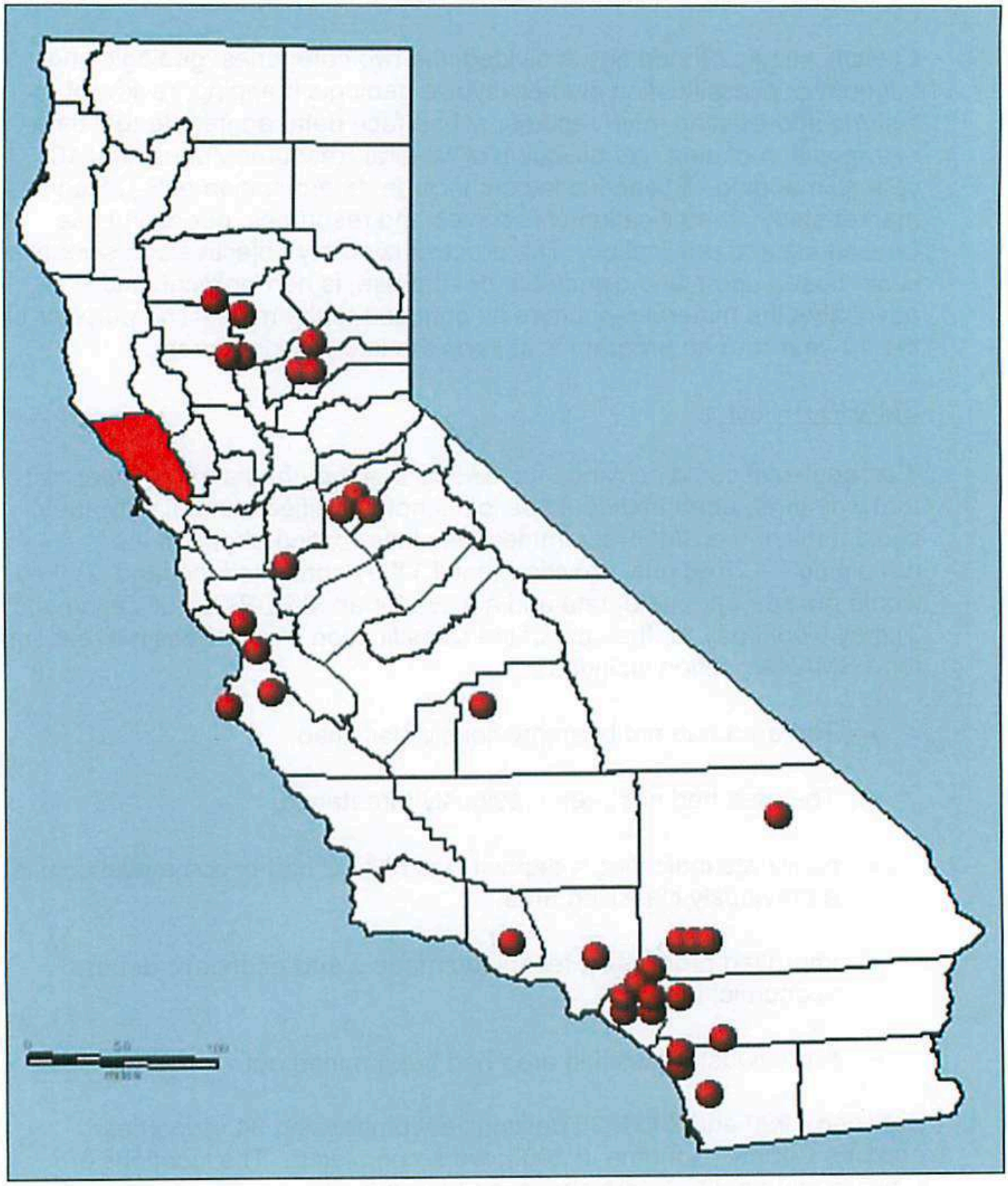


Figure 6. Location of Classification Petitions from 1980 through 2006.

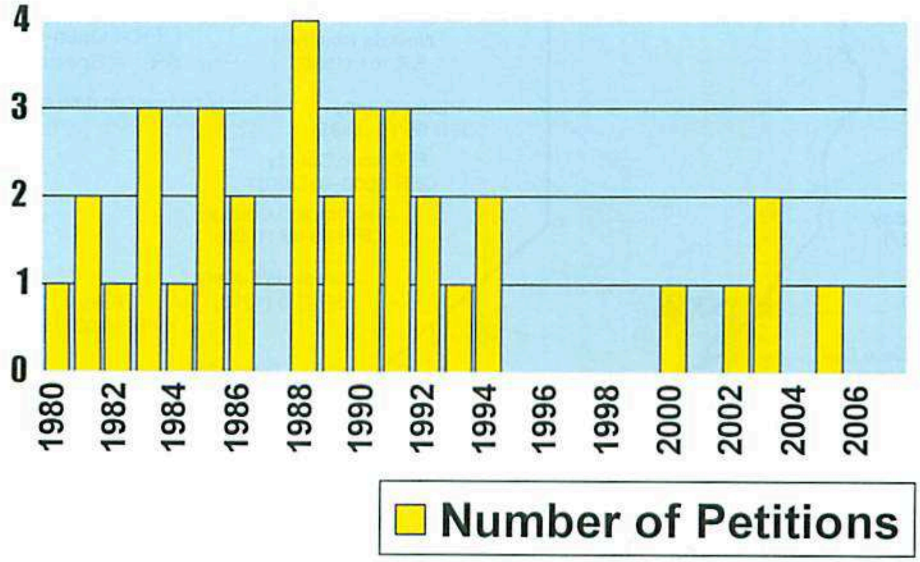


Figure 7. SMARA Classification petitions completed by year since 1980.

Aggregate studies performed by CGS showing progress of the Urban Program from 1976 through 2006 are presented in Figure 8. SMARA construction aggregate classification studies that have been updated, completed or are in progress, are presented in Figure 9. Eight SMARA Construction Aggregate Classification areas have been completed as of 2005, with six areas in progress. Those completed include Ventura County (1993), Los Angeles County (1994), Orange County (1995), South San Francisco Bay and San Diego County (1996), Monterey Bay and Fresno (1999) and Sonoma County (2005). Those areas in progress as of 2006 included Claremont-Upland, Bakersfield, North San Francisco Bay, Palm Springs, Stockton-Lodi areas, and San Bernardino County.

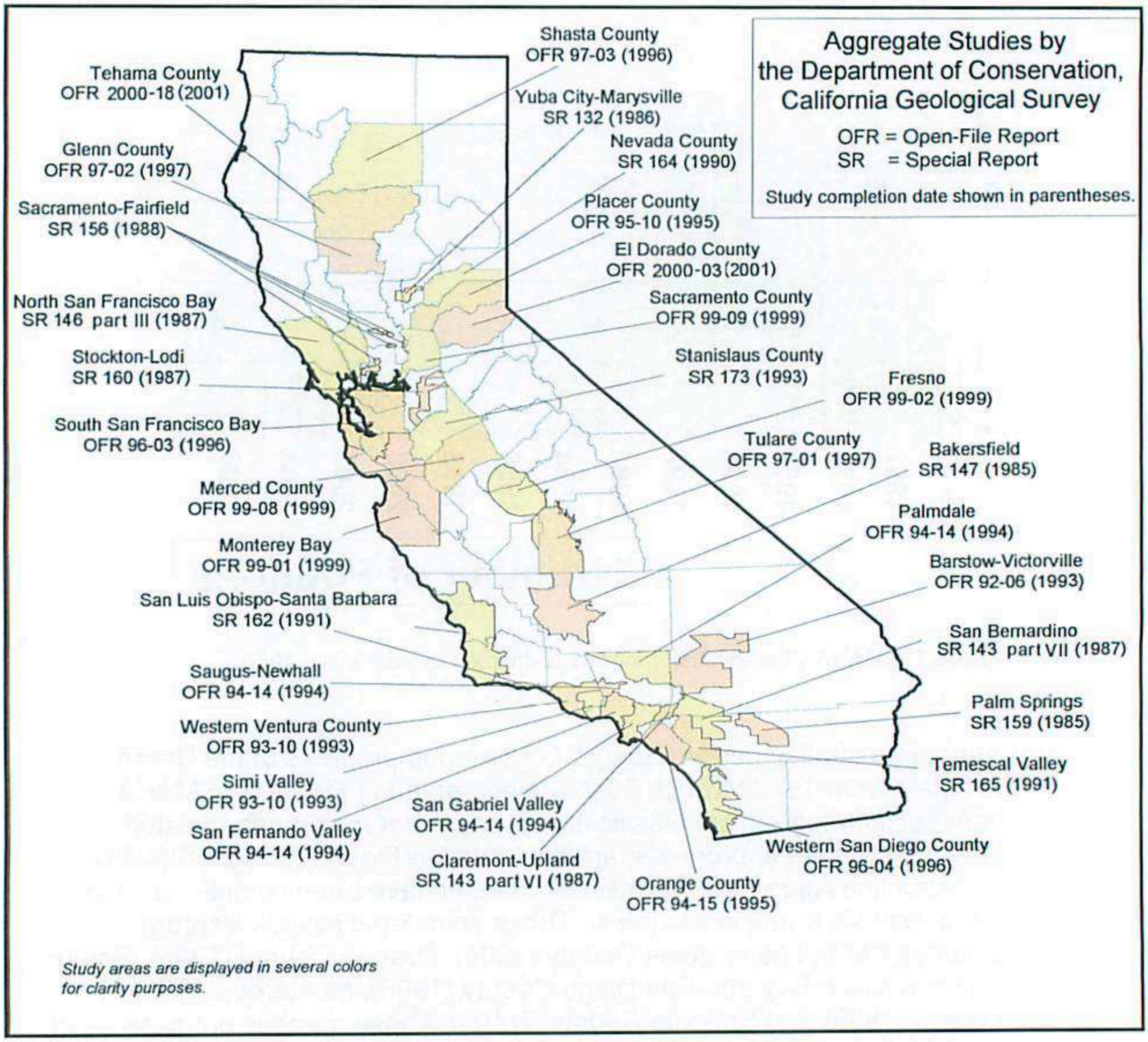


Figure 8. Aggregate studies performed by CGS showing progress of the Urban Program from 1976 through 2006.

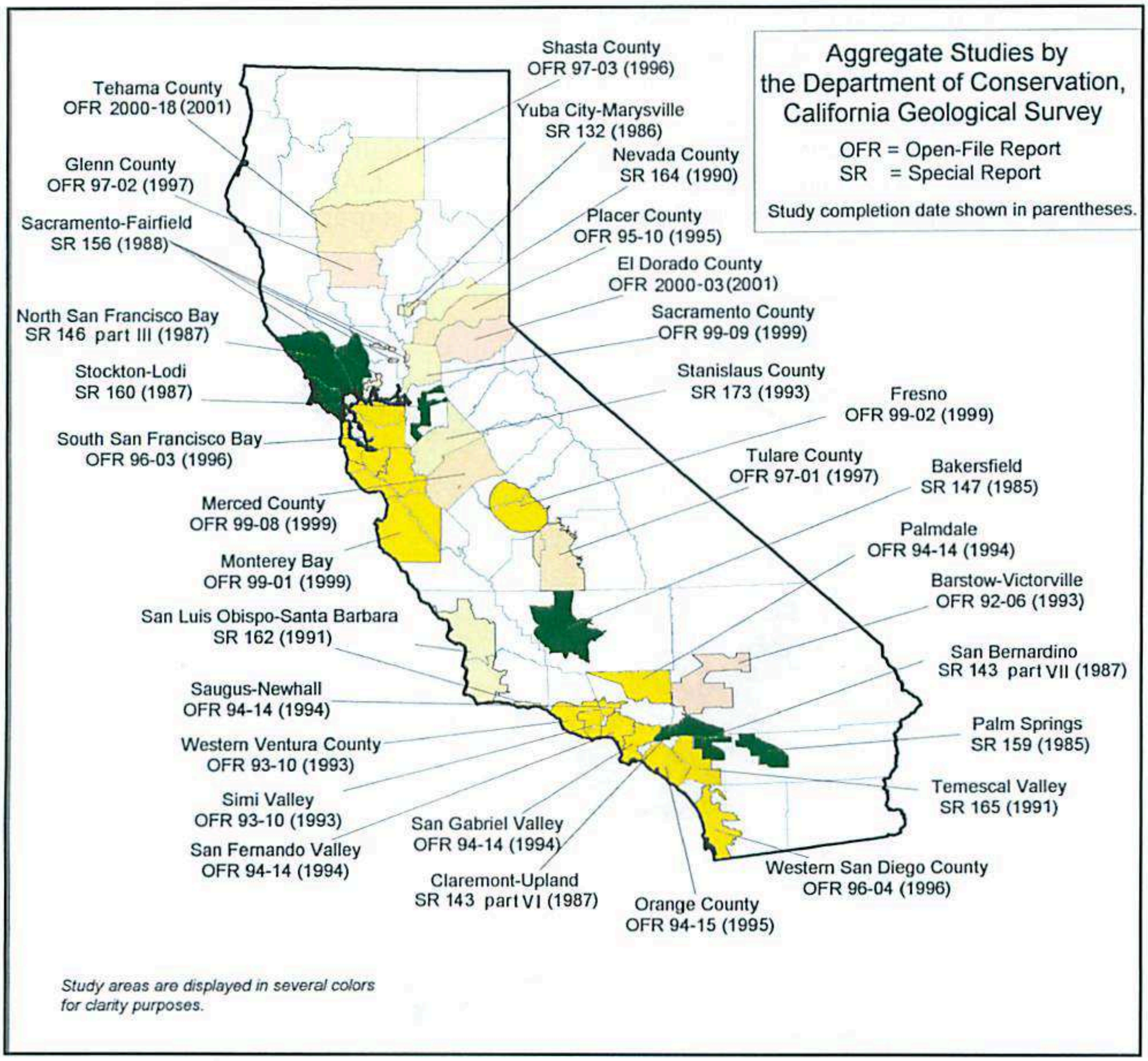


Figure 9. SMARA construction aggregate classification studies either updated, completed, or in progress.

Mineral Land Designation:

Designation is the process by which the SMGB formally recognizes the statewide or regional significance of classified mineral resources. If after receiving a classification report from the State Geologist, the SMGB deems it appropriate it may take an additional step to protect those areas classified as MRZ-2. This step is accomplished by "Designating" some or all of those mineral resources as "Regionally Significant" in meeting the future needs of the State or the region. A formal process to Designate a resource was specified in SMARA and in the SMGB Guidelines (SP 51). Designation routinely followed classification, and the first designation, San Fernando Valley P-C Region, was finalized in January 1982. A total of ten Designations have been completed covering 16 P-C Regions (Figure 10). The last Designation took place in 1990. Fourteen more classified P-C Regions remain to be designated (Figure 11). SMARA P-C Regions Designated by the SMGB per year since 1982 is graphically illustrated in Figure 12.

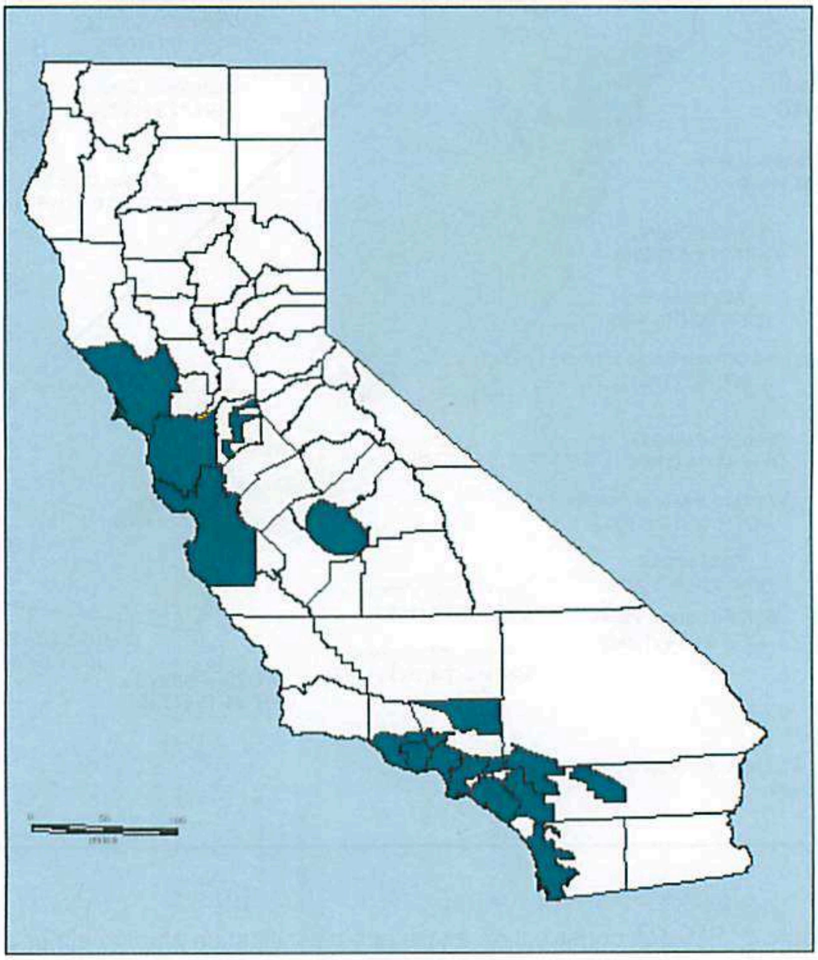


Figure 10. Statewide map showing the 16 Production-Consumption Regions Designated by the SMGB through 1989.

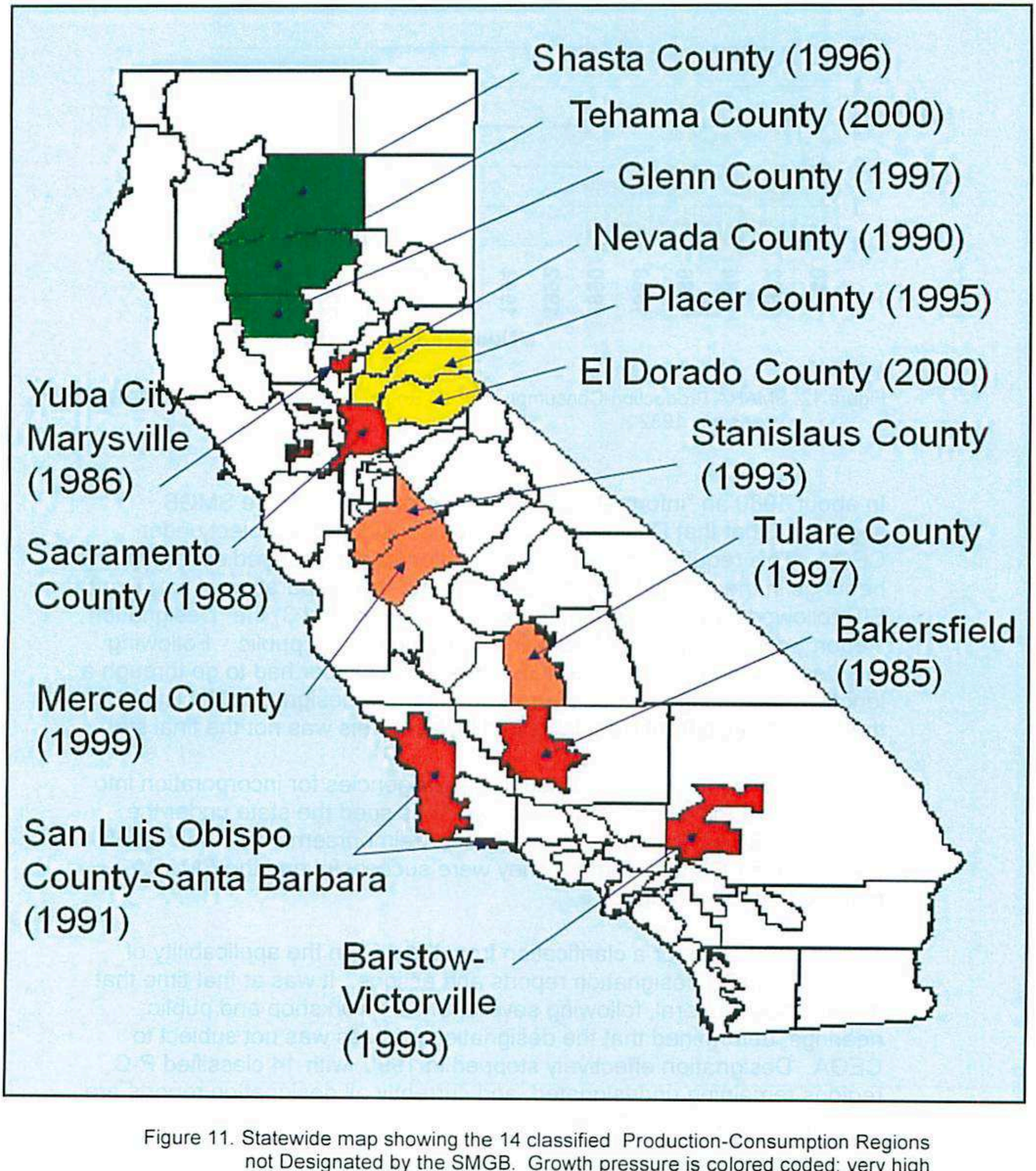


Figure 11. Statewide map showing the 14 classified Production-Consumption Regions not Designated by the SMGB. Growth pressure is colored coded: very high (red), high (orange), mdium (yellow) and low (green).

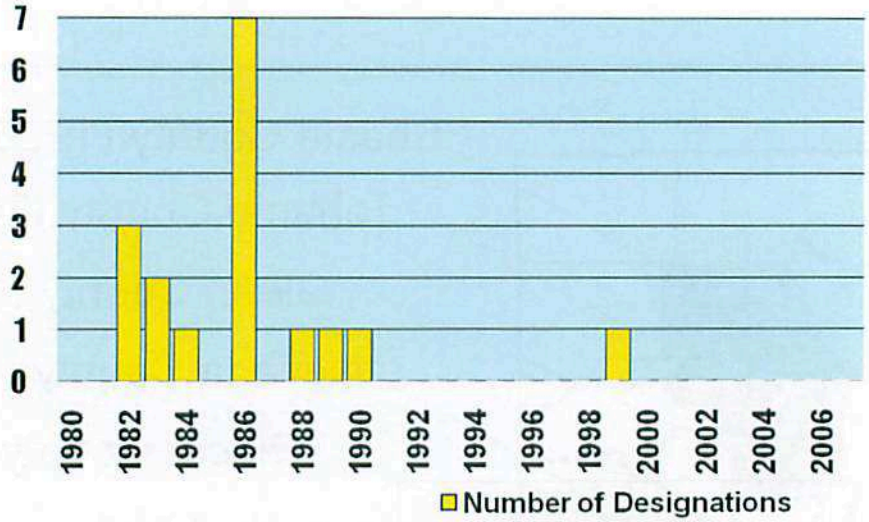


Figure 12. SMARA Production-Consumption (P-C) Regions Designated by the SMGB per year since 1982.

In about 1980 an "informal" Attorney General opinion to the SMGB suggested that that Designation could be considered a project under CEQA. This required that each Designation Action required several public hearings in the region being considered, and the preparation of a 1) Draft EIR followed by public comments, 2) a Final EIR, and 3) the "Designation Report", conveying the SMGB's final decisions to the public. Following the Designation Report the SMGB's Executive Officer had to go through a lengthy rulemaking process in order to enter the designation decisions into the California Code of Regulations. However, this was not the final step.

The decision was then forwarded to Lead Agencies for incorporation into their General Plans. Several Lead Agencies sued the state under the "Unfunded State Mandates" provisions for reimbursement of the cost of updating their General Plans. They were successful and the SMARA reserve had to be tapped.

The SMGB asked for a clarification from the AG on the applicability of CEQA to SMGB designation reports and actions. It was at that time that the Attorney General, following several SMGB workshop and public hearings, determined that the designation process was not subject to CEQA. Designation effectively stopped in 1990, with 14 classified P-C regions remaining undesignated, and currently all designation reports are out-of-print and unavailable.

In general, SMARA Designation methodology reflects the following elements:

- Hold public meetings in P-C region.
- Focus on MRZ-2 areas.
- Eliminate Parks, Cemeteries, Military Bases, existing and planned developments, roads, etc.
- Identify what remains as "Resource Sectors".
- Apply normal setbacks and slopes locally required by local government permits, and quantify resources.
- Present recommendations of the State Geologist to the SMGB for designation decision.
- Publish designation report and codify decision.

CURRENT STATUS

Since 1979, 30 P-C Regions and 29 non-Urban studies have been completed as of 2006, covering 25% of the State's area and incorporating 90% of its population (Figure 13). Urban and County studies were incorporated into a single program in 1994. Some of these studies were published as Special Reports, while some were published as Open-File Reports. The number of staff working annually on classification, reclamation, and for the SMGB, from 1976 through 2006, is illustrated in Figure 14. Mineral Land Classification peaked in about 1986 and has progressively decreased, although by 2007 three SMARA Classification positions were restored. Cuts in the General Fund temporarily eliminated the Classification Program from 2002 through 2004. The last new area classified was Tehama County in 2001.

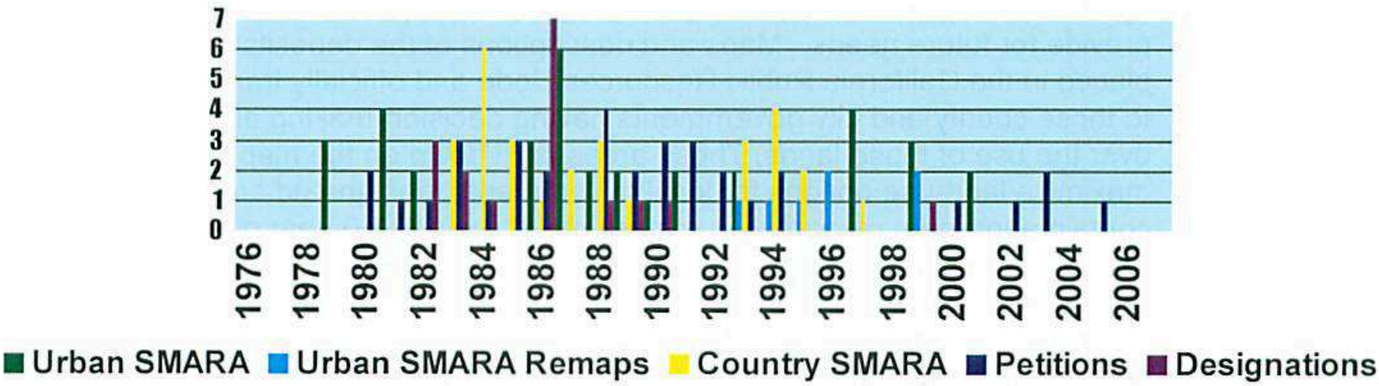


Figure 13. SMARA Mineral Land Classification and Designations completed by year since 1979.

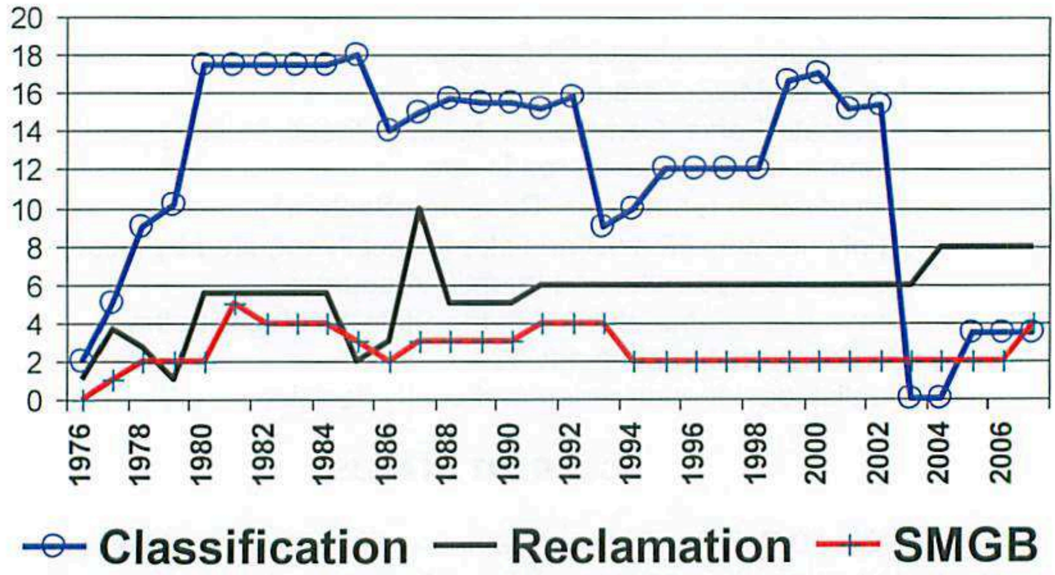


Figure 14. Graph showing number of staff working annually on classification and reclamation, and for the SMGB.

The importance of aggregates in California has been exemplified in two unique products. In 1999, the SMGB in concert with CGS implemented the SMARA Regional Synthesis Map series. A concept initiated by the SMGB's Past Chairman Robert E. Grunwald, the first of the series, and last, was the area covering the Los Angeles Basin (Figure 15). The classification of aggregate resources in the three-county area of Los Angeles, Orange, and Ventura, was followed by a "designation" process by the SMGB that formally recognized significant deposits that could provide for future needs. Maps and descriptions of the deposits were placed in the California Public Resources Code and officially transmitted to those county and city governments having decision-making authority over the use of those lands. Those areas are shown on the map in red. To maximize land-use options for local governments, designated areas contain aggregate resources in excess of the region's 50-year need. Since the designation of the aggregate resource areas in the 1980s, about 6 percent of those resources have been covered by urbanization. Commonly referred to as the Los Angeles Basin "placemat" map, it was very useful for regional planners and the general citizenry since it provided a broader perspective not readily apparent in the P-C Region maps.

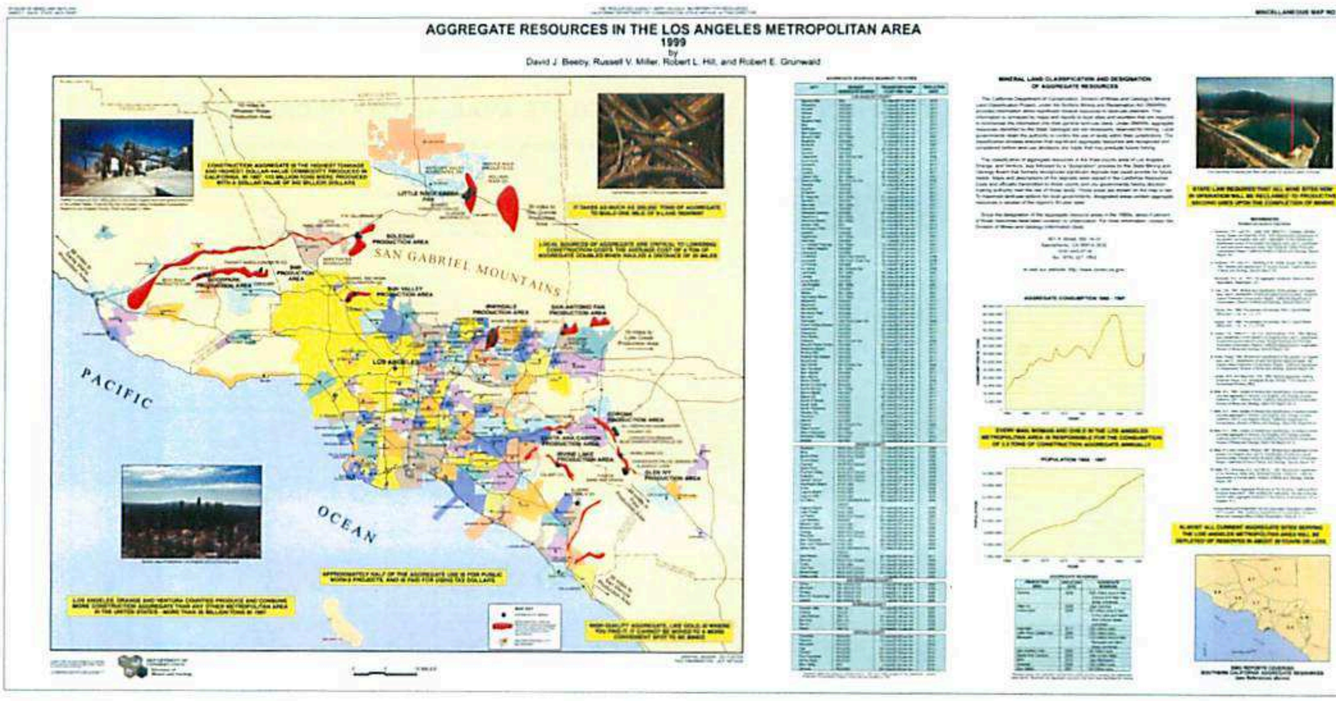


Figure 15. The SMARA Regional Synthesis Map for the Los Angeles Basin region. Although intended to be the first in a series, this map was the first and only map created which showed the location of the surface mining operations, designated mineral lands, and users.

In 2002, CGS published *Aggregate Availability in California -Map Sheet 52* which summarized data from studies by CGS for 32 aggregate resource areas throughout the state (Kohler, 2002). This map and accompanying report was updated n 2006 (CGS, 2006). This statewide synthesis map (Figure 16) and accompanying report provided information about the current availability of California's permitted aggregate resources. The purpose of the map is to compare projected aggregate demand for the next 50 years with currently permitted aggregate resources in 31 regions of the state. The map also highlights regions where there are less than 10 years of permitted aggregate supply remaining.

Figure 16. SMARA synthesis map showing aggregate availability in California statewide (California Geological Survey, 2006).

At the SMGB's September 13, 2007, regular business meeting, CGS proposed eighteen classification projects to be scheduled between September 2007 and the year 2010 (Table 1). The prioritization of areas to be considered for classification was based on constituency surveys and other considerations.

Table 1

Summary of CGS's Proposed Classification Projects

Priority	Project	Fiscal Year	Status
A	Palm Springs P-C Region Update	2007/2008	Completed
A	Claremont-Upland P-C Region Update	2007/2008	Completed
A	San Bernardino P-C Region Update	2007/2008	In progress
A	North San Francisco Bay P-C Region Update	2007/2008	In progress
A	Stockton-Lodi P-C Region Update	2007/2008	In progress
	Annual Summary of Mining in California	2008/2009	
B	Bakersfield P-C Region Update	2008/2009	
B	San Luis Obispo-Santa Barbara P-C Region Update	2008-2009	
B	San Gabriel Valley P-C Region Update	2008/2009	
C	Temescal Valley-Orange County P-C Region Update	2008/2009	
C	San Fernando Valley-Saugus-Newhall/ Simi/Palmdale P-C Region Update	2008/2009	
C	Nevada County Update	2008/2009	
	Annual Summary of Mining in California	2008/2009	
D	Western San Diego County P-C Region Update	2009/2010	
D	Placer County P-C Region Update	2009/2010	
D	South San Francisco Bay P-C Region Update	2009-2010	
	Annual Summary of Mining in California	2009/2010	
	Statewide Aggregate Availability Map Update	2009/2010	

At the SMGB's February 14, 2008, regular business meeting, CGS recommended new designation activities by the SMGB built upon the new classification studies presented in Table 1. Upon completion of the updated classification studies, these regions may be considered for designation, or updates to previous designations, which may include removal of areas that have been previously designated. These updated classification studies include both areas that have been previously designated and areas that were never designated after the original classification was completed. As an initial list of candidates for the SMGB to consider, CGS suggested that the SMGB consider the studies presented in Table 2. Six of the eight studies are in urban areas previously classified and portions subsequently designated, and two pending studies, Bakersfield and San Luis Obispo-Santa Barbara, are areas that have not been previously designated.

Table 2

Summary of Initial Candidates for Designation Consideration

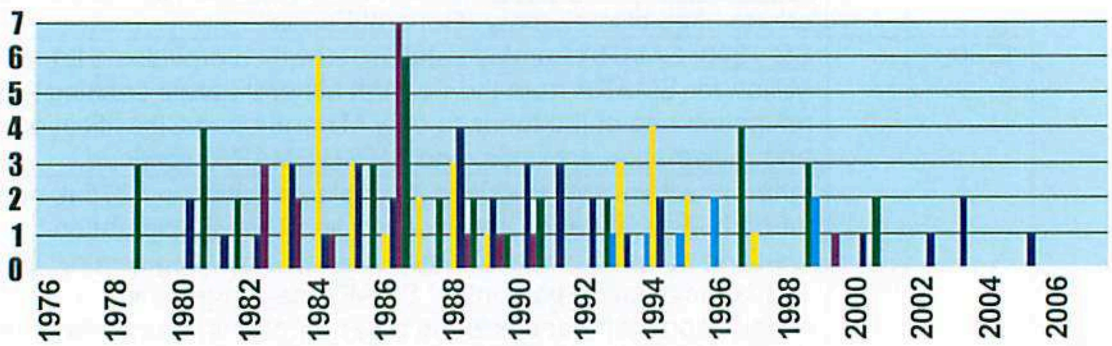
Project	**Status**
Palm Springs P-C Region	Classification update completed
Claremont-Upland P-C Region	Classification update completed
San Bernardino P-C Region	Classification update in progress
North San Francisco Bay P-C Region	Classification update in progress
Stockton –Lodi P-C Region	Classification update in progress
Bakersfield P-C Region	Classification update pending
San Luis Obispo-Santa Barbara P-C Region	Classification update pending
San Gabriel Valley P-C Region	Classification update pending

LEGISLATIVE HISTORY AND RESOURCES

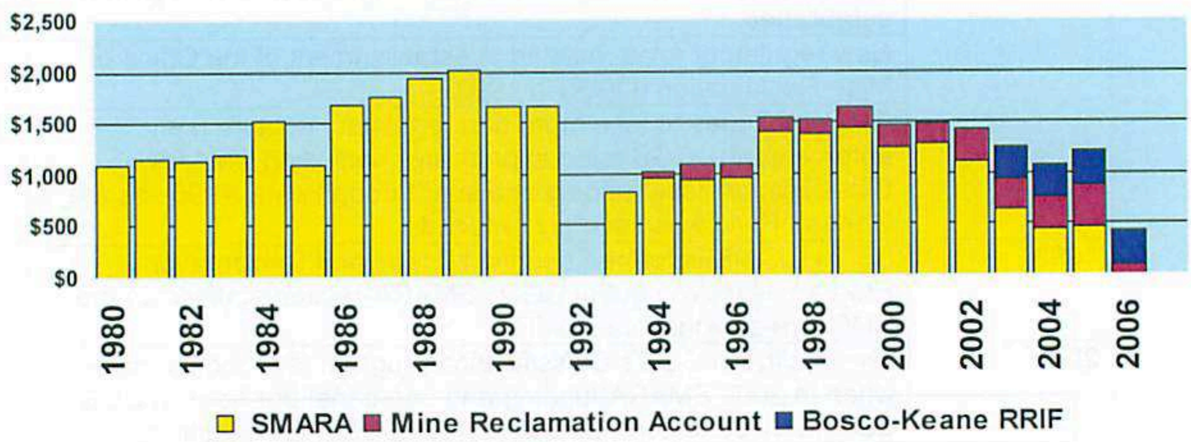
Key events in the implementation of SMARA's Mineral Land Classification and Designation elements from 1975 through 2007 are summarized in Table 3.

Table 3	
Summary of Key Events in the Implementation of SMARA's Classification and Designation Elements	
Year	Event
1975	Promulgation of SMARA: No funding mechanism provided. Initial efforts used discretionary "General Funds".
1980	SB 1300: SMARA Fund is established which provides $1.1 Million for SMARA from the Federal Mineral Lands Leasing Act, restricting use of the funds to only Mineral Land Classification and reclamation activities, and SMGB SMARA workload.
	Inherent within SMARA since its implementation in 1975 is need for both Mineral Land Classification and Mine Reclamation, resulting in many of the 28 amendments by the legislature. In the 1980s reclamation portions of SMARA de-funded and reclamation staff transferred to other programs. Amendments during this period began the emphasis from Classification, and increasing SMARA's regulatory authority.
1985	SB 593: Ceiling on SMARA increased to $2.0 Million and sets a trigger; if the Federal Revenues fall below $20 Million, the SMARA Account reverts to $1.1 Million.
1990	AB 3551: Tighter oversight on mine operators is established, annual inspections initiated, Mine Reclamation Account (MRA) established.
	New regulatory roles resulted in establishment of the Office of Mine Reclamation (OMR) in 1990.
	OMR continues to take more of a regulatory posture (i.e., enforcement). CGS mineral programs, including SMARA Classification, lose funding and staff through early 1990s as the General Fund was severely reduced.
1993	SB 741: OMR is formed and the Mined Land Reclamation Program is moved out of CGS. SMARA-related staff within the SMGB re-assigned into OMR.
2002	The decline in CGS's Classification program reached its "nadir" when in 2002 SMARA funding and personnel positions in CGS were reduced to zero, and relocated to OMR for regulatory activities.
2005	SB 71: Committee on Budget and Fiscal Review – Resources (Annual Resources Budget Trailer Bill); SMARA statues are modified to remove the $2.0 Million trigger.
	SB 1110: Modified statues allow DOC to use SMARA funds for activities of the Abandoned Mine Lands Unit (AMLU).
2007	Three of CGS's Classification staff positions were restored.

Overall productivity (number of Classification Reports per year) is directly related to the amount of funding (Figures 17a and b). As shown in Figures 18a and b, from the period 1980 to 2002, the appropriation of the combined SMARA/RRIF/MRA Funds between programs for Classification and Reclamation activities were 45 percent for both the Mine Land Reclamation and Mineral Land Classification, and 10 percent for the SMGB. In 2007, the appropriations of funds were 63 percent for Mined Land Reclamation, 35 percent for Mineral Land Classification and 2 percent for the SMGB.



(a) Classification productivity (reports per year).



(b) Classification budget (x $1,000).

Figures 17(a) and 17(b). Graphs illustrating the relationship between classification productivity (a) versus classification budget (b).

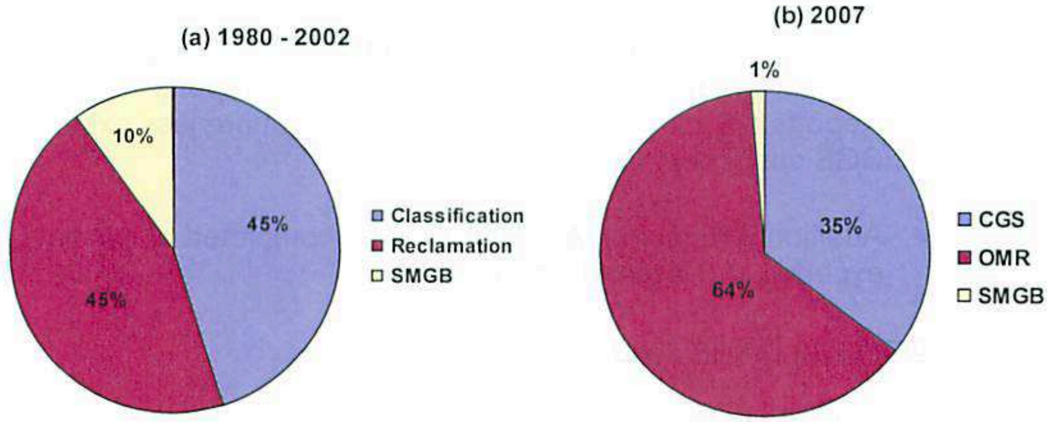


Figure 18. Approximate split of the combined SMARA/RRIF/MRA Funds between programs for Classification and Reclamation work for the period 1980 – 2002 (a) and 2007 (b).

OBSERVATIONS

Observations pertaining to mineral land classification, mineral land designation, SMARA petitions, regional synthesis maps, are summarized below.

<u>Mineral Land Classification</u>:

- Mineral Land Classification is very dependent on staffing and funding. Reductions in program resources have resulted in a direct reduction in productivity. A substantially increased and long term source of funding is needed to restore the effectiveness of the Classification Program;

- Mandated 10-year re-maps of previously competed P-C Regions have exceeded CGS program capability. Most re-maps have been in progress more than 5 years. Many regions remain out-of-date;

- At the current staffing level of the CGS Classification Program, new classification studies appear virtually impossible;

- Classification Reports appear to have fallen "below the radar" in many Lead Agencies, and copies have become lost from their files. Increased outreach is critical to reconnect with local government;

- Special Reports are the publication format of choice because they are more widely distributed than Open-File Reports. Special Reports are more expensive to produce but are less expensive to CGS customers; and

- Additional Regional Maps can only be completed at this time at the expense of the mandated re-maps.

Mineral Land Designation:

- Construction Aggregate deposits in urban areas are the only mineral commodity ever Designated. This may need to be reconsidered;

- Designation by the SMGB has been "on hold" for the past 17 years (since 1990);

- Fourteen Classified P-C regions still await Designation by the SMGB; this might be inhibiting the ability of mines to get operating permits, and is certainly not helping;

- Fiscal concerns of Designation (CEQA project and Un-funded State Mandate) may be non-issues but may need to be definitively addressed; and

- Designation reports and documents are all out-of-print and have been essentially unavailable. They have however recently been made available on the SMGB's website.

SMARA Petitions:

- Petitions for Mineral Land Classification have been accepted since the beginning of the SMARA program. Petitions for Designation have been allowable in SMGB Guidelines but have never been submitted to the SMGB;

- Past policy required the petitioner to have control (ownership or lease) of the land being petitioned for classification; and

- With minimal staff, the acceptance of petitions is a higher priority than the mandated re-maps.

Regional Synthesis Maps:

- Regional Synthesis Maps represent a simplified and more "user-friendly" conveyance of information than the more detailed (and intimidating) P-C Region reports;
- Regional Synthesis Maps appear to be a very underutilized product to bring aggregate permitting to the attention of the public and of elected officials;
- The two types of products serve different needs and both are essential to their specific users; and
- Additional Regional Synthesis Maps can only be completed at the expense of the mandated re-maps.

RECOMMENDATIONS

Recommendations for the Classification and Designation programs, and further considerations for policy decisions, are outlined below.

Classification:

The following classification recommendations are offered:

1) Consider additional staffing needs to be added in CGS and trained before remaining Classification staff retires and mentoring ability disappears.

2) Increase and re-emphasize outreach efforts to reconnect SMARA with local government.

3) Reprint Classification Open-File Reports as Special Reports and distribute to appropriate local governments.

4) Produce additional regional maps similar in style and format as to what was previously published for Los Angeles County (i.e., San Diego, San Francisco Bay area, and the Central Valley area are all possible candidates).

5) Adopt new Resolution specifying Classification Priorities. In the past recommendations from the State Geologist have been adopted.

Designation:

The following designation recommendations are offered:

1) Resume the Designation process for the 14 P-C Regions that have been classified but not designated. Such efforts have recently been implemented by CGS and the SMGB.

2) Reprint and publicize the Designation Reports and Environmental Impact Reports, or at minimum, provide such reports in a digital format on the SMGB's website. Such steps have since been implemented by the SMGB.

Policy Decisions Considerations:

The following considerations regarding policy decisions are offered:

- Evaluate whether Designation is working and whether lead agencies are fulfilling their obligations and responsibilities;
- Consider termination of designation on designated land that has been developed as a means to avoid the misperception that mineral land is available when in fact it is not. Such steps have since been implemented.
- Consider accepting Designation Petitions;
- Consider re-evaluating land ownership requirements for petitioners;
- Consider determining whether acceptance of petitions is a higher priority than the mandated re-maps; and
- Consider whether mineral commodities other than construction aggregates should ever be Designated (i.e., borates, limestone, etc.).

REFERENCES

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DOT HS 811 488

June 2011

Experimental Measurement of The Stopping Performance of A Tractor-Semitrailer From Multiple Speeds

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Experimental Measurement of the Stopping Performance of a Tractor-Semitrailer From Multiple Speeds	June 2011
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7. Author(s) Dr. W. Riley Garrott, National Highway Traffic Safety Administration Mark Heitz and Brad Bean, Transportation Research Center Inc.	8. Performing Organization Report No.
9. Performing Organization Name and Address National Highway Traffic Safety Administration Vehicle Research and Test Center P.O. Box 37 East Liberty, OH 43319	10. Work Unit No. (TRAIS) 11. Contract or Grant No.
12. Sponsoring Agency Name and Address National Highway Traffic Safety Administration 1200 New Jersey Avenue SE. Washington, DC 20590	13. Type of Report and Period Covered Final Report, October 2010 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

On July 27, 2009, the National Highway Traffic Administration (NHTSA) published a final rule reducing the maximum allowable truck tractor stopping distances from 60 mph. FMVSS No. 121 also contains maximum allowable stopping distances for vehicles that cannot attain a speed of 60 mph in two miles. In this case, a vehicle is tested from an initial speed four to eight mph less than the maximum attainable speed.

NHTSA received a petition for reconsideration of the July 27, 2009 final rule requesting that the agency revise the table of stopping distances for those truck tractors that cannot attain an initial test speed of 60 mph. The objective of this research was to obtain data on the stopping performance of one truck tractor-semitrailer combination vehicle from a range of initial speeds. The truck tractor tested was a 1991 Volvo 6x4 tractor towing a 28 foot long, unbraked control trailer. A decision was made to modify the loading from the normal FMVSS No. 121 loaded condition. The loading was changed such that the 60 mph stopping distance specified in FMVSS No. 121 was just achieved (the Modified Gross Vehicle Weight Rating (MGVWR) loading). This vehicle was also tested at its Lightly Loaded Vehicle Weight (LLVW).

For MGVWR loading, as initial speed is decreased from 60 mph, average measured corrected stopping distance drops faster than maximum permitted stopping distance until an initial speed of 35 mph is reached. The MGVWR vehicle had its largest margin of compliance at 35 mph. As initial speed decreased from 35 mph, maximum permitted stopping distance drops faster than average measured corrected stopping distance. The MGVWR vehicle had a negative margin of compliance at an initial speed of 20 mph. The maximum permitted stopping distance for the LLVW vehicle is greater than average measured corrected stopping distance for all initial speeds. The LLVW vehicle had its smallest (though still positive) margin of compliance at an initial speed of 20 mph.

Average MGVWR and LLVW deceleration rise times, 0.43 and 0.30 seconds, respectively, are both less than the 0.45 second rise time that was used to calculate the maximum permitted stopping distances in FMVSS No. 121.

Actual measured steady state deceleration is greater than FMVSS No. 121 assumed deceleration for the MGVWR loading condition for all initial speeds. This is surprising since actual measured corrected stopping distance exceeds maximum permitted stopping distance at an initial speed of 20 mph. This indicates possible discrepancies between the idealized deceleration shape used to calculate the FMVSS No. 121 values and the actual deceleration shape. The actual measured steady state deceleration is substantially greater than the FMVSS No. 121 assumed deceleration for the LLVW loading condition for all initial speeds.

The equation FMVSS No. 121 uses to calculate maximum permitted stopping distances for initial speed below 60 mph was used to calculate steady state vehicle decelerations. The measured steady state decelerations are consistently higher than the steady state decelerations calculated using the FMVSS No. 121 equation. The magnitude of the difference increases with decreasing initial speed. The reasons for the difference between the two steady state decelerations are not known. Also, it is not known which of these methods provides the best estimate for steady state deceleration. In terms of the overall goal of this research, it probably does not matter which estimate of steady state deceleration is best. At an initial speed of 20 mph, measured average corrected stopping distance for the MGVWR loading exceeded the maximum stopping distance permitted by FMVSS No. 121.

17. Key Words	18. Distribution Statement
Heavy Truck Braking, Stopping Distance, FMVSS No. 121, Brake Performance	Document is available to the public from The National Technical Information Service www.ntis.gov

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	47	

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CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
in	inches	2.54	centimeters	cm
ft	feet	30.48	centimeters	cm
mi	miles	1.61	kilometers	km
AREA				
in^2	square inches	6.45	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
mi^2	square miles	2.59	square kilometers	km^2
MASS (weight)				
oz	ounces	28.35	grams	g
lb	pounds	0.45	kilograms	kg
PRESSURE				
psi	pounds per $inch^2$	0.07	bar	bar
psi	pounds per $inch^2$	6.89	kilopascals	kPa
VELOCITY				
mph	miles per hour	1.61	kilometers per hour	km/h
ACCELERATION				
ft/s^2	feet per $second^2$	0.30	meters per $second^2$	m/s^2
TEMPERATURE (exact)				
°F	Fahrenheit	5/9[(Fahrenheit) - 32°F]	Celsius	°C

Approximate Conversions to English Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
mm	millimeters	0.04	inches	in
cm	centimeters	0.39	inches	in
m	meters	3.3	feet	ft
km	kilometers	0.62	miles	mi
AREA				
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	10.76	square feet	ft^2
km^2	square kilometers	0.39	square miles	mi^2
MASS (weight)				
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
PRESSURE				
bar	bar	14.50	pounds per $inch^2$	psi
kPa	kilopascals	0.145	pounds per $inch^2$	psi
VELOCITY				
km/h	kilometers per hour	0.62	miles per hour	mph
ACCELERATION				
m/s^2	meters per $second^2$	3.28	feet per $second^2$	ft/s^2
TEMPERATURE (exact)				
°C	Celsius	9/5 (Celsius) + 32°F	Fahrenheit	°F

NOTE REGARDING COMPLIANCE WITH THE AMERICANS WITH DISABILITIES ACT, SECTION 508

For the convenience of visually impaired readers of this report using text-to-speech software, additional descriptive text has been provided for graphical images contained in this report to satisfy Section 508 of the Americans with Disabilities Act (ADA).

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Executive Summary

On July 27, 2009, the National Highway Traffic Administration (NHTSA) published a final rule amending Federal Motor Vehicle Safety Standard (FMVSS) No. 121, Air Brake Systems, to require improved stopping distance performance for truck tractors. This rule reduced the maximum allowable stopping distance in the loaded to Gross Vehicle Weight Rating (GVWR) condition, for an initial vehicle speed of 60 mph, from 355 feet to 250 feet for "normal duty" truck tractors ("normal duty" truck tractors are two- or three-axle truck tractors with a GVWR of 70,000 pounds or less, and truck tractors with four or more axles and a GVWR of 85,000 pounds or less; these are the type of tractors examined in this report). For all truck tractors, the maximum allowable stopping distance in the unloaded condition, for an initial vehicle speed of 60 mph, was reduced from 335 feet to 235 feet.

FMVSS No. 121 also contains maximum allowable stopping distances for vehicles that cannot attain a speed of 60 mph in two miles of driving on a flat, level roadway. If a vehicle cannot attain a speed of 60 mph, it is tested to ensure that it can meet the maximum permitted stopping distance requirement from an initial speed that is four to eight mph less than the maximum speed that is attainable.

On September 10, 2009, NHTSA received a petition for reconsideration of the July 27, 2009 final rule from the Truck Manufacturers Association (TMA). In this petition, TMA states that NHTSA "did not conduct any testing at reduced speeds... [o]nly tests from an initial speed of 60 mph were conducted."[1] Also, TMA states that "the rulemaking record does not include any data to validate the equation used to derive the reduced speed stopping distance requirements in the final rule."[2]

The objective of this research was to obtain data on the stopping performance of one truck tractor-semitrailer combination vehicle from a range of initial speeds. The truck tractor tested was a 1991 Volvo 6x4 tractor towing a 28 foot long, unbraked control trailer. Vehicle testing was performed in accordance with the Office of Vehicle Safety Compliance Laboratory Test Procedure No. TP-121V-04.

Since only one truck tractor was tested, a decision was made to modify its loading from its normal FMVSS No. 121 Loaded-to-GVWR condition. The loading was changed to a value such that the 60 mph stopping distance specified in FMVSS No. 121 was just achieved (the Modified Gross Vehicle Weight Rating (MGVWR) loading). It is the authors' belief that by loading this vehicle so as to just achieve the 60 mph stopping distance specified in FMVSS No. 121, test results would provide greater insight into the appropriateness of stopping distance values from other vehicle initial speeds that are in FMVSS No. 121. As per FMVSS No. 121, this vehicle was also tested at its Lightly Loaded Vehicle Weight (LLVW).

For the MGVWR loading condition, as initial speed decreased from 60 mph, average measured corrected stopping distance drops faster than maximum permitted stopping distance until an initial speed of 35 mph is reached. The MGVWR vehicle had the largest margin of compliance at an initial speed of 35 mph. As the initial speed decreased from 35 mph, maximum permitted stopping distance drops faster than average measured corrected stopping distance. The MGVWR vehicle had a negative margin of compliance at an initial speed of 20 mph.

[1] US Department of Transportation Docket Document NHTSA-2009-0083-0005, posted 9/17/2009.
[2] Ibid

The maximum permitted stopping distance according to FMVSS No. 121 for the LLVW vehicle is greater than average measured corrected stopping distance for all initial speeds. As initial speed decreased from 60 mph, average measured corrected stopping distance drops at the same rate as maximum permitted stopping distance until an initial speed of 35 mph is reached. The LLVW vehicle had a fairly constant (between 22.0 and 24.8 percent) margin of compliance for initial speeds from 60 to 35 mph. As initial speed decreased from 35 mph, maximum permitted stopping distance drops faster than average measured corrected stopping distance. The LLVW vehicle had its smallest (though still positive) margin of compliance at an initial speed of 20 mph.

The average MGVWR and LLVW deceleration rise times, 0.43 and 0.30 seconds, respectively, are both less than the 0.45 second rise time that was used to calculate the maximum permitted stopping distances in FMVSS No. 121. Assuming a 0.45 second deceleration rise is, therefore, conservative.

Actual measured steady state deceleration is greater than FMVSS No. 121 assumed deceleration for the MGVWR loading condition for all initial speeds. This is surprising since actual measured corrected stopping distance equals maximum permitted stopping distance at an initial speed of 60 mph and exceeds maximum permitted stopping distance at an initial speed of 20 mph. This indicates possible discrepancies between the idealized deceleration shape used to calculate the FMVSS No. 121 values and the actual deceleration shape.

Actual measured steady state deceleration is substantially greater than FMVSS No. 121 assumed deceleration for the LLVW loading condition for all initial speeds. However, in violation of the FMVSS No. 121 assumptions, there is a rapid decrease of steady state deceleration with initial speed for initial speeds below 35 mph.

The equation FMVSS No. 121 uses to calculate maximum permitted stopping distances for initial speed below 60 mph contains four parameters. If values for any three of these parameters are specified, then the corresponding value of the fourth parameter can be calculated. Experimentally measured values of Total Stopping Distance, Vehicle Initial Speed, and Deceleration Rise Time were specified and corresponding Steady State Vehicle Deceleration calculated.

Measured steady state decelerations, as determined by numerically differentiating the speed channel and then averaging the resulting channel from completion of deceleration rise time until end of stop time, are consistently higher than steady state decelerations calculated using the FMVSS No. 121 equation. This difference increases with decreasing initial speed. Reasons for this difference are not known. Also, it is not known which of these methods provides the best estimate for steady state deceleration.

In terms of the overall goal of this research, it probably does not matter which estimate of steady state deceleration is best. At an initial speed of 20 mph, measured average corrected stopping distance for the MGVWR loading exceeded the maximum stopping distance permitted by FMVSS No. 121.

Acknowledgments

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Mark Heitz
Brad Bean

1.0 Introduction and Research Objectives

1.1 The Current Version of FMVSS No. 121 Air Brake Systems

On July 27, 2009, the National Highway Traffic Administration (NHTSA) published a final rule in the Federal Register[3] amending Federal Motor Vehicle Safety Standard (FMVSS) No. 121, Air Brake Systems, to require improved stopping distance performance for truck tractors. This rule reduced the maximum allowable stopping distance in the loaded to Gross Vehicle Weight Rating (GVWR) condition, for an initial speed of 60 mph, from 355 feet to 250 feet for the vast majority of truck tractors (two- and three-axle truck tractors with a GVWR of 70,000 pounds or less, and truck tractors with four or more axles and a GVWR of 85,000 pounds or less). For a small minority of truck tractors (three-axle truck tractors with a GVWR greater than 70,000 pounds, and truck tractors with four or more axles and a GVWR greater than 85,000 pounds), the maximum allowable stopping distance in the GVWR loading condition, for an initial speed of 60 mph, was reduced from 355 feet to 310 feet. For all truck tractors, the maximum allowable stopping distance in the unloaded condition, for an initial speed of 60 mph, was reduced from 335 feet to 235 feet.

This report will focus on the braking performance of the vast majority of truck tractors, i.e., two- and three-axle truck tractors with a GVWR of 70,000 pounds or less, and truck tractors with four or more axles and a GVWR of 85,000 pounds or less. These will be referred to in the remainder of this report as "normal duty" truck tractors (as compared to "severe duty" truck tractors, i.e., those three-axle truck tractors with a GVWR greater than 70,000 pounds, and truck tractors with four or more axles and a GVWR greater than 85,000 pounds).

FMVSS No. 121 also contains maximum allowable stopping distances for vehicles that cannot attain a speed of 60 mph in two miles of driving on a flat, level roadway. If a vehicle cannot attain a speed of 60 mph, it is tested to ensure that it can meet the maximum permitted stopping distance requirement from an initial speed that is four to eight mph less than the maximum speed that is attainable. The rightmost column of Table 1 lists maximum permissible stopping distances for normal duty truck tractors in the GVWR loading condition. Similarly, the rightmost column of Table 2 lists maximum permissible stopping distances for both normal duty and severe duty truck tractors in the unloaded condition.

Note that FMVSS No. 121 does not apply to "any truck or bus that has a speed attainable in 2 miles of not more than 33 mph."[4] Therefore, although Tables 1 and 2 include both 25 and 20 mph Vehicle Initial Speed rows, these rows cannot be used by any vehicles currently covered by FMVSS No. 121. (Since compliance testing is performed from an initial speed that is four to eight mph less than the maximum speed that is attainable in two miles of driving, the 30 mph Vehicle Initial Speed row could conceivably be used.)

The maximum permissible stopping distances in Tables 1 and 2 were calculated using the equation:

$$S = \frac{1}{2} V_0 t_r + \frac{1}{2}\frac{V_0^2}{d_{ss}} - \frac{1}{24} d_{ss} t_r^2 \qquad \text{(Equation 1)}$$

Where

S = Total Stopping Distance in feet,

V_0 = Vehicle Initial Speed in feet per second,

[3] 74 FR 37122

[4] Federal Motor Vehicle Safety Standard No. 121; Air Brake Systems, S3 (c)

t_r = Deceleration Rise Time in seconds, and
d_{ss} = Steady State Vehicle Deceleration in feet per second squared.

Table 1: Maximum Permissible Stopping Distances at Various Speeds for Two- and Three-Axle Truck Tractors with a GVWR of 70,000 Pounds or Less, and Truck Tractors with Four or More Axles and a GVWR of 85,000 Pounds of Less, in the GVWR Loading Condition. Deceleration rise time is 0.45 seconds.

Vehicle Initial Speed		Assumed Steady State Vehicle Deceleration		Maximum Permitted Stopping Distance from FMVSS No. 121
(mph)	(ft/sec)	(ft/sec^2)	(g's)	(ft)
20	29.3	18.00	0.56	30.0
25	36.7	18.00	0.56	45.0
30	44.0	17.50	0.54	65.0
35	51.3	17.00	0.53	89.0
40	58.7	17.00	0.53	114.0
45	66.0	16.80	0.52	144.0
50	73.3	16.80	0.52	176.0
55	80.7	16.80	0.52	212.0
60	88.0	16.80	0.52	250.0

Table 2: Maximum Permissible Stopping Distances for Truck Tractors in the Unloaded Condition. Deceleration rise time is 0.45 seconds.

Vehicle Initial Speed		Steady State Deceleration (Assumed Value)		Maximum Permitted Stopping Distance from FMVSS No. 121
(mph)	(ft/sec)	(ft/sec^2)	(g's)	(ft)
20	29.3	19.80	0.61	28.0
25	36.7	19.40	0.60	43.0
30	44.0	18.80	0.58	61.0
35	51.3	18.10	0.56	84.0
40	58.7	18.10	0.56	108.0
45	66.0	17.95	0.56	136.0
50	73.3	17.95	0.56	166.0
55	80.7	17.95	0.56	199.0
60	88.0	17.95	0.56	235.0

When Equation 1 was used to calculate the maximum permitted stopping distances in Tables 1 and 2, the Acceleration Rise Time, t_r, is assumed to be equal to the maximum permitted air pressure rise time to 60 psi in the brake chambers (for a 100 psi brake application). As per S5.3.3.1 (a) of FMVSS No. 121, t_r is assumed to be equal to 0.45 seconds.

Also note that when Equation 1 was used to calculate maximum permitted stopping distances in Tables 1 and 2, all stopping distances were rounded to the nearest integer foot.

Equation 1 was developed from simple kinematics using the idealized deceleration versus time profile shown in Figure 1. As mentioned above, the Acceleration Rise Time, t_r, used to generate Tables 1 and 2 is always assumed to be 0.45 seconds. The Steady State Vehicle Deceleration , d_{ss}, varies according to both the Vehicle Initial Speed and the vehicle's loading condition. The third and fourth columns from the left hand side of Tables 1 and 2 contain the Steady State Vehicle Deceleration values that were assumed to generate the maximum permissible stopping distances for Loaded-to-GVWR and Unloaded truck tractors, respectively.

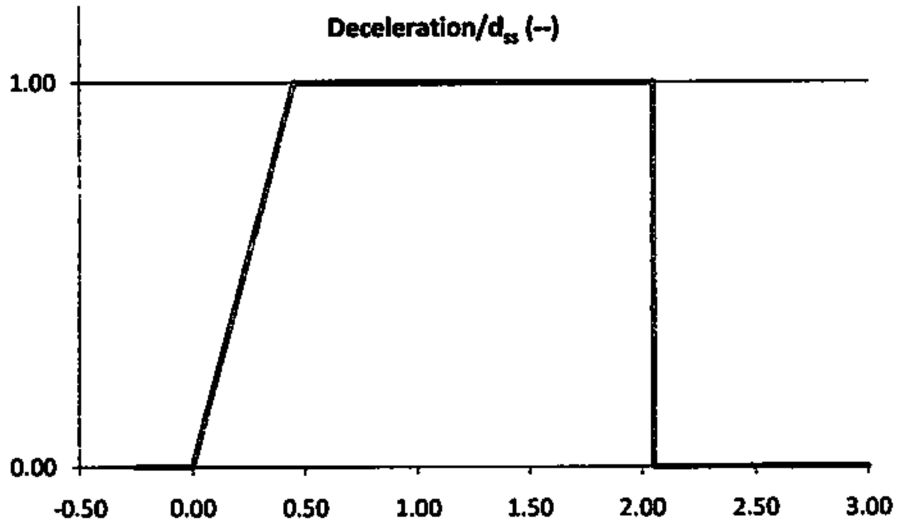

Figure 1: Assumed Vehicle Deceleration versus Time Profile for a Stop Taking 2.05 Seconds

1.2 Research Objective

On September 10, 2009, NHTSA received a petition for reconsideration of the July 27, 2009 final rule from the Truck Manufacturers Association (TMA)[5]. Section 3 of this petition for reconsideration reads as follows:

> **"3. The reduced speed stopping distance requirements are not supported by the rulemaking record.**
> The entire focus of this rulemaking, and of all the known testing to support it, involves stopping distances from 60 mph. In fact, there is no empirical data to support the practicability of, or the justification for, the new stopping distance requirements at initial test speeds 20 through 55 mph. The only analysis on the record is derived from an unproven, unverified mathematical equation that uses data from 60 mph stops to estimate stopping distances for the reduced speeds.
>
> In the preamble, NHTSA states that "we did not conduct any testing at reduced speeds... [o]nly tests from an initial speed of 60 mph were conducted at [NHTSA's Vehicle Research and Test Center]." Id. at 37149. Accordingly, the rulemaking record does not include any data to validate the equation used to derive the reduced speed stopping distance requirements in the final rule. This lack of data is due to the appropriate concentration, by both NHTSA and industry, on the 60 mph stopping distance requirements that would address the large majority of tractors produced.

[5] US Department of Transportation Docket Document NHTSA-2009-0083-0005, posted 9/17/2009

TMA supports appropriate shortening of the reduced speed stopping distance requirements. However, we object to the requirements included in the final rule. Those reduced speed stopping distances may require the development of complicated and unique braking systems on tractors that, but for their speed being limited, are identical to vehicles for which the 60 mph stopping distances apply. NHTSA must withdraw the reduced speed stopping distance requirements until it has obtained appropriate test data supporting the new requirements for tractors with speeds less than 60 mph. TMA members are currently conducting such testing, and we are willing to provide that data to supplement the agency's testing."

The objective of this research was to obtain information that the agency could use to address TMA's concerns and either defend or revise the table of stopping distances for those truck tractors that cannot attain an initial test speed of 60 mph. `Specifically, this research tested one truck tractor for a range of initial speeds in both loaded and unloaded loading conditions.

Since only one truck tractor was tested, a decision was made to modify its loading from that used for normal FMVSS No. 121 testing in the Loaded-to-GVWR condition. The vehicle loading was changed from that specified in normal FMVSS No. 121 testing for Loaded-to-GVWR testing to a different loading (referred to as the MGVWR condition) such that the 60 mph stopping distance specified in Table 1 was just achieved. It is the authors' belief that by loading this vehicle so as to just achieve the specified 60 mph stopping distance, test results would give greater insight into the appropriateness of stopping distance values from other initial speeds that are in Table 1. Furthermore, direct comparisons of corrected stopping distances and steady state decelerations could be made.

Data collected during this testing were then analyzed; both to see how closely the experimentally measured stopping distance matched Equation 1 as a function of initial vehicle speed and to see how closely experimentally measured data matched the values contained in Tables 1 and 2.

2.0 Experimental Test Program

2.1 Test Plan

The test plan for this research consisted of the following steps:

1. Instrument test vehicle.
2. Burnish test vehicle's brakes.
3. Measure test vehicle brake timing.
4. Load test truck tractor with control trailer to GVWR as per FMVSS No. 121.
5. Perform six stops from as close to 60 mph initial speed as feasible. Calculate corrected stopping distance for each stop and average over all six stops.
6. Adjust test vehicle loading to bring average corrected stopping distance from all six stops closer to the target stopping distance of 250 feet.
7. Iterate Steps 5 and 6 as many times as needed to achieve an average corrected stopping distance of 250±1 feet. This established the Modified Gross Vehicle Weight Rating (MGVWR) loading condition used during this testing.
8. With the test vehicle loaded to the MGVWR condition, perform six stops from as close to each desired initial speed as feasible. Testing was performed at desired initial speeds of 55, 50, 45, 40, 35, 30, 25, 20, and 60 mph, in that order.
9. With the test vehicle in the unloaded (LLVW) condition, perform six stops from as close to each desired initial speed as feasible. Testing was performed at desired vehicle initial speeds of 60, 55, 50, 45, 40, 35, 30, 25, 20, and 60 mph, in that order.
10. With the completion of Step 9, testing for this research was complete. All instrumentation was removed from the test vehicle.

Vehicle testing was performed in accordance with the Office of Vehicle Safety Compliance Laboratory Test Procedure No. TP-121V-04. This Laboratory Test Procedure is based on FMVSS No. 121, Air Brake Systems (Code of Federal Regulations 49 CFR 571.121, 10-1-02 Edition). The sections of this procedure that were used included:

- Section 6. Test Track Requirements
- Section 7. Calibration of Test Instruments
- Section 8. Photographic Documentation
- Section 10.1 Verification of Required Equipment
- Section 10.3. Road Tests
- General Test Condition
- Test Sequence (49 CFR 571.121; S5.3.1)
  - C. Burnish (49 CFR 571.121; S6.1.8)
  - E. Service Brake Stopping Distance Test (49 CFR 571.121; S5.3.1.1)

2.2 Test Vehicle

The truck tractor tested was a 1991 Volvo 6x4 tractor. For the MGVWR testing, this truck tractor was towing the Transportation Research Center's (TRC's) 28 foot long, unbraked control trailer (loaded with the appropriate weights). Figure 2 shows an overall picture of this truck tractor-semitrailer rig.

Additional information about the 1991 Volvo 6x4 tractor is contained in Appendix A.

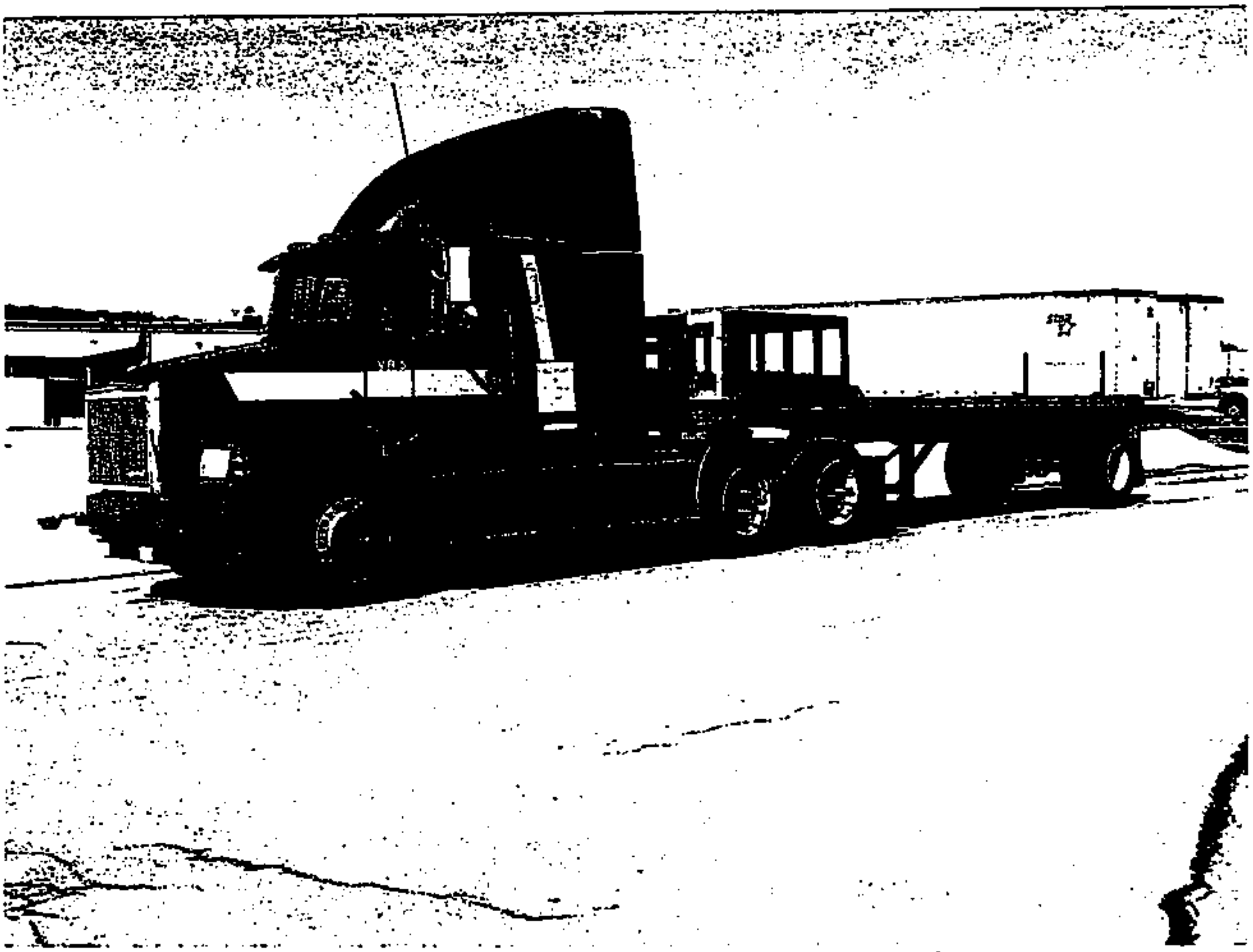

Figure 2: 1991 Volvo 6x4 Tractor with TRC's 28 foot long, unbraked control trailer

Please note that since this vehicle was manufactured during 1991, it does not have to meet the stopping distance requirements that are shown in Tables 1 and 2. It has to meet the requirements of the version of FMVSS No. 121 that were in effect in 1991. Past NHTSA testing has demonstrated that this vehicle meets all of the 1991 FMVSS No. 121 requirements. This tractor was equipped with an antilock brake system (ABS) that meets all of the FMVSS No. 121 requirements that became effective on March 1, 1997.

Although this vehicle is fairly old, the age of the tractor is expected to *not* affect the results of this research. While the ABS may not be the most modern design, it was sufficient to prevent the tractors wheels from locking up. The effects of age on braking system performance were compensated for by use of the Modified Gross Vehicle Weight Rating loading (see discussion in Section 2.5, below) for the most important portion of this testing. The age of the vehicle could have slightly affected stopping performance during the LLVW testing; however, for this loading the vehicle had such a large margin of compliance that the slight effects of vehicle age were not important. All in all, the use of a current model year tractor is expected to have resulted in the same research results.

During testing performed with the tractor in both the Gross Vehicle Weight Rating loading and the Modified Gross Vehicle Weight Rating loading (see discussion in Section 2.5, below), the Volvo tractor was towing an unbraked control trailer. This control trailer conforms to all of the requirements specified for an unbraked control in FMVSS No. 121[6].

The control trailer used was a 1977 Ravens 28-foot long, flatbed semitrailer. Additional information about this semitrailer is contained in Appendix B.

2.3 Test Vehicle Instrumentation

Prior to testing, the 1991 Volvo 6x4 truck tractor was instrumented to measure and record the following data channels:

- Vehicle Speed,
- Wheel Rotational Speeds,
- Brake Pedal Trigger Switch,
- Stopping Distance,
- Longitudinal Deceleration,
- Treadle Valve Pressure,
- Primary and Secondary Reservoir Pressures,
- Brake Chamber Pressures, and
- Brake Lining Temperatures.

Office of Vehicle Safety Compliance Laboratory Test Procedure TP-121V-04 instrumentation typically used by the Transportation Research Center was installed for this testing.

Upon the completion of instrumentation installation, a brake burnish, per the requirements of Office of Vehicle Safety Compliance Laboratory Test Procedure No. TP-121V-04 was performed.

2.4 Test Vehicle Brake Timing

Brake timing testing (performed as per Step 3 of the Test Plan) was conducted using the FMVSS No. 121 test conditions and procedures. Apply tests measure the time for the air pressure to rise to 60 psi following a 100 psi application of air at the treadle valve. Release tests measure the time for the air pressure to fall from 95 to 5 psi when, after a 95 psi brake application has been made and air pressure has reached steady state, the driver releases the treadle valve.

Initially, the brake apply timing of both tractor drive axles did not comply with the requirements of FMVSS No. 121 (a maximum apply time of 0.45 seconds). This is believed to be due to the fact that it had been several years since this vehicle's brakes had last had significant maintenance. Therefore, as a first corrective action, the rear relay valve was replaced. This helped but was insufficient to have both tractor drive axles comply with the requirements of FMVSS No. 121. Therefore, as a second corrective action, lubrication was performed of the s-cam brake shaft bearings (note that s-cam brakes were only present on this truck tractor's drive axle brakes; the front axle was fitted with air disc brakes during this testing) via the lubrication fittings and the service brakes exercised in a number of stops. This second corrective action was sufficient to have both tractor drive axles comply with the requirements of FMVSS No. 121.

Table 3 summarizes results of brake timing tests that were performed for this truck tractor. As can be seen, all brakes meet the timing requirements of FMVSS No. 121 (apply times of less than 0.45 seconds for each of the brakes and 0.35 seconds for the 50 cubic inch gladhand reservoir and release times of less than 0.55 seconds for each of the brakes and 0.75 seconds for the 50 cubic inch gladhand reservoir).

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[6] Federal Motor Vehicle Safety Standard No. 121; Air Brake Systems, S6.1.10

Table 3: Brake Actuation and Release Times

Run No.	Front Axle		Intermediate Drive Axle		Rear Drive Axle		50 cubic inch Gladhand Reservoir	
	Apply Time (sec)	Release Time (sec)	Apply Time (sec)	Release Time (sec)	Apply Time (sec)	Release Time (sec)	Apply Time (sec)	Release Time (sec)
1	0.30	0.50	0.41	0.49	0.40	0.46	0.35	0.68
2	0.31	0.47	0.42	0.47	0.41	0.45	0.33	0.68
3	0.31	0.51	0.42	0.51	0.41	0.48	0.33	0.68
Average	**0.31**	**0.49**	**0.42**	**0.49**	**0.41**	**0.46**	**0.34**	**0.68**

2.5 Establishing Modified Gross Vehicle Weight Rating Vehicle Loading

As stated above, since only one truck tractor was tested, a decision was made to modify its loading for normal FMVSS No. 121 testing in the Loaded-to-GVWR condition. The vehicle loading was changed from that specified for normal FMVSS No. 121 testing in the Loaded-to-GVWR testing to a different loading (referred to as the MGVWR condition) such that the 60 mph stopping distance specified in Table 1 was just achieved. It is the authors' belief that by loading this vehicle so as to just achieve the 60 mph stopping distance specified in Table 1, test results would give greater insight into the appropriateness of stopping distance values from other initial speeds that are in Table 1. Furthermore, direct comparisons of corrected stopping distances and steady state decelerations could be made.

To determine the MGVWR vehicle loading, the following procedure (Steps 4 through 7 of the Test Plan) was used:

1. Load test truck tractor with control trailer to GVWR as per FMVSS No 121.
2. Perform six stops from as close to 60 mph initial speed as feasible. Calculate corrected stopping distance for each stop and average resulting data over all six stops.
3. Adjust test vehicle loading to bring the average corrected stopping distance from all six stops closer to the target of 250 feet.
4. Iterate Steps 5 and 6 as many times as needed to achieve an average corrected stopping distance of 250±1 feet. This established the Modified Gross Vehicle Weight Rating (MGVWR) loading condition used during this testing.

Initially, the Volvo 6x4 tractor and control trailer were loaded, as specified by FMVSS No. 121 for the Loaded to GVWR condition, so as to have the following loads on each axle:

Front Axle:	11,120 pounds
Drive Axles:	33,680 pounds
Trailer Axles:	4,510 pounds
Total Weight:	**49,310 pounds**

The Loaded to GVWR Volvo 6x4 tractor and control trailer were then used to perform six stops from an initial speed of 60 mph. Table 4 summarizes the resulting stopping distances.

Table 4: Stopping Performance for the GVWR Vehicle

	Target Speed = 60 mph		
Stop Number	**Actual Initial Speed (mph)**	**Measured Stopping Distance (ft)**	**Corrected Stopping Distance (ft)**
1	60.5	277.7	273.1
2	60.1	275.1	274.2
3	59.8	294.6	296.6
4	60.2	315.2	313.1
5	60.4	324.0	319.7
6	60.0	291.1	291.1
		Average Corrected Stopping Distance	**294.6**

Since average corrected stopping distance for the vehicle in the Loaded to GVWR condition exceeded 250 ft, ballast was removed. Since sensitivity of stopping distance to ballast changes was not known, initially 3,000 pounds of ballast was removed. This reduced the weight of the Volvo 6x4 tractor and control trailer to 46,310 pounds (the Iteration 2 Weight). The Iteration 2 Weight Volvo 6x4 tractor and control trailer was then used to perform six stops from an initial speed of 60 mph. Table 5 summarizes the resulting stopping distances.

Table 5: Stopping Performance for the Iteration 2 Weight Vehicle

	Target Speed = 60 mph		
Stop Number	**Actual Initial Speed (mph)**	**Measured Stopping Distance (ft)**	**Corrected Stopping Distance (ft)**
1	59.6	289.0	292.9
2	59.7	271.3	274.0
3	60.4	289.0	285.2
4	60.1	290.9	289.9
5	60.2	293.9	292.0
6	60.2	294.2	292.2
		Average Corrected Stopping Distance	**287.7**

Since average corrected stopping distance for the vehicle at the Iteration 2 weight continued to exceed 250 ft, additional ballast was removed. Now, however, enough data was available to estimate, based on linear extrapolation, the amount of ballast that needed to be removed to attain a corrected stopping distance of 250 ft. Based on this calculation, an additional 12,000 pounds of ballast was removed. This reduced the weight of the Volvo 6x4 tractor and control trailer to 34,310 pounds (the Iteration 3 Weight). The Iteration 3 Weight Volvo 6x4 tractor and control trailer was then used to perform six stops from an initial speed of 60 mph. Table 6 summarizes the resulting stopping distances.

Table 6: Stopping Performance for the Iteration 3 Weight Vehicle

	Target Speed = 60 mph		
Stop Number	Actual Initial Speed (mph)	Measured Stopping Distance (ft)	Corrected Stopping Distance (ft)
1	59.9	221.0	221.7
2	59.6	232.3	235.4
3	60.4	226.1	223.1
4	60.4	226.4	223.4
5	59.4	223.7	228.2
6	60.1	230.8	230.0
Average Corrected Stopping Distance			227.0

Since average corrected stopping distance for the vehicle at the Iteration 3 weight was less than 250 ft, ballast was added. Now, however, enough data was available to estimate, based on quadratic interpolation, the amount of ballast that needed to be added to attain a corrected stopping distance of 250 ft. Based on this calculation, 6,310 pounds of ballast was added. This increased the weight of the Volvo 6x4 tractor and control trailer to 40,620 pounds (the Iteration 4 Weight). The Iteration 4 Weight Volvo 6x4 tractor and control trailer was then used to perform six stops from an initial speed of 60 mph. Table 7 summarizes the resulting stopping distances.

Table 7: Stopping Performance for the Iteration 4 Weight Vehicle

	Target Speed = 60 mph		
Stop Number	Actual Initial Speed (mph)	Measured Stopping Distance (ft)	Corrected Stopping Distance (ft)
1	60.5	243.9	239.9
2	60.3	251.0	248.5
3	60.3	259.2	256.6
4	60.2	244.3	242.7
5	60.2	252.0	250.3
6	60.2	251.7	250.0
Average Corrected Stopping Distance			248.0

Unfortunately, at this point in this test program, winter weather set in. Due to weather, testing could not be performed from December 19, 2009 through March 7, 2010. When testing resumed in March 2010, the first tests performed checked whether the stopping performance for the Iteration 4 vehicle had changed during the winter. Changes in stopping performance during the winter are likely to occur for such reasons as weather-induced changes to the test pavement's frictional characteristics, aging-induced effects on the tires' frictional characteristics, etc. Not surprisingly, the average corrected stopping distance in March 2010 of the Iteration 4 vehicle was found to differ from its average corrected stopping distance in December 2009. The March 2010 average corrected stopping distance was 240.9 ft.

Since the average corrected stopping distance for the vehicle at the Iteration 4 weight was less than 250 ft, ballast was added. A constant reduction to previous stopping distance data of 7.1 ft was assumed.

Quadratic interpolation could then be used to estimate the amount of ballast that needed to be added to attain a corrected stopping distance of 250 ft. Based on this calculation, 2,220 pounds of ballast was added. This increased the weight of the Volvo 6x4 tractor and control trailer to 42,840 pounds (the Iteration 5 Weight). The Iteration 5 Weight Volvo 6x4 tractor and control trailer was then used to perform six stops from an initial speed of 60 mph. Table 8 summarizes the resulting stopping distances.

Table 8: Stopping Performance for the Iteration 5 Weight Vehicle

	Target Speed = 60 mph		
Stop Number	**Actual Initial Speed (mph)**	**Measured Stopping Distance (ft)**	**Corrected Stopping Distance (ft)**
1	59.9	246.0	246.8
2	59.8	240.5	242.1
3	60.1	253.5	252.7
4	60.1	250.5	249.7
5	60.3	252.8	250.3
6	59.7	259.8	262.4
		Average Corrected Stopping Distance	**250.7**

Since average corrected stopping distance for the vehicle at the Iteration 5 weight was within ±1 ft of the desired 250 ft, the Iteration 5 weight was selected as this vehicle's Modified Gross Vehicle Weight Rating (MGVWR) that was used for the MGVWR portion of the subsequent testing. In the MGVWR loading condition, the Volvo 6x4 tractor with the control trailer had the following loads on each axle:

Front Axle: 10,990 pounds
Drive Axles: 27,360 pounds
Trailer Axles: 4,490 pounds
Total Weight: 42,840 pounds

3.0 Test Results

As per Step 8 of the Test Plan, with the test vehicle loaded to MGVWR condition, six stops were performed from each desired initial speed. From testing performed to establish MGVWR condition, data had already been collected for an initial speed of 60 mph. Testing was next performed at initial speeds of 55, 50, 45, 40, 35, 30, 25, and 20 mph, in that order. Stopping distance data from this testing is summarized in Table 9.

Table 9: Summary of MGVWR Stopping Distance Data

	Target Speed = 60 mph			Target Speed = 55 mph			Target Speed = 50 mph		
Stop Number	Actual Initial Speed (mph)	Measured Stopping Distance (ft)	Corrected Stopping Distance (ft)	Actual Initial Speed (mph)	Measured Stopping Distance (ft)	Corrected Stopping Distance (ft)	Actual Initial Speed (mph)	Measured Stopping Distance (ft)	Corrected Stopping Distance (ft)
1	59.9	246.0	246.8	54.9	197.1	197.8	50.3	166.5	164.5
2	59.8	240.5	242.1	55.2	207.2	205.7	50.7	165.0	160.5
3	60.1	253.5	252.7	55.2	201.0	199.5	49.9	170.2	170.9
4	60.1	250.5	249.7	55.3	211.8	209.5	50.1	171.0	170.3
5	60.3	252.8	250.3	55.0	190.9	190.9	50.4	172.1	169.4
6	59.7	259.8	262.4	55.2	201.2	199.7	50.2	170.8	169.4
	Average Value		250.7	Average Value		200.5	Average Value		167.5
	Standard Deviation		6.8	Standard Dev.		5.9	Standard Dev.		4.1

	Target Speed = 45 mph			Target Speed = 40 mph			Target Speed = 35 mph		
Stop Number	Actual Initial Speed (mph)	Measured Stopping Distance (ft)	Corrected Stopping Distance (ft)	Actual Initial Speed (mph)	Measured Stopping Distance (ft)	Corrected Stopping Distance (ft)	Actual Initial Speed (mph)	Measured Stopping Distance (ft)	Corrected Stopping Distance (ft)
1	44.9	136.6	137.2	40.3	106.3	104.7	35.3	80.2	78.8
2	45.1	139.0	138.4	40.4	106.1	104.0	35.8	81.0	77.4
3	45.5	137.0	134.0	39.6	103.9	106.0	35.4	81.7	79.9
4	44.9	133.3	133.9	40.3	108.2	106.6	35.2	79.6	78.7
5	45.1	136.8	136.2	40.1	100.2	99.7	35.3	81.0	79.6
6	45.6	139.1	135.5	40.1	105.7	105.2	35.2	79.2	78.3
	Average Value		135.9	Average Value		104.4	Average Value		78.8
	Standard Deviation		1.8	Standard Dev.		2.5	Standard Dev.		0.9

	Target Speed = 30 mph			Target Speed = 25 mph			Target Speed = 20 mph		
Stop Number	Actual Initial Speed (mph)	Measured Stopping Distance (ft)	Corrected Stopping Distance (ft)	Actual Initial Speed (mph)	Measured Stopping Distance (ft)	Corrected Stopping Distance (ft)	Actual Initial Speed (mph)	Measured Stopping Distance (ft)	Corrected Stopping Distance (ft)
1	30.2	61.7	60.9	24.8	43.0	43.7	20.2	32.7	32.1
2	30.1	62.3	61.9	25.6	45.3	43.2	20.2	31.2	30.6
3	30.8	63.4	60.1	24.7	42.8	43.8	20.3	32.4	31.4
4	30.5	63.6	61.5	24.6	45.3	46.8	20.0	30.4	30.4
5	30.2	62.3	61.5	25.2	44.7	44.0	20.3	31.9	31.0
6	30.2	63.6	62.8	25.4	44.9	43.5	20.2	32.5	31.9
	Average Value		61.4	Average Value		44.2	Average Value		31.2
	Standard Deviation		0.9	Standard Dev.		1.3	Standard Dev.		0.7

As a check that nothing about the vehicle's braking performance had changed during the lower initial speed MGVWR testing, at the completion of this lower initial speed testing a final MGVWR tests series was performed with an initial speed of 60 mph. Table 10 summarizes the results of this testing.

Table 10: Stopping Distance Data from MGVWR Check Test Series

	Target Speed = 60 mph		
Stop Number	**Actual Initial Speed (mph)**	**Measured Stopping Distance (ft)**	**Corrected Stopping Distance (ft)**
1	60.5	252.7	248.5
2	59.8	252.7	254.4
3	60.5	249.8	245.7
4	59.7	244.1	246.6
5	59.6	250.2	253.6
6	60.2	235.6	234.0
		Average Corrected Stopping Distance	247.1
		Standard Deviation	7.3

The difference between averaged corrected stopping distance from the initial 60 mph MGVWR testing and the final 60 mph MGVWR Check Test Series, 3.6 ft, is less than the standard deviation for either test series. The Student t-Test, assuming equal variances, was run for these two populations. The resulting t-Statistic was 0.86, which is considerably less than the critical t-Statistic value (the value for which there is a 95 percent probability that two populations are different) for these population sizes of 2.23. Therefore, nothing about this vehicle's braking performance changed during lower initial speed MGVWR testing.

Deceleration data collected during MGVWR testing from all of the initial speeds tested was analyzed. For this analysis, it was assumed that vehicle deceleration during each stop had the idealized shape shown in Figure 1, i.e., a ramp rise followed by holding constant at its steady state value until the end of the stop. Note that unlike Figure 1 in which the ramp rise time was fixed at 0.45 seconds, for this analysis the ramp rise time was allowed to vary and was determined by the analyst. Figure 3 shows both the measured and idealized deceleration for a typical stop from an initial speed of 60 mph.

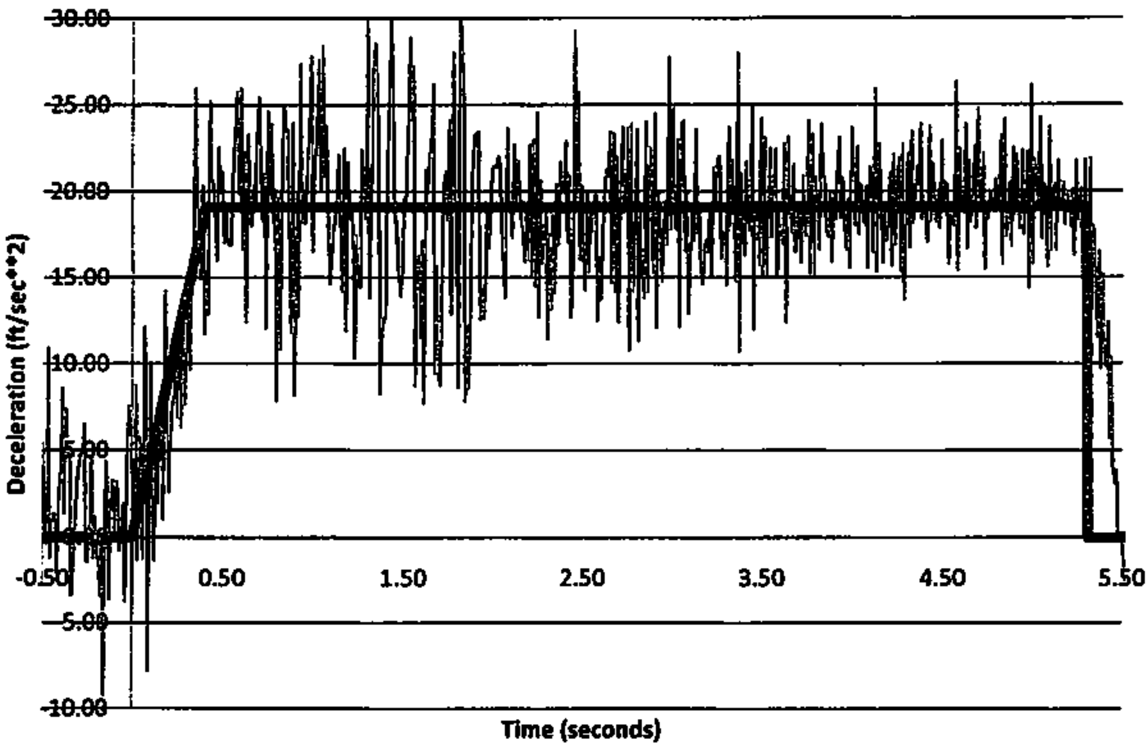

Figure 3: Measured and Idealized Deceleration for a Typical 60 mph Stop

For each stop, the analyst determined, somewhat subjectively, $t_{r,}$ the Deceleration Rise Time in seconds, from a time history trace of deceleration versus time. The analyst also determined the time at which deceleration began to drop rapidly to zero.

After Deceleration Rise Time had been determined, $d_{ss,}$ the Steady State Vehicle Deceleration was determined. This was initially done by determining the average value of deceleration, as measured by the longitudinal accelerometer that was mounted on the vehicle during testing, from the end of the Deceleration Rise Time to the time at which deceleration began to drop rapidly to zero. Unfortunately, values for Steady State Vehicle Deceleration obtained via this method seemed unreasonably high, indicating calibration problems with the longitudinal accelerometer. Therefore, a new deceleration channel was calculated for each stop by dividing the change in measured vehicle speed between each two successive data collection points by the time interval between these two data points (0.01 seconds). Steady State Vehicle Deceleration values were then re-calculated by determining the average value of this channel from the end of the Deceleration Rise Time to the time at which the deceleration began to drop rapidly to zero. This method gave more reasonable values for Steady State Vehicle Decelerations (although, as discussed later, still somewhat too high values).

Table 11 summarizes the Deceleration Rise Times and the Steady State Vehicle Decelerations that were determined from the MGVWR testing from all initial speeds.

Table 11: Summary of MGVWR Deceleration Data

Stop Number	Target Speed = 60 mph		Target Speed = 55 mph		Target Speed = 50 mph	
	Deceleration Rise Time (sec)	Steady State Deceleration (ft/sec^2)	Deceleration Rise Time (sec)	Steady State Deceleration (ft/sec^2)	Deceleration Rise Time (sec)	Steady State Deceleration (ft/sec^2)
1	0.50	17.7	0.36	18.9	0.40	18.9
2	0.37	18.0	0.34	17.9	0.48	19.6
3	0.39	17.1	0.42	18.6	0.40	18.4
4	0.35	17.3	0.46	17.6	0.37	18.2
5	0.41	17.1	0.43	19.5	0.43	18.6
6	0.37	16.4	0.35	18.4	0.40	18.6
Average	**0.40**	**17.3**	**0.39**	**18.5**	**0.41**	**18.7**
Stand. Dev.	**0.05**	**0.6**	**0.05**	**0.7**	**0.04**	**0.5**

Stop Number	Target Speed = 45 mph		Target Speed = 40 mph		Target Speed = 35 mph	
	Deceleration Rise Time (sec)	Steady State Deceleration (ft/sec^2)	Deceleration Rise Time (sec)	Steady State Deceleration (ft/sec^2)	Deceleration Rise Time (sec)	Steady State Deceleration (ft/sec^2)
1	0.38	19.0	0.37	19.4	0.31	20.8
2	0.53	19.1	0.40	19.5	0.46	20.9
3	0.45	19.3	0.36	19.5	0.38	21.1
4	0.43	19.7	0.41	19.8	0.40	21.3
5	0.44	19.0	0.39	21.4	0.46	20.6
6	0.41	18.6	0.39	19.1	0.39	21.4
Average	**0.44**	**19.1**	**0.39**	**19.8**	**0.40**	**21.0**
Stand. Dev.	**0.05**	**0.3**	**0.02**	**0.8**	**0.06**	**0.3**

Stop Number	Target Speed = 30 mph		Target Speed = 25 mph		Target Speed = 20 mph	
	Deceleration Rise Time (sec)	Steady State Deceleration (ft/sec^2)	Deceleration Rise Time (sec)	Steady State Deceleration (ft/sec^2)	Deceleration Rise Time (sec)	Steady State Deceleration (ft/sec^2)
1	0.37	21.0	0.58	21.9	0.38	18.6
2	0.62	21.0	0.54	20.7	0.38	20.2
3	0.54	20.8	0.55	22.8	0.37	19.4
4	0.60	20.5	0.67	21.3	0.41	21.0
5	0.37	19.9	0.57	20.6	0.36	19.8
6	0.49	21.1	0.45	21.4	0.63	20.7
Average	**0.50**	**20.7**	**0.56**	**21.4**	**0.42**	**20.0**
Stand. Dev.	**0.11**	**0.4**	**0.07**	**0.8**	**0.10**	**0.9**

As per Step 9 of the Test Plan, with the test vehicle in the unloaded condition (LLVW), six stops were performed from each desired initial speed. Testing was performed at initial speeds of 60, 55, 50, 45, 40, 35, 30, 25, and 20 mph, in that order. Stopping distance data from this testing is summarized in Table 12.

Table 12: Summary of LLVW Stopping Distance Data

	Target Speed = 60 mph			Target Speed = 55 mph			Target Speed = 50 mph		
Stop Number	Actual Initial Speed (mph)	Measured Stopping Distance (ft)	Corrected Stopping Distance (ft)	Actual Initial Speed (mph)	Measured Stopping Distance (ft)	Corrected Stopping Distance (ft)	Actual Initial Speed (mph)	Measured Stopping Distance (ft)	Corrected Stopping Distance (ft)
1	59.5	182.1	185.2	55.5	159.2	156.3	49.4	121.5	124.5
2	59.8	181.8	183.0	55.7	155.6	151.7	50.8	129.7	125.6
3	61.0	192.8	186.5	54.3	148.8	152.7	50.0	124.8	124.8
4	59.9	184.0	184.6	55.6	160.4	157.0	50.3	120.9	119.5
5	59.9	182.2	182.8	54.7	154.8	156.5	50.0	128.6	128.6
6	59.9	179.7	180.3	54.6	155.4	157.7	50.1	127.1	126.6
		Average Value	183.7		Average Value	155.3		Average Value	124.9
		Standard Deviation	2.2		Standard Dev.	2.5		Standard Dev.	3.1

	Target Speed = 45 mph			Target Speed = 40 mph			Target Speed = 35 mph		
Stop Number	Actual Initial Speed (mph)	Measured Stopping Distance (ft)	Corrected Stopping Distance (ft)	Actual Initial Speed (mph)	Measured Stopping Distance (ft)	Corrected Stopping Distance (ft)	Actual Initial Speed (mph)	Measured Stopping Distance (ft)	Corrected Stopping Distance (ft)
1	45.5	102.1	99.9	40.5	84.2	82.1	35.3	64.8	63.7
2	45.0	104.9	104.9	41.4	87.7	81.9	34.2	61.8	64.7
3	45.5	105.1	102.8	40.9	84.6	80.9	35.6	63.0	60.9
4	45.6	105.6	102.8	40.3	84.7	83.4	35.6	66.3	64.1
5	45.8	105.1	101.5	40.4	84.4	82.7	36.4	69.4	64.2
6	45.3	106.3	104.9	41.0	84.1	80.0	35.3	64.8	63.7
		Average Value	102.8		Average Value	81.9		Average Value	63.5
		Standard Deviation	2.0		Standard Dev.	1.2		Standard Dev.	1.4

	Target Speed = 30 mph			Target Speed = 25 mph			Target Speed = 20 mph		
Stop Number	Actual Initial Speed (mph)	Measured Stopping Distance (ft)	Corrected Stopping Distance (ft)	Actual Initial Speed (mph)	Measured Stopping Distance (ft)	Corrected Stopping Distance (ft)	Actual Initial Speed (mph)	Measured Stopping Distance (ft)	Corrected Stopping Distance (ft)
1	30.7	49.5	47.3	25.1	36.0	35.7	20.5	28.6	27.2
2	30.2	48.9	48.3	25.1	36.7	36.4	20.0	24.6	24.6
3	30.5	48.6	47.0	25.0	37.4	37.4	20.0	25.7	25.7
4	29.5	48.5	50.2	24.8	36.5	37.1	20.3	25.5	24.8
5	30.2	48.0	47.4	25.2	36.1	35.5	19.2	24.0	26.0
6	30.0	48.8	48.8	25.3	34.7	33.9	19.9	25.6	25.9
		Average Value	48.1		Average Value	36.0		Average Value	25.7
		Standard Deviation	1.2		Standard Dev.	1.3		Standard Dev.	1.0

Finally, as a check that nothing about the vehicle's braking performance had changed during lower initial speed LLVW testing, at the completion of this lower initial speed testing a final LLVW tests series was performed with an initial speed of 60 mph. Table 13 summarizes the results of this testing.

Table 13: Stopping Distance Data from LLVW Check Test Series

	Target Speed = 60 mph		
Stop Number	**Actual Initial Speed (mph)**	**Measured Stopping Distance (ft)**	**Corrected Stopping Distance (ft)**
1	59.2	184.3	189.3
2	59.8	188.1	189.4
3	60.4	185.4	183.0
4	60.3	187.4	185.5
5	59.3	181.9	185.2
6	60.1	181.7	181.1
		Average Corrected Stopping Distance	**185.6**
		Standard Deviation	**3.3**

The difference between averaged corrected stopping distance from the 60 mph LLVW testing and from the final 60 mph LLVW Check Test Series, 1.9 ft, is less than the standard deviation for either test series. The Student t-Test, assuming equal variances, was run for these two populations. The resulting t-Statistic was 1.14, which is considerably less than the critical t-Statistic value (the value for which there is a 95 percent probability that the two populations are different) for these population sizes of 2.23. Therefore, nothing about the vehicle's braking performance changed during lower initial speed LLVW testing.

Again, for the LLVW test data, for each stop, the analyst determined, somewhat subjectively, t_r, Deceleration Rise Time in seconds, from the time history trace of deceleration versus time. The analyst also determined the time at which the deceleration began to drop rapidly to zero.

After the Deceleration Rise Time had been determined, Steady State Vehicle Deceleration (in feet per second squared) was determined. This was initially done by determining the average value of deceleration, as measured by the longitudinal accelerometer, from the end of the Deceleration Rise Time to the time at which the deceleration began to drop rapidly to zero. As was the case for the MGVWR data, the values for Steady State Vehicle Deceleration obtained found calibration problems with the longitudinal accelerometer. Therefore, a new deceleration channel was again calculated for each stop by dividing the change in measured vehicle speed between each two successive data collection points by the time interval between these two data points (0.01 seconds). The LLVW Steady State Vehicle Deceleration values were then re-calculated by determining the average value of this channel from the end of the Deceleration Rise Time to the time at which the deceleration began to drop rapidly to zero. This method gave more reasonable LLVW Steady State Vehicle Deceleration values (although, as discussed later, the resulting values were still seemed somewhat too high).

Table 14 summarizes the Deceleration Rise Times and the Steady State Vehicle Decelerations that were determined from LLVW testing from all initial speeds.

Table 14: Summary of LLVW Deceleration Data

Stop Number	Target Speed = 60 mph		Target Speed = 55 mph		Target Speed = 50 mph	
	Deceleration Rise Time (sec)	Steady State Deceleration (ft/sec²)	Deceleration Rise Time (sec)	Steady State Deceleration (ft/sec²)	Deceleration Rise Time (sec)	Steady State Deceleration (ft/sec²)
1	0.25	22.8	0.32	23.4	0.31	24.6
2	0.27	23.7	0.28	23.4	0.35	24.3
3	0.29	22.7	0.32	24.5	0.31	24.3
4	0.26	22.3	0.27	22.7	0.28	25.4
5	0.28	22.9	0.27	23.2	0.33	24.3
6	0.24	23.3	0.28	22.6	0.32	24.5
Average	**0.27**	**23.0**	**0.29**	**23.3**	**0.32**	**24.6**
Stand. Dev.	**0.02**	**0.5**	**0.02**	**0.7**	**0.02**	**0.4**

Stop Number	Target Speed = 45 mph		Target Speed = 40 mph		Target Speed = 35 mph	
	Deceleration Rise Time (sec)	Steady State Deceleration (ft/sec²)	Deceleration Rise Time (sec)	Steady State Deceleration (ft/sec²)	Deceleration Rise Time (sec)	Steady State Deceleration (ft/sec²)
1	0.28	24.6	0.28	23.7	0.29	24.3
2	0.28	23.8	0.31	24.8	0.33	26.0
3	0.27	24.2	0.31	24.9	0.31	25.9
4	0.28	23.8	0.33	24.8	0.31	23.9
5	0.31	24.6	0.33	24.5	0.32	24.5
6	0.31	23.7	0.28	24.2	0.30	23.7
Average	**0.29**	**24.1**	**0.31**	**24.5**	**0.31**	**24.7**
Stand. Dev.	**0.02**	**0.4**	**0.02**	**0.4**	**0.01**	**1.0**

Stop Number	Target Speed = 30 mph		Target Speed = 25 mph		Target Speed = 20 mph	
	Deceleration Rise Time (sec)	Steady State Deceleration (ft/sec²)	Deceleration Rise Time (sec)	Steady State Deceleration (ft/sec²)	Deceleration Rise Time (sec)	Steady State Deceleration (ft/sec²)
1	0.32	24.2	0.29	23.0	0.32	22.6
2	0.29	24.3	0.29	23.5	0.30	22.5
3	0.34	25.0	0.25	21.2	0.27	21.4
4	0.33	23.8	0.31	21.6	0.30	20.5
5	0.33	25.4	0.32	23.8	0.27	21.0
6	0.31	23.5	0.29	23.5	0.25	21.9
Average	**0.32**	**24.4**	**0.29**	**22.8**	**0.29**	**21.7**
Stand. Dev.	**0.02**	**0.7**	**0.02**	**1.1**	**0.03**	**0.8**

4.0 Analysis of Test Results

4.1 Analysis of Stopping Distance

Table 15 compares maximum permitted stopping distance according to FMVSS No. 121 (as shown in Table 1) with average measured corrected stopping distance for a variety of speeds (as shown in Table 9) with the test vehicle at MGVWR loading. The margin of compliance, calculated as a percentage of maximum permitted stopping distance according to FMVSS No. 121, is also shown. Speeds for which the margin of compliance is negative are highlighted. Please note that since this vehicle was manufactured during 1991, it does not have to meet the stopping distance requirements that are shown in Tables 1 and 2. It has to meet the requirements of the version of FMVSS No. 121 that were in effect in 1991. Past NHTSA testing has demonstrated that this vehicle meets all of the 1991 FMVSS No. 121 requirements. Furthermore, the MGVWR tests are not part of the FMVSS No. 121 standard; they were done solely for research purposes.

Table 15: Stopping Distance Analysis of the MGVWR Test Data

Initial Speed (mph)	Maximum Permitted Stopping Distance (ft)	Average Measured Corrected Stopping Distance (ft)	Margin of Compliance (%)
60	250.0	250.7	-0.3 %
55	212.0	200.5	5.4 %
50	176.0	167.5	4.8 %
45	144.0	135.9	5.6 %
40	114.0	104.4	8.4 %
35	89.0	78.8	11.5 %
30	65.0	61.4	5.5 %
25	45.0	44.2	1.8 %
20	30.0	31.2	-4.0 %

Figure 4 shows maximum permitted stopping distance according to FMVSS No. 121 and average measured corrected stopping distance graphed against initial speed for the MGVWR loading condition.

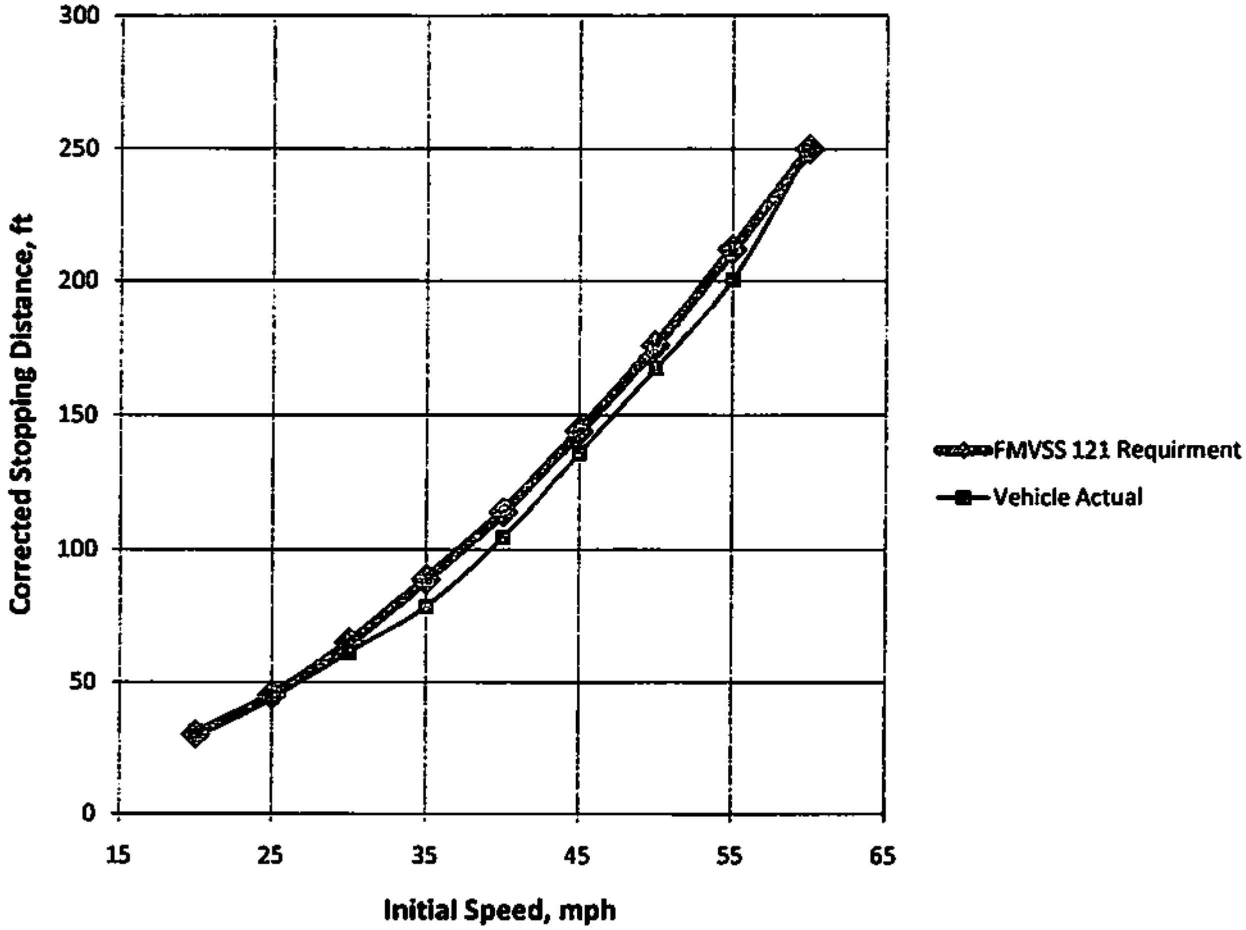

Figure 4: Maximum Permitted Stopping Distance and Average Measured Corrected Stopping Distance graphed against Initial Speed at MGVWR Loading

As Figure 4 and Table 15 show, maximum permitted stopping distance according to FMVSS No. 121 for the MGVWR loading condition matches average measured corrected stopping distance for an initial speed of 60 mph. As explained above, this is by design and is the criteria used to determine the MGVWR loading condition.

As initial speed decreased from 60 mph, average measured corrected stopping distance drops faster than maximum permitted stopping distance until an initial vehicle speed of 35 mph is reached. As per Table 15, for the MGVWR loading condition, the vehicle had the largest positive margin of compliance at an initial speed of 35 mph.

As initial speed decreased from 35 mph, maximum permitted stopping distance drops faster than average measured corrected stopping distance. As per Table 15, for the MGVWR loading condition, the vehicle had a negative margin of compliance at an initial speed of 20 mph.

Table 16 compares maximum permitted stopping distance according to FMVSS No. 121 (as shown in Table 2) with average measured corrected stopping distance for a variety of speeds (as shown in Table 9) with the unloaded (LLVW) test vehicle. The margin of compliance, calculated as a percentage of maximum permitted stopping distance according to FMVSS No. 121, is also shown.

Table 16: Stopping Distance Analysis of the LLVW Test Data

Initial Speed (mph)	Maximum Permitted Stopping Distance (ft)	Average Measured Corrected Stopping Distance (ft)	Margin of Compliance (%)
60	235.0	183.7	22.7 %
55	199.0	155.3	22.0 %
50	166.0	124.9	24.8 %
45	136.0	102.8	24.4 %
40	108.0	81.9	24.2 %
35	84.0	63.5	24.4 %
30	61.0	48.1	21.1 %
25	43.0	36.0	16.3 %
20	28.0	25.7	8.2 %

Figure 5 shows maximum permitted stopping distance according to FMVSS No. 121 and average measured corrected stopping distance graphed against initial speed for the LLVW vehicle.

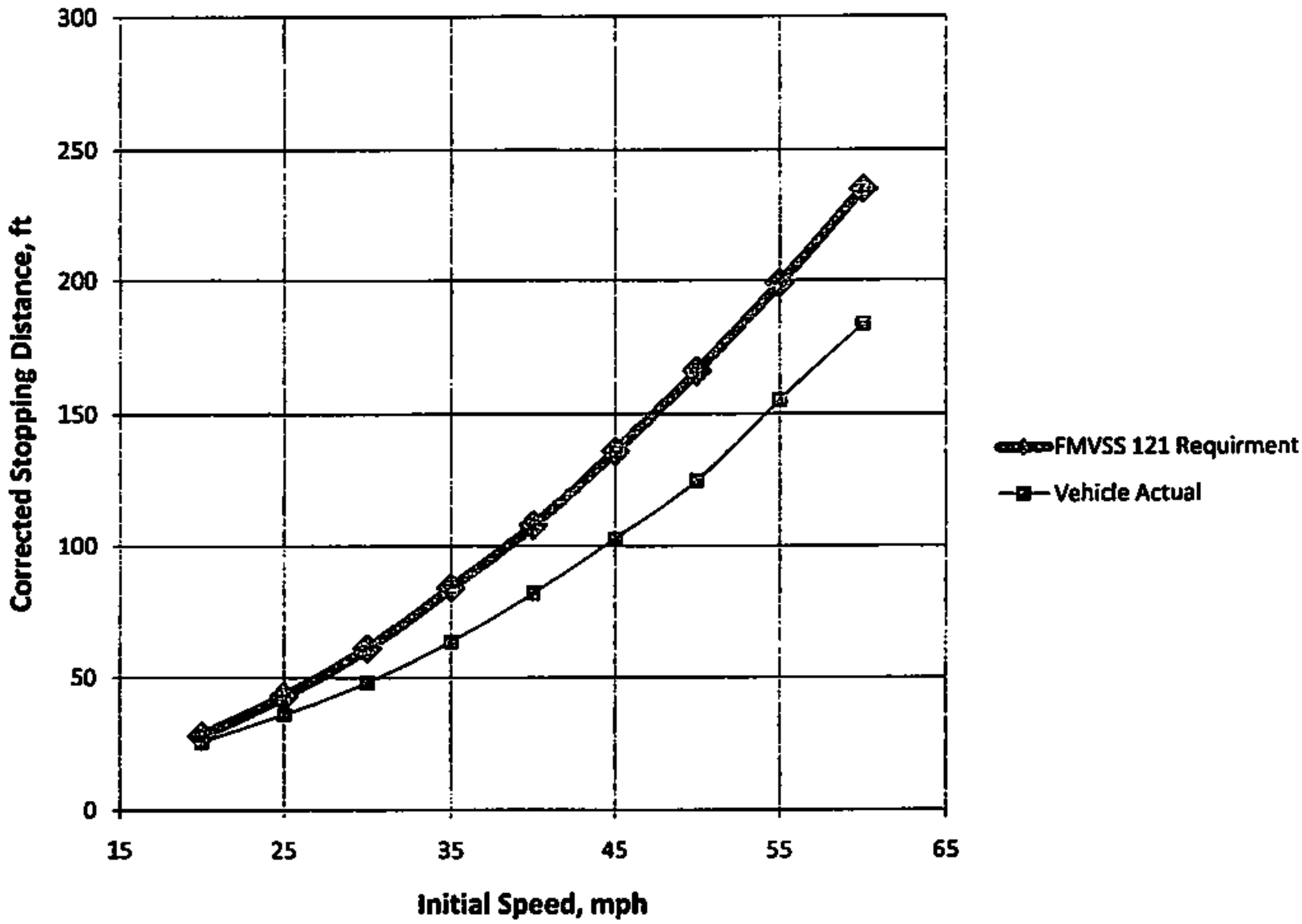

Figure 5: Maximum Permitted Stopping Distance and Average Measured Corrected Stopping Distance graphed against Initial Speed at LLVW Loading

As Figure 5 and Table 16 show, maximum permitted stopping distance according to FMVSS No. 121 for the LLVW vehicle is less than average measured corrected stopping distance for all initial speeds. As initial speed decreased from 60 mph, average measured corrected stopping distance drops at the same rate as maximum permitted stopping distance until an initial vehicle speed of 35 mph is reached. As per Table 16, the LLVW vehicle had a fairly constant (between 22.0 and 24.8 percent) margin of compliance for initial speeds from 60 to 35 mph.

As initial speed decreased from 35 mph, maximum permitted stopping distance drops faster than average measured corrected stopping distance. As per Table 16, the LLVW vehicle had its smallest (though still positive) margin of compliance at an initial speed of 20 mph.

4.2 Analysis of Deceleration Rise Time

Table 17 summarizes average deceleration rise time and standard deviations of the deceleration rise time for the MGVWR and LLVW vehicle.

Table 17: Deceleration Rise Times from MGVWR and LLVW Testing

Initial Speed (mph)	MGVWR Vehicle Loading		LLVW Vehicle Loading	
	Deceleration Rise Time (seconds)	Standard Deviation of Rise Time (seconds)	Deceleration Rise Time (seconds)	Standard Deviation of Rise Time (seconds)
60	0.40	0.05	0.27	0.02
55	0.39	0.05	0.29	0.02
50	0.41	0.04	0.32	0.02
45	0.44	0.05	0.29	0.02
40	0.39	0.02	0.31	0.02
35	0.40	0.06	0.31	0.01
30	0.50	0.11	0.32	0.02
25	0.56	0.07	0.29	0.02
20	0.42	0.10	0.29	0.03
Average	**0.43**	**0.6**	**0.30**	**0.02**

A first observation is that the deceleration rise time is longer for MGVWR loading than it is for the LLVW vehicle. This is confirmed by performing a Student t-Test (assuming equal variances) on the two populations. The resulting t-Statistic was 11.64, which is considerably more than the critical t-Statistic value (the value for which there is a 95 percent probability that the two populations are different) for these population sizes of 1.98. It was expected that deceleration rise time would be longer for the MGVWR loading than for the LLVW vehicle since less air pressure is required to achieve maximum deceleration for the LLVW vehicle.

Linear regression analysis was used to perform a least squares fit of the MGVWR experimental data using initial speed as the independent variable and deceleration rise time as the dependent variable. This analysis resulted in an intercept of 0.5311 and a slope of -0.0024 along with a R^2 value of 0.14. The 95 percent confidence limits on this slope are -0.0041 to -0.0008. Therefore, the deceleration rise time for the MGVWR loading decreases slightly, on the average, with increasing initial speed.

Linear regression analysis was used to perform a least squares fit of the LLVW experimental data using initial speed as the independent variable and deceleration rise time as the dependent variable. This analysis resulted in an intercept of 0.3121 and a slope of -0.0004 along with a R^2 value of 0.04. The 95 percent confidence limits on this slope include zero. Therefore, the deceleration rise time for the LLVW loading does not vary systematically with initial speed.

The average MGVWR and LLVW deceleration rise times, 0.43 and 0.30 seconds, respectively, are both less than the 0.45 second rise time that was used in Equation 1 to calculate maximum permitted stopping distances in Tables 1 and 2. Assuming a 0.45 second deceleration rise is, therefore, conservative. This will tend to make it easier for vehicles to meet the FMVSS No. 121 requirements.

4.3 Analysis of Steady-State Deceleration

Table 18 summarizes average steady-state decelerations and standard deviations of steady-state deceleration for the MGVWR and LLVW vehicle loadings.

Table 18: Steady-State Decelerations from MGVWR and LLVW Testing

Initial Speed (mph)	MGVWR Vehicle Loading		LLVW Vehicle Loading	
	Steady-State Deceleration (ft/sec^2)	Standard Deviation of Steady-State Deceleration (ft/sec^2)	Steady-State Deceleration (ft/sec^2)	Standard Deviation of Steady-State Deceleration (ft/sec^2)
60	17.3	0.6	23.0	0.5
55	18.5	0.7	23.3	0.7
50	18.7	0.5	24.6	0.4
45	19.1	0.3	24.1	0.4
40	19.8	0.8	24.5	0.4
35	21.0	0.3	24.7	1.0
30	20.7	0.4	24.4	0.7
25	21.4	0.8	22.8	1.1
20	20.0	0.9	21.7	0.8
Average	19.6	0.6	23.7	0.7

Tables 19 and 20, for MGVWR and LLVW loading, respectively, compare the assumed steady-state deceleration values used to calculate maximum permitted stopping distances from various initial speeds (as shown in Tables 1 and 2) with average measured steady-state decelerations (as shown in Table 18). The margin of compliance, calculated as a percentage of assumed steady-state deceleration values, is also shown.

Table 19: Steady-State Analysis of MGVWR Test Data

Initial Speed (mph)	Assumed Steady State Vehicle Deceleration (ft/sec^2)	Measured Steady-State Deceleration (ft/sec^2)	Margin of Compliance (%)
60	16.80	17.30	3.0 %
55	16.80	18.50	10.1 %
50	16.80	18.70	11.3 %
45	16.80	19.10	13.7 %
40	17.00	19.80	16.5 %
35	17.00	21.00	23.5 %
30	17.50	20.70	18.3 %
25	18.00	21.40	18.9 %
20	18.00	20.00	11.1 %

Table 20: Steady-State Analysis of LLVW Test Data

Initial Speed (mph)	Assumed Steady State Vehicle Deceleration (ft/sec^2)	Measured Steady-State Deceleration (ft/sec^2)	Margin of Compliance (%)
60	17.95	23.00	28.1 %
55	17.95	23.30	29.8 %
50	17.95	24.60	37.0 %
45	17.95	24.10	34.3 %
40	18.10	24.50	35.4 %
35	18.10	24.70	36.5 %
30	18.80	24.40	29.8 %
25	19.40	22.80	22.7 %
20	19.80	21.70	14.6 %

Figure 6 shows assumed steady state vehicle decelerations used to calculate maximum permitted stopping distances at various speeds in FMVSS No. 121 and average measured steady state decelerations graphed against initial speed for the MGVWR loading condition.

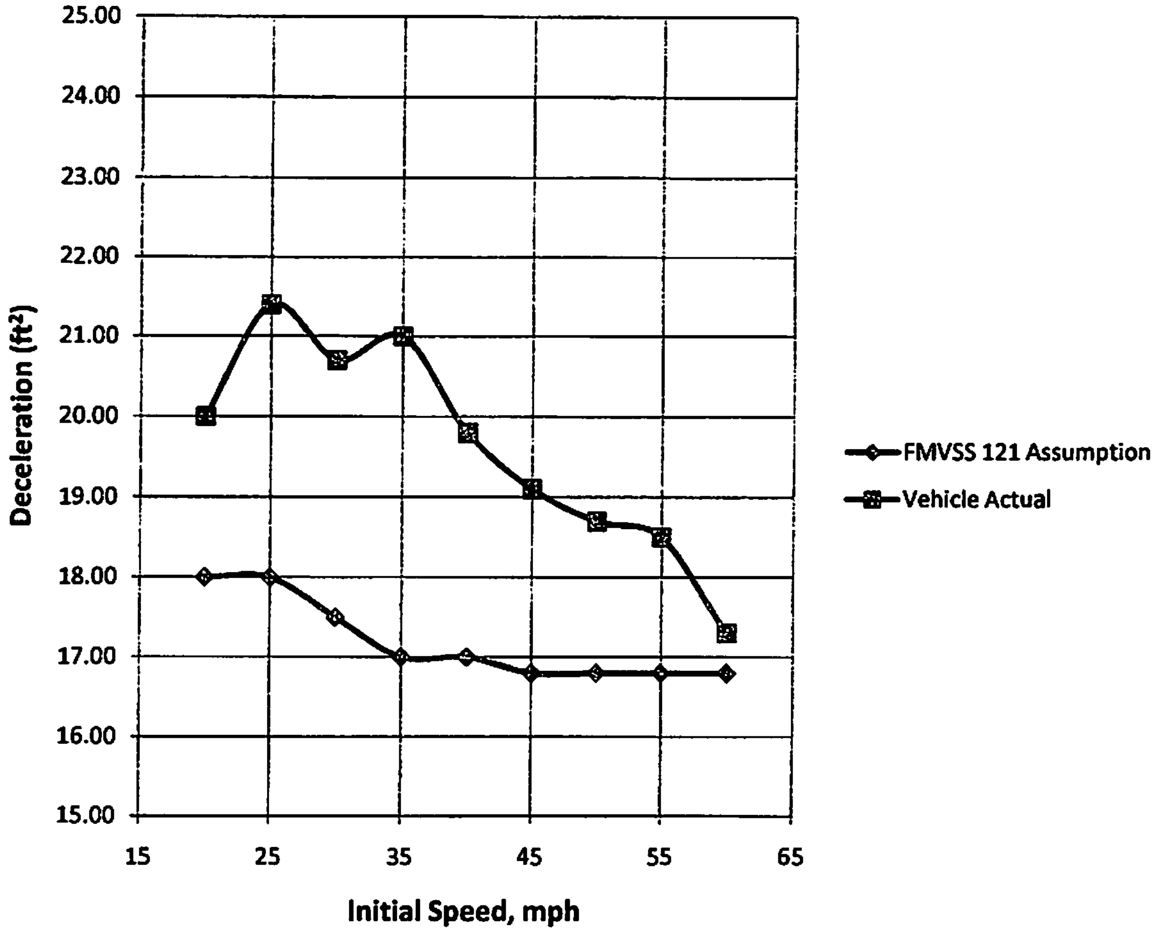

Figure 6: FMVSS No. 121 Assumed and Average Measured Deceleration graphed against Initial Speed at MGVWR Loading

As Figure 6 and Table 19 show, actual measured steady state deceleration is greater than FMVSS No. 121 assumed deceleration for the MGVWR loading condition for all initial speeds. This is surprising since, as shown in Figure 4 and Table 15, actual measured corrected stopping distance equals maximum permitted stopping distance at an initial speed of 60 mph and exceeds maximum permitted stopping distance at an initial speed of 20 mph. This indicates possible discrepancies between the idealized deceleration shape used to calculate Equation 1 and the actual deceleration shape.

Figure 7 shows assumed steady state vehicle decelerations used to calculate maximum permitted stopping distances at various speeds in FMVSS No. 121 and average measured steady state decelerations graphed against initial speed for the LLVW loading condition.

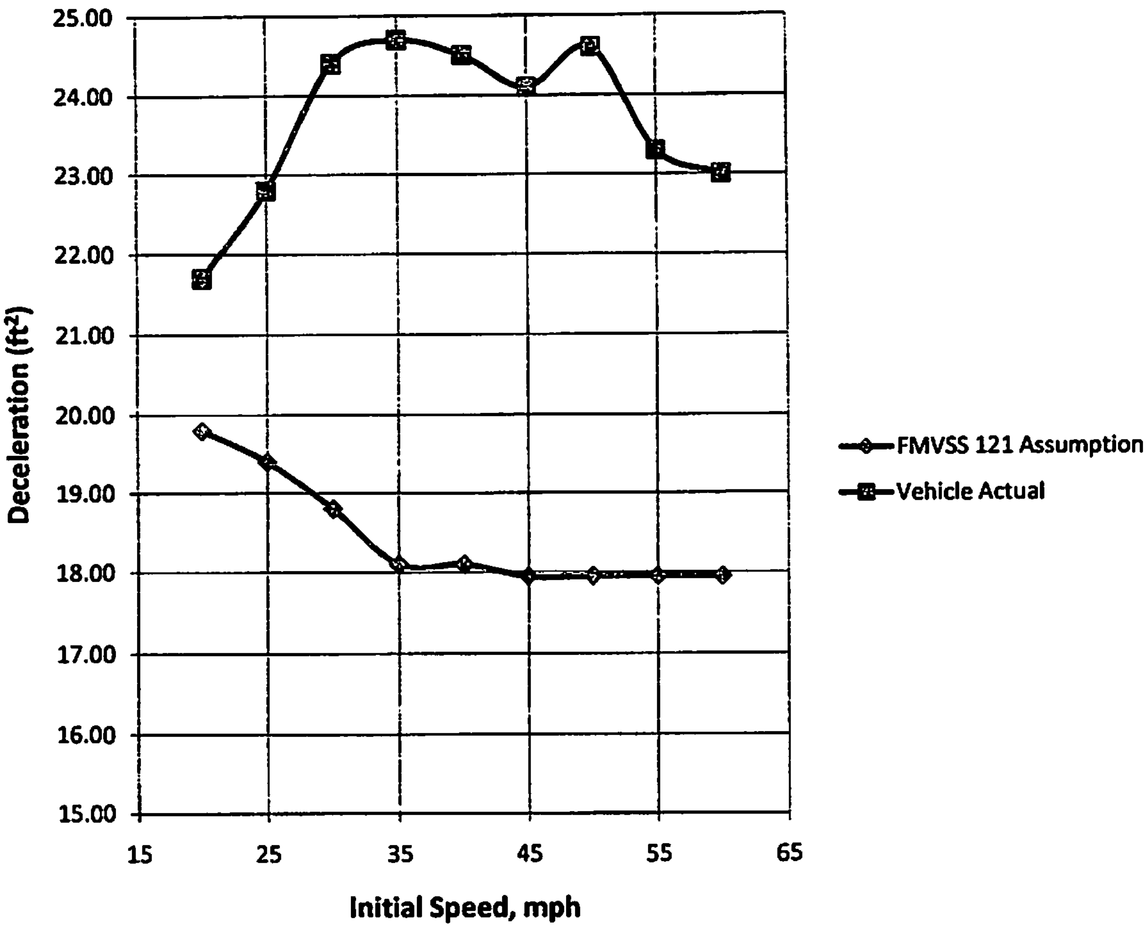

Figure 7: FMVSS No. 121 Assumed and Average Measured Deceleration graphed against Initial Speed at LLVW Loading

As Figure 7 and Table 20 show, actual measured steady state deceleration is substantially greater than FMVSS No. 121 assumed deceleration for the LLVW loading condition for all initial speeds. This is as expected since, as shown in Figure 5 and Table 16, actual measured corrected stopping distance is always less than maximum permitted stopping distance for all initial speeds for the LLVW loading. However, in violation of FMVSS No. 121 assumptions, there is a rapid decrease of steady state deceleration with initial speed for initial speeds below 35 mph.

Based in the issues above, the authors decided to further examine steady state deceleration. Equation 1 contains four parameters:

S = Total Stopping Distance,
V_0 = Vehicle Initial Speed,
t_r = Deceleration Rise Time, and
d_{ss} = Steady State Vehicle Deceleration.

If values for any three of these parameters are specified, then the corresponding value of the fourth parameter can be calculated. Therefore, the authors decided to specify the experimentally measured values of Total Stopping Distance, Vehicle Initial Speed, and Deceleration Rise Time and calculate the corresponding Steady State Vehicle Deceleration. Table 21 summarizes the results of this calculation for the MGVWR stops while Table 22 summarizes the results for the LLVW stops.

Table 21: Calculated Steady-State Deceleration from MGVWR Test Data

Initial Speed (mph)	Assumed Steady-State Deceleration (ft/sec^2)	Measured Steady-State Deceleration (ft/sec^2)	Calculated Steady-State Deceleration from Eq. 1 (ft/sec^2)	Measured minus Calculated Declaration (ft/sec^2)
60	16.80	17.30	16.60	0.70
55	16.80	18.50	17.60	0.90
50	16.80	18.70	17.60	1.10
45	16.80	19.10	17.90	1.20
40	17.00	19.80	18.50	1.30
35	17.00	21.00	19.20	1.80
30	17.50	20.70	19.10	1.70
25	18.00	21.40	19.70	1.70
20	18.00	20.00	17.10	2.90

Table 22: Calculated Steady-State Deceleration from LLVW Test Data

Initial Speed (mph)	Assumed Steady-State Deceleration (ft/sec^2)	Measured Steady-State Deceleration (ft/sec^2)	Calculated Steady-State Deceleration from Eq. 1 (ft/sec^2)	Measured minus Calculated Declaration (ft/sec^2)
60	17.95	23.00	22.50	0.50
55	17.95	23.30	22.60	0.70
50	17.95	24.60	23.70	0.90
45	17.95	24.10	23.30	0.80
40	18.10	24.50	23.50	0.90
35	18.10	24.70	23.60	1.10
30	18.80	24.40	23.50	0.90
25	19.40	22.80	21.90	0.90
20	19.80	21.70	20.00	1.70

Tables 21 and 22 demonstrate that measured steady state decelerations, as determined by numerically differentiating the speed channel and then averaging the resulting deceleration channel from the completion of the deceleration rise time until the end of stop time, are consistently higher than steady state decelerations calculated using Equation 1. The magnitude of this difference increases with decreasing initial speed. Reasons for this difference are not known. Also, it is not known which of these methods provides the best estimate for steady state deceleration.

In terms of the overall goal of this research, it probably does not matter which estimate of steady state deceleration is best. At an initial speed of 20 mph, measured average corrected stopping distance for the MGVWR loading exceeded maximum stopping distance permitted by FMVSS No. 121.

5.0 Summary and Conclusions

On July 27, 2009, the National Highway Traffic Administration (NHTSA) published a final rule amending Federal Motor Vehicle Safety Standard (FMVSS) No. 121, Air Brake Systems, to require improved stopping distance performance for truck tractors. This rule reduced maximum allowable stopping distance in the loaded to Gross Vehicle Weight Rating (GVWR) condition, for an initial speed of 60 mph, from 355 feet to 250 feet for "normal duty" truck tractors ("normal duty" truck tractors are two- or three-axle truck tractors with a GVWR of 70,000 pounds or less, and truck tractors with four or more axles and a GVWR of 85,000 pounds or less; these are the type of tractors examined in this report). For all truck tractors, maximum allowable stopping distance in the unloaded condition, for an initial speed of 60 mph, was reduced from 335 feet to 235 feet.

FMVSS No. 121 also contains maximum allowable stopping distances for vehicles that cannot attain a speed of 60 mph in two miles of driving on a flat, level roadway. If a vehicle cannot attain a speed of 60 mph, it is tested to ensure that it can meet maximum permitted stopping distance requirement from an initial speed that is four to eight mph less than the maximum speed that is attainable.

On September 10, 2009, NHTSA received a petition for reconsideration of the July 27, 2009 final rule from the Truck Manufacturers Association (TMA). In this petition, TMA states that NHTSA "did not conduct any testing at reduced speeds... [o]nly tests from an initial speed of 60 mph were conducted."[7] Also, TMA states that "the rulemaking record does not include any data to validate the equation used to derive the reduced speed stopping distance requirements in the final rule."[8]

The objective of this research was to obtain data on the stopping performance of one truck tractor-semitrailer combination vehicle from a range of initial speeds. The truck tractor tested was a 1991 Volvo 6x4 tractor. For the loaded condition testing, this truck tractor was towing the Transportation Research Center's (TRC's) 28 foot long, unbraked control trailer (loaded with the appropriate weights). Vehicle testing was performed in accordance with the Office of Vehicle Safety Compliance Laboratory Test Procedure No. TP-121V-04.

Since only one truck tractor was tested, a decision was made to modify its loading from the normal FMVSS No. 121 Loaded-to-GVWR condition. The loading was changed to a value such that the 60 mph stopping distance specified in FMVSS No. 121 was just achieved (the Modified Gross Vehicle Weight Rating (MGVWR) loading). It is the authors' belief that by loading this vehicle so as to just achieve the 60 mph stopping distance specified, the test results would provide greater insight into the appropriateness of stopping distance values from other initial speeds that are in FMVSS No. 121. As per FMVSS No. 121, this vehicle was also tested at its Lightly Loaded Vehicle Weight (LLVW).

Maximum permitted stopping distance according to FMVSS No. 121 for the GVWR loading condition matches average measured corrected stopping distance for the MGVWR loading condition for an initial speed of 60 mph. This is by design and is the criteria used to determine the MGVWR loading condition.

For the MGVWR loading condition, as initial speed decreased from 60 mph, average measured corrected stopping distance drops faster than maximum permitted stopping distance until an initial speed of 35 mph is reached. The MGVWR vehicle had the largest margin of compliance at an initial speed of 35 mph. As

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[7] US Department of Transportation Docket Document NHTSA-2009-0083-0005, posted 9/17/2009

[8] Ibid

initial speed decreased from 35 mph, maximum permitted stopping distance drops faster than average measured corrected stopping distance. The MGVWR vehicle had a negative margin of compliance at an initial speed of 20 mph.

Maximum permitted stopping distance according to FMVSS No. 121 for the LLVW vehicle is greater than average measured corrected stopping distance for all initial speeds. As initial speed decreased from 60 mph, average measured corrected stopping distance drops at the same rate as maximum permitted stopping distance until an initial speed of 35 mph is reached. The LLVW vehicle had a fairly constant (between 22.0 and 24.8 percent) margin of compliance for initial speeds from 60 to 35 mph. As initial speed decreased from 35 mph, maximum permitted stopping distance drops faster than average measured corrected stopping distance. The LLVW vehicle had its smallest (though still positive) margin of compliance at an initial speed of 20 mph.

Deceleration rise time is longer for the MGVWR loading condition than it is for the LLVW vehicle. It was expected that deceleration rise time would be longer for the MGVWR loading than for the LLVW vehicle since less air pressure is required to achieve maximum deceleration for the LLVW vehicle. The deceleration rise time for the MGVWR loading decreased with increasing initial speed. For the LLVW loading, deceleration rise time did not vary systematically with initial speed.

Average MGVWR and LLVW deceleration rise times, 0.43 and 0.30 seconds, respectively, are both less than the 0.45 second rise time that was used to calculate maximum permitted stopping distances in FMVSS No. 121. Assuming a 0.45 second deceleration rise is, therefore, conservative. This will tend to make it easier for vehicles to meet the FMVSS No. 121 requirements.

Actual measured steady state deceleration is greater than FMVSS No. 121 assumed deceleration for the MGVWR loading condition for all initial speeds. This is surprising since actual measured corrected stopping distance equals the maximum permitted stopping distance at an initial speed of 60 mph and exceeds maximum permitted stopping distance at an initial speed of 20 mph. This indicates possible discrepancies between the idealized deceleration shape used to calculate the FMVSS No. 121 values and the actual deceleration shape.

Actual measured steady state deceleration is substantially greater than FMVSS No. 121 assumed deceleration for the LLVW loading condition for all initial speeds. This is as expected since actual measured corrected stopping distance is always less than the maximum permitted stopping distance for all initial speeds for the LLVW loading. However, in violation of the FMVSS No. 121 assumptions, there is a rapid decrease of steady state deceleration with initial speed for initial speeds below 35 mph.

Based in the issues above, the authors decided to further examine steady state deceleration. The equation FMVSS No. 121 uses to calculate maximum permitted stopping distances for initial speeds below 60 mph contains four parameters. If values for any three of these parameters are specified, then the corresponding value of the fourth parameter can be calculated. Therefore, the authors decided to specify the experimentally measured values of Total Stopping Distance, Vehicle Initial Speed, and Deceleration Rise Time and calculate the corresponding Steady State Vehicle Deceleration.

Measured steady state decelerations, as determined by numerically differentiating the speed channel and then averaging the resulting deceleration channel from the completion of the deceleration rise time until the end of stop time, are consistently higher than the steady state decelerations calculated using the FMVSS No. 121 equation. The magnitude of the differences increases with decreasing initial speed. The reasons for the differences between the two steady state decelerations, one determined by numerically differentiating the speed channel and then averaging the resulting deceleration channel and the other determined by calculation from the FMVSS No. 121 equation, are not known. Also, it is not known which of these methods provides the best estimate for steady state deceleration.

In terms of the overall goal of this research, it probably does not matter which estimate of steady state deceleration is best. At an initial speed of 20 mph, measured average corrected stopping distance for the MGVWR loading exceeded the maximum stopping distance permitted by FMVSS No. 121.

Appendix A: 1991 Volvo 6x4 Truck Tractor Data

TEST VEHICLE INFORMATION: Note: Many characteristics are only available from Manufacturer provided information.

Year/Make/Model/Body Type 1991 White GMC (Made by Volvo)

VIN: 4VIWDBJH5NN645138

TRC/NHTSA NO.: TRC 162 Build Date: June 1991

ENGINE DATA: Type: Cummins, model # CUM91 N14-460E 460

TRANSMISSION: 18 speed x manual ___ automatic ___ overdrive

AXLE/DRIVE CONFIGURATION: 6 x 4

INITIAL ODOMETER READING: 65,471 miles.

OPTIONS:______________________________

WHEELBASE (in.): 189.5

AERODYNAMIC TREATMENTS: Yes x No ______

BRAKES:

Axles:	Type[1]	Size	Make	Lining (Edge Code)
1	disc	16.54 x 1.77	Meritor	N/A
2	s-cam drum	16.5 x 7	Meritor	NA212FF47030
3	s-cam drum	16.5 x 7	Meritor	NA212FF47030

[1] Cam, disc, wedge, etc.

BRAKE DRUM/ROTOR:

Axles:	Type[2]	Make	Dust Shields Installed?
1	rotor	Meritor	No
2	drum	Rockwell	No
3	drum	Rockwell	No

[2] Cast or composite drum, vented or non-vented rotor, etc.

ACTUATION DETAILS:

AIR CHAMBERS			SLACK ADJUSTERS	
Axles:	Make	Type[3]	Length or Wedge angle	Cam Rotation[4]
1	Meritor	20	5.5"	N/A
2	Meritor	30	5.5"	opposite
3	Meritor	30	5.5"	opposite

[3] Size and diaphragm or piston

[4] Same or opposite to forward wheel rotation

TIRES

Axles:	Pressure (psi)	Size	Make	Model	Static Loaded Radius: Measured	Static Loaded Radius: Databook
1	105	275/80R24.5	Michelin	X2A-1	N/A	N/A
2	100	275/80R24.5	Michelin	XDA-3	N/A	N/A
3	100	275/80R24.5	Michelin	XDA-3	N/A	N/A

REMARKS:

ABS: Rear axle disabled

Mfr: Wabco Model: unknown Configuration: 4S/4M

FRONT SUSPENSION:

Type: leaf spring Make: Rockwell Model: 2FF961HX2-FF961

REAR SUSPENSION:

Type: leaf spring Make: Rockwell Model: RT40-145

Rear Axle Spread, (in): 96"

FIFTH WHEEL:

Fifth Wheel Height Relative to Ground, mm (in): 45"

Fifth Wheel Position, mm (in)[5]: 24.5"

[5] Relative to rear axle(s) centerline

Appendix B: 1977 Ravens Flatbed Semitrailer Data

TEST VEHICLE INFORMATION:

MANUFACTURE DATE: August 1977
MAKE AND MODEL: Ravens, modified flatbed trailer

VIN: 771207

TRC IDENTIFICATION: FMVSS 121 Control Trailer

AXLE CONFIGURATION AND SUSPENSION: Single Axle, air suspension

WHEELBASE (in.): 259 (center of axle to kingpin)

BED STYLE AND LENGTH: Flatbed, 28'

BRAKES: Not Equipped

TIRES

	Pressure (psi)	Size	Make
Axles: 1	100	11R22.5	Ameri-Harvest

REMARKS:

Originally manufactured as a 48' tandem spread axle aluminum trailer. Modified in-house to reduce deck length to FMVSS requirements, one axle retained with brakes removed, and adjustable ballast retention cage installed.

DOT HS 811 488
June 2011

U.S. Department
of Transportation

National Highway
Traffic Safety
Administration

NHTSA
www.nhtsa.gov

VEHICLE STOPPING DISTANCE AND TIME

University of Pennsylvania School of Engineering & Applied Science

Available online at:

www.seas.upenn.edu/~ese302/lab-content/STOPPING_DISTANCE_DOC.pdf

Vehicle Stopping Distance and Time

Highway traffic and safety engineers have some general guidelines they have developed over the years and hold now as standards. As an example, if a street surface is dry, the average driver can safely decelerate an automobile or light truck with reasonably good tires at the rate of about 15 feet per second (fps). That is, a driver can slow down at this rate without anticipated probability that control of the vehicle will be lost in the process.

The measure of velocity is distance divided by time (fps), stated as feet per second. The measure of acceleration (or deceleration in this case) is feet per second per second. That assumes a reasonably good co-efficient of friction of about .75; better is .8 or higher while conditions or tire quality might yield a worse factor of .7 or lower.

No matter the velocity, that velocity is reduced 15 fps every second. If the initial velocity is 60 mph, 88 fps, after 1 second elapsed, the vehicle velocity would be 73 fps, after 2 seconds it would be 58 fps decreasing progressively thereafter. For the true mathematical perfectionist (one who carries PI to 1000 decimal places), it would have been technically correct to indicated the formula is 'fpsps' rather than 'fps', but far less understandable to most drivers. Since at speeds of 200 mph or less, the difference from one method to the other is in thousanths of seconds, our calculations in these examples are based on the simple fps calculations.

Given the previous set of conditions, it would mean that a driver could stop the described vehicle in a total of 6.87 seconds (including a 1 second delay for driver reaction) and your total stopping distance would be 302.28 feet, slightly more than a football field in length!

Virtually all current production vehicles' published road braking performance tests indicate stopping distances from 60 mph that are typically 120 to 140 feet, slightly less than half of the projected safety distances. While the figures are probably achievable, they are not realistic and certainly not average; they tend to be misleading and to those that actually read them, they create a false sense of security.

By increasing braking skills, drivers can significantly reduce both the time it takes to stop and the distance taken to stop a vehicle. Under closed course conditions, professional drivers frequently achieve 1g deceleration (32 fpsps) or better. A reasonably skilled driver could easily get deceleration rates in excess of 20 fpsps without loss of control. It is very possible and probable that with some effort, the driver that attempts to be aware of braking safety procedures and practices can and should get much better braking (safely) than the guidelines used nationally, approaching that of the professionally driver published performance tests.

To determine how long it will take a driver to stop a vehicle, assuming a constant rate of deceleration, the process is to divide the initial velocity (in fps) by the rate of deceleration. You may want to use our **Vehicle Stopping Distance Calculator** to do actual model calculations.

60 MPH = 88 fps. (fps=1.467 * MPH). If the vehicle deceleration rate is 20 fpsps (rather than the previously calculated 15 fps), then stopping time = 88/20 = 4.4 seconds. Since there is a 1 second delay (driver reaction time) in hitting your bral.es (both recognition and reaction time is often 2 seconds), the total time to stop is 5.4 seconds to 6.4 seconds.

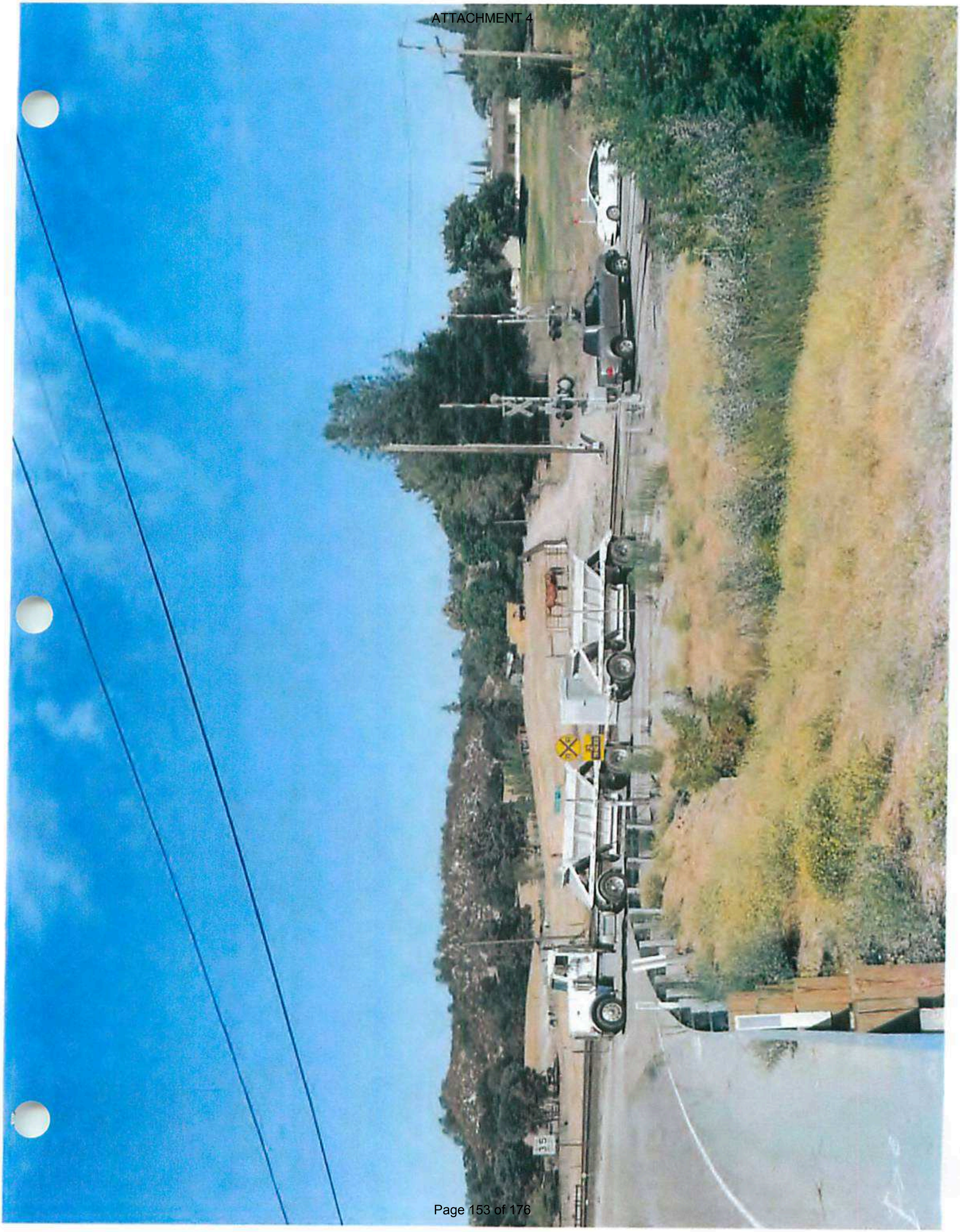
To determine how far the vehicle will travel while braking, use the formula of 1/2 the initial velocity multiplied by the time required to stop. In this case, this works out to be .5 * 88 * 4.4 = 193.6 feet, plus a reaction time of either 88 feet for a second delay in reaction time, or 176 feet for two seconds reaction time. That yields 281.6 feet or 369.6 when added to the base stopping distance of 193.6 feet. If the driver is very responsive and takes only a half a second to react, the distance is reduced to 237.6 feet. Notice that the reaction time is a huge factor since it is at initial velocity.

Based on pure math, it is evident that there is a very large difference in the reported performance tests and reality. Assuming a deceleration rate of 32 fpsps (1g), calculations indicate a braking stop time of 2.75 seconds (88/32). Distance traveled now is calculated to be 121 feet, which is for all practical purposed, the published performance figures, excluding reaction times.

The intelligent driver will error on the safe side and leave room fcr reaction time and less than perfect conditions. That driver will also hone the braking skills to give more of a margin of safety. That margin can save lives. Pay attention to the need to react quickly.

Braking/Stopping Distances

10	14.7	5	22	27
15	22	11	33	44
20	29.3	19	44	63
25	36	30	55	85
30	44	43	66	109
35	51.3	59	77	136
40	58.7	76	88	164
45	66	97	99	196
50	73.3	119	110	229
55	80.7	144	121	265
60	88	172	132	304
65	95.3	202	143	345
70	102.7	234	154	388
75	110	268	165	433
80	117.3	305	176	481
85	124.7	345	187	532
90	132	386	198	584



SESPE
CONSULTING, INC.
468 Poli Street, Suite 2E• Ventura, California 93001

MEMORANDUM

Date: October 28, 2011

To: JAH, JLK

From: SDC

Re: Oster Quarry Market and Haul Truck Emissions

The aggregate market in the region of the proposed Oster Quarry ("Project") was researched in order to evaluate how operation of the Project would affect supply and demand for aggregate in the region. The Oster Quarry Target Market Area is shown in Figure 1 and consists mainly of U.S. Highway 101 corridor between the City of San Luis Obispo and the northern County line.

Figure 1: Oster Quarry Market Area

Note: Green circles represent mines in 2009 Mine Database from Office of Mine Reclamation.

Supply

The State of California Geological Survey (CGS) identifies mineral resources and forecasts future demand for aggregate in "mineral land classification" reports. Mineral land classification reports are the main resources used by planners and decision makers to manage land-use within their region. Special Report 162 (SR 162) describes aggregate resources availability and demand within the San Luis Obispo-Santa Barbara Production-Consumption (P-C) Region (CGS, 1989). A P-C region is one or more aggregate production districts (a group of producing aggregate mines) and the market area they serve.

Sectors are areas that have been classified as Mineral Resource Zone 2 (MRZ-2) for Portland cement concrete (PCC) grade aggregate and have been designated as a Regionally Significant Construction Aggregate Resource Area by the State Mining and Geology Board (SMGB). The Project is located in Sector C – La Panza Granitics. Notable quotations from SR 162 include:

> "The San Luis Obispo – Santa Barbara Production-Consumption (P-C) Region covers approximately 2,062 square miles and includes the urbanizing portions of San Luis Obispo and Santa Barbara counties. In any urbanizing region it is important that land-use decisions be made with full recognition of the local natural resources. Mineral resources including construction aggregate are limited within a given region. This is especially true of Portland cement concrete (PCC) aggregate resources, an indispensable, high-grade construction aggregate which is costly to transport." (Page vii, SR 162.)
>
> "The boundaries of the San Luis Obispo – Santa Barbara P-C Region were defined to include all areas within the two counties where PCC-grade aggregate is produced (the mining sites), and the market area where their product is consumed (the urban centers within the counties).... The P-C Region is therefore as near to a closed system as possible, with aggregate production nearly equal to aggregate consumption within it." (Page vii, SR 162.)
>
> "Other than the large areas classified as MRZ-2 for Portland cement concrete (especially the La Panza granitics and the alluvium of the Santa Maria River), there are few promising sources for future PCC-grade aggregate in the region...." (Page 31, SR 162.)

Table 1 presents conditions that existed in 1987 as reported in SR 162 as well as subsequent estimates of total permitted reserves that were published in Map Sheet 52 – Aggregate Availability in California (MS52, published 2002 and revised 2006).

Table 1: Aggregate Sectors and Characteristics

Sector (SR 162, 1989)	Total Acres	Acres Permitted for PCC-Grade	PCC-Grade Permitted Reserves (million tons)	PCC-Grade Resources (million tons)
A – Salinas River	2,014	0	0	58 (sand)
B – Navajo Creek	135	135	*	* (sand and gravel)
C – La PanzaGranitics	12,239	212	*	6,119 (crushed stone)
D – Santa Maria River	17,758	409	*	4,528 (sand and gravel)
E–SisquocRiver	3,742	582	*	470
Total (SR 162, 1989)	35,888	1,338	107	11,175 **
Total (MS52, 2002)			93	
Total (MS52, 2006)			77	
* Proprietary data.	** Does not include resources in Sector B.			

Table 1 shows that permitted aggregate reserves are dwindling. This is because new resources are not being permitted at a sufficient rate to offset consumption. Accordingly, the CGS statement about the importance of the La Panza granitics in meeting future demand in the region is every bit as valid today as it was in 1989.

Regional Demand

Demand for aggregate is inelastic, which means that neither the supply nor the price of aggregate influences demand for the commodity. In fact, aggregate demand is most closely related to population growth.

> "The assumption that each person will use a certain amount of aggregate every year is a simplification of actual usage patterns, but overall, an increase in the population leads to the use of more aggregate. Over a long enough period, perhaps 20 years or longer, the random impacts of major public construction projects and economic recessions tend to be smoothed out and consumption trends become similar to historic per capita consumption rates. Per capita consumption is a commonly used and accepted national, state, and regional measure for purposes of forecasting." (Page 5, Map Sheet 52.)

Accordingly, aggregate will be consumed at a given rate with or without the Project. Approval of the Project will not affect demand for aggregate but may affect the distance that aggregates travel within the region. Project aggregate will replace existing materials hauled from farther distances and supply new demand for aggregate that occurs proportionally with growth in population. This basis for analysis is supported by Dr. Peter Berck's Working Paper No. 994 – A Note on the Environmental Costs of Aggregate (Department of Agricultural and Resource Economics and Policy, Division of Agriculture and Natural Resources, University of California at Berkeley, January 2005). According to Dr. Berck:

> "The opening of a new quarry for aggregates will change the pattern of transportation of aggregates in the area served by the quarry. In this note, we will show that, so long as aggregate producers are cost minimizing, the new pattern of transportation requires less truck transport than the pattern of transportation that existed before the opening of the new quarry. Since the costs of providing aggregates falls, it is reasonable to assume that the price of delivered aggregates also will fall. This note also shows that the demand expansion effect is of very small magnitude. Since the demand increase from a new quarry is quite small, the dominant effect is that the quarries are on average closer to the users of aggregates and, as a result, the truck mileage for aggregate hauling decreases. To summarize the effects of a new quarry project:
>
> a) The project in itself will not significantly increase the demand for construction materials in the region through market forces, which include the downward pressure on pricing.
> b) Truck traffic (i.e. vehicle miles traveled) in the region will not increase and may decrease as a result of the project."

SR 162 reports the long-term average annual per capita aggregate consumption rate to be 6.0 tons per person per year for the period between 1960 and 1987. The California Department of Finance (DoF) projects population for each county in the State. The sum of DoF projections for San Luis Obispo and Santa Barbara counties is multiplied by the average per capita consumption to estimate demand. It is noteworthy that the method of estimating demand does not depend upon the presence of permitted reserves or resources. This is because demand for aggregate is inelastic. Increased population corresponds to increased construction and demand for aggregate. Addition of new aggregate resources to the market does not result in increased use of aggregate (Berck, 2005).

CGS published in 2002 and revised in 2006, the Map Sheet 52 and the associated report entitled "Aggregate Availability in California." The purpose of Map Sheet 52 is to assess the 50-year demand and supply of aggregate resources within the 31 Production-Consumption (P-C) Regions of California. In California as whole, and the San Luis Obispo – Santa Barbara P-C Region in particular, 50-year aggregate demand exceeds the permitted supply. As of 2006, the 50-year aggregate demand in the San Luis Obispo – Santa Barbara P-C Region was 243 million tons and the permitted aggregate reserves were 77 million tons (32% of demand). Figure 2 presents a portion of the most recent Map Sheet 52 showing the Project location.

Of the population in the P-C Region, Santa Barbara County constitutes sixty percent (60%) while San Luis Obispo County constitutes the remaining forty percent (40%). Accordingly, one would expect a similar split in the amount of aggregate consumed within the two counties. Review of Table 1 shows that permitted acreage in Sectors D and E, which are within or on the border of Santa Barbara County, exceeds the permitted acreage in Sectors A through C, which are located fully within San Luis Obispo County, by more than the 60/40 split.

As shown in Figure 2, the area of the P-C Region in which the Project is located contains several small mines. The small triangles in the figure represent mines producing less than 500,000 tons per year and the larger triangles are mines that produce less than 2,000,000 tons per year. The Project is well located to serve the urban centers of San Luis Obispo and Atascadero where future growth will be focused as discussed later in this memo.

Figure 2: Portion of Map Sheet 52 Showing Project Location

The Project will make available new reserves and produce materials that will substitute for materials that have historically been produced elsewhere and imported from father away. Recent California Department of Finance population estimates and the 6.0 ton per year per capita consumption rate reported in SR 162 are used to estimate future demand for aggregates in Table 2.

Table 2: Regional Aggregate Market

Date	Population In SLO – SB P-C Region	Estimated Annual Demand (million tons)	PCC-Grade Permitted Aggregate Resources (million tons)	Fifty Year Demand All Grades (million tons)
1987	522,000	3.1	107	206
2001	653,788	3.9	93	99
2006	675,985	4.1	77	243
2011	695,906	4.2	67	240
2015	711,719	4.3	ND	ND
2020	734,246	4.4	ND	ND
2061	916,888	5.5	ND	ND

Notes:

- Population estimates are based upon the DoF Interim County Projections for 2010, 2015, and 2020 Benchmarked on Census 2010. Growth rates for decades after 2020 were inferred from P-1 Table 1 County by Decade that was previously published by DoF based upon the 2000 census.
- Permitted resources for 1989, 2001, and 2006 are copied from CGS documents (i.e. SR 162, MS 52).
- 2011 permitted resources are estimated assuming decrease consistent with average per capita consumption of 6.0 tons/year between 2006 and 2011 (approx. 25 MMtons) with 15 MMtons added by recent approval of the Diamond Rock Mine in eastern Santa Barbara County even though most of the material from this location is likely to be used in a neighboring region. Demand is lower in 2011 than 2006 due to the updated DoF population forecast.
- Future permitted resource and aggregate demand amounts are speculative and therefore have not been determined (ND).

The Project is proposing peak annual production of 0.5 million tons per year (MMtpy) which, if produced, constitutes slightly less than twelve percent (12%) of the market in the San Luis Obispo - Santa Barbara PC Region in the Year 2011. Aggregate produced by the Project will displace materials produced elsewhere and make available additional capacity within the Region to achieve the increased annual production rates that are necessary to satisfy future growth.

As population grows the amount of aggregates that is consumed grows proportionally. The effects of this growth are incremental above the existing physical setting which already includes the regional effects of trucks delivering aggregate. It is estimated that within the next 50 years, the market in this P-C Region will grow by approximately 1.28 million tons per year (MMtpy) from 4.2 MMtpy in 2011 to 5.4 MMtpy in 2060. By itself, the Project will not satisfy all future growth in regional aggregate demand which surpasses 0.5 MMtpy in approximately 2031.

Two possible methods of estimating the Project's share of future growth:

1. The Project maximum annual rate represents a fraction of the market and the Project is responsible for that same fraction of the growth. Initially, the Project would be 12% of the market and by 2060 the Project would be approximately 9% of the market. The full increment of the Project would be reached when the Project's share of future growth equals the maximum annual rate. This condition would not be reached for several hundred years given the rates of growth forecasted by DoF.

2. The Project is responsible for 100% of growth that occurs up to the time when the maximum annual rate is exceeded by forecasted growth in demand (i.e. 0.5 MMtpy of growth will be reached in 2031).

In either case, the effect of the Project phases in over a period of time. The more conservative approach would be Number 2 because the Project phases in more quickly. Figure 3 presents approach Number 2 which is selected for use in estimating effects of the Project on transportation emissions in the region.

Figure 3: Forecasted Growth in Regional Aggregate Demand

Distance to Market

The effect of a new quarry project that is located close to the market is to reduce aggregate trucking vehicle miles traveled (VMT). In this case, the Project is within the North County Area which is expected to experience the most intense growth as described in the San Luis Obispo Council of Governments (SLOCOG) Preliminary Sustainable Community Strategy (PSCS). The PSCS was prepared by SLOCOG as part of the 2010 Regional Transportation Plan (RTP) to initiate land use and transportation planning methods that will be required in the next RTP cycle under Senate Bill 375 (2008). "Between 1993 and 2006 the North County saw the greatest increase in housing construction and population growth of all areas in the county, and is projected to grow more than any other part of the county during the next 25 years." (Page 1-11, PSCS). Thus, the Project will provide access to additional aggregate resources in an area where they will be used and is expected to reduce VMT.

Effect of Regulations on Haul Truck Emissions

Haul truck air pollutant emissions are reduced in the future by regulations that are currently in effect. The attached spreadsheet calculates annual VMT using the methodology described above and the corresponding mass of air pollutant emissions using EMFAC2011 derived emissions factors for the fleet operating within San Luis Obispo County. Vehicle type "T7 – Tractor Construction" annual emissions are divided by the VMT to determine the emissions factor in units of pounds per VMT (lb/VMT) for each pollutant-year combination shown on Page 3 of the spreadsheet.

In the time between 2011 and 2031 the market is projected to grow by 0.5 MMtpy. This amount is also equal to the proposed throughput for the Project. EMFAC2011 reports emissions through 2035, after which time emissions are assumed to remain constant. As the market grows, diesel truck emissions control regulations will be phased in by CARB. Accordingly, NOx emissions fluctuate and the maximum year of NOx emissions is predicted to occur in 2020 while other pollutant maximums occur in 2031.

Conclusion

The existing physical setting (i.e. CEQA baseline) includes regional aggregate consumption of approximately 4.2 MMtpy. The Project would contribute 0.5 MMtpy to the regional market which initially substitutes for materials being produced elsewhere and then satisfies an amount of regional growth in aggregate consumption up to Baseline plus the Project (i.e. 4.7 MMtpy) which occurs in 2031. Using the methodology described above, the maximum regional effect of NOx emissions from Project haul trucks is 2.98 tons per year and occurs in 2020.

Haul Truck Emissions
and Market Share Assessment

Oster Quarry

Year	P-C Region Population	P-C Region Aggregate Consumption / Demand (tons)	P-C Region 2012+ Cumulative Consumption / Demand (tons)	w/ Project P-C Region (VMT @ 25 mi./trip)	Market Growth Above Baseline (tons)	Market Growth Above Baseline (VMT)
2011	699,005	4,194,033	-	8,388,066	-	-
2012	702,118	4,212,711	4,212,711	8,425,422	18,678	37,356
2013	705,245	4,231,472	8,444,183	8,462,944	37,439	74,879
2014	708,388	4,250,317	12,694,500	8,500,634	56,284	112,569
2015	711,719	4,270,316	16,964,816	8,540,631	76,283	152,566
2016	716,100	4,296,599	21,261,415	8,593,198	102,566	205,132
2017	720,507	4,323,044	25,584,459	8,646,088	129,011	258,023
2018	724,942	4,349,652	29,934,111	8,699,304	155,619	311,239
2019	729,404	4,376,424	34,310,535	8,752,848	182,391	364,782
2020	734,246	4,405,477	38,716,011	8,810,953	211,444	422,887
2021	738,235	4,429,410	43,145,422	8,858,821	235,378	470,755
2022	742,246	4,453,474	47,598,896	8,906,949	259,442	518,883
2023	746,278	4,477,669	52,076,565	8,955,338	283,636	567,273
2024	750,333	4,501,995	56,578,561	9,003,991	307,962	615,925
2025	754,409	4,526,454	61,105,014	9,052,907	332,421	664,842
2026	758,507	4,551,045	65,656,059	9,102,090	357,012	714,024
2027	762,628	4,575,770	70,231,829	9,151,539	381,737	763,474
2028	766,771	4,600,629	74,832,458	9,201,257	406,596	813,192
2029	770,937	4,625,623	79,458,080	9,251,246	431,590	863,180
2030	775,125	4,650,753	84,108,833	9,301,506	456,720	913,440
2031	779,337	4,676,019	88,784,853	9,352,039	481,987	963,973
2032	783,571	4,701,423	93,486,276	9,402,846	507,390	1,014,781
2033	787,827	4,726,965	98,213,241	9,453,930	532,932	1,065,864
2034	792,108	4,752,645	102,965,886	9,505,291	558,613	1,117,225
2035	796,411	4,778,465	107,744,351	9,556,931	584,433	1,168,865
2036	800,738	4,804,426	112,548,777	9,608,851	610,393	1,220,786
2037	805,088	4,830,527	117,379,304	9,661,054	636,494	1,272,989
2038	809,462	4,856,770	122,236,074	9,713,540	662,737	1,325,475
2039	813,859	4,883,156	127,119,230	9,766,312	689,123	1,378,246
2040	818,281	4,909,685	132,028,915	9,819,370	715,652	1,431,304
2041	822,726	4,936,358	136,965,274	9,872,716	742,325	1,484,651
2042	827,196	4,963,176	141,928,450	9,926,353	769,144	1,538,287
2043	831,690	4,990,140	146,918,590	9,980,280	796,107	1,592,215
2044	836,208	5,017,250	151,935,841	10,034,501	823,218	1,646,435
2045	840,751	5,044,508	156,980,349	10,089,016	850,475	1,700,950
2046	845,319	5,071,914	162,052,262	10,143,827	877,881	1,755,762
2047	849,911	5,099,468	167,151,731	10,198,937	905,435	1,810,871
2048	854,529	5,127,173	172,278,903	10,254,345	933,140	1,866,279
2049	859,171	5,155,027	177,433,931	10,310,055	960,994	1,921,989
2050	863,839	5,183,033	182,616,964	10,366,067	989,001	1,978,001
2051	868,532	5,211,192	187,828,156	10,422,383	1,017,159	2,034,318
2052	873,250	5,239,503	193,067,658	10,479,006	1,045,470	2,090,940
2053	877,995	5,267,968	198,335,626	10,535,936	1,073,935	2,147,870
2054	882,765	5,296,588	203,632,214	10,593,175	1,102,555	2,205,109
2055	887,560	5,325,363	208,957,576	10,650,725	1,131,330	2,262,660
2056	892,382	5,354,294	214,311,871	10,708,588	1,160,261	2,320,523
2057	897,230	5,383,383	219,695,253	10,766,766	1,189,350	2,378,700
2058	902,105	5,412,630	225,107,883	10,825,259	1,218,597	2,437,193
2059	907,006	5,442,035	230,549,918	10,884,070	1,248,002	2,496,005
2060	911,933	5,471,600	236,021,519	10,943,201	1,277,568	2,555,135
2061	916,888	5,501,326	241,522,845	11,002,653	1,307,294	2,614,587
2062	921,869	5,531,214	247,054,059	11,062,428	1,337,181	2,674,362

Haul Truck Emissions
and Market Share Assessment

Oster Quarry

Year	Project VMT	Project ROG (Tons)	Project CO (Tons)	Project NOx (Tons)	Project CO2 (Metric Tons)	Project PM10 (Tons)	Project SOx (Tons)
2011	-	-	-	-	-	-	-
2012	37,356	0.04	0.16	0.60	66	0.03	0.00
2013	74,879	0.07	0.30	1.13	133	0.05	0.00
2014	112,569	0.09	0.40	1.59	200	0.07	0.00
2015	152,566	0.08	0.38	1.99	273	0.06	0.00
2016	205,132	0.09	0.43	2.35	366	0.06	0.00
2017	258,023	0.08	0.37	2.50	462	0.06	0.00
2018	311,239	0.09	0.43	2.70	557	0.06	0.01
2019	364,782	0.11	0.52	2.84	652	0.07	0.01
2020	422,887	0.13	0.60	2.98	755	0.08	0.01
2021	470,755	0.14	0.69	2.61	841	0.09	0.01
2022	518,883	0.17	0.80	2.09	926	0.10	0.01
2023	567,273	0.19	0.93	1.74	1,013	0.11	0.01
2024	615,925	0.20	0.96	1.67	1,098	0.12	0.01
2025	664,842	0.21	1.04	1.81	1,185	0.13	0.01
2026	714,024	0.23	1.12	1.95	1,273	0.14	0.01
2027	763,474	0.25	1.20	2.09	1,361	0.15	0.01
2028	813,192	0.26	1.28	2.23	1,449	0.16	0.02
2029	863,180	0.28	1.35	2.36	1,538	0.16	0.02
2030	913,440	0.29	1.43	2.49	1,628	0.17	0.02
2031	963,973	0.31	1.51	2.63	1,718	0.18	0.02
2032	1,000,000	0.32	1.56	2.72	1,782	0.19	0.02
2033	1,000,000	0.32	1.56	2.72	1,782	0.19	0.02
2034	1,000,000	0.32	1.56	2.72	1,782	0.19	0.02
2035	1,000,000	0.32	1.56	2.72	1,782	0.19	0.02
Maximums	**1,000,000**	**0.32**	**1.56**	**2.98**	**1,782**	**0.19**	**0.02**

In the time between 2011 and 2031 the market is projected to grow by 500,000 tons per year. This amount is also equal to the proposed throughput for the Project. EMFAC2011 reports emissions through 2035 after which time emissions are assumed to remain constant. As the market grows, diesel truck emissions control regulations will be phased in by CARB. Accordingly, NOx emissions fluctuate and the maximum year of NOx emissions is predicted to occur in 2020 while other pollutant maximums occur in 2031 when the market growth is 500,000 tons per year.

Parameters:		
	6.0	tons per capita
	240	MMtons, 50-Year Total Demand in P-C Region
	25	tons per truck
	25	miles one-way (historical and Project)

Year	EMFAC ROG (lb/VMT)	EMFAC CO (lb/VMT)	EMFAC NOx (lb/VMT)	EMFAC CO2 (lb/VMT)	EFMAC PM10 (lb/VMT)	EMFAC SOx (lb/VMT)	EFMAC Fuel Efficiency (MPG)
2011	0.0019	0.0086	0.0323	3.90	0.0014	0.00004	5.7
2012	0.0018	0.0079	0.0302	3.91	0.0013	0.00004	5.7
2013	0.0016	0.0071	0.0282	3.92	0.0012	0.00004	5.7
2014	0.0011	0.0050	0.0262	3.94	0.0008	0.00004	5.6
2015	0.0009	0.0042	0.0229	3.94	0.0006	0.00004	5.6
2016	0.0006	0.0029	0.0194	3.95	0.0004	0.00004	5.6
2017	0.0006	0.0028	0.0173	3.94	0.0004	0.00004	5.6
2018	0.0006	0.0028	0.0156	3.94	0.0004	0.00004	5.6
2019	0.0006	0.0028	0.0141	3.94	0.0004	0.00004	5.6
2020	0.0006	0.0029	0.0111	3.94	0.0004	0.00004	5.6
2021	0.0006	0.0031	0.0081	3.94	0.0004	0.00004	5.6
2022	0.0007	0.0033	0.0062	3.94	0.0004	0.00004	5.6
2023	0.0006	0.0031	0.0054	3.93	0.0004	0.00004	5.7
2024	0.0006	0.0031	0.0054	3.93	0.0004	0.00004	5.7
2025	0.0006	0.0031	0.0055	3.93	0.0004	0.00004	5.7
2026	0.0006	0.0031	0.0055	3.93	0.0004	0.00004	5.7
2027	0.0006	0.0031	0.0055	3.93	0.0004	0.00004	5.7
2028	0.0006	0.0031	0.0055	3.93	0.0004	0.00004	5.7
2029	0.0006	0.0031	0.0055	3.93	0.0004	0.00004	5.7
2030	0.0006	0.0031	0.0054	3.93	0.0004	0.00004	5.7
2031	0.0006	0.0031	0.0054	3.93	0.0004	0.00004	5.7
2032	0.0006	0.0031	0.0054	3.93	0.0004	0.00004	5.7
2033	0.0006	0.0031	0.0054	3.93	0.0004	0.00004	5.7
2034	0.0006	0.0031	0.0054	3.93	0.0004	0.00004	5.7
2035	0.0006	0.0031	0.0054	3.93	0.0004	0.00004	5.7

The emissions factors are derived from CARB EMFAC2011 using the method described in CalEEMod User Manual, Appendix A. EMFAC was run for Kern County calculated by sub-area and in annual mode for all model years with output settings for Mysql. Daily emissions (tons per day), vehicle miles traveled (VMT), and fuel use reported by EMFAC2011 were used to calculate the emissions factors.

Project emissions are calculated using the increment in VMT. The Project is not credited for future reductions in fleet emissions that will occur as a result of turnover and regulatory programs even though emissions will descrease as shown for the Facility. Aggregate demand and population forecasts from Special Report 162 (CGS, 1989), Map Sheet 52 (CGS, 2001, rev. 2006), and Department of Finanace population estimates.

Construction Aggregate Supply Limitations
Some Estimates of Economic Impact–November 2011

- Aggregates are low-value, heavy-weight building materials used in construction, including sand, gravel, crushed stone, and recycled concrete. Aggregates are mined and either used as raw material (for example, as foundations) or serve as composite materials in the production of concrete and asphalt. The main end markets for aggregates include private residential construction (34 percent), commercial construction (17 percent), and public infrastructure projects (43 percent, including 26 percent for public highways, streets and transit).

- Aggregates are usually shipped from quarries or production sites close to their end market because transportation is a major element in the cost of delivered aggregates and the cost depends on the distance of the delivery. According to the industry, shipping costs for aggregates can outweigh production costs if the material is trucked more than 20 miles.[1] Permitting new aggregate sites would lead to shorter haul distance to minimize transport/shipping cost.

- According to the California Geological Survey (CGS), California has an estimated 74 billion tons of aggregate resources underlying mineral lands classified by the State Geologist. However, only about six to seven percent have actually been permitted by local agencies for mining activities. Permitting of mining sites is difficult and time consuming due to environmental, land development, and zoning laws, and could take between five and ten years. At the current rate of production, available aggregate supply in some areas in the State could be depleted in a decade.

- According to the California Department of Finance, housing construction activity in California more than doubled between 1996-2005, the longest sustained growth period in recent history; but experienced more than 80 percent decline during 2006-2009 (from 209 to 36 thousand units). Despite a 23 percent rebound in housing construction spending in 2010, overall construction industry in California remains depressed. This has contributed to a significant reduction in both production and value of construction aggregate in recent years.

- According to the CGS, California produced 133.5 million tons (valued at $1.4 billion) of construction sand, gravel, and crushed stone in 2009, compared to 237.3 million tons (valued at $1.9 billion) in 2006, an almost 44 percent drop since 2006. The transportation of 133.5 million tons of construction aggregates generates about 5.3 million truckloads (@ 25 tons per truck), or a total of 10.7 million truck trips a year (including empty trucks returning to the aggregate sites) related to the transportation of construction aggregates in the State.

- According to the Teichert Construction and West Coast Aggregates, Inc. the average hauling distance for aggregates in California may be as high as 50 miles. Truck transportation accounts for about 99 percent of shipping aggregates for 40 miles or less.[2] At an average 50-mile distance, the total aggregate-truck VMT would be 535 million miles per year (10.7 million trucks x 50 miles).

- Let us assume that permitting additional mining facilities would reduce the average hauling distance from 50 to 35 miles statewide. Using an average hauling distance of 35 miles, the total annual aggregate-truck miles of travel would be 375 million miles (10.7 million trucks x 35 miles). The 15-mile shorter hauling distance would reduce aggregate-truck miles of travel by 160 million miles per year (535-375), and annual diesel fuel consumption by 20 million gallons [using California Air Resources Board (CARB) diesel fuel consumption rate of 0.13 gallons per vehicle-mile at 55-60 mph speed].

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[1] Therese Dunphy, "Evening the Playing Field," *Aggregates Manager*, August 2006.
[2] Tina Grady Barbaccia, "Off-highway Transportation," *Aggregates Manager*, July 2006.

- A recent University of California, Berkeley study[3] confirms that the most likely, and dominant, effect of the opening of new sites for the production of construction aggregates would be a reduction in truck miles of travel for hauling aggregates (i.e., new quarry will be located closer to the users to minimize transportation costs), thus a reduction in emissions from trucks.

- Based on the CARB emission factors estimates, and assuming an average 55-60 miles per hour speed, a reduction of 160 million miles of truck travel (or 20 million gallons of diesel fuel consumption) would reduce truck emissions (CO, NOx, PM10, SOx, VOC, and CO2) by about 22,436 tons a year.

- The total transportation cost of aggregates (at $0.10 per ton per mile) shipped 35-miles average distance throughout California would be $936 million (10.7 million trucks x 25 tons x 35 miles x $0.1), and over $1.3 billion if shipped an average distance of 50 miles. The statewide transportation cost savings of reduced hauling distance would amount to $376 million a year (or a 30 percent cost savings).

- The California Department of Transportation (Caltrans) estimates that on average, about $2.5 billion is spent on State and local capital outlay projects each year, and on average, aggregates account for 8-10 percent of total project costs, or about $250 million annually. A 30 percent increase/decrease in shipping cost of aggregates would increase/decrease the total annual project costs by $75 million per year.

- The reduction in aggregate-related truck miles of travel would also reduce traffic congestion and traffic accidents on roads, but these impacts would be difficult to estimate. An additional benefit from truck trip reduction would be reduced pavement deterioration. Caltrans expects to spend about $700 million annually on pavement rehabilitation projects. Assuming trucks account for 60 percent of the pavement damage on the State highways, and aggregate-trucks on average account for 5 percent of all heavy truck travel on the State highways, the trucks shipping aggregates would account for about $20 million of cost savings in the pavement rehabilitation each year.

- Project delays due to lack of aggregate supply in the area, would also result in project cost escalation and reduced user benefits (reduced travel time and accidents) that would have otherwise been generated. A delay of 10 percent of the projects (or $250 million in capital outlay expenditures) for one year would increase the cost of the State and local capital outlay program by $13 million a year (at 5 percent average cost escalation factor).

- Generalizing, and pro rating, the user benefits estimated for the 2008 Interregional Transportation Improvement Program projects, a delay of ten percent of the capital outlay program for one year could also cost California about $97 million in increased roadway congestion and traffic accidents.

In conclusion, the overall picture may indicate that the concerns over the limited supply of construction aggregates may have eased for now due to the severe housing decline and economic slowdown. However, over the long run, with the eventual housing and economic rebound, the supply-demand imbalance will continue for many areas. Meanwhile, for some specific localities and construction projects, the challenge of adequate and cost-effective supply of construction aggregates persists.

[3] Peter Berck, "A Note on the Environmental Costs of Aggregates," *Working Paper No. 994*, Dept. of Agricultural and Resource Economics and Policy, University of California, Berkeley, January 2005.

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UNIVERSITY OF CALIFORNIA AT BERKELEY

WORKING PAPER NO. 994

A NOTE ON THE ENVIRONMENTAL COSTS OF AGGREGATES

by

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January 2005

A Note on the Environmental Costs of Aggregates

by Peter Berck*
January 10, 2005

Abstract:

The opening of a new site for the production of aggregates has both direct and indirect impacts on the environment. The indirect impacts include changes in the environmental costs of hauling aggregates and possible changes in the level of construction activity. In this note, we show that the most likely effect of a new aggregate site is to reduce the truck miles used for aggregate hauling, which is an environmental benefit. We also show that the change in construction activity induced by a new site is likely to be extremely small.

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* Peter Berck is Professor of Agricultural and Resource Economics. I would like to thank Atanu Dey for able research assistance. The remaining errors are mine.

A Note on the Environmental Costs of Aggregates

The opening of a new quarry for aggregates will change the pattern of transportation of aggregates in the area served by the quarry. In this note, we will show that, so long as aggregate producers are cost minimizing, the new pattern of transportation requires less truck transport than the pattern of transportation that existed before the opening of the new quarry. Since the costs of providing aggregates falls, it is reasonable to assume that the price of delivered aggregates also will fall. This note also shows that the demand expansion effect is of very small magnitude. Since the demand increase from a new quarry is quite small, the dominant effect is that the quarries are on average closer to the users of aggregates and, as a result, the truck mileage for aggregate hauling decreases. To summarize the effects of a new quarry project:

a) The project in itself will not significantly increase the demand for construction materials in the region through market forces, which include the downward pressure on pricing.

b) Truck traffic (i.e. vehicle miles traveled) in the region will not increase and may decrease as a result of the project.

As a result, the effect of a new quarry project will be to reduce the air emissions from aggregate trucking. The reduction in emissions should be included as a positive impact of a quarry project in any analysis of the environmental consequences of a new quarry.

The remainder of this note provides a brief description of the economics of construction materials and explains why these points must be true.

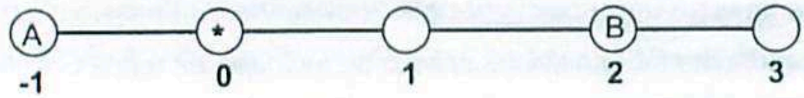
Based upon the available evidence, a project would decrease haul distances for aggregates and would therefore decrease emissions from trucks, rather than increase them.

There are two economic facts that are important to understand in evaluating the likely addition or subtraction to truck traffic from a new quarry. One is the economics of location. The second is the demand for aggregates, which is the quantity of aggregates used as a function of price.

That a new site leads to smaller haul distance is a matter of geometry and economics. Transportation is a major element in the cost of delivered aggregate, so new sites are chosen, within the limits placed by the natural availability of aggregates, to minimize transport costs.

An example should make this fact clear. Consider diagram 1. Circles represent aggregate-using projects of equal size. The five projects shown are located at miles marked –1, 0, 1, 2, and 3. Two of the project sites are marked with the letters A and B, and they are potential locations for aggregate production. The location at mile 0 is an existing aggregate production site and it is marked by an asterisk (*). The scale is in miles. For simplicity, each project uses one unit of aggregate.

Diagram 1



With only one aggregate production site at mile 0, the miles traveled to supply the five projects is seven: zero miles for project at mile 0, one mile for each for the projects at mile –1 and 1, two miles for the project at 2 and three miles for the project at 3 for a total of 7 miles. If an additional aggregate production site is started at A, the miles traveled decreases to six, because there is no transportation required for the aggregate-using project at A and all other projects are served by the original site. However, if the new site is placed at B instead of being placed at A, transport distance falls to three miles because then two projects have aggregate production at their location and thus have zero transportation requirements, and the three remaining sites each require a one-mile transport. Each aggregate production site supplies 2.5 units of aggregates, that is, half the total required by the five projects. Since cost depends on distance and, markets minimize costs, the free market system always will choose a point like B, the one with the lowest cost. In this case it is also the lowest transport distance.

Other forms of industrial organization lead to higher prices being charged for aggregates, but the effect of additional suppliers is to lower prices and haul distances. Appendix A elucidates the case where the price depends upon the delivered costs of the second most efficient producer.

The second issue for the siting of aggregate production is the possibility that lower delivered costs lead to more projects or more use of aggregates in existing projects. The degree to which decrease in the price of a good, in this case construction material, leads to an increase in the quantity of that material used is described by the elasticity of demand. The elasticity of demand is the percent increase in use caused by a one percent decrease in price.

A search of the economic literature found no articles estimating a positive elasticity of demand for aggregates. A review by the Susan Kohler[†] finds that only population and not price is correlated with aggregate usage. In other words, a reduction in the price of aggregate does not lead to an increase in demand for it.

While it is a theoretical possibility that the quantity of aggregates demanded (that is, the quantity used in projects) is responsive to price, two facts about construction make this unlikely. First, the cost of aggregates is usually a tenth or less of the cost of a project. Second, the building of projects -- housing, roads, and commercial construction -- is not very sensitive to the costs of producing them.

[†] *Map Sheet 52. Aggregate Availability in California.* by Susan L. Kohler. California Department of Conservation. California Geological Survey. Sacramento. 2002.

Although we have not found literature on the elasticity of demand for either public projects or contract construction, there is an empirical literature on the elasticity of demand for housing[‡]. In these studies, a one percent change in the price leads to about a half percent change in the quantity of housing consumed. Public projects, like roads, are budgeted, often from specials funds, like road taxes. In that case, a one percent decrease in the costs of *all* projects in a taxing jurisdiction would lead to a one percent increase in the quantity of roads built. Since aggregates are very expensive to ship, the quarry being considered likely would only change the costs of nearby road construction, perhaps for just one county.

For example, Monterey County has a population of 400,000 while the state population is 33.9 million people.[§] Assuming that road construction is roughly proportional to population, about 1.2 percent of road construction would be in Monterey. So, if a new quarry in Monterrey decreased the price of aggregates in Monterrey by 1 percent and left the price the same in the rest of the state, then the average price in the whole state would fall by about 0.01 percent, which is negligible. A project that affects only a small part of a taxing jurisdiction has only a small effect on that jurisdiction's costs and can have no major affect on the quantity of services supplied by that jurisdiction.

We know of no evidence of elasticities for construction work as high as one. We estimate the elasticity of demand for projects using aggregates to be much less than one, likely under a half in the private sector and near zero in the public sector.

Given that projects will be built, there is some possibility of substituting of other structural materials for aggregates in buildings. However these substitute materials too would be trucked. The realistic possibility for roads is that there are no materials to substitute for aggregates. I do not believe this pathway to greater use of aggregates in building would be triggered by the transport savings from a new aggregate source or that it would result in an increase in net truck miles.

[‡] Hanushek, Eric A., John Quigley. "What is the price elasticity of housing demand?" *Review of Economics and Statistics.* August, 1980.
[§] Population figures are for the year 2000.

Since a change in price of aggregates does not lead to either a substantial substitution of other materials for aggregates or a substantial increase in the quantity of projects, the demand for aggregates is very inelastic. This inelasticity of demand is exactly the reason that the State of California can use a fixed per-capita consumption rate for forecasting the need for construction materials.

An example will make clear how the transport advantage and elasticity of demand arguments fit together. Let us consider a new quarry that, through its transportation advantage over existing quarries, would save 12.5 miles of trucking on each and every project in the study area. We shall assume that the average truck haul pre-project was 25 miles.

According to the *Map Sheet 52: Aggregate Availability in California*, the cost of construction aggregate doubles every 25-35 miles from the point of production. The following calculations are carried out assuming that a 25 mile haul doubles the cost. Assuming that a unit of aggregate costs $1 at the production site, then its delivered cost at a project site 25 miles away is $2. If the haul distance were to be reduced to 12.5 miles due to a new quarry, then half of the transportation costs – or $0.50 – would be saved. This represents a cost savings of 25 percent in the delivered cost of aggregate and is entirely due to a 50 percent decrease in miles traveled.

The only way for a new quarry to influence the quantity of construction is through the price of aggregates. This example presents the competitive case, where the delivered price decreases by the full amount of the transport cost savings. In the competitive case, the effect on the quantity of construction will be extremely moderate, as demonstrated below. (Appendix A presents a less than perfectly competitive example.)

In keeping with the fact that the cost of aggregate accounts for less than 10 percent of the total cost of a construction project, a price reduction of 25 percent on aggregate is a cost saving of 2.5 percent or less on the project. Let us assume a very liberal price elasticity of demand for construction of 0.5. In other words, 2.5 percent reduction in the cost of construction would lead to 1.25 percent increase in the quantity of construction demanded. This increased quantity of delivered aggregate leads to additional truck haul miles. The number of increased miles from the increased aggregate sales is 1.25 percent of the original quantity times the new haul distance which is 50% of the original distance. Therefore, the percentage increase in truck haul miles occasioned by a decrease in aggregate price will be 0.625 percent because the new aggregate location is only half as far away.

In this example, the new quarry saves 50 percent of truck trip miles through location and contributes 0.625 percent of new truck trip miles from demand increase. This leads to a net decrease of 49.375 percent in truck miles. The following Table 1 summarizes the net reduction of truck haul miles for three different scenarios – the new aggregate project site located at 12.5, 6.25, and 2.5 miles from a construction site.

Table 1

Distance to New Quarry (miles)	Decrease in haul miles (%)**	Decrease in delivered aggregate cost (%)	Decrease in construction cost (%)	Increase in construction quantity (%)	Increase in haul miles from additional construction(%)††	Net decrease in miles hauled (%)
12.5	50	25	2.5	1.25	0.62	49.4
6.25	25	37.5	3.75	1.85	0.46	74.5
2.5 miles	90	45	4.5	2.25	0.22	89.8

There is a general rule to be deduced from the example: The percent decrease in cost for the delivery of aggregates equals the percent decrease in miles driven, while the increase in the use of aggregates equals the elasticity of demand for a final product (such as roads) times the cost share of aggregates in making the product times the decrease in cost. Since the elasticity of demand for a final product is much less than one, and the cost

** This decrease is with respect to the pre-project haul miles.
†† This increase is with respect to the pre-project haul miles.

share of aggregates in making the product is about 8 percent, a new quarry must decrease truck miles and decrease NOX and other emissions from trucks.

Appendix A

Spatial Models with Imperfect Competition

When a producer has a price advantage over other producers because of lower transport costs, the producer can exploit that advantage by charging consumers a price greater than its marginal cost. Marginal cost is the cost of producing one incremental unit.
In this appendix, I will briefly investigate one model of spatial competition that is derived from a classical model of Hotelling [⁑]

In Hotelling's model, two stores (which are analogous to production sites) can relocate at no cost and then compete based on price. Since consumers are some distance from the store, they see the price of a product as the amount they pay for the product plus the cost of travel. They go to the store with the least total cost (cost of product plus cost of travel). The stores seek to make the most money they can make. The price the consumer will pay is the largest price that the store the consumer goes to can charge without losing the customer to the other store.[§§] In Hotelling's model, the two stores will locate next to each other, split the market in half, and charge the competitive price. While the pricing rule of the Hotelling model may well apply to aggregates, the assumption of complete location flexibility is not applicable.

Returning to the model of diagram 1, shown above., I now consider the effects on pricing of adding one aggregate production site with competition in prices. Consider the case where both aggregate production sites and aggregate-using projects exist at location A and *. The production site at * would be willing to supply the project at location A at its marginal cost of production (mc) plus the cost of transport for one mile, for a total of mc + 1 c. This is higher than the marginal plus transport costs that production site A has for

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[5] Hotelling, Harold. 1929. "Stability in Competition." Economic Journal 39:41-57
[6] Salop, Steven C. 1979. "Monopolistic Competition with Outside Goods." *The Bell Journal of Economics.* Salop models the competition between stores in terms of quantity, so that the price for consumers near a store is determined as a monopolist would determine price. With a very low elasticity of demand as is true for aggregates, the price competition model of Hotelling seems more appropriate.

supplying the project at A. However, the site at A can charge up to mc+c without losing the customer. The site charges mc+c while its costs are mc and makes c units of pure profit. The site at * prices in the same way—a price just high enough to avoid the site at A from taking the customer. For the sites to the right of *, the prices are mc+2, mc+3, and mc+ 4. In each case, this is the highest price site * can charge without losing the customer to site A.

In this model, one of the best places for a new site would be at B. The new site would sell ½ unit to the project between it and * at a price of mc + c, a whole unit to the project located at B at a price of mc + 2c (the price at which the site at * would be willing to supply aggregate), and a whole unit to the project located to its right at a price of mc + 3c. The result of adding the new site would be that the price for each project to the right of the project at * fell by c.

With competitive (marginal cost) pricing as described in the body of the note, the addition of the new site at B would result in the prices paid by projects decreasing by four, while with imperfect competition as described in this appendix, the new site would result in the prices paid by projects decreasing only by three. Compared to the competitive case cited above, the imperfect competition example results in smaller changes in prices and therefore a larger decrease in truck traffic.