Appendix M Special-Status Species Evaluated

Table M-1
Special-Status Plant Species Known to Occur in the Project Vicinity

Scientific Name	Common Name	Status			General Habitat Description	Species Present (P)/ Absent (A)	Rationale (Potential for Species to Occur)
		USFWS	CDFG	CNPS			
Astragalus hornii var. *hornii*	Horn's milk-vetch	–	–	1B.1	Meadows and seeps; playas/lake margins (alkaline).	A	Not observed during focused surveys.
Atriplex cordulata	heartscale	–	–	1B.2	Vernal pools; saltbush scrub; meadows and seeps (saline or alkaline); valley and foothill grassland.	A	Not observed during focused surveys.
Atriplex depressa	brittlescale	–	–	1B.2	Chenopod scrub, meadows and seeps, playas, valley and foothill grassland, and vernal pools; alkaline or clay areas.	A	Not observed during focused surveys.
Atriplex minuscula	lesser saltscale	–	–	1B.1	Saltbush scrub; grasslands; often in association with slough systems and river floodplains (sandy, alkaline).	A	Not observed during focused surveys.
Atriplex tularensis	Bakersfield smallscale	–	SE	1B.1	Alkali sinks; saltbush scrub.	A	No suitable habitat.
Atriplex coronata var. *vallicola*	Lost Hills crownscale	–	–	1B.2	Saltbush scrub; valley and foothill grassland; vernal pools; alkali sinks.	A	Not observed during focused surveys.
Calochortus striatus	alkali mariposa lily	–	–	1B.2	Alkali meadows; ephemeral washes; vernally moist depressions; seeps.	A	Not observed during focused surveys.
Caulanthus californicus	California jewel-flower	FE	SE	1B.1	Saltbush scrub; pinyon and juniper woodland; valley and foothill grassland (sandy).	A	Not observed during focused surveys.
Cirsium crassicaule	slough thistle	–	–	1B.1	Saltbush scrub; marshes and swamps (sloughs); riparian scrub.	A	Not observed during focused surveys.
Cordylanthus mollis ssp. *hispidus*	hispid bird's beak	–	–	1B.1	Meadows and seeps; playas; valley and foothill grassland (alkaline).	A	Not observed during focused surveys.
Delphinium recurvatum	recurved larkspur	–	–	1B.2	Saltbush scrub; cismontane woodland; valley and foothill grassland (alkaline).	A	Not observed during focused surveys.
Eremalche parryi ssp. *kernensis [E. kernensis]*	Kern mallow[a]	FE	–	1B.1	Saltbush scrub; valley and foothill grassland.	A	Not observed during focused surveys.
Eriastrum hooveri	Hoover's eriastrum	–	–	4.2	Saltbush scrub; pinyon-juniper woodland; valley and foothill grassland.	A	Not observed during focused surveys.
Eschscholzia lemmonii ssp. *Kernensis*	Tejon poppy	–	–	1B.1	Saltbush scrub; valley and foothill grassland.	A	Not observed during focused surveys.

Table M-1 (Continued)
Special-Status Plant Species Known to Occur in the Project Vicinity

Scientific Name	Common Name	Status			General Habitat Description	Species Present (P)/ Absent (A)	Rationale (Potential for Species to Occur)
		USFWS	CDFG	CNPS			
Fritillaria striata	striped adobe-lily	–	ST	1B.1	Cismontane woodland; valley and foothill grassland (adobe clay soil).	A	No suitable habitat.
Imperata brevifolia	California satintail	–	–	2.1	Chaparral; coastal scrub; Mojavean desert scrub; meadows and seeps (often alkali); riparian scrub.	A	Not observed during focused surveys.
Layia leucopappa	Comanche Point layia	–	–	1B.1	Open slopes in heavy soil; elevations between 490 and 1,150 feet above msl.	A	No suitable habitat.
Mimulus pictus	Calico monkeyflower	–	–	1B.2	Bare, sunny areas around shrubs; rock outcrops on granitic soils.	A	No suitable habitat.
Monolopia [*Lembertia*] *congdonii*	San Joaquin woolly-threads	FE	–	1B.2	Saltbush scrub; valley and foothill grassland (sandy).	A	Not observed during focused surveys.
Navarretia setiloba	Piute Mountains navarretia	–	–	1B.1	Depressions in clay or gravelly loam; elevations between 1,640 and 6,890 feet above msl.	A	No suitable habitat.
Opuntia basilaris var. *treleasei*	Bakersfield cactus	FE	SE	1B.1	Saltbush scrub; cismontane woodland; valley and foothill grassland (sandy or gravelly).	A	Not observed during focused surveys.
Pseudobahia peirsonii	San Joaquin adobe sunburst	FT	SE	1B.1	Valley and foothill grassland (adobe clay soil).	A	No suitable habitat.
Pterygoneurum californicum	California chalk-moss	–	–	1B.1	Saltbush scrub; valley and foothill grassland (alkali).	A	Not observed during focused surveys.
Stylocline citroleum	oil neststraw	–	–	1B.1	Saltbush scrub; mesquite scrub.	A	Not observed during focused surveys.
Stylocline masonii	Mason’s neststraw	–	–	1B.1	Saltbush scrub; pinyon and juniper woodland/sandy.	A	No suitable habitat.
Tortula californica	California screw-moss	–	–	1B.2	Sandy soil.	A	Not observed during focused surveys.
Trichostema ovatum	San Joaquin bluecurls	–	–	4.2	Saltbush scrub; valley and foothill grassland.	A	Not observed during focused surveys.

Table M-1 (Continued) Special-Status Plant Species Known to Occur in the Project Vicinity

Scientific Name	Common Name	Status			General Habitat Description	Species Present (P)/ Absent (A)	Rationale (Potential for Species to Occur)
		USFWS	CDFG	CNPS			

STATUS DESIGNATIONS

Federal Designations

FE Listed by the federal government as an endangered species
FT Listed by the federal government as a threatened species

State Designations

SE Listed as endangered by the State of California
ST Listed as threatened by the State of California

California Native Plant Society

1B Plants rare, threatened, or endangered in California and elsewhere
2 Plants rare, threatened, or endangered in California but more common elsewhere
3 Plants about which we need more information - review list
4 Plants that are limited in distribution in California

California Native Plant Society Threat Code Extensions

None Plants lacking any threat information
.1 Seriously endangered in California (over 80% of occurrences threatened; high degree and immediacy of threat)
.2 Fairly endangered in California (20-80% of occurrences threatened)
.3 Not very endangered in California (less than 20% of occurrences threatened or no current threats known)

[a] Professional discussions are currently occurring regarding the positive identification of Kern mallow; some previously identified records may be misidentified and the range maps shown in the Recovery Plan for Upland Species may be incorrect for the 2nd Edition of the Jepson Manual (California Department of Fish and Game 1998; Painter 2009).

Source: *Natural Environment Study* March 2011

Table M-2
Special-Status Wildlife Species Known to Occur in the Project Vicinity

Scientific Name	Common Name	Status		General Habitat Description	Species P/ A* or Habitat Present (HP)	Rationale (Potential for Species to Occur)
		USFWS	CDFG			
Invertebrates						
Branchinecta conservatio	conservancy fairy shrimp	FE	–	Ephemeral freshwater habitats, such as vernal pools and swales.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Branchinecta longiantenna	longhorn fairy shrimp	FE	–	Ephemeral freshwater habitats, such as vernal pools and swales.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Branchinecta lynchi	vernal pool fairy shrimp	FT	–	Ephemeral freshwater habitats, such as vernal pools and swales.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Desmocerus californicus dimorphus	valley elderberry longhorn beetle	FT	–	Associated with blue elderberry (*Sambucus mexicana*).	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Fish						
Hypomesus transpacificus	delta smelt	FT	ST	Sacramento-San Joaquin Delta.	A	Not expected to occur; outside known range; not observed during general wildlife surveys.
Amphibians						
Spea hammondii	western spadefoot	–	SSC	Washes, floodplains, alluvial fans, alkali flats; breeds in quiet streams, vernal pools, temporary ponds.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Rana [*aurora*] *draytonii*	California red-legged frog	FT	SSC	Variety of aquatic habitats in forests, woodlands, grasslands, and streamsides with deep, still, or slow-moving water.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Rana boylii	foothill yellow-legged frog	–	SSC	Streams or rivers in woodlands, chaparral, and forests.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Reptiles						
Actinemys [*Clemmys*] *marmorata pallida*	southwestern pond turtle	–	SSC	Freshwater rivers, streams, lakes, ponds, vernal pools, and seasonal wetlands with basking sites.	HP	Limited potential to occur; limited suitable habitat; not observed during general wildlife surveys.

Table M-2 (Continued) Special-Status Wildlife Species Known to Occur in the Project Vicinity

Scientific Name	Common Name	Status		General Habitat Description	Species P/ A* or Habitat Present (HP)	Rationale (Potential for Species to Occur)
		USFWS	CDFG			
Gambelia sila	blunt-nosed leopard lizard	FE	SE/FP	Semiarid grasslands, alkali flats, washes.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Phrynosoma coronatum (*frontale* population)	coast (California) horned lizard	–	SSC	Scrubland, grassland, coniferous forests, broadleaf woodlands.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Anniella pulchra pulchra	silvery legless lizard	–	SSC	Loose, sandy soils in chaparral, pine-oak woodland, beach, and riparian areas.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Masticophis flagellum ruddocki	San Joaquin whipsnake	–	SSC	Variety of habitats including desert prairie, scrubland, juniper grassland, woodland, thorn forest, farmland.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Thamnophis gigas	giant garter snake	FT	ST	Perennial fresh water with emergent wetland vegetation and basking sites.	A	Not expected to occur; outside current known range; not observed during general wildlife surveys.
Birds						
Gymnogyps californianus	California condor	FE	SE	Forages in open habitats such as savannahs, grasslands, and foothill chaparral; nests in caves, crevices, and ledges on cliffs.	A	Not expected to occur for foraging or nesting; not known to forage in project vicinity; no suitable nesting habitat; not observed during general wildlife surveys.
Aquila chrysaetos	golden eagle	–	FP[a,b]	Forages in open habitats such as grasslands, deserts, or savannahs; nests in large trees or cliffs in mountainous areas.	A	Not expected to occur for foraging or nesting; not known to forage in project vicinity; no suitable nesting habitat; not observed during general wildlife surveys.
Buteo swainsoni	Swainson's hawk	–	ST	Forages in grasslands and ruderal vegetation; breeds in open areas with scattered groves of trees.	A	Not expected to occur for foraging or nesting; limited marginally suitable foraging habitat; no suitable nesting habitat; not observed during general wildlife surveys.

Table M-2 (Continued)
Special-Status Wildlife Species Known to Occur in the Project Vicinity

Scientific Name	Common Name	Status		General Habitat Description	Species P/ A* or Habitat Present (HP)	Rationale (Potential for Species to Occur)
		USFWS	CDFG			
Circus cyaneus	northern harrier	–	SSC[a]	Forages in scrub, riparian, and grassland habitats; nests on ground in a variety of wetland and upland habitats.	A	Not expected to occur for foraging or nesting; limited marginally suitable foraging habitat; no suitable nesting habitat; not observed during general wildlife surveys.
Elanus leucurus	white-tailed kite	–	FP[a]	Forages in grasslands and scrublands; nests in trees.	HP	Limited potential to occur for foraging; limited suitable foraging habitat; not expected to occur for nesting; no suitable nesting habitat; not observed during general wildlife surveys
Falco peregrinus anatum	American peregrine falcon	–	FP[a]	Forages in a variety of habitats, particularly wetlands and coastal areas; nests in cliffs.	A	Not expected to occur for foraging or nesting; not known to forage in project vicinity; no suitable nesting habitat; not observed during general wildlife surveys.
Charadrius alexandrinus nivosus	western snowy plover	–[a,c]	SSC[a,d]	Barren sandy beaches and flats, alkali lakes.	A	Not expected to occur for nesting; no suitable nesting habitat; not observed during general wildlife surveys.
Charadrius montanus	mountain plover	–	SSC[b]	Grasslands or similar habitats (e.g., cultivated fields, fallow agricultural fields).	A	Not expected to occur for wintering; no suitable foraging habitat; nests outside the project region; not observed during general wildlife surveys.
Coccyzus americanus occidentalis	western yellow-billed cuckoo	FC[a]	SE[a]	Old-growth riparian habitats dominated by willows and cottonwoods with a dense understory.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Athene cunicularia	burrowing owl	–	SSC[e]	Forages over open habitats such as grasslands and flat to low rolling hills in treeless terrain, also found in burrows along banks and roadsides.	P	Observed during 2008 focused surveys; suitable habitat (see Figures 5A–5C).

Table M-2 (Continued)
Special-Status Wildlife Species Known to Occur in the Project Vicinity

Scientific Name	Common Name	Status		General Habitat Description	Species P/ A* or Habitat Present (HP)	Rationale (Potential for Species to Occur)
		USFWS	CDFG			
Lanius ludovicianus	loggerhead shrike	–	SSC[a]	Grassland and other dry, open habitats.	P	Observed during 2008 focused surveys; limited suitable habitat.
Vireo bellii pusillus	least Bell's vireo	FE[a]	SE[a]	Riparian habitats dominated by willows with dense understory vegetation.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Toxostoma lecontei	Le Conte's thrasher	–	SSC[f]	Nests and forages in sparsely vegetated desert flats, dunes, alluvial fans, or gently rolling hills with saltbush and/or cholla.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Agelaius tricolor	tricolored blackbird	–	SSC[g]	Forages in wet pastures, agricultural fields, and seasonal wetlands; nests in marsh vegetation.	A	Not expected to occur; no suitable nesting habitat; not observed during general wildlife surveys.
Mammals						
Sorex ornatus relictus	Buena Vista Lake shrew	FE	SSC	Wetlands with dense vegetation and an abundant layer of detritus.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Antrozous pallidus	pallid bat	–	SSC	Forages in grasslands; roosts in rock crevices and tree cavities.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Eumops perotis	western mastiff bat	–	SSC	Open semi-arid to arid habitats, including woodlands, scrub, grasslands, and urban areas; crevices on cliff faces for roosting.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Ammospermophilus nelsoni	Nelson's antelope squirrel	–	ST	Arid annual grassland and shrubland with sparse to moderate shrub cover; friable soils for burrows.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Dipodomys ingens	giant kangaroo rat	FE	SE	Slopes in grasslands and shrub communities.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Dipodomys nitratoides brevinasus	short-nosed kangaroo rat	–	SSC	Arid grasslands and shrublands; friable soils.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Dipodomys nitratoides nitratoides	Tipton kangaroo rat	FE	SE	Alkali sink scrub and valley saltbrush scrub with widely scattered shrubs.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.

Table M-2 (Continued) Special-Status Wildlife Species Known to Occur in the Project Vicinity

Scientific Name	Common Name	Status		General Habitat Description	Species P/ A* or Habitat Present (HP)	Rationale (Potential for Species to Occur)
		USFWS	CDFG			
Onychomys torridus tularensis	Tulare grasshopper mouse	–	SSC	Arid shrubland communities.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.
Vulpes macrotis mutica	San Joaquin kit fox	FE	ST	Valley sink scrub, saltbush scrub, upper Sonoran scrub, annual grasslands, oil fields, urban areas.	P	Observed during 2008 focused surveys (see Figures 5A–5C).
Taxidea taxus	American badger	–	SSC	Grasslands and other open habitats with friable, uncultivated soils.	A	Not expected to occur; no suitable habitat; not observed during general wildlife surveys.

A Absent
P Present
HP Habitat Present

Federal Designations
FE Listed by the federal government as an endangered species
FT Listed by the federal government as a threatened species
FC Candidate for federal listing as threatened or endangered

State Designations
SE Listed as endangered by the State of California
ST Listed as threatened by the State of California
SSC Species of Special Concern
FP Fully Protected

Note:
[a] Listing refers to nesting individuals.
[b] Listing refers to wintering individuals.
[c] Listing refers to Pacific coastal population only.
[d] Listing refers to both coastal and interior populations.
[e] Listing refers to burrow sites.
[f] Listing refers only to the San Joaquin population (i.e., *T.l. macmillanorum*).
[g] Listing refers to nesting colonies.

*Focused surveys were conducted for the burrowing owl and San Joaquin kit fox. Findings for other species are based on the biologist's best judgment based on the habitat quality within the BSA and known distributions of species within the region.
Source: *Natural Environment Study* March 2011

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825

November 7, 2011

Document Number: 111107070155

Patricia Moyer
Caltrans, District 6
Southern San Joaquin Valley Environmental Management Branch
Fresno, CA

Subject: Species List for Rosedale Highway Widening Project

Dear: Ms. Moyer

We are sending this official species list in response to your November 7, 2011 request for information about endangered and threatened species. The list covers the California counties and/or U.S. Geological Survey 7½ minute quad or quads you requested.

Our database was developed primarily to assist Federal agencies that are consulting with us. Therefore, our lists include all of the sensitive species that have been found in a certain area *and also ones that may be affected by projects in the area*. For example, a fish may be on the list for a quad if it lives somewhere downstream from that quad. Birds are included even if they only migrate through an area. In other words, we include all of the species we want people to consider when they do something that affects the environment.

Please read Important Information About Your Species List (below). It explains how we made the list and describes your responsibilities under the Endangered Species Act.

Our database is constantly updated as species are proposed, listed and delisted. If you address proposed and candidate species in your planning, this should not be a problem. However, we recommend that you get an updated list every 90 days. That would be February 05, 2012.

Please contact us if your project may affect endangered or threatened species or if you have any questions about the attached list or your responsibilities under the Endangered Species Act. A list of Endangered Species Program contacts can be found at www.fws.gov/sacramento/es/branches.htm.

Endangered Species Division

TAKE PRIDE IN AMERICA

U.S. Fish & Wildlife Service
Sacramento Fish & Wildlife Office
Federal Endangered and Threatened Species that Occur in or may be Affected by Projects in the Counties and/or U.S.G.S. 7 1/2 Minute Quads you requested

Document Number: 111107070155

Database Last Updated: September 18, 2011

Quad Lists

Listed Species

Invertebrates

Branchinecta lynchi
vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus
valley elderberry longhorn beetle (T)

Fish

Hypomesus transpacificus
delta smelt (T)

Amphibians

Rana draytonii
California red-legged frog (T)

Reptiles

Gambelia (=Crotaphytus) sila
blunt-nosed leopard lizard (E)

Thamnophis gigas
giant garter snake (T)

Birds

Empidonax traillii extimus
southwestern willow flycatcher (E)

Mammals

Dipodomys ingens
giant kangaroo rat (E)

Dipodomys nitratoides nitratoides
Tipton kangaroo rat (E)

Sorex ornatus relictus
Buena Vista Lake shrew (E)

Vulpes macrotis mutica
San Joaquin kit fox (E)

Plants

Caulanthus californicus
California jewelflower (E)

Eremalche kernensis
Kern mallow (E)

Monolopia congdonii (=Lembertia congdonii)
San Joaquin woolly-threads (E)

Opuntia treleasei
Bakersfield cactus (E)

Quads Containing Listed, Proposed or Candidate Species:

OIL CENTER (239B)
LAMONT (239C)
OILDALE (240A)
ROSEDALE (240B)
STEVENS (240C)
GOSFORD (240D)
RIO BRAVO (241A)
TUPMAN (241D)
FAMOSO (263C)
NORTH OF OILDALE (263D)
WASCO (264D)

County Lists

No county species lists requested.

Key:

(E) *Endangered* - Listed as being in danger of extinction.
(T) *Threatened* - Listed as likely to become endangered within the foreseeable future.
(P) *Proposed* - Officially proposed in the Federal Register for listing as endangered or threatened.
(NMFS) Species under the Jurisdiction of the National Oceanic & Atmospheric Administration Fisheries Service. Consult with them directly about these species.
Critical Habitat - Area essential to the conservation of a species.
(PX) *Proposed Critical Habitat* - The species is already listed. Critical habitat is being proposed for it.
(C) *Candidate* - Candidate to become a proposed species.
(V) Vacated by a court order. Not currently in effect. Being reviewed by the Service.
(X) *Critical Habitat* designated for this species

Important Information About Your Species List

How We Make Species Lists

We store information about endangered and threatened species lists by U.S. Geological Survey 7½ minute quads. The United States is divided into these quads, which are about the size of San Francisco.

The animals on your species list are ones that occur within, **or may be affected by** projects within, the quads covered by the list.

- Fish and other aquatic species appear on your list if they are in the same watershed as your quad or if water use in your quad might affect them.
- Amphibians will be on the list for a quad or county if pesticides applied in that area may be carried to their habitat by air currents.
- Birds are shown regardless of whether they are resident or migratory. Relevant birds on the county list should be considered regardless of whether they appear on a quad list.

Plants

Any plants on your list are ones that have actually been observed in the area covered by the list. Plants may exist in an area without ever having been detected there. You can find out what's in the surrounding quads through the California Native Plant Society's online Inventory of Rare and Endangered Plants.

Surveying

Some of the species on your list may not be affected by your project. A trained biologist and/or botanist, familiar with the habitat requirements of the species on your list, should determine whether they or habitats suitable for them may be affected by your project. We recommend that your surveys include any proposed and candidate species on your list. See our Protocol and Recovery Permits pages.

For plant surveys, we recommend using the Guidelines for Conducting and Reporting Botanical Inventories. The results of your surveys should be published in any environmental documents prepared for your project.

Your Responsibilities Under the Endangered Species Act

All animals identified as listed above are fully protected under the Endangered Species Act of 1973, as amended. Section 9 of the Act and its implementing regulations prohibit the take of a federally listed wildlife species. Take is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any such animal.

> Take may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or shelter (50 CFR §17.3).

Take incidental to an otherwise lawful activity may be authorized by one of two procedures:

- If a Federal agency is involved with the permitting, funding, or carrying out of a project that may result in take, then that agency must engage in a formal consultation with the Service.

  During formal consultation, the Federal agency, the applicant and the Service work together to avoid or minimize the impact on listed species and their habitat. Such consultation would result in a biological opinion by the Service addressing the anticipated effect of the project on listed and proposed species. The opinion may authorize a limited level of incidental take.

- If no Federal agency is involved with the project, and federally listed species may be taken as part of the project, then you, the applicant, should apply for an incidental take permit. The Service may issue such a permit if you submit a satisfactory conservation plan for the species that would be affected by your project.

  Should your survey determine that federally listed or proposed species occur in the area and are likely to be affected by the project, we recommend that you work with this office and the California Department of Fish and Game to develop a plan that minimizes the project's direct and indirect impacts to listed species and compensates for project-related loss of habitat. You should include the plan in any environmental documents you file.

Critical Habitat

When a species is listed as endangered or threatened, areas of habitat considered essential to its conservation may be designated as critical habitat. These areas may require special management considerations or protection. They provide needed space for growth and normal behavior; food, water, air, light, other nutritional or physiological requirements; cover or shelter; and sites for breeding, reproduction, rearing of offspring, germination or seed dispersal.

Although critical habitat may be designated on private or State lands, activities on these lands are not restricted unless there is Federal involvement in the activities or direct harm to listed wildlife.

If any species has proposed or designated critical habitat within a quad, there will be a separate line for this on the species list. Boundary descriptions of the critical habitat may be found in the Federal Register. The information is also reprinted in the Code of Federal Regulations (50 CFR 17.95). See our Map Room page.

Candidate Species

We recommend that you address impacts to candidate species. We put plants and animals on our candidate list when we have enough scientific information to eventually propose them for listing as threatened or endangered. By considering these species early in your planning process you may be able to avoid the problems that could develop if one of these candidates was listed before the end of your project.

Species of Concern

The Sacramento Fish & Wildlife Office no longer maintains a list of species of concern. However, various other agencies and organizations maintain lists of at-risk species. These lists provide essential information for land management planning and conservation efforts. More info

Wetlands

If your project will impact wetlands, riparian habitat, or other jurisdictional waters as defined by section 404 of the Clean Water Act and/or section 10 of the Rivers and Harbors Act, you will need to obtain a permit from the U.S. Army Corps of Engineers. Impacts to wetland habitats require site specific mitigation and monitoring. For questions regarding wetlands, please contact Mark Littlefield of this office at (916) 414-6520.

Updates

Our database is constantly updated as species are proposed, listed and delisted. If you address proposed and candidate species in your planning, this should not be a problem. However, we recommend that you get an updated list every 90 days. That would be February 05, 2012.

Appendix N Responses to Comments

This appendix contains the written comments received during the public circulation and comment period from December 9, 2011 to January 24, 2012. Comments have been received from the agencies, organizations, businesses, and individuals listed below. In addition, comments made before the City of Bakersfield Planning Commission on January 5, 2012 and to the court reporter at the public open house on January 10, 2012 have also been included. Transcripts of the Planning Commission meeting, as well as of the comments provided to the court reporter at the public open house, have been included in this section. A response follows each comment presented.

The following is a listing of the comments included in this Appendix (Note: the date of the comment is listed in parentheses):

- Governor's Office of Planning and Research State Clearinghouse and Planning Unit (January 10, 2012)
- California Highway Patrol (December 19, 2011)
- Native American Heritage Commission (December 20, 2011)
- North Kern Water Storage District (December 28, 2011)
- California Public Utilities Commission (January 6, 2012)
- Chevron (January 4, 2012)
- Independent Pipe & Steel, Inc (January 4, 2012)
- John R. Wilson, Inc. (January 8, 2012)
- Big City Sign Company (January 10, 2012)
- Cigars & More (January 10, 2012)
- Enterprise Rent-a-Car (January 10, 2012)
- Frye Construction (January 10, 2012)
- Hooters (January 10, 2012)
- Rosedale Square Shopping Center (January 10, 2012)
- Rosedale Square Shopping Center (January 10, 2012)
- RW Henry Oil Producers (January 10, 2012)
- State Farm Insurance (January 10, 2012)
- T-Mobile (January 10, 2012)

- John R. Wilson, Inc. (January 11, 2012)
- Rockstar Nails (January 10, 2012)
- John R. Wilson, Inc. (January 20, 2012)
- John R. Wilson, Inc. (January 24, 2012)
- The UPS Store #6021 (January 10, 2012)
- Carol Bender (January 1, 2012)
- Unsigned (January 10, 2012)
- Carol Bender (January 10, 2012)
- Matt Hayes (January 10, 2012)
- Dewey and Norma Maynard (January 10, 2012)
- Rich ONeil (January 10, 2012)
- Dolores Ventura (January 10, 2012)
- Rebecca Wells (January 10, 2012)
- Jacob Marquez (January 11, 2012)
- Melinda Perez (January 11, 2012)
- John O'Connor (January 11, 2012)
- Brian Rachuy (January 11, 2012)
- David L. Jones (January 24, 2012)
- Sierra Club (January 10, 2012)
- Sierra Club (January 24, 2012)
- Bike Bakersfield (January 4, 2012)
- Bike Bakersfield (January 22, 2012)
- Transcript from the Planning Commission Meeting (January 5, 2012)
- Transcript from the Public Hearing (January 10, 2012)

Comment from State Clearinghouse

STATE OF CALIFORNIA
GOVERNOR'S OFFICE *of* PLANNING AND RESEARCH
STATE CLEARINGHOUSE AND PLANNING UNIT

EDMUND G. BROWN JR.
GOVERNOR

KEN ALEX
DIRECTOR

January 10, 2012

RECEIVED
JAN 17 2012
PW-TRIP

Theodore D. Wright
City of Bakersfield
900 Truxtun Avenue, Suite 201
Bakersfield, CA 93301

Subject: State Route 58 (Rosedale Highway) Widening Project
SCH#: 2011122028

Dear Theodore D. Wright:

The State Clearinghouse submitted the above named Mitigated Negative Declaration to selected state agencies for review. On the enclosed Document Details Report please note that the Clearinghouse has listed the state agencies that reviewed your document. The review period closed on January 9, 2012, and the comments from the responding agency (ies) is (are) enclosed. If this comment package is not in order, please notify the State Clearinghouse immediately. Please refer to the project's ten-digit State Clearinghouse number in future correspondence so that we may respond promptly.

Please note that Section 21104(c) of the California Public Resources Code states that:

> "A responsible or other public agency shall only make substantive comments regarding those activities involved in a project which are within an area of expertise of the agency or which are required to be carried out or approved by the agency. Those comments shall be supported by specific documentation."

These comments are forwarded for use in preparing your final environmental document. Should you need more information or clarification of the enclosed comments, we recommend that you contact the commenting agency directly.

This letter acknowledges that you have complied with the State Clearinghouse review requirements for draft environmental documents, pursuant to the California Environmental Quality Act. Please contact the State Clearinghouse at (916) 445-0613 if you have any questions regarding the environmental review process.

Sincerely,

Scott Morgan
Director, State Clearinghouse

Enclosures
cc: Resources Agency

1400 10th Street P.O. Box 3044 Sacramento, California 95812-3044
(916) 445-0613 FAX (916) 323-3018 www.opr.ca.gov

Document Details Report
State Clearinghouse Data Base

SCH#	**2011122028**
Project Title	State Route 58 (Rosedale Highway) Widening Project
Lead Agency	Bakersfield, City of

Type	**MND** Mitigated Negative Declaration
Description	The project proposes improvements to SR 58 (known locally as Rosedale Highway) from west of Allen Road to SR 99. The project is located within the City of Bakersfield and in portions of unincorporated Kern County. The project proposes to build two additional lanes (one in each direction) on SR 58 between Allen Road and SR 99. Other improvements include minor changes, such as restriping approach lanes to provide an additional turn lane on the side street approaches to SR 58. With the proposed improvements, SR 58 would increase from a four-lane roadway to a six-lane roadway from Allen Road to SR 99. In addition, a grade-separated rail crossing would ultimately be built where SR 58 crosses the San Joaquin Valley Railroad rail line between Mohawk Street and Landco Drive.

Lead Agency Contact

Name	Theodore D. Wright		
Agency	City of Bakersfield		
Phone	661 326 3700	***Fax***	
email			
Address	900 Truxtun Avenue, Suite 201		
City	Bakersfield	***State*** CA	***Zip*** 93301

Project Location

County	Kern		
City	Bakersfield		
Region			
Lat / Long	35° 21' 12.80" N / 119° 2' 21.17" W		
Cross Streets	Allen Road intersection (PM 46.1) to SR 99 (PM 51.7)		
Parcel No.			
Township	***Range***	***Section***	***Base***

Proximity to:

Highways	Hwy 58, 99
Airports	
Railways	BNSF and SJVR
Waterways	Kern River
Schools	Rosedale MS & Vista West Continuation HS
Land Use	Residential, Commercial, Industrial, Agriculture

Project Issues	Aesthetic/Visual; Agricultural Land; Air Quality; Archaeologic-Historic; Biological Resources; Drainage/Absorption; Economics/Jobs; Fiscal Impacts; Flood Plain/Flooding; Geologic/Seismic; Noise; Population/Housing Balance; Public Services; Recreation/Parks; Schools/Universities; Soil Erosion/Compaction/Grading; Toxic/Hazardous; Traffic/Circulation; Vegetation; Water Quality; Wetland/Riparian; Growth Inducing; Landuse; Cumulative Effects

Reviewing Agencies	Resources Agency; Department of Fish and Game, Region 4; Office of Historic Preservation; Department of Parks and Recreation; Department of Water Resources; California Highway Patrol; Caltrans, District 6; Air Resources Board, Transportation Projects; Regional Water Quality Control Bd., Region 5 (Fresno); Native American Heritage Commission; Public Utilities Commission

Date Received 12/09/2011 ***Start of Review*** 12/09/2011 ***End of Review*** 01/09/2012

Note: Blanks in data fields result from insufficient information provided by lead agency.

State of California | Business, Transportation and Housing Agency

Memorandum

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1/9/2012
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RECEIVED
DEC 22 2011
STATE CLEARING HOUSE

Date: December 19, 2011

To: State Clearning House
1400 Tenth Street, Room 121
Sacramento, CA 95814

From: **DEPARTMENT OF CALIFORNIA HIGHWAY PATROL**
Bakersfield Area

File No.: 420.11632.12883

Subject: RESPONSE TO SCH #2011122028, STATE ROUTE 58 (ROSEDALE HIGHWAY) WIDENING PROJECT

Thank you for the opportunity to review the Initial Study/Environmental Assessment for the State Route 58 (Rosedale Highway) widening project, State Clearing House (SCH) #2011122028. The California Highway Patrol (CHP) is the primary agency that provides traffic law enforcement, safety and management services within the unincorporated portions of the county. As a result of this project, we anticipate local CHP operations will be impacted in the following manner:

- Traffic congestion on all ancillary roadways will increase. Therefore, additional patrol units will need to be assigned to the area as the traffic will be using multiple roadways, instead of State Route 58.

Although we are not opposed to this project, the aforementioned merits consideration. Concern exists that local CHP resources will soon be overwhelmed. In order to continue to provide the high level of safety, service and security the local population has come to expect, future growth of the Bakersfield CHP office is necessary. Questions regarding this matter should be directed to Lieutenant Larry McGuire at (661)864-4436.

W. B. NATION, Captain
Commander
Bakersfield Area

cc: Special Projects Section

Safety, Service, and Security
CHP 51 (Rev. 03-11) OPI 076

An Internationally Accredited Agency

STATE OF CALIFORNIA Edmund G. Brown, Jr., *Governor*

NATIVE AMERICAN HERITAGE COMMISSION
915 CAPITOL MALL, ROOM 364
SACRAMENTO, CA 95814
(916) 653-6251
Fax (916) 657-5390
Web Site www.nahc.ca.gov
ds_nahc@pacbell.net

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1/9/2012
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RECEIVED
DEC 23 2011
STATE CLEARING HOUSE

December 20, 2011

Mr. Theodore D. Wriight, Planner
City of Bakersfield
900 Truxtun Avenue, Suite 201
Bakersfield, CA 93301

Re: SCH#2011122028 CEQA Notice of Completion; proposed Mitigated Negative Declaration for the **"State Route 58 (Rosedale Highway) Widening Project;"** located in the City of Bakersfield; Kern County, California

Dear Mr. Wright:

The Native American Heritage Commission (NAHC) is the State of California 'Trustee Agency' for the protection and preservation of Native American cultural resources pursuant to California Public Resources Code §21070 and affirmed by the Third Appellate Court in the case of EPIC v. Johnson (1985: 170 Cal App. 3rd 604). The court held that the NAHC has jurisdiction and special expertise, as a state agency, over affected Native American resources, impacted by proposed projects including archaeological, places of religious significance to Native Americans and burial sites. The NAHC wishes to comment on the proposed project.

This letter includes state and federal statutes relating to Native American historic properties of religious and cultural significance to American Indian tribes and interested Native American individuals as 'consulting parties' under both state and federal law. State law also addresses the freedom of Native American Religious Expression in Public Resources Code §5097.9.

The California Environmental Quality Act (CEQA – CA Public Resources Code 21000-21177, amendments effective 3/18/2010) requires that any project that causes a substantial adverse change in the significance of an historical resource, that includes archaeological resources, is a 'significant effect' requiring the preparation of an Environmental Impact Report (EIR) per the CEQA Guidelines defines a significant impact on the environment as 'a substantial, or potentially substantial, adverse change in any of physical conditions within an area affected by the proposed project, including ... objects of historic or aesthetic significance." In order to comply with this provision, the lead agency is required to assess whether the project will have an adverse impact on these resources within the 'area of potential effect (APE), and if so, to mitigate that effect.

The NAHC Sacred Lands File (SLF) search resulted as follows: **Native American cultural resources were not identified** within the project area identified. Also, the absence of archaeological resources does not preclude their existence. . California Public Resources Code §§5097.94 (a) and 5097.96 authorize the NAHC to establish a Sacred Land Inventory to record Native American sacred sites and burial sites. These records are exempt from the provisions of the California Public Records Act pursuant to. California Government Code §6254 (r). The purpose of this code is to protect such sites from vandalism, theft and destruction. The NAHC "Sacred Sites,' as defined by the Native American Heritage Commission and the California Legislature in California Public Resources Code §§5097.94(a) and 5097.96. Items in the NAHC

Sacred Lands Inventory are confidential and exempt from the Public Records Act pursuant to California Government Code §6254 (r).

Early consultation with Native American tribes in your area is the best way to avoid unanticipated discoveries of cultural resources or burial sites once a project is underway. Culturally affiliated tribes and individuals may have knowledge of the religious and cultural significance of the historic properties in the project area (e.g. APE). We strongly urge that you make contact with the list of Native American Contacts on the
list of Native American contacts, to see if your proposed project might impact Native American cultural resources and to obtain their recommendations concerning the proposed project. Special reference is made to the *Tribal Consultation* requirements of the California 2006 Senate Bill 1059: enabling legislation to the federal Energy Policy Act of 2005 (P.L. 109-58), mandates consultation with Native American tribes (both federally recognized and non federally recognized) where electrically transmission lines are proposed. This is codified in the California Public Resources Code, Chapter 4.3 and §25330 to Division 15.

Furthermore, pursuant to CA Public Resources Code § 5097.95, the NAHC requests that the Native American consulting parties be provided pertinent project information. Consultation with Native American communities is also a matter of environmental justice as defined by California Government Code §65040.12(e). Pursuant to CA Public Resources Code §5097.95, the NAHC requests that pertinent project information be provided consulting tribal parties. The NAHC recommends *avoidance* as defined by CEQA Guidelines §15370(a) to pursuing a project that would damage or destroy Native American cultural resources and Section 2183.2 that requires documentation, data recovery of cultural resources.

Consultation with tribes and interested Native American consulting parties, on the NAHC list, should be conducted in compliance with the requirements of federal NEPA and Section 106 and 4(f) of federal NHPA (16 U.S.C. 470 *et seq*), 36 CFR Part 800.3 (f) (2) & .5, the President's Council on Environmental Quality (CSQ, 42 U.S.C 4371 *et seq.* and NAGPRA (25 U.S.C. 3001-3013) as appropriate. The 1992 *Secretary of the Interiors Standards for the Treatment of Historic Properties* were revised so that they could be applied to all historic resource types included in the National Register of Historic Places and including cultural landscapes. Also, federal Executive Orders Nos. 11593 (preservation of cultural environment), 13175 (coordination & consultation) and 13007 (Sacred Sites) are helpful, supportive guides for Section 106 consultation. The aforementioned Secretary of the Interior's *Standards* include recommendations for all 'lead agencies' to consider the historic context of proposed projects and to "research" the cultural landscape that might include the 'area of potential effect.'

Confidentiality of "historic properties of religious and cultural significance" should also be considered as protected by California Government Code §6254(r) and may also be protected under Section 304 of he NHPA or at the Secretary of the Interior discretion if not eligible for listing on the National Register of Historic Places. The Secretary may also be advised by the federal Indian Religious Freedom Act (cf. 42 U.S.C., 1996) in issuing a decision on whether or not to disclose items of religious and/or cultural significance identified in or near the APEs and possibility threatened by proposed project activity.

Furthermore, Public Resources Code Section 5097.98, California Government Code §27491 and Health & Safety Code Section 7050.5 provide for provisions for accidentally discovered archeological resources during construction and mandate the processes to be followed in the event of an accidental discovery of any human remains in a project location other than a 'dedicated cemetery'.

To be effective, consultation on specific projects must be the result of an ongoing relationship between Native American tribes and lead agencies, project proponents and their contractors, in the opinion of the NAHC. Regarding tribal consultation, a relationship built around regular meetings and informal involvement with local tribes will lead to more qualitative consultation tribal input on specific projects.

If you have any questions about this response to your request, please do not hesitate to contact me at (916) 653-6251.

Sincerely,

Dave Singleton
Program Analyst

Cc: State Clearinghouse

Attachment: Native American Contact List

3

Response to Comment from the Governor's Office of Planning and Research State Clearinghouse and Planning Unit

Thank you for your comments on the project. No response is necessary.

Comment from Department of California Highway Patrol

State of California

Business, Transportation and Housing Agency

Memorandum

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1/9/2012
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Date: December 19, 2011

RECEIVED
DEC 22 2011
STATE CLEARING HOUSE

To: State Clearning House
1400 Tenth Street, Room 121
Sacramento, CA 95814

From: **DEPARTMENT OF CALIFORNIA HIGHWAY PATROL**
Bakersfield Area

File No.: 420.11632.12883

Subject: RESPONSE TO SCH #2011122028, STATE ROUTE 58 (ROSEDALE HIGHWAY) WIDENING PROJECT

Thank you for the opportunity to review the Initial Study/Environmental Assessment for the State Route 58 (Rosedale Highway) widening project, State Clearing House (SCH) #2011122028. The California Highway Patrol (CHP) is the primary agency that provides traffic law enforcement, safety and management services within the unincorporated portions of the county. As a result of this project, we anticipate local CHP operations will be impacted in the following manner:

- Traffic congestion on all ancillary roadways will increase. Therefore, additional patrol units will need to be assigned to the area as the traffic will be using multiple roadways, instead of State Route 58.

Although we are not opposed to this project, the aforementioned merits consideration. Concern exists that local CHP resources will soon be overwhelmed. In order to continue to provide the high level of safety, service and security the local population has come to expect, future growth of the Bakersfield CHP office is necessary. Questions regarding this matter should be directed to Lieutenant Larry McGuire at (661)864-4436.

WBN

W. B. NATION, Captain
Commander
Bakersfield Area

cc: Special Projects Section

Safety, Service, and Security
CHP 51 (Rev. 03-11) OPI 076

An Internationally Accredited Agency

Response to Comments from Department of California Highway Patrol

Thank you for your comments on the project.

As noted on page 65 of the draft initial study/environmental assessment (page 67 of the final initial study/environmental assessment), the increased congestion would only be expected during the construction period. Once construction is complete, the level of service on the roadway would improve. The project would not result in new or altered land uses; therefore, the project would not increase the overall number of vehicle trips. The increased numbers of trips reflected in the traffic projections are not attributable to the project; rather, they are a result of projected regional growth. Standard Condition SC-2 requires the preparation of a Traffic Management Plan.The Traffic Management Plan will, among other things, optimize roadway capacity, signal phasing, and timing during construction with the goal of ensuring safe and efficient traffic flow throughout the project study area during all phases of construction.

Comment from Native American Heritage Commission

STATE OF CALIFORNIA Edmund G. Brown, Jr., Governor

NATIVE AMERICAN HERITAGE COMMISSION
915 CAPITOL MALL, ROOM 364
SACRAMENTO, CA 95814
(916) 653-6251
Fax (916) 657-5390
Web Site www.nahc.ca.gov
ds_nahc@pacbell.net

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RECEIVED
DEC 23 2011
STATE CLEARING HOUSE

December 20, 2011

Mr. Theodore D. Wriight, Planner
City of Bakersfield
900 Truxtun Avenue, Suite 201
Bakersfield, CA 93301

Re: SCH#2011122028 CEQA Notice of Completion; proposed Mitigated Negative Declaration for the **"State Route 58 (Rosedale Highway) Widening Project;"** located in the City of Bakersfield; Kern County, California

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Sacred Lands Inventory are confidential and exempt from the Public Records Act pursuant to California Government Code §6254 (r). **1 cont.**

Early consultation with Native American tribes in your area is the best way to avoid unanticipated discoveries of cultural resources or burial sites once a project is underway. Culturally affiliated tribes and individuals may have knowledge of the religious and cultural significance of the historic properties in the project area (e.g. APE). We strongly urge that you make contact with the list of Native American Contacts on the list of Native American contacts, to see if your proposed project might impact Native American cultural resources and to obtain their recommendations concerning the proposed project. Special reference is made to the *Tribal Consultation* requirements of the California 2006 Senate Bill 1059: enabling legislation to the federal Energy Policy Act of 2005 (P.L. 109-58), mandates consultation with Native American tribes (both federally recognized and non federally recognized) where electrically transmission lines are proposed. This is codified in the California Public Resources Code, Chapter 4.3 and §25330 to Division 15.

Furthermore, pursuant to CA Public Resources Code § 5097.95, the NAHC requests that the Native American consulting parties be provided pertinent project information. Consultation with Native American communities is also a matter of environmental justice as defined by California Government Code §65040.12(e). Pursuant to CA Public Resources Code §5097.95, the NAHC requests that pertinent project information be provided consulting tribal parties. The NAHC recommends *avoidance* as defined by CEQA Guidelines §15370(a) to pursuing a project that would damage or destroy Native American cultural resources and Section 2183.2 that requires documentation, data recovery of cultural resources.

Consultation with tribes and interested Native American consulting parties, on the NAHC list, should be conducted in compliance with the requirements of federal NEPA and Section 106 and 4(f) of federal NHPA (16 U.S.C. 470 *et seq*), 36 CFR Part 800.3 (f) (2) & .5, the President's Council on Environmental Quality (CSQ, 42 U.S.C 4371 *et seq.* and NAGPRA (25 U.S.C. 3001-3013) as appropriate. The 1992 *Secretary of the Interiors Standards for the Treatment of Historic Properties* were revised so that they could be applied to all historic resource types included in the National Register of Historic Places and including cultural landscapes. Also, federal Executive Orders Nos. 11593 (preservation of cultural environment), 13175 (coordination & consultation) and 13007 (Sacred Sites) are helpful, supportive guides for Section 106 consultation. The aforementioned Secretary of the Interior's *Standards* include recommendations for all 'lead agencies' to consider the historic context of proposed projects and to "research" the cultural landscape that might include the 'area of potential effect.' **2**

Confidentiality of "historic properties of religious and cultural significance" should also be considered as protected by California Government Code §6254(r) and may also be protected under Section 304 of he NHPA or at the Secretary of the Interior discretion if not eligible for listing on the National Register of Historic Places. The Secretary may also be advised by the federal Indian Religious Freedom Act (cf. 42 U.S.C., 1996) in issuing a decision on whether or not to disclose items of religious and/or cultural significance identified in or near the APEs and possibility threatened by proposed project activity. **3**

Furthermore, Public Resources Code Section 5097.98, California Government Code §27491 and Health & Safety Code Section 7050.5 provide for provisions for accidentally discovered archeological resources during construction and mandate the processes to be followed in the event of an accidental discovery of any human remains in a project location other than a 'dedicated cemetery'. **4**

2

To be effective, consultation on specific projects must be the result of an ongoing relationship between Native American tribes and lead agencies, project proponents and their contractors, in the opinion of the NAHC. Regarding tribal consultation, a relationship built around regular meetings and informal involvement with local tribes will lead to more qualitative consultation tribal input on specific projects. 5

If you have any questions about this response to your request, please do not hesitate to contact me at (916) 653-6251.

Sincerely,

Dave Singleton
Program Analyst

Cc: State Clearinghouse

Attachment: Native American Contact List

3

Response to Comments from the Native American Heritage Commission

Thank you for your comments on the project.

Response to comment #1: The finding that the Native American Heritage Commission's Sacred Lands File did not identify any cultural resources in the project study area is consistent with our earlier coordination with the commission. As indicated on page 110 of the draft initial study/environmental assessment (page 112 of the final initial study/environmental assessment), coordination with the Native American Heritage Commission was initiated in June 2007 as part of the larger Thomas Roads Improvement Program. The Native American Heritage Commission confirmed the lack of resources in written correspondence dated June 21, 2007. A copy of the letter from the Native American Heritage Commission, as well as a summary of the consultation with Native American tribes, is included in the Historic Property Survey Report for the project.

Response to comment #2: Early consultation with Native American tribes was initiated. Twelve Native American contacts for Kern County were identified by the Native American Heritage Commission along with ten other individuals. These groups and individuals were contacted via written correspondence dated July 30, 2007. The contacts were asked if they were aware of any resources or sensitive locations in the project area. Of the 22 groups and individuals contacted, three provided comments that expressed general concerns related to potential damage to archaeological sites and offered various recommendations. This is addressed on page 110 of the draft initial study/environmental assessment (pages 112–113 of the final initial study/environmental assessment).

Response to comment #3: Thank you for the reminder on the process. Caltrans and the City of Bakersfield are aware of the confidential nature of the location of historic properties of religious and cultural significance. For the State Route 58 Widening Project, there are no such known resources.

Response to comment #4: The initial study/environmental assessment has identified a Standard Condition (SC-3) to address appropriate action if cultural materials are discovered during construction. The measure specifically identifies compliance with Section 7050.5 of the California Health and Safety Code and Section 5097.98 of the California Public Resources Code if human remains are discovered (page 112 of the draft initial study/environmental assessment and page 114 of the final initial study/environmental assessment).

Response to comment #5: Caltrans District 6 has a designated liaison for Native American coordination to ensure consistent interaction with the appropriate tribes on all projects.

Comment from North Kern Water Storage District

P.O. Box 81435
Bakersfield, CA 93380-1435
Administration
Telephone: 661-393-2696
Facsimile: 661-393-6884

33380 Cawelo Avenue
Bakersfield, CA 93308-9575
Water Orders and Operations
Telephone: 661-393-3361
Telephone: 661-746-3364

NORTH KERN WATER STORAGE DISTRICT

December 28, 2011

Bryan Apper, Senior Environmental Planner
Southern Valley Environmental Analysis Branch
California Department of Transportation
855 M Street, Suite 200
Fresno, California 93721

Subject: State Route 58 (Rosedale Highway) Widening Project
06-KER-58-PM 46.1/51.7
Project ID 0600000076

The above-referenced project crosses the North Kern Water Storage District's Calloway Canal at two locations. The Calloway Canal was constructed in the mid 1870's and is a critical component used by the District for conveyance of water for irrigation and ground water recharge. We wish to offer the following comments: 1

1. Any expansion of right of way or significant change in existing canal crossings needs to be formalized in a license agreement or common use agreement with the District.

2. The canal crossings should be fenced to protect small children and the public in general. 2

3. The maintenance access of the District must be maintained off of Rosedale Highway on both sides of the canal crossings. 3

    a. All access points should be designed with turning radius so the District can access the canal with a truck and trailer.
    b. A guardrail was installed in the past on the south side of Rosedale

State Route 58 (Rosedale Highway) Widening Project

12/28/2011 Page 1 of 2

Highway on west side of the easterly crossing (near Fruitvale) that blocks maintenance access and the District cannot find any notification from or agreement with Caltrans in its files. This guardrail needs to be removed so the District can access its canal bank. **3 cont.**

4. Any expansion of the width of bridges should not increase the District's maintenance exposure. The inverts of the canal crossings should be concrete paved to offset maintenance of the increased widths. **4**

5. Any bridge work should not diminish the District's hydraulic capacity. No new bridge pilings should be installed in the canal invert. **5**

Very truly yours,

DANA S. MUNN
Engineer-Manager

Response to Comments from the North Kern Water Storage District

Thank you for your comments on the project.

Response to comment #1: As indicated in the initial study/environmental assessment (Table 2.3—page 39 of the draft document and 39 of the final document), roadway widening would only be required over the westerly crossing of Calloway Canal. About 78 square feet of additional right-of-way would be required for the Build Alternative. The City of Bakersfield will coordinate with the North Kern Water Storage District during design of the improvements in this location regarding a license agreement or a common use agreement. The need for this approval has been added to Table 1.4, Project Permits and Approvals, in the final initial study/environmental assessment (see pages 23–24).

Response to comment #2: During project design, the City of Bakersfield will coordinate with the North Kern Water Storage District to ensure the fencing provided meets the district's requirements to ensure safety at the canal.

Response to comment #3: At the west crossing, where project improvements are proposed, the City of Bakersfield will coordinate with the North Kern Water Storage District to ensure the district's access to the canal is not reduced. The project does not propose any alteration to the easterly crossing of State Route 58 over the Calloway Canal. The previous installation of a guard rail on the south side of Rosedale on the west side of the easterly crossing is not related to this project, especially since the project will not alter this crossing. However, this issue will be addressed by the City of Bakersfield during project design to ensure that the district has access to the canal and that safety issues are properly addressed.

Response to comment #4: Widening the bridge over the canal will not alter the width of the channel. Therefore, the project would not increase maintenance responsibilities for the district. Paving the canal inverts is not proposed.

Response to comment #5: The project would have a *de minimus* impact on the hydraulic capacity of the canal because of the limited area displaced in the canal by the new columns needed to support the widened roadway and because the new columns would be in line with existing columns.

Comment from California Public Utilities Commission

STATE OF CALIFORNIA EDMUND G. BROWN JR., *Governor*

PUBLIC UTILITIES COMMISSION
320 WEST 4TH STREET, SUITE 500
LOS ANGELES, CA 90013

RECEIVED
JAN 11 2012
PW-TRIP

January 6, 2012

Theodore D. Wright
City of Bakersfield
1715 Chester Avenue
Bakersfield, CA 93301

Dear Mr. Wright:

Re: SCH 2011122028; State Route 58 (Rosedale Highway) Widening Project

The California Public Utilities Commission (Commission) has jurisdiction over the safety of highway-rail crossings (crossings) in California. The California Public Utilities Code requires Commission approval for the construction or alteration of crossings and grants the Commission exclusive power on the design, alteration, and closure of crossings.

The Commission's Rail Crossings Engineering Section (RCES) is in receipt of the *Notice of Completion & Environmental Document Transmittal-Mitigated Negative Declaration* from the State Clearinghouse for State Route (SR) 58 Widening Project from west of Allen Road to SR 99. The project description mentions the addition of two lanes, one in each direction. The BNSF Railway Company existing grade-separated crossing (BNSF) (CPUC No. 002-893.80-A, DOT No. 028375U) would be included and in addition the San Joaquin Valley Railroad Company (SJVR) at-grade crossing (CPUC No. 103Q-113.20, DOT No. 029473N) would be grade-separated. **1**

Modifications to an existing grade separated crossing require authorization from the Commission. The new SJVR grade-separated crossing would require a formal application for authorization. More information can be found at:
http://www.cpuc.ca.gov/PUC/transportation/crossings/Filing+Procedures/

City should arrange a meeting with RCES, BNSF and SJVR staff to discuss relevant safety issues and requirements for authority to alter the existing grade-separated crossing and construct a new grade separation. **2**

If you have any questions in this matter, please contact Sergio Licon, Utilities Engineer at 213-576-7085, sal@cpuc.ca.gov or myself at (213) 576-7078 or at rxm@cpuc.ca.gov.

Sincerely,

Rosa Muñoz, PE
Senior Utilities Engineer
Rail Crossings Engineering Section
Consumer Protection & Safety Division

Response to Comments from Public Utilities Commission

Thank you for your comments on the project.

Response to comment #1: The need for Public Utilities Commission approval of the new grade-separated crossing is identified in Table 1.4, Project Permits and Approvals.

Response to comment #2: Coordination with the railroads and Public Utilities Commission staff has been initiated. A copy of correspondence from the BNSF Railway and the San Joaquin Valley Roadway has been added to Appendix L, Key Correspondence.

Comment from Chevron

Chevron

Bakersfield, California
January 4, 2012

Bryan Apper
Department of Transportation
Southern Valley Environmental Analysis Branch
85 M Street, Suite 200
Fresno, CA 93721

Re: **State Route 58 (Rosedale Highway) Widening Project**

Bryan:

Thank you for giving us the opportunity to send you information on our facilities. We would like to give you a little background on our pipelines and some of the safety requirements we require before allowing any work near our pipelines.

Chevron Pipe Line Company (CPL) records reflect that there are one (1) 4-inch oil pipeline, one (1) 6-inch oil pipeline and three (3) 8-inch oil pipelines within your project area. CPL's easements and pipelines are protected by State and Federal Pipeline Safety Laws, which restrict installation of structures or improvements by persons other than the operator of the easement. CPL's policy is to remain in compliance and to maintain its easements regardless of the current operational status of the pipelines.

Our pipelines are operated and maintained under Federal Regulations (D.O.T. 195) and State Regulations (California Pipeline Safety Act).

Regarding restrictions on development over our pipelines, as previously mentioned, our pipelines and easements are operated and maintained under Federal Regulations (D.O.T. 195) and California Pipeline Safety Act (CAPSA). Inspection of the pipeline rights-of-way are required by Federal law D.O.T (CFR 195.412), and is extremely important in maintaining safe pipeline operations. Article 51014.6 (a) of CAPSA specifies that no person, other than the pipeline operator, shall (1) build, erect or create a structure or improvement within the pipeline easement or permit the building, erection, or creation thereof. 1

In order to comply with the above stated regulations it is imperative that CPL has the opportunity of reviewing and evaluating all construction plans that involve proposed right-of-way encroachments. **In addition, any proposed modification to the existing grade over the pipeline including the addition or elimination of soil by cut or fill will need to have prior approval of CPL.** All excavations within 24-inches of CPL's facilities must be done by hand tools only.

CPL, Federal, and State regulations require 12-inches (minimum) clearance between petroleum pipeline and other crosslines that intersect at a 90° angle (perpendicular to each other). If the intersection angle is less than 90°, the minimum clearance between the two pipelines must be 24-inches or greater.

Please be advised that any modification or relocation of any of CPL's pipeline facilities would be at the cost and expense of the developer, including the acquisition of a replacement easement agreement if required, and Chevron would be reimbursed for the total costs of any adjustment of our facilities to accommodate the proposed project.

If a conflict cannot be avoided and the developer's project is subject to the CEQA/NEPA (California Environmental Quality Act/National Environmental Policy Act), then CPL's work is an integral component of the developer's project ("Action"). As such, we will look to the developer to acquire any and all resource agency permitting necessary for CPL's integral component of the Action. Additionally, we will look to the developer to administer all applicable conditions and/or measures stemming from the Action's EIS (Environmental Impact Statement) or equivalent and/or associated permits.

Enclosed for your reference are, a portion of Drawing Number PL-A 10092 and a portion of Drawing Number 304-R-394 showing the **approximate** location of the CPL-operated pipelines, a copy of our "Minimum Design Considerations for the Protection of High Risk Pipelines" and a Real Estate Development and Urban Planning brochure. CPL assumes no responsibility for the accuracy of the drawing and it should be used only for the general location of our facilities. Actual depths and alignment could only be determined by field checking and potholing the pipeline. CPL will provide a Facility Inspector to mark and help locate our pipeline. Your company or contractor is responsible for providing a backhoe and operator and a surveyor if needed. **1 cont.**

All work that would affect our pipeline needs to be coordinated with our office at P.O. Box 2930, Bakersfield, CA. 93303.

So that we can field mark our lines prior to any construction, we request that the property owner/contractor make the following notifications: **2**

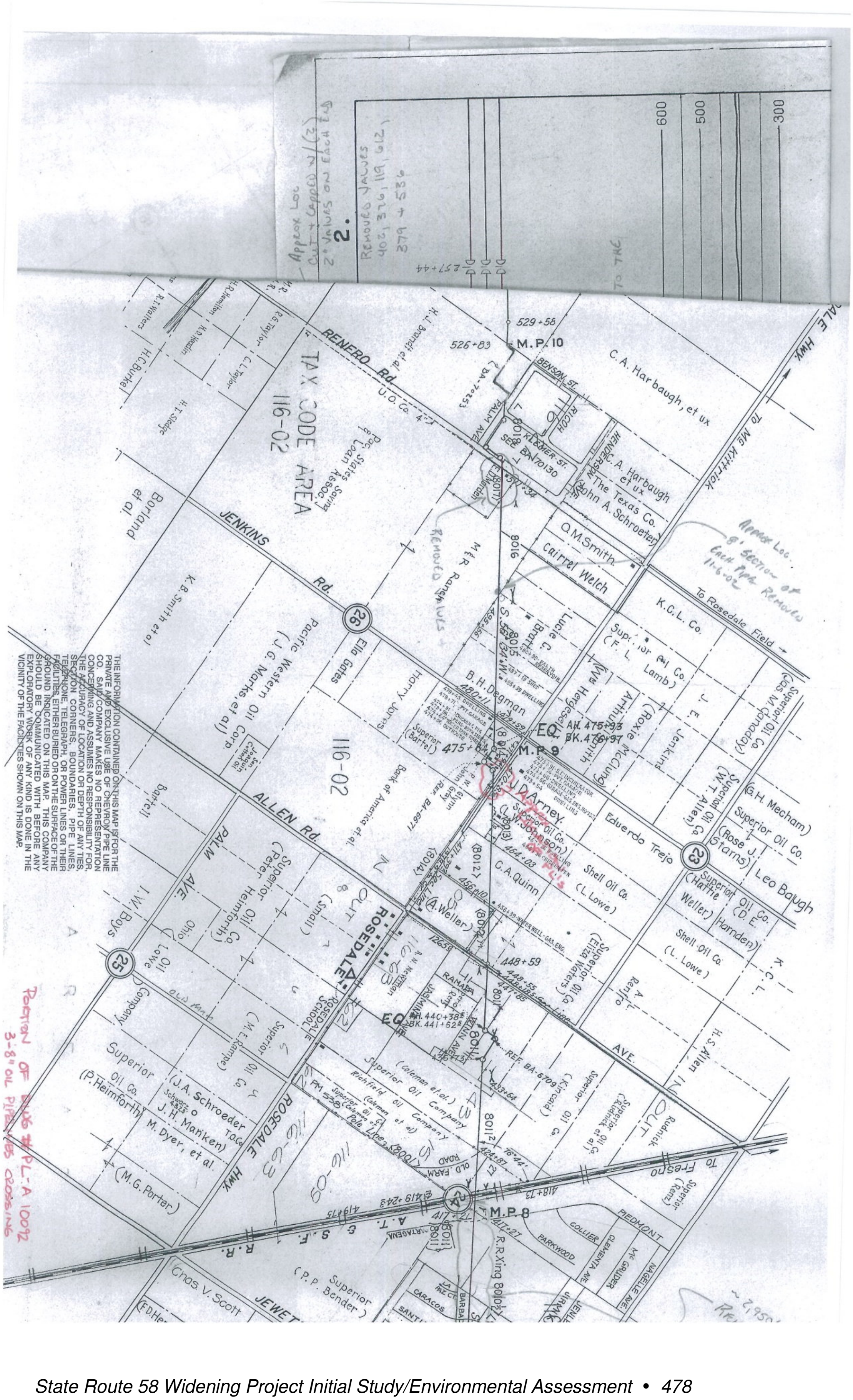
- Underground Service Alert at (800) 227-2600, two working days prior to any on-site work
- Chevron Pipe Line Company Facilities Inspection Office (Armando Rivera) at (661-763-2245).

If there are any questions concerning this matter, I can be reached at (661) 654-7024. When corresponding, please refer to our File No. 11-089.

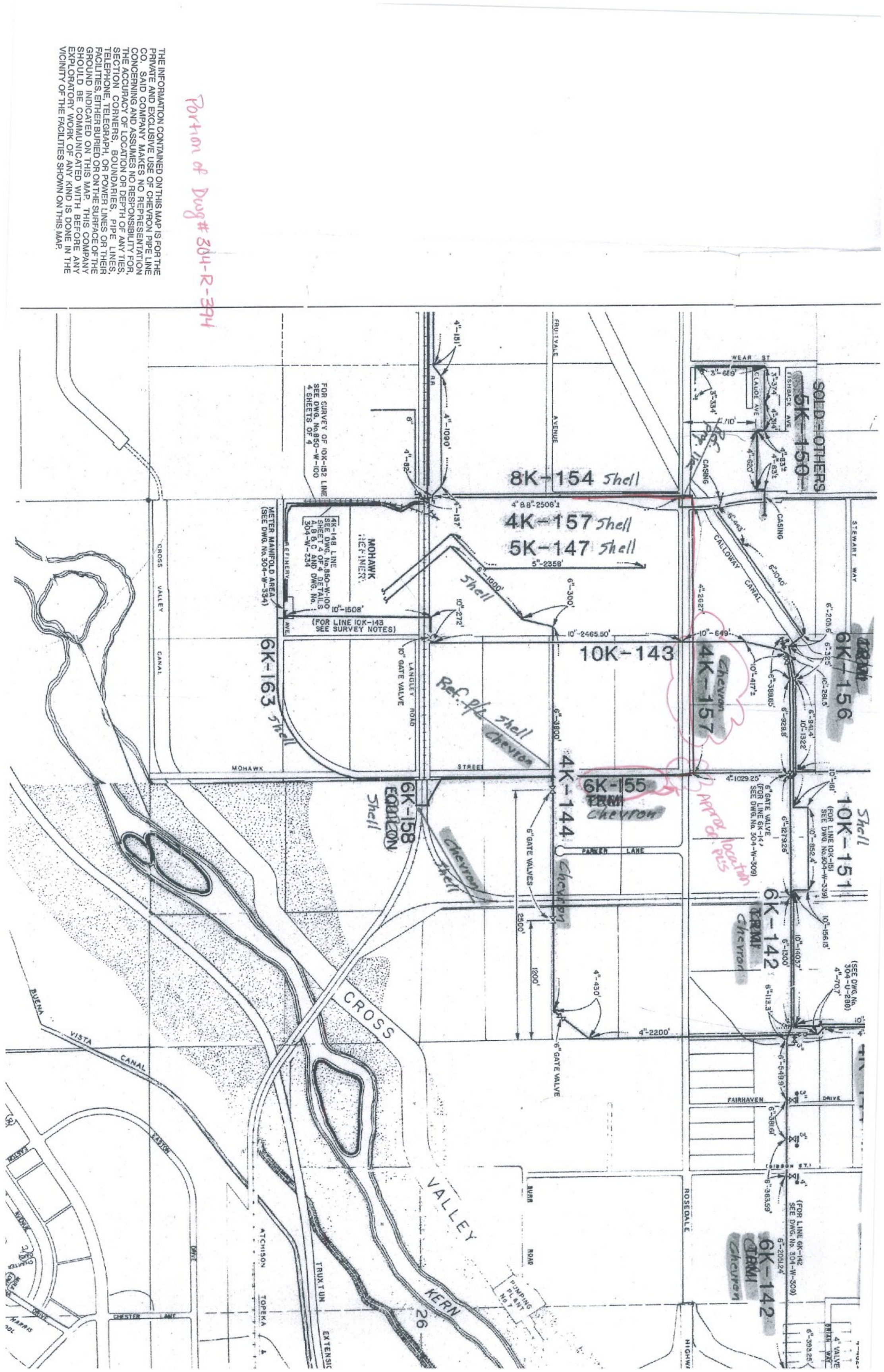
Sincerely,

Lisa Wilson
Contract Right of Way Specialist

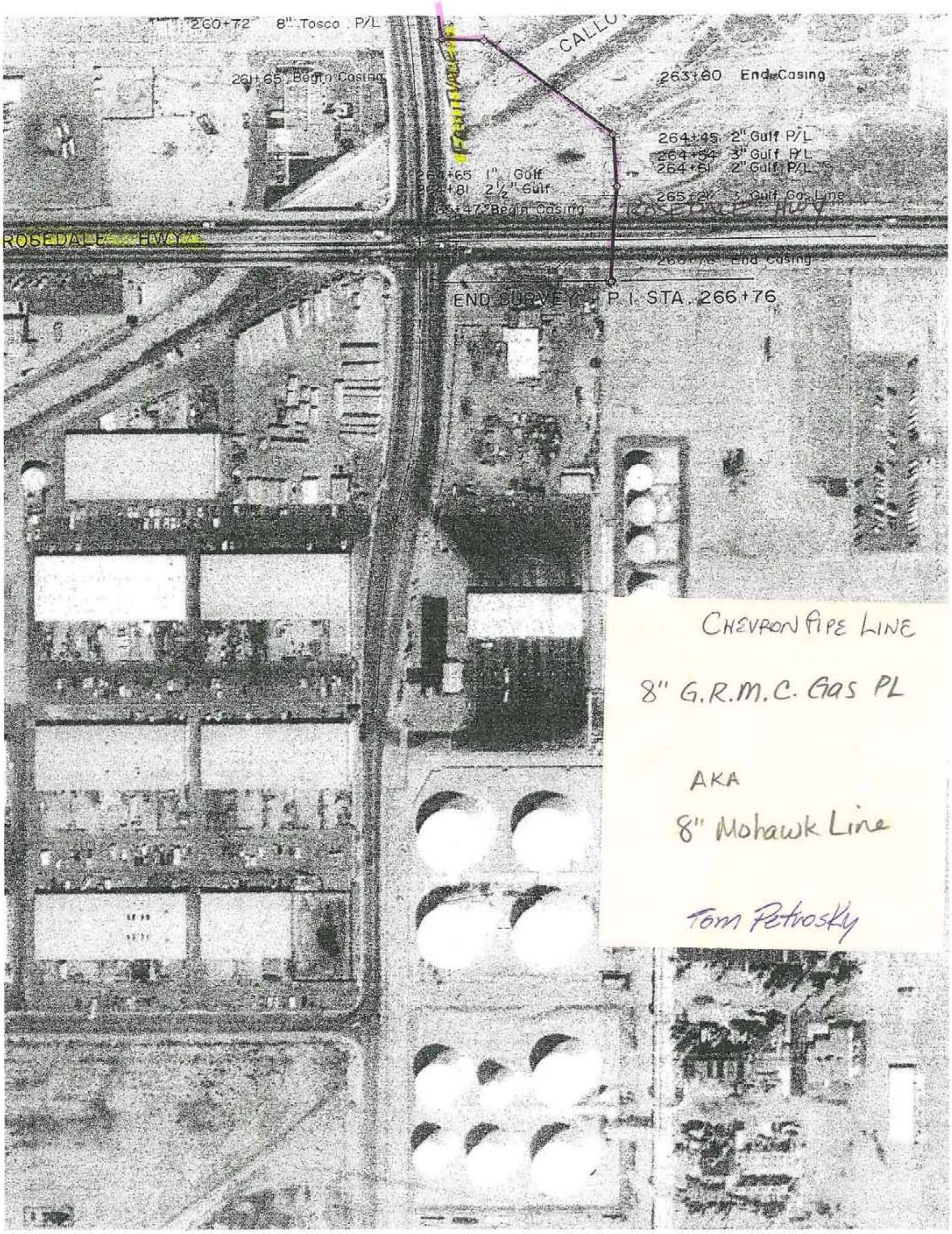
Attachment



RENERO Rd.
JENKINS Rd.
ALLEN Rd.
PALM AVE
ROSEDALE HWY
TAX CODE AREA 116-02
M.P. 10
M.P. 9
M.P. 8
C.A. Harbaugh, et ux
The Texas Co.
To Rosedale Field
Eduardo Trejo
G.H. Mecham
Leo Baugh
Superior Oil Co.
Shell Oil Co.
Bank of America et al
Pacific Western Oil Corp.
K.B. Smith et al
Borland et al
Superior Oil Company
Richfield Oil Company
A.T. & S.F. R.R.
Chas V. Scott
To Fresno
PIEDMONT
600
500
300


THE INFORMATION CONTAINED ON THIS MAP IS FOR THE PRIVATE AND EXCLUSIVE USE OF CHEVRON PIPE LINE CO. SAID COMPANY MAKES NO REPRESENTATION CONCERNING AND ASSUMES NO RESPONSIBILITY FOR, THE ACCURACY OF LOCATION OR DEPTH OF ANY TIES, SECTION CORNERS, BOUNDARIES, PIPE LINES, TELEPHONE, TELEGRAPH, OR POWER LINES OR THEIR FACILITIES, EITHER BURIED OR ON THE SURFACE OF THE GROUND INDICATED ON THIS MAP. THIS COMPANY SHOULD BE COMMUNICATED WITH BEFORE ANY EXPLORATORY WORK OF ANY KIND IS DONE IN THE VICINITY OF THE FACILITIES SHOWN ON THIS MAP.
Portion of Dwg# 304-R-394
8K-154 Shell
4K-157 Shell
5K-147 Shell
10K-143
4K-157
Chevron
6K-163 Shell
4K-144
6K-155
Chevron
6K-158
EQUILON
Shell
6K-156
10K-151
Shell
6K-142
Chevron
SOLD-OTHERS
5K-150
MOHAWK REFINERY
CROSS VALLEY CANAL
BUENA VISTA CANAL
CROSS VALLEY
KERN
STEWART WAY
CALLOWAY CANAL
MOHAWK STREET
PARKER LANE
FAIRHAVEN DRIVE
ROSEDALE
TRUXTUN EXTENSION
ATCHISON
TOPEKA
Approx location of P/Ls
Ref.-P/L Shell Chevron

Comment from Tom Petrosky



Minimum Design Considerations for Protection of High Risk Pipelines

1. Identify Positive Location: Pothole & Survey Easement Boundaries & Exact Elevations of Underground Facilities: Pipeline elevations must be obtained a minimum of every 100 feet to provide data to render profile views of the pipelines on design plans to allow consideration and calculation for determination of clearance and maximum allowable load capacities (surcharge +/or overburden).
2. Design to Miss and Protect in Place:
   - (a) Plot detail section +/or profile views indicating easement boundaries; elevation of underground facilities in relation to proposed improvements; existing and proposed grade elevations. (Easement boundaries and pipeline locations should be surveyed and delineated on site before any work in proximity to CPL facilities).
   - (b) Determine and develop appropriate written "Contractor Job Site Safety Plan (JSSP)" (i.e., safe construction plans/proper excavation techniques and equipment placement procedures to protect and support existing pipelines from any excessive anticipated static or dynamic loads, which may cause facilities to move or rupture). (Heavy vibratory equipment loading must be considered and alternative compaction methods used to avoid direct stress applied to the pipelines).
   - (c) Determine minimum depth of cover requirements to protect pipelines in place from anticipated loads during and upon completion of construction to ensure compliance with Company Policy; Street and Highway Standards (HS); Pipeline Safety Law; Government Code and other related regulatory requirements. Where less than five and a half feet of compacted soil cover exist project design must provide equivalent protection that will not exceed HS-20 loading.
   - (d) Grade design must provide adequate protective soil cover allowing pipelines to withstand dynamic forces exerted by anticipated traffic loads, during and upon completion of construction activity impacting CPL easements.
   - (e) Equipment lists specifying fully loaded gross vehicle weights must be provided to confirm that maximum allowable loads will not apply excessive load/abnormal bearing forces that may cause pipelines to move, rupture or sustain mechanical damage.
   - (f) Proposed grade changes must be approved by CPL Facilities Representative and Engineering/Technical Services. Excessive fill will not be permitted over CPL facilities. Changes to existing pipeline cover, within 50 feet of any occupiable proposed structure, requires adjustment of proposed cover to maintain a minimum of 48 inches cover above the pipelines.
   - (g) Design to avoid placement of major structural encroachments within and immediately adjacent to existing Hazardous Liquid Pipeline Easements and realign +/or adjust structures adjacent to any pipeline easement to prevent easement obstruction or impairment and interference with future maintenance access to existing pipeline facilities.
   - (h) No structural encroachments or improvements impacting safe pipeline operations are permitted within or immediately adjacent to CPL easements (e.g., foundations, footings, trees, or paralleling utilities etc.). Backfill must be rock free native, clean sand or zero sack slurry.
   - (i) As determined and approved by qualified engineering personnel; To prevent undermining of proposed structures; And allow for safe construction offset for future routine or emergency pipeline maintenance excavation access; Structural improvements in proximity to and out of the easement/immediately adjacent to easement boundaries must provide for minimum safe construction offsets of:
     1) A minimum of five (5) feet outside of easement boundaries; or
     2) A one and a half to one (1+1/2:1) excavation angle of repose from the pipeline nearest to proposed structures; or
     3) A dimension required by government code, whichever of items 1 through 3 is greater.
     4) Field conditions preventing minimum safe offsets, require minimum footing depths of 24" to 30" or more below the bottom of the deepest pipeline within the easement; And must ensure the angle load influence is designed to miss underground pipelines; (To prevent stress in excess of maximum allowable loads to the pipelines). In no case will face of footings be permitted with less than 24 inches horizontal clearance away from the pipeline nearest proposed structural footings.
     5) Due diligence and reasonable practicality near pipeline easements; dictate large trees, woody shrubs or any dense trunk bodied species, and/or deep rooted plant types; will not be planted within the easement or the zone of compliance required for safe trench sloping, maintenance excavation access and safe pipeline operational procedures.
        - (a) No trees, woody shrubs or any dense trunk bodied species are permitted within the right-of-way. Root systems can cause damage interfering with the integrity of pipeline coating and corrosion control systems. Trees and overhanging branches create obstruction and shielding impairing aerial patrol observation and

preventing complete unimpaired and unobstructed easement access for vehicular routine or emergency maintenance ingress and egress.

(b) Plant types with major root systems proposed within the zone of adverse impact to CPL facilities will require root guards to be installed a minimum depth of 36 inches below the bottom of the deepest pipeline within the easement. Plant plans and root system detail review approval required for proposed landscaping impacting CPL easements.

3. Before beginning construction activity near or over Chevron Pipe Line Company (CPL) facilities; Proposed final design and construction plans for "protection in place" of CPL facilities must be reviewed and approved by the CPL Facilities Representative and CPL Engineering/Technical Services; To ensure minimum safe construction offset for placement of major structures outside of CPL easement boundaries and consideration of excessive loads have been calculated and compensated for. All responsible parties must agree upon an appropriately "Engineered Solution" for construction activities and improvements proposed in proximity to CPL facilities.

Structural encroachments within and obstructions adjacent to Chevron Pipe Line Company (CPL) easement which would prevent unimpaired surfaces access and shrubbery or shielding which would impair aerial observation of the easement are not permitted. To maintain compliance with Pipeline Safety Laws and CPL policy, please insure all Contractors associated with the project comply with the following minimum facilities inspection requirements:

1. A CPL representative must be present whenever Contractors are working over or near CPL facilities.
2. Notify CPL Facilities Inspection Office at (661) 763-2036 and Underground Service Alert at: (800) 227-2600 a minimum of 2 to 14 working days prior to any on-site work.
3. Excavators must verify exact elevations/depth of cover (DOC) of CPL facilities in conflict with the project by excavating with hand tools. CPL Facilities are to be exposed by hand digging only, before using power-operated equipment over or within pipeline easements operated or maintained by CPL. DOC data obtained during pothole survey shall be and remains proprietary and confidential property of Chevron Pipe Line Company. Project Developers and Excavation Contractors may use data obtained, only for the sole purpose of assisting with design of the project, to determine proper excavation techniques and construction requirements, to protect pipelines in place during project activity over or near CPL for preventing unauthorized or illegal encroachment of CPL facilities.
4. CPL facilities must be protected from hazards causing pipelines to move or sustain abnormal loads, or excess localized stress and potential pipeline rupture. Anticipated external loads must be provided for during construction and upon completion of approved improvements over or near CPL facilities. DOC data must be obtained for calculation of safe load bearing factors to be determined before deployment of heavy equipment or placement of load-bearing structures over CPL product pipelines.
5. Final DOC over CPL facilities must meet minimum Department of Transportation depth of cover requirements, plus maximum allowable external load application, and be approved by CPL Engineering/Technical Services Department. Adequate ground cover is required and critical for maintaining safe pipeline operations. Existing cover over CPL is to be field verified by the Project Excavation Contractors under observation of the assigned CPL Facilities Inspector.
6. Specific details of proposed foreign utilities crossing CPL are required to be planned in advance with CPL. Installation of utility crossings must be placed below CPL facilities and provide 24" clearance if feasible, but not less than 12'' of clearance is required. Only lateral service crossings are permitted within CPL easements. Parallel utilities are not permitted.
7. CPL facilities are Cathodically Protected: In event of improvements proposing any metallic pipes or structures in proximity to the easement, it is absolutely necessary that arrangements be made for the protection of CPL facilities in order to prevent problems of electrical interference upon the pipelines.
8. Backfill must protect coating and support pipe. Only rock free native soil, clean sand or zero sack slurry may be used as backfill material. No cement slurry allowed within 24" of CPL pipelines.
9. No structural encroachments or improvements impacting safe pipeline operations are permitted within or immediately adjacent to CPL easements (e.g., foundations, footings, trees, parallel fencing and/or utilities etc.).
10. Proposed structures or improvements adjacent to CPL easement boundaries require engineering/technical calculations to determine safe construction and equipment offset distances, appropriate angle of repose, surcharge or overburden factors, to insure prevention of undermining proposed improvements in the event of future CPL pipeline maintenance or emergency excavations to access pipeline facilities.
11. If it is determined by CPL Engineering/Technical Services; that adequate cover, clearance or protection from load bearing forces cannot be obtained within the scope of proposed Project Design, then CPL would require CPL facilities to be modified, relocated, lowered in place or additional fill placed above the pipelines. Except express terms and conditions in reference to responsibility for costs, it is expected, that improvements requiring pipeline system design changes, that CPL would be reimbursed for actual costs and receive payment of estimated costs in advance before scheduling work for such changes (i.e., changes in DOC, modifications, lowering, relocation or removal of pipelines to accommodate new construction improvements for Project Site Development).
12. All Developers and Contractors associated with the project must agree to sign and abide by the terms of the attached Acknowledgement of Line Crossing Procedures and/or Hazardous Liquid Substructure Notification, as specified at time of construction by the CPL Facilities Inspector.

Failure to comply with requirements of Pipeline Safety Laws subject the violator to liability for any damage incurred by CPL Facilities during excavation/construction operations. Civil and/or Criminal Penalties may result from Failure to Comply.

Minimum Design and Inspection Specifications, and Load Capacities for High Risk Pipelines

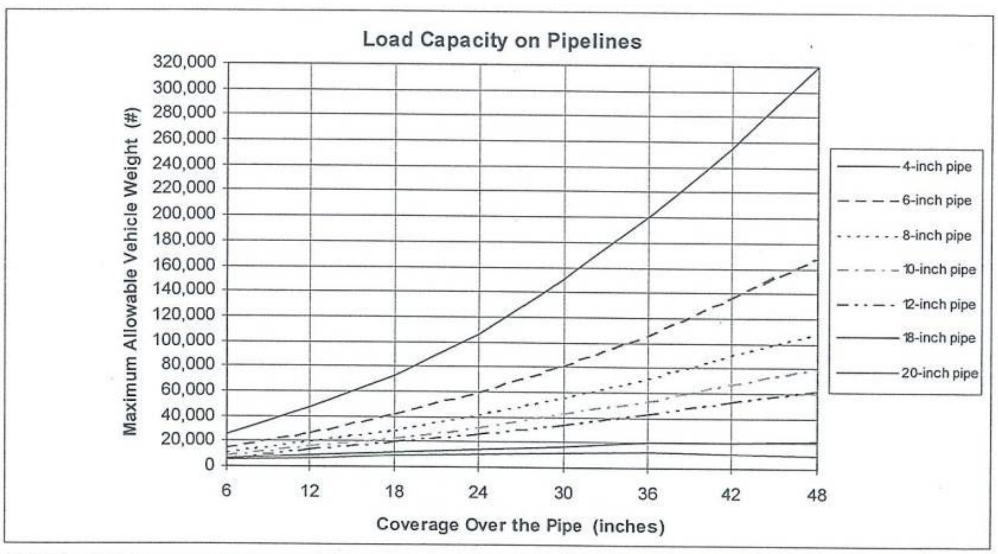
(NOTE: For purpose of minimum safe design; Boundaries immediately adjacent to, over or within CPL with easement, rights of way or fee property are synonymous)

LOAD BEARING CAPACITY GUIDELINES FOR PIPELINES

Coverage Over the Top of the Pipe	Maximum Allowable Vehicle Weight							
	4-inch pipe	6-inch pipe	8-inch pipe	10-inch pipe	12-inch pipe	18-inch pipe	20-inch pipe
inches	pounds	pounds	pounds	pounds	pounds	pounds	pounds
6	26,000	15,000	11,000	9,000	7,000	6,000	5,000
12	47,000	27,000	20,000	16,000	14,000	9,000	7,000
18	73,000	42,000	29,000	23,000	20,000	11,000	8,500
24	106,000	60,000	42,000	32,000	27,000	14,000	10,500
30	150,000	82,000	56,000	43,000	35,000	17,000	12,000
36	200,000	106,000	72,000	54,000	43,000	20,000	12,500
42	255,000	136,000	90,000	67,000	53,000	21,000	12,000
48	320,000	168,000	109,000	80,000	62,000	22,000	10,000

Assumptions:

1. Grade-B pipe strength
2. Lap Weld Joints
3. Schedule 10 pipe wall thickness
4. Vehicle has 4 wheels
5. Weight includes vehicle-driver-cargo-fuel
6. Weight does not include dynamic forces of a moving vehicle over rough terrain
7. Analysis performed with the typical 1.25 factor of safety
8. Internal pipe pressure = 0-psi



NOTES: Table presented as guidelines only: Current calculations for pressurized pipe must be calculated and / or confirmed by CPL Engineering Staff for project proposed/anticipated Maximum Allowable External Load.

1. Anticipated external dynamic and/or static loads must be calculated and compensated for in project design
2. Pipelines must be protected from hazards that may cause the pipeline to move or to sustain abnormal loads
3. Load factor calculations must be computed and verified by project design and pipeline operator engineering staff
4. Load capacity tabulated data are presented as guidelines only. Parties using load capacity guidelines do so at their own risk and indemnify the presenter harmless from all claims of liability resulting from death or injury to persons, and from all loss, damage to property by using the above referenced data. Indemnification hereunder shall include all cost and expenses, including all court and/or arbitration costs, filing fees, attorney's fees and costs of settlement

Minimum Design and Inspection Specifications, and Load Capacities for High Risk Pipelines

(NOTE: For purpose of minimum safe design; Boundaries immediately adjacent to, over or within CPL with easement, rights of way or fee property are synonymous)

Chevron Pipe Line Company
Emergency Number
Número De la Emergencia
1-800-762-3404

Regional One-Call Centers
Centros Regionales One-Call

- Alabama 1-800-292-8525
- Alaska 1-800-478-3121
- California 1-800-227-2600
- Colorado 1-800-922-1987
- Idaho 1-800-342-1585
- Louisiana 1-800-272-3020
- Mississippi 1-800-227-6477
- New Mexico 1-800-321-2537
- Oregon 1-800-332-2344
- Texas 1-800-344-8377
- Utah 1-800-662-4111
- Washington 1-800-424-5555
- Wyoming 1-800-348-1030

Office of Pipeline Safety
http://primis.phmsa.dot.gov/comm/

Dig Safely
http://www.digsafely.com
1-888-258-0808

American Petroleum Institute - Pipeline Information
www.pipeline101.com

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·800 Fournace
ʼellaire, TX 77401-2324

Chevron

Real Estate Development and Urban Planning
Pipeline Safety In Your Community

Desarrollo de bienes raíces y planeación urbana
La seguridad de las tuberías de distribución en su comunidad

Chevron

November 2006

Chevron Pipe Line Company is committed to helping communities live safely with nearby underground pipelines that we operate.

Assurance of pipeline safety can best be achieved with the support and assistance of local government officials and real estate planning agencies. One of our industry's major safety initiatives in recent years has been the prevention of spills caused by people who damage underground pipelines due to excavation activities

We are enclosing important pipeline safety information for you because your community is located within the same county or parish where underground pipelines are operated by Chevron Pipe Line Company.

We hope that you will take a few minutes to familiarize yourself and your personnel with this important pipeline safety information and keep it as a reference to be reviewed periodically. We have also included safety recommendations for planning new property use and space allocations, as well as guidance on property improvements and buffer requirements.

We value your input and would like to hear from you. Please take a moment to answer the brief enclosed survey and return the prepaid postage card. You are not required to provide your name. However, we do encourage you to return your survey, and we welcome your comments and/or suggestions.

We consider you a partner of Chevron Pipe Line Company's commitment in protecting the public and environment. For additional information, please write to us at Chevron Pipe Line Company, 4800 Fournace, Bellaire, TX 77401-2324. If you have a non-emergency issue concerning Chevron Pipe Line Company and you would like to speak with our representative, please call 1-877-596-2800 or **send us an email at CPLCAO@chevron.com.**

Thank you for your attention and cooperation on behalf of Chevron Pipe Line Company.

Sincerely,

Rebecca B Roberts

Rebecca Roberts
President

Chevron Pipe Line Company

Chevron

Chevron Pipe Line Company

Pipeline System Map / Mapa Del Sistema De la Tubería

10,800 Miles / 13 States / 123 Counties and 25 Parishes




ble of Contents:

dice:

Chevron Pipe Line Company operates pipelines for the following companies:

Chevron Pipe Line Company funciona las tuberias para las siguientes compañias:

- Chevron Pipe Line Company
- Bridgeline Holdings L.P.
- Bridgeline Gas Distribution LLC
- Bridgeline Storage Co. LLC
- Texaco Pipelines LLC
- Texaco Petrochemical Pipeline LLC
- Sabine Pipe Line LLC
- Louisiana Generating LLC
- Unocal Pipeline Co.
- White Cap Pipe Line Co. LLC
- Unocal Keystone Gas Storage LLC
- Cook Inlet Pipeline Co.

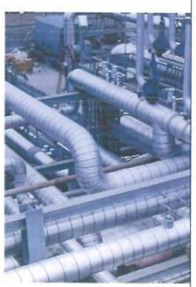
Pipeline Industry

Importance to safe urban planning and redevelopment

The management of community safety as it relates to underground pipelines involves the cooperation and teamwork between pipeline operating companies, urban planning departments and real estate development companies.

Nationally, there are 2.3 million miles of underground pipeline systems transporting petroleum products safely and economically. Pipeline transportation of petroleum and natural gas products is an integral part of the infrastructure of all communities and serves as a critical infrastructure supporting the economic viability of our nation. Truck and rail transportation cannot equal the safety records of pipeline transportation of these petroleum products, nor can they match the efficiency of pipelines to deliver these products economically.

The nation's pipelines are the arteries of our national energy supply. Pipelines are essential to our transportation system and our way of life.



Suburban development in previously rural areas has placed many residential communities, businesses, schools, churches and shopping complexes closer to our nation's pipeline systems.

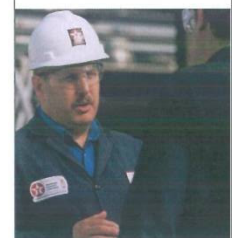
At Chevron Pipe Line Company, our goal is to promote and enhance pipeline safety in communities where we operate pipelines to assure safe coexistence.

This booklet provides real estate planning and development agencies with the essential information needed to make informed decisions about pipeline safety and how to prepare safely for coexistence with the presence of pipelines in your community.

Industria de tuberías de distribución

Importancia de la planeación y reestructuración

El control de la seguridad comunitaria en cuanto a tuberías de distribución subterráneas implica la colaboración y trabajo en equipo de las empresas que operan tuberías de distribución, los departamentos de planeación urbana y las entidades de desarrollo de bienes raíces.



En todo el país hay 2.3 millones de millas de sistemas de tuberías de distribución subterráneas que transportan productos del petróleo en forma segura y económica. El transporte de productos de petróleo y gas natural es una parte integral de la infraestructura de todas las comunidades y sirve como infraestructura esencial que sustenta la viabilidad económica de nuestra nación. El transporte mediante camiones de carga y ferrocarril no iguala los parámetros de seguridad del transporte de estos productos a través de tuberías ni puede compararse con la eficiencia económica de las tuberías para distribuir estos productos.

Las tuberías de distribución de nuestro país son las arterias que nos suministran energía. Las tuberías de distribución son un elemento esencial para nuestro sistema de transporte y de nuestra forma de vida.

El desarrollo suburbano en lo que solían ser áreas rurales ha creado muchas comunidades residenciales, comercios, escuelas e iglesias, así como complejos comerciales cercanos a nuestros sistemas de tuberías de distribución subterráneas.

En Chevron Pipe Line Company tenemos como meta promover y mejorar la seguridad de las tuberías de distribución en las comunidades donde operamos dichas tuberías con el fin de garantizar una coexistencia segura.

En este folleto proporcionamos información esencial a las entidades de bienes raíces y de desarrollo para que tomen decisiones fundamentadas relacionadas con la seguridad de las tuberías de distribución y en cuanto a la forma de prepararse en forma segura para coexistir con la presencia de las líneas de distribución en su comunidad.

5

Rights-of-Way and Easements Agreements

Pipeline and landowner responsibilities

Easement agreements between pipeline companies and landowners define the pathway corridor to exist on the landowner's property, commonly known as the "right-of-way" corridor. Governmental authorities grant utility companies the rights to transport products underground across many parcels as a service for the public interest along these rights-of-ways.

Landowners and pipeline companies each have independent responsibilities to maintain the land and the right to pursue their uninhibited use of the land within the easement.

These pipeline easement agreements typically allow pipeline companies to enter the property, construct pipeline facilities, conduct surveys and perform tests, operate the pipeline and perform routine maintenance. Pipeline companies are usually responsible for maintaining these rights-of-way in order that they may properly perform certain surveys and patrols, which are required by pipeline safety regulations.

Landowners are responsible to know the presence of underground utilities along the easement and to keep the right-of-way clear of any vegetation or encroachment that may limit access by the pipeline firm to the right-of-way. Most importantly, landowners are to notify the regional One-Call Center (see **page 16**) before performing any excavation activities, so that companies with underground utilities in the area can mark their locations. This is a free service to the landowner. **It's the law!**

County and municipal assessor offices and local title companies are required to attach written descriptions of the easements to each property deed. Each attachment should be clearly defined in the title search as to the type of underground utility located underground in the right-of-way, such as water, sewer, electrical, communication, or petroleum or natural gas, such as operated by Chevron Pipe Line Company.

Municipal and county building department permitting agencies are required to inform the landowners in writing about utility easements on the property parcel prior to any construction. Community development agencies are to include all existing easement defined properties when allocating space for their future development plans.

Chevron Pipe Line Company actively assists community planning agencies in the location and definition of underground pipelines in our operating system. We encourage all community planning agencies to contact us at **1-877-596-2800** for assistance.

Convenios de derecho de vía y derechos de paso

Responsabilidades de las empresas que operan tuberías de distribución y de los propietarios de tierras

Los convenios de derecho de paso entre las compañías que operan tuberías de distribución y los propietarios de tierras definen el corredor con la trayectoria que existirá en la propiedad de los dueños de las tierras, comúnmente conocidos como corredores de "derecho de vía". Las autoridades gubernamentales otorgan a las empresas de servicios públicos el derecho de transportar productos en forma subterránea a través de las parcelas como un servicio de interés público junto con estos derechos de vía.

Los propietarios de tierras y las empresas que operan tuberías de distribución tienen responsabilidades independientes para mantener la tierra y el derecho a buscar hacer uso del suelo sin inhibiciones en el marco del derecho de paso.

Estos convenios de derecho de paso para tuberías de distribución permiten comúnmente a las empresas que las operan ingresar a la propiedad, construir instalaciones para las tuberías de distribución, llevar a cabo estudios y realizar pruebas, operar las tuberías y darles mantenimiento de rutina. Las compañías que operan tuberías de distribución generalmente son responsables de mantener estos derechos de vía en orden de manera que pueden realizar ciertas inspecciones y patrullajes, los cuales son un requisito de las normas de seguridad de las tuberías de distribución.

Los propietarios de tierras son responsables de estar enterados de la presencia de servicios subterráneos dentro del derecho de paso y de mantener el derecho de vía exento de vegetación o invasiones que puedan restringir el ingreso al derecho de paso a la compañía que opera las tuberías. Aún más importante es que los propietarios de tierras deben notificar al Centro Regional One-Call (de Una Llamada) (ver página 16) antes de llevar a cabo cualquier excavación para que las compañías a cargo de servicios públicos subterráneos en el área puedan marcar la ubicación de éstos. **¡Esto es por ley!**

La Oficina del Tasador del condado y municipal, así como las compañías locales de títulos de propiedad deben cumplir con las descripciones escritas de los derechos de paso para cada título de propiedad. Cada anexo debe estar claramente definido en la búsqueda del título en referencia al tipo de servicio público oculto ubicado subterráneamente en el derecho de vía, tal como agua, alcantarillado, electricidad, comunicaciones y petróleo o gas natural, en la forma como son operados por Chevron Pipe Line Company.

Las entidades del departamento de construcción municipal y del condado que otorgan permisos deben informar por escrito a los propietarios de tierras acerca de los derechos de paso de los servicios públicos en la parcela de su propiedad antes de que se inicie cualquier trabajo de construcción. Las entidades de desarrollo comunitario deben incluir todas las propiedades definidas con derecho de paso cuando asignen los espacios para sus planes futuros de desarrollo.

Chevron Pipe Line Company asiste continuamente a las entidades de planeación comunitaria con la ubicación y definición de tuberías de distribución subterráneas en nuestro sistema operativo. Invitamos a todas las entidades de planeación comunitaria a comunicarse con nosotros al teléfono **1-877-596-2800** para solicitar asesoría.

7

Guidelines for Property Development

Planned pipeline safety in your community

Professional property administrators and real estate developers set the standards for the quality of life in the communities they represent.

Chevron Pipe Line Company shares this commitment with your community and your community safety standards. We want to promote public safety at all times, and to be of assistance in the correct planning for your community growth and business development.

Property and deed records will show if pipelines are near your planned development. Space should be allocated to avoid the easement dimensions and to allow pipeline firms easy access to the right-of-way.

At the development site, rural property and highway property will be marked with pipeline markers. Above ground pipeline markers, as illustrated in **Figure 1**, indicate the presence of underground pipelines in the area. Each pipeline marker will indicate the name of the company operating the pipelines, as well as the type of product being transported through the pipelines. There will be a toll-free telephone number to call for questions or assistance about the pipelines below the markers.

Survey crews and field inspections of the development parcels should be aware of and recognize pipeline markers when observing the development site.

Parcel information documents as mapped and recorded at county and title offices, along with field observations, are required for safe development planning prior to parcel zoning and space allowances being granted.

Pautas para el desarrollo de la propiedad

Seguridad planeada de las tuberías de distribución en su comunidad

Los administradores profesionales de la propiedad y entidades de desarrollo de bienes raíces establecen los estándares para la calidad de vida en las comunidades que representan.

Chevron Pipe Line Company comparte este compromiso con la comunidad que usted representa y con los estándares de seguridad de la misma. Deseamos promover la seguridad pública en todo momento, además de brindar asistencia para la planeación correcta del crecimiento de su comunidad y del desarrollo comercial.

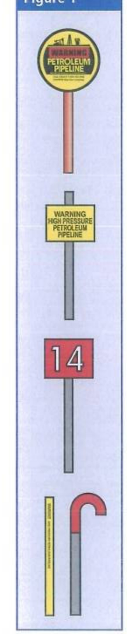
Los registros de la propiedad y de títulos mostrarán si existen tuberías de distribución cerca del área planeada de desarrollo. Se deberá asignar el espacio para respetar las dimensiones del derecho de paso y permitir que las compañías que operan tuberías de distribución utilicen con facilidad al derecho de vía.

El lugar de desarrollo, la propiedad rural y el derecho de vía de las autopistas deben ser marcados con indicadores de tuberías de distribución. Los indicadores de tuberías de distribución en la superficie del terreno, como se ilustra en la **Figura 1**, señalan la presencia de estas tuberías en el área. Cada indicador de tuberías de distribución indica el nombre de la compañía que las opera, así como el tipo de producto que éstas transportan. Hay un número gratuito para hacer preguntas o para pedir asistencia respecto a las tuberías.

Las cuadrillas de levantamientos y los inspectores de campo de las parcelas deben estar enterados de la presencia de los indicadores de tuberías de distribución y reconocerlos cuando inspeccionen el lugar que se va a desarrollar.

Es un requisito que los documentos de información de la parcela según estén trazados y registrados en las oficinas del condado y de títulos de propiedad, junto con observaciones de campo, sean entregados para planeación del desarrollo antes de hacer la zonificación de la parcela y de que se concedan los permisos para el espacio.

Figure 1



9

Property Improvements

Safe development of existing properties with pipelines

Chevron Pipe Line Company will assist your construction planning for improvements to existing properties where pipelines are present.

Property improvements to existing, occupied properties near pipelines require special attention for safety and compliance with applicable local construction ordinances for each type of improvement.

Construction is not allowed in the utility right-of-way. Special circumstances are required for each of these improvements when the right-of-way is encroached.

- New Structures. New construction of buildings and out-structures require minimum industry setbacks from the right-of-way. All local requirements for minimum setbacks are to be observed.
- New Roadways and Driveways. Roadways or property driveways which cross perpendicular to underground pipelines require advisement and new marking from the utility pipeline company representative.
- New Culverts and Drainage Systems. Land contouring and excavation for drainage control requires consultation from the utility pipeline company representative and new field markings for pipeline locations.
- New Landscaping and Fencing. Landscaping should not cover any pipeline signage or pipeline markers. In some cases, grass and vegetation will be maintained by the pipeline operator. Fencing should not limit access to the right-of-way, and setback and maximum depth for footings are to be observed.
- Nearby Seismic Testing. Minimum setbacks from the pipeline for seismic tests requiring vibrations and soil probes are to be observed.
- Nearby Blasting Projects. Minimum distances for each blast are to be observed at all ignitions. Only qualified blast contractors with proper permits are to be contracted for any blasting services.

All improvements require your contractor to call the regional One-Call Center (see **page 16**). One-Call representatives can assist with the safety of your improvement project by identifying the utility owners that may have facilities in the area prior to the commencement of excavation activities.

You must call the regional One-Call Center before commencing excavation of any type. Federal regulations (OSHA 29CFR Ch.XVII-1926.561) require excavators to notify underground utilities prior to the start of actual excavation. **It's the law!**

Chevron Pipe Line representatives will assist with safe planning for these improvements on existing properties adjacent to our pipeline right-of-way.

Please call 1-877-596-2800.

Mejoras a la propiedad

Desarrollo seguro de propiedades existentes con tuberías de distribución

Chevron Pipe Line Company le asiste para planear su construcción con el objetivo de hacer mejoras a las propiedades existentes en donde pasan tuberías de distribución.

Las mejoras a las propiedades existentes ocupadas que se encuentran cerca de tuberías de distribución requieren especial atención en cuanto a seguridad y conformidad con las ordenanzas de construcción aplicables según el tipo de mejora.

La construcción no está permitida dentro del derecho de vía de los servicios públicos. Cada tipo de estas mejoras requiere circunstancias especiales cuando se ha invadido el derecho de paso.

- Nuevas estructuras. La construcción nueva de edificios y estructuras salientes requiere retranqueos mínimos de la industria con respecto al derecho de vía. Se deben aplicar todos los retranqueos mínimos locales.
- Nuevas calzadas y caminos privados. Las calzadas o caminos privados que cruzan perpendicularmente las tuberías de distribución subterráneas deben tener anuncios e indicadores nuevos de tuberías de distribución de servicios públicos proporcionados por el representante de la compañía.
- Sistemas nuevos de alcantarillado y drenaje. La formación de contornos y excavaciones del suelo requieren la consulta del representante de la compañía que opera las tuberías de servicios públicos y la colocación de indicadores de tuberías subterráneas.
- Paisajismo y cercado nuevos. Los trabajos de paisajismo no deben ocultar los señalamientos ni los indicadores de las tuberías de distribución. En algunas de los casos, el operador de la tubería de distribución deberá preservar el césped y la vegetación. El cercado no deberá restringir el ingreso al derecho de paso y se deben aplicar el retranqueo y la profundidad máxima de las zapatas.
- Prueba sísmica cercana. Se debe aplicar el retranqueo mínimo con respecto a la tubería de distribución para las pruebas sísmicas que requieren vibraciones y sondas de suelo.
- Proyectos de explosiones cercanas. Se deben aplicar las distancias mínimas para cada explosión en todas las detonaciones. Solamente se empelará a los contratistas calificados que tengan los permisos correspondientes para prestar servicios de explosiones.

Todas las mejoras exigen que el contratista llame al Centro Regional One-Call (ver la página 16). Los representantes de One-Call pueden ayudarle con el aspecto de seguridad de su proyecto al identificar a los propietarios de las instalaciones de servicios públicos en el área antes de iniciar las actividades de excavación.

Usted debe llamar al Centro One-Call antes de iniciar una excavación de cualquier tipo. Los reglamentos federales (OSHA 29CFR C.XVII-1926.651) requieren que las compañías excavadoras notifiquen a los operadores de servicios públicos subterráneos antes de iniciar sus excavaciones. **¡Esto es por ley!**

Los representantes de Chevron Pipe Line auxiliarán con la planeación de la seguridad de estas mejoras en las propiedades adyacentes al derecho de vía de nuestras tuberías de distribución.

Comuníquese al teléfono 1-877-596-2800.

11

One-Call Centers For your community's safety. It's the law!

Public utilities and pipeline companies have established a nationwide network, known as the One-Call System, to notify utility companies of any plans to dig near pipelines or near the right-of-way corridors.

All property development and improvement projects are required to call their regional One-Call Center a minimum of 48 hours prior to commencing excavation. **It's the law!**

The One-Call Center will notify the appropriate utility companies of your planned excavation activities. A representative from the utility companies with the underground facilities in the vicinity will contact the construction firm and/or developer to arrange to meet at the site and to mark the location of all underground pipelines and/or other utilities.

Pipeline damage during excavation with digging equipment is the number one cause of pipeline accidents, injuries and related property damage. Utilization of the regional One-Call Center by excavators is mandated by law in order to prevent pipeline damage caused by excavation equipment.

Real estate developers and community planning agencies are obligated to require all construction and excavation contractors to call the regional One-Call Center for their property development projects.

A listing of the regional One-Call Centers toll-free telephone numbers is on **page 16**. Call first before you dig. It is a free service to the excavator. It is the right thing to do. **It's the law!**

Centros One-Call Para la seguridad de su comunidad. ¡Esto es por ley!

Las compañías que administran servicios públicos y tuberías de distribución han establecido una red nacional conocida como One-Call System para notificar a las compañías de servicios públicos cuando existen planes para excavar cerca de donde hay tuberías de distribución o cerca de los corredores de derecho de vía.

Los representantes de todos los proyectos de desarrollo de propiedades y proyectos para propiedades deben llamar a su Centro Regional One-Call por lo menos 48 horas antes de iniciar una excavación. **¡Esto es por ley!**

El Centro One-Call notificará a las compañías correspondientes acerca de los trabajos planeados de excavación. Un representante de las compañías de servicios públicos con instalaciones subterráneas en la vecindad se comunicará con la compañía constructora o entidad de desarrollo para planear una reunión en el lugar de la obra y para marcar la ubicación de todas las tuberías de distribución subterráneas u otras instalaciones.

El daño a las tuberías de distribución durante la excavación con maquinaria es la principal causa de accidentes, lesiones y daños a la propiedad relacionados con tuberías de distribución. La ley obliga a las compañías excavadoras a llamar al Centro Regional One-Call con el fin de evitar que la maquinaria de excavación dañe las tuberías de distribución.

Las entidades de desarrollo de bienes raíces y de planeación comunitaria están obligadas a exigir a todos los contratistas constructores y excavadores que llamen al Centro Regional One-Call con respecto a todos sus proyectos de desarrollo de propiedades.

En la **página 16** se encuentra una lista con los números telefónicos gratuitos de los Centros Regionales One-Call. Llame antes de excavar. Éste es un servicio gratuito para los excavadores. Es la forma correcta de proceder. **¡Esto es por ley!**

13

Local Partnerships

Local partnerships ensure proactive programs for your community's safety

Chevron Pipe Line Company operates with the belief that good community relationships result in improved pipeline safety. We are focused on safety as the first priority, and we view local governing officials as an integral partner.

We have initiated many national and systemwide safety programs in an effort to promote pipeline safety. Each of these programs has a positive impact on your community.

- We are strengthening our partnership with federal and state pipeline safety agencies to ensure safety in your community.
- We are implementing a communication campaign for raising public awareness of the benefits and the presence of pipelines in local neighborhoods.
- We have improved our mapping system to better inspect our pipelines and to identify areas of high consequence specific to local communities.
- We have raised the standards for pipeline safety through increased integrity management requirements, and we have authored new regulations for industry consensus standards of pipeline safety.
- We actively participate in industry damage prevention organizations to reduce construction and excavation accidents.
- We have invested in new technology to assess and repair pipelines, and we continue to conduct research for pipeline improvements.
- We have provided guidance to your local fire and law enforcement officials on how to minimize public safety risk and property damage in the unlikely event of an incident.

The hardworking men and women at Chevron Pipe Line Company share your dedicated commitment to community safety and public confidence in our nation's pipeline systems.

Fact: The Code of Federal Regulations, 49 CFR 192 and 49 CFR 195 require all gas and liquid operators to have an Integrity Management Plan (IMP) that addresses how the operator will assess and repair their pipeline in High Consequence Areas (HCAs). HCAs include areas that are highly populated, in environmentally sensitive areas or in or near navigable waterways. You can obtain more information regarding Chevron Pipe Line Company's IMP for pipelines operating in your area by writing to Chevron Pipe Line Company, 4800 Fournace, Bellaire, TX 77401-2324.

Sociedades locales

Las sociedades locales garantizan que haya programas anticipados para la seguridad de sus comunidades

En Chevron Pipe Line Company operamos con la creencia de que las buenas relaciones comunitarias resultan de una mejor seguridad de las tuberías de distribución. Nuestra máxima prioridad es la seguridad y consideramos a los funcionarios del gobierno de nuestras comunidades como un socio integral.

Hemos iniciado muchos programas de seguridad nacionales y sistemáticos extensivos como un esfuerzo para promover la seguridad de las tuberías de distribución. Todos estos programas tienen resultados favorables en su comunidad.

- Estamos reforzando nuestra sociedad con las entidades federales y estatales de seguridad de las tuberías de distribución para garantizar la seguridad en su comunidad.
- Estamos implementando una campaña de comunicación para crear conciencia en el público acerca de los beneficios y de la presencia de las tuberías de distribución en las vecindades de nuestras comunidades.
- Hemos mejorado nuestro sistema de trazo para inspeccionar mejor nuestras tuberías de distribución y para identificar áreas de grandes consecuencias específicas para comunidades locales.
- Hemos establecido los estándares de seguridad para tuberías de distribución a través del incremento de los requisitos para el control de la integridad, y hemos creado nuevos reglamentos para estándares de consenso de seguridad de las líneas de distribución en la industria.
- Participamos en forma activa en organizaciones para la prevención de daños industriales con el fin de reducir los accidentes relacionados con la construcción y la excavación.
- Hemos invertido en nueva tecnología para evaluar y reparar tuberías de distribución y continuamos haciendo investigación para mejorar estas tuberías.
- Hemos proporcionado pautas a los funcionarios encargados del cumplimiento de la ley acerca de la forma de reducir al mínimo el impacto a la seguridad pública y los daños a la propiedad en el remoto caso de un incidente.

Los hombres y mujeres que se esfuerzan grandemente en Chevron Pipe Line Company comparten el compromiso que usted tiene con la seguridad de la comunidad y la confianza pública en nuestros sistemas nacionales de tuberías de distribución.

Hechos: El Code of Federal Regulations, 49 CFR 192 y 49 CFR 195 exige que todos los operadores de gas y líquido cuenten con un Plan de Control de Integridad (IMP, por sus siglas en inglés) que describa la forma como el operador valorará y reparará sus tuberías de distribución en Áreas de Grandes Consecuencias (HCA, por sus siglas en inglés). Las HCA incluyen áreas altamente pobladas, ya sea en áreas de alto impacto ambiental o cerca de vías fluviales navegables. Usted puede obtener más información acerca del IMP de Chevron Pipe Line Company para las tuberías de distribución en su área escribiendo a Chevron Pipe Line Company, 4800 Fournace, Bellaire, TX 77401-2324.

Notification

Notificación

Chevron Pipe Line Company

Emergency Number / *Número De la Emergencia*: 1-800-762-3404

Regional One-Call Centers / Centros Regionales One-Call

- Alabama 1-800-292-8525
- Alaska 1-800-478-3121
- California 1-800-227-2600
- Colorado 1-800-922-1987
- Idaho 1-800-342-1585
- Louisiana 1-800-272-3020
- Mississippi 1-800-227-6477
- New Mexico 1-800-321-2537
- Oregon 1-800-332-2344
- Texas 1-800-344-8377
- Utah 1-800-662-4111
- Washington 1-800-424-5555
- Wyoming 1-800-348-1030

How You Can Find Out More

Cómo puede usted saber más

Chevron Pipe Line Company

4800 Fournace
Bellaire, TX 77401-2324
Attn: Pipeline Safety Specialist

If you have a non-emergency issue concerning pipe lines, and would like to speak with our representatives, please call 877-596-2800 or send us an email at CPLCAO@chevron.com.

Si usted tiene alguna duda que no sea de emergencia respecto a una tubería de distribución y desea hablar con nuestros representantes, llame al teléfono 877-596-2800 o escríbanos un correo electrónico a CPLCAO@chevron.com..

For Non-Emergency Use Only / Sólo para casos que no sean de emergencia

Office of Pipeline Safety

http://primis.phmsa.dot.gov/comm/

Dig Safely

http://www.digsafely.com
1-888-258-0808

American Petroleum Institute - Pipeline Information

www.pipeline101.com

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PO BOX 2925
RANCHO CORDOVA CA 95741-9954

Chevron

Response to Comments from Chevron

Thank you for your comments on the project.

Response to comment #1: Thank you for the most current mapping of pipelines and design considerations for protection of high-risk pipelines in the vicinity of State Route 58. Caltrans and the City of Bakersfield will be coordinating with Chevron during the project design and construction phases of the project to ensure the appropriate requirements and restrictions are incorporated into the final design plans and included as special provisions in the construction contract. Other than the grade separation, the project would not change the grade of the road or require substantial fill. Chevron, however, does not have pipelines in the vicinity of the grade separation, so there should be no conflict.

Response to comment #2: Consistent with standard practices and to allow adequate time to field mark where underground facilities are located, contract specifications will require the contractor to contact Underground Service Alert and utility owners prior to any ground disturbance.

Comment from Independent Pipe & Steel, Inc.

Received and placed on file
Planning Commission Meeting
of Jan 5, 2012
dlc

IP&S
Independent Pipe & Steel, Inc.
5303 Rosedale Hwy.
Bakersfield, CA 93308-6014
661-325-0398 FAX: 325-0269
www.indps.com

January 4, 2011

City of Bakersfield
Planning Commission
1501 Truxtun Avenue
Bakersfield, California 93301

Re: Rosedale Highway Widening Project Draft
Initial Study

We are the owners of Assessor's Parcel 332-270-01, Independent Pipe and Steel, Inc., 5303 Rosedale Highway, Bakersfield, 93308. We have reviewed the Draft of the above referenced Initial Study and we have the following comments.

Independent Pipe and Steel, Inc. operates as a pipe and steel supplier. Our materials come to our site as off-loads from the on-site railroad spur as well as from large trucks generally coming from Highway 99 traveling west. The majority of our delivery trucks depart the site by traveling west on Rosedale Highway and return the same direction. In addition we use an existing drive approach located on the north side of our property to access directly onto Rosedale Highway.

Our concerns center around:

the closing of Parker Lane access to westbound Rosedale Highway, without providing a reasonable alternate. Approximately 50-75 large truck/trailer rigs enter and leave Rosedale Highway through Parker Lane daily. As stated previously, a majority of our trucks enter our site from westbound Rosedale Highway, and leave on westbound Rosedale Highway. Returning trucks enter from eastbound Rosedale Highway. Right turn in and right turn out will require the trucks to find a alternate circuitous route because a "u-turn" on Rosedale Highway is not an option at any location. Trucks entering the site would probably use Olive Drive/Fruitvale/Rosedale as an entry route. The California Avenue to Truxtun to Rosedale is not a safe option due to traffic and narrow lanes. Leaving trucks would travel eastbound Rosedale 1

Highway to Gibson, north to East, west to Fairhaven and west on Rosedale Highway; **1 cont.**

the plans for the Grade Separation project were not shown in the Draft Initial Study. It is presumed that the elevating of the overpass will require approximately 900 feet of road to transition back to Rosedale Highway grade from the rail crossing. Parker Lane is approximately 500 feet westerly of the rail crossing. The Draft Initial Study states that the properties fronting Rosedale Highway between Mohawk and Parker will be "acquired/displaced". It is our guess that a "frontage type road" will be constructed easterly along the southerly side of Rosedale Highway through the "acquired" properties to access Parker Lane. This type of access will further the problems with the Parker Lane truck traffic. It appears that the overcrossing will be elevated approximately 4 or more feet at Parker Lane. **2**

The following are our comments in regards to the Draft Initial Document itself, as referenced to the pages in the report.

Page i, para 2

In addition, a grade separated rail crossing...would be built..."

Question - is the Grade Separation project a part of the Draft Initial document? Is the Grade Separation project <u>not</u> required to follow CEQA notification requirements? **3**

Page i, para 3

"Before finalizing the environmental document....Caltrans would relinquish...making the segment of roadway a local facility rather than a state route."

Question - Will there be a County of Kern Planning Commission meeting in regards to the Rosedale Highway widening? **4**

Page 15, para 2

"As part of the first phase...and 11-foot turnouts would be provided to allow trucks and busses to move outside traffic lanes."

Question - the plans in the Draft Initial document appear to not show the 11-foot turn lanes. Will the 11-foot lanes require additional street dedication in those areas? The placement of the 11-foot lanes may affect our existing driveway, would you please provide additional information? **5**

Page 16, Figure 1-5

Question - what is the existing lane widths? Will the proposed lane widths be narrowed from existing? **6**

Page 17, para 4

"On State Route 58, at Maher and Parker Lane, the median would be closed, and only right-in and right-out movement would be allowed." **7**

Question - our previous comments are included in this question. What will be the 'final' configuration of the Parker Lane access after the Grade Separation is completed?

Page 18, para 1

"The Build Alternative proposes a grade separation...The proposed grade separation would be built on the current alignment for State Route 58."

Question - would there be any additional right-of-way required for the grade separation project? In addition to the "current alignment"? 8

Page 18, para 3

During construction of the grade separation, a temporary route on the north side of the roadway would be provided to allow traffic to continue to use State Route 58. The temporary route would be next to the roadway and would use property bought for the project." 9

Question - what is the proposed access route for the truck traffic from Parker Lane to reach the north side of Rosedale Highway?

Page 41, para 1

"Construction of an overcrossing would have the potential to sever access to the adjacent land uses." 10

Question - as our property lies due south of the overcrossing, will our parcel be severed from direct access to Rosedale Highway, in any of the phases?

Page 41, para 3

"...the longest distance to the nearest intersections that would allow U-turns is approximately 2,250 feet..."

Question - the statement is extremely ambiguous. The word "currently" should be inserted. In addition no mention is made of the distance required for a large truck to travel to a location where a U-turn is physically possible. If your assertion is that a large truck could make a U-turn where allowed, how much time would traffic be backed up while one truck makes that turn? Where are the intersections where a large truck can physically and safely make a U-turn on Rosedale Highway? Mohawk does not allow U-turns for any vehicle. The approximate distance from Parker lane to the next westerly location for a currently legal U-turn, Refinery Road, is 2350 feet (0.45 miles) 11

Page 41, para 3

"...these median closures are not expected to substantially erode the client base for commercial uses or require changes to school service area? 12

Question - what about the Industrial uses that may be physically or financially "eroded" due to median closures?

Page 55, para 1

"Construction of the grade separation in 2025 would result in the full acquisition of 8 parcels and potentially 14 displacements." 13

Question - where are those 8 parcels and 14 displacements? Only the 'displacements' are shown in Table 2.6

Page 113, para 7

"Based on information provided by Caltrans, a test for lead in soil was performed within the Caltrans right-of-way. results indicated that levels of lead in the soil are below levels identified as hazardous." 14

Question - what reports have Caltrans provided in regards to levels of contaminates of concern? The soil could be contaminated with lead, or many other constituents of concern, above background levels, but below hazardous levels. Along with the tests within the Caltrans right-of-way, or proposed right-of-way, have any tests been completed to establish accepted background levels? The railroad right-of-way was not mentioned as a potential source of contamination/pollution. Don't railroad properties have historic elevated levels of lead and arsenic, and others? Did Caltrans do any testing on the paint used in the striping, as the paint has historically used lead and historically the lead levels were hazardous? 14 cont.

Page 115, para 6

"Though the lead level in the soil is classified as non-hazardous, there is some lead in the soil."

Question - just because levels of constituents are "non-hazardous" doesn't mean that they are; above background, designated wastes, etc.. What are the levels of lead in the soil, and did Caltrans prepare any reports documenting those efforts? 15

Page 117, para 2

"Prior to finalization of the environmental document, a Preliminary Site Investigation shall be conducted."

Question - will the "Preliminary Site Investigation" be included in the Environmental document? Will the Environmental document be re-distributed after the "Preliminary Site Investigation" is completed and attached? The results of the "Preliminary Site Investigation" should be included in the Environmental document and submitted for public review rather than just mentioned. 16

Regards,

Hal Blackburn, President
Independent Pipe & Steel Inc.

Response to Comments from Independent Pipe & Steel, Inc.

Thank you for your comments on the project.

Response to comment #1: Your concerns related to the access modifications by Parker Lane are noted. Access to your site from State Route 58 would be maintained; however, only right-in and right-out movement would be allowed. Trucks may need to change their access route coming from the east or exiting to the west once the median is constructed. As indicated in the comment, an alternative route for those trips coming from southbound State Route 99 would be to use Olive Drive to Fruitvale Avenue to State Route 58. This would allow the trucks to stay on major streets and not take them far from the direction of travel.

With the recently opened extension of Mohawk Street, trucks traveling northbound on State Route 99 could use the Stockdale Highway or California Avenue exit from State Route 99 and go north on Mohawk Street to State Route 58, again minimizing out-of-direction travel. Trucks leaving the Independent Pipe & Steel site would go east on State Route 58, turn left at the signal on Gibson Street, turn left on East Street, and then use Fairhaven Drive to return to State Route 58. This would require about 1.9 miles of out-of-direction travel. An alternative would be to turn right on Gibson Street, then use Camino del Rio Court to return to State Route 58. This would require about 2.1 miles of out-of-direction travel.

Response to comment #2: A copy of the conceptual design for the grade separation has been added to Appendix G, Project Plans, in the final initial study/environmental assessment. You are correct that, with the grade separation, State Route 58 (Rosedale Highway) would be elevated at Parker Lane. The elevation difference would necessitate modification to the current access point for the parcel occupied by Independent Pipe & Steel. These issues are typically looked at during the design process. Compensation for site modifications would be evaluated at the time right-of-way for the grade separation is acquired. Specifics on construction access would also be determined at the time design plans are developed. However, access to the parcel would be maintained during construction.

Response to comment #3: The impacts associated with the grade separation were addressed throughout the initial study/environmental assessment prepared pursuant to the California Environmental Quality Act and the National Environmental Policy Act. Notification of availability of the draft initial study/environmental assessment was provided by newspaper notices in the *Bakersfield Californian* and the *El Popular* newspapers and notices mailed directly to adjacent property owners. However, it should be noted that the California Environmental Quality Act does provide a Statutory Exemption for "[A]ny railroad grade separation project which eliminates an existing grade crossing or which reconstructs an existing grade separation as set forth in Section 21080.13 of the Public Resources Code" (Section 15282[g] of the California Environmental Quality Act Guidelines).

Response to comment #4: On January 5, 2012, the City of Bakersfield Planning Commission held a meeting to receive comments on the project. Another hearing before the City Planning Commission and the City Council will occur as part of the project approval process and certification of the environmental document. A hearing by the County of Kern Planning Commission on the Rosedale Widening Project is not required because the county is not a lead agency on the project.

Response to comment #5: The conceptual plans do show the turnout lanes for trucks and buses at the railroad crossing. These are shown as transitions from 8-foot-wide standard shoulders to 11-foot-wide shoulders on each side of the tracks. In this location, a driveway or rolled curb can be provided to allow for the rolling gate that currently provides access to the Independent Pipe & Steel parcel on State Route 58 (Rosedale Highway).

Response to comment #6: Existing lane widths vary along State Route 58. At Parker Lane in front of Independent Pipe & Steel, Inc., the lane widths will not be narrowed. Currently, at this location there is a 2-foot-wide inside shoulder (closest to median), two 12-foot-wide travel lanes, and an 8-foot to 10-foot-wide outside shoulder. With the roadway widening, the project would maintain the 2-foot-wide inside shoulder. The roadway would have three 12-foot-wide travel lanes. The outside shoulder would vary between 8 feet and 11 feet in width.

Response to comment #7: When the grade separation is constructed, Parker Lane would still connect to State Route 58. The movement would remain as right-turn in and right-turn out at this location.

Response to comment #8: Table 2.6 of the initial study/environmental assessment identifies those parcels that would be acquired as part of building the grade separation. A graphic (Figure K-1) has been added to Appendix K in the final initial study/environmental assessment that shows the location of those parcels where full acquisition would be required. An additional parcel has been added to the list of potential full acquisitions associated with the grade separation. Assessor Parcel Number 332-270-14 is a portion of the site currently used by Independent Pipe &

Steel. Right-of-way is not required from Assessor Parcel Number 332-270-14; however, it is being identified as a potential full acquisition because access from Parker Lane may be eliminated once the State Route 58/Parker Lane intersection is elevated with the construction of the grade separation. There may be an opportunity to provide access from Mohawk Street to Parker Lane on the residual parcels acquired for constructing the grade separation. However, even if acquisition is required, the operations of Independent Pipe & Steel may not be affected. There would be an opportunity to sell the residual property from Parcel 332-270-14 to the adjacent property owner (the other parcel occupied by Independent Pipe & Steel) to create one large parcel that has access from Parker Lane. This will be more closely evaluated during the project design phase for the grade separation.

Response to comment #9: The grade-separation would be constructed in phases. As part of the design, detailed access plans would be developed to ensure all remaining parcels have access. Since with the grade separation direct access from State Route 58 would no longer be available, an option may be to provide driveway access to the parcel from Mohawk Street through the residual portion of properties needed for the grade separation. This would also improve access both during construction and after the grade separation is completed.

Response to comment #10: Access to your parcel would be from Parker Lane. Direct access from State Route 58 would be eliminated when the grade separation is constructed. The effects of the loss of access from State Route 58 would be considered as part of the appraisal process with right-of-way acquisition. As indicated in response to comment #9 above, there may be opportunities to provide an alternative access to the parcel through the residual portion of properties needed for the grade separation.

Response to comment #11: The statement has been clarified on page 41 in the final initial study/environmental assessment that the distance cited would be the longest distance that automobiles would need to travel to make U-turns. A statement has been added that longer out-of-direction travel may be required for trucks that are unable to do U-turns at the intersections. Alternative access routes for Independent Pipe & Steel are discussed above in response to Comment #1.

Response to comment #12: Eliminating left turns at Parker Lane would not limit the use of the adjacent industrial parcel. Closing the median would not prohibit trucks from accessing the site in a safe manner. As indicated on page 41 of the draft initial study/environmental assessment (page 42 of the final initial study/environmental assessment), there would be an inconvenience factor associated with needing to make a U-turn at those locations where turning movements are modified. As stated in Response #11 above, text will be added to indicate that this may also require large trucks to alter their approach or exit path from certain parcels. The inconvenience factor is often less for industrial uses than with commercial uses because the industrial users generally frequent the location consistently and factor access restrictions into their routing. State Route 58 is a designated conventional highway and a raised median between intersections is consistent with the design standards.

Response to comment #13: Table 2.6 of the initial study/environmental assessment identifies the parcels that would be acquired as part of building the grade separation.

Response to comment #14: Lead sampling data was obtained during an investigation performed in 2008. Concern for lead in the soils caused from historic leaded fuel emissions drives soil sampling criteria. Lead was detected in an average concentration of 9.15 milligrams per kilograms for total lead, and soluble lead was detected at 0.5 milligram per liter, well below the threshold for hazardous waste (1,000 milligrams per kilogram for total lead and 5.0 milligrams per liter for soluble lead).

Since a structure will span the railroad, geotechnical studies were performed and samples were taken in this area for the lead investigation. Piles will be driven into soil, but no excess soil will be generated. Project-wide dust-control measures and a lead compliance plan will be in effect to minimize dust exposure. Traffic striping, depending on method of removal, may be a hazardous waste. Yellow thermoplastic traffic stripe, if removed separate from pavement, is expected to be a California Hazardous Waste. Standard Special Provisions are in place to handle this waste stream. Because the material is expected to be hazardous, sampling was not done.

Response to comment #15: According to soil analysis performed for this project, levels of lead in soil averaged 9.15 milligrams per kilograms for total lead (1,000 milligrams per kilogram is considered hazardous waste), and soluble lead was measured at 0.5 milligram per liter (5.0 milligrams per liter is a California Hazardous Waste).

Response to comment #16: The Preliminary Site Investigation was prepared to support the final environmental document. The report has been summarized in Section 2.2.1 of the final environmental document. The full technical study will be available for review.

Comment from John R. Wilson, Inc.

"John R. Wilson"<jrwrce@aol.com>
To: <bryan_apper@dot.ca.gov> 01/08/2012 09:40 AM
cc:
Re: Rosedale Lane Widening

Attached is a copy of a letter from Independent Pipe 5303 Rosedale Highway in regards to the initial document. Within the letter are quite a few questions. Will there be answers complied for those questions and made available to Independent Pipe?

Should the letter be sent to others who can provide answers?

You cannot multiply wealth by dividing it.

John R. Wilson, Inc.
2012 "E" Street
Bakersfield, CA 93301
Tele 661-325-4862
(Embedded image moved to file: pic22748.jpg)
Fax 661-325-5126
Mobile 661-301-5678

Response to Comment from John R. Wilson, Inc.

Thank you for transmitting the comments from Independent Pipe & Steel, Inc. The responses to the letter are above. With regard to your query if the responses to comments will be made available, Bryan Apper, Caltrans environmental branch chief, responded by e-mail on January 8, 2012 informing Mr. Wilson that all written comments made during the public review period will be published in the final environmental document and will include a written response to each comment or question. Mr. Apper also informed Mr. Wilson that the January 10, 2012 public hearing will be held at the Connection Assembly of God Church in Bakersfield, California.

Comment from Big City Sign Co.

COMMENT Card

Rosedale Highway@Widening

SR 58 (Rosedale Highway) Widening Project

NAME: ANTONIO SALDANA
ADDRESS: 1508 GLENWOOD DR
CITY: BAKERSFIELD CA. ZIP: 93306
E-MAIL ADDRESS: A GUITAR PLAYERS MOM @ ATT.NET
REPRESENTING: BIG CITY SIGN CO. FABRICATOR, PAINTER

☐ Please add me to the project mailing list

I would like the following comments filed in the record *(please print)*:

GREAT JOB BAKERSFIELD!

EVERYONE INVOLVED

GET ER DONE!

WE NEED IT!

THANKS!

Please respond by January 24, 2012

How did you hear about this meeting?

☐ newspaper ☐ internet ☑ someone told me about it ☐ other:

Response to Comment from Big City Sign Company

Thank you for your comment on the project. No response is necessary.

Comment from Cigars & More

1/10/12

COMMENT Card

Rosedale Highway 58 Widening

SR 58 (Rosedale Highway) Widening Project

NAME: Cigars + More

ADDRESS: 4208 Rosedale Hwy Suite 304

CITY: Bakersfield ZIP: 93304

E-MAIL ADDRESS:

REPRESENTING:

☐ Please add me to the project mailing list

I would like the following comments filed in the record *(please print)*:

We need a light put on the corner of Fairhaven and Rosedale Highway to help with the congestion of traffic. You can not turn into Fairhaven from Rosedale in the east turn lane due to all the traffic. It is the cause of alot of our business not to come over to our store. It would also help with all the people pulling out in front of traffic at Hooters.

Please respond by January 24, 2012

How did you hear about this meeting?

☐ newspaper ☐ internet ☒ someone told me about it ☐ other:

Response to Comment from Cigars & More

Thank you for your comment on the project.

A traffic signal is not proposed at the Fairhaven Drive intersection for two reasons: (1) traffic volume requirements and (2) the close spacing of the intersections. For a traffic signal to be installed on State Route 58, either existing or projected traffic volumes must meet a minimum of peak hour, four-hour, and eight-hour volumes (this level is known as a “signal warrant”). Both the existing and projected left-turn traffic volumes at the intersection of Fairhaven Drive do not meet these warrants. Having vehicles make a left turn across three lanes of traffic without having a place in the median to wait and safely merge with oncoming traffic can be a safety problem. Therefore, it was decided to provide westbound right-turn in, westbound right-turn out, and eastbound left-turn in to access land uses on Fairhaven Drive.

The left-turn traffic would be required to make a right-turn onto westbound State Route 58 and make a U-turn at the Landco Drive intersection less than 0.25 mile to the west. Also, as indicated above, with existing traffic signals at both Gibson Street and Landco Drive, there is insufficient distance between Fairhaven Drive and Gibson Street for installation of a third traffic signal along this 0.4-mile section of State Route 58. With Fairhaven Drive only 650 feet west of Gibson Street, the ability to coordinate these closely spaced intersections would degrade operating conditions on State Route 58. In addition, eliminating the left turn from southbound Fairhaven Drive to eastbound State Route 58 will reduce delays, and vehicles will be less likely to use the shopping center as a cut-through to get to State Route 58.

It should also be noted that in October 2004, when the development plans were being processed for the shopping center, Caltrans identified that a signal would not be allowed at Fairhaven Drive, and that future plans included the installation of a raised median on State Route 58 to prohibit the left-turn movement out of Fairhaven Drive. This correspondence is attached in Appendix L.

Comment from Enterprise Rent-a-Car

COMMENT Card

SR 58 (Rosedale Highway) Widening Project

Rosedale Highway 58 Widening

NAME: Stacy Grady Enterprise Rent a Car

ADDRESS: 8929 Rosedale HWY

CITY: Bakersfield ZIP: 93312

E-MAIL ADDRESS: stacy.d.grady@erac.com

REPRESENTING: Enterprise Rent a Car

☒ Please add me to the project mailing list

I would like the following comments filed in the record *(please print)*:

I fell this will place a hardship on our buisness. My buisness depends on the flow of traffic on our street. Our traffic in and out of the busness driveway is heavy. With the road closuer and delays from continual construction would be detrimental for our company. Rosedale Hwy is such a high demand road that the buisness alinging Rosedale would suffer greatly.

Please respond by January 24, 2012

How did you hear about this meeting?

☐ newspaper ☐ internet ☒ someone told me about it ☐ other:

Response to Comment from Enterprise Rent-a-Car

Thank you for your comments on the project.

It is acknowledged that there will be some delays due to construction traffic, but State Route 58 will remain open during construction. There will be no road closures and access will be maintained during business hours. To help reduce the impacts during construction, a standard condition, which would apply to the project, is the preparation of a Traffic Management Plan (see Standard Condition SC-2 page 80 of the draft environmental document and page 83 of the final environmental document). The Traffic Management Plan will, among other things, optimize roadway capacity, signal phasing, and timing during construction with the goal of ensuring safe and efficient traffic flow throughout the project study area during all phases of construction. Though construction activities do result in short-term traffic delays, it is projected that the businesses along State Route 58 will receive long-term benefits from improved traffic flow. The impact of not implementing any improvements would be long-term congestion throughout the State Route 58 corridor.

Comment from Frye Construction

COMMENT Card

Rosedale Highway 58 Widening

SR 58 (Rosedale Highway) Widening Project

NAME: INEZ FRYE

ADDRESS: 10010 ROSEDALE HWY

CITY: BAKERSFIELD CA ZIP: 93312

E-MAIL ADDRESS: inez@fryeconstruction.com

REPRESENTING: Frye Construction

☑ Please add me to the project mailing list

I would like the following comments filed in the record *(please print)*:

Please respond by January 24, 2012

How did you hear about this meeting?

☒ newspaper ☐ internet ☐ someone told me about it ☐ other:

Response to Comment from Frye Construction

Thank you for your interest in the project.

Your name has been added to the mailing list, as requested.

Comment from Hooters

1/10/12

COMMENT Card

SR 58 (Rosedale Highway) Widening Project

NAME: Deanna Arellano Luy

ADDRESS: 4208 Rosedale Hwy #100

CITY: Bakersfield CA

E-MAIL ADDRESS: deanna @ hootersofCalifor...

REPRESENTING: Hooters

☑ Please add me to the project mailing list

I would like the following comments filed in the record *(please print)*:

I would like to See a Signal light @ the corner of Fairhaven and Rosedale Hwy. The flow of Traffic is very unsafe to turn left onto Rosedale Hwy coming ~~on~~ From fairhaven. Due to the Back up on Rosedale and Cars awaiting opportunity to turn onto Rosedale the Car flow drives into our Shopping Centers and Creates unsafe like drivers to become in a hurry. The ~~[illegible]~~ Guest are unSafe walking in our parking lot.

[signature]

Please respond by January 24, 2012

How did you hear about this meeting?

☐ newspaper ☐ internet ☐ someone told me about it ☐ other: ______

Response to Comment from Hooters

Thank you for your comment on the project.

A traffic signal is not proposed at the Fairhaven Drive intersection for two reasons: (1) traffic volume requirements and (2) the close spacing of the intersections. For a traffic signal to be installed on State Route 58, either existing or projected traffic volumes must meet a minimum of peak hour, four-hour, and eight-hour volumes (this level is known as a "signal warrant"). Both the existing and projected left-turn traffic volumes at the intersection of Fairhaven Drive do not meet these warrants. Having vehicles make a left turn across three lanes of traffic without having a place in the median to wait and safely merge with oncoming traffic can be a safety problem. Therefore, it was decided to provide westbound right-turn in, westbound right-turn out, and eastbound left-turn in to access land uses on Fairhaven Drive.

The left-turn traffic would be required to make a right-turn onto westbound State Route 58 and make a U-turn at the Landco Drive intersection less than 0.25 mile to the west. Also, as indicated above, with existing traffic signals at both Gibson Street and Landco Drive, there is insufficient distance between Fairhaven Drive and Gibson Street for installation of a third traffic signal along this 0.4-mile section of State Route 58. With Fairhaven Drive only 650 feet west of Gibson Street, the ability to coordinate these closely spaced intersections would degrade operating conditions on State Route 58. In addition, eliminating the left turn from southbound Fairhaven Drive to eastbound State Route 58 will reduce delays, and vehicles will be less likely to use the shopping center as a cut-through to get to State Route 58.

It should also be noted that in October 2004, when the development plans were being processed for the shopping center, Caltrans identified that a signal would not be allowed at Fairhaven Drive, and that future plans included the installation of a raised median on State Route 58 to prohibit the left-turn movement out of Fairhaven Drive. This correspondence is attached in Appendix L.

Comment from Rosedale Square Shopping Center (Hooters)

COMMENT Card

Rosedale Highway Widening

SR 58 (Rosedale Highway) Widening Project

NAME: Dale Denio

ADDRESS: 453 Lakeshore Blvd.

CITY: Incline Village, NV. ZIP: 89451

E-MAIL ADDRESS: ddenio.dld@gmail.com

REPRESENTING: Rosedale Square Shopping Center (Hooters)

☒ Please add me to the project mailing list

I would like the following comments filed in the record *(please print)*:

A traffic signal is desperately needed at Fairhaven and Rosedale. 1

The traffic count data appears to be from late 2007 or early 2008. At that time Fairhaven traffic was only a little less than Landco and Gibson. 2

Rosedale Square opened in 2009 and I am sure the traffic count at Fairhaven now equals or exceeds Landco and Gibson.

Due to the difficulty to access Rosedale Hwy from Fairhaven we (Rosedale Square) are experiencing an increasing amount of traffic cutting thru our parking lot and exiting onto Rosedale. This is a danger to our customers as these people are in a hurry and drive fast. A signal would provide a safer and positive entry to Rosedale. 3

Provide a right turn and a left turn lane from Fairhaven onto Rosedale so traffic does not stack to far back. 4

Thank you. [signature]

Please respond by January 24, 2012

How did you hear about this meeting?

☐ newspaper ☐ internet ☐ someone told me about it ☒ other: Property owner Notice

Response to Comments from the Rosedale Square Shopping Center

Thank you for your comments on the project.

Response to comment #1: A traffic signal is not proposed at the Fairhaven Drive intersection for two reasons: (1) traffic volume requirements and (2) the close spacing of the intersections. For a traffic signal to be installed on State Route 58, either existing or projected traffic volumes must meet a minimum of peak hour, four-hour, and eight-hour volumes (this level is known as a "signal warrant"). Both the existing and projected left-turn traffic volumes at the intersection of Fairhaven Drive do not meet these warrants. Having vehicles make a left turn across three lanes of traffic without having a place in the median to wait and safely merge with oncoming traffic can be a safety problem. Therefore, it was decided to provide westbound right-turn in, westbound right-turn out, and eastbound left-turn in to access land uses on Fairhaven Drive.

The left-turn traffic would be required to make a right-turn onto westbound State Route 58 and make a U-turn at the Landco Drive intersection less than 0.25 mile to the west. Also, as indicated above, with existing traffic signals at both Gibson Street and Landco Drive, there is insufficient distance between Fairhaven Drive and Gibson Street for installation of a third traffic signal along this 0.4-mile section of State Route 58. With Fairhaven Drive only 650 feet west of Gibson Street, the ability to coordinate these closely spaced intersections would degrade operating conditions on State Route 58. In addition, eliminating the left turn from southbound Fairhaven Drive to eastbound State Route 58 will reduce delays, and vehicles will be less likely to use the shopping center as a cut-through to get to State Route 58.

It should also be noted that in October 2004, when the development plans were being processed for the shopping center, Caltrans identified that a signal would not be allowed at Fairhaven Drive, and that future plans included the installation of a raised median on State Route 58 to prohibit the left-turn movement out of Fairhaven Drive. This correspondence is attached in Appendix L.

Response to comment #2: As indicated in response to comment #1 above, there is insufficient distance between Fairhaven Drive and Gibson Street for the installation of another traffic signal. An additional traffic signal in this location (between Gibson Street and Landco Drive) would actually worsen traffic flow along the State Route 58 corridor.

Response to comment #3: As indicated in the response to comment #1 above, eliminating the left turn from southbound Fairhaven Drive to eastbound State Route 58 will also reduce the delays at this intersection, and vehicles will be less likely to use the shopping center as a cut-through to get to State Route 58.

Response to comment #4: The need for a dedicated right-turn lane on Fairhaven Drive will not be needed once the median on State Route 58 eliminates the left-turn movements. The queue (back up) of vehicles will not be as long when the only option is a right turn.

Comment from Rosedale Square Shopping Center

8/10/12

Name: Dale Denio, 775-250-4283
Address: 453 Lakeshore Blvd.
City: Incline Village, NV. **ZIP:** 89451
Representing: Rosedale Square Shopping Center
Please add me to your mailing list

Public comment

As proposed this project will create a right turn only onto Rosedale Hwy (Westbound) from Fairhaven. No East bound traffic would be allowed from the intersection of Fairhaven and Rosedale. This would inhibit the free flow of traffic from Fairhaven and to or from businesses on the South side of Rosedale. This would have a negative impact on customers as well as truck deliveries to and from all business in the area of this intersection. 1

Rather than downgrading this intersection, a much better design would be to upgrade this intersection with a signal light. If a signal were to be electronically coordinated with the existing signals at Gibson and Landco Dr., there would be a great improvement on the thru-traffic flow of the highway. This would create safe ingress and egress onto and off of Rosedale Hwy. and eliminate the unsafe forced u-turns at Landco Dr. A signal would have a positive impact on the businesses in the area of this intersection by making all traffic maneuvers safe and more convenient to the public. 2

As the former owner of J.L. Denio, Inc. a General Engineering Company for over 35 years, I have built many Roads, Airports and other grading and paving projects with traffic concerns. The following are specific problems and solutions that I would like to bring to your attention:

Problems:

1) Current design will degrade the traffic flow thru-put by forcing all traffic exiting Fairhaven to go westbound creating a forced u-turn for all traffic needing to go eastbound. This also will force truck traffic to stay on Rosedale Hwy for an extended length westbound looking for a route back to Freeway 99. 3

2) Current design will have a great negative economic impact on approximately 30+ area businesses. 4

3) Current design upgrades the highway but degrades the intersection creating a greater unsafe condition. 5

Solutions:

1) Install a signal at Fairhaven at the very beginning of construction; this will facilitate better traffic flow during construction. 6

2) Coordinate the signals at Gibson, Fairhaven and Landco together, thereby allowing side traffic to make safe turns at the same time and improving traffic thru-put because vehicles would only be stopped at one light. 7

3) Schedule Phase 1 (Gibson to Calloway) in sections such as from Gibson to the railroad tracks as one section. Complete one section at a time so that businesses are not affected for such a long construction period, and the traffic is not congested as much by a long stretch of roadway under construction. 8

Response to Comments from Rosedale Square Shopping Center

Thank you for your comments on the project.

Response to comment #1: The page 41 of the draft initial study/environmental assessment (page 42 of the final initial study/environmental assessment) does acknowledge that there is an inconvenience factor when left turns are restricted. However, a raised median between intersections is consistent with the Caltrans' roadway design standards for a conventional highway.

Response to comment #2: A traffic signal is not proposed at the Fairhaven Drive intersection for two reasons: (1) traffic does not meet volume requirements and (2) the close spacing of the intersections. In order for a traffic signal to be installed on State Route 58, either existing or projected traffic volumes must meet a minimum of peak hour, four-hour, and eight-hour volumes (this level is known as a signal warrant). Both the existing and projected left-turn traffic volumes at the intersection of Fairhaven Drive do not meet these warrants. Having vehicles make a left turn across three lanes of traffic without having a place in the median to wait and safely merge with oncoming traffic can be a safety problem. Therefore, it was decided to provide westbound right-turn in, westbound right-turn out, and eastbound left-turn in to access land uses on Fairhaven Drive.

The left-turn traffic would be required to make a right-turn onto westbound State Route 58 and make a U-turn at the Landco Drive intersection less than 0.25 mile to the west. Also, as indicated above, with existing traffic signals at both Gibson Street and Landco Drive, there is insufficient distance between Fairhaven Drive and Gibson Street for installation of a third traffic signal along this 0.4-mile section of State Route 58. With Fairhaven Drive only 650 feet west of Gibson Street, the ability to coordinate these closely spaced intersections would degrade operating conditions on State Route 58. Both Landco Drive and Gibson Street have signals that provide a protected left-turn (turn arrow) so U-turns at these locations would be safe.

Response to comment #3: Eliminating the left-turn movement at Fairhaven Drive will improve the level of service at this intersection because there would not be the back-up of cars waiting to turn left onto State Route 58. Vehicles forced to turn right out of Fairhaven that want to go eastbound on State Route 58 would have to travel a quarter of a mile to Gibson Street to make a U-turn.

Response to comment #4: The project will provide long-term congestion relief along this segment of State Route 58, which is a benefit to local businesses. Access to the shopping center will be maintained for both eastbound and westbound traffic. Though the eastbound movement exiting the shopping center will not be available, a U-turn is available at Landco Drive, less than 0.25 mile west of the shopping center driveway. This would not represent a substantial burden to shoppers that would lead to an economic impact.

It should also be noted that in October 2004, when the development plans were being processed for the shopping center, Caltrans identified that a signal would not be allowed at Fairhaven Drive, and that future plans included the installation of a raised median on State Route 58 to prohibit the left-turn movement out of Fairhaven Drive. This correspondence is attached in Appendix L.

Response to comment #5: As stated in responses to comments #2 and #3 above, eliminating the left-turn movement at Fairhaven Drive will improve the level of service at this intersection, and both Landco Drive and Gibson Street have signals that provide a protected left turn so U-turns can safely be made at these locations.

Response to comment #6: As stated in response to comment #2, above, there is insufficient distance between Fairhaven Drive and Gibson Street for installation of a signal at Fairhaven Drive and State Route 58. The Traffic Management Plan will, among other things, optimize roadway capacity, signal phasing, and timing during construction with the goal of ensuring safe and efficient traffic flow throughout the project study area during all phases of construction.

Please see response to comment #2 regarding correspondence pertaining to the signal. Also, future plans include the installation of a raised median on State Route 58 that would eventually prohibit the left-turn movement out of Fairhaven Drive.

Response to comment #7: Signal interconnects are not effective when signals are spaced that closely.

Response to comment #8: The phasing of construction has to be done in large enough segments to get meaningful circulation improvements. If only short segments are constructed, not only is the circulation benefit delayed, it can actually result in more traffic backups because traffic would need to almost immediately merge back into the existing lanes. In times of heavy traffic, cars would create a queue (line) waiting to merge into the through lanes. This can increase potential for accidents.

Comment from RW Henry Oil Producers

COMMENT Card

Rosedale Highway Widening

SR 58 (Rosedale Highway) Widening Project

NAME: Gail Schulz (RW Henry Oil Producers)

ADDRESS: 2200 Greeley Rd

CITY: Bakersfield CA ZIP: 93314

E-MAIL ADDRESS: gailbarryschulz@aol.com

REPRESENTING: RW Henry Oil Producers

☒ Please add me to the project mailing list

I would like the following comments filed in the record *(please print)*:

This is a much needed project. Hopefully upon its completion much of the traffic congestion on Rosedale Hwy can be eliminated.

Please respond by January 24, 2012

How did you hear about this meeting? Planning commission sent letter

☐ newspaper ☐ internet ☐ someone told me about it ☐ other:

Response to Comment from RW Henry Oil Producers

Thank you for your comments on the project. No response is necessary.

Comment from State Farm Insurance

1/10/12

COMMENT Card

SR 58 (Rosedale Highway) Widening Project

Rosedale Highway Widening

NAME: John WILLIAMSON

ADDRESS: 4208 RoseDAle Hwy st 202

CITY: BAKersfield ZIP: 93308

E-MAIL ADDRESS: Johnny@JohnnysINSURANCE.com

REPRESENTING: STATE FARM INSurance

☑ Please add me to the project mailing list

I would like the following comments filed in the record *(please print)*:

Not Allowing EASTBOUND traffic to turn left onto Fairhaven will have A MAJOR Impact on my Business.

I Propose A traffic Light Be INstalled on the corner of Fairhaven & Rosedale

Please respond by January 24, 2012

How did you hear about this meeting?

☐ newspaper ☐ internet ☒ someone told me about it ☐ other: ______

Response to Comment from State Farm Insurance

Thank you for your comment on the project.

A traffic signal is not proposed at the Fairhaven Drive intersection for two reasons: (1) traffic volume requirements and (2) the close spacing of the intersections. For a traffic signal to be installed on State Route 58, either existing or projected traffic volumes must meet a minimum of peak hour, four-hour, and eight-hour volumes (this level is known as a “signal warrant”). Both the existing and projected left-turn traffic volumes at the intersection of Fairhaven Drive do not meet these warrants. Having vehicles make a left turn across three lanes of traffic without having a place in the median to wait and safely merge with oncoming traffic can be a safety problem. Therefore, it was decided to provide westbound right-turn in, westbound right-turn out, and eastbound left-turn in to access land uses on Fairhaven Drive.

The left-turn traffic would be required to make a right-turn onto westbound State Route 58 and make a U-turn at the Landco Drive intersection less than 0.25 mile to the west. Also, as indicated above, with existing traffic signals at both Gibson Street and Landco Drive, there is insufficient distance between Fairhaven Drive and Gibson Street for installation of a third traffic signal along this 0.4-mile section of State Route 58. With Fairhaven Drive only 650 feet west of Gibson Street, the ability to coordinate these closely spaced intersections would degrade operating conditions on State Route 58. In addition, eliminating the left turn from southbound Fairhaven Drive to eastbound State Route 58 will reduce delays, and vehicles will be less likely to use the shopping center as a cut-through to get to State Route 58.

It should also be noted that in October 2004, when the development plans were being processed for the shopping center, Caltrans identified that a signal would not be allowed at Fairhaven Drive, and that future plans included the installation of a raised median on State Route 58 to prohibit the left-turn movement out of Fairhaven Drive. This correspondence is attached in Appendix L.

Comment from T-Mobile

Name: Jerry Mitchell

Address: 4208 Rosedale Hwy. Ste 201

Representing: T-Mobile

1/10/12

Problems:

1. Current design will have traffic coming through the our shopping center 1
2. Current design will have a negative economic impact on the local business 2
3. Current design upgrades the highway but degrades the intersection. 3

Solution:

1. Installing a signal at Fairhaven will facilitate better traffic flow during construction. 4
2. Complete one section at a time so that local businesses are not affected for such a long period of time. Also that would help with not creating so much traffic congestion on Rosedale. 5
3. Coordinate the signals at Gibson, Fairhaven and Landco Together, thereby allowing side traffic to make safe turns at the same time and improving traffic thru-put because vehicles would only be stopped at one light. 6

Response to Comments from T-Mobile

Thank you for your comments on the project.

Response to comment #1: Eliminating the left turn from southbound Fairhaven Drive to eastbound State Route 58 will reduce delays at this intersection, and vehicles will be less likely to use the shopping center as a cut-through to State Route 58.

Response to comment #2: The project will provide long-term congestion relief along this segment of State Route 58, which is a benefit to local businesses. Access to the shopping center will be maintained for both eastbound and westbound traffic. Though the eastbound movement exiting the shopping center will not be available, a U-turn is available at Landco Drive less than 0.25 mile west of the shopping center driveway. This would not represent a substantial burden to shoppers that would lead to an economic impact.

It should also be noted that in October 2004, when the development plans were being processed for the shopping center, Caltrans identified that a signal would not be allowed at Fairhaven Drive and that future plans included the installation of a raised median on State Route 58 that would eventually prohibit the left-turn movement out of Fairhaven Drive. This correspondence is attached in Appendix L.

Response to comment #3: Eliminating the left-turn movement at Fairhaven Drive will improve the level of service at this intersection because there would not be the back-up of cars waiting to turn left onto State Route 58.

Response to comment #4: A traffic signal is not proposed at the Fairhaven Drive intersection for two reasons: (1) traffic volume requirements and (2) the close spacing of the intersections. In order for a traffic signal to be installed on State Route 58, either existing or projected traffic volumes must meet a minimum of peak hour, four-hour, and eight-hour volumes (this level is known as a signal warrant). Both the existing and projected left-turn traffic volumes at the intersection of Fairhaven Drive do not meet these warrants. Having vehicles make a left turn across three lanes of traffic without having a place in the median to wait and safely merge with oncoming traffic can be a safety problem. Therefore, it was decided to provide westbound right-turn in, westbound right-turn out, and eastbound left-turn in to access land uses located on Fairhaven Drive. The left-turn traffic would be required to make a right-turn onto westbound State Route 58 and make a U-turn at the Landco Drive intersection less than 0.25 mile to the west. Also, as indicated above, with existing traffic signals at both Gibson Street and Landco Drive, there is insufficient distance between Fairhaven Drive and Gibson Street for installation of a third traffic signal along this 0.4-mile section of State Route 58. With Fairhaven Drive only 650 feet west of Gibson Street, the ability to coordinate these closely spaced intersections would degrade operating conditions on State Route 58. In addition, eliminating the left turn from southbound Fairhaven Drive to eastbound State Route 58 will reduce delays and vehicles will be less likely to use the shopping center as a cut-through to get to State Route 58.

To ease the short-term traffic impacts during construction, a Traffic Management Plan will be prepared (see Standard Condition SC-2 page 80 of the draft environmental document and page 83 of the final environmental document). The plan, among other things, will optimize roadway capacity, signal phasing, and timing during construction with the goal of ensuring safe and efficient traffic flow throughout the project study area during all phases of construction.

Response to comment #5: The phasing of construction has to be done in large enough segments to get meaningful circulation improvements. If only short segments are constructed, not only is the circulation benefit delayed, it can actually result in more traffic backups because traffic would need to almost immediately merge back into the existing lanes. In times of heavy traffic, cars would create a queue (line) waiting to merge into the through lanes. This can increase potential for accidents.

Response to comment #6: As indicated in response to comment #4, the intersections are too closely spaced to effectively coordinate the signals at these intersections.

Comment from John R. Wilson, Inc.

"John R. Wilson"<jrwrce@aol.com>
To: <bryan_apper@dot.ca.gov> 01/11/2012 06:48 AM
cc:
Re: Rosedale Lane Widening

Bryan,
Thanks for your assistance. We attended the meeting yesterday and thankfully the CalTrans engineers supplied additional information in regards to out clients access to Rosedale from Parker Lane during and after construction.

After explaining to our clients that Parker Lane would not only be limited to right in/right out but that access would be limited to Parker Lane from our clients property, at the southeast corner of Parker/Rosedale, by retaining walls from a distance of approximately 450 southerly of Rosedale
Highway. 1

Our clients would appreciate meeting with you or somebody from CalTrans in order to gather further information. Our clients believe a signal at the Parker Lane intersection, or improved access southerly on Parker Lane to tie into Mohawk at Walker Trail (the ultimate connection) which has a signalized intersection. 2

Please advise if a meeting in Fresno, in the near future, with CalTrans can be accomplished and if answers to our questions are in the cards also.

You cannot multiply wealth by dividing it.

John R. Wilson, Inc.
2012 "E" Street
Bakersfield, CA 93301
Tele 661-325-4862
Fax 661-325-5126
Mobile 661-301-5678

Response to Comments from John R. Wilson, Inc.

Thank you for your comments on the project.

Response to comment #1: As part of the roadway widening, the access to the Independent Pipe & Steel, Inc. property would have right-turn in and right-turn out access from State Route 58 (Rosedale Highway). At the time the grade separation is constructed (planned in 2025) access to the property would be restricted to Parker Lane due to an elevation difference between the grade separation and the Independent Pipe & Steel, Inc. property. However, during design of the grade separation, there may be the ability to provide a driveway access to the site from Mohawk Street through the residual portion of properties needed for the grade separation.

Response to comment #2: Your request for a meeting to discuss potential additional improvements to provide access to Mohawk Street via Walker Trail is noted. A meeting was held on March 19, 2012 Caltrans staff, the Thomas Roads Improvement Program, Kern County, and the City of Bakersfield. As part of this discussion, a private access route from Parker Lane that would connect to Mohawk Street at the intersection of Walker Trail was reviewed. While this improvement can be pursued as a separate project, it will not be incorporated as part of the State Route 58 (Rosedale Highway) Widening Project.

Comment from Rockstar Nails

COMMENT Card

SR 58 (Rosedale Highway) Widening Project

Rosedale Highway Widening

NAME: Rockstar Nails
ADDRESS: 4208 Rosedale Hwy. #303
CITY: Bakersfield ZIP: 93308
E-MAIL ADDRESS: Rockstarnails@att.net
REPRESENTING:
☒ Please add me to the project mailing list

I would like the following comments filed in the record *(please print)*:

We need a traffic light at the intersection of Rosedale Hwy and fairheaven because:
1. It will avoid accident when people are turning left to fairheaven or turning left to Rosedale Hwy.
2. It will help the customers easy to enter and exit the Rosedale Square shopping center.
3. It will help all the business in the Rosedale Square shopping center.
4. It will help a better traffic flow.

Please respond by January 24, 2012

How did you hear about this meeting?

☐ newspaper ☐ internet ☒ someone told me about it ☐ other:

Response to Comment from Rockstar Nails

Thank you for your comments on the project.

A traffic signal is not proposed at the Fairhaven Drive intersection for two reasons: (1) traffic volume requirements and (2) the close spacing of the intersections. In order for a traffic signal to be installed on State Route 58, either existing or projected traffic volumes must meet a minimum of peak hour, four-hour, and eight-hour volumes (this level is known as a "signal warrant"). Both the existing and projected left-turn traffic volumes at the intersection of Fairhaven Drive do not meet these warrants. Having vehicles make a left turn across three lanes of traffic without having a place in the median to wait and safely merge with oncoming traffic can be a safety problem. Therefore, it was decided to provide westbound right-turn in, westbound right-turn out, and eastbound left-turn in to access land uses located on Fairhaven Drive. The left-turn traffic would be required to make a right-turn onto westbound State Route 58 and make a U-turn at the Landco Drive intersection less than 0.25 mile to the west. Also, as indicated above, with existing traffic signals at both Gibson Street and Landco Drive, there is insufficient distance between Fairhaven Drive and Gibson Street for installation of a third traffic signal along this 0.4-mile section of State Route 58. With Fairhaven Drive only 650 feet west of Gibson Street, the ability to coordinate these closely spaced intersections would degrade operating conditions on State Route 58. In addition, eliminating the left turn from southbound Fairhaven Drive to eastbound State Route 58 will reduce delays, and vehicles will be less likely to use the shopping center as a cut-through to State Route 58.

It should also be noted that, in October 2004, when the development plans were being processed for the shopping center, Caltrans identified that a signal would not be allowed at Fairhaven Drive, and that future plans included the installation of a raised median on State Route 58 that would eventually prohibit the left-turn movement out of Fairhaven Drive. This correspondence is attached in Appendix L.

Comment from John R. Wilson, Inc.

"John R. Wilson"<jrwrce@aol.com>
To: <bryan_apper@dot.ca.gov> 01/20/2012 04:35 PM
cc:
Re: Rosedale Lane Widening

We have not heard from anyone re a meeting, and the drop dead date for replies to the Environmental Document is fast approaching, so we will be submitting comments in regards to our unanswered questions.

You cannot multiply wealth by dividing it.

John R. Wilson, Inc.
2012 "E" Street
Bakersfield, CA 93301
Tele 661-325-4862
Fax 661-325-5126
Mobile 661-301-5678

Response to Comment from John R. Wilson, Inc.

Thank you for your comment on the project.

On January 23, 2012, Bryan Apper, Caltrans environmental branch chief, responded by e-mail to Mr. Wilson's request for a meeting and directed that all comments be submitted by the January 24, 2012 deadline. Mr. Apper indicated to Mr. Wilson that a meeting with the engineers can still be arranged after the close of the public review period, but that his comments needed to be submitted prior to the deadline. A meeting was held on March 19, 2012 Caltrans staff, the Thomas Roads Improvement Program, Kern County, and the City of Bakersfield. As part of this discussion, a private access route from Parker Lane that would connect to Mohawk Street at the intersection of Walker Trail was reviewed. While this improvement can be pursued as a separate project, it will not be incorporated as part of the State Route 58 (Rosedale Highway) Widening Project.

Comment from John R. Wilson, Inc.

"John R. Wilson"<jrwrce@aol.com>
To: <bryan_apper@dot.ca.gov> 01/24/2012 04:34 PM
cc:
Re: Rosedale Lane Widening

Bryan,
Comments on the EIR - the Plans in the Env. Doc. were not the same as 1
the plans shown at the Tuesday meeting on Rosedale Hwy.

the env. document did not address the LOS at the intersections
where large trucks that cannot make a U-turn on Rosedale Hwy, have to 2
navigate through the neighboring areas to circle
around.

the Tuesday meeting did reveal from the stafff that there would
be 'other' designated u-turns on Rosedale Hwy that are not in the Env
document that would change the LOS of the intersections
where U-turns are not currently permitted or proposed. 3

we are still concerned that the intersections that are 'closed'
under the plans shown at the Tuesday meeting are not addressed in the
Env doc as to where large vehicles can
turn around.

the Parker Lane closure will hamper the turning movement of
50-75 large trucks a day---as one new client intends to send 5800 truck
loads of material through Parker Lane a year, that is 2900 trucks from
the east returning to the east, and 5800 trucks going west and returning 4
from the west. this is in addition to the trucks already coming and going.

for Parker Lane, the answer appears to be a route out the back
to attach through the Mohawk traffic signal intersection.

You cannot multiply wealth by dividing it.

John R. Wilson, Inc.
2012 "E" Street
Bakersfield, CA 93301
Tele 661-325-4862
Fax 661-325-5126
Mobile 661-301-5678

Response to Comments from John R. Wilson, Inc.

Thank you for your comments on the project.

Response to comment #1: After comparison of the plan sheets and the set of plans provided in Appendix G (Project Plans), they appear the same. The difference may be that the plans you reviewed at the public meeting included the grade separation, accidently left out of Appendix G. Project plans with the grade separation have been included in Appendix G of the final environmental document.

Response to comment #2: The level of service calculations do factor into truck trips.

Response to comment #3: Staff indicated there was a discussion of evaluating various options where U-turns would be allowed at additional intersections along State Route 58. The project plans already propose multiple locations where turn pockets are provided for left turns/U-turns between signals, although turn pockets cannot be provided at every side-street location. Mohawk Street was included in the discussion.

At present, U-turns are not permitted for westbound to eastbound traffic at Mohawk Street. With the widening project, this restriction is planned to be removed. This segment of the roadway will remain in Caltrans jurisdiction and would need the agency's approval. However, it should be noted that Independent Pipe & Steel trucks would likely exceed the size that could make the U-turn at this location. Preliminary analysis indicates that the biggest truck that can make a U-turn (going westbound to eastbound) without affecting the adjacent lane is a 30.8-foot-long vehicle. This would be the same for at Landco Drive.

As indicated in response to comment #2, the level of service calculations do assume truck trips making turns. Page 41 of the draft initial study/environmental assessment (page 42 of the final initial study/environmental assessment) does identify an inconvenience factor for having to double back, but the distance between intersections where turns could be made is not substantial.

Response to comment #4: During design of the grade separation, there may be the ability to provide a driveway access to the site from Mohawk Street through the residual portion of properties needed for the grade separation.

Comment from The UPS Store #6021

COMMENT Card

SR 58 (Rosedale Highway) Widening Project

Rosedale Highway Widening

NAME: Barbara and Brian Simpson
ADDRESS: 4208 ROSEDALE HWY
CITY: BAKERSFIELD, CA ZIP: 93308
E-MAIL ADDRESS: Store 6021 @ the ups store.com
REPRESENTING: THE UPS STORE #6021
☒ Please add me to the project mailing list

I would like the following comments filed in the record *(please print)*:

I AM A SMALL BUSINESS OWNER OF THE UPS STORE IN THE ROSEDALE SQUARE SHOPPING PLAZA ON THE CORNER OF ROSEDALE HIGHWAY AND FAIRHAVEN. IN MY PROFESSIONAL OPINION, I BELIEVE THAT PUTTING A RIGHT TURN ONLY ONTO ROSEDALE HIGHWAY WILL DISCOURAGE CUSTOMERS FROM USING OUR STORE AND HURT MY BUSINESS. MY REQUEST FOR CONSIDERATION IS TO PUT IN A LIGHT SIGNAL SO CUSTOMERS CAN SAFELY HEAD EASTBOUND AND NOT SECOND GUESS WEATHER THEY WILL USE OUR STORE BECAUSE OF SAFETY REASONS OR FOR INCONVENIENCE. WE WISH TO GROW OUR CLIENTELE AS WELL AS MAINTAIN OUR CURRENT CUSTOMERS. PLEASE CONSIDER A STOP LIGHT FOR ROSEDALE HIGHWAY AND FAIRHAVEN.

Please respond by January 24, 2012
How did you hear about this meeting?
☐ newspaper ☐ internet ☒ someone told me about it ☐ other: ______

Response to Comment from UPS Store #6021

Thank you for your comment on the project.

A traffic signal is not proposed at the Fairhaven Drive intersection for two reasons: (1) traffic volume requirements and (2) the close spacing of the intersections. In order for a traffic signal to be installed on State Route 58, either existing or projected traffic volumes must meet a minimum of peak hour, four-hour, and eight-hour volumes (this level is known as a “signal warrant”). Both the existing and projected left-turn traffic volumes at the intersection of Fairhaven Drive do not meet these warrants. Having vehicles make a left turn across three lanes of traffic without having a place in the median to wait and safely merge with oncoming traffic can be a safety problem.

Therefore, it was decided to provide westbound right-turn in, westbound right-turn out, and eastbound left-turn in to access land uses located on Fairhaven Drive. The left-turn traffic would be required to make a right-turn onto westbound State Route 58 and make a U-turn at the Landco Drive intersection less than 0.25 mile to the west. Also, as indicated above, with existing traffic signals at both Gibson Street and Landco Drive, there is insufficient distance between Fairhaven Drive and Gibson Street for installation of a third traffic signal along this 0.4-mile section of State Route 58. With Fairhaven Drive only 650 feet west of Gibson Street, the ability to coordinate these closely spaced intersections would degrade operating conditions on State Route 58. In addition, eliminating the left turn from southbound Fairhaven Drive to eastbound State Route 58 will reduce delays, and vehicles will be less likely to use the shopping center as a cut-through to State Route 58.

The project will provide long-term congestion relief along this segment of State Route 58, which is a benefit to local businesses. Access to the shopping center will be maintained for both eastbound and westbound traffic. Though the eastbound movement exiting the shopping center will not be available, a U-turn can be made at Lando Drive less than 0.25 mile west of the shopping center driveway.This would not represent a substantial burden to shoppers that would lead to an economic impact.

It should also be noted that in October 2004, when the development plans were being processed for the shopping center, Caltrans identified that a signal would not be allowed at Fairhaven Drive, and that future plans included the installation of a raised median on State Route 58 to prohibit the left-turn movement out of Fairhaven Drive. This correspondence is attached in Appendix L.

Comment from Carol Bender

January 1, 2012

Re: Rosedale Highway Widening Project EIR

Dear Bakersfield Planning Department and Commissioners:

As a private citizen, I have been trying to wade through this EIR and am finding a lot of issues that are quite concerning. It is very disappointing to see that all plans to widen Rosedale Highway, west of Allen Rd. have been abandoned in this EIR.

As you know, many of the projects (residential, commercial and industrial) planned and ultimately approved out here in Rosedale have all been challenged in some way due to inappropriate infrastructure (especially roads). The projects west of Allen (including the approved Target shopping center on Renfro/Rosedale, and various housing and commercial projects) were 1
justified to some degree because of the upcoming Rosedale Hwy widening project. This project originally would have widened Rosedale Highway to Enos Lane.

I think it prudent to submit my questions and concerns in some sort of written form before the Jan 5 hearing at the Bakersfield City Planning Commission meeting. My hope is that someone can address these questions/concerns in that meeting.

I am wondering where the County of Kern stands on this. Is this review all being done by the city, who historically seems to be in charge of all things 2
funded by the Thomas Road Project ? Will the county have its own set of hearings on this?

I do have some safety concerns as well. In summary, these include lack of sidewalks, bus turnouts and bike lanes, as well as exceptions to zoning 3
restrictions of 25' setbacks on residential properties abutting the roadway. Additionally, mitigations are very "iffy". The language is reminiscent of that used in the HSR Authority EIR. For example, what is considered 4
"reasonable" to spend on noise abatement for a public middle school should be evaluated further. Concrete mitigation measures, monetary "allowances" and other detailed information is also lacking. 5
I am also wondering if any consideration was given to cumulative noise and other environmental impacts with the HSR project running so very close to a preschool and middle school 6
discussed in the EIR.

I would sure like to see an alternative that would widen Rosedale Highway AT LEAST to Renfro Road which is the only north-south road in close proximity to Allen that actually has any length to it. Jenkins, as you know, 7
dead-ends south of Brimhall Rd.

To illuminate my concern: One chart of traffic projections (pg 25 on EIR) shows that westbound traffic on 58 between Allen and Jenkins will increase by 11-12% by 2015 and to 24-25% by 2035. The closest study intersection (Calloway to Verdugo) will increase 8-9% by 2015 and 18-19% by 8
2035....and this is with 6 lanes! West of Allen will remain 2 lanes for 20+ years, and all future projections for 2035 ASSUME that the West Beltway will already be built in 2035. We know that this is not likely.

1

2

The last Kern Cog report stated there was no funding for the West Beltway this far north and that it was planned for BEYOND 2035. I do not believe that the data in this EIR is accurate. Perhaps a projected traffic study for the year 2020 or 2025 is warranted? 9

The EIR states this project is not meant to address growth, because "our plan" is for infill........
I do not think this is accurate. For this to be true, we would be looking at reducing growth and project approvals west of Allen Rd. That is not what I am seeing and hearing in either the Kern County Planning Commission or Board of Supervisors chambers. It would seem that the city is continuing to approve projects west of Allen and annex land areas here for development as well. 10

I would greatly appreciate any input you may have with regard to my concerns.

Best regards,

Carol Bender
13340 Smoke Creek Ave
Bakersfield, CA 93314
661-588-0806

Response to Comments from Carol Bender

Thank you for your comments on the project.

Response to comment #1: The segment of State Route 58 from Allen Road to State Route 43 (Enos Lane) will eventually be widened from two to four lanes. The Kern Council of Governments' Regional Transportation Plan identifies widening State Route 58 (Rosedale Highway) from Allen Road to State Route 43 (Enos Lane) as an improvement in the 2021 to 2025 timeframe. This improvement would be a separate project and have a separate environmental document at the time the project is proposed. In addition, portions of the roadway will be widened as development next to the roadway is constructed.

Response to comment #2: As a member of the project development team, Kern County has been a regular participant in the planning efforts for the State Route 58 Widening Project. As shown in Table 1.4, Permits and Approvals, the City of Bakersfield and Kern County will enter into a cooperative agreement that outlines their respective responsibilities for project implementation. Both agencies have received preliminary design information and technical studies to ensure the project meets the needs of the local jurisdictions. Kern County will not have separate hearings on the project. The City of Bakersfield held hearings on the project because they are the lead agency under the California Environmental Quality Act.

Response to comment #3: Sidewalks exist throughout the study area but are not continuous on either side of the roadway. The project would build facilities meeting the requirements of the Americans with Disabilities Act. Improvements would include installation of Americans with Disabilities Act-compliant ramps at curb returns; Americans with Disabilities Act-compliant sidewalk and driveway widths; and continuous sidewalks on at least one side of the roadway. The project would also include sound alerts on pedestrian crossing signals (page 78 of the draft initial study/environmental assessment; page 80 of the final initial study/environmental assessment).

Response to comment #4: Caltrans' *Traffic Noise Analysis Protocol* discussed in the *Noise Abatement Decision Report* establishes the criteria for determining when an abatement measure is reasonable and feasible. Feasibility of noise abatement is basically an engineering concern. A minimum reduction of 5 A-weighted decibels in the future noise level must be achieved for an abatement measure to be considered feasible. The reasonableness determination is basically a cost-benefit analysis.

Factors used in determining whether a proposed noise-abatement measure is reasonable include residents' acceptance and the cost per benefited residence; the absolute noise level; build versus existing noise; environmental impacts of abatement; public and local agency input; and newly built development versus development pre-dating 1978 (pages 135 though 137 of the draft initial study/environmental assessment; pages 137–139 of the final initial study/environmental assessment). Though cost is only one factor, the analysis provides for a base allowance of about $31,000, then factors in other criteria, such as the age of the home and the amount of noise reduction provided by the wall. For this project, that equated to a cost threshold of about $45,000 per home for determining if a soundwall is reasonable. If a wall protects multiple homes, this is reflected in the allowance for making the determination of reasonableness. Establishing a reasonableness standard is important to avoid inappropriate use of taxpayer funds.

For the project, the reasonableness information is all shown in Table 2.20, Determination of Reasonableness of Recommended Soundwalls, of the initial study/environmental assessment. This table shows the receptors that would be protected, and the reasonableness allowance that was used for each soundwall evaluated as part of the noise analysis for the project.

There are two public schools in the project area—Rosedale Middle School and Vista West Continuation School. At Rosedale Middle School, soundwalls were not considered to be feasible because they did not provide a 5-decibel reduction for the exterior noise level. At Vista West Continuation High School, there is no feasible location to place a noise barrier because of the location of the driveway entrance of the school's parking lot. Adding a barrier at that location will interfere with access to the school driveway, and adding a discontinuous soundwall would affect the feasibility of the wall. It should be noted that, with windows closed, the inside noise level for classrooms is usually 25 decibels less than the outside noise level, making the inside noise level 48 A-weighted decibels. Additionally, the project would have little effect on the noise levels along State Route 58 (see Table 2.19 in the initial study/environmental assessment). At Rosedale Middle School, the outside noise level is 72 A-weighted decibels. In 2035, both with and without the project, the noise level is expected to increase to 73 A-weighted decibels.

All of this information is further discussed in the *Noise Study Report* and the *Noise Abatement Decision Report*.

Response to comment #5: The noise-abatement discussion starts on page 150 of the draft initial study/environmental assessment (page 154 of the final initial study/environmental assessment). It states which soundwalls are recommended based on current design. The following wall locations were identified as part of Measure N-1 on page 156 of the draft environmental document (page 160 of the final environmental document):

- Barrier 02 along the north side of the State Route 58 right-of-way east of Maher Drive and next to ABC Preschool Academy. Calculations based on preliminary design data indicate that the barrier would reduce noise levels by 5 A-weighted decibels at a height of 12 feet for four receptors at an estimated cost of $178,945. This cost is considered reasonable since it is less than the reasonable allowance maximum of $188,000.
- Barrier 11 along the private property line near an adjacent parking lot south of State Route 58 and next to Verdugo Lane. Calculations based on preliminary design data indicate that the barrier would reduce noise levels by 5 A-weighted decibels at a height of 8 feet for two receptors at an estimated cost of $71,081. This cost is considered reasonable since it is less than the reasonable allowance maximum of $86,000.

Response to comment #6: The noise analysis also considers the 2035 traffic volumes. This would account for the cumulative traffic noise impacts associated with the projected regional growth and the roadway improvements to be provided by the Thomas Roads Improvement Program and the Metropolitan Bakersfield Transportation Impact Fee Program. Noise from the California High Speed Rail Project was not calculated into the noise analysis for the Build Alternative. The precise impacts associated with the rail project would depend on the number of trains. However, the California High Speed Rail Project Environmental Impact Report/Environmental Impact Statement identifies moderate to severe noise impacts to sensitive receptors in the location where the trains would cross State Route 58. The noise would be considerable but of short duration (as the trains pass) and would be localized (covering an area of about one to 2 miles next to the rail line). The California High Speed Rail Project proposes the construction of barriers to minimize noise impacts. According to the California High Speed Rail Project Environmental Impact Report/Environmental Impact Statement, with the barriers the severe noise impacts from the California High Speed Rail Project would be avoided in the project study area. The two noise barriers proposed by the project would help to reduce the cumulative noise impacts from roadway noise associated with regional growth. This would be a benefit of the project. As shown in Table 2.19, Predicted Traffic Noise Level, at most there are only a few decibel differences between the existing and future noise levels. The project would not substantially contribute to cumulative noise impact.

Response to comment #7: As indicated in response to comment #1 above, the segment of State Route 58 from Allen Road to State Route 43 (Enos Lane) is scheduled for widening in the 2021 to 2025 timeframe. In addition, portions of the roadway will be widened as development next to the roadway is constructed.

Response to comment #8: The widening of State Route 58 west of Allen Road is expected to be constructed between 2021 and 2025. Page 19 of the draft initial study/environmental assessment incorrectly stated that the improvements west of Allen Road were not expected to be needed until 2035. The following correction is made to the final environmental document (page 20; note new text is shown in *italics* and deleted text is shown in ~~strikeout~~): "Additionally, the traffic study showed that the improvements west of Allen Road would not be needed until *2025."* ~~after 2035~~.

The West Beltway is listed as four projects in the 2011 Regional Transportation Plan Amendment #1 regionally adopted on May 19, 2011 and federally approved on June 2, 2011. The segment from State Route 58 (Rosedale Highway) to Westside Parkway would be constructed in 2025. In 2033, the West Beltway would be extended from Pacheco Road to the Westside Parkway and from State Route 58 (Rosedale Highway) to 7th Standard Road. A subsequent phase would construct a new facility from Taft Highway to Pacheco Road. Even with this delay, the adopted time frame assumes the West Beltway within the project area would be built before the design year (2035) for the State Route 58 Widening Project.

Response to comment #9: It is not clear which Kern Council of Governments report is being referenced that indicates a delay in the construction of the West Beltway. Presumably, it is the Regional Transportation Plan Amendment #1, which does delay the construction of the roadway from earlier assumptions. The Regional Transportation Plan, developed by the Kern Council of Governments is a long-term (20-year) plan for the Kern County transportation network that includes all types of travel and freight movement. The Regional Transportation Plan establishes the projects needed to improve Kern County's transportation system through 2035 in order to meet the transportation needs and meet the federal air quality conformity requirements. As discussed in response to comment #8, the first phase of the West Beltway is planned to be constructed in 2025.

The traffic analysis uses the Kern Council of Governments Traffic Model to predict future traffic volumes in the study area. The Federal Highway Administration requires Caltrans to do the traffic analysis for design year, which is 20 years after opening of the improvements. For this project, that is 2035.

Response to comment #10: Section 2.1.2 in the initial study/environmental assessment addresses the potential for growth-inducing impacts. The document does identify that, based on the Kern Council of Governments' projections (using the California Department of Finance 2007 data), the population of the City of Bakersfield is projected to increase about 69 percent between 2000 and 2020. The analysis states that, as a result of the project, major changes in the travel patterns in the study area would not be expected, even with the future growth, because the land uses that are attracting the trips (the jobs and shops) already exist or would be infill development (development of vacant lots in mostly developed areas), consistent with the long-term growth projections. Since the project is in the urban core of metropolitan Bakersfield, most of the surrounding area is already developed. The project does not open up new areas to development, nor does it provide excess capacity that would facilitate redevelopment that would result in growth beyond the level already assumed as part of the growth projections.

Comment from Unsigned

COMMENT Card

SR 58 (Rosedale Highway) Widening Project

Rosedale Highway@Widening

NAME: 2-10 h

ADDRESS:

CITY: ZIP:

E-MAIL ADDRESS:

REPRESENTING:

☐ Please add me to the project mailing list

I would like the following comments filed in the record *(please print)*:

I really enjoyd the public meeting. It was very ~~to~~ informative to see how the roads are developing. Please keep advertising these types of workshops in the paper.

Please respond by January 24, 2012

How did you hear about this meeting?

☒ newspaper ☐ internet ☐ someone told me about it ☐ other:

Caltrans

Response to Comment from Unsigned

Thank you for your comment on the project.

Comment from Carol Bender

NOTES RE: ROSEDALE HWY WIDENING DRAFT EIR OPEN HOUSE (PUBLIC HEARING)
JANUARY 10, 2012

PUBLIC COMMENT TO DRAFT EIR TRIP ROSEDALE HWY WIDENING PROJECT:
Please submit these questions and comments for the record under formal public comments.

General Questions/Comments

1 From the Draft EIR: (pg 66) The project plan is focused on a plan for infill....not to support growth." If this were true, both the county and city would be limiting growth/building west of Allen Rd. That is not happening. Past project approvals were often justified in part because the plan in the near future was to widen Rosedale Hwy to Enos Lane. This EIR recommendation crushes that plan, stating instead that the widening will end at Allen Road. 1

2. The EIR ASSUMES that the Westside Parkway AND the 24th St Improvement Project AND the Hageman Flyover Project will be COMPLETE by 2015. Is this realistic to expect that these will ALL be completed within 3 years? 2

3. The EIR also ASSUMES that by 2035, the Westside Parkway will connect with HWY 58 east of 99. What is the current projection of completion of that project?? Adoption of alignment? 3

SPECIFIC AREAS OF CONCERN:

A. TRAFFIC STUDY: States that improvements west of Allen Rd. are not needed until after 2035! This is unrealistic. The West Beltway (northern end in particular..north of Rosedale Hwy)has no funding and according to the last KERNCOG update is not planned until AFTER 2035. 4

Alternatives A, B and C
The cheapest of these is A, at 87 million dollars.. (110' cross section), and would include adding a lane out to Enos Lane. However this is not recommended due to the cost of purchasing property.

Alternatives B and C ask for 126' cross section and 134'(Caltrans criteria for cross section width) and are not recommended.

Why is there not an Alternative D that would consider an extra lane to either Renfro (location of approved Target Shopping Center) or Rudd Rd. (location of West Beltway)? This makes the most sense to address current congestion and to prevent degradation below LOS E and F in the near future. By 2015, Jenkins will have LOS F at the afternoon peak hours. Renfro will be at LOS E during the same timeframe. It is important that Rosedale Highway be widened west of Allen Rd. at least far enough to meet another major arterial roadway that runs north to south. Jenkins dead-ends just south of Brimhall..but Renfro provides a route south to Stockdale Highway. Again, bear in mind in this EIR, the 2015 traffic analysis assumes that the Westside Parkway, 24th Street Improvements Project and the Hageman Flyover are COMPLETE. 5

An alternative such as "D" with adequate pedestrian walkways and bikepaths would indeed be in keeping with the "Walkable Communities" concept and decrease road traffic. Residential neighborhoods back up to Rosedale Highway, west of Allen Rd.

Note page 68...statistics used to project growth use previous studies of 2000-2012 growth and 2006-2013 growth. Question: How old are these studies? When (what date) were studies done to project growth beyond 2013? 6

In reference to the traffic study analyses done for 2015 and 2035: The traffic study for 2035 assumes the West Beltway is already completely built (which is likely inaccurate given the history of funding of transportation projects in Kern.) Therefore it seems reasonable to do ANOTHER traffic study perhaps for 2020 or 2025 that will evaluate the traffic situation more accurately! 7

B. TRAFFIC FEES

Pg. 90 states that the existing traffic impact fee program assumes 4 intersection improvements none of which are west of Allen. How can this be? Traffic impact fees collected by projects west of Allen (including proposed Target shopping center on Renfro/Allen, and others) should be earmarked for their respective areas whenever possible. Are we just talking CITY traffic impact fees? **8**

C. SIDEWALKS, BUS TURNOUTS AND BIKELANES

If the goal is to promote walkable communities and alternative transit opportunities, why do the plans eliminate bikeways, bus turnouts and sidewalks? This goes against everything the community has voiced concern over. Eliminating these things will make the roadway increasingly unsafe for pedestrian and bike travel...ultimately increasing automobile traffic. This type of design discourages future transit plans and is in direct opposition to the walkable communities concept. Discouraging future light rail amd bus transit, as well as pedestrian and bike use, will ultimately contribute to poor air quality and an increase in greenhouse gases. It will make citizens rely MORE on their automobiles/trucks for SAFE travel along this roadway. **9**

It should be noted also that many neighborhoods west of Allen Road actually back up to Rosedale Highway currently. Residents cannot walk to the closest residential shopping areas because there are no contiguous sidewalks. That is considered adequate until 2035?

Rationale for lack of bus turnouts......(EIR pg 37)"Increased transit service on 58 will not be enough to reduce traffic volumes"??? What is "enough"? How much is Kern county willing to increase the transit service? This is a weak rationale. **10**

If setbacks in residential front yards will be < 25 feet...the EIR states that the project will allow a non-conforming use so that it won't be a zoning problem. This seems particularly unwise AND unsafe. **11**

D. AESTHETICS

Since Rosedale Hwy is in both the city AND the county, what will be the responsibility of each with regard to maintenance of the roadway, any medians and landscaping? Given that we still do not have an updated Metro Bakersfield plan that might include the unincorporated areas of the Metro area in a joint roadway/median/landscape plan, this is unsettling. It is understood that currently the county of Kern does not have a landscape maintenance budget and current medians in the unincorporated Metro area are minimally expected to be comprised of asphalt which becomes unsightly quite quickly. Additionally, even weed abatement on these county medians is lax. Landscaping of some sort (along with an understanding of who maintains it) and stamped concrete or stone medians should be part of the plan of this project. A joint street paving plan schedule should also be standardized. **12**

E. NOISE ABATEMENT

Sound walls are noted as being need based on "reasonable" criteria. This criteria includes that such sound walls will be considered "reasonable" if they can be built for LESS than the allowance! However standard this language may be in an EIR document, this language is very vague and does not truly outline what ACTUALLY will be mitigated. It takes the "wait and see" approach which is much like the approach outlined in the High Speed Rail EIR that was much maligned by the city...and rightly so. **13**

What is of particular concern is that Rosedale Middle School as studied in the EIR will most likely not qualify for noise barriers because it would not fall under the "reasonable" criteria. Given that it is a public school that will not be relocated anytime soon....it seems "more reasonable" to give it "special" attention. It is important to look at how decibel levels both outside AND inside will be affected by this project so proper sound wall and other noise/vibration mitigation can occur. A place of learning needs to be as quiet as possible. Higher decibel noise levels in this environment are unacceptable. **14**

Given that the High Speed Rail (HSR) alignment is planned so near Rosedale Middle School, it seems prudent to have the cumulative noise/vibration/air quality impacts (with HSR) also noted in this EIR. **15**

Respectfully,

Carol Bender

Carol Bender
13340 Smoke Creek Ave
Bakersfield, CA 93314

661-588-0806

1-10-12

Response to Comments from Carol Bender

Thank you for your comments on the project. It should be noted that the page numbers referenced in several of the comments are actually the page count of the electronic file rather than the document page number located at the bottom of each page of the document. For clarity, the response identifies the page number that the comment is referencing.

Response to comment #1: This document does identify that there will be growth in the region (pages 47 to 50). The limits of the project addressed in the initial study/environmental assessment are focused on the segment of State Route 58 from Allen Road to State Route 99 because that is the location with the greatest need for improvements. Given the funding limitations, Caltrans and the City of Bakersfield, in cooperation with Kern County and the Kern Council of Governments, prioritized this segment of roadway. As part of a future project, with its own environmental document, the portion of State Route 58 from State Route 43 (Enos Lane) to Allen Road will also be widened. Widening the roadway before the demand is present could also encourage premature growth in the area.

Response to comment #2: All three projects are on the same schedule. The environmental documents are projected to all be completed by the end of 2012, and the design efforts will be initiated shortly after the environmental documents are finalized. Funding is available to allow concurrent construction of the improvements.

Response to comment #3: The Regional Transportation Plan also assumes the completion of the Centennial Corridor around 2018. The technical studies and the environmental document are currently being prepared and should be out for public review before the end of 2012. Selection of an alignment and approval of the environmental document is assumed to be completed in 2013.

Response to comment #4: Page 19 of the draft initial study/environmental assessment should have stated that the improvements west of Allen Road were not expected to be needed until 2025, not 2035. Thank you for calling this to our attention. The following correction is made to page 20 the Final Environmental Document (new text shown in *italics* and deleted text shown in ~~strikeout~~): "Additionally, the traffic study showed that the improvements west of Allen Road would not be needed until *2025.*~~after 2035~~"

Response to comment #5: As indicated in response to comment #1 above, given the funding limitations, this segment of roadway was prioritized as having the greatest need for improving. As part of a future project, the portion of State Route 58 from State Route 43 (Enos Lane) to Allen Road will also be widened.

Response to comment #6: The use of studies or references that use different time frames is in part dependent on the topic being evaluated. Discussion of the projected housing between 2006 and 2013 is referencing the Regional Housing Needs Assessment. As discussed on page 48 of the draft initial study/environmental assessment (page 50 of the final initial study/environmental assessment), the California Department of Housing and Community Development prepares a State Housing Needs Assessment, which determines the housing requirements to meet the State demand over a five-year period. Each jurisdiction is allocated the number of additional housing units necessary to meet State and local housing goals. This allocation, known as the Regional Housing Needs Allocation, also considers the number of housing units needed for specific income classes. The current Housing Needs Assessment covers the period between January 1, 2006 and June 30, 2013. This number provides a snapshot of the housing growth that Kern County and the City of Bakersfield are expected to provide in the near term. The California Department of Housing and Community Development formally transmitted Kern County's housing allocation to the Kern Council of Governments in September 2006.

There were no references to studies that projected growth between 2000 and 2012, though there were references to studies that addressed growth between 2000 and 2020 and from 2000 to 2030. These numbers were developed by the California Department of Finance. The discussion of long-range projections uses both 2020 and 2030 because many of the numbers were being updated while the initial study/environmental assessment was being prepared. The projections help organizations like the Kern Council of Governments in their long-term planning. The Department of Finance data used was developed in 2007.

Response to comment #7: The circulation system in the traffic analysis is from the Kern Council of Governments Traffic Model, which uses the assumptions from the Regional Transportation Plan. The Federal Highway Administration requires Caltrans to do the traffic analysis for the design year, which is 20 years after opening of the improvements. For this project, that is 2035.

Response to comment #8: It appears the referenced discussion is on pages 71 and 72 about the roadway networks for 2015 and 2035. This discussion lists the major improvements that are assumed in the Kern Council of Governments Traffic Model that would have the greatest influence on traffic on State Route 58. For the 2015 time period, four major improvements are identified (these are more than intersection improvements). For 2035, it states that the roadway network assumptions include the completion of the Thomas Roads Improvement Program projects as well as the roadway projects included in the Metropolitan Bakersfield Transportation Impact Fee program. The document indicates that the Metropolitan Bakersfield Transportation Impact Fee program includes a range of local street improvements designed to relieve traffic congestion, including widening of several north-south roadways that cross State Route 58, particularly in the western portion of the study area**.**

Response to comment #9: The project is not removing sidewalks, bikeways, or bus turnouts. Sidewalks are not continuous on either side of the roadway throughout the study area. The project would provide a continuous sidewalk on at least one side of the roadway throughout the study area. This would improve the corridor for pedestrians and enhance the goal of a walkable community. Currently, there are no bus turnouts. The improved traffic flow on State Route 58 would also improve transit travel time.

As indicated in the Initial Study/Environmental Assessment, the *Metropolitan Bakersfield General Plan* does not designate any bike trails or paths along State Route 58 (page 80 of the draft document; page 82 of the final document). Given the right-of-way constraints, the high traffic volumes, high percentage of trucks, and number of driveway breaks, a dedicated bikeway is not proposed as part of the project.

As with existing conditions, the project would not place any restrictions on the use of State Route 58 by bicyclists. The City of Bakersfield and Kern County do not encourage bicyclist to use State Route 58 because it is a designated truck route and carries a high volume of trucks. The *Metropolitan Bakersfield General Plan* has designated bikeways on Brimhall Road and Hageman Road that run parallel to State Route 58. These parallel roadways provide more suitable routes because they carry less traffic and fewer trucks. Connecting bikeways from State Route 58 to the bikeways on both Brimhall Road and Hageman Road can be made via Allen Road, Calloway Drive, and Coffee Road. Additionally, though Mohawk Street currently ends at State Route 58, there are plans to extend Mohawk Street through to Hageman Road.

As discussed below, though there is not enough bicycle ridership to support the usage of State Route 58 as an important bicycle linkage, the lane widths will be reconfigured to provide a wider outside lane and shoulder. For the segment of roadway from Allen Road to Mohawk Street, rather than having three 12-foot-wide travel lanes with a 2-foot-wide outside shoulder, the width of the middle travel lane will be reduced to 11 feet. The additional foot will allow a 15-foot outside lane (12-foot-wide travel lane and a 3-foot shoulder). This will not be considered a bike lane, but would provide additional area should a bicyclist decide to use State Route 58.

As indicated above, State Route 58 currently has low bicycle ridership. Based on the comments received regarding bicycle access on State Route 58 (Rosedale Highway), the City of Bakersfield, the County of Kern, and the Kern Council of Governments decided to look further into current bicycle usage on the highway. The County of Kern conducted bicycle counts on two days to gauge the level of ridership on the roadway. The following are the findings of the bicycle counts:

- On Wednesday, February 1, 2012, counts were taken between 6:30 a.m. and 9:00 a.m. at State Route 58 at Landco Drive. A total of three bicyclists were riding at this location during this time period. One rider was riding against the flow of traffic.
- On Wednesday, February 1, 2012, counts were taken between 6:30 a.m. and 9:00 a.m. at State Route 58 at Old Farm Road. No bicyclists were riding at this location during this time period.
- On Saturday, February 4, 2012, counts were taken between 9:00 a.m. and noon at State Route 58 at Landco Drive. A total of four bicyclists were riding at this location during this time period. Again, one rider was riding against the flow of traffic.
- On Saturday, February 4, 2012, counts were taken between 9:00 a.m. and noon at State Route 58 at Old Farm Road. Four bicyclists were riding at this location during this time period.

In addition, bicycle rack surveys were conducted on Saturday, February 4, 2012 in the morning in conjunction with bicycle counts. The following reflects the usage of bicycle racks between 9:00 a.m. and noon on February 4, 2012:

- Bicycle rack locations on the north side of State Route 58 between Oak Street and Calloway Drive:
    - Kyoto Sushi – no bicycles

  - 24-hour fitness – one bicycle
  - Cactus Valley Mexican Restaurant – no bicycles
- Bicycle rack locations on the south side of State Route 58 between Oak Street and the Northwest Promenade Marketplace:
  - Although the Hooters shopping center does not have official bike racks, they do have benches that would accommodate bicycles – no bicycles were present
  - Northwest Promenade:
    - Pet Smart – 3 bicycles
    - WalMart – 2 bicycles
    - Target shopping center – no bicycles

The Northwest Promenade Shopping center is also the location of the Golden Empire Transit stop for the area (near WalMart).

Response to comment #10: The discussion referenced is the reason why a Transit and Transportation System Management Alternative was not carried forward (see page 21 of the Initial Study/Environmental Assessment and page 22 of the Final Initial Study/Environmental Assessment). This alternative would have relied only on increased transit service/frequency on State Route 58 to increase the regional mode split from auto to transit, replacing the need for widening State Route 58. The document states that even with improvements such as bus turnout lanes and transit signal priority the travel time on State Route 58 would not substantially improve because there would still be insufficient roadway capacity.

To provide some perspective, the *Metropolitan Bakersfield General Plan* (2007), which cites the *Highway Capacity Manual* (1985), indicates that the daily traffic capacity of a 6-lane arterial highway is 60,000 vehicles, compared to 40,000 vehicles on a four-lane arterial highway. Golden Empire Transit has two bus routes that serve this segment of State Route 58 (Routes 14 and 18). In 2012, the average number of passengers boarding the bus on a weekday is 167 riders for Route 18 and 556 riders for Route 14. These ridership numbers are for the entire route, not just the segment of State Route 58 that would be widened. As indicated on page 21 of the draft initial study/environmental assessment (page 22 of the final initial study/environmental assessment), increased transit service on State Route 58 would provide more frequent buses for transit users, but would not provide the required mode shift from automobiles to transit to reduce traffic volumes on State Route 58. Additionally, increasing the frequency of the buses would not be cost effective given that these routes are not currently running at capacity. Increased transit operations would not be enough to offset the equivalence of two travel lanes (as noted in the above estimate of providing capacity for 20,000 vehicles per day).

Response to comment #11: Minimal right-of-way is being acquired from residential properties. Only seven residential parcels are affected by the roadway widening. The amount of right-of-way required ranges from 11 square feet to 665 square feet per parcel (ranges from 0.04 percent to 1.8 percent of the entire parcel). The right-of-way acquisitions are listed in Appendix K. In all cases, the acquisition constitutes a small strip of land along the roadway. In no case would it place the home immediately adjacent to the roadway. The measure is a safeguard to allow the home to remain in place even if the setback is slightly less than 25 feet.

Response to comment #12: The project will replace existing landscaping and irrigation in the median if it is damaged by construction. The maintenance would be the responsibility of the agency that owns the segment of roadway.

Response to comment #13: As discussed in response to comment #4 of your January 1, 2012 comment, the reasonableness information is shown in Table 2.20, Determination of Reasonableness of Recommended Soundwalls, of the initial study/environmental assessment. This table shows the receptors that would be protected and the reasonableness allowance that was used for each soundwall evaluated as part of the project's noise analysis. Though cost is only one factor, the analysis provides for a base allowance of about $31,000, then factors in other criteria, such as the age of the home is and the amount of noise reduction provided by the wall. For this project, that equated to a cost threshold of about $45,000 per home for determining if a soundwall is reasonable. If a wall protects multiple homes, this is reflected in the allowance for making the determination of reasonableness. The abatement measure recommended based on current design is detailed in both Table 2.20 and measure N-1.

Response to comment #14: At Rosedale Middle School, soundwalls were not considered to be feasible because they would not provide a 5-decibel reduction for the exterior noise level and because noise levels are not high enough to warrant mitigation. It should be noted, however, that the project would have very little effect on the noise levels along State Route 58. At Rosedale Middle School, the outside noise level is 72 A-weighted decibels. In 2035, both with and without the project, the noise level is expected to increase to 73 A-weighted decibels. The classroom noise level threshold is 52 A-weighted decibels. With windows closed, the inside noise level for classrooms is usually 25 decibels less than the outside noise level, making the inside noise level 48 A-weighted decibels. Additionally, the school classrooms do have air conditioning, which would allow the classroom doors to be closed and the interior noise levels would be reduced. Therefore, soundwalls were not warranted.

Response to comment #15: The traffic noise analysis was a cumulative analysis that assumed the projected regional growth, the roadway improvements to be provided by the Thomas Roads Improvement Program, and the Metropolitan Bakersfield Transportation Impact Fee program. As shown in Table 2.19, Predicted Traffic Noise Level, at most, there are only a few decibel differences between the existing and future noise levels, even factoring in cumulative growth. The project would not substantially contribute to a cumulative noise impact. Similarly, the air quality analysis also provided a cumulative analysis because it reflects the traffic volumes projected for 2035.

The California High Speed Rail Project Environmental Impact Report/Environmental Impact Statement evaluates noise and vibration studies for the California High Speed Rail Project. If the California High Speed Rail Project is implemented, the construction of barriers to minimize the noise impacts associated with the rail project would be constructed at that time. The California High Speed Rail Project Environmental Impact Report/Environmental Impact Statement also evaluates air quality impacts. Generally, rail is a low polluting mode of transportation.

Comment from Matt Hayes

COMMENT Card

SR 58 (Rosedale Highway) Widening Project

Rosedale Highway Widening

NAME: Matt Hayes
ADDRESS: 2205 Turquoise Lane
CITY: Bakersfield, CA ZIP: 93308
E-MAIL ADDRESS: mb.hayes@att.net
REPRESENTING: Self

☐ Please add me to the project mailing list

I would like the following comments filed in the record *(please print)*:

my Rosedale property address is 10111 & 10115 Rosedale Hwy, the Nearest cross streets are Dean Ave and Calloway Dr.
Is it possible to consider a turn in to one of these properties, if you are driving West on Rosedale Hwy the turn in would be to the South going into the above address.

Thank you
Matt Hayes

Please respond by January 24, 2012

How did you hear about this meeting?

☐ newspaper ☐ internet ☐ someone told me about it ☑ other: T.V.

Response to Comment from Matt Hayes

Thank you for your comment on the project.

A median break will not be added at either location you identified. Vehicles traveling west will need to travel to Verdugo Lane and make a U-turn. This will require about a 0.25 mile out-of-direction travel to access the property at 10111 Rosedale Highway and 0.30 mile out-of-direct travel to access 10115 Rosedale Highway.

Comment from Dewey and Norma Maynard

COMMENT Card

SR 58 (Rosedale Highway) Widening Project

Rosedale Highway Widening

Dewey and Norma Maynard

NAME: Dewey & Norma Maynard

ADDRESS: 12038 Rosedale Hwy

CITY: Bks ZIP: 93312

E-MAIL ADDRESS: [illegible]

REPRESENTING:

☑ Please add me to the project mailing list

I would like the following comments filed in the record *(please print)*:

How will this project affect
Zoning Rosedale Hwy & old
Farm Rd

The comment reads: "How will this project affect zoning Rosedale Hwy and Old Farm Rd?"

Please respond by January 24, 2012

How did you hear about this meeting?

☐ newspaper ☐ internet ☐ someone told me about it ☒ other: mailing

Response to Comment from Dewey and Norma Maynard

Thank you for your comment on the project.

The project will not have any effect on the zoning at State Route 58 and Old Farm Road. A small amount of right-of-way is needed from your parcel at 12038 Rosedale Highway to build a wheelchair ramp to meet the requirements of the Americans with Disabilities Act. All other roadway improvements can be accommodated within the existing road right-of-way.

Comment from Rich ONeil

From: rich oneil <oneilpedal4@gmail.com>
Subject: Fw: Elimination of bicyclist access/transpo along Rosedale Hwy widening in Bakersfield
To <bryan_apper@dot.ca.gov>
Date: 01/10/2012 09:25

Cc zac griffen zac@bikebakersfield.org
tina bike Bakersfield tina@bikebakersfield.org
Bob Smith bob@bikebakersfield.org
Peter Smith PSmith@kerncog.org

Bryan:
I object to the elimination of the bicyclist's safe access and transport along the Rosedale Hwy widening project in Bakersfield.
No CALTrans project shall proceed without it first accommodating bicycle transportation. There shall be a safe lane remaining for bicyclists so that we can travel safely both directions along Rosedale to downtown Bakersfield and make a safe return trip to Western Bakersfield neighborhoods.
This is creating a "health and public safety" problem for the people of Bakersfield.

Sincerely,
Rich ONeil
208 Los Nietos Ct
Bakersfield, Ca 93309

Response to Comment from Rich ONeil

Thank you for your comment on the project.

As indicated in the Initial Study/Environmental Assessment, the *Metropolitan Bakersfield General Plan* does not designate any bike trails or paths along State Route (page 80 of the draft document, page 82 of the final document). Given the right-of-way constraints, the high traffic volumes, high truck percentage of trucks, and number of driveway breaks, a dedicated bikeway is not proposed as part of the project.

As with existing conditions, the project would not place any restrictions on the use of State Route 58 by bicyclists. The City of Bakersfield and County of Kern do not encourage bicyclist to use State Route 58 because it is a designated truck route and carries a high volume of trucks. The *Metropolitan Bakersfield General Plan* has designated bikeways on Brimhall Road and Hageman Road, which run parallel to State Route 58. These parallel roadways provide more suitable routes because they carry less traffic and fewer trucks. Connecting bikeways from State Route 58 to the bikeways on both Brimhall Road and Hageman Road can be made via Allen Road, Calloway Drive, and Coffee Road. Additionally, though Mohawk Street currently ends at State Route 58, there are plans to extend Mohawk Street through to Hageman Road.

Though there is not enough bicycle ridership to support the use of State Route 58 as an important bicycle linkage, the lane widths will be reconfigured to provide a wider outside lane and shoulder (see ridership discussion below). For the segment of roadway from Allen Road to Mohawk Street, rather than having three 12-foot-wide travel lanes with a 2-foot-wide outside shoulder, the width of the middle travel lane will be reduced to 11 feet. The additional foot will allow a 15-foot outside lane (12-foot travel lane and a 3-foot shoulder). This will not be considered a bike lane, but would provide additional area should a bicyclist decide to use State Route 58. The portion of the project east of Mohawk Street will maintain 8-foot shoulders that can accommodate bicyclists.

As indicated above, State Route 58 currently has low bicycle ridership. Based on the comments received regarding bicycle access on State Route 58 (Rosedale Highway), the City of Bakersfield, Kern County, and the Kern Council of Governments decided to look further into current bicycle usage on the highway. Kern County conducted bicycle counts on two days to gauge the level of ridership on the roadway. The following are the findings of the bicycle counts:

- On Wednesday, February 1, 2012, counts were taken between 6:30 a.m. and 9:00 a.m. at State Route 58 at Landco Drive. A total of three bicyclists were riding at this location during this time period. One rider was riding against the flow of traffic.
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- On Saturday, February 4, 2012, counts were taken between 9:00 a.m. and noon at State Route 58 at Old Farm Road. Four bicyclists were riding at this location during this time period.

In addition, bicycle rack surveys were conducted on Saturday, February 4, 2012 in the morning in conjunction with bicycle counts. The following reflects the usage of bicycle racks between 9:00 a.m. and noon on February 4, 2012:

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    - 24-hour fitness – one bicycle
    - Cactus Valley Mexican Restaurant – no bicycles
- Bicycle rack locations on the south side of State Route 58 between Oak Street and the Northwest Promenade Marketplace:
    - Although the Hooters shopping center does not have official bike racks, they do have benches that would accommodate bicycles. No bicycles, however, were present.

- Northwest Promenade:
  - Pet Smart – 3 bicycles
  - WalMart – 2 bicycles
  - Target shopping center – no bicycles

The Northwest Promenade Shopping center is also the location of the Golden Empire Transit stop for the area (near WalMart).

Comment from Dolores Ventura

COMMENT Card

Rosedale Highway Widening

SR 58 (Rosedale Highway) Widening Project

NAME: Dolores Ventura

ADDRESS: 5501 Lennox Ave #22

CITY: Bakersfield, CA 93309 ZIP:

E-MAIL ADDRESS: dventura@iecorporation.com

REPRESENTING:

☒ Please add me to the project mailing list

I would like the following comments filed in the record *(please print)*:

Please respond by January 24, 2012

How did you hear about this meeting?

☐ newspaper ☐ internet ☒ someone told me about it ☐ other:

Response to Comment from Dolores Ventura

Thank you for your interest in the project. As requested, your name has been added to the mailing list.

Comment from Rebecca Wells

COMMENT Card

SR 58 (Rosedale Highway) Widening Project

Rosedale Highway Widening

NAME: 9021 Rosedale Hwy 93312 (Mailing 9801 Holland St. 93312)

ADDRESS: Rebecca Wells

CITY: Bakersfield ZIP: 93312

E-MAIL ADDRESS: rwells4@bak.rr.com

REPRESENTING:

☒ Please add me to the project mailing list

I would like the following comments filed in the record *(please print)*:

I have two signs that I believe will be effected and will need to be relocated
I'm also concerned about the overhang of the front of ~~the~~ Building A & the side walk.

Please respond by January 24, 2012

How did you hear about this meeting?

☐ newspaper ☐ internet ☐ someone told me about it ☒ other: letter mailed

Response to Comment from Rebecca Wells

Thank you for your comment on the project.

The roadway widening will not impact the signs on your property or the overhang of your building. The distance from the edge of the curb face to the sign will be 14 feet.

Comment from Jacob Marquez

Jacob Marquez<jacob@jacobmarquez.com>
To: bryan_apper@dot.ca.gov 01/11/2012 12:33 PM
cc:
Subject: Rosedale Hwy Widening

Jake Marquez
Lic#01449795
(661)717-1011 Cell
(661)367-9543 eFax

From: Jacob Marquez [mailto:jacob@jacobmarquez.com]
Sent: Wednesday, January 11, 2012 4:11 PM
To: 'Bryan_Apper@dot.ca.gov.'
Subject: Rosedale Hwy Widening
Importance: High

Hello Bryan,

My name is Jacob Marquez and I am writing to you in regards to the widening of Rosedale hwy. First of all I wanted to thank you for taking the time to read this since I am sure you will be receiving numerous emails and perhaps mostly heated. In fact, that is why I too am taking the time to write this.

I am not one to put in my two cents, however, this seems like a much more important matter that I think we fail to realize.

Other than the environmental reports that state that the widening could have an impact for the worse(I for one believe that it will be better due to the less congestion) and the business that it might affect- which undoubtedly we know that it will since I know for sure I will do everything I can to avoid Rosedale hwy if the plan is approved. And of course the byclists that will lose their"lane".

I really do think that the real factor here is the future. Yes the widening will be a sacrifice for all those affected, and yes traffic will flow smoother once it is completed (I avoid Rosedale hwy right now due to that same reason too darn tight) I believe that overall if we can improve the transportation in this city, it will be more attractive for other business in other cities and other people thinking about relocating to Bakersfield which in turn could create more jobs and there for help our economy for the long haul.

How many times have you heard from people that live out of town or even people that live here in town how poor the transportation planning really is?

I mean its horrendous! That's not just Rosedale hwy, that's all over, luckily there are plans now in place to alleviate that traffic in this town, but the benefits of smoother transportation in a growing city are HUGE! I hope that we can all come to terms and realize that the best thing for us in the long term (decades to come) would be to move forward with the widening of Rosedale hwy.

Again I am aware that it is a sacrifice, but what we could potentially lose as a whole community if it is not done, just seems so much greater.

Once again, I appreciate your time and wish you the very best!

Jake Marquez
(661)717-1011 Cell
(661)367-9543 eFax

Response to Comment from Jacob Marquez

Thank you for your comment on the project.

Comment from Melinda Perez

Melinda<Perezmel1@yahoo.com>
To: "Bryan_Apper@dot.ca.gov"<bryan_apper@dot.ca.gov>
01/11/2012 12:33 PM
cc:
Subject: Widening of lanes on rosedale near Allen rd

How will this affect the homes that run along rosedale hwy?
Will there be block walls put up to control traffic noise?
We live at 2600 maher way and are concerned about the noise level
going up with the additional lanes.

Sent from my iPhone

Response to Comment from Melinda Perez

Thank you for your comment on the project.

The noise impacts of the roadway are addressed in Section 2.2.3 of the initial study/environmental assessment. Your location (2600 Maher Way) was one of the noise monitoring locations used in the study. The current noise level is 72 A-weighted decibels and is predicted to increase to 73 A-weighted decibels with or without the project due to higher traffic volumes in the year 2035. Though the project would not result in an increase in noise levels, 73 A-weighted decibels is above the noise-abatement criteria used by Caltrans. The Caltrans process analyzes if a sound wall would provide a 5-A-weighted-decibel reduction in the noise level and can be constructed within the cost allowance (a formula based on the number of structures being protected from the noise by the wall). At your location, a 12-foot-high wall would be needed to achieve a 5 A-weighted-decibel reduction. The total cost allowance, calculated in accordance with the Caltrans' Traffic Noise Analysis Protocol, is $188,000. The current estimated cost of the wall is $178,945. Based on the studies completed to date, Caltrans intends to incorporate noise abatement in the form a 12-foot-high soundwall along State Route 58 next to your house.

Comment from John O'Connor

JDO <joconnor@bak.rr. com>
To: <Bryan_Apper@dot.ca.gov>
01/11/2012 05:22 AM
Subject: Rosedale Hwy Widening Project

Good morning - I read the article in the Californian this morning. I gladly welcome the project; however, why stop at Allen Rd.? A lot of the gridlock on the west end is because of the existing bottleneck at Allen Rd. I am sure you have look into this situation. Do you have any insights on my concerns?

Thanks in advance,

John O'Connor
Rosedale Resident
661-201-7468
Best Regards,

Response to Comment from John O'Connor

Thank you for your comment on the project.

The segment of State Route 58 from Allen Road to State Route 43 (Enos Lane) will eventually be widened from two to four lanes. The Kern Council of Governments' Regional Transportation Plan identifies widening State Route 58 (Rosedale Highway) from Allen Road to State Route 43 (Enos Lane) as an improvement in the 2021 to 2025 timeframe. This improvement would be a separate project and would have a separate environmental document at the time the project is proposed.

Comment from Brian Rachuy

Brian Rachuy<metrulez@hotmail.com>
To: <bryan_apper@dot.ca.gov> 01/11/2012 12:33 PM
cc:
Subject: Rosedale Highway plans

I have always thought a good way to expand the traffic capacity on Rosedale HWY would be to do a Golden Gate Bridge style setup with a roadway above the roadway. The higher level would be mainly for commuters who plan to go a log distance down Rosedale and therefor do not need as many exits. I do not know how difficult that would be with California's earthquake regulations and such, but it might be kinda cool.

It would give a higher speed corridor across the city as well as ease the general traffic flow without greatly impacting the roadside businesses.

Thanks,

Brian

Response to Comment from Brian Rachuy

Thank you for your comment on the proposed project.

The cost of building a double deck roadway would be prohibitive and would exceed the available funding for the project. If an alternative exceeds the available funding, it is not considered a reasonable alternative because it could not get built.

Comment from David L. Jones

-----Dave Jones<djoneskern@gmail.com>-----
To: bryan_apper@dot.ca.gov 01/24/2012 03:14 PM
cc: <heather.ellison@parsons.com>
Subject: Rosedale Highway Widening Comment

Dear Mr. Apper:

Subject: Rosedale Highway Widening Project

This email is to express my concerns that the "Initial Study with Proposed Mitigated Negative Declaration/Environmental Assessment" (hereinafter, Mitigated Negative Declaration) is seriously flawed. I have previously made verbal comments at the January 5, 2012 Public Hearing conducted by the City of Bakersfield Planning Commission, and to the court reporter assigned to take testimony at the January 10, 2012 Open House held by Caltrans. I hereby incorporate those prior comments by reference in order to avoid having to completely restate all of my comments in this email. The intent of this email is to provide some additional information supporting and clarifying my earlier statements and to propose remedies for these issues. 1

The core of my objection is to the inaccurate depiction of the impacts this project will have on the intersections of Renfro and Jenkins with Rosedale Highway west of the Allen Road intersection. The following two statements on pages 19 and 20 under "Alternatives Considered but Eliminated from Further Discussion" were used to justify not analyzing an alternative that increased Rosedale Highway to four lanes west of Allen Road. The first statement below is made on page 19, and the second statement is made on page 20.

Additionally, the traffic study showed that the improvements west of Allen Road would not be needed until after 2035.

Alternatives A through C were not carried forward for the following reasons:
The additional traffic capacity west of Allen Road would not be required before 2035 (the project design year). 2

These statements were based on the 2035 Level of Service (LOS) modeling that was done for the project and showed LOS C at the two intersections in question. What was actually modeled though to achieve the LOS C at Renfro and Jenkins in 2035 was the improvement of Rosedale Highway to four lanes west of Allen Road. This was the very alternative that was supposedly discarded. In Figure 7A of the "Final Traffic Operations Report Rosedale Highway Improvements" (TOR) by Fehrs and Peers on which Mitigated Negative Declaration is based, the 2035 LOS modeling clearly had four lanes of travel on Rosedale at both Renfro and Jenkins, and the 2015 LOS modeling had only two lanes. Which agency is building these new lanes and where is the funding coming from? The analysis also holds the increase in expected peak hour traffic on Rosedale to surprising low levels from 2015 to 2035 (see following paragraph). It is no surprise then that the LOS for these two intersections in the modeling would go from E to C and F to C in that period. All of the statements in the Mitigated Negative Declaration made concerning the Renfro and Jenkins intersections operating at LOS C in 2035 should be corrected to indicate those levels can only be achieved with improvements.

The traffic levels that were used for the peak hour analysis in the LOS modeling are unusual. They show east and west bound through traffic on Rosedale at Renfro and Jenkins to be decreasing from 2015 to 2035 during peak hours (Figures 4A and 5A). These figures also show the same estimated traffic levels for both the build/no build scenarios in 2015 (Figure 4A) and the build/no build scenarios in 2035 (Figure 5A). The build project scenario would have to have show some differences in the traffic coming west bound from the Allen intersection from the no build scenarios, if a proper analysis was actually conducted for these two intersections. 3

Those vehicle traffic numbers that were for the future years in this area west of Allen do not correlate with another traffic study for an EIR for this Renfro Rosedale area adopted in 2010 by Kern County, the Ruettgers & Schuler Traffic Study for the Rosedale Renfro EIR. Their analysis only went out to 2030, but took into account other approved and expected developments and their traffic volumes for their no-project alternative were significantly higher than those used for this no-project alternative for 2035. An explanation should be given in your response for the differences in traffic results for these two traffic studies, considering that the other study was developed for an EIR only one year earlier than this traffic study and oversight of the EIR was by Kern County, one of the major agencies participating in this project. **3 cont.**

In conclusion, the Mitigated Negative Declaration as circulated has not provided evidence sufficient to conclude that there would be no significant negative impact to the Renfro and Jenkins intersections. The 2035 LOS modeling that was done supports the opposite conclusion that Rosedale should be widened west of Allen to four lanes. For any new analysis done to correct these deficiencies, it should include as one alternative widening Rosedale to four lanes from Allen to the future intersection with the Westside Beltway at Rudd. **4**

Thank you for consideration of my comments. If you wish to discuss them with me, you can call me at 661-565-6518, or email me at either davejoneskern@bak.rr.com or djoneskern@gmail.com.

Sincerely,

David L. Jones

cc: Heather Ellison

Response to Comment from David L. Jones

Thank you for your comments on the project.

Response to comment #1: Your comment made at the January 5, 2012 Planning Commission hearing and to the court reporter at the January 10, 2012 public meeting are acknowledged and responded to separately as part of the responses to comments made at the Planning Commission and the Public Meeting. These responses are provided later in this document. (See Responses to Comments from the January 5, 2012 City of Bakersfield Planning Commission [David Jones, Response to transcript comment #2] and Responses to Comments from the January 10, 2012 Public Open House [Response to Comments Provided by Mr. Jones, transcript comments #1 through #3]) later in this document.

Response to comment #2: Your comment regarding the need for improvements west of Allen Road is noted. The segment of State Route 58 from Allen Road to State Route 43 (Enos Lane) will be widened from two to four lanes as development continues to the west. The funding available for this project is insufficient to widen State Route 58 (Rosedale Highway) west of Allen Road. Given the funding limitations, Caltrans and the City of Bakersfield, in cooperation with Kern County and the Kern Council of Governments prioritized the segment between Gibson Street and Allen Road for improvements at this time. However, the long-term need for the improvements is recognized and funding has been incorporated into the Metropolitan Bakersfield Transportation Impact Fee program to widen State Route 58 west of Allen Road. The Kern Council of Governments' Regional Transportation Plan identifies widening of State Route 58 from Allen Road to State Route 43 (Enos Lane) as an improvement in the 2021 to 2025 timeframe. Those improvements would be a separate project and have their own environmental document.

The initial study/environmental assessment (page 19 of the draft document and page 20 of the final document) should have stated that the improvements west of Allen Road were not expected to be needed until 2025, not 2035. The following correction is made to the final environmental document (new text shown in *italics* and deleted text shown in ~~strikeout~~): "Additionally, the traffic study showed that the improvements west of Allen Road would not be needed until *2025*. ~~after 2035~~".

Response to comment #3: Section 2.1.5 of the initial study/environmental assessment identifies traffic projections using the regional growth assumptions for 2035, as well as the roadway improvements proposed as part of the Kern Council of

Governments Regional Transportation Plan, the Thomas Roads Improvement Program, and the Metropolitan Bakersfield Transportation Impact Fee program. Several of the key circulation improvements were identified that will influence the traffic volumes of this portion of State Route 58 (Rosedale Highway), most notably the West Beltway and the Centennial Corridor. In addition, the Initial Study/Environmental Assessment (page 72 of the draft document and page 74 of the final document) does indicate that the Metropolitan Bakersfield Transportation Impact Fee program includes a range of local street improvements designed to relieve traffic congestion, particularly in the western portion of the study area. The inclusion of these regional improvements may explain the differences between the results of the traffic analysis done for this project versus the study cited in the comment.

The West Beltway is listed as four projects in the 2011 Regional Transportation Plan Amendment #1. The segment from State Route 58 (Rosedale Highway) to the Westside Parkway would be constructed in 2025. In 2033, the West Beltway would be extended from Pacheco Road to the Westside Parkway and from State Route 58 (Rosedale Highway) to 7th Standard Road. The adopted time frame assumes the West Beltway within the project area would be constructed before the design year (2035) for the State Route 58 Widening Project. The Regional Transportation Plan also assumes the completion of the Centennial Corridor around 2018. The Centennial Corridor would provide a six-lane freeway facility parallel to State Route 58 (Rosedale Highway). The Centennial Corridor will use the Westside Parkway, which is currently under construction, and is planned to connect with the freeway portion of State Route 58 (East). The Centennial Corridor would provide a high-speed facility without the delays of stop lights approximately two miles south of the Rosedale Highway segment of State Route 58. The construction of these two major transportation facilities is expected to reduce traffic volumes on the Rosedale Highway portion of State Route 58. This is why the traffic volumes are projected to decrease between 2015 and 2035 at the Renfro Road and Jenkins Road intersections.

Caltrans will be the agency responsible for the construction of the Centennial Corridor connection to State Route 58 (east). The agency responsible for constructing the other improvements identified in the Regional Transportation Plan and the Metropolitan Bakersfield Transportation Impact Fee program will depend on the ultimate funding and which jurisdiction owns the roadway. In unincorporated Kern County, the county would likely be the lead agency on improvements. However, it is not uncommon when an improvement is in two jurisdictions for there to be an agreement that identifies one agency as the lead. This question would be answered closer to when the improvement is getting constructed.

The Build and the No-Build alternatives have the same traffic volumes because it is the land uses, not the roadway itself that generates and attracts the trips. Since the land uses are consistent between the two scenarios, the same number of trips would be generated and attracted to the area and land uses along State Route 58. The 2035 circulation network assumes the roadway improvements proposed as part of the Regional Transportation Plan and the Metropolitan Bakersfield Transportation Impact Fee program, which will generally provide a balance between the circulation network and the land uses. As a result, the regional trips will use higher capacity roadways, such as Centennial Corridor, and the local roadways will serve the adjacent land uses.

Response to comment #4: As indicated in response to comment #2 above, the Initial Study/Environmental Assessment (page 19 of the draft document and page 20 of the final document) should have stated that the improvements west of Allen Road were not expected to be needed until 2025, not 2035. The initial study/environmental assessment also describes the network assumptions for both the 2015 and 2035 (see pages 71 and 72 of the draft document and pages 73 and 74 of the final document). This is also further detailed in the *Traffic Operations Report*. This information adequately addresses the traffic impacts at both Renfro and Jenkins Roads. Traffic conditions would be improved with the Build Alternative compared to the No-Build Alternative.

Comment from Sierra Club

From: <gnipp@bak.rr.com>
To: <paul_pineda@dot.ca.gov>
01/10/2012 09:53 AM
cc:
Subject: Rosedale Highway widening

The Technical Studies for the above project don't seem to be available online at your website. Do you have the Growth Inducement Analysis and other studies available electronically?

Thanks,

Gordon Nipp
Sierra Club

Response to Comment from the Sierra Club

Thank you for your inquiry on the project. On January 18, 2012, Janet Wheeler from the Thomas Roads Improvement Program office responded by sending you the link to the technical studies for the document.

Comment from Sierra Club

SIERRA CLUB
KERN-KAWEAH CHAPTER

P.O. Box 3357
Bakersfield, CA 93385
January 24, 2012

VIA ELECTRONIC MAIL

Bryan Apper, Senior Environmental Planner
Southern Valley Environmental Analysis Branch
California Department of Transportation
855 M Street, Suite 200, Fresno, California 93721

Re: Rosedale Highway Widening Project

Dear Planners:

The Sierra Club has a number of comments on the EA/MND for the Rosedale Highway Widening Project.

There are several other planning efforts underway, major thrusts of which could be precluded by adoption of this Rosedale Highway widening project. For example:

- SB 375 requires a *Sustainable Communities Strategy* involving cutbacks in primarily traffic-related greenhouse gas emissions. The Rosedale Highway widening project would allow GHG emissions to increase, a potential conflict with a Sustainable Communities Strategy.
- Work is presumably underway on a *Climate Action Plan*. The Rosedale Highway widening project would allow GHG emissions to increase, potentially precluding certain approaches to achieving statewide goals and lowering our community's GHG footprint.
- Work will soon begin on a new *Bicycle Master Plan*. The Rosedale Highway widening project does not include bicycle lanes and would preclude the potential for safe bicycling on Rosedale Highway. 1
- The *Metropolitan Bakersfield General Plan* is being updated (albeit something of a slow process). Rosedale Highway is a major transportation corridor; the Rosedale Highway widening project should be considered in the larger context of the MBGPU, on its growth inducement impact on the urban fringe and of its overall effects on our community. This project should be addressed in an EIR for the MBGPU.

The Rosedale Highway widening project should be incorporated as part and parcel of other major planning efforts that are underway so as not to preclude more progressive approaches.

The environmental documents for the Rosedale Highway widening project are deficient in a number of ways. For example:

GLOBAL WARMING AND AIR POLLUTION

The EA/MND does not contain specific feasible standards and implementation measures to reduce VMT. Ironically, the Air Study states, "Caltrans is firmly committed to implementing measures to help reduce greenhouse gas emissions."

On page 217, the EA/MND states, "The City of Bakersfield is supporting efforts to reduce vehicle miles traveled by planning and implementing smart land use strategies: job/housing proximity, developing transit-oriented communities, and high-density housing along transit corridors." The Rosedale Highway widening project would be a good opportunity to demonstrate this support by facilitating development of transit-oriented communities and high-density housing along the Rosedale corridor, but we find no movement toward such "smart land use strategies" in the EA/MND.

On page 75 of the Air Study and on page 219 of the EA/MND, there are a number of measures that could "reduce the greenhouse gases emissions and potential climate change impacts from the project", but a measure will only be included in the project to "the extent that it is applicable or feasible." How will feasibility or applicability be determined? Will "lighter color surfaces such as Portland cement" actually be used? The public deserves to be able to judge the effectiveness of these measures, and it cannot do so without more information as to how and if they will be implemented. It is established CEQA policy that a mitigation measure is legally inadequate if it is so undefined that it is impossible to gauge its effectiveness. Feasibility determination for these measures is so vague and tentative that neither the public nor the decision-makers can understand their effect, and the EA/MND should not consider them to be effective mitigation for the project's impact on global warming. 2

We haven't found a firm commitment to VMT reduction from either Caltrans or the City of Bakersfield in the EA/MND. CEQA requires, "A public agency shall provide that measures to mitigate or avoid significant effects on the environment are fully enforceable through permit conditions, agreements, or other measures." (Public Resources Code, §21081.6(b)) As an SB 375 goal, VMT reduction is an important component in air pollution and greenhouse gas reduction. The EA/MND should contain measures to reduce VMT.

GROWTH INDUCEMENT

Since this project will make motorized vehicle commuting easier (at least for a time), it likely will be growth inducing, leading to more residential growth on prime farmland northwest of Bakersfield. 3

- On page 49, the EA/MND states, "Since State Route 58 is an existing roadway, the proposed widening would not be expected to change travel behavior." The EA/MND fails to give the reasoning behind this counterintuitive speculation. We see no reason why widening an existing roadway so as to make private vehicle commuting easier would not incentivize more driving on the expanded roadway, replacing incentives to use public transportation or to live in the urban core close to jobs.

- On page 49, the EA/MND states, "The land uses that are attracting the trips (the jobs and shops) already exist or would be infill development consistent with the long-term growth projections. The study area is currently part of the urban center. The travel pattern in the study area would not be expected to have major changes, even with the future growth that Kern Council of Governments, together with the County of Kern and the City of Bakersfield, has planned for the region. The project would not result in excess capacity that would encourage development beyond the approved levels." The EA/MND contains no substantial evidence for these counterintuitive statements and addresses an unnecessarily restricted study area. The project study area does not include the major destination downtown core, nor does it include rapidly developing areas close to Rosedale Highway to the west of Allen Road (see Figure 2-2). We note that the County Supervisor for the area has publicly stated that he accepts urban development west to Greeley Road. The EA/MND is flawed in not having included the downtown and the rapidly developing western regions in the study area. 3 cont.
- The EA/MND's counterintuitive conclusion that the project will not be growth inducing is presumably based on a January 2009, Growth Inducement Analysis. This analysis is heavily flawed in that it takes little account of growth in the western area close to Rosedale Highway west of Allen Road. For example, Figure 3-2 of this analysis ("Current Development Trends as Indicated by Project Activity") lists no projects in this area, and Figure 3-5 ("Metro Bakersfield Housing Units in 2006") shows few units in the western area. Figure 2-2 of the Growth Inducement Analysis ("Household Growth from 2006 to 2035") is based on the glaringly outdated existing Metropolitan Bakersfield General Plan, a Plan which assumes comparatively little growth in the western area and which is currently being updated. None of these Figures includes the Hageman Northwest project, the Bakersfield Land Investment project, the Stockdale Ranch project and many other projects that are already approved or currently building. Presumably based on these Figures, the Study assumes that only 14% of growth in metro Bakersfield will be in the western Zone R2, a percentage that seems to ignore much of the frantic development just before the downturn, this at a time when Bakersfield is projected to grow by 69% between 2000 and 2020.

The EA/MND's conclusion that the Rosedale Highway widening will not be growth-inducing is based on inaccurate assumptions and should be revisited.

BICYCLING

We quote Bob Smith, President of Bike Bakersfield and incorporate his oral testimony before the Bakersfield Planning Commission. "The summary table lists the impact on bicycle facilities as no impact. This is not correct. The existing roadway has an eight 4 foot paved shoulder. Using nationally accepted methods to calculate the bicycle level of service the existing roadway provides a level of service B and a very high compatibility level. **The proposed roadway has no shoulder and no bike lane** (emphasis added)**.** The level of service for the proposed roadway is E and a very low compatibility level. What this project does is remove an existing bicycle facility, which is the main corridor from northwest Bakersfield to downtown and east Bakersfield. Therefore any existing and future non-motorized non-polluting access is being eliminated." 4 cont.

Bicycle lanes (preferably Class 1 routes separated from the road) and walking facilities should be incorporated into the new Rosedale Highway.

ALTERNATIVES

The EA/MND assesses only two alternatives, the No-Build Alternative in which nothing is done, and the project itself, the Build Alternative, a business-as-usual autocentric approach in which progressive notions (even bicycling) are discouraged. The environmental documents should assess another alternative, a **Sustainability Alternative** that reduces VMT and includes bicycle routes and enhanced public transportation and addresses the potential for light rail. Such an alternative should encourage real infill around public transportation nodes and discourage growth in the far Metro Bakersfield perimeter. In order to help our community achieve the goals of AB 32 and SB 375, this alternative should include methods of reducing the Metro Bakersfield carbon footprint, reducing transportation related greenhouse gas emissions instead of increasing them, as the Build and No-Build Alternatives would do. Given that we fight it out annually with Los Angeles for having the dirtiest air in the nation, this alternative should also include methods to reduce criteria pollutants from transportation emissions. 5

AESTHETICS

Since the existing Rosedale Highway is arguably one of the ugliest streets in California, it seems unlikely that the proposed project could make it less aesthetically pleasing. The proposed construction does, however, open up the opportunity to make Rosedale Highway a more pleasant part of our community. The EA/MND admits, "overhead electrical and telephone lines" are among "the most noticeable features." **While earth moving construction is taking place anyway, we suggest that overhead electrical and telephone lines be buried and that other not so apparent means of beautifying the project be implemented.** The environmental documents should assess burying electrical and telephone lines and investigate other means of improving aesthetics along Rosedale Highway. 6

Lighting should be shielded so as to reduce glare and light pollution. Street lighting fixtures should be consistent with the recommendations of the International Dark Sky Association.

The project should hire a professional landscape architect to beautify the project and design the landscaping. To the extent feasible, landscaping plants should be native and/or drought tolerant plants. 7

The environmental documents are lacking in many ways. There should be a full upgraded EIR/EIS done for this project. 8

FUNDAMENTAL LAW OF CONGESTION

A major University of Toronto study by Duranton and Turner (available at http://grist.files.wordpress.com/2011/12/tecipa-370.pdf) states, "the 'fundamental law of congestion' holds not only for urban interstates but also for major urban roads and nonurban interstates. Thus, our data suggest the following law of road congestion: **adding road capacity will not alleviate congestion on any sort of major urban road or rural highway within metropolitan boundaries** (emphasis added)." 9

While we sympathize with the desire to reduce congestion on Rosedale Highway, we see this project as part of a business-as-usual cycle – more roads to accommodate more sprawl, more traffic because of the increased sprawl, more roads to accommodate the increased traffic, more sprawl, more traffic, more roads, more sprawl, and so on. **Unless we break that cycle by reducing sprawl, it won't take long to have as much congestion on the new expanded Rosedale Highway as we have now.** We, as a community, should demand a more progressive approach that would help to reign in sprawl and build a more sustainable and livable Bakersfield.

Please place the Sierra Club on the distribution list for the Rosedale Highway widening project to receive any noticing of meetings, hearings, availability of documents, and to receive the environmental documents. We prefer email communications and electronic formatting of documents. Please communicate noticing of meetings, hearings, and availability of documents by email. Thank you for your consideration and for the opportunity to comment. 10

Sincerely,

Gordon L. Nipp

Gordon L. Nipp, Ph.D.
Vice-Chair
gnipp@bak.rr.com

Response to Comments from the Sierra Club

Thank you for your comments on the project.

Response to comment #1: It is acknowledged that there are a number of planning documents being developed. However, it is not reasonable to assume that all improvements would stop until these programs are developed. There will always be programs being developed or updated. As stated in Table 2.4, Consistency with State, Regional, and Local Plans and Programs, of the initial study/environmental assessment, this segment of State Route 58 is designated on the *Metropolitan Bakersfield General Plan* as a six-lane roadway. Land uses have been approved and developed with the assumption that the roadway would be widened. The improvements are limited to the area that is predominately built out and is currently experiencing a deficient level of service. Though the development of these plans are outside of Caltrans' jurisdiction, Kern County, the Kern Council of Governments, and the City of Bakersfield—all the agencies responsible for the development of the plans referenced in the comment—have been involved with the development of the project. It is not anticipated that, as these plans develop, the function of State Route 58 is expected to substantially change. It should also be noted that Caltrans' Climate Action Program is discussed in Section 2.5, Climate Change, of the Initial Study/Environmental Assessment.

As the Sustainable Communities Strategy and the Climate Action Plan are developed, the existing land use patterns and development will have to be used as a baseline. The analysis in Section 2.5, Climate Change, of the Initial Study/Environmental Assessment found that, when compared to the No-Build Alternative, air quality would generally improve because the project would improve traffic flow. Table 2.15 identifies that carbon monoxide concentrations would be reduced in both 2015 and 2035 compared to existing conditions and would be slightly less with the project than with the No-Build Alternative. Table 2.16 identifies that mobile source air toxic emissions would also be reduced in both 2015 and 2035 compared to existing conditions and would be the same for the project and No-Build Alternative. Carbon dioxide emissions are expected to increase from existing conditions to 2035 conditions due to increases in total vehicle miles traveled (see Table 2.23). Under future 2015 conditions, vehicle miles traveled will decrease from no-build conditions to build conditions, resulting in a decrease of carbon dioxide emissions for build 2015 conditions. However, in future 2035 conditions, the total vehicle miles traveled is expected to increase from no-build to build conditions; therefore, there is a slight increase of carbon dioxide emissions.

As indicated in Section 2.1.5 of the Initial Study/Environmental Assessment, there are no designated bike paths or lanes along State Route 58. Additionally, the South Valley Bicycle Coalition has posted the Bakersfield Metro Bicycling Map on their website created by the City of Bakersfield Engineering Department (www.southvalleybike.org/maproute.htm); Rosedale Highway (State Route 58) is not listed as a bike route on this map. The decision not to provide a bike lane along State Route 58 is because (1) the roadway is a designated truck route and carries a high volume of trucks; (2) the posted travel speed east of Mohawk Street is 50 miles per hour; and (3) there are a large number of driveways that take direct access from State Route 58. These considerations, together with the fact that there are alternative designated bike routes on parallel roads, were used when making the decision not to provide a bike lane on State Route 58.

Response to comment #2: The comment states that the initial study/environmental assessment shows no indication of movement to “smart land use strategies.” The State Route 58 Widening Project is a roadway project using road funds. The project is a joint effort between Caltrans (the current owner of the roadway) and the City of Bakersfield. Caltrans does not have land use authority. The City of Bakersfield is able to show their support for “smart land use” through their actions on land development projects. The City of Bakersfield has approved projects, such as the Bakersfield Commons development, that, by their mixed-use nature, will serve to reduce vehicle miles traveled and provide a better interface with transit. The commitment to the goals of reducing greenhouse gases is done on a comprehensive level and is demonstrated through programs such as the general plan, which establishes policies provides the blueprint for future development. While it is honorable for the Sierra Club to monitor these issues, it must be recognized that there are many smaller components that implement the long-term vision. Projects, such as the State Route 58 Widening Project, must be evaluated in the context of what they are able to achieve. The State Route 58 Widening Project will provide an incremental reduction of carbon monoxide and particulate matter emissions by reducing congestion (Section 2.2.2, Air Quality, of the Initial Study/ Environmental Assessment).

Since it was uncertain if the measures identified on page 219 of the draft initial study/ environmental assessment could be implemented, they were not identified as mitigation measures and have not been incorporated into the Environmental

Commitments Report (Appendix E). As such, the project does not assume any offset in emissions based on the measures recommended for consideration. However, these measures are recommended for inclusion to the extent that they are feasible. The recommendations taken from page 219 of the draft initial study/environmental assessment have been evaluated for feasibility and a mitigation measure has been added for those components that are feasible and are not addressed elsewhere in the document. The new text can be found on pages 229–230 of this final initial study/environmental assessment:

- Use of Reclaimed Water—The ability to use reclaimed water either during construction or for irrigation is dependent upon the availability of the reclaimed water. Currently, there are not reclaimed water lines available in the road; however, given that a portion of the project would be implemented in 2025, this resource may be available at that time.
- Landscaping—The project does propose to provide replacement landscaping (page 17 of the Draft Initial Study/Environmental Assessment and page 17 of the Final Initial Study/ Environmental Assessment).
- Portland Cement—Portland cement can be used in the curb, gutter, and sidewalks for the roadway widening. This is feasible and has been included as a mitigation measure in the Environmental Commitments Report (Appendix E). The use of Portland cement for the grade-separation will be evaluated when that component of the project is implemented until 2025.
- Lighting—Use of energy efficient lighting, such as light-emitting diode (LED) traffic signals, is feasible and has been included as a mitigation measure in the Environmental Commitments Report (Appendix E).
- Idling restrictions—Idling restrictions for trucks and equipment at construction sites is already provided for as a construction noise measure (SC-13).

It should also be noted that the project does not result in a significant impact, from the perspective of the California Environmental Quality Act and that the Caltrans' Climate Action Program is discussed in Initial Study/Environmental Assessment (Section 2.5, Climate Change).

Response to comment #3: The project goes through the more urbanized portion of Bakersfield. Within the project limits there are opportunities for infill development; however, there are limited opportunities for new large scale development. Widening this segment of State Route 58 to be consistent with the General Plan designation is not expected to substantially change drivers' commute patterns because State Route 58 is already one of the major east-west corridors in the city. State Route 58 will always be a heavily traveled corridor because it provides access to the major commercial area for this portion of the city, but more importantly because it is one of the few routes that crosses the Kern River and provides access to State Route 99. This results in higher traffic volumes on this roadway than it may have otherwise experienced without the river barrier and freeway access because other parallel routes do not provide the same level of accessibility.

State Route 58 is also a designated truck route. The project segment is heavily used not only because State Route 58 provides the connectivity between Interstate 5 and State Route 99 but also because it continues east of State Route 99 and provides links to other important goods movement corridors nationwide such as State Route 14, Interstate 15, Interstate 40, and United States 395. The Interregional Transportation Strategic Plan identifies State Route 58 as a "Transportation Gateway of Major Statewide Significance." The project corridor is also identified as part of a "High Emphasis Focus Route" in the Interregional Road System and a "Priority Global Gateway" east of Interstate 5 for goods movement in the Global Gateways Development Program. Therefore, regardless of the project, State Route 58 will continue to be a preferred route to access commercial uses, services, and the downtown area.

The comment incorrectly states that growth inducement analysis takes little account of the growth west of Allen Road. The 2009 *Growth Inducement Analysis*, which reflects the assumptions of the most current general plan, was one resource used when assessing the potential growth in the region. Caltrans, together with the Federal Highway Administration and the United States Environmental Protection Agency, developed a new guidance document entitled *Guidance for Preparers of Growth-Related, Indirect Impact Analyses*. The guidance focuses on the influence that transportation projects may have on growth and development. The document was not saying there would be no growth in the area or that the growth would not use the widened State Route 58. By providing sufficient capacity on State Route 58, trips would continue to use the existing facility, which would diminish the need to provide new routes or construct alternative commercial centers in more remote locations as the projected growth occurs. The Initial Study/Environmental Assessment (see Section 2.1.2, Growth) discusses the historic and projected growth trends in the region. The growth analysis looks at the broader Kern County and City of Bakersfield, as well as the more focused census tracts adjacent to the project. The growth projections cited were for the entire county and the metropolitan Bakersfield area. At this level, it was acknowledged that there will be substantial growth in the region and in the city of Bakersfield. The Kern Council of Governments projects a 69 percent increase in population between the year 2000 and 2030 based on California Department of Finance data (2007). A large percentage of this projected growth is expected to occur within the City of Bakersfield.

As indicated in Section 2.1.2 of the initial study/environmental assessment, the growth is reflected in the assumptions of the California Department of Finance. There is a difference between growth occurring based on regional and state projections, and to say that this project will be fostering the growth. As the initial study/environmental assessment identifies, and the comment points out, there are a number of projects that have been approved in the surrounding region. These projects have all been approved independent of this project. Therefore, since they are approved prior to formal consideration of this project, it is unlikely that this project is fostering the growth.

The analysis in the initial study/environmental assessment takes the following factors, among others, into consideration: whether the project will change commute patterns; whether the project will open new areas to development that did not have previous access; and whether the project will change the rate of growth (see Section 2.2.2 for a full list of the questions asked as part of the analysis of the growth effects of the project). In response to these questions, the analysis determines that project is not expected to result in substantial changes to growth because (1) the project is in the urban center portion of Bakersfield; (2) the project would not result in excess capacity that would encourage development beyond the approved levels; and (3) the heavy growth that is projected to occur in the metropolitan Bakersfield area would serve as the natural extension of the existing urban center, consistent with local and regional planning programs. As a result, the project would not change access to areas or result in growth beyond what is assumed as part of regional and local planning efforts.

It is recognized that current planning concepts encourage people to live in the urban core close to jobs. The intent is to have transit-oriented development to minimize the use of private automobile, thereby reducing the carbon footprint of development. To withhold improvements with the hopes of encouraging transit usage and incentives to live in the urban core does not look at the realities on the ground. Much of the area surrounding downtown Bakersfield was developed in post World War II when residential development was predominately single-family homes. Since these homes are lived in, additional residents needed to move beyond the downtown core. This has happened. In response, smaller employment centers have developed. Based on 2006 data from the California Employment Development Department, the area surrounding the project is one of those areas, providing employment and commercial uses, as well as providing access to the downtown area. The City of Bakersfield is taking measures to incorporate the mixed-use concept into more recent development approvals, such as recently approved Bakersfield Commons (a high intensity mixed-use project). However, the planning process has to balance the long-term vision with the needs of the development that is already here. It is clear that the area surrounding State Route 58 is envisioned as part of the urban core for City of Bakersfield. To support that goal, the *Metropolitan Bakersfield General Plan* identified the need for State Route 58 to be a six-lane roadway. This project serves the current and projected need. This project would not open new areas to development—it is within the area currently developed as an employment and commercial center.

The county supervisor may have stated that he accepts urban development west to Greeley Road. This would be a land use decision that is not associated with or in any way dependent on this project. The 2009 *Growth Impact Analysis* does project a substantial amount of development west of Allen Road between Rosedale Highway and Seventh Standard Road (see Figure 2-2). At this point in time, the precise location of development is still speculative. However, it would reasonably be able to be accommodated within the long-range growth projections. Kern County, as the local jurisdiction, would have land use authority for that action and would be responsible for considering the effects of those approvals.

Response to comment #4: To provide a Class I bikeway along State Route 58 would require extensive acquisition of property and would displace commercial and residential uses. As indicated in the Initial Study/Environmental Assessment, the *Metropolitan Bakersfield General Plan* does not designate any bike trails or paths along State Route (page 80 of the initial study/environmental assessment, page 82 of the final document). As discussed in response to comment #1, given the right-of-way constraints, the high traffic volumes, high truck percentage of trucks, and number of driveway breaks, a dedicated bikeway is not proposed as part of the project. The *Metropolitan Bakersfield General Plan* has designated bikeways on Brimhall Road and Hageman Road that run parallel to State Route 58. These parallel roadways provide more suitable routes because they carry less traffic and fewer trucks. Connecting bikeways from State Route 58 to the bikeways on both Brimhall Road and Hageman Road can be made via Allen Road, Calloway Drive, and Coffee Road.

Additionally, though Mohawk Street currently ends at State Route 58, there are plans to extend Mohawk Street through to Hageman Road.

Though there is not enough bicycle ridership to support the usage of State Route 58 as an important bicycle linkage, the lane widths will be reconfigured to provide a wider outside lane and shoulder. For the segment of roadway from Allen Road to Mohawk Street, rather than having three 12-foot travel lanes with a 2-foot outside shoulder, the width of the middle travel lane will be reduced to 11 feet. The additional foot will allow a 15-foot outside lane (12-foot travel lane and a 3-foot shoulder). This will not be considered a bike lane, but would provide additional area should a bicyclist decide to use State Route 58. Additional detail on bicycle counts taken along the State Route 58 is provided in the response to comments by Bike Bakersfield.

With regards to the request for walking facilities, the project would provide a continuous sidewalk meeting the requirements of the Americans with Disabilities Act along the entire length of the project. Improvements would include installation of Americans with Disabilities Act-compliant ramps at curb returns; Americans with Disabilities Act-compliant sidewalk and driveway widths; and continuous sidewalks on at least one side of the roadway. The project would also include sound alerts on pedestrian crossing signals (page 78 of the initial study/environmental assessment, page 80 of the final document).

Response to comment #5: The suggestion is that a sustainable alternative be developed that would encourage bicyclists and that would enhance public transportation and the potential for light rail. As indicated in response to comment #2, the project is a roadway project and does not involve any land use decisions. Most of the area surrounding the project site is developed. Providing for alternatives that would establish new land uses that would have the densities to support light rail within the study area is far beyond the scope of this project. The City of Bakersfield currently does not have the land use densities required to support light rail. Not even the bus lines along State Route 58 have substantial ridership. To date in 2012, the average number of passengers boarding the bus on a weekday is 167 riders for Route 18 and 556 riders for Route 14. These ridership numbers are for the entire route, not just the segment of State Route 58 that would be widened. The cost associated with providing light rail along State Route 58 would also be very high, as would the extent of impacts on surrounding land uses.

The decision not to provide a bike lane along State Route 58 is discussed in response to comment #1, above.

Response to comment #6: Placing the utilities underground would exceed the funds available for this project. In addition, minimal earthwork is required to widen the road. The only grading required will be to prepare the roadbed, which is usually only to a depth of 2 to 5 feet.

The existing light will be relocated to the back of the walk. It should be noted that shielding street lights would have minimal effectiveness along this segment of State Route 58 because of the amount of commercial uses within the study area.

Response to comment #7: Landscaping damaged by construction will be replaced with native materials (see Mitigation Measure B-7 page 198 of the draft environmental document which is now Mitigation Measure B-9 on page 199 of the final environmental document). Design and installation would be overseen by Caltrans professional landscapers and a qualified Biologist.

Response to comment #8: No significant project-related impacts have been identified either as part of the draft initial study/environmental assessment or the public review process that would require preparation of an environmental impact report pursuant with the California Environmental Quality Act or an Environmental Impact Statement pursuant to the National Environmental Policy Act.

Response to comment #9: The premise of the cited study (http://grist.files.wordpress.com/2011/12/tecipa-370.pdf) is that transportation improvements do not reduce congestion or the vehicle kilometers traveled (the study was conducted in Canada on metropolitan cities in the United States so kilometers were the unit of measure). However, it acknowledges that it "did not factor in external benefits unrelated to travel time savings" (page 42). One such factor is quality of life, and the residents of Bakersfield have indicated that the congestion on State Route 58 (Rosedale Highway) is a problem. The study also states "certain specific improvements of the system, for example inexpensive improvements to bottlenecks, may well be justified" (page 42). Even with the extensive growth projected by the California Department of Finance, the level of service on State Route 58 is projected in 2035 to be improved over current conditions. The cited study also came to similar conclusions that public transit does not reduce traffic levels. The study advocates the use of congestion pricing as a policy response to traffic congestion.

As shown in Table 1.2, Intersection Levels of Service (Existing, 2015, and 2035), State Route 58 already has a number of deficient intersections. The population of the City of Bakersfield is projected to increase 69 percent between 2000 and 2020 based on the California Department of Finance growth projections for the region (see Section 2.1.2, Growth). It is recognized that, with growth of this magnitude, additional capacity being added to State Route 58 will get used. However, not doing any improvements is not the answer. The growth will come regardless. The project is adding capacity in the urbanized portion of Bakersfield where there are limited opportunities for additional growth. Enhancing circulation in this portion of the city will allow the existing commercial and business uses along State Route 58 to effectively serve the community. This will maximize the use of existing facilities. Additionally, as noted in response to comment #2, Caltrans does not have land use authority, and the City is able to show their support for “smart land use” through their actions on land development projects.

Response to comment #10: The Sierra Club will be added to a notification list regarding future meetings and availability of the final environmental document.

Comment from Bike Bakersfield

BIKEBAKERSFIELD
BICYCLING FOR EVERYDAY TRANSPORTATION
BIKEBAKERSFIELD.ORG

January 4, 2012
Bryan Apper, Senior Environmental Planner
Southern Valley Environmental Analysis Branch
California Department of Transportation
855 M Street, Suite 200, Fresno, California 93721

Dear Bryan,

Thank you for providing us with the opportunity to comment on the Initial Study with Proposed Mitigated Negative Declaration/Environmental Assessment for the Rosedale Highway Widening Project in Bakersfield.

We do not believe that the Environmental Document accurately analyzes the impact on bicycle transportation and is therefore flawed in its environmental analysis. Specifically as it relates to air quality and environmental justice. 1

The summary table list the impact on bicycle facilities as no impact. This is not correct. The existing roadway has an eight foot paved shoulder. Using nationally accepted methods to calculate the bicycle level of service the existing roadway provides a level of service B and a very high compatibility level. The proposed roadway has no shoulder and no bike lane. The level of service for the proposed roadway is E and a very low compatibility level.

What this project does is remove an existing bicycle facility which is the main corridor from north-west Bakersfield to downtown and east Bakersfield. Therefore any existing and future non-motorized non-polluting access is being eliminated. 2

Therefore this project will increase air pollution now and in the future. The estimated amount could be based on the expected future bicycle mode share if proper facilities were provided. Cities around the nation and state have seen exponential growth in bicycle trips when good facilities are installed. Many cities are presently obtaining a five to eight per-cent mode share with goals of attaining 20 to 30 per-cent. A 20 per-cent mode share 3

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FROM THE DESK OF
BOB SMITH

on Rosedale Highway could be obtained in the future and would be a very significant amount of air pollution. 3 cont.

The projects environmental justice analysis does not take into account the destruction of an affordable transportation option for the lower income commuters. Access to jobs along the corridor will be greatly diminished for these income groups. 4

The federal Department of Transportation has a policy statement that states that

bicycling and walking facilities will be incorporated into all transportation projects unless exceptional circumstances exist;

Since this project is using federal money it would seem that it would have to comply with this policy.

It seems that a simple solution to the design of the project would be to narrow the travel lanes. The AASHTO recommended lane widths for arterials are from ten to twelve ft. The city of Bakersfield has many existing arterials with ten and eleven ft. travel lanes with no adverse effects. Caltrans highway design manual allows a reduction in lane widths in order to accommodate bicycle lanes. The highway capacity manual factors for capacity do not change with lane widths between ten and twelve ft.. Nationally recognized studies have shown that there is no safety difference between urban arterials with ten to twelve ft. It would not effect the safety or capacity of automobile traffic while providing for a non-motorized option as well. 5

Whatever the solution is there is no question that air quality will be enhanced by providing non-motorized transportation.

We appreciate the opportunity to comment on the environmental document and hope that the project can be improved through the process.

Sincerely yours,

Bob Smith

Relationship of Lane Width to Safety on Urban and Suburban Arterials

Ingrid B. Potts, Douglas W. Harwood, and Karen R. Richard

This research investigated the relationship between lane width and safety for roadway segments and intersection approaches on urban and suburban arterials. The research found no general indication that the use of lanes narrower than 3.6 m (12 ft) on urban and suburban arterials increases crash frequencies. This finding suggests that geometric design policies should provide substantial flexibility for use of lane widths narrower than 3.6 m (12 ft). The inconsistent results suggested increased crash frequencies with narrower lanes in three specific design situations. Narrower lanes should be used cautiously in these three situations unless local experience indicates otherwise.

This research addresses the relationship of lane width to safety for urban and suburban arterials. A cross-sectional analysis approach was used because suitable sites to conduct a before–after observational study were not available. Lane width for both midblock segments and intersection approaches has been considered. A full report of the research results has been prepared by Potts et al. (*1*).

CURRENT STATE OF KNOWLEDGE ON SAFETY EFFECTS OF LANE WIDTHS

The conventional wisdom of most highway engineers is that use of narrower lanes in the design of a roadway will result in more crashes if other design characteristics of the roadway remain unchanged. This has been demonstrated for lane widths on rural two-lane highways (*2*), but there is no definitive research on the safety effect of lane widths for urban and suburban arterials. If narrower lanes can be used on urban and suburban arterials without affecting safety negatively, there may be many other benefits to highway agencies and highway users. The use of narrower lanes may have advantages in some situations on arterials by reducing pedestrian crossing distances or providing space for additional through lanes, auxiliary lanes, bicycle lanes, buffer areas between travel lanes and sidewalks, and placement of roadside hardware. Concerns have been raised that the use of narrower lanes could increase crash frequencies, but there are no definitive studies that address the relationship between lane width and safety for urban and suburban arterials.

The results of past studies to determine the traffic safety effects of lane width are varied. Despite the extensive research that has been conducted on this issue, it is difficult to draw any definite conclusions about the relationship. Hauer et al. (*3*) developed six statistical models to predict the nonintersection crash frequency of urban four-lane undivided roads. Separate models were developed for off-road and on-road crashes. Hauer et al. concluded that for off-road crashes, if crash frequency is influenced by lane width, it is not discernable. For on-road crashes, lane width was found to be associated with property-damage-only (PDO) crashes but not injury crashes. For the PDO model, Hauer et al. noted that wider lanes were associated with higher crash frequencies (not lower ones). However, Hauer et al. also noted that the relationship is weak and that lane width is included in the model only because of traditional interest in this variable.

Research by Strathman et al. (*4*) on the design attributes and safety of Oregon state highways found no relationship between lane width and crash frequency for urban nonfreeways.

Hadi et al. (*5*) developed negative binomial regression models to estimate the safety of various cross-sectional elements and found significant relationships between lane width and crashes for undivided highways. Hadi et al. found that increasing lane widths up to 3.6 m (12 ft) and 4.0 m (13 ft) would be expected to decrease crash rates for urban two-lane and four-lane undivided roadways, respectively.

While reducing crossing distance for pedestrians at intersections is considered desirable, no studies have documented the quantitative effect of lane width on pedestrian or bicycle safety.

CURRENT GEOMETRIC DESIGN POLICIES FOR LANE WIDTH ON URBAN AND SUBURBAN ARTERIALS

Highway design policies for arterial roadways indicate a preference for the use of 3.6-m (12-ft) lane widths but allow flexibility for use of narrower lanes where 3.6-m (12-ft) lanes are infeasible or impractical (*6*).

Geometric design practices related to lane width must consider the needs of motor vehicle, pedestrian, and bicycle traffic. The AASHTO *Policy on Geometric Design of Highways and Streets* (*6*), commonly known as the Green Book, offers guidelines on the selection of appropriate lane widths on urban and suburban arterials while considering primarily the needs of motor vehicle traffic. In Chapter 7 of the Green Book, lane widths from 3.0 to 3.6 m (10 to 12 ft) are addressed as are specific circumstances for which each width should be considered.

Despite the flexibility provided by geometric design policies and the lack of definitive safety studies, there has always existed a conventional wisdom that narrower lanes result in higher crash frequencies. The purpose of this research is to investigate whether this conventional wisdom is correct, determine whether and how lane width affects safety, and identify situations in which design flexibility to use narrower lanes should or should not be used.

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SAFETY EVALUATION OF LANE WIDTHS ON ARTERIAL MIDBLOCK SEGMENTS

Available Database

Ongoing research in NCHRP Project 17-26, Methodology to Predict the Safety Performance of Urban and Suburban Arterials, has developed a database that was used in this research to examine the effects of roadway features, including lane width, on safety for arterials. The objective of NCHRP Project 17-26 is to develop a prediction methodology for urban and suburban arterials for application in the forthcoming *Highway Safety Manual*. This database is also suitable for investigation of the relationship between lane width and safety and has been used for that purpose in the current research (*7*).

The database includes site characteristics, traffic volume, and crash data for arterial roadway segments in Minnesota and Michigan. The roadway segments in Minnesota are located primarily in the Minneapolis–St. Paul metropolitan area and include roadways in both urban and suburban communities. The roadway segments in Michigan are located in Oakland County, in the northern portion of the Detroit metropolitan area. Oakland County includes some urban communities, but most of the area is considered suburban. The database for both areas includes a mixture of arterials under state and local jurisdiction.

The available data include five arterial roadway types:

- Two-lane undivided arterials (2U),
- Three-lane arterials including a center TWLTL (two-way left-turn lane) (3T),
- Four-lane undivided arterials (4U),
- Four-lane divided arterials (4D), and
- Five-lane arterials including a center TWLTL (5T).

Table 1 presents a summary of the number and total length of roadway segment sites for which site characteristics (including lane width, traffic volume, and crash data) are available in each state. Each site consists of one block (i.e., the arterial roadway from one public road intersection to the next), ranging from 0.06 to 2.28 km (0.04 to 1.42 mi), with an average block length of 0.21 km (0.13 mi).

The lane widths at these sites were measured in the field. The lane widths shown in Table 1 represent the average lane widths across all through travel lanes. Sites for which measured lane widths were not available have been omitted from Table 1 and from the subsequent analyses. The lane width categories listed in Table 1 and subsequent tables are defined as follows:

Lane Width Category (ft)	*Range of Lane Widths (ft)*
9	9.5 or less
10	9.5–10.5
11	10.5–11.5
12	11.5–12.5
13+	12.5 or more

Crash data were obtained for all sites shown in Table 1 for a 5-year period—1998 to 2002 in Minnesota and 1999 to 2003 in Michigan—including 4,786 crashes in Minnesota and 17,037 crashes in Michigan. The analysis performed in this study included all single- and multiple-vehicle crashes except pedestrian and bicycle collisions. These were omitted because they are being addressed in separate analyses in NCHRP Project 17-26.

TABLE 1 Number and Total Length of Roadway Segment Analysis Sites by Roadway Type and Lane Width

Roadway Type	Lane Width (ft) 9	10	11	12	13+	Total
Number of sites						
Minnesota						
2U	2	20	20	162	176	380
3T	—	16	5	73	35	129
4U	19	147	121	91	62	440
4D	—	2	44	61	71	178
5T	—	—	8	18	—	26
Subtotal	21	185	198	405	344	1,153
Michigan						
2U	61	82	229	148	70	590
3T	31	25	12	32	15	115
4U	104	181	157	29	—	471
4D	12	10	69	33	16	140
5T	—	17	357	114	74	562
Subtotal	208	315	824	356	175	1,878
Total	229	500	1,022	76	519	3,031
Total length of sites (mi)						
Minnesota						
2U	0.19	2.86	3.34	21.02	24.88	52.29
3T	—	1.27	0.65	11.96	4.14	18.02
4U	—	0.50	5.79	11.29	13.81	31.39
4D	1.43	13.74	14.15	12.77	5.40	47.49
5T	—	—	1.57	2.71	—	4.28
Subtotal	1.62	18.37	25.50	59.75	48.23	153.47
Michigan						
2U	7.50	11.45	33.90	23.81	11.40	88.06
3T	4.11	2.52	1.80	5.36	1.96	15.48
4U	7.76	14.28	14.17	4.07	—	40.28
4D	0.78	9.59	12.01	4.42	2.83	29.63
5T	—	1.16	50.78	19.30	10.27	81.51
Subtotal	20.15	39.00	112.66	55.96	26.46	254.96
Total	21.77	57.37	138.16	116.71	74.69	408.43

Analysis Approach

While the use of a before–after evaluation would be the preferred approach to determining the effect of lane width on safety, a before–after evaluation was not feasible because highway agencies seldom change the lane width of a roadway without making other changes that would confound the results of any such evaluation. Because the before–after approach was not feasible, a cross-sectional analysis approach was used to investigate the relationships between lane width and safety.

Two approaches to cross-sectional analysis to examine the effects of lane width have been applied in this research. Each approach was applied separately to data from each state and each roadway type. In the first approach, only three variables were considered: average daily traffic (ADT) volume, roadway segment length, and lane width. In the second approach, a broader set of site characteristics were considered in addition to those three.

The first approach began by developing an ADT-only negative binomial regression model in the following form:

$$N = \exp\left(a + b\ln \text{ADT} + \ln L\right) \qquad (1)$$

where

N = predicted number of crashes per year of a particular crash type,
ADT = average daily traffic volume (veh/day) on roadway segment,
L = length of roadway segment (mi), and
a, b = regression coefficients.

In addition to the ADT term, the ADT-only models for roadway segments also included the roadway segment length as a factor representing exposure. Then, models were developed in the same form as Equation 1 but with a set of variables added to represent the effect of lane width:

$$N = \exp\left(a + b\ln \text{ADT} + \ln L + c_9\text{LW}_9 + c_{10}\text{LW}_{10} + c_{11}\text{LW}_{11} + c_{12}\text{LW}_{12} + c_{13+}\text{LW}_{13+}\right) \qquad (2)$$

where

LW_9 = indicator variable (= 1 if lane width of roadway segment = 9 ft; = 0 if not),
LW_{10} = indicator variable (= 1 if lane width of roadway segment = 10 ft; = 0 if not),
LW_{11} = indicator variable (= 1 if lane width of roadway segment = 11 ft; = 0 if not),
LW_{12} = indicator variable (= 1 if lane width of roadway segment = 12 ft; = 0 if not),
LW_{13+} = indicator variable (= 1 if lane width of roadway segment = 13 ft or more; = 0 if not), and
$c_9, \ldots, c_{13+}$ = regression coefficients.

Lane width was treated as a categorical, rather than continuous, variable in this modeling approach because there was no reason to presume a linear or log-linear relationship between lane width and safety. Treatment of lane width as a categorical variable provides an opportunity for unusual or unexpected relationships between it and safety to be identified. Lane width effects were included in models in the form show in Equation 2 only if the effect of lane width was found to be statistically significant.

The second approach began with the "best" models developed in NCHRP Project 17-26, in which variables other than lane width were considered. These models were typically in the following form:

$$N = \exp\left(a + b\ln \text{ADT} + \ln L + d\text{SW} + e\text{OSP} + f\text{RHR}\right) \qquad (3)$$

where

SW = shoulder width (ft),
OSP = on-street parking indicator (= 0 if curb parking is present on either side of street; = 1 if not present),
RHR = roadside hazard rating for roadway segment (1 to 7 scale), and
d, e, f = regression coefficients.

The shoulder width, on-street parking, and roadside hazard rating variables were included only if their coefficients were statistically significant. The roadside hazard rating was a rating on a scale of 1 (best roadside) to 7 (poorest roadside) developed by Zegeer et al. (*8*).

To this best model from NCHRP Project 17-26, in the form shown in Equation 3, the current research then added the same lane width effects considered in Equation 2:

$$N = \exp\left(a + b\ln \text{ADT} + \ln L + d\text{SW} + e\text{OSP} + f\text{RHR} + c_9\text{LW}_9 + c_{10}\text{LW}_{10} + c_{11}\text{LW}_{11} + c_{12}\text{LW}_{12} + c_{13+}\text{LW}_{13+}\right) \qquad (4)$$

Lane width was added to Equation 4 only if its effect was found to be statistically significant.

Nine dependent variables (represented by N in Equations 1 through 4) were considered:

- All crashes,
- Fatal-and-injury crashes,
- Property-damage-only crashes,
- All multiple-vehicle crashes (non-driveway-related),
- Fatal-and-injury multiple-vehicle crashes (non-driveway-related),
- Property-damage-only multiple-vehicle crashes,
- All single-vehicle crashes,
- Fatal-and-injury single-vehicle crashes, and
- Property-damage-only single-vehicle crashes.

Both analysis approaches were applied to the following elements:

- Two model forms (either Equations 1 and 2 or Equations 3 and 4),
- Nine dependent variables, and
- Five roadway types.

Thus, a total of 90 regression models were developed for each analysis approach. The results of these modeling approaches follow.

Analysis Results

All 45 models of Minnesota roadway segment crashes that used the ADT-only model in the form shown in Equation 1 were statistically significant with R^2_{LR} ranging from .08 to .45. Lane width variables were added to create models in the form of Equation 2.

Table 2 shows the coefficients of the lane width variables (c_9, c_{10}, c_{11}, c_{12}, and c_{13+} in Equation 2). The coefficients are all expressed through comparison with a nominal lane width of 3.6 m (12 ft) (i.e., the value of coefficient c_{12} is always zero). Positive coefficients indicate that roadways with the corresponding lane width would be expected to have higher crash frequencies than roadways with 3.6-m (12-ft) lanes. Negative coefficients indicate that roadways with the corresponding lane width would be expected to have lower crash frequencies than roadways with 3.6-m (12-ft) lanes. The values of the coefficients must be interpreted in accordance with Equation 2. The actual effect of lane width on safety is determined by taking the exponential function of the coefficient [e.g., $\exp(c_{10})$].

The final two columns in Table 2 indicate the results of comparisons of the coefficients for different lane widths. The next-to-last column indicates a comparison of the lane width effects for 2.7- and 3.0-m

TABLE 2 Negative Binomial Regression Models with ADT and Lane Width for Roadway Segments in Minnesota

		Model Coefficients										Comments on Lane Width Effect
				Lane Width Category (ft)								
Roadway Type	Number of Sites	Intercept	AADT	9	10	11	12	13+	Dispersion	R^2_{LR}	Statistical Significance	9 or 10 ft to 11 or 12 ft
All crashes												
2U	380										R^2 below .10	
3T	129	–6.56	0.84		–0.56	0.70	0	0.26	0.65	.13	Significant	Increase
4D	178	–9.15	1.11		–0.04	–0.22	0	–0.52	0.93	.21	Significant	Inconsistent
4U	440	–15.31	1.79	1.06	0.81	0.40	0	0.43	0.79	.31	Significant	Decrease
5T	26										No model found	
Fatal-and-injury crashes												
2U	380										No model found	
3T	129										R^2 below .10	
4D	178										No model found	
4U	440	–15.43	1.66	0.62	0.57	0.20	0	0.00	0.93	.17	Significant	Decrease
5T	26										No model found	
Property-damage-only crashes												
2U	380										R^2 below .10	
3T	129	–6.78	0.84		–0.26	0.79	0	0.35	0.54	.12	Significant	Increase
4D	178	–9.73	1.12		–0.04	–0.27	0	–0.62	0.97	.21	Significant	Inconsistent
4U	440	–15.86	1.82	1.28	0.94	0.49	0	0.63	0.88	.29	Significant	Decrease
5T	26										No model found	
All multiple-vehicle crashes												
2U	380										No model found	
3T	129										No model found	
4D	178	–10.35	1.21		0.04	–0.23	0	–0.47	1.10	.20	Significant	No change
4U	439	–17.45	1.98	1.11	0.79	0.33	0	0.39	1.02	.29	Significant	Decrease
5T	26	–24.90	2.75			–0.86	0		0.08	.45	Significant	
Fatal-and-injury multiple-vehicle crashes												
2U	380										No model found	
3T	129										No model found	
4D	178										No model found	
4U	439	–17.34	1.83	0.52	0.56	0.14	0	–0.03	1.32	.15	Significant	Decrease
5T	26										No model found	
Property-damage-only multiple-vehicle crashes												
2U	380										No model found	
3T	129										No model found	
4D	178	–10.82	1.21		–0.04	–0.26	0	–0.55	1.20	.19	Significant	No change
4U	435	–18.28	2.04	1.39	0.97	0.45	0	0.61	1.17	.27	Significant	Decrease
5T	26										No model found	
All single-vehicle crashes												
2U	380										R^2 below .10	
3T	129										No model found	
4D	178	–7.59	0.76		–0.24	–0.22	0	–0.75	0.89	.10	Significant	Increase
4U	440	–9.40	1.05	0.92	0.91	0.61	0	0.68	0.61	.13	Significant	Decrease
5T	26										No model found	

(continued)

TABLE 2 *(continued)* Negative Binomial Regression Models with ADT and Lane Width for Roadway Segments in Minnesota

Roadway Type	Number of Sites	Model Coefficients: Intercept	AADT	Lane Width Category (ft): 9	10	11	12	13+	Dispersion	R^2_{LR}	Statistical Significance	Comments on Lane Width Effect: 9 or 10 ft to 11 or 12 ft
Fatal-and-injury single-vehicle crashes												
2U	380										No model found	
3T	129										No model found	
4D	178										No model found	
4U	440	−9.56	0.88	1.11	0.71	0.36	0	0.18	0.14	.05	Significant	Decrease
5T	26										No model found	
Property-damage-only single-vehicle crashes												
2U	380										R^2 below .10	
3T	129										No model found	
4D	178										R^2 below .10	
4U	440	−9.80	1.07	0.87	0.97	0.66	0	0.82	0.68	.11	Significant	Decrease
5T	26										No model found	

NOTE: Coefficients are used in the model form shown in Equation 2.

(9- and 10-ft) lanes with those for 3.3- and 3.6-m (11- and 12-ft) lanes. The comments in the last column of Table 2 (and subsequent tables) are interpreted as follows:

- "Decrease" means that 3.3- to 3.6-m (11- to 12-ft) lanes have lower crash frequencies than 2.7- to 3.0-m (9- to 10-ft) lanes. This is consistent with the conventional wisdom that wider lanes result in lower crash frequencies.
- "Increase" means that 3.3- to 3.6-m (11- to 12-ft) lanes have higher crash frequencies than 2.7- to 3.0-m (9- to 10-ft) lanes. This is opposite to the conventional wisdom.
- "No change" means that the crash frequencies for 3.3- to 3.6-m (11- and 12-ft) lanes are so close to those for 2.7- and 3.0-m (9- and 10-ft) lanes that there is little practical engineering difference between these values.
- "Inconsistent" means that the crash frequencies for 2.7- and 3.0-m (9- and 10-ft) lanes fall between those for 3.3- and 3.6-m (11- and 12-ft) lanes.

Table 2 shows that when the lane width variable was added to the 45 statistically significant ADT-only models

- In 17 cases, statistically significant models involving both ADT and lane width were found;
- In 22 cases, no model was found (i.e., the modeling algorithm did not converge). This indicates that the addition of the lane width interfered with the relationship between safety and ADT that had already been determined; and
- In six cases, statistically significant models were found, but the value of R^2_{LR} was so low (below .10) that the model has little predictive ability. In these cases, the ADT-only model had R^2_{LR} above .10, so the predictive ability of the model including lane width was less than that of the ADT-only model.

In the 28 cases for which no model was found or a model with R^2_{LR} below 0.10 was found, there is no indication of a strong relationship between lane width and safety. In the 17 cases for which both ADT and lane width had a statistically significant effect, there were only nine cases in which the effect for lane width in the range of 2.7 to 3.6 m (9 to 12 ft) was in the direction expected by the conventional wisdom (i.e., decreasing crash frequency for wider lanes). These nine cases included all dependent variables considered for one particular roadway type: four-lane undivided roadways. In general, for four-lane undivided roadways on Minnesota arterials, roadways with lane widths of 3.0 m (10 ft) or less were found to have higher crash frequencies than comparable roadways with 3.3- or 3.6-m (11- or 12-ft) lanes. There was no indication in the Minnesota data of a consistent relationship between safety and lane width for any other roadway type. The Minnesota data contained relatively few sites with 2.7-m (9-ft) lanes. Therefore, the finding noted above generally indicated that four-lane undivided arterials in Minnesota with 3.0-m (10-ft) lanes tended to experience more crashes than those with 3.3- and 3.6-m (11- and 12-ft) lanes.

Table 3 presents comparable results to those in Table 2 for arterial roadway segments in Oakland County, Michigan. The results were comparable to the Minnesota results in that there were only a limited number of statistically significant models incorporating both ADT and lane width. Specifically, of the 45 cases for which statistically significant ADT-only models were found,

- In 25 cases statistically significant models involving both ADT and lane width were found;
- In four cases statistically significant models were found but the value of R^2_{LR} was below .10; and
- In 16 cases no model was found (i.e., the modeling algorithm did not converge).

The Michigan data did not show a lane width effect for four-lane undivided roadways similar to that found for the Minnesota data. Four-lane undivided roadways with 3.0-m (10-ft) lanes in Michigan generally had crash frequencies comparable to roadways with 3.3- and 3.6-m (11- and 12-ft) lanes. The only pattern noted was that,

TABLE 3 Negative Binomial Regression Models with ADT and Lane Width for Roadway Segments in Oakland County, Michigan

		Model Coefficients										Comments on Lane Width Effect
				Lane Width Category (ft)								
Roadway Type	Number of Sites	Intercept	AADT	9	10	11	12	13+	Dispersion	R^2_{LR}	Statistical Significance	9 or 10 ft to 11 or 12 ft
All crashes												
2U	590	–10.14	1.27	0.07	–0.19	–0.24	0	–0.18	0.37	.43	Significant	No change
3T	100	–8.92	1.11	0.02	–0.23	–0.24	0	–0.78	0.31	.50	Significant	No change
4D	140	–7.36	0.96	0.39	–0.98	0.10	0	–0.21	0.68	.23	Significant	Inconsistent[a]
4U	440	–3.94	0.60	–0.22	0.23	0.69	0		0.52	.18	Significant	Inconsistent
5T	549	–7.58	1.03		–0.63	0.04	0	–0.10	0.62	.18	Significant	Increase
Fatal-and-injury crashes												
2U	590	–11.71	1.28	–0.35	–0.18	–0.43	0	–0.24	0.25	.29	Significant	No change
3T	100										No model found	
4D	140	–8.96	0.98	1.12	–1.98	–0.14	0	–0.03	0.57	.20	Significant	Inconsistent[a]
4U	440										R^2 below.10	
5T	549										No model found	
Property-damage-only crashes												
2U	590	–10.32	1.26	0.21	–0.15	–0.19	0	–0.14	0.40	.39	Significant	Inconsistent[a]
3T	100	–8.43	1.02	0.03	–0.17	–0.21	0	–0.91	0.30	.46	Significant	Inconsistent
4D	140	–7.45	0.94	0.13	–0.85	0.16	0	–0.29	0.66	.23	Significant	Inconsistent
4U	440	–3.99	0.58	–0.19	0.27	0.74	0		0.55	.16	Significant	Inconsistent
5T	549	–8.06	1.05		–0.69	0.04	0	–0.12	0.63	.18	Significant	Increase
All multiple-vehicle crashes												
2U	588	–13.88	1.63	0.07	–0.24	–0.42	0	–0.11	0.56	.43	Significant	Inconsistent[b]
3T	100	–9.93	1.20	0.10	–0.24	–0.36	0	–0.73	0.42	.47	Significant	Inconsistent[b]
4D	140	–11.34	1.33	0.75	–0.73	0.05	0	–0.31	0.84	.26	Significant	Inconsistent[a]
4U	438	–4.98	0.67	0.08	0.57	0.98	0		0.57	.18	Significant	Inconsistent
5T	549	–8.45	1.11		–0.66	0.06	0	–0.09	0.73	.18	Significant	Increase
Fatal-and-injury multiple-vehicle crashes												
2U	590	–16.16	1.72	–0.48	–0.34	–0.54	0	–0.21	0.37	.32	Significant	Inconsistent
3T	100										No model found	
4D	140	–10.90	1.16	1.41	–1.67	–0.06	0	0.05	0.60	.21	Significant	Inconsistent[a]
4U	440	–7.45	0.79	0.02	0.50	0.88	0		0.75	.10	Significant	No change
5T	549										No model found	
Property-damage-only multiple-vehicle crashes												
2U	585	–13.83	1.60	0.27	–0.15	–0.39	0	–0.04	0.62	.38	Significant	Inconsistent[a]
3T	100	–9.37	1.11	0.08	–0.18	–0.33	0	–0.90	0.42	.43	Significant	Inconsistent
4D	140	–11.53	1.31	0.44	–0.63	0.08	0	–0.45	0.84	.26	Significant	Inconsistent[a]
4U	438	–5.20	0.66	0.11	0.59	1.00	0		0.60	.16	Significant	No change
5T	548	–8.82	1.12		–0.70	0.05	0	–0.12	0.77	.17	Significant	Increase
All single-vehicle crashes												
2U	590										R^2 below .10	
3T	100										No model found	
4D	140										No model found	
4U	440										No model found	
5T	549										No model found	

(continued)

TABLE 3 (continued) Negative Binomial Regression Models with ADT and Lane Width for Roadway Segments in Oakland County, Michigan

Roadway Type	Number of Sites	Model Coefficients: Intercept	AADT	Lane Width Category (ft): 9	10	11	12	13+	Dispersion	R^2_{LR}	Statistical Significance	Comments on Lane Width Effect: 9 or 10 ft to 11 or 12 ft
Fatal-and-injury single-vehicle crashes												
2U	590										No model found	
3T	100										No model found	
4D	140										No model found	
4U	440										R^2 below .10	
5T	549										No model found	
Property-damage-only single-vehicle crashes												
2U	590										R^2 below .10	
3T	100										No model found	
4D	140										No model found	
4U	440										No model found	
5T	549										No model found	

NOTE: Coefficients are used in the model form shown in Equation 2.
[a]Substantially more crashes for 9-ft lanes than for 10-ft lanes.
[b]A few more crashes for 9-ft lanes than for 10-ft lanes.

for four-lane divided arterials in Michigan, roadways with 2.7-m (9-ft) lanes tend to have higher crash frequencies than roadways with 3.0-m (10-ft) lanes.

Table 4 presents the results of the modeling of Minnesota roadway segment crashes that used the second approach discussed earlier. The table shows the comparison of 45 pairs of models (nine dependent variables for each of five roadway types). Each pair of models includes, on the first line, the best of the base models from NCHRP Project 17-26. These models are in the form shown in Equation 3. All base models include ADT, and they also include the effects of on-street parking, shoulder width, and roadside hazard rating if these effects were statistically significant. The second line for each pair of models includes the same model shown in the first line with the lane width variables added in the form shown in Equation 4.

The results for the 45 pairs of models indicate that

- In 16 cases the lane width term added to the base model was statistically significant;
- In one case the lane width term added to the model was statistically significant but resulted in a model with a value of R^2_{LR} so low (below .10) that the model has little predictive power; and
- In 28 cases no model was found when the lane width term was added to the base model (i.e., the modeling algorithm did not converge).

For the models including lane width that were statistically significant, the only consistent pattern observed was the higher crash frequencies for 2.7- to 3.0-m (9- to 10-ft) lanes on four-lane undivided arterials also observed in Table 2.

Table 5 shows results comparable to those in Table 4 for arterial roadway segments in Oakland County, Michigan. The results for the 45 pairs of models indicate that

- In 21 cases the lane width term added to the base model was statistically significant;
- In two cases the lane width term added to the model was statistically significant but resulted in a model with a value of R^2_{LR} below .10; and
- In 22 cases no model was found when the lane width term was added to the base model (i.e., the modeling algorithm did not converge).

There was no indication in the Michigan data of elevated crash frequencies for 3.0 m (10-ft) lanes on four-lane undivided roadways as found for Minnesota. There was an indication in the Michigan data that higher crash frequencies may be found for 2.7-m than for 3.0-m (9-ft than for 10-ft) lanes on four-lane divided arterials. There were no other consistent results.

SAFETY EVALUATION OF LANE WIDTHS ON ARTERIAL INTERSECTION APPROACHES

Available Database

An analysis similar to that presented earlier for arterial midblock sections were also performed for lane widths on approaches to arterial intersections. The database from NCHRP Project 17-26 also includes data for arterial intersections and their approaches. The NCHRP Project 17-26 database includes site characteristics, traffic volume, and crash data for approaches to arterial intersections in Minnesota and North Carolina. The Minnesota intersections are all located in the Minneapolis–St. Paul metropolitan area; the North Carolina intersections are all located in the city of Charlotte. The intersections in both states include both urban and suburban sites. The major-road approaches to the intersections in Minnesota include roadways under both state and local jurisdiction. Most of the major-road approaches in Charlotte are roadways under local jurisdiction. In both states, the minor-road approaches to the intersections are primarily roads under local jurisdiction.

TABLE 4 Negative Binomial Regression Models with ADT, Other Independent Variables, and Lane Width for Roadway Segments in Minnesota

				Base Model Coefficients					
						Curb Parking			
Roadway Type	Model Type	Independent Variables in Model	Number of Sites	Intercept	AADT	None	Either Side	Shoulder Width	Roadside Rating
All crashes									
2U	B	SW and RR	458	–6.66	0.84			–0.04	0.14
2U	B + LWC	LWC and SW and RR	377	–5.68	0.69			–0.03	0.21
3T	B	ShoulderW	262	–8.94	1.14			–0.08	
3T	B + LWC								
4D	B	ShoulderW	379	–10.31	1.26			–0.04	
4D	B + LWC	LWC and SW	174	–10.98	1.32			–0.07	
4U	B	SW and RR	701	–13.37	1.55			–0.06	0.13
4U	B + LWC	LWC and SW and RR	440	–15.37	1.74			–0.03	0.13
5T	B	ShoulderW	169	–8.16	1.03			–0.10	
5T	B + LWC								
Fatal-and-injury crashes									
2U	B	ShoulderW	462						
2U	B + LWC								
3T	B	ShoulderW	262						
3T	B + LWC								
4D	B	ShoulderW	379	–11.90	1.31			–0.05	
4D	B + LWC								
4U	B	AADT only	742	–13.96	1.54				
4U	B + LWC	LWC	440	–15.43	1.66				
5T	B	AADT only	205						
5T	B + LWC								
Property-damage-only crashes									
2U	B	CP and SW	462	–7.20	0.99	–1.07	0	–0.02	
2U	B + LWC								
3T	B	ShoulderW	262	–9.70	1.19			–0.08	
3T	B + LWC								
4D	B	ShoulderW	379	–10.48	1.24			–0.04	
4D	B + LWC	LWC and SW	174	–11.61	1.34			–0.08	
4U	B	SW and RR	701	–14.69	1.64			–0.08	0.16
4U	B + LWC	LWC and SW and RR	440	–15.98	1.76			–0.05	0.16
5T	B	ShoulderW	169						
5T	B + LWC								
All multiple-vehicle crashes									
2U	B	CP and SW	451	–11.05	1.36	–0.79	0	–0.02	
2U	B + LWC								
3T	B	ShoulderW	261	–14.66	1.74			–0.11	
3T	B + LWC								
4D	B	ShoulderW	378	–12.33	1.45			–0.05	
4D	B + LWC	LWC and SW	174	–12.40	1.45			–0.08	
4U	B	ShoulderW	700	–15.27	1.78			–0.10	
4U	B + LWC	LWC and SW	439	–17.87	2.03			–0.06	
5T	B	ShoulderW	168	–8.58	1.05			–0.17	
5T	B + LWC								
Fatal-and-injury multiple-vehicle crashes									
2U	B	ShoulderW	459						
2U	B + LWC								
3T	B	ShoulderW	262	–15.40	1.68			–0.10	
3T	B + LWC								
4D	B	ShoulderW	377	–13.17	1.42			–0.06	
4D	B + LWC								
4U	B	ShoulderW	700	–14.97	1.63			–0.08	
4U	B + LWC	LWC and SW	439	–17.74	1.88			–0.06	
5T	B	AADT only	204						
5T	B + LWC								

Dispersion	R^2_{LR}	Lane Width Coefficients: 9	10	11	12	13+	Statistical Significance	Comments on Lane Width Effect: 9 or 10 ft to 11 or 12 ft
0.89	.18						Significant	
0.78	.21		−0.12	−0.80	0.00	−0.15	Significant	Inconsistent
0.84	.14						Significant	
							No model found	
0.78	.25						Significant	
0.89	.26		−0.42	−0.69	0.00	−0.66	Significant	Inconsistent
0.96	.26						Significant	
0.76	.33	1.03	0.56	0.30	0.00	0.27	Significant	Decrease
0.82	.10						Significant	
							No model found	
							R^2 below .10	
							No model found	
							R^2 below .10	
							No model found	
0.95	.17						Significant	
							No model found	
1.16	.14						Significant	
0.93	.17	0.62	0.57	0.20	0.00	0.00	Significant	Decrease
							Significant	
							No model found	
0.79	.24						Significant	
							No model found	
0.90	.13						Significant	
							No model found	
0.86	.22						Significant	
0.91	.27		−0.46	−0.79	0.00	−0.80	Significant	Inconsistent
1.08	.25						Significant	
0.83	.32	1.22	0.63	0.36	0.00	0.43	Significant	Decrease
							R^2 below .10	
							No model found	
1.19	.20						Significant	
							No model found	
0.97	.20						Significant	
							No model found	
0.94	.26						Significant	
1.05	.25		−0.37	−0.75	0.00	−0.60	Significant	Inconsistent
1.24	.24						Significant	
1.00	.30	1.01	0.71	0.31	0.00	0.36	Significant	Decrease
0.80	.12						Significant	
							No model found	
							R^2 below .10	
							No model found	
1.16	.10						Significant	
							No model found	
1.10	.16						Significant	
							No model found	
1.57	.12						Significant	
1.30	.15	0.43	0.48	0.13	0.00	−0.05	Significant	Decrease
							R^2 below .10	
							No model found	

(continued on next page)

TABLE 4 *(continued)* Negative Binomial Regression Models with ADT, Other Independent Variables, and Lane Width for Roadway Segments in Minnesota

				Base Model Coefficients					
						Curb Parking			
Roadway Type	Model Type	Independent Variables in Model	Number of Sites	Intercept	AADT	None	Either Side	Shoulder Width	Roadside Rating
Property-damage-only multiple-vehicle crashes									
2U	B	CP and SW	453	–12.69	1.52	–0.91	0	–0.04	
2U	B + LWC								
3T	B	ShoulderW	261	–14.80	1.71			–0.11	
3T	B + LWC								
4D	B	ShoulderW	378	–12.59	1.43			–0.05	
4D	B + LWC	LWC and SW	174	–12.97	1.47			–0.09	
4U	B	ShoulderW	696	–16.54	1.88			–0.10	
4U	B + LWC	LWC and SW	435	–18.57	2.07			–0.06	
5T	B	ShoulderW	169	–8.10	0.97			–0.23	
5T	B + LWC								
All single-vehicle crashes									
2U	B	CP and RR	564	–3.00	0.41	–0.98	0		0.10
2U	B + LWC	LWC and CP and RR	377	–1.03	0.17	–1.09	0		0.15
3T	B	AADT only	380						
3T	B + LWC								
4D	B	CP and RR	536						
4D	B + LWC								
4U	B	CP and RR	742	–9.64	1.03	–0.63	0		0.14
4U	B + LWC	LWC and CP and RR	440	–7.68	0.83	–0.47	0		0.12
5T	B	AADT only	205						
5T	B + LWC								
Fatal-and-injury single-vehicle crashes									
2U	B								
2U	B + LWC								
3T	B								
3T	B + LWC								
4D	B	RS Rating	536						
4D	B + LWC								
4U	B	CP and RR	742						
4U	B + LWC	LWC and CP and RR	440						
5T	B								
5T	B + LWC								
Property-damage-only single-vehicle crashes									
2U	B	CP and RR	564	–4.46	0.55	–1.11	0		0.11
2U	B + LWC	LWC and CP and RR	377	–2.40	0.31	–1.24	0		0.14
3T	B	AADT only	380	–6.37	0.63				
3T	B + LWC								
4D	B	CP and RR	536	–5.94	0.56	–0.38	0		0.20
4D	B + LWC	LWC and CP and RR	178	–4.53	0.35	–0.41	0		0.40
4U	B	CP and RR	742	–10.86	1.13	–0.68	0		0.14
4U	B + LWC	LWC and CP and RR	440	–8.08	0.86	–0.47	0		0.11
5T	B	AADT only	205						
5T	B + LWC								

NOTE: Base model (B) coefficients are used in the model form shown in Equation 3. Base model plus lane width (B + LWC) coefficients are used in the model form shown in Equation 4.

		Lane Width Coefficients						Comments on Lane Width Effect
Dispersion	R^2_{LR}	9	10	11	12	13+	Statistical Significance	9 or 10 ft to 11 or 12 ft
1.15	.20						Significant	
							No model found	
1.03	.18						Significant	
							No model found	
1.05	.23						Significant	
1.13	.25		−0.50	−0.85	0.00	−0.72	Significant	Inconsistent
1.47	.21						Significant	
1.15	.28	1.31	0.89	0.44	0.00	0.58	Significant	Decrease
0.96	.11						Significant	
							No model found	
0.76	.15						Significant	
0.45	.24		−0.55	−0.37	0.00	−0.31	Significant	Increase
							R^2 below .10	
							No model found	
							R^2 below .10	
							No model found	
0.77	.15						Significant	
0.51	.17	0.76	0.64	0.32	0.00	0.31	Significant	Decrease
							R^2 below .10	
							No model found	
							No model found	
							No model found	
							No model found	
							No model found	
							R^2 below .10	
							No model found	
							R^2 below .10	
							R^2 below .10	
							No model found	
							No model found	
0.74	.16						Significant	
0.44	.24		−0.76	−0.49	0.00	−0.41	Significant	Increase
1.34	.02						R^2 below .10	
							No model found	
0.98	.06						R^2 below .10	
0.70	.19		−0.69	−0.88	0.00	−0.48	Significant	Inconsistent
0.87	.14						Significant	
0.56	.15	0.70	0.70	0.37	0.00	0.45	Significant	Decrease
							R^2 below .10	
							No model found	

TABLE 5 Negative Binomial Regression Models with ADT, Other Independent Variables, and Lane Width for Roadway Segments in Oakland County, Michigan

Roadway Type	Model Type	Independent Variables in Model	Number of Sites	Base Model Coefficients: Intercept	AADT	Curb Parking: None	Curb Parking: Either Side	Shoulder Width	Roadside Rating
All crashes									
2U	B	ShoulderW	590	–10.53	1.33			–0.01	
2U	B + LWC								
3T	B	ShoulderW	100	–9.03	1.19			–0.04	
3T	B + LWC	LWC and SW	100	–9.43	1.18			–0.03	
4D	B	AADT only	140	–6.17	0.86				
4D	B + LWC	ShoulderW	140	–6.01	0.85			–0.18	
4U	B	Parking2	440						
4U	B + LWC	LWC and CP	440	–3.65	0.62	–0.42	0		
5T	B	ShoulderW	549	–7.82	1.07			–0.08	
5T	B + LWC	LWC and SW	549	–7.59	1.05			–0.08	
Fatal-and-injury crashes									
2U	B	AADT only	590	–12.31	1.35				
2U	B + LWC	LWC	590	–11.71	1.28				
3T	B	AADT only	100	–13.58	1.48				
3T	B + LWC								
4D	B	AADT only	140						
4D	B + LWC	LWC	140	–8.96	0.98				
4U	B	AADT only	440						
4U	B + LWC	LWC	440	–6.83	0.77				
5T	B	ShoulderW	549	–8.65	1.01			–0.07	
5T	B + LWC								
Property-damage-only crashes									
2U	B	ShoulderW	590	–10.52	1.30			–0.01	
2U	B + LWC								
3T	B	ShoulderW	100	–8.69	1.14			–0.05	
3T	B + LWC	LWC and SW	100	–9.10	1.12			–0.04	
4D	B	AADT only	140	–6.77	0.90				
4D	B + LWC	LWC	140	–7.45	0.94				
4U	B	Parking2	440						
4U	B + LWC	LWC and CP	440	–3.65	0.59	–0.51	0		
5T	B	ShoulderW	549	–8.27	1.09			–0.07	
5T	B + LWC	LWC and SW	549	–8.06	1.07			–0.07	
All multiple-vehicle crashes									
2U	B	ShoulderW	588	–14.75	1.73			–0.02	
2U	B + LWC	LWC and SW	588	–14.08	1.67			–0.02	
3T	B	ShoulderW	100	–10.03	1.29			–0.04	
3T	B + LWC	LWC and SW	100	–10.50	1.29			–0.04	
4D	B	AADT only	140	–8.84	1.11				
4D	B + LWC	LWC	140	–11.34	1.33				
4U	B	CP and SW	438						
4U	B + LWC								
5T	B	ShoulderW	549	–8.68	1.14			–0.08	
5T	B + LWC	LWC and SW	549	–8.45	1.12			–0.08	
Fatal-and-injury multiple-vehicle crashes									
2U	B	AADT only	590	–17.11	1.81				
2U	B + LWC	LWC	590	–16.16	1.72				
3T	B	AADT only	100	–14.81	1.59				
3T	B + LWC								
4D	B	AADT only	140	–8.13	0.88				
4D	B + LWC	LWC	140	–10.90	1.16				
4U	B	AADT only	440						
4U	B + LWC	LWC	440	–7.45	0.79				
5T	B	ShoulderW	548	–9.60	1.09			–0.07	
5T	B + LWC								

		Lane Width Coefficients						Comments on Lane Width Effect
Dispersion	R^2_{LR}	9	10	11	12	13+	Statistical Significance	9 or 10 ft to 11 or 12 ft
0.39	0.42						Significant	
							No model found	
0.33	0.47						Significant	
0.29	0.51	−0.10	−0.28	−0.34	0	−0.69	Significant	Inconsistent
0.75	0.17						Significant	
0.74	0.18						Not significant	
							R^2 below .10	
0.51	0.19	−0.24	0.16	0.68	0		Significant	Inconsistent
0.62	0.19						Significant	
0.61	0.20		−0.64	0.03	0	0.02	Significant	Increase
0.28	0.27						Significant	
0.25	0.29	−0.35	−0.18	−0.43	0	−0.24	Significant	Inconsistent
0.38	0.35						Significant	
							No model found	
							R^2 below .10	
0.57	0.20	1.12	−1.98	−0.14	0	−0.03	Significant	Inconsistent[a]
							R^2 below .10	
0.67	0.09	−0.30	0.13	0.53	0		Significant	Inconsistent
0.60	0.13						Significant	
							No model found	
0.42	0.38						Significant	
							No model found	
0.32	0.44						Significant	
0.27	0.48	−0.14	−0.22	−0.35	0	−0.80	Significant	Inconsistent
0.73	0.18						Significant	
0.66	0.23	0.13	−0.85	0.16	0	−0.29	Significant	Inconsistent[b]
							R^2 below .10	
0.53	0.18	−0.21	0.18	0.73	0		Significant	Inconsistent
0.63	0.18						Significant	
0.62	0.19		−0.70	0.03	0	0.00	Significant	Increase
0.61	0.42						Significant	
0.56	0.43	0.00	−0.26	−0.41	0	−0.08	Significant	Inconsistent
0.44	0.45						Significant	
0.40	0.48	−0.03	−0.29	−0.49	0	−0.62	Significant	Inconsistent
0.92	0.20						Significant	
0.84	0.26	0.75	−0.73	0.05	0	−0.31	Significant	Inconsistent[a]
							R^2 below .10	
							No model found	
0.73	0.18						Significant	
0.72	0.19		−0.67	0.05	0	0.03	Significant	Increase
0.43	0.30						Significant	
0.37	0.32	−0.48	−0.34	−0.54	0	−0.21	Significant	Inconsistent
0.47	0.33						Significant	
							No model found	
0.82	0.10						Significant	
0.60	0.21	1.41	−1.67	−0.06	0	0.05	Significant	Inconsistent[a]
							R^2 below .10	
0.75	0.10	0.02	0.50	0.88	0		Significant	Inconsistent
0.64	0.13						Significant	
							No model found	

(continued on next page)

TABLE 5 *(continued)* Negative Binomial Regression Models with ADT, Other Independent Variables, and Lane Width for Roadway Segments in Oakland County, Michigan

				Base Model Coefficients					
						Curb Parking			
Roadway Type	Model Type	Independent Variables in Model	Number of Sites	Intercept	AADT	None	Either Side	Shoulder Width	Roadside Rating
Property-damage-only multiple-vehicle crashes									
2U	B	ShoulderW	585	–14.51	1.68			–0.02	
2U	B + LWC								
3T	B	ShoulderW	100	–9.64	1.23			–0.06	
3T	B + LWC	LWC and SW	100	–10.11	1.22			–0.05	
4D	B	AADT only	140	–9.91	1.20				
4D	B + LWC	LWC	140	–11.53	1.31				
4U	B	CP and SW	438						
4U	B + LWC	LWC and CP and	438	–4.56	0.66	–0.51	0	–0.23	
5T	B	ShoulderW	548	–9.02	1.15			–0.08	
5T	B + LWC	LWC and SW	548	–8.81	1.13			–0.07	
All single-vehicle crashes									
2U	B	AADT only	590						
2U	B + LWC	LWC	590						
3T	B	AADT only	100	–4.59	0.48				
3T	B + LWC								
4D	B								
4D	B + LWC								
4U	B								
4U	B + LWC								
5T	B	ShoulderW	549						
5T	B + LWC								
Fatal-and-injury single-vehicle crashes									
2U	B	AADT only	590						
2U	B + LWC								
3T	B	AADT only	100						
3T	B + LWC								
4D	B								
4D	B + LWC								
4U	B								
4U	B + LWC								
5T	B								
5T	B + LWC								
Property-damage-only single-vehicle crashes									
2U	B	AADT only	590						
2U	B + LWC	LWC	590						
3T	B	AADT only	100						
3T	B + LWC								
4D	B								
4D	B + LWC								
4U	B								
4U	B + LWC								
5T	B	ShoulderW	549						
5T	B + LWC								

NOTE: Base model (B) coefficients are used in the model form shown in Equation 3. Base model plus lane width (B + LWC) coefficients are used in the model form shown in Equation 4.
[a]Substantially more crashes for 9-ft lanes than for 10-ft lanes.
[b]A few more crashes for 9-ft lanes than for 10-ft lanes.

		Lane Width Coefficients						Comments on Lane Width Effect
Dispersion	R^2_{LR}	9	10	11	12	13+	Statistical Significance	9 or 10 ft to 11 or 12 ft
0.67	.36						Significant	
							No model found	
0.43	.41						Significant	
0.38	.45	−0.09	−0.24	−0.50	0	−0.77	Significant	Inconsistent
0.90	.22						Significant	
0.84	.26	0.44	−0.63	0.08	0	−0.45	Significant	Inconsistent[a]
							R^2 below .10	
0.58	.18	−0.09	0.33	0.83	0		Significant	Inconsistent[b]
0.76	.17						Significant	
0.76	.18		−0.70	0.05	0	0.00	Significant	Increase
							R^2 below .10	
							R^2 below .10	
0.57	.04						R^2 below .10	
3							No model found	
							No model found	
							No model found	
							No model found	
							No model found	
							R^2 below .10	
							No model found	
							R^2 below .10	
							No model found	
							R^2 below .10	
							No model found	
							No model found	
							No model found	
							No model found	
							No model found	
							No model found	
							No model found	
							R^2 below .10	
							R^2 below .10	
							R^2 below .10	
							No model found	
							No model found	
							No model found	
							No model found	
							No model found	
							R^2 below .10	
							No model found	

The available data include four intersection types:

- Three-leg signalized intersections (3SG),
- Three-leg intersections with minor-road stop control (3ST),
- Four-leg signalized intersections (4SG), and
- Four-leg intersections with minor-road stop control (4ST).

Table 6 presents a summary of the number of intersection approaches for which site characteristics, including lane width, traffic volume, and crash data, were available in each state. Data were available for a total of 1,342 intersection approaches (707 in Minnesota and 635 in North Carolina).

The lane widths at these sites were measured in the field. The lane width categories shown in the table represent the average lane width across all through travel lanes on a particular intersection approach. Intersection approaches for which measured lane widths were not available have been omitted from Table 6 and from subsequent analyses.

Crash data were obtained for all of the sites shown in Table 6 for a 5-year period: 1998 to 2002 in Minnesota and 1999 to 2003 in North Carolina. The crash data included 2,653 crashes in Minnesota and 8,742 crashes in North Carolina.

Analysis Approach

An approach to cross-sectional analysis similar to that used for roadway segments in Equations 1 and 2 was applied to examine the effect of lane width on intersection approaches. This approach was applied separately to data from each state and each intersection type. In this approach, only two variables were considered: ADT volume and lane width. The second approach, used for roadway segments (in which a broader set of site characteristics were considered in addition to ADT and lane width) was not applied for intersection approaches because no site characteristics other than lane width and ADT were statistically significant.

TABLE 6 Number of Intersection Approach Analysis Sites by Roadway Type and Lane Width Category

Intersection Type	Number of Intersection Approaches by Lane Width Category (ft) 9	10	11	12	13+	Total
Minnesota						
3SG	8	6	21	40	21	96
3ST	4	7	21	36	55	123
4SG	25	32	49	102	88	296
4ST	2	7	16	54	113	192
Subtotal	39	52	107	232	277	707
North Carolina						
3SG	8	29	49	27	13	126
3ST	11	26	36	28	40	141
4SG	6	32	75	39	24	176
4ST	10	30	66	28	58	192
Subtotal	35	117	226	122	135	635
Total	74	169	333	354	412	1,342

The analysis began by developing an ADT-only negative binomial regression model in the following form:

$$N = \exp\left(a + b \ln \mathrm{ADT}\right) \tag{5}$$

where ADT is the average daily traffic volume (veh/day) on the intersection approach.

Then, models were developed in the same form as Equation 5 but with a set of variables added to represent the effect of lane width:

$$N = \exp\left(a + b \ln \mathrm{ADT} + \ln L + c_9 \mathrm{LW}_9 + c_{10} \mathrm{LW}_{10} + c_{11} \mathrm{LW}_{11} + c_{12} \mathrm{LW}_{12} + c_{13+} \mathrm{LW}_{13+}\right) \tag{6}$$

where

LW_9 = indicator variable (= 1 if lane width of intersection approach = 9 ft; = 0 if not),
LW_{10} = indicator variable (= 1 if lane width of intersection approach = 10 ft; = 0 if not),
LW_{11} = indicator variable (= 1 if lane width of intersection approach = 11 ft; = 0 if not),
LW_{12} = indicator variable (= 1 if lane width of intersection approach = 12 ft; = 0 if not), and
LW_{13+} = indicator variable (= 1 if lane width of intersection approach = 13 ft or more; = 0 if not).

As in the roadway segment study, lane width for intersection approaches was treated as a categorical variable, rather than as a continuous variable, to provide an opportunity for unusual or unexpected relationships between lane width and safety to be identified. Lane width was added to Equation 6 only if its effect was found to be statistically significant.

Six dependent variables (represented by N in Equations 5 and 6) were considered:

- All crashes,
- Fatal-and-injury crashes,
- Property-damage-only crashes,
- All multiple-vehicle crashes,
- Fatal-and-injury multiple-vehicle crashes, and
- Property-damage-only multiple-vehicle crashes.

Analyses were conducted for single-vehicle crashes but have been omitted here because the frequencies of single-vehicle crashes on intersection approaches were extremely low. Few statistically significant results were expected for models of single-vehicle crashes. The analysis was applied to

- Six dependent variables and
- Four intersection types.

Thus, a total of 24 regression models were developed for this analysis approach. The modeling results follow.

Analysis Results

All but two of the 24 models of Minnesota intersection crashes using the ADT-only model in the form shown in Equation 5 were statistically significant, with R^2_{LR} ranging from .17 to .65. Table 7 shows

TABLE 7 Negative Binomial Regression Models with ADT and Lane Width for Intersection Approaches in Minnesota

		Model Coefficients										Comments on Lane Width Effect
				Lane Width Coefficients								
Intersection Type	Number of Sites	Intercept	AADT	9	10	11	12	13+	Dispersion	R^2_{LR}	Statistical Significance	9 or 10 ft to 11 or 12 ft
All crashes												
3SG	96										No model found	
3ST	123										No model found	
4SG	296										No model found	
4ST	192	11.52	1.16		0.66	–0.49	0	0.21	0.18	.67	Significant	Decrease
Fatal-and-injury crashes												
3SG	96	–12.99	1.14		–0.16	–0.20	0	–0.92	0.33	.49	Significant	Inconsistent
3ST	123										No model found	
4SG	296										No model found	
4ST	192										No model found	
Property-damage-only crashes												
3SG	96										No model found	
3ST	123										No model found	
4SG	296										No model found	
4ST	192	–11.77	1.14		0.84	–0.49	0	0.33	0.23	.58	Significant	Decrease
All multiple-vehicle crashes												
3SG	96										No model found	
3ST	123										No model found	
4SG	296										No model found	
4ST	192	–12.02	1.19		0.58	–0.42	0	0.25	0.18	.65	Significant	Decrease
Fatal-and-injury multiple-vehicle crashes												
3SG	96	–13.15	1.14		–0.11	–0.24	0	–1.05	0.27	.51	Significant	Inconsistent
3ST	123										No model found	
4SG	296										No model found	
4ST	192										No model found	
Property-damage-only multiple-vehicle crashes												
3SG	96										No model found	
3ST	123										No model found	
4SG	296										No model found	
4ST	192	–12.58	1.21		0.80	–0.49	0	0.39	0.29	.55	Significant	Decrease
North Carolina												
All crashes												
3SG	126										No model found	
3ST	141										No model found	
4SG	176										No model found	
4ST	192	–5.96	0.63	–1.89	–0.37	–0.31	0	–0.51	0.71	.51	Significant	Increase
Fatal-and-injury crashes												
3SG	126										No model found	
3ST	141										No model found	
4SG	176										No model found	
4ST	192	–7.67	0.69	–2.02	–0.15	–0.18	0	–0.74	0.80	.43	Significant	Inconsistent

(continued on next page)

TABLE 7 *(continued)* Negative Binomial Regression Models with ADT and Lane Width for Intersection Approaches in Minnesota

		Model Coefficients		Lane Width Coefficients								Comments on Lane Width Effect
Intersection Type	Number of Sites	Intercept	AADT	9	10	11	12	13+	Dispersion	R^2_{LR}	Statistical Significance	9 or 10 ft to 11 or 12 ft
Property-damage-only crashes												
3SG	126										No model found	
3ST	141										No model found	
4SG	176										No model found	
4ST	192	–6.14	0.61	–1.86	–0.49	–0.39	0	–0.40	0.67	.45	Significant	Increase
All multiple-vehicle crashes												
3SG	126										No model found	
3ST	141										No model found	
4SG	176										No model found	
4ST	192	–6.67	0.71	–1.87	–0.50	–0.29	0	–0.41	0.79	.51	Significant	Increase
Fatal-and-injury multiple-vehicle crashes												
3SG	126										No model found	
3ST	141										No model found	
4SG	176										No model found	
4ST	192	–8.52	0.78	–1.88	–0.23	–0.07	0	–0.60	0.85	.44	Significant	Increase
Property-damage-only multiple-vehicle crashes												
3SG	126										No model found	
3ST	141										No model found	
4SG	176										No model found	
4ST	192	–6.77	0.68	–1.90	–0.59	–0.44	0	–0.33	0.71	.46	Significant	Increase

NOTE: Coefficients are used in the model form shown in Equation 6.

the analysis results when lane width variables were added to create models in the form of Equation 6.

In the six cases in which the effect of ADT and lane width was statistically significant, there were four cases in which the effect for lane width in the range from 2.7 to 3.6 m (9 to 12 ft) was in the direction expected by conventional wisdom (i.e., decreasing crash frequency for wider lanes). These four cases included most of the dependent variables considered for one particular intersection type: four-leg stop-controlled intersections. In general, for approaches to four-leg stop-controlled intersections on Minnesota arterials, intersection approaches with lane widths of 3.0 m (10 ft) or less were found to have higher crash frequencies than comparable approaches with 3.3- or 3.6-m (11- or 12-ft) lanes. There was no indication in the Minnesota data of a consistent relationship between safety and lane width for any other intersection approach type. The Minnesota data contained relatively few sites with 2.7-m (9-ft) lanes. Therefore, the finding noted above generally indicates that approaches to four-leg stop-controlled intersections with 3.0-m (10-ft) lanes tend to experience more crashes than those with 3.3- and 3.6-m (11- and 12-ft) lanes.

Table 7 also presents results for intersection approaches in Charlotte. The results are comparable to the Minnesota results in that there are only a limited number of statistically significant models incorporating both ADT and lane width. Specifically, of the 22 cases for which statistically significant ADT-only models were found,

- In only six cases statistically significant models involving both ADT and lane width were found, and
- In 18 cases no model was found when lane width was added to the ADT-only model (i.e., the modeling algorithm did not converge).

As in the case of the Minnesota data for intersection approaches, the Charlotte data showed statistically significant effects for the differences between 2.7-, 3.0-, and 3.6-m (9-, 10-, and 12-ft) lanes primarily for approaches to four-leg stop-controlled intersections. However, the Charlotte data did not show a lane width effect for four-leg stop-controlled intersections similar to that found in Minnesota. In contrast to the Minnesota finding, the Charlotte data indicated that approaches to four-leg stop-controlled intersections show higher crash frequencies for approaches with 3.6-m (12-ft) lanes than for comparable approaches with 2.7- to 3.0-m (9- to 10-ft) lanes. In other words, the only statistically significant results for Charlotte intersections showed lane width effects opposite the conventional wisdom that wider lanes have lower crash experience.

INTERPRETATION OF RESULTS

Lane Widths on Arterial Roadway Segments

Analysis of geometric design, traffic volume, and crash data found that, with limited exceptions, there was no consistent, statistically significant relationship between lane width and safety for midblock sections of urban and suburban arterials. There was no indication that the use of 3.0- or 3.3-m (10- or 11-ft lanes) rather than 3.6-m (12-ft) lanes for midblock segments led to increases in crash frequency. There are situations in which use of narrower lanes may provide both benefits in traffic operations, pedestrian safety, or reduced interference with surrounding development and space for geometric features that enhance safety, such as medians or turn lanes. The analysis results indicated that narrow lanes can generally be used to obtain these benefits without compromising safety.

Two caveats should be noted. First, the data for one of the states analyzed showed an increase in crash rates for four-lane undivided arterials with lane widths of 3.0 m (10 ft) or less, while the data from another state showed an increase in crash rates for four-lane divided arterials with lane widths or 2.7 m (9 ft) or less. While the results from each state were not confirmed in data from the other state, the findings indicated that lane widths of 3.0 m (10 ft) or less on four-lane undivided arterials and lane widths of 2.7 m (9 ft) or less on four-lane divided arterials should be used cautiously unless local experience indicates otherwise. Second, until more is learned about the interactions between motor vehicles and bicycles on streets with narrower lanes, lane widths less than 3.6 m (12 ft) should be used cautiously where substantial volumes of bicyclists share the road with motor vehicles, unless an alternative facility for bicycles, such as a wider curb lane or paved shoulder, is provided.

Lane Widths on Arterial Intersection Approaches

Analysis of geometric design, traffic volume, and crash data found that, with limited exceptions, there was no consistent, statistically significant relationship between lane width and safety for approaches to intersections on urban and suburban arterials. There was no indication that the use of 3.0- or 3.3-m (10- or 11-ft lanes) rather than 3.6-m (12-ft) lanes for arterial intersection approaches led to increases in crash frequency. There are situations in which use of narrower lanes may provide both benefits in traffic operations, pedestrian safety, or reduced interference with surrounding development and space for geometric features that enhance safety, such as medians or turn lanes. The analysis results indicated that narrow lanes can generally be used to obtain these benefits without compromising safety.

Two caveats should be noted. First, the data for one of the states analyzed showed an increase in crash rates for approaches to four-leg stop-controlled intersections with lane widths of 3.0 m (10 ft) or less; however, just the opposite was found in the other state. While the findings are not fully consistent, they suggest that lane widths of 3.0 m (10 ft) or less on approaches to four-leg stop-controlled intersections should be used cautiously unless local experience indicates otherwise. Second, as noted earlier, lane widths less than 3.6 m (12 ft) should be used cautiously where substantial volumes of bicyclists share the road with motor vehicles, unless an alternative facility for bicycles, such as a wider curb lane or paved shoulder, is provided.

CONCLUSIONS AND RECOMMENDATIONS

A safety evaluation of lane widths for arterial roadway segments found no indication, except in limited cases, that narrower lanes increased crash frequencies. The lane width effects in the analyses conducted were generally either not statistically significant or indicated that narrower lanes were associated with lower rather than higher crash frequencies. There were limited exceptions to this general finding. It was found that crash frequency in one state was higher for 3.0 m (10 ft) lanes than for 3.3 and 3.6 m (11 and 12 ft) lanes on four-lane undivided arterials and was higher in the other state for 2.7 m (9 ft) lanes than for 3.0 m (10 ft) lanes on four-lane divided arterials. However, neither of these statistically significant effects observed in one state was statistically significant in the other state.

Similarly, a safety evaluation of lane widths for arterial intersection approaches found no indication, except in limited cases, that the use of narrower lanes increased crash frequencies. The lane width effects in the analyses conducted were generally not statistically significant or they were inconsistent. With only one limited exception, there was no indication that the use of lanes narrower than 3.6 m (12 ft) on intersection approaches led to increases in crash frequency. The data for one state showed higher crash frequencies for approaches to four-leg stop-controlled intersections for approaches with 3.0 m (10 ft) lanes than for approaches with 3.6 m (12 ft) lanes; however, just the opposite was found in data from the other state.

It was concluded from this research that there was no indication of an increase in crash frequencies as lane width decreased for arterial roadway segments or arterial intersection approaches.

These findings suggest that the AASHTO Green Book is correct in providing substantial flexibility for use of lane widths narrower than 3.6 m (12 ft) on urban and suburban arterials. Use of narrower lanes in appropriate locations can provide other benefits to users and the surrounding community, including shorter pedestrian crossing distances and space for additional through lanes, auxiliary and turning lanes, bicycle lanes, buffer areas between travel lanes and sidewalks, and placement of roadside hardware. Interpretation of design policies as rigidly requiring the use of 3.6-m (12-ft) lanes on urban and suburban arterials may miss the opportunity for these other benefits without any documentable gain in safety.

The research found three situations in which the observed lane width effect was inconsistent—showing increasing crash frequency with decreasing lane width in one state and the opposite effect in another state. These three situations are the following:

- Lane widths of 3.0 m (10 ft) or less on four-lane undivided arterials,
- Lane widths of 2.7 m (9 ft) or less on four-lane divided arterials, and
- Lane widths of 3.0 m (10 ft) or less on approaches to four-leg stop-controlled arterial intersections.

Because of these inconsistent findings, it should not be inferred that the use of narrower lanes must be avoided in these situations. Rather, it is recommended that narrower lanes be used cautiously in these situations unless local experience indicates otherwise.

ACKNOWLEDGMENT

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REFERENCES

1. Potts, I. B., D. W. Harwood, D. J. Torbic, K. M. Bauer, D. K. Gilmore, D. K. Lay, J. F. Ringert, J. D. Zegeer, D. L. Harkey, and J. M. Barlow. *Lane Widths, Channelized Right Turns, and Right-Turn Deceleration Lanes in Urban and Suburban Areas.* Final report. NCHRP Project 3-72, Midwest Research Institute, Kansas City, Mo., Aug. 2006.
2. Harwood, D. W., F. M. Council, E. Hauer, W. E. Hughes, and A. Vogt. *Prediction of the Expected Safety Performance of Rural Two-Lane Highways.* FHWA-RD-99-207. FHWA, U.S. Department of Transportation, Dec. 2000.
3. Hauer, E., F. M. Council, and Y. Mohammedshah. Safety Models for Urban Four-Lane Undivided Road Segments. In *Transportation Research Record: Journal of the Transportation Research Board, No. 1897,* Transportation Research Board of the National Academies, Washington, D.C., 2004, pp. 96–105.
4. Strathman, J. G., K. J. Dueker, J. Zhang, and T. Williams. *Analysis of Design Attributes and Crashes on the Oregon Highway System.* Oregon Department of Transportation, Salem, and Center for Urban Studies, Portland State University, 2001.
5. Hadi, M. A., J. Aruldhas, L.-F. Chow, and J. A. Wattleworth. Estimating Safety Effects of Cross-Section Design for Various Highway Types Using Negative Binomial Regression. In *Transportation Research Record 1500,* TRB, National Research Council, Washington, D.C., 1995, pp. 169–177.
6. *A Policy on Geometric Design of Highways and Streets.* AASHTO, Washington, D.C., 2001.
7. Harwood, D. W., K. M. Bauer, K. R. Richard, D. K. Gilmore, J. L. Graham, I. B. Potts, D. J. Torbic, and E. Hauer. *Methodology to Predict the Safety Performance of Urban and Suburban Arterials:* Final Report of Phases I and II. NCHRP Project 17-26, Midwest Research Institute, Kansas City, Mo., 2007.
8. Zegeer, C. V., D. W. Reinfurt, J. Hummer, L. Herf, and W. Hunter. Safety Effects of Cross-Section Design for Two-Lane Roads. In *Transportation Research Record 1195,* TRB, National Research Council, 1988, pp. 20–32.

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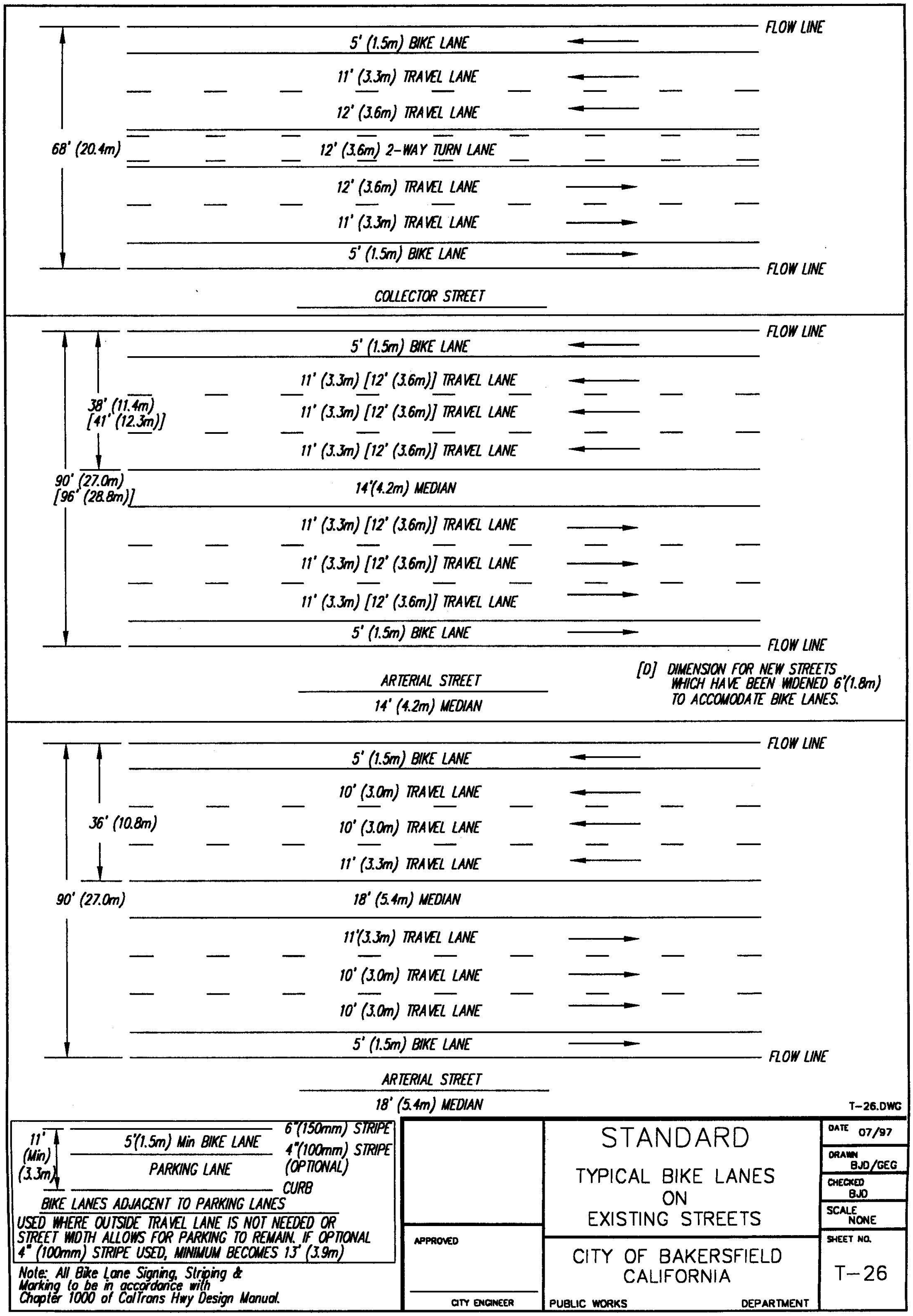
FLOW LINE
5' (1.5m) BIKE LANE
11' (3.3m) TRAVEL LANE
12' (3.6m) TRAVEL LANE
68' (20.4m)
12' (3.6m) 2-WAY TURN LANE
12' (3.6m) TRAVEL LANE
11' (3.3m) TRAVEL LANE
5' (1.5m) BIKE LANE
FLOW LINE
COLLECTOR STREET
FLOW LINE
5' (1.5m) BIKE LANE
11' (3.3m) [12' (3.6m)] TRAVEL LANE
38' (11.4m) [41' (12.3m)]
11' (3.3m) [12' (3.6m)] TRAVEL LANE
11' (3.3m) [12' (3.6m)] TRAVEL LANE
90' (27.0m) [96' (28.8m)]
14'(4.2m) MEDIAN
11' (3.3m) [12' (3.6m)] TRAVEL LANE
11' (3.3m) [12' (3.6m)] TRAVEL LANE
11' (3.3m) [12' (3.6m)] TRAVEL LANE
5' (1.5m) BIKE LANE
FLOW LINE
ARTERIAL STREET
14' (4.2m) MEDIAN
[D] DIMENSION FOR NEW STREETS WHICH HAVE BEEN WIDENED 6'(1.8m) TO ACCOMODATE BIKE LANES.
FLOW LINE
5' (1.5m) BIKE LANE
10' (3.0m) TRAVEL LANE
36' (10.8m)
10' (3.0m) TRAVEL LANE
11' (3.3m) TRAVEL LANE
90' (27.0m)
18' (5.4m) MEDIAN
11'(3.3m) TRAVEL LANE
10' (3.0m) TRAVEL LANE
10' (3.0m) TRAVEL LANE
5' (1.5m) BIKE LANE
FLOW LINE
ARTERIAL STREET
18' (5.4m) MEDIAN
T-26.DWG
11' (Min) (3.3m)
5'(1.5m) Min BIKE LANE
6"(150mm) STRIPE
4"(100mm) STRIPE (OPTIONAL)
PARKING LANE
CURB
BIKE LANES ADJACENT TO PARKING LANES
USED WHERE OUTSIDE TRAVEL LANE IS NOT NEEDED OR STREET WIDTH ALLOWS FOR PARKING TO REMAIN. IF OPTIONAL 4" (100mm) STRIPE USED, MINIMUM BECOMES 13' (3.9m)
Note: All Bike Lane Signing, Striping & Marking to be in accordance with Chapter 1000 of CalTrans Hwy Design Manual.
APPROVED
CITY ENGINEER
STANDARD
TYPICAL BIKE LANES ON EXISTING STREETS
CITY OF BAKERSFIELD CALIFORNIA
PUBLIC WORKS DEPARTMENT
DATE 07/97
DRAWN BJD/GEG
CHECKED BJD
SCALE NONE
SHEET NO.
T-26

Design Guidance
Accommodating Bicycle and Pedestrian Travel: A Recommended Approach

A US DOT Policy Statement
Integrating Bicycling and Walking into Transportation Infrastructure

On this page:

Purpose

Accommodating Bicycle and Pedestrian Travel: A Recommended Approach is a policy statement adopted by the United States Department of Transportation. USDOT hopes that public agencies, professional associations, advocacy groups, and others adopt this approach as a way of committing themselves to integrating bicycling and walking into the transportation mainstream.

The Design Guidance incorporates three key principles:

a. a policy statement that **bicycling and walking facilities will be incorporated into all transportation projects** unless exceptional circumstances exist;

b. an approach to achieving this policy that has already worked in State and local agencies; and

c. a series of action items that a public agency, professional association, or advocacy group can take to achieve the overriding goal of improving conditions for bicycling and walking.

The Policy Statement was drafted by the U.S. Department of Transportation in response to Section 1202 (b) of the Transportation Equity Act for the 21st Century (TEA-21) with the input and assistance of public agencies, professional associations and advocacy groups.

TOP

Introduction

Bicycling and walking issues have grown in significance throughout the 1990s. As the new millennium dawns public agencies and public interest groups alike are striving to define the most appropriate way in which to accommodate the two modes within the overall transportation system so that those who walk or ride bicycles can safely, conveniently, and comfortably access every destination within a community.

Public support and advocacy for improved conditions for bicycling and walking has created a widespread acceptance that more should be done to enhance the safety, comfort, and convenience of the nonmotorized traveler. Public opinion surveys throughout the 1990s have demonstrated strong support for increased planning, funding and implementation of shared use paths, sidewalks and on-street facilities.

At the same time, public agencies have become considerably better equipped to respond to this demand. Research and practical experience in designing facilities for bicyclists and pedestrians has generated numerous national, State and local design manuals and resources. An increasing number of professional planners and engineers are familiar with this material and are applying this knowledge in towns and cities across the country.

The 1990 Americans with Disabilities Act, building on an earlier law requiring curb ramps in new, altered, and existing sidewalks, added impetus to improving conditions for sidewalk users. People with disabilities rely on the pedestrian and transit infrastructure, and the links between them, for access and mobility.

Congress and many State legislatures have made it considerably easier in recent years to fund nonmotorized projects and programs (for example, the Intermodal Surface Transportation Efficiency Act and the Transportation Equity Act for the 21st Century), and a number of laws and regulations now mandate certain planning activities and design standards to guarantee the inclusion of bicyclists and pedestrians.

Despite these many advances, injury and fatality numbers for bicyclists and pedestrians remain stubbornly high, levels of bicycling and walking remain frustratingly low, and most communities continue to grow in ways that make travel by means other than the private automobile quite challenging. Failure to provide an accessible pedestrian network for people with disabilities often requires the provision of costly paratransit service. Ongoing investment in the Nation's transportation infrastructure is still more likely to overlook rather than integrate bicyclists and pedestrians.

In response to demands from user groups that every transportation project include a bicycle and pedestrian element, Congress asked the Federal Highway Administration (FHWA) to study various approaches to accommodating the two modes. The Transportation Equity Act for the 21st Century (TEA-21) instructs the Secretary to work with professional groups such as AASHTO, ITE, and other interested parties to recommend policies and standards that might achieve the overall goal of fully integrating bicyclists and pedestrians into the transportation system.

TEA-21 also says that, "Bicycle transportation facilities and pedestrian walkways shall be considered, where appropriate, in conjunction with all new construction and reconstruction of transportation projects, except where bicycle and pedestrian use are not permitted." (Section 1202)

In August 1998, FHWA convened a Task Force comprising representatives from FHWA, AASHTO, ITE, bicycle and pedestrian user groups, State and local agencies, the U.S. Access Board and representatives of disability organizations to seek advice on how to proceed with developing this guidance. The Task Force reviewed existing and proposed information on the planning and technical design of facilities for bicyclists and pedestrians and concluded that these made creation of another design manual unnecessary. For example, AASHTO published a bicycle design manual in 1999 and is working on a pedestrian facility manual.

SEC. 1202. BICYCLE TRANSPORTATION AND PEDESTRIAN WALKWAYS.

(b) Design Guidance.-

(1) In general.-In implementing section 217(g) of title 23, United States Code, the Secretary, in cooperation with the American Association of State Highway and Transportation Officials, the Institute of Transportation Engineers, and other interested organizations, shall develop guidance on the various approaches to accommodating bicycles and

The area where information and guidance was most lacking was in determining when to include designated or special facilities for bicyclists and pedestrians in transportation projects. There can also be uncertainty about the type of facility to provide, and the design elements that are required to ensure accessibility.

For example, when a new suburban arterial road is planned and designed, what facilities for bicyclists and pedestrians should be provided? The task force felt that once the decision to provide a particular facility was made, the specific information on designing that facility is generally available. However, the decision on whether to provide sidewalks on neither, one or both sides of the road, or a shoulder, striped bike lane, wide outside lane or separate trail for bicyclists is usually made with little guidance or help.

pedestrian travel.

(2) Issues to be addressed. -The guidance shall address issues such as the level and nature of the demand, volume, and speed of motor vehicle traffic, safety, terrain, cost, and sight distance.

(3) Recommendations. -The guidance shall include recommendations on amending and updating the policies of the American Association of State Highway and Transportation Officials relating to highway and street design standards to accommodate bicyclists and pedestrians.

(4) Time period for development. -The guidance shall be developed within 18 months after the date of enactment of this Act.

After a second meeting with the Task Force in January 1999, FHWA agreed to develop a **Policy Statement on Accommodating Bicyclists and Pedestrians in Transportation Projects** to guide State and local agencies in answering these questions. Task Force members recommended against trying to create specific warrants for different facilities (warrants leave little room for engineering judgement and have often been used to avoid providing facilities for bicycling and walking). Instead, the purpose of the Policy Statement is to provide a recommended approach to the accommodation of bicyclists and pedestrians that can be adopted by State and local agencies (as well as professional societies and associations, advocacy groups, and Federal agencies) as a commitment to developing a transportation infrastructure that is safe, convenient, accessible, and attractive to motorized AND nonmotorized users alike. The Policy Statement has four elements:

a. an acknowledgment of the issues associated with balancing the competing interests of motorized and nonmotorized users;

b. a recommended policy approach to accommodating bicyclists and pedestrians (including people with disabilities) that can be adopted by an agency or organizations as a statement of policy to be implemented or a target to be reached in the future;

c. a list of recommended actions that can be taken to implement the solutions and approaches described above; and

d. further information and resources on the planning, design, operation, and maintenance of facilities for bicyclists and pedestrians.

TOP

The Challenge: Balancing Competing Interests

For most of the second half of the 20th Century, the transportation, traffic engineering and highway professions in the United States were synonymous. They shared a singular purpose: building a transportation system that promoted the safety, convenience and comfort of motor vehicles. The post-war boom in car and home ownership, the growth of suburban America, the challenge of completing the Interstate System, and the continued availability of cheap gasoline all fueled the development of a transportation infrastructure focused almost exclusively on the private motor car and commercial truck.

Initially, there were few constraints on the traffic engineer and highway designer. Starting at the centerline, highways were developed according to the number of motor vehicle travel lanes that were needed well into the future, as well as providing space for breakdowns. Beyond that, facilities for bicyclists and pedestrians, environmental mitigation, accessibility, community preservation, and aesthetics were at best an afterthought, often simply overlooked, and, at worst, rejected as unnecessary, costly, and regressive. Many States passed laws preventing the use of State gas tax funds on anything other than motor vehicle lanes and facilities. The resulting highway environment discourages bicycling and walking and has made the two modes more dangerous. Further, the ability of pedestrians with disabilities to travel independently and safely has been compromised, especially for those with vision impairments.

Over time, the task of designing and building highways has become more complex and challenging. Traffic engineers now have to integrate accessibility, utilities, landscaping, community preservation, wetland mitigation, historic preservation, and a host of other concerns into their plans and designs - and yet they often have less space and resources within which to operate and traffic volumes continue to grow.

The additional "burden" of having to find space for pedestrians and bicyclists was rejected as impossible in many communities because of space and funding constraints and a perceived lack of demand. There was also anxiety about encouraging an activity that many felt to be dangerous and fraught with liability issues. Designers continued to design from the centerline out and often simply ran out of space before bike lanes, paved shoulders, sidewalks and other "amenities" could be included.

By contrast, bicycle and pedestrian user groups argue the roadway designer should design highways from the right-of-way limits in, rather than the centerline out. They advocate beginning the design of a highway with the sidewalk and/or trail, including a buffer before the paved shoulder or bike lane, and then allocating the remaining space for motor vehicles. Through this approach, walking and bicycling are positively encouraged, made safer, and included as a critical element in every transportation project rather than as an afterthought in a handful of unconnected and arbitrary locations within a community.

Retrofitting the built environment often provides even more challenges than building new roads and communities: space is at a premium and there is a perception that providing better conditions for bicyclists and pedestrians will necessarily take away space or convenience from motor vehicles.

During the 1990s, Congress spearheaded a movement towards a transportation system that favors people and goods over motor vehicles with passage of the Intermodal Surface Transportation Efficiency Act (1991) and the Transportation Equity Act for the 21st Century (1998). The call for more walkable, liveable, and accessible communities, has seen bicycling and walking emerge as an "indicator species" for the health and well-being of a community. People want to live and work in places where they can safely and conveniently walk and/or bicycle and not always have to deal with worsening traffic congestion, road rage and the fight for a parking space. Vice President Gore launched a Livability Initiative in 1999 with the ironic statement that "a gallon of gas can be used up just driving to get a gallon of milk."

The challenge for transportation planners, highway engineers and bicycle and pedestrian user groups, therefore, is to balance their competing interest in a limited amount of right-of-way, and to develop a transportation infrastructure that provides access for all, a real choice of modes, and safety in equal measure for each mode of travel.

This task is made more challenging by the widely divergent character of our nation's highways and byways. Traffic speeds and volumes, topography, land use, the mix of road users, and many other factors mean that a four-lane highway in rural North Carolina cannot be designed in the same way as a four-lane highway in New York City, a dirt road in Utah or an Interstate highway in Southern California. In addition, many different agencies are responsible for the development, management, and operation of the transportation system.

In a recent memorandum transmitting Program Guidance on bicycle and pedestrian issues to FHWA Division Offices, the Federal Highway Administrator wrote that "We expect every transportation agency to make accommodation for bicycling and walking a routine part of their planning, design, construction, operations and maintenance activities." The Program Guidance itself makes a number of clear statements of intent:

- Congress clearly intends for bicyclists and pedestrians to have safe, convenient access to the transportation system and sees every transportation improvement as an opportunity to enhance the safety and convenience of the two modes.
- "Due consideration" of bicycle and pedestrian needs should include, at a minimum, a presumption that bicyclists and pedestrians will be accommodated in the design of new and improved transportation facilities.
- To varying extents, bicyclists and pedestrians will be present on all highways and transportation facilities where they are permitted and it is clearly the intent of TEA-21 that all new and improved transportation facilities be planned, designed and constructed with this fact in mind.
- The decision not to accommodate [bicyclists and pedestrians] should be the exception rather than the rule. There must be exceptional circumstances for denying bicycle and pedestrian access either by prohibition or by designing highways that are incompatible with safe, convenient walking and bicycling.

The Program Guidance defers a suggested definition of what constitutes "exceptional circumstances" until this Policy Statement is completed. However, it does offer interim guidance that includes controlled access highways and projects where the cost of accommodating bicyclists and pedestrians is high in relation to the overall project costs and likely level of use by nonmotorized travelers.

Providing access for people with disabilities is a civil rights mandate that is not subject to limitation by project costs, levels of use, or "exceptional circumstances". While the Americans with Disabillities Act doesn't require pedestrian facilities in the absence of a pedestrian route, it does require that pedestrian facilities, when newly constructed or altered, be accessible.

TOP

Policy Statement

1. Bicycle and pedestrian ways shall be established in new construction and reconstruction projects in all urbanized areas unless one or more of three conditions are met:

- bicyclists and pedestrians are prohibited by law from using the roadway. In this instance, a greater effort may be necessary to accommodate bicyclists and pedestrians elsewhere within the right of way or within the same transportation corridor.
- the cost of establishing bikeways or walkways would be excessively disproportionate to the need or probable use. Excessively disproportionate is defined as exceeding twenty percent of the cost of the larger transportation project.
- where sparsity of population or other factors indicate an absence of need. For example, the Portland Pedestrian Guide requires "all construction of new public streets" to include sidewalk improvements on both sides, unless the street is a cul-de-sac with four or fewer dwellings or the street has severe topographic or natural resource constraints.

2. In rural areas, paved shoulders should be included in all new construction and reconstruction projects on roadways used by more than 1,000 vehicles per day, as in States such as Wisconsin. Paved shoulders have safety and operational advantages for all road users in addition to providing a place for bicyclists and pedestrians to operate.

Rumble strips are not recommended where shoulders are used by bicyclists unless there is a minimum clear path of four feet in which a bicycle may safely operate.

3. Sidewalks, shared use paths, street crossings (including over- and undercrossings), pedestrian signals, signs, street furniture, transit stops and facilities, and all connecting pathways shall be designed, constructed, operated and maintained so that all pedestrians, including people with disabilities, can travel safely and independently.

4. The design and development of the transportation infrastructure shall improve conditions for bicycling and walking through the following additional steps:

- planning projects for the long-term. Transportation facilities are long-term investments that remain in place for many years. The design and construction of new facilities that meet the criteria in item 1) above should anticipate likely future demand for bicycling and walking facilities and not preclude the provision of future improvements. For example, a bridge that is likely to remain in place for 50 years, might be built with sufficient width for safe bicycle and pedestrian use in anticipation that facilities will be available at either end of the bridge even if that is not currently the case
- addressing the need for bicyclists and pedestrians to cross corridors as well as travel along them. Even where bicyclists and pedestrians may not commonly use a particular travel corridor that is being improved or constructed, they will likely need to be able to cross that corridor safely and conveniently. Therefore, the design of intersections and interchanges shall accommodate bicyclists and pedestrians in a manner that is safe, accessible and convenient.
- getting exceptions approved at a senior level. Exceptions for the non-inclusion of bikeways and walkways shall be approved by a senior manager and be documented with supporting data that indicates the basis for the decision.
- designing facilities to the best currently available standards and guidelines. The design of facilities for bicyclists and pedestrians should follow design guidelines and standards that are commonly used, such as the AASHTO *Guide for*

> *the Development of Bicycle Facilities*, AASHTO's *A Policy on Geometric Design of Highways and Streets,* and the ITE Recommended Practice "*Design and Safety of Pedestrian Facilities*".

TOP

Policy Approach

"Rewrite the Manuals" Approach

Manuals that are commonly used by highway designers covering roadway geometrics, roadside safety, and bridges should incorporate design information that integrates safe and convenient facilities for bicyclists and pedestrians -- including people with disabilities - into all new highway construction and reconstruction projects.

In addition to incorporating detailed design information - such as the installation of safe and accessible crossing facilities for pedestrians, or intersections that are safe and convenient for bicyclists - these manuals should also be amended to provide flexibility to the highway designer to develop facilities that are in keeping with transportation needs, accessibility, community values, and aesthetics. For example, the Portland Pedestrian Design Guide (June 1998) applies to every project that is designed and built in the city, but the Guide also notes that:

> "Site conditions and circumstances often make applying a specific solution difficult. The Pedestrian Design Guide should reduce the need for ad hoc decision by providing a published set of guidelines that are applicable to most situations. Throughout the guidelines, however, care has been taken to provide flexibility to the designer so she or he can tailor the standards to unique circumstances. Even when the specific guideline cannot be met, the designer should attempt to find the solution that best meets the pedestrian design principles described [on the previous page]"

In the interim, these manuals may be supplemented by stand-alone bicycle and pedestrian facility manuals that provide detailed design information addressing on-street bicycle facilities, fully accessible sidewalks, crosswalks, and shared use paths, and other improvements.

Examples: Florida DOT has integrated bicycle and pedestrian facility design information into its standard highway design manuals and New Jersey DOT is in the process of doing so. Many States and localities have developed their own bicycle and pedestrian facility design manuals, some of which are listed in the final section of this document.

TOP

Applying Engineering Judgement to Roadway Design

In rewriting manuals and developing standards for the accommodation of bicyclists and pedestrians, there is a temptation to adopt "typical sections" that are applied to roadways without regard to travel speeds, lane widths, vehicle mix, adjacent land uses, traffic volumes and other critical factors. This approach can lead to inadequate provision on major roads (e.g. a four foot bike lane or four foot sidewalk on a six lane high-speed urban arterial) and the over-design of local and neighborhood streets (e.g. striping bike lanes on low volume residential roads) , and leaves little room for engineering judgement.

After adopting the policy that bicyclists and pedestrians (including people with disabilities) will be fully integrated into the transportation system, State and local governments should encourage engineering judgement in the application of the range of available treatments.

For example:

- Collector and arterial streets shall typically have a minimum of a four foot wide striped bicycle lane, however wider lanes are often necessary in locations with parking, curb and gutter, heavier and/or faster traffic.
- Collector and arterial streets shall typically have a minimum of a five foot sidewalk on both sides of the street, however wider sidewalks and landscaped buffers are necessary in locations with higher pedestrian or traffic volumes, and/or higher vehicle speeds. At intersections, sidewalks may need to be wider to accommodate accessible curb ramps.

- Rural arterials shall typically have a minimum of a four foot paved shoulder, however wider shoulders (or marked bike lanes) and accessible sidewalks and crosswalks are necessary within rural communities and where traffic volumes and speeds increase.

This approach also allows the highway engineer to achieve the performance goal of providing safe, convenient, and comfortable travel for bicyclists and pedestrians by other means. For example, if it would be inappropriate to add width to an existing roadway to stripe a bike lane or widen a sidewalk, traffic calming measures can be employed to reduce motor vehicle speeds to levels more compatible with bicycling and walking.

TOP

Actions

The United States Department of Transportation encourages States, local governments, professional associations, other government agencies and community organizations to adopt this Policy Statement as an indication of their commitment to accommodating bicyclists and pedestrians as an integral element of the transportation system. By so doing, the organization or agency should explicitly adopt one, all, or a combination of the various approaches described above AND should be committed to taking some or all of the actions listed below as appropriate for their situation.

a. Define the exceptional circumstances in which facilities for bicyclists and pedestrians will NOT be required in all transportation projects.

b. Adopt new manuals, or amend existing manuals, covering the geometric design of streets, the development of roadside safety facilities, and design of bridges and their approaches so that they comprehensively address the development of bicycle and pedestrian facilities as an integral element of the design of all new and reconstructed roadways.

c. Adopt stand-alone bicycle and pedestrian facility design manuals as an interim step towards the adoption of new typical sections or manuals covering the design of streets and highways.

d. Initiate an intensive re-tooling and re-education of transportation planners and engineers to make them conversant with the new information required to accommodate bicyclists and pedestrians. Training should be made available for, if not required of, agency traffic engineers and consultants who perform work in this field.

TOP

Conclusion

There is no question that conditions for bicycling and walking need to be improved in every community in the United States; it is no longer acceptable that 6,000 bicyclists and pedestrians are killed in traffic every year, that people with disabilities cannot travel without encountering barriers, and that two desirable and efficient modes of travel have been made difficult and uncomfortable.

Every transportation agency has the responsibility and the opportunity to make a difference to the bicycle-friendliness and walkability of our communities. The design information to accommodate bicyclists and pedestrians is available, as is the funding. The United States Department of Transportation is committed to doing all it can to improve conditions for bicycling and walking and to make them safer ways to travel.

TOP

Further Information and Resources

General Design Resources

A Policy on Geometric Design of Highways and Streets, 1994 (The Green Book). American Association of State Highway and

Transportation Officials (AASHTO), P.O. Box 96716, Washington, DC, 20090-6716, Phone: (888) 227-4860.

Highway Capacity Manual, Special Report 209, 1994. Transportation Research Board, Box 289, Washington, DC 20055, Phone: (202) 334-3214. Next Edition: FHWA Research Program project has identified changes to HCM related to bicycle and pedestrian design.

Manual on Uniform Traffic Control Devices, 1988. Federal Highway Administration (FHWA), Superintendent of Documents. P.O. Box 371954, Pittsburgh, PA 15250-7954. Next Edition: 2000, will incorporate changes to Part IX that will soon be subject of Notice of Proposed Rulemaking.

Flexibility in Highway Design, 1997. FHWA. HEP 30, 400 Seventh Street SW, Washington, DC 20590.

TOP

Pedestrian Facility Design Resources

Design and Safety of Pedestrian Facilities, A Recommended Practice, 1998. Institute of Transportation Engineers, 525 School Street, S.W, Suite 410, Washington, DC 20024-2729, Phone: (202) 554-8050.

Pedestrian Compatible Roadways-Planning and Design Guidelines, 1995. Bicycle / Pedestrian Transportation Master Plan, Bicycle and Pedestrian Advocate, New Jersey Department of Transportation, 1035 Parkway Avenue, Trenton, NJ 08625, Phone: (609) 530-4578.

Improving Pedestrian Access to Transit: An Advocacy Handbook, 1998. Federal Transit Administration / WalkBoston. NTIS, 5285 Port Royal Road, Springfield, VA 22161.

Planning and Implementing Pedestrian Facilities in Suburban and Developing Rural Areas, Report No. 294A, Transportation Research Board, Box 289, Washington, DC 20055, Phone: (202) 334-3214.

Pedestrian Facilities Guidebook, 1997. Washington State Department of Transportation, Bicycle and Pedestrian Program, P.O. Box 47393, Olympia, WA 98504.

Portland Pedestrian Design Guide, 1998. Portland Pedestrian Program, 1120 SW Fifth Ave, Room 802; Portland, OR 97210. (503) 823-7004.

* *Implementing Pedestrian Improvements at the Local Level,* 1999. FHWA, HSR 20, 6300 Georgetown Pike, McLean, VA .

* AASHTO *Guide to the Development of Pedestrian Facilities,* 2000. AASHTO. (currently under discussion)

TOP

Bicycle Facility Design Resources

Guide for the Development of Bicycle Facilities, 1999., American Association of State Highway and Transportation Officials (AASHTO), P.O. Box 96716, Washington, DC, 20090-6716, Phone: (888) 227-4860.

Implementing Bicycle Improvements at the Local Level, (1998), FHWA, HSR 20, 6300 Georgetown Pike, McLean, VA .

Bicycle Facility Design Standards, 1998. City of Philadelphia Streets Department, 1401 JFK Boulevard, Philadelphia, PA 19103.

Selecting Roadway Design Treatments to Accommodate Bicyclists, 1993. FHWA, R&T Report Center, 9701 Philadelphia Ct, Unit Q; Lanham, MD 20706. (301) 577-1421 (fax only)

North Carolina Bicycle Facilities Planning and Design Guidelines, 1994. North Carolina DOT, P.O. Box 25201, Raleigh, NC 27611. (919) 733-2804.

Bicycle Facility Planning, 1995. Pinsof & Musser. American Planning Association, Planning Advisory Service Report # 459.

American Planning Association, 122 S. Michigan Ave, Suite 1600; Chicago, IL 60603.

Florida Bicycle Facilities Planning and Design Manual, 1994. Florida DOT, Pedestrian and Bicycle Safety Office, 605 Suwannee Street, Tallahassee, FL 32399.

Evaluation of Shared-use Facilities for Bicycles and Motor Vehicles, 1996. Florida DOT, Pedestrian and Bicycle Safety Office, 605 Suwannee Street, Tallahassee, FL 32399.

TOP

Bicycle and Pedestrian Design Resources

Oregon Bicycle and Pedestrian Plan, 1995. Oregon Department of Transportation, Bicycle and Pedestrian Program, Room 210, Transportation Building, Salem, OR 97310, Phone: (503) 986-3555

Improving Conditions for Bicyclists and Pedestrians, A Best Practices Report, 1998. FHWA, HEP 10, 400 Seventh Street SW, Washington, DC 20590.

TOP

Traffic Calming Design Resources

Traffic Calming: State of the Practice. 1999. Institute of Transportation Engineers, 525 School Street, SW, Suite 410; Washington, DC 20024.

Florida Department of Transportation's Roundabout Guide. Florida Department of Transportation, 605 Suwannee St., MS-82, Tallahassee, FL 23299-0450.

National Bicycling and Walking Study. Case Study # 19, Traffic Calming and Auto-Restricted Zones and other Traffic Management Techniques-Their Effects on Bicycling and Pedestrians, Federal Highway Administration (FHWA).

Traffic Calming (1995), American Planning Association, 122 South Michigan Avenue, Chicago, IL 60603

Traditional Neighborhood Development Street Design Guidelines, 1997. Proposed Recommended Practice, Institute of Transportation Engineers, 525 School Street, SW, Suite 410; Washington, DC 20024.

Making Streets that Work, City of Seattle, 600 Fourth Ave., 12th Floor, Seattle, WA 98104-1873, Phone: (206) 684-4000, Fax: (206) 684-5360.

Traffic Control Manual for In-Street Work, 1994. Seattle Engineering Department, City of Seattle, 600 4th Avenue, Seattle, WA 98104-6967, Phone: (206) 684-5108.

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ADA-related Design Resources

Accessible Pedestrian Signals, 1998. U.S. Access Board 1331 F Street NW, Suite 1000; Washington, DC 20004. (800) 872-2253.

Accessible Rights of Way: A Design Manual, 1999. U.S. Access Board, 1331 F Street NW, Suite 1000; Washington, DC 20004. (800) 872-2253.

Designing Sidewalks and Trails for Access, Part One. 1999. FHWA, HEPH-30, 400 Seventh Street SW, Washington, DC 20590.

ADA Accessibility Guidelines for Buildings and Facilities, 1998 (ADAAG). U.S. Access Board, 1331 F Street NW, Suite 1000; Washington, DC 20004. (800) 872-2253.

Uniform Federal Accessibility Standards, 1984 (UFAS), available from the U.S. Access Board, 1331 F Street NW, Suite 1000; Washington, DC 20004. (800) 872-2253

Universal Access to Outdoor Recreation: A Design Guide, 1993. PLAE, Inc, MIG Communications, 1802 Fifth Street, Berkeley, CA 94710. (510) 845-0953.

Recommended Street Design Guidelines for People Who Are Blind or Visually Impaired. American Council of the Blind, 1155 15th Street NW, Suite 720; Washington, DC 20005. (202) 467-5081.

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Trail Design Resources

Trails for the 21st Century, 1993. Rails to Trails Conservancy, 1100 17th Street NW, 10th Floor, Washington DC 20036. (202) 331-9696.

Greenways: A Guide to Planning, Design, and Development, 1993. The Conservation Fund. Island Press, 1718 Connecticut Ave NW, Suite 300; Washington, DC 20009.

Trail Intersection Design Guidelines, 1996. Florida Department of Transportation, 605 Suwannee St., MS-82, Tallahassee, FL 23299-0450.

* Indicates publication not yet available

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To provide Feedback, Suggestions, or Comments for this page contact Gabe Rousseau at gabe.rousseau@dot.gov.

This page last modified on January 18, 2012 This page last modified on April 4, 2011

Response to Comments from Bike Bakersfield

Thank you for your comments on the project.

Response to comment #1: As indicated in the initial study/environmental assessment, the *Metropolitan Bakersfield General Plan* does not designate any bike trails or paths along State Route (page 80 of the draft document, page 82 of the final document). Given the right-of-way constraints, the high traffic volumes, and high percentage of trucks, a dedicated bikeway is not proposed as part of the project. Though there is not enough bicycle ridership to support the usage of State Route 58 as an important bicycle linkage, the lane widths will be reconfigured to provide a wider outside lane and shoulder. For the segment of roadway from Allen Road to Mohawk Street, rather than having three 12-foot travel lanes with a 2-foot outside shoulder, the width of the middle travel lane will be reduced to 11 feet. The additional foot will allow a 15-foot outside lane (12-foot travel lane and a 3-foot shoulder). This will not be considered a bike lane, but would provide additional area should a bicyclist decide to use State Route 58.

With regards to the inadequacy of the analysis because the air quality and environmental justice analysis do not take into consideration the effects of the potential loss of bicycle usage on State Route 58, the current bike usage of State Route 58 is not substantial enough to alter the analysis in the Draft Initial Study/Environmental Assessment. The comment indicates that State Route 58 would have a level of service B for bikeways based on the existence of a shoulder that can be used by bicyclists. However, even with the shoulders, this route has limited usage (between 0 and 4 bicyclists) based on the bike counts done as part of the responses to comments for this document (see response to comment #3, below, for more discussion on the bicycle counts). The number of trips is too low to change the results of any of the analyses.

Response to comment #2: As with existing conditions, the project would not place any restrictions on the use of State Route 58 by bicyclists. The City of Bakersfield and County of Kern do not encourage bicycle use along State Route 58 because it is a designated truck route and carries a high volume of trucks. The *Metropolitan Bakersfield General Plan* has designated bikeways on Brimhall Road and Hageman Road, which run parallel to State Route 58. These parallel roadways provide more suitable routes because they carry less traffic and fewer trucks. Connecting bikeways from State Route 58 to the bikeways on both Brimhall Road and Hageman Road can be made via Allen Road, Calloway Drive, and Coffee Road. Additionally, though

Mohawk Street currently ends at State Route 58, there are plans to extend Mohawk Street through to Hageman Road.

For those individuals that want to travel from northwest Bakersfield to downtown or to east Bakersfield, there are alternative routes (specifically, Brimhall Road and Hageman Road) that are better bicycle routes because the traffic volumes and number of trucks are not as high as what is experienced along State Route 58.

Response to comment #3: As indicated above, based on the comments received regarding bicycle access on State Route 58 (Rosedale Highway), the City of Bakersfield, the County of Kern, and the Kern Council of Governments decided to look further into current bicycle usage on the highway. The County of Kern conducted bicycle counts on two days to gauge the level of ridership on the roadway. The following are the findings of the bicycle counts:

- On Wednesday, February 1, 2012, counts were taken between 6:30 and 9:00 in the morning at State Route 58 at Landco Drive. A total of three bicyclists were riding at this location during this time period. One rider was riding against the flow of traffic.
- On Wednesday, February 1, 2012, counts were taken between 6:30 and 9:00 in the morning at State Route 58 at Old Farm Road. No bicyclists were riding at this location during this time period.
- On Saturday, February 4, 2012, counts were taken between 9:00 in the morning and noon at State Route 58 at Landco Drive. A total of four bicyclists were riding at this location during this time period. Again, one rider was riding against the flow of traffic.
- On Saturday, February 4, 2012, counts were taken between 9:00 in the morning and noon at State Route 58 at Old Farm Road. Four bicyclists were riding at this location during this time period.

In addition, bicycle rack surveys were conducted on Saturday, February 4, 2012 in the morning in conjunction with bicycle counts.The following reflects the usage of bicycle racks between 9:00 in the morning and noon on February 4, 2012:

- Bicycle rack locations on the north side of State Route 58 between Oak Street and Calloway Drive:
    - Kyoto Sushi – no bicycles

  - 24-hour fitness – one bicycle
  - Cactus Valley Mexican Restaurant – no bicycles

- Bicycle rack locations on the south side of State Route 58 between Oak Street and the Northwest Promenade Marketplace:
  - Although the Hooters shopping center does not have official bike racks, they do have benches that would accommodate bicycles – no bicycles were present
  - Northwest Promenade:
    - Pet Smart – 3 bicycles
    - WalMart – 2 bicycles
    - Target shopping center – no bicycles

The Northwest Promenade Shopping center is also the location of the Golden Empire Transit stop for the area (near WalMart).

As noted in response to comment #1 above, the amount of bicycle traffic using State Route 58 is too low to change the air quality analysis. There may be some jurisdictions that are currently obtaining a five to eight percent mode share, but that is not representative of Kern County or the City of Bakersfield, even for those roadways with designated bikeways. The comment does not provide the documentation proving that assuming a 20 percent mode share on State Route 58 could be obtained in the future. For a comparison, the U.S. Census Bureau's 2008 American Community Survey (released on September 22, 2009) identifies 0.55 percent of Americans use a bicycle as the primary means of getting to work. Portland, Oregon—which has been identified as one of the most bicycle friendly communities in the country—has about six percent of commuters who are bicyclists.

Response to comment #4: As discussed in Section 2.1.3.3, Environmental Justice, the census blocks next to the roadway are more predominately white and have a higher median annual income when compared to the city and the county populations. The analysis considered the potential for low-income and minority populations being disproportionately affected by right-of-way acquisition, greater air emissions, increased noise levels, or changes to transit service. No environmental justice issues were identified. It should also be noted that the analysis in the initial study/environmental assessment (Table 2.15) found carbon monoxide concentrations would be reduced in both 2015 and 2035 compared to existing conditions and would be slightly less with the project compared to the No-Build Alternative because the project would improve traffic flow. Table 2.16 identifies that mobile source air toxic emissions would also be reduced in both 2015 and 2035 compared to existing conditions and would be the same for the project and No-Build Alternative. With regards to the position that the project would remove an affordable transportation option for lower income commuters, as discussed above, bicyclists are not precluded from using State Route 58 and alternative designated bike routes are provided parallel to State Route 58.

Response to comment #5: The Federal Department of Transportation policies regarding incorporation of bicycling and walking facilities into all transportation projects unless exceptional circumstances exists, is noted. The City of Bakersfield and Kern County considered this point, and exceptional circumstances do apply for State Route 58. The decision not to reduce widths of all the travel lanes and provide a bike lane was because (1) State Route 58 is a designated truck route and carries a high volume of trucks; (2) the travel posted speed east of Mohawk Street is 50 miles per hour; (3) the median is a raised object next to the inside travel lane; and (4) there are a large number of driveways that take direct access from State Route 58. These considerations, together with the fact that there are alternative designated bike routes on parallel roads, were used when making the decision not to provide a bike lane on State Route 58.

Comment from Bike Bakersfield

BIKEBAKERSFIELD
BICYCLING FOR EVERYDAY TRANSPORTATION
BIKEBAKERSFIELD.ORG

January 22, 2012
Bryan Apper, Senior Environmental Planner
Southern Valley Environmental Analysis Branch
California Department of Transportation
855 M Street, Suite 200, Fresno, California 93721

Dear Bryan,

Thank you for providing us with the opportunity to comment on the Initial Study with Proposed Mitigated Negative Declaration/Environmental Assessment for the Rosedale Highway Widening Project in Bakersfield.

As I stated in our previous letter we do not believe that the Environmental Document accurately analyzes the impact on bicycle transportation and is therefore flawed in its environmental analysis. Specifically as it relates to air quality and environmental justice. 1

I have attached the NCHRP multimodal study which explains the methods for multimodal level of service calculation. I believe they are now included in the Highway Capacity Manual. Using theses methods it is clear that the level of service is significantly lowered by the project for non-motorized transportation and therefore a decrease in air quality because of the design of the project.

I am also attaching the FHWA guidance document for bicycle and pedestrian provisions of federal transportation legislation. The language is clear that bicycle transportation shall not have a significant adverse impact by any projects funded by federal dollars. 2

Whatever the solution is there is no question that air quality will be enhanced by continuing to provide a good level of service for non-motorized transportation. 3

1424 17TH ST. BAKERSFIELD CA 93301
BIKEBAKERSFIELD.ORG

FROM THE DESK OF
BOB SMITH

We again state that we appreciate the opportunity to comment on the environmental document and hope that the project can be improved through the process. 3 cont.

Sincerely yours,

Bob Smith

FHWA Guidance - (Updated October 22, 2008) Bicycle and Pedestrian Provisions of Federal Transportation Legislation

This page was revised on October 22, 2008 to:

1. Replace references to TEA-21 and SAFETEA-LU that are codified into Federal surface transportation law.
2. To make technical corrections and clarifications.
3. To include references and links to other policies or guidelines and to new links.

On this page:

Introduction

On August 10, 2005, President Bush signed into law the Safe Accountable, Flexible, Efficient Transportation Equity Act: a Legacy for Users (SAFETEA-LU). The legislation updated Titles 23 and 49 of the United States Code (U.S.C.) and built on the significant changes made to Federal transportation policy and programs by the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) and the 1998 Transportation Equity Act for the 21st Century (TEA-21). The legislation had a number of provisions to improve conditions for bicycling and walking and increase the safety of the two modes. This document describes the range of opportunities to improve conditions for bicycling and walking.

TOP

Policy: Mainstreaming Nonmotorized Transportation

Federal transportation policy is to increase nonmotorized transportation to at least 15 percent of all trips and to simultaneously reduce the number of nonmotorized users killed or injured in traffic crashes by at least 10 percent. This policy, which was adopted in 1994 as part of the National Bicycling and Walking Study, remains a high priority for the U.S. Department of Transportation (DOT). SAFETEA-LU continued to provide the funding opportunities, planning processes, and policy language by which States and metropolitan areas can achieve this ambitious national goal.

Improving conditions and safety for bicycling and walking embodies the spirit and intent of Federal surface transportation law and policy to create an integrated, intermodal transportation system which provides travelers with a real choice of transportation modes. State and local agencies are challenged to work together cooperatively with transportation providers, user groups, and the public to develop plans, programs, and projects which reflect this vision. At the Federal level, the Federal Highway Administration (FHWA) is working with the National Highway Traffic Safety Administration (NHTSA), the Federal Transit Administration (FTA), the Federal Railroad Administration (FRA), and other agencies, to implement the bicycle and pedestrian provisions of Federal surface transportation law. This guidance document provides additional information on this important subject.

SAFETEA-LU confirmed and continued the principle in Federal surface transportation law that the safe accommodation of nonmotorized users shall be considered during the planning, development, and construction of all Federal-aid transportation projects and programs. To varying extents, bicyclists and pedestrians will be present on all highways and transportation facilities where they are permitted and it is clearly the intent of Federal surface transportation law that all new and improved transportation facilities be planned, designed, and constructed with this fact in mind.

- The long range metropolitan and statewide transportation plans, and the Metropolitan and Statewide Transportation Improvement Programs shall "provide for the development and integrated management and operation of transportation facilities (including accessible pedestrian walkways and bicycle transportation facilities) that will function as an intermodal transportation system... (23 U.S.C 134(c)(2) and 135(a)(2))
- The process in developing the long-range statewide and metropolitan transportation plans and transportation improvement plans is to consider "...all modes of transportation..." (23 U.S.C.134(c)(3) and 135(a)(3))
- The long-range metropolitan and statewide transportation plans are to "provide for the development and implementation of the intermodal transportation system". (23 U.S.C. 134(i)(2) and 135(f)(1))
- SAFETEA-LU added "representatives of users of pedestrian walkways and bicycle transportation facilities" to the list of 'interested parties" with whom metropolitan areas and States must include in the development of the long range metropolitan and Statewide transportation plans. (23 U.S.C 134(i)(5) and 135 (f)(3)(A))
- Bicyclists and pedestrians shall be given due consideration in the comprehensive transportation plans developed by each metropolitan planning organization and State..." (23 U.S.C. 217(g)(1))
- "Bicycle transportation facilities and pedestrian walkways shall be considered, where appropriate, in conjunction with all new construction and reconstruction and transportation facilities, except where bicycle and pedestrian use are not permitted." (23 U.S.C. 217(g)(1))
- "Transportation plans and projects shall provide due consideration for safety and contiguous routes for bicyclists and pedestrians." (23 U.S.C. 217(g)(2))
- "In any case where a highway bridge deck is being replaced or rehabilitated with Federal financial participation, and bicyclists are permitted on facilities at or near each end of such bridge, and the safe accommodation of bicyclists can be provided at reasonable cost as part of such replacement or rehabilitation, then such bridge shall be so replaced or rehabilitated as to provide such safe accommodations." (23 U.S.C. 217(e))
- "The Secretary shall not approve any project or take any regulatory action under this title that will result in the severance of an existing major route or have significant adverse impact on the safety for nonmotorized transportation traffic and light motorcycles, unless such project or regulatory action provides for a reasonable alternate route or such a route exists." (23 U.S.C. 109(m))

While these sections stop short of requiring specific bicycle and pedestrian accommodation in every transportation project, Congress clearly intends for bicyclists and pedestrians to have safe, convenient access to the transportation system and sees every transportation improvement as an opportunity to enhance the safety and convenience of the two modes. "Due consideration" of bicycle and pedestrian needs should include, at a minimum, a presumption that bicyclists and pedestrians will be accommodated in the design of new and improved transportation facilities. In the planning, design, and operation of transportation facilities, bicyclists and pedestrians should be included as a matter of routine, and the decision to not accommodate them should be the exception rather than the rule. There must be exceptional circumstances for denying bicycle and pedestrian access either by prohibition or by designing highways that are incompatible with safe, convenient walking and bicycling.

TEA-21 Section 1202(b) required FHWA to undertake a design study to "develop guidance on the various approaches to accommodating bicycles and pedestrian travel" and to report back to Congress by December 9, 1999. The guidance clarified those "exceptional circumstances" where bicyclists and pedestrians may not be accommodated. This Design Guidance language can be found at www.fhwa.dot.gov/environment/bikeped/design.htm. Supplementary guidance to clarify a number of issues in the original design guidance can be found at www.fhwa.dot.gov/environment/bikeped/supdesgn.htm. Even where circumstances are exceptional and bicycle use and walking are either prohibited or made incompatible, States, MPOs, and local governments must still ensure that bicycle and pedestrian access along the corridor served by the new or improved facility is not made more difficult or impossible. For example, there may be ways to provide alternate routes on parallel surface streets that are still safe and convenient, or to provide shuttle bus service on major bridge crossings.

Maintaining access to the transportation system for nonmotorized users is not an optional activity. Section 109(m) of Title 23, United States Code, states that "The Secretary shall not approve any project or take any regulatory action under this title that will result in the severance of an existing major route or have significant adverse impact on the safety for nonmotorized transportation traffic and light motorcycles, unless such project or regulatory action provides for a reasonable alternate route or such a route exists."

Bicyclists and pedestrians have the same origins and destinations as other transportation system users and it is important for them to have safe and convenient access to airports, ports, ferry services, transit terminals, and other intermodal facilities as well as to jobs, services, recreation facilities, and neighborhoods. Federal surface transportation law places a strong emphasis on creating a seamless transportation system that all users can enjoy and use efficiently and safely.

TOP

Incidental Projects

There are many simple and cost-effective ways to integrate nonmotorized users into the design and operation of our transportation system by including bicycle and pedestrian accommodation as an incidental part of larger ongoing projects. Examples include:

- Providing paved shoulders on new and reconstructed roads.
- Restriping roads (either as a stand-alone project or after a resurfacing or reconstruction project) to create a wider outside lane or striped bike lanes.
- Building sidewalks and trails, and marking crosswalks or on-street bike lanes as a part of new highways, and requiring new transit vehicles to have bicycle racks and/or hooks already installed.

There are usually a number of good reasons for doing these things without specific reference to bicycle and pedestrian access -- shoulders are good for motorist safety as well as providing bicyclists a place to ride -- and the broad eligibility of bicycle and pedestrian facilities in all the major Federal surface transportation funding programs means that incidental improvements such as these are appropriate to be included as part of larger transportation projects.

TOP

General Funding Requirements

a) Flexibility.
Federal surface transportation law provides tremendous flexibility to States and MPOs to fund bicycle and pedestrian improvements from a wide variety of programs. Virtually all the major transportation funding programs can be used for bicycle and pedestrian-related projects. When considering ways to improve conditions for bicycling and walking, States and MPOs are specifically encouraged to:

- Include bicycle and pedestrian improvements as an incidental part of larger projects, as described above, and
- To review and use the most appropriate funding source for a particular project and not rely primarily on the Transportation Enhancement activities. Many bicycle and pedestrian projects are more suitable for funding under the Congestion Mitigation and Air Quality Improvement Program, Surface Transportation Program, or one of the other programs listed in Appendix 2.

b) Transportation Purpose.
Section 217(i) of Title 23 requires that bicycle projects be "principally for transportation rather than recreation purposes", with the exception of the Recreational Trails Program under which projects should be for recreational use. FHWA has determined that to meet the "transportation purpose" requirement, a bicycle facility must be more than a closed loop trail within a park that can only be used for recreational purposes - users must be able to get somewhere other than back to their starting point. Beyond this, any bicycle facility providing access from one point to another can and will be used for transportation purposes and is therefore eligible for Federal-aid funding. Section 217(i) only applies to **bicycle projects**, not to projects to accommodate pedestrians and other users.

c) Motorized Vehicle Use.
In general, motorized vehicles are not permitted on nonmotorized trails and pedestrian walkways funded under Title 23.

Exceptions to this general rule exist for maintenance vehicles; motorized wheelchairs; when State or local regulations permit, snowmobiles; and electric bicycles (weighing under 100 pounds and a top speed of less than 20 miles per hour); "and such other circumstances as the Secretary deems appropriate" (except the Recreational Trails Program which specifically provides funds for motorized trails). In 2008, FHWA developed a Framework for Considering Motorized Use on Nonmotorized Trails and Pedestrian Walkways to implement the "other circumstances" provision.

Figure 1 provides an overview of the availability of Federal transportation funds for a wide variety of bicycle and pedestrian projects and offers guidance as to the most appropriate potential funding category for a range of typical projects and programs. For a detailed description of the eligibility requirements and other factors related to each funding program, please refer to Appendix 2.

Fig. 1 Bicycle/Pedestrian Funding Opportunities

	NHS	STP	HSIP	SRTS	TEA	CMAQ	RTP	FTA	TE	BRI	402	PLA	TCSP	JOBS	FLH	BYW
Bicycle and pedestrian plan		*				*						*	*			
Bicycle lanes on roadway	*	*	*	*	*	*		*	*	*					*	*
Paved Shoulders	*	*	*	*	*	*				*					*	*
Signed bike route	*	*		*	*	*									*	*
Shared use path/trail	*	*		*	*	*	*			*					*	*
Single track hike/bike trail							*									
Spot improvement program		*	*	*	*	*										
Maps		*		*		*					*					
Bike racks on buses		*			*	*		*	*							
Bicycle parking facilities		*		*	*	*		*	*							*
Trail/highway intersection	*	*	*	*	*	*	*								*	*
Bicycle storage/service center		*		*	*	*		*	*				*	*		
Sidewalks, new or retrofit	*	*	*	*	*	*		*	*	*					*	*
Crosswalks, new or retrofit	*	*	*	*	*	*		*	*						*	*
Signal improvements	*	*	*	*	*	*										
Curb cuts and ramps	*	*	*	*	*	*										

Traffic calming		*	*	*									*			
Coordinator position		*		*		*							*			
Safety/education position		*		*		*					*					
Police Patrol		*		*							*					
Helmet Promotion		*		*	*						*					
Safety brochure/book		*		*	*	*	*				*					
Training		*		*	*	*	*				*					

KEY

NHS	National Highway System	BRI	Bridge
STP	Surface Transportation Program	402	State and Community Traffic Safety Program
HSIP	Highway Safety Improvement Program	PLA	State/Metropolitan Planning Funds
SRTS	Safe Routes to School Program	TCSP	Transportation and Community and System Preservation Pilot Program
TEA	Transportation Enhancement Activities	JOBS	Access to Jobs/Reverse Commute Program
CMAQ	Congestion Mitigation/Air Quality Program	RTP	Recreational Trails Program
FLH	Federal Lands Highway Program	FTA	Federal Transit Capital, Urban & Rural Funds
BYW	Scenic Byways	TE	Transit Enhancements

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Summary of Eligibility Issues

Bicycle and pedestrian projects are broadly eligible for most Federal surface transportation funding categories. Eligibility does not, however, guarantee that bicycle and pedestrian projects, plans, and programs will be funded -- States and MPOs retain broad control over project selection procedures and choices and can set their own priorities for funding within the categories described above.

Eligibility issues relating to individual projects may arise in one of the following areas:

- **Transportation purpose.** Bicycle projects must be principally for transportation purposes (23 U.S.C. 217(i)). Any bicycle facility that provides access from one point to another can and will be used for transportation purposes and is therefore eligible for Federal aid funding. The exception to this rule is the Recreational Trails Program (RTP) under which projects may be for recreational purposes. However, projects funded by the RTP are not necessarily ineligible for other Federal-aid highway funds, for example for a second or subsequent phase of the project, and other Federal-aid highway funds may be used to make up the matching fund requirements for RTP projects. The "transportation purpose" provision does not apply to pedestrian, equestrian, or any other kind of project.
- **Nonconstruction activities.** Most Federal-aid funding is focused on construction projects. However, non-construction bicycle and pedestrian projects are also eligible for STP (including the enhancement set-aside), the Highway Safety Improvement Program, and the CMAQ Program (23 U.S.C. 217(a)). State and Community Highway Safety Grant Program funds (Section 402) are to be used exclusively for nonconstruction activities.
- **Bicycle and pedestrian coordinator positions.** Bicycle and pedestrian coordinator positions at State DOTs can be

funded from STP or CMAQ funding. (23 U.S.C. 217(d))

- **Projects on local roads.** Funds under Title 23 generally may be used only for projects that are on the Federal-aid highway system -- which typically does not include local or minor collector roads. However, bicycle and pedestrian projects not located on the Federal-aid highway system may be funded under the STP (and therefore also under the Transportation Enhancement Activities, Congestion Mitigation and Air Quality Improvement Program) and under the Bridge Program. Highway Safety Improvement Program funds may be spent on any public highway or trail. (23 U.S.C. 133(c), exceptions for (b)(3) and 4); 23 U.S.C. 144(g)(2); 23 U.S.C. 148(d))

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Summary of Matching Funds Requirements

Most Federal-aid highway funding programs require a 20 percent State match of Federal funds. This general rule is adjusted for States with significant Federal land holdings: a sliding scale up to 95 percent Federal funding is determined according to the percentage of Federal land holdings in the State. The matching ratio for bicycle and pedestrian projects is the same as for all other activities under the same program.

There are however, important exceptions to the general 80/20 rule related to programs that fund bicycle and pedestrian projects, including:

- For the Highway Safety Improvement Program, the Federal share is 90 percent, subject to the sliding scale rates, except that the Federal share is 100 percent; for certain safety improvements listed in 23 U.S.C. 120(c).
- Bicycle-related transit projects are 90 percent Federal and may increase to 95 percent Federal for bicycle-related transit enhancement projects;
- Federal Lands Highway projects are 100 percent Federal;
- Individual Transportation Enhancement and Recreational Trails Program projects may exceed the 80 percent Federal share provided the State program overall matches at the 80/20 level.

The State and/or local funds used to match Federal-aid highway projects may include donations of funds, materials, services, or right-of-way. (23 U.S.C. 323(c))

See specific funding programs for additional information on Federal share requirements.

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Planning

The transportation planning process established in 1991 in ISTEA was amended in TEA-21, and revised in SAFETEA-LU. States and metropolitan areas (with populations of more than 50,000) are required to plan for the "development and integrated management and operation of transportation facilities (including accessible pedestrian walkways and bicycle transportation facilities) that will function as an intermodal transportation system..." (23 U.S.C 134(c)(2) and 135(a)(2)). The planning process for both States and metropolitan areas is further required to consider a range of projects and strategies including those which will increase the safety and security of the transportation system for nonmotorized users, increase accessibility and mobility options available to people, improve the quality of life, and enhance the integration and connectivity of the transportation system for people.

23 U.S.C. 217 calls for the planning for bicyclists and pedestrians to be an integral part of the ongoing transportation planning process, and that projects and programs identified in the planning process should be implemented:

- "Bicyclists and pedestrians shall be given due consideration in the comprehensive transportation plans developed by each metropolitan planning organization and State.
- "Bicycle transportation facilities and pedestrian walkways shall be considered, where appropriate, in conjunction with all new construction and reconstruction and transportation facilities, except where bicycle and pedestrian use are not permitted."
- "Transportation plans and projects shall provide due consideration for safety and contiguous routes for bicyclists and pedestrians."

States and MPOs are required to produce two basic planning documents: a Long-range Transportation Plan and a Transportation Improvement Program (TIP) or Statewide Transportation Improvement Program (STIP). The Long-range Transportation Plans have at least a 20-year horizon and must be regularly updated. The TIPs/STIPs must list approved projects for which there is identified funding for each of the following three years, and must be periodically updated.

The Long-range Transportation Plans set the long term direction for transportation investment and typically include a broad vision statement, long-term goals and objectives, policy statements, and priority areas for the State or metropolitan area. Metropolitan plans will identify specific projects, and statewide plans may also provide this level of detail. In addition, the plans might identify important corridors which need study, or programmatic areas (such as improving access for people with disabilities) that will receive special attention. Coverage of bicycle and pedestrian issues may be integrated into the overall transportation plan or contained in a separate plan which is incorporated by reference into the overall plan. In the latter instance, a separate bicycle and pedestrian plan may contain planning and design guidance related to shared use paths, on-street facilities for bicyclists, sidewalks, crosswalks, and other pedestrian facilities which will determine how nonmotorized infrastructure is developed in the years ahead. Further guidance on the content and scope of bicycle and pedestrian planning is provided in Appendix 3.

The TIPs/STIPs comprise a list of the specific projects which will be undertaken by the State or MPO in each of the following three years, each with a short description of the actions to be taken. Every project in the TIP/STIP must be consistent with projects, programs, and/or policies contained in the long range plan and must have an identified source of funding.

Specific requirements for the TIPs/STIPs include:

- The process in developing the long-range statewide and metropolitan transportation plans and transportation improvement plans is to consider "...all modes of transportation..." (23 U.S.C.134(c)(3) and 135(a)(3))
- The long-range metropolitan and statewide transportation plans are to "provide for the development and implementation of the intermodal transportation system". (23 U.S.C. 134(i)(2) and 135(f)(1))
- SAFETEA-LU added "representatives of users of pedestrian walkways and bicycle transportation facilities" to the list of "interested parties" with whom metropolitan areas and States must include in the development of the long range metropolitan and statewide transportation plan. (23 U.S.C 134(i)(5) and 135 (f)(3)(A))
- Bicyclists and pedestrians shall be given due consideration in the comprehensive transportation plans developed by each metropolitan planning organization and State..." (23 U.S.C. 217(g)(1))

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Streamlining Procedures

In many ways, bicycling and walking embody the goals and objectives of ISTEA, TEA-21, and SAFETEA-LU: the two modes quietly, cleanly, efficiently, and effectively serve local transportation needs including work, shopping, school, and personal trips. They are also critical to ensuring that people can get to and from transit services. Because of that, FHWA has provided maximum opportunities for States to streamline the approval and implementation of bicycle and pedestrian projects and programs. It makes no sense for activities such as crosswalk striping, bicycle parking installation, and bike line marking - which usually require no additional right-of-way and cause no negative environmental impact - to have the same approval process as a multi-lane highway construction project. States and MPOs are encouraged to take advantage of the following streamlining measures and to take any additional steps they can to speed up the implementation of projects that improve conditions for bicycling and walking.

- The construction of bicycle and pedestrian facilities, and non-construction activities, normally are exempt from having to complete a project-specific Environmental Impact Assessment under the National Environmental Policy Act (NEPA).
- There are flexibilities for the Federal share for Transportation Enhancement and Recreational Trails Program projects (see links).
- States may allow in-kind contributions such as volunteer labor, land donations, and in-kind services to count towards State matching funds, provided that a cash value can be attributed to the donated time, resource or product. See Donations.
- Transportation Enhancement and Recreational Trails Program projects not located within highway right-of-way may be procured using State procedures and do not need to follow Federal bidding procedures. See Procurement Memo.
- Except for unusual circumstances, bicycle and pedestrian projects are not normally required to undergo a Section 4(f) evaluation (FHWA Memo, May 23, 1977). See Section 4(f) Policy Paper section on bikeways.

- Davis-Bacon requirements for wage rates apply to projects greater than $2,000 that are located within an existing right-of-way or that are linked to a Federal-aid facility based on proximity or impact. Thus, Davis-Bacon does not apply to projects whose eligibility is based on function such as shared-use paths located outside the highway right-of-way. See Davis Bacon memo.
- Bicycle and pedestrian projects of a similar nature may be grouped together for the purposes of funding without each project having to be approved individually.
- Independent bicycle and pedestrian facilities are exempt from transportation conformity requirements. However, bicycle and pedestrian projects that are incidental elements of larger transportation projects may experience a delay in implementation while the requirements are met for the larger project.

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Project Selection

States and MPOs have enormous freedom to fund transportation projects which best meet their local needs and respond to local input - project selection for many of the Federal-aid funding programs rests exclusively out of the hands of the Federal government. Thus, bicycle and pedestrian projects enjoy wide eligibility for funding in almost all the funding programs but are not guaranteed or required to be funded. Similarly, State and MPO transportation plans must address bicycle and pedestrian issues, but there is no quantifiable minimum amount of attention which must be paid to the two modes in those planning documents.

FHWA Division Office and Headquarters staff may be called upon to determine the eligibility of projects for certain funding categories, explain streamlining procedures, and serve as members of project selection panels. They are no longer the final arbiters of the project selection process.

Therefore, a State may decide to use all or none of its Transportation Enhancement or CMAQ funds on bicycle and pedestrian projects - States are free to make that choice based on their own priorities. However, it should be clear there is nothing in Federal transportation legislation forcing them to make that decision. As an example, a State may choose to sub-allocate certain program funds to MPOs and set aside $10 million of its STP funds for pedestrian improvements.

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Design Guidance

Just as the Federal government has stepped out of the role of project selection and approval, so it has allowed States and local governments greater flexibility in the design of streets and highways improved or built with Federal-aid funds. Indeed, 23 CFR 625.3(a)(2) states that "Federal-aid projects not on the NHS are to be designed, constructed, operated, and maintained in accordance with State laws, regulations, directives, safety standards, design standards, and construction standards." Therefore, a State may decide to pave a 1.5 meter (five foot) shoulder on all State roads for the benefit of bicyclists (and motorists) or it may choose to leave shoulders unpaved. The application of rumble strips or installation of sidewalks on State roads is a State decision.

For projects on roads which make up the National Highway System (whether or not NHS funds are being used), however, FHWA must ensure that the NHS facility "adequately serves the existing and planned future traffic of the highway in a manner that is conducive to safety, durability, and economy of maintenance." The Secretary of Transportation, in cooperation with State highway departments, approves design and construction standards for new construction, reconstruction, resurfacing, restoration, or rehabilitation of a highway on the NHS, and those standards may take into account the built and natural environment; the environmental, scenic, aesthetic, historic, preservation, and community impacts; and access for other modes of transportation.

See additional Design Guidance on FHWA Bicycle and Pedestrian Guidance web page.

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State Bicycle and Pedestrian Coordinator Position

Each State is required to fund a Bicycle and Pedestrian Coordinator position in its State Department of Transportation to promote and facilitate the increased use of nonmotorized transportation. Activities may include developing facilities for the use of pedestrians and bicyclists, and public educational, promotional, and safety programs for using such facilities. CMAQ and STP funds may be used for the Federal share of the cost of the position.

The position is a critical one for the development of bicycle and pedestrian policies and programs at the State level. In most States, the Coordinator is a full-time position with sufficient responsibility to deal effectively with other agencies, State offices, and divisions within the State DOT. Many States have established bicycle and pedestrian offices or teams to deal with the growing interest in these issues, and some have separated the bicycle and pedestrian responsibilities and have program coordinators or managers for each area. See State DOT Bicycle and Pedestrian Coordinator Contact Information.

FHWA's January 28, 1992, Memorandum on the Designation of Bicycle and Pedestrian Coordinators within State DOTs lists the typical duties and qualities necessary for the position. Experience shows that the coordinator typically acts as an advocate within the agency for bicycle and pedestrian issues, a vital technical resource, and an important point of contact for local agencies and user groups seeking to improve conditions for the two modes.

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Conclusion

Bicycling and walking are important elements of an integrated, intermodal transportation system. Constructing sidewalks, installing bicycle parking at transit, teaching children to ride and walk safely, installing curb cuts and ramps for wheelchairs, striping bike lanes, and building trails all contribute to our national transportation goals of safety, mobility, economic growth and trade, enhancement of communities and the natural environment, and national security.

All of these activities are eligible for funding as part of the Federal Highway Program. Federal surface transportation law continues to confirm the place of bicycling and walking in the mainstream of transportation decisionmaking at the State and local level, and enables communities to encourage more people to bicycle and walk safely.

Appendix 1

Title 23 United States Code
§217. Bicycle transportation and pedestrian walkways

a. Use Of STP And Congestion Mitigation Program Funds. --Subject to project approval by the Secretary, a State may obligate funds apportioned to it under sections 104(b)(2) and 104(b)(3) of this title for construction of pedestrian walkways and bicycle transportation facilities and for carrying out nonconstruction projects related to safe bicycle use.

b. Use Of National Highway System Funds.--Subject to project approval by the Secretary, a State may obligate funds apportioned to it under section 104(b)(1) of this title for construction of pedestrian walkways and bicycle transportation facilities on land adjacent to any highway on the National Highway System.

c. Use Of Federal Lands Highway Funds.--Funds authorized for forest highways, forest development roads and trails, public lands development roads and trails, park roads, parkways, Indian reservation roads, and public lands highways shall be available, at the discretion of the department charged with the administration of such funds, for the construction of pedestrian walkways and bicycle transportation facilities.

d. State Bicycle And Pedestrian Coordinators. --Each State receiving an apportionment under sections 104(b)(2) and 104(b)(3) of this title shall use such amount of the apportionment as may be necessary to fund in the State department of transportation a position of bicycle and pedestrian coordinator for promoting and facilitating the increased use of nonmotorized modes of transportation, including developing facilities for the use of pedestrians and bicyclists and public education, promotional, and safety programs for using such facilities.

e. Bridges.--In any case where a highway bridge deck being replaced or rehabilitated with Federal financial participation is located on a highway on which bicycles are permitted to operate at each end of such bridge, and the Secretary determines that the safe accommodation of bicycles can be provided at reasonable cost as part of such replacement or rehabilitation, then such bridge shall be so replaced or rehabilitated as to provide such safe accommodations.

f. Federal Share.--For all purposes of this title, construction of a pedestrian walkway and a bicycle transportation facility shall be deemed to be a highway project and the Federal share payable on account of such construction shall be determined in accordance with section 120(b).

g. Planning and Design.--

   1. In General.--Bicyclists and pedestrians shall be given due consideration in the comprehensive transportation plans developed by each metropolitan planning organization and State in accordance with sections 134 and 135, respectively. Bicycle transportation facilities and pedestrian walkways shall be considered, where appropriate, in conjunction with all new construction and reconstruction of transportation facilities, except where bicycle and pedestrian use are not permitted.

   2. Safety considerations.--Transportation plans and projects shall provide due consideration for safety and contiguous routes for bicyclists and pedestrians. Safety considerations shall include the installation, where appropriate, and maintenance of audible traffic signals and audible signs at street crossings.

h. Use Of Motorized Vehicles.--Motorized vehicles may not be permitted on trails and pedestrian walkways under this section, except for--

1. maintenance purposes;
2. when snow conditions and State or local regulations permit, snowmobiles;
3. motorized wheelchairs;
4. when State or local regulations permit, electric bicycles; and
5. such other circumstances as the Secretary deems appropriate. [See the Framework for Considering Motorized Use on Nonmotorized Trails and Pedestrian Walkways]

Transportation Purpose. --No bicycle project may be carried out under this section unless the Secretary has determined that such bicycle project will be principally for transportation, rather than recreation, purposes.

Definitions. --In this section, the following definitions apply:

1. Bicycle transportation facility. --The term 'bicycle transportation facility' means a new or improved lane, path, or shoulder for use by bicyclists and a traffic control device, shelter, or parking facility for bicycles.

2. Electric bicycle. --The term 'electric bicycle' means any bicycle or tricycle with a low-powered electric motor weighing under 100 pounds, with a top motor-powered speed not in excess of 20 miles per hour.

3. Pedestrian. --The term 'pedestrian' means any person traveling by foot and any mobility impaired person using a wheelchair.

4. Wheelchair. --The term 'wheelchair' means a mobility aid, usable indoors, and designed for and used by individuals with mobility impairments, whether operated manually or motorized.

See also: Bicycle and Pedestrian Legislation in Title 23 United States Code (U.S.C.).

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Appendix 2

Funding Sources: Federal Highway Administration

Interstate Maintenance

Interstate Maintenance (IM) funding is targeted at maintaining and improving the 46,000 mile Interstate highway system.

Eligibility- IM funds may be used for resurfacing, restoration, rehabilitation, and reconstruction (4R) projects. TEA-21 also expanded eligibility of these funds to allow certain additions to the system to be funded.

Matching funds- 90 percent Federal, 10 percent State, subject to sliding scale.

Transferability- States may transfer no more than 50 percent of their IM apportionments to the NHS, STP, CMAQ, Bridge, and Recreational Trails Program. In addition, States that have Interstate Construction funds may transfer them to the NHS program.

Discussion- Prior to SAFETEA-LU, IM fund eligibility was limited to 3R work plus reconstruction of interchanges and overpasses. Section 1107(a) of TEA-21 modified 23 U.S.C. 119 and expanded IM eligibility to include the 4th R - "reconstruction." As a result, other reconstruction work, such as new interchanges, new rest areas, additional noise walls, and other new features may now be funded with IM funds. For instance, "new features" which may involve pedestrian safety and bicycle facilities that are incorporated in the design of new interchanges and overcrossings may be considered eligible for IM funding under the 4th R category. In other words, there are no funds under the IM program which would specifically be set aside for pedestrian and/or bicycle improvements but if included in the design of "new features" on an existing Interstate, these improvements may be eligible for IM funds.

In most western States (and certain Interstate sections in New Jersey and Pennsylvania), bicyclists may use Interstate shoulders. Thus, shoulder reconstruction projects may benefit bicyclists. In addition, the "improvement" and reconstruction of Interstates may involve work on intersections and local road which cross Interstates (e.g. bridges or underpasses) where bicyclists and pedestrians currently have access. In both cases, projects should address the continued safety and convenience of bicyclists and pedestrians on the surface street system and may be used to fund specific bicycle and pedestrian improvements.

Further Information: Implementing Guidance, Interstate Maintenance Program TEA-21 Provisions. August 7, 1998.

National Highway System

The National Highway System (NHS) is composed of 163,000 miles of urban and rural roads serving major population centers, major travel destinations, international border crossings, and intermodal transportation facilities. The Interstate System is part of the National Highway System.

Eligibility- Bicycle and pedestrian facilities within NHS corridors are eligible activities for NHS funds, including projects within Interstate rights-of-way. (23 U.S.C. 103(b)(6))

Matching funds- 80 percent Federal, 20 percent State, subject to sliding scale.

Transferability- A State may transfer up to 50 percent of its NHS funds to the Interstate Maintenance, Surface Transportation Program (STP), Congestion Mitigation and Air Quality Improvement Program, Bridge Replacement and Rehabilitation (Bridge) Program, and/or the Recreational Trails Program. If approved by the Secretary of Transportation, and if sufficient notice and opportunity for public comment is given, 100 percent of NHS funds may be transferred to the STP.

Discussion- Shared use paths along Interstate corridors are eligible for the use of NHS funds, as are bike lane, shoulder and sidewalk improvements on major arterial roads that are part of the NHS, and bicycle and/or pedestrian bridges and tunnels that cross NHS facilities. Examples of paths alongside Interstate facilities include I-90 in Seattle, WA; I-70 in Glenwood Canyon, CO; and I-66 in Arlington, VA. See Shared Use Paths Along or Near Freeways.

Bicyclists and pedestrians can be expected to use NHS facilities, especially in urban and suburban areas, and thus should be accommodated in the design and operation of these facilities. Opportunities to improve conditions for the nonmotorized modes should be taken whenever resurfacing, reconstruction, or expansion projects on NHS routes are undertaken.

Each State has designated its segments of the National Highway System. A map of the NHS is available on-line at http://www.fhwa.dot.gov/planning/nhs/index.html, or may be obtained from the FHWA Division Office in each State or the State Department of Transportation.

Bridge Program

The Highway Bridge Replacement and Rehabilitation Program enables States to replace or rehabilitate highway bridges over waterways, other topographical barriers, other highways, or railroads when those bridges are unsafe.

Eligibility- Highway bridges, located on any public road, that are either "functionally obsolete" or "structurally deficient" are eligible for replacement or rehabilitation using Bridge Program funds (23 U.S.C. 144).

In any case where a highway bridge deck is being replaced or rehabilitated with Federal financial participation, and bicyclists are permitted to operate at each end of such bridge, and the safe accommodation of bicyclists can be provided at reasonable cost as part of such replacement or rehabilitation, then such bridge shall be so replaced or rehabilitated as to provide such safe accommodations (23 U.S.C. 217).

Matching funds- 80 percent Federal, 20 percent State, subject to sliding scale.

Transferability- A State may transfer up to 50 percent of its Bridge program funds to the Interstate Maintenance, National Highway System, Surface Transportation Program (STP), and/or Congestion Mitigation and Air Quality Improvement program.

Discussion- Bicyclists and pedestrians are impacted greatly by diversions and obstacles which add even relatively short distances to a trip - the average walking trip is just half a mile - so the lack of access or safe facilities on a bridge can mean trips are not made or short trips are made by car instead. The safety and convenience of bridge crossings of rivers, Interstates, major highways, railway lines, and other corridors are critical for bicyclist and pedestrian mobility as there are often limited opportunities to overcome these obstacles. Bicycle and pedestrian improvements on bridges are usually carried out as an incidental part of a larger replacement or rehabilitation project and funds can be used to provide a range of on-street, sidewalk, and trail facilities depending on the appropriate design for the bridge and the location.

Surface Transportation Program

The Surface Transportation Program (STP) provides States with flexible funds which may be used for a wide variety of projects on any Federal-aid Highway including the NHS, bridges on any public road, and transit facilities.

Eligibility- Bicycle and pedestrian improvements are eligible activities under the STP. This covers a wide variety of projects such as on-road facilities, off-road trails, sidewalks, crosswalks, bicycle and pedestrian signals, parking, and other ancillary facilities. The modification of sidewalks to comply with the requirements of the Americans with Disabilities Act is an eligible activity.

As an exception to the general rule described above, STP-funded bicycle and pedestrian facilities may be located on local and collector roads which are not part of the Federal-aid Highway System. In addition, bicycle-related non-construction projects, such as maps, coordinator positions, and encouragement programs, are eligible for STP funds.

NOTE: There is a set-aside program within the STP, funded with 10 percent of STP's total funding. The Transportation Enhancement Activities set-aside is dealt with in later sections.

Matching funds- 80 percent Federal, 20 percent State, subject to sliding scale.

Transferability- Funds transferred into the STP from the Interstate Maintenance, National Highway System, Congestion Mitigation and Air Quality Improvement, and Bridge programs are not subject to the 10 percent set-asides for the Enhancements and Safety programs. Funds that are sub-allocated to metropolitan areas may not be transferred.

Discussion- STP funds are eligible to be spent on a wide variety of improvements for bicycling and walking including, but not limited to, on- and off-road facilities, bicycle parking, planning studies, State and local bicycle and pedestrian coordinator positions, spot improvement programs, sidewalks, crosswalks, and traffic calming projects. As the category of funding with probably the broadest eligibility, the STP should be considered by States and MPOs as a primary source of funds for both independent and incidental bicycle and pedestrian projects, as well as non-construction projects.

Transportation Enhancement Activities

Ten percent of a State's STP apportionment must be set-aside for Transportation Enhancement (TE) activities.

Eligibility- The list of 12 eligible activities includes three which relate specifically to bicycle and pedestrian transportation:

- provision of facilities for bicyclists and pedestrians
- provision of safety and educational activities for pedestrians and bicyclists
- preservation of abandoned railroad corridors (including the conversion and use for pedestrian or bicycle trails).

The category of "safety and educational activities for pedestrians and bicyclists", was added by TEA-21 even though non-construction bicycle and pedestrian projects were already eligible activities under this program by virtue of their inclusion in the overall STP. It is not intended to replace or duplicate existing funding opportunities for bicycle and pedestrian safety training and other educational activities currently available from the National Highway Traffic Safety Administration. Activities such as bicycle safety training for children, pedestrian safety publicity campaigns, and enforcement activities related to bicycle and pedestrian safety are still more appropriately funded under the Section 402 State and Community Traffic Safety Program. However, project sponsors under the Transportation Enhancement Activities are encouraged to integrate safety messages and educational opportunities for bicyclists and pedestrians into enhancement projects through the development of maps, brochures, and other interpretive devices. States may also consider funding stand-alone projects that, through safety messages and educational opportunities, enhance the traveling experience of bicyclists and pedestrians. Examples might include route marking, maps, and interpretive materials.

As with all bicycle and pedestrian activities under the STP, projects using TE funds need not be located on the Federal-aid Highway System and may be non-construction activities. However, enhancement projects should "relate to surface transportation" and have typically been limited by States to construction projects, planning activities, and related publications rather than salaries and administrative costs.

Matching funds- The TE guidance describes several flexibility provisions.

Discussion- As more than half of bicycle and pedestrian improvements using Federal-aid funds come were funded from this source, the range of exemplary projects is wide. Among the most commonly funded activities have been rail-trails, bike lanes, sidewalks, crosswalks, streetscaping, the renovation of train depots to become transportation centers with bike parking and pedestrian access improvements, and bike route signing.

Despite the popularity of the TE activities for bicycle and pedestrian projects, States and MPOs are encouraged to consider other, perhaps more appropriate, sources of funding for these activities. TE supports activities that are not, or have not been, part of the routine design of streets and highways. Many bicycle and pedestrian facilities funded under this program *should* be part of the routine design of streets and highways and would therefore be more appropriately funded as part of STP, NHS, or other projects. TE funds should be reserved for projects that retrofit poorly designed facilities which were completed before the ISTEA/TEA-21 era and for projects that go above and beyond traditional highway designs and projects.

Streamlined Procedures for Enhancement Projects. Numerous provisions have been enacted to streamline the administrative and regulatory procedures surrounding TE project development and implementation. See the TE Guidance on Streamlining Measures.

States are encouraged to use qualified youth conservation or service corps for construction and maintenance activities under this program.

Highway Safety Improvement Program (HSIP)

SAFETEA-LU established the Highway Safety Improvement Program (HSIP) in 2005. It replaced the previous setaside of each State's STP apportionment for infrastructure safety activities. See http://safety.fhwa.dot.gov/hsip/ for program information and reporting requirements. HSIP funds can be used for pedestrian and bicycle safety improvements. States may obligate funds under the HSIP to carry out-

1. Any highway safety improvement project on any public road or publicly owned bicycle or pedestrian pathway or trail; or
2. As provided under Flexible Funding for States With a Strategic Highway Safety Plan, other safety projects.

Safe Routes to School Program

The Safe Routes to Schools Program was created by Section 1404 of the *Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users Act* (SAFETEA-LU). The SRTS Program is funded at $612 million over five Federal fiscal years (FY 2005-2009) and is to be administered by State Departments of Transportation (DOTs).

The Program provides funds to the States to substantially improve the ability of primary and middle school students to walk and bicycle to school safely. The purposes of the program are:

1. to enable and encourage children, including those with disabilities, to walk and bicycle to school
2. to make bicycling and walking to school a safer and more appealing transportation alternative, thereby encouraging a healthy and active lifestyle from an early age; and
3. to facilitate the planning, development, and implementation of projects and activities that will improve safety and reduce traffic, fuel consumption, and air pollution in the vicinity (approximately 2 miles) of primary and middle schools (Grades K-8).

Each State administers its own program and develops its own procedures to solicit and select projects for funding. The program establishes two distinct types of funding opportunities: infrastructure projects (engineering improvements) and non-infrastructure related activities (such as education, enforcement, and encouragement programs). More detail on eligible projects, as well as program set-up is provided in the SRTS Program Guidance document.

Congestion Mitigation and Air Quality Improvement Program

The Congestion Mitigation and Air Quality Improvement (CMAQ) Program assists areas designated as nonattainment or maintenance under the Clean Air Act Amendments of 1990 to achieve and maintain healthful levels of air quality by funding transportation projects and programs.

Eligibility- Projects funded under the CMAQ program must be located in areas that were designated as a non-attainment area Section 107(d) of the Clean Air Act and classified pursuant to Sections 181(a), 186(a), or 188(a) or (b) of the Clean Air Act.

Projects must be likely to contribute to the attainment of national ambient air quality standards (or the maintenance of such standards where this status has been reached) based on an emissions analysis. Eligible activities include:

a. Transportation Control Measures published pursuant to Section 108(f) of the Clean Air Act, which includes "limiting portions of the road surface or sections of a metropolitan area to the use of nonmotorized vehicles"; "employer participation in programs to encourage bicycling"; and "programs for secure bicycle storage facilities and other facilities, including bicycle lanes, for the convenience and protection of bicyclists in both public and private places."
b. projects in an approved State Implementation Plan and which will have air quality benefits.
c. a determination by the Secretary of Transportation, in consultation with the EPA Administrator, that the project or program is likely to contribute to the attainment of a national ambient air quality standard, whether through reductions in vehicle miles traveled, fuel consumption, or through other factors.
d. a determination that a traffic monitoring, management, and control facility or program is likely to contribute to the attainment of a national ambient air quality standard.
e. FHWA's 1996 Guidance on the CMAQ program, which identifies:
    - construction of bicycle and pedestrian facilities
    - nonconstruction projects related to safe bicycle use, and
    - establishment and funding of State bicycle/pedestrian coordinator positions, as established by ISTEA, for the promoting and facilitating the increased use of nonmotorized modes of transportation. This includes public education, promotional, and safety programs for using such facilities.
f. The 1996 Guidance also identifies a variety of "Newly Eligible Activities" for the CMAQ program that includes outreach activities (with no limit on the number of years for which support may be given), fare and fee subsidy programs and innovative financing mechanisms. Each of these may have direct application to potential bicycle and pedestrian-related activities.

States may allocate CMAQ funds to private and nonprofit entities, under public-private partnership agreements with public agencies, for land, facilities, vehicles, and other expenses.

Matching funds- The Federal share for most eligible activities and projects is 80 percent; or 90 percent if used on certain activities on the Interstate System; or up to 100 percent for certain identified activities such as traffic control signalization and carpooling projects.

Transferability- Up to 50 percent of the amount by which a State's CMAQ apportionment for the fiscal year exceeds the amount that would have been apportioned for that fiscal year if the CMAQ program had been funded at an annual level of $1.35 billion may be transferred to the STP, NHS, IM, and/or the Bridge programs. Transferred funds may only be used in nonattainment and maintenance areas.

Discussion- the CMAQ program has funded numerous bicycle and pedestrian improvements including bikeway networks in cities such as Philadelphia, Houston, and New York City, pedestrian and bicycle spot improvement programs, bicycle parking, bicycle racks on buses, sidewalks, trails, and promotional programs such as bike-to-work events. CMAQ funds have also been used to fund bicycle and pedestrian coordinator positions at the State and local level.

Further information: FHWA Guidance and other information on the Congestion Mitigation and Air Quality Improvement Program are available on line at http://www.fhwa.dot.gov/environment/air_quality/cmaq/index.cfm

Recreational Trails Program

The Recreational Trails Program provides funds to States to develop and maintain recreational trails and trail-related facilities for both nonmotorized and motorized recreational trail uses. Each State administers its own program - usually through a State resource or park agency - and develops its own application and project selection process. Each State has a Recreational Trail Advisory Committee to assist with the program.

Eligibility- Recreational Trails Program (RTP) funds may be used for:

- maintenance and restoration of existing trails
- development and rehabilitation of trailside and trailhead facilities and trail linkages
- purchase and lease of trail construction and maintenance equipment
- construction of new trails (with restrictions for new trails on Federal lands)
- acquisition of easements or property for trails
- assessment of trail conditions for accessibility and maintenance
- operation of educational programs to promote safety and environmental protection as those objectives relate to the use of recreational trails, but in an amount not to exceed 5 percent of the apportionment made to the State for the fiscal year.
- State administrative costs related to the program (up to 7 percent of a State's funds)

States must use 30 percent of their funds for motorized trail uses, 30 percent for nonmotorized trail uses and 40 percent for diverse trail uses. The RTP is intended to fund recreational trails and may not be used to improve roads for general passenger vehicle use or to provide shoulders or sidewalks along roads.

Matching funds- In general, the maximum Federal share for each project is 80 percent; however, see RTP Matching Share for more information.

Transferability- Up to 50 percent of RTP funds may be transferred to NHS, IM, CMAQ, STP, and/or Bridge programs. Transfers in States where the program is administered by a non-DOT agency will require the concurrence of the administering agency.

Project sponsors- States may make grants to private organizations, or to any government entity.

Discussion- The RTP provides funds for projects that are primarily for recreational rather than transportation purposes. In most States the RTP is administered by a State resource agency rather than the State DOT. However, projects funded by the Recreational Trails Program are not necessarily ineligible for other Federal-aid highway funds (for example for a second or subsequent phase of a project) and other Federal-aid highway funds may be used to make up the matching fund requirements for RTP projects.

States are encouraged to use qualified youth conservation or service corps for construction and maintenance activities under this program.

Further information on the Recreational Trails Program

Federal Lands Highways Program

The Federal Lands Highway Program (FLHP) provides funding for a coordinated program of public roads and transit facilities serving Federal and Indian lands.

Eligibility- Provision for pedestrians and bicycles are eligible activities in conjunction with projects on each of the classes of Federal Lands Highways: Forest Highways, Indian Reservation Roads, Park Roads and Parkways, Refuge Roads, and Public Lands Highways.

Project selection is determined by the appropriate Federal Land Agency or tribal government.

Matching funds- The Federal share is 100 percent. In addition, FLHP funds may be used as matching funds for other Federal-aid Highway funds including STP, IM, NHS, and CMAQ.

Transferability- FLHP funds are not transferable to other programs.

Discussion- Bicyclists and pedestrians are legitimate and frequent users of highways on Federal lands and provision for their safety, comfort, and convenience should be integrated into all FLHP projects. Nonmotorized travel to and within Federal lands can help reduce the impact of visitors on the resource and transportation infrastructure, can significantly enhance the enjoyment of Federal lands for users, and can better serve the needs of the residents of communities in and around our public lands.

National Scenic Byways Program

The National Scenic Byways Program recognizes roads having outstanding scenic, historic, cultural, natural, recreational and archaeological qualities by designating them as National Scenic Byways or All-American Roads.

Eligibility- Funds may be spent on a variety of activities including "construction along a scenic byway of a facility for pedestrians and bicyclists, rest area, turnout, highway shoulder improvement passing lane, overlook, or interpretive facility." Projects must be either associated with a National Scenic Byway, All-American Road, or a State Scenic Byway.

Matching funds- The Federal share is 80 percent.

Transferability- No funds are transferable to other programs.

Discussion- Bicyclists and pedestrians are likely to be drawn to and use roads designated as Scenic Byways because the very qualities (natural, scenic, cultural, historic, recreational and archaeological) that support their designation are appealing to nonmotorized travelers. Improvements for bicyclists and pedestrians might include the provision of paved shoulders, striped bike lanes, bicycle and pedestrian information signing, parallel shared-use paths, crosswalks and sidewalks, rest stops, and bicycle parking - provided that such facilities do not destroy the qualities inherent in the Scenic Byway and are consistent with the Corridor Management Plan required for such routes.

Further information: National Scenic Byways

High Priority Projects

Eligibility- High Priority Project funds may be used only for the projects identified in the law.

Statewide Planning funds

Eligibility- Two percent of the funds States receive for the IM, NHS, STP, CMAQ and Bridge programs are available only for planning, research, and technology transfer activities. This list includes the Statewide Long Range Transportation Plan and Transportation Improvement Program, and may include bicycle- and pedestrian-related plans, research, and technology transfer activities.

Matching funds- Federal share is 80 percent, but this may be increased by the Secretary of Transportation.

Transferability- The funds may not be transferred to other programs.

Discussion- States are encouraged to use SPR funds to develop the nonmotorized element of the Long Range Transportation Plan, either as a separate planning document or as an integral part of the overall plan. In addition, States are encouraged to fund research and technology transfer activities that will improve conditions for bicyclists and pedestrians in their State.

Metropolitan Planning funds

Eligibility- One percent of the funds authorized for the IM, NHS, STP, CMAQ, and Bridge programs are available only for metropolitan transportation planning. The funds are allocated to each State based on the population of urbanized areas in each State. Funds may be used for bicycle- and pedestrian-related plans that are part of the metropolitan transportation planning process.

Matching funds- Federal share is 80 percent, but this may be increased by the Secretary of Transportation.

Transferability- The funds may not be transferred to other programs.

Discussion- Metropolitan Planning Organizations are encouraged to use PL funds to develop the nonmotorized element of the Long Range Transportation Plan, either as a separate planning document or as an integral part of the overall plan.

Funding Sources: National Highway Traffic Safety Highway Administration

State and Community Highway Safety Grant Program (Section 402)

The State and Community Highway Safety Grant Program supports State highway safety programs designed to reduce traffic crashes and resulting deaths, injuries, and property damage.

Eligibility- States are eligible for these funds (known as "Section 402 funds") by submitting a Performance Plan, with goals and performance measures, and a Highway Safety Plan describing actions to achieve the Performance Plan. Grant funds are provided to States, the Indian Nations, and Territories each year according to a statutory formula based on population and road mileage.

Funds may be used for a wide variety of highway safety activities and programs including those that improve pedestrian and bicycle safety. States are to consider highly effective programs (previously known as National Priority Program Areas), including bicycle and pedestrian safety, when developing their programs, but are not limited to this list of activities.

Matching funds- Federal share is 80 percent.

Transferability- Funds are not transferrable to other programs.

Discussion- States may determine the kinds of activities on which they spend these funds. States are encouraged to consider bicycle and pedestrian safety initiatives as these are areas of national concern where effective countermeasures have been identified.

States have funded a wide variety of enforcement and educational activities with Section 402 funds including safety brochures; "Share the Road" materials; bicycle training courses for children, adults, and police departments; training courses for traffic engineers; helmet promotions; and safety-related events.

Funding Sources: Federal Transit Administration

Urbanized Area Formula Grants (transit)

The Urbanized Area Formula Grants program provides transit capital and operating assistance to urbanized areas with populations of more than 50,000.

Eligibility- Capital projects are defined as including "pedestrian and bicycle access to a mass transportation facility."

Matching funds- Federal share is typically 80 percent. However, bicycle projects may be funded at up to a 90 percent Federal share.

Transferability- Urbanized Area Formula funds apportioned to Transportation Management Areas (over 200,000 population) which cannot be used for the payment of transit operating expenses may be made available for highway projects if a) such use is approved by the MPO, b) funds are not needed for capital transit investments required by the Americans with Disabilities Act, and c) State and local matching funds are also eligible to be used for either highway or transit projects.

Discussion -Urban areas with between 50,000 and 200,000 population may use their allocation of Urbanized Area Formula Grants for capital or operating costs. Urban areas with more than 200,000 may not spend these funds on operating costs but can cover the costs of preventive maintenance as well as other capital costs. These funds may be spent to provide stand-alone bicycle and pedestrian improvements such as bicycle parking and pedestrian access to transit stations, and on larger projects that include bicycle and pedestrian elements, such as the purchase of new buses with bicycle racks.

At least one percent of Urbanized Area Formula funds appropriated to areas with more than 200,000 population must be used for transit enhancement activities, as described below.

Transit Enhancements

One percent of the Urbanized Area Formula Grants apportioned to urban areas of at least 200,000 population are set aside for a new category of transit enhancements. This program is distinct from the Transportation Enhancement Program.

- *Eligibility*- The list of nine eligible activities under the Transit Enhancement Program includes
- pedestrian access and walkways, and bicycle access, including bicycle storage facilities and installing equipment transporting bicycles on mass transportation vehicles.

Matching funds- Federal share for bicycle-related transit enhancements is 95 percent. Federal share for all other transit enhancements is 80 percent.

Transferability- One percent of Urbanized Area Formula Grant funds remaining after any transfer of those funds to other sources (see above) must be spent on transit enhancement activities.

Discussion- MPOs, in collaboration with transit operators, have the responsibility to determine how the funds in this new category will be allocated to transit projects, and to ensure that one percent of the urbanized area's apportionment (as opposed to one percent of each transit agency's funds) is expended on projects and project elements that qualify as enhancements. The one percent figure is not a maximum or cap on the amount of funding that can be spent on enhancement activities, except for those activities (in particular operating costs for historic facilities) that are only eligible as enhancement activities.

Recipients of transit enhancement funding must submit a report to the relevant FTA Regional Office listing the projects or elements of projects carried out during the previous fiscal year, together with the amount expended.

Formula Program for Other than Urbanized Areas

The Formula Program for Other than Urbanized Areas provides transit capital and operating assistance to urbanized areas with populations of less than 50,000.

Eligibility- Capital projects are defined as including "pedestrian and bicycle access to a mass transportation facility."

Matching funds- Federal share is typically 80 percent. However, bicycle projects may be funded at up to a 90 percent Federal share.

Transferability- Formula Program for Other than Urbanized Areas funds are not transferable.

Discussion- The FTA encourages States to use these funds to expand the coverage of transit service into rural and small urban areas currently unserved, and to improve levels of service in those areas with minimal service. These funds may be spent to provide stand-alone bicycle and pedestrian improvements such as bicycle racks on buses and pedestrian access to transit stations, and on larger projects that include bicycle and pedestrian elements, such as the purchase of new buses with bicycle racks.

Capital Program Grants and Loans

The renamed Capital Investment Grants and Loans Program (formerly Discretionary Grants) provides transit capital assistance for new fixed guideway systems and extensions to existing fixed guideway systems (New Starts), fixed guideway modernization, and bus and bus related facilities.

Eligibility- Capital projects are defined as including "pedestrian and bicycle access to a mass transportation facility."

Matching funds- Federal share is typically 80 percent. However, bicycle projects may be funded at up to a 90 percent Federal share.

Transferability- Capital program grants are not transferable.

Discussion- Transit agencies are encouraged to include facilities and access for bicycles and pedestrians in the design of new transit systems. The purchase of new buses can specify the attachment of bicycle racks, new rolling stock can be ordered to accommodate bicycles on-board, and passenger facilities can be designed to include safe pedestrian access, secure bicycle parking, and convenient access.

Funding Sources: Miscellaneous other sources

Access to Jobs

The Access to Jobs Program provides competitive grants to local governments and non-profit organizations to develop transportation services to connect welfare recipients and low-income persons to employment and support services. Programs, which must be approved by a transit agency, may include activities that encourage bicycling. Project selection is made by States in communities under 200,000 and MPOs in urban areas with more than 200,000 population. The Federal share for

Access to Jobs projects is 50 percent.

Transportation and Community and System Preservation (TCSP) Pilot Program

The TCSP is a competitive grant program designed to support exemplary or innovative projects that show how transportation projects and plans, community development, and preservation activities can be integrated to create communities with a higher quality of life. The annual grant program is administered by the FHWA, in partnership with the FTA and Environmental Protection Agency, and may be used to fund State, MPO, or local government agencies. Bicycling, walking, and traffic calming projects are eligible activities and may well feature as an integral part of many proposed projects that address larger land use and transportation issues.

Emergency Relief

An emergency relief fund is available for the reconstruction of highways, roads, and trails in any part of the United States that the Secretary finds has suffered serious damage as a result of natural disaster over a wide area (e.g. flood, hurricane, tidal wave, earthquake) or catastrophic failure from any external cause. The restoration of bicycle and pedestrian facilities, including shared-use paths, is an eligible activity for Emergency Relief funds.

Safety Incentive Programs

1. Seat Belt Use: An incentive program to encourage States to increase seat belt wearing rates rewards those States with higher than average rates with a greater percentage of funding from a $500 million funding category created by TEA-21. The funds may be used for any project eligible for funding under Title 23 - this includes a range of bicycle and pedestrian projects, both construction and non-construction. The incentive program makes $82 million available for FY 1999 and this gradually increases to $112 million by 2002 and 2003. (Section 1404, TEA-21)
2. 0.08 BAC Law. An incentive program to reward those States that have enacted and are enforcing a 0.08 Blood Alcohol Content law (WA, OR, CA, ID, UT, NM, KS, IL, AL, FL, NC, VA, VT, NH, ME, HI) makes grants available for any project eligible under Title 23 - this includes a wide range of bicycle and pedestrian projects, both construction and non-construction. $500 million is available over the six years of TEA-21. (Section 1405, TEA-21)
3. Open Container Law. In FY 2001 and 2002, States that have not passed a law prohibiting open containers of alcohol in motor vehicles must transfer one and one half percent of their National Highway System, Interstate Maintenance, and Surface Transportation Program funds into their Section 402 State and Community Highway Safety Grant Program fund (for alcohol-impaired driver countermeasures and enforcement) OR they may elect to use some or all of those transferred funds for their Hazard Elimination Program. The Federal share for these transferred funds will be 100 percent. If a State has still not passed such a law by FY 2003, the percentage of funds to be transferred rises to 3 percent. (Section 1406, TEA-21)
4. Minimum Penalties for DWI and DUI Repeat Offenders. In FY 2001 and 2002, States that have not passed or are not enforcing a repeat intoxicated driver law must transfer one and one half percent of their National Highway System, Interstate Maintenance, and Surface Transportation Program funds into their Section 402 State and Community Highway Safety Grant Program fund (for alcohol-impaired driver countermeasures and enforcement) OR they may elect to use some or all of those transferred funds for their Hazard Elimination Program. The Federal share for these transferred funds will be 100 percent. If a State has still not passed such a law by FY 2003, the percentage of funds to be transferred rises to 3 percent. (Section 1407, TEA-21)

Discretionary Programs

Some Federal-aid funds under several programs (including some of those mentioned above) are set aside each fiscal year for distribution at the discretion of the Secretary. These are among the few funds over which FHWA has direct control of project selection, and different application procedures are established for each. The programs with discretionary set asides are listed below. See also Discretionary Programs.

- Bridge
- Corridor Planning and Development and Border Infrastructure (Corridors & Borders)
- Delta Region Transportation Development Program
- Ferry Boats
- Highways for LIFE
- Innovative Bridge Research and Construction
- Innovative Bridge Research and Deployment Program
- National Historic Covered Bridge Program

- Interstate Maintenance
- Public Lands Highways
- Scenic Byways
- Transportation and Community and System Preservation Program
- Transportation Infrastructure Finance and Innovation Act (TIFIA)
- Truck Parking
- Value Pricing Pilot Program

TOP

Appendix 3

Planning Guidance

The inclusion of the bicycle and pedestrian elements in transportation plans and programs may be accomplished by addressing bicycle and pedestrian issues throughout the transportation planning process and integrating bicycle and pedestrian elements as appropriate in the transportation plan and programs. A separate section on bicycle and pedestrian specific issues in addition to or in place of an integrated element may be appropriate. This approach would address the Federal planning mandate of developing transportation facilities that will function as an intermodal transportation system.

The bicycle and pedestrian plan elements should contain policy statements, goals and, whenever possible, specific projects and programs. The plan and TIP should identify the financial resources necessary to implement the bicycle and pedestrian projects and programs.

Bicycle and pedestrian projects may be on- or off-road facilities. For off-road trails, all such facilities that serve a transportation function must be consistent with the planning process.

A trail serves a valid transportation purpose if it serves as a connection between origins and destinations. Trails funded through programs requiring FHWA or FTA approval, except for the Recreational Trails Program (RTP), are determined to serve primarily a transportation purpose. These must be included in Statewide and MPO plans and programs.

Bicycle and pedestrian projects using Federal-aid transportation funds must be included in the Statewide and metropolitan area Transportation Improvement Programs (STIPs and TIPs).

Projects using other Federal funds or non-Federal funds may be included in the STIP and TIP for informational purposes only, or in the case of a TIP in an air quality nonattainment or maintenance area, for the purposes of air quality analysis.

If a bicycle and/or pedestrian project is deemed to be regionally significant (as defined in CFR 23 Section 450.104) it must be included in the STIP or TIP if it is in a nonattainment or maintenance area, and in attainment areas such projects should be included for informational purposes. Bicycle and pedestrian projects are, however, exempt from transportation conformity requirements (40 CFR Parts 51 and 93).

Bicycle and Pedestrian Considerations in a Transportation Planning Process

As is the case for the broader transportation plans, the bicycle and pedestrian element of transportation plans should include:

1. Vision and Goal Statements, and Performance Criteria:

The vision statements express concisely what the plan is expected to accomplish. For example:

- The vision of this program is a nation of travellers with new opportunities to walk or ride a bicycle as part of their everyday life. The vision of this program is the creation of a changed transportation system that offers not only choices among travel modes for specific trips, but more importantly presents these options in a way that they are real choices that meet the needs of individuals and society as a whole.

The goals to reach the vision, and the time frame for reaching each goal should be spelled out. They should be clear and objectively measurable. For example, some goals would be:

- To double the percentage of trips taken by bicycling and walking for all transportation purposes, and to reduce by 10 percent the number of bicyclist injuries and fatalities by 2015.

- To increase the number of bicyclists and pedestrians or to increase facility mileage by a certain amount by a given year.
- To improve the connections among bicycle, pedestrian, and transit systems.
- To allow people to bicycle safely, conveniently, and pleasurably within 8 km (5 mi) of their homes, and to make streets and roads "bicycle friendly" and well-designed to accommodate both motorized and nonmotorized modes of transportation.

Network performance criteria also should be developed. Some applicable criteria would be accessibility, directness, continuity, route attractiveness, low numbers of conflicts with other route users, number of bicycle links with transit, cost, ease of implementation, etc.

Specific State and MPO goals and performance criteria should be developed to support locally determined bicycle and pedestrian program implementation efforts.

2. Assessment of Current Conditions and Needs:

A baseline of information should be collected on which to base strategies and actions necessary to reach the vision and goal statements. The information collected in this step should determine the extent to which the existing transportation system meets the needs of bicyclists and pedestrians. The Intermodal Management System should provide information on existing and needed bicycle and pedestrian access to major intermodal transportation terminals such as commuter rail stations.

Specifically, this assessment could include:

- Determination of current levels of use for bicycling and walking transportation trips, and current numbers of injuries and fatalities involving bicyclists and pedestrians. Evaluation of the existing transportation infrastructure (including on-and off-road facilities) to determine current conditions and capacities and to identify gaps or deficiencies in terms of accommodating potential and existing bicycle and pedestrian travel.
- Determination of the capacities and the type and security level of bicycle parking offered at intermodal connections such as transit facilities and destination points.
- Identification of desired travel corridors for bicycle and pedestrian trips.
- Examination of existing land use and zoning, and the patterns of land use in the community.
- Planning, design standards, and agency policies and the extent to which they affect the accessibility of the transportation system for bicyclists and pedestrians, e.g., do they meet policies and design guidance issued by the American Association of State Highway and Transportation Officials (AASHTO) for bicycle and pedestrian facilities?
- State and local laws and regulations affecting the vision and goals, e.g., growth management and trip reduction laws, or constitutional restraints on expending highway funds on bicycle and pedestrian facilities.
- Availability of bike-on-bus or bike-on-rail access; including hours service is available, routes where available, and incentives and barriers to using the service (i.e., training, permit, or additional charges required).

3. Identification of activities required to meet the vision and goals developed above. These activities or strategies could include:

- Basis of the need for modifications to the transportation system through surveys, origin destination studies, public input, or other data collection techniques.
- Needed modifications to the existing transportation system of on- and off-road facilities to meet the vision and goal statements.
- Development and application of criteria to prioritize and to identify specific facility-related improvements.
- Identification of changes required to planning, design standards, agency policies, and/or State or local legislation.
- Specification of education, encouragement, and law enforcement components to support facility development.
- Identification of nonconstruction activities such as mapping, parking facilities, etc., that are needed to reach the vision and goals developed above.
- Investigation of the effects on bicyclist and pedestrian safety.
- The relationship of Statewide, MPO, and local plans for bicyclists and pedestrians, i.e., ensuring that such plans are coordinated among the involved jurisdictions.

The inclusion of recreational bicycling and walking facilities such as recreational trails is encouraged, but not required. Nevertheless, the coordination of transportation and recreational bicycle and pedestrian facilities and programs is essential. Provide a mechanism for evaluating the performance of the transportation system containing implemented projects against the performance of the original system.

4. Implementation of the bicycle and pedestrian elements in the Statewide and MPO transportation plans and transportation improvement programs:

Inclusion in the Plans: The bicycle and pedestrian elements as a set of policy statements and/or a list of projects will be included in Statewide and metropolitan transportation plans and will be updated appropriately as Statewide and MPO plans are updated.

Inclusion in the TIPs: The bicycle and pedestrian element of transportation plan should be implemented by including identified projects in the TIP/STIP in accordance with priorities established by MPOs, States, and transit operators, and in accordance with 23 CFR Part 450, sections 216 and 324.

5. Evaluation of progress:

Using the performance measures developed previously, regularly determine progress in reaching the identified vision and goals. Appropriate changes to either the vision and goals or to the strategies and proposed projects should be made.

6. Public Involvement:

Public involvement is essential in the development of transportation plans and programs including the bicycle and pedestrian components. Public involvement should include, to the extent possible, input from individuals who will be affected by the transportation plan and programs. This involvement must meet the requirements for Statewide planning spelled out in the regulations in 23 CFR Section 450.212, and those for MPO planning spelled out in 23 CFR Section 450.316(b). Any subsequent policy statements and guidance provided by the FHWA and FTA also needs to be considered.

The regulations require that State departments of transportation and MPOs have public involvement processes which are followed in preparing transportation plans and programs. Bicycle and pedestrian groups should be aware of the opportunity to participate in the development of these public involvement processes and to comment on them before they are adopted. This is in addition to the opportunity to participate according to the public involvement processes in the development of transportation plans and programs. Public involvement will occur at key decision points as described in the public involvement procedures for the planning process.

7. Transportation Conformity Requirements for Air Quality:

Per 40 CFR Parts 51 and 93, bicycle and pedestrian facilities are exempt from transportation conformity requirements. Their inclusion as part of a larger project that does not meet the conformity requirements could result in delay while the requirements for the larger project are satisfied.

To provide Feedback, Suggestions, or Comments for this page contact Gabe Rousseau at gabe.rousseau@dot.gov.

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United States Department of Transportation - **Federal Highway Administration**

NCHRP

REPORT 616

NATIONAL
COOPERATIVE
HIGHWAY
RESEARCH
PROGRAM

Multimodal Level of Service Analysis for Urban Streets

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP REPORT 616

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Academies was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state and local governmental agencies, universities, and industry; its relationship to the National Research Council is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the National Research Council and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the National Research Council and the Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

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NOTICE

The project that is the subject of this report was a part of the National Cooperative Highway Research Program conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council. Such approval reflects the Governing Board's judgment that the program concerned is of national importance and appropriate with respect to both the purposes and resources of the National Research Council.

The members of the technical committee selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and, while they have been accepted as appropriate by the technical committee, they are not necessarily those of the Transportation Research Board, the National Research Council, the American Association of State Highway and Transportation Officials, or the Federal Highway Administration, U.S. Department of Transportation.

Each report is reviewed and accepted for publication by the technical committee according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

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Advisers to the Nation on Science, Engineering, and Medicine

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FOREWORD

By Dianne Schwager
Staff Officer
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NCHRP Report 616: Multimodal Level of Service Analysis for Urban Streets will be of interest to public agencies responsible for the planning, design, and operation of urban streets. This report provides a method for assessing how well an urban street serves the needs of all of its users: auto drivers, transit passengers, bicycle riders, and pedestrians.

NCHRP Project 3-70 developed and calibrated a method for evaluating the multimodal level of service (MMLOS) provided by different urban street designs and operations. This MMLOS method is designed for evaluating "complete streets," context-sensitive design alternatives, and smart growth from the perspective of all users of the street. The analyst can use the MMLOS method to evaluate the tradeoffs of various street designs in terms of their effects on the auto driver's, transit passenger's, bicyclist's, and pedestrian's perceptions of the quality of service provided by the street.

The MMLOS method is described in the user's guide appendix to this final report (published as *NCHRP Web-Only Document 128*). It can be implemented in a simple spreadsheet.

The MMLOS method estimates the auto, bus, bicycle, and pedestrian level of service on an urban street using a combination of readily available data and data normally gathered by an agency to assess auto and transit level of service. The data requirements of the MMLOS method include geometric cross-section, signal timing, the posted speed limit, bus headways, traffic volumes, transit patronage, and pedestrian volumes.

The NCHRP Project 3-70 MMLOS method also enables agencies to balance the level of service needs of auto drivers, transit riders, bicycle riders, and pedestrians in their street designs by providing agencies with a tool for testing different allocations of scarce street right-of-way to the different modes using the street.

CONTENTS

AUTHOR ACKNOWLEDGMENTS

The research reported herein was performed under NCHRP Project 3-70 by Dowling Associates, Inc., Oakland, California.

Dr. Aimee Flannery of George Mason University and Dr. Nagui Rouphail of the Institute for Transportation Research and Education (ITRE) developed the recommended auto level of service model. Dr. Flannery developed the auto video clips and conducted the auto, bicycle, and pedestrian video laboratories around the United States. Dr. Flannery developed the linear and non-linear regression models and conducted the initial statistical analysis for the auto LOS models. Dr. Kathryn Wochinger assisted in the design of the video laboratory survey instruments and protocol.

Dr. Rouphail and Laureano Rangel led the statistical development of the ordered logistic auto LOS model.

Mr. Paul Ryus of Kittelson Associates developed the transit LOS model and conducted the Phase 1 transit data collection effort.

Mr. David Reinke of Dowling Associates led the Phase 2 transit data collection effort and performed various statistical analyses in support of the auto and transit model developments. Mr. Chris Ferrell of Dowling Associates updated the literature review.

Mr. Bruce Landis, Mr. Theo Petritsch, and Dr. Herman Huang of Sprinkle Consulting, Inc., developed the pedestrian and bicycle LOS models and performed the statistical analyses associated with that effort. They also shot the video clips for the bicycle and pedestrian portions of the video laboratories.

Mr. Mark Vandehey of Kittelson Associates and Dr. James Bonneson of Texas A & M coordinated the subject research with the ongoing NCHRP 3-79 project and provided Highway Capacity Committee perspectives on the research.

The authors would like to thank the management of Tri-Met (Portland, OR), Broward County Transit (Ft. Lauderdale, FL), Washington Metropolitan Area Transit Authority (Washington, DC), AC Transit (Oakland, CA) and Muni (San Francisco, CA) for their permission and support to conduct on-board transit surveys on selected routes.

S U M M A R Y

Multimodal Level of Service Analysis for Urban Streets

This report presents the results of a 2-year investigation into how users of urban streets perceive the multimodal quality of service provided by the streets, NCHRP Project 3-70, Multimodal Level of Service for Urban Streets.

A preliminary investigation was conducted to determine the key factors influencing travelers' perceptions of urban street level of service (LOS) from the perspective of auto drivers, bus riders, bicycle riders, and pedestrians. The results of this preliminary investigation were used to design a series of video laboratories (for auto, bicycle, and pedestrian modes) and field surveys (for the bus mode).

Video clips were shot of typical urban street segments in the United States from the perspective of auto drivers, bicycle riders, and pedestrians. Between 26 and 35 video clips were shot for each mode. These video clips were then shown to 145 people in four different urban areas of the United States. Survey participants were asked to rate the quality of service displayed in each video clip on a scale from A to F, with A being defined as Best and F being defined as Worst.

In the field, on-board surveys were conducted of 14 bus routes in four different metropolitan areas. A total of 2,678 bus passengers were surveyed about their perceptions of bus quality of service.

Four separate LOS models (one for each mode) were then fitted to the video laboratory and field survey data. All four LOS models are sensitive to the street design (e.g., number of lanes, widths, and landscaping), traffic control devices (signal timing, speed limits), and traffic volumes. The models incorporate directly and indirectly the interactions of the various users of the street. For example, improved signal timing increases auto speeds and bus speeds which increases auto and bus LOS. However, the higher auto and bus speeds adversely affect the level of service perceived by bicyclists and pedestrians.

The LOS models are ideal for evaluating the benefits of "complete streets" and "context-sensitive" design options because the models quantify the interactions of the modes sharing the same street right-of-way.

The models enable the analyst to test the tradeoffs of various allocations of the urban street cross section among autos, buses, bicycles, and pedestrians. For example, the analyst can test the effects of reducing a four-lane street to three lanes and using the width saved to provide bicycle lanes and a landscaped strip between the sidewalk and the street. The method enables the analyst to compute the before and after levels of service for auto, bus, bicycle, and pedestrians.

A User's Guide was written explaining the LOS models and their application. The User's Guide is written in the general format of a draft chapter for the *Highway Capacity Manual* to facilitate its potential incorporation into the next edition of the *Highway Capacity Manual.*

A spreadsheet software engine was written and delivered to assist analysts in applying the LOS methods.

The Final Report describes the development of the LOS models, while the User's Guide focuses on explaining the application of the models with detailed descriptions of each model and example applications.

CHAPTER 1

Introduction

In many urban areas throughout the United States, there is a desire to evaluate transportation services of roadways from a multimodal perspective. Improvements to non-automobile modes are often emphasized to achieve community goals such as "Smart Growth" and curbing urban sprawl. The Transportation Equity Act for the 21st Century (TEA-21) and its predecessor, the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), call for mainstreaming transit, pedestrian, and bicycle projects into the planning, design, and operation of the U.S. transportation system. In addition to measuring the levels of service for automobile users, measuring the levels of service for transit, pedestrian, and bicycle users along U.S. roadways is also desired.

1.1 Research Objective and Scope

The objective of NCHRP Project 3-70 was to develop and test a framework and enhanced methods for determining levels of service for automobile, transit, bicycle, and pedestrian modes on urban streets, paying particular respect to the interaction among the modes.

The scope of the project was as follows:

- Urban streets were defined as arterials and major collectors.
- This research project was to address all vehicular and pedestrian movements along urban streets, including turning movements and pedestrian movements across urban streets.
- Transit (i.e., bus and rail) was initially defined as at-grade, scheduled, fixed-route services that operated within the roadway right-of-way. Other forms of transit services were allowed be addressed subsequently.
- The analysis techniques were not necessarily to be restricted to 1-hour or 15-minute analysis time frames (transit or pedestrian "micro-peaks").
- Safety and economic aspects were to be included only and insofar as they influenced the perceptions of LOS.
- The HCM lists nine conditions (p. 15-1) not accounted for in the current urban streets methodology:
  1. Presence or lack of on-street parking;
  2. Driveway density or access control;
  3. Lane additions leading up to or lane drops leading away from intersections;
  4. The impacts of grades between intersections;
  5. Any capacity constraints between intersections (such as a narrow bridge);
  6. Mid-block medians and two-way left turn lanes;
  7. Turning movements that exceed 20 percent of the total volume on the street;
  8. Queues at one intersection backing up to and interfering with the operation of an upstream intersection; and
  9. Cross-street congestion blocking through traffic.

These limitations were not necessarily to be accepted in this project.

- Although this project was to address automobile LOS, revisions in operational techniques (e.g., calculation of average travel speed, mid-block running times, and control delay) for the automobile mode were not a significant part of this project.

1.2 The Research Plan

The research plan consisted of the following tasks:

0. Development of Amplified Work Plan
1. LOS Framework Revisions
2. Data Collection
3. Develop LOS Models
4. Interim Report
5. HCM Chapter
6. HCM Software
7. HCM Sample Problems

8. Final Report
9. HCQS Presentations

1.3 This Report

This Report presents the final recommended LOS models and draft Urban Streets chapter on urban street level of service for the 2010 *Highway Capacity Manual*. The report is organized as follows:

- Chapter1, Introduction. This chapter presents an overview of the research project and the organization of the report.
- Chapter 2, State Of The Practice. This chapter reviews the state of the practice for estimating the level of service for auto drivers, transit riders, bicycle riders, and pedestrians on urban streets. The *Highway Capacity Manual*, *Transit Capacity and Quality of Service Manual*, and the Florida DOT Quality/Level of Service Guide are reviewed.
- Chapter 3, Literature Review. This chapter presents an overview of recent literature in the field of modal level of service.
- Chapter 4, Data Collection. This chapter describes the selection of the data collection methods for this study and describes the video lab and field work used to obtain observations from the traveling public on their perceptions of level of service.
- Chapter 5, Auto LOS Model. This chapter presents the recommended LOS model for auto drivers along with an alternative model designed to address concerns raised by the Highway Capacity Committee. Validation data are provided illustrating the accuracy of the model.
- Chapter 6, Transit LOS Model. This chapter describes the recommended LOS model for transit passengers on an urban street. Validation data are provided illustrating the accuracy of the model.
- Chapter 7, Bicycle LOS Model. This chapter describes the recommended LOS models for bicycle riders on an urban street. Validation data are provided illustrating the accuracy of the model.
- Chapter 8, Pedestrian LOS Model. This chapter describes the recommended LOS models for pedestrians on an urban street. Validation data are provided illustrating the accuracy of the model.
- Chapter 9, Integrated Multimodal LOS Model Framework. This chapter explains how the four modal LOS models are integrated in that they share the same LOS rating system, share much of the same input data, and reflect intermodal effects of one mode on the perceived level of service of the other.
- Chapter 10, Accomplishment of Research Objectives. This chapter summarizes the accomplishment of the research objectives.
- Appendix A, Subject Data Collection Forms. This appendix provides copies of the video lab data collection forms.
- Appendix B, Study Protocol. This appendix describes the protocol used to collect LOS perceptions in the video labs.
- Appendix C, Example Recruitment Flyer/Poster. This appendix shows the flyer used to recruit participants in the video laboratories.

Appendix D, Draft Users Guide, which presents the draft users guide on urban street level of service, is available on line as *NCHRP Web-Only Document 128* at http://trb.org/news/blurb_detail?id=9186.

CHAPTER 2

State of the Practice

This chapter summarizes the state of the practice in the United States with regard to multimodal LOS analysis and identifies needed improvements. The review includes national and state guides on LOS analysis and profiles of typical and state-of-the-art applications of modal and multimodal LOS by public agencies in the United States.

2.1 State-of-the-Practice Survey

A brief state-of-the-practice survey was conducted of a few selected representative public agencies to determine how public agencies currently use level of service. Exhibit 1 lists the people and agencies contacted.

The state-of-the-practice survey identified three major professional manuals typically referenced by public agencies when computing multimodal highway level of service. These manuals are the *Highway Capacity Manual* [**1**], the *Transit Capacity and Quality of Service Manual* [**2**], and *Florida's Quality/Level of Service Handbook* [**3**]. The portions of these manuals relevant to the current research are summarized in the following subsections.

Highway Capacity Manual

The *Highway Capacity Manual* (HCM) provides LOS measures, thresholds, and estimation procedures for auto, transit, bicycle, and pedestrian modes.

Urban Street LOS

Chapter 15 of the HCM defines urban street LOS according to the mean speed of through traffic on an urban street. The precise thresholds vary by urban street class (see Exhibit 2), which affects the presumed mid-block free-flow speed on each street.

When one takes into account the differing typical free-flow speeds for the urban street classes, the speed breakpoint for LOS A averages about 85% of the typical mid-block free-flow speed, LOS B averages 67%, LOS C averages 51%, LOS D averages 39%, and LOS E averages 29%.

The HCM provides a methodology for estimating the mean speed for through traffic on an urban street. The methodology reduces the mid-block free-flow speed according to the average delay to through traffic at each traffic signal. This speed is further reduced to account for delays between signals due to short signal spacing (called "segment running time" in the HCM). The effects of signal progression are taken into account in the computation of mean delay at each signal.

For comparison with the other model forms discussed later, the HCM look-up table can be expressed (approximately) in the form of a linear function of facility type and speed, as follows:

$$LOS = Integer\{0.151231 * Speed + 0.636927 * Class - 2.17765\} \quad \text{(Eq. 1)}$$

Where

LOS = HCM LOS Integer Scale (where A=5, F = 0)
Integer = The integer function (rounds off the value to the nearest integer value).
Speed = Mean speed of through traffic on arterial in mph.
Class = Arterial Class as defined by HCM (Class 1, 2, 3, or 4)

(R-Square = 0.97, all variables significant)

Transit LOS

Chapter 27 of the HCM provides four transit LOS measures, adapted from the six presented in the *Transit Capacity and Quality of Service Manual*, First Edition: Service Frequency, Hours of Service, Passenger Load, and Service Reliability. These measures are presented below under the *Transit Capacity and Quality of Service Manual* section.

Exhibit 1. Contacts for State of Practice Survey.

Contact	Agency	Location	Geographic US	Agency Type
1. Conan Cheung	MTDB	San Diego, CA	West	Transit Operator
2. Douglas Dalton	Wisconsin DOT	Milwaukee, WI	Central	DOT
3. Doug McLeod	Florida DOT	Tallahassee, FL	East	DOT
4. Juan Robles	Colorado DOT	Denver, CO	Mountain	DOT
5. James Okazaki	Los Angeles DOT	Los Angeles, CA	West	City
6. Carolyn Gonot	Santa Clara VTA	San Jose, CA	West	CMA/Transit
7. Jim Altenstadter	PIMA AG	Tucson, AZ	Mountain	MPO
8. John Halkias	FHWA	Washington, DC	East	Federal

Bicycle LOS

Chapter 19 of the HCM provides bicycle LOS criteria, thresholds, and estimation procedures for off-street paths and designated bicycle lanes on urban streets (summarized in Exhibit 3 and 4). It is based on research conducted for the FHWA [**4**].

The HCM provides procedures for estimating mean bicycle speed and mean control delay. The mean control delay is estimated based on the signal timing at each signal. The mean speed is estimated by reducing the presumed 15 mph bicycle free-flow speed by the delay at each signal.

For off-street bicycle/pedestrian paths, the HCM-adopted bicycle LOS criterion is based on the frequency of encounters (i.e. passing and meeting events) between bicyclists and pedestrians on the path. For two-way, two-lane paths, less than 40 encounters per hour is LOS A. More than 195 encounters per hour is LOS F. A procedure is provided for estimating the number of encounters based on pedestrian and bicycle volumes.

Pedestrian LOS

Chapter 18 of the HCM provides pedestrian LOS criteria, thresholds, and estimation procedures for sidewalks, street corners, crosswalks, and off-street paths. It is based on research conducted for the FHWA [**5**].

For sidewalks, the key service criterion is space per pedestrian (inverse of density) (see Exhibit 5). A procedure is provided for estimating this based on facility width and pedestrian volumes. These are based on observations from Fruin [**6**].

For shared bicycle and pedestrian paths, the pedestrian LOS is computed according to the expected number of bicycle-pedestrian encounters per hour (see Exhibit 6). The criteria and thresholds are based on research by Botma [**7**]. A procedure is provided for estimating this based on pedestrian and bicycle volumes.

At signalized intersections, the pedestrian LOS is measured using average delay to the pedestrians waiting to cross the streets (see Exhibit 7). A procedure is provided for estimating delay based on the pedestrian or vehicle signal timing.

Average crossing delay is also used to estimate pedestrian LOS for unsignalized intersections. The LOS thresholds are more conservative (less than 5 seconds of delay equals LOS A. More than 45 seconds of delay equals LOS F).

For urban streets with sidewalks, the HCM bases the pedestrian level of service on mean speed over the length of the street (see Exhibit 8). The average walking speed between intersections is reduced according to the average wait time at each intersection to arrive at a mean walking speed for the length of the urban street.

Transit Capacity and Quality of Service Manual

TCRP Report 100: Transit Capacity and Quality of Service Manual, 2nd Edition (TCQSM) presents a two-dimensional LOS framework. It is a matrix covering two service quality dimensions (i.e., Availability and Comfort & Convenience) for three transit system elements (i.e., Stops, Route Segments, and Systems) (see Exhibit 9). Each of the six cells of the matrix provides a service measure for which levels of service are

Exhibit 2. Urban Street Level of Service.

Urban Street Class	I	II	III	IV
Range of FFS	45-55 mph	35-45 mph	30-35 mph	25-35 mph
Typical FFS	50 mph	40 mph	35 mph	30 mph
LOS				
A	>42 mph	> 35 mph	>30 mph	>25 mph
B	>34-42	>28-35	>24-30	>19-25
C	>27-34	>22-28	>18-24	>13-19
D	>21-27	>17-22	>14-18	>9-13
E	>16-21	>13-17	>10-14	>7-9
F	≤16	≤13	≤10	≤7

FFS = mid-block free-flow speed of street. Exhibit adapted from Exhibit 15-2, *Highway Capacity Manual*

Exhibit 3. HCM Bicycle LOS for Bicycle Lanes on Urban Streets.

LOS	Average Bicycle Speed
A	> 14 mph
B	>9-14
C	>7-9
D	>5-7
E	≥4-5
F	<4

Adapted from Exhibit 19-5 of the *Highway Capacity Manual.*

Exhibit 4. HCM Bicycle LOS at Signals.

LOS	Average Control Delay
A	< 10 secs
B	≥10-20
C	>20-30
D	>30-40
E	>40-60
F	>60

Adapted from Exhibit 19-4 of the *Highway Capacity Manual.*

Exhibit 5. HCM Pedestrian LOS Criteria for Sidewalks.

LOS	Space/Pedestrian
A	>60 S.F.
B	>40-60
C	>24-40
D	>15-24
E	>8-15
F	≤8

S.F. = square feet. Adapted from Exhibit 18-3 of the *Highway Capacity Manual*

Exhibit 6. HCM Pedestrian LOS Criteria for Paths.

LOS	Encounters/hour
A	≤38
B	>38-60
C	>60-103
D	>103-144
E	>144-180
F	>180

Adapted from Exhibit 18-8 of the *Highway Capacity Manual*

Exhibit 7. HCM Pedestrian LOS at Signals.

LOS	Average Crossing Delay
A	< 10 secs
B	≥10-20
C	>20-30
D	>30-40
E	>40-60
F	>60

Adapted from Exhibit 18-9 of the *Highway Capacity Manual.*

Exhibit 8. HCM Pedestrian LOS for Urban Streets.

LOS	Mean Walking Speed
A	> 4.36 fps
B	>3.84-4.36
C	>3.28-3.84
D	>2.72-3.28
E	>1.90-2.72
F	< 1.90 fps

fps = feet per second. Adapted from Exhibit 18-14 of the Highway Capacity Manual.

developed; the TCQSM 1st Edition (*TCRP Web-Only Document 6*) also provided one or more other performance measures also thought to be important to consider. Lower-level measures (e.g., stop level) are also applicable at higher levels (i.e., the route segment or system levels).

The TCQSM distinguishes between demand-responsive transit and fixed-route transit service. The LOS criteria for fixed-route transit service are covered in this review.

Availability Measures of Level of Service

For transit stops the frequency of service is the LOS criterion (see Exhibit 10).

For transit route segments and corridors, the hours of service each day (i.e., the number of hours per day when service is available at least hourly) is the LOS criterion (see Exhibit 11). For route segments and corridors where stops are made, service frequency would also be evaluated at the individual stops (depending on routing and scheduling patterns, not all buses may stop at every stop).

At the system level, the service coverage area as a percentage of the transit supportive area is the LOS criterion. The transit supportive area is defined as the area with a minimum density of four jobs per gross acre or three dwellings per gross acre, based on work by Pushkarev and Zupan [**8**]. The transit service coverage area is that area

Exhibit 9. TCQSM Two-Dimensional LOS Framework.

LOS Dimension	Transit Stop	Route Segment	System
Availability	Frequency	Hours of Service	Coverage
Comfort & Convenience	Load Factor	Reliability	Time Differences

Adapted from Exhibit 3-1, *Transit Capacity and Quality of Service Manual*

Exhibit 10. TCQSM Service Frequency LOS.

LOS	Vehicles Per Hour
A	> 6
B	5 to 6
C	3 to 4
D	2
E	1
F	< 1

Adapted from Exhibit 27-1 of the *Highway Capacity Manual.*

Exhibit 11. TCQSM Hours of Service LOS.

LOS	Hours Per Day
A	19-24
B	17-18
C	14-16
D	12-13
E	4-11
F	0-3

Adapted from Exhibit 27-4 of the *Highway Capacity Manual.*

within the transit supportive area that lies within one-quarter air mile of a stop. Greater than 90% is LOS A. Less than 50% is LOS F.

Comfort & Convenience Measures of LOS

For transit stops, the TCQSM "comfort and convenience" measure of level of service is based on passenger load (see Exhibit 12). For typical bus services operating on urban streets, where most passengers would be seated, LOS A-C is based on the load factor (i.e., total number of passengers divided by the number of seats), while LOS D-F is based on the average area per person available for standees. This measure originated in the 1985 HCM.

For route segments and corridors, the comfort and convenience level of service measure is "on-time performance" and headway adherence. For scheduled service of fewer than six vehicles per hour, Exhibit 13 is used.

For scheduled service of six vehicles per hour or greater the reliability LOS is according to Exhibit 14.

Exhibit 12. TCQSM Passenger Load LOS for Bus.

LOS	Standing Passenger Area (ft^2/p)	Load Factor
A	>10.8	0.00-0.50
B	8.2-10.8	0.51-0.75
C	5.5-8.1	0.76-1.00
D	3.9-5.4	1.01-1.25
E	2.2-3.8	1.26-1.50
F	<2.2	>1.50

Adapted from Exhibit 3-26 of the TCQSM.

The on-time performance measure applies to all services with a published timetable, and its LOS thresholds are all in 5% increments, with the LOS E/F threshold set at 75%. The headway adherence measure now applies to all services scheduled to a headway or operating at headways of 10 minutes or less (thus, both measures could apply to some routes). The measure definition allows for variable headways during the peak hour, and the LOS thresholds correspond to the probability that no more than a certain percentage of transit vehicles would be more than one-half headway off schedule.

For the system level, the LOS criterion is door-to-door "travel time difference" between driving a car and taking transit. If transit takes 60 minutes longer than driving, it is LOS F for transit. If they are equal, or transit is faster, it is LOS A for transit.

In addition to the LOS measures presented in the Quality of Service section of the TCQSM, the Stop, Station, and Terminal Capacity section presents a series of pedestrian levels of service for elements of passenger facilities, such as walkways and stairways, based on work by Fruin (same reference as previous). These levels of service are presented more for design purposes (e.g., sizing a station element to provide a certain level of service) than for evaluating existing facilities. These levels of service are similar to, but have different thresholds

Exhibit 13. TCQSM Reliability LOS for Infrequent Urban Scheduled Transit Service.

LOS	On-Time Percentage
A	95.0-100.0%
B	90.0-94.9%
C	85.0-89.9%
D	80.0-84.9%
E	75.0-79.9%
F	<75%

Applies to scheduled service of fewer than six vehicles per hour.
Adapted from Exhibit 3-29 of the TCQSM.

Exhibit 14. TCQSM Reliability LOS for Frequent Urban Scheduled Transit Service.

LOS	Coefficient of Variation
A	0.00-0.21
B	0.22-0.30
C	0.31-0.39
D	0.40-0.52
E	0.53-0.74
F	≥0.75

Applies to scheduled service of six or more vehicles per hour.
The coefficient of variation is the ratio of the standard deviation of headway deviations divided by the mean scheduled headway. Headway deviations are measured as the actual headway minus the scheduled headway.
Adapted from Exhibit 3-30 of the TCQSM.

than, the HCM pedestrian measures, as the TCQSM measures are intended for transit facilities, while the HCM measures are intended for sidewalks. However, the TCQSM's pedestrian waiting area measure would be applicable to bus stops along arterial streets.

Florida Quality/Level of Service Handbook

The Florida Q/LOS Handbook provides LOS measures, thresholds, and estimation methodologies for auto, transit, bicycle, and pedestrian modes.

Auto LOS

The FDOT handbook uses the urban street LOS criteria and thresholds contained in the Urban Streets chapter of the *Highway Capacity Manual*. Various default values are provided for some of the more difficult to obtain input data.

Transit LOS

The transit level of service method and thresholds in the FDOT handbook are designed to be applied only to fixed-route, fixed-schedule bus service. The bus LOS thresholds are keyed to the adjusted service frequency (see Exhibit 15). The actual service frequency is reduced (or increased) depending on the hours of daily operation of the bus service (see Exhibit 16), the difficulty of crossing the street on foot (see Exhibit 17), and the difficulty of walking the length of the street segment (see Exhibit 18).

Exhibit 15. FDOT Bus LOS Thresholds.

LOS	Adjusted Service Frequency (vehicles per hour)
A	> 6.0
B	4.01 to 6.0
C	3.0 to 4.0
D	2.0 to 2.99
E	1.0 to 1.99
F	< 1.0

Exhibit 16. Bus Span of Service Adjustment Factors for Bus LOS (SpanAdj).

Daily Hours of Service	SpanAdj
19 – 24	1.15
17 – 18	1.05
14 – 16	1.00
12 – 13	0.90
4 – 11	0.75
0 – 3	0.55

$$ASF = SF * PLOSAdj * CrossAdj * SpanAdj \qquad \text{(Eq. 2)}$$

Where

ASF = Adjusted Service Frequency (vph)
SF = Actual Service Frequency (vph)
PLOSAdj = Adjustment factor for pedestrian LOS
CrossAdj = Adjustment factor for street crossing difficulty for pedestrians
SpanAdj = Adjustment factor for daily hours of bus service.

The FDOT Q/LOS Handbook uses the HCM LOS criteria and thresholds for urban streets for the automobile level of service.

The Handbook provides two LOS estimation procedures for planning level analyses: Generalized Planning Analysis, and Conceptual Planning Analysis. Generalized planning analysis is a "broad type of planning application such as statewide analyses, initial problem identification, and future year analyses." Conceptual planning is a "preliminary engineering application detailed enough to reach a decision on design concept and scope."

Generalized planning analysis consists of look-up tables of maximum service volumes for auto LOS by facility type, area type, number of lanes, and median type. The bicycle and pedestrian LOS look-up tables provide maximum auto service volumes according to the percentage of sidewalk and bicycle lane coverage on the road segment.

Exhibit 17. Roadway Crossing Adjustment Factors for Bus LOS (CrossAdj).

Conditions that must be met				
Arterial Class	Median	Mid-Block Through Lanes	Auto LOS	CrossAdj
I	All situations	2	A or B	1.05
II	All situations	2	A, B, or C	1.05
III	All situations	≤ 4	A or B	1.05
IV	All situations	≤ 4	All LOS	1.05
I	None or non-restrictive	≥ 4	B-F	0.80
I	Restrictive	≥ 8	All LOS	0.80
II	None or non-restrictive	≥ 4	C-F	0.80
II	Restrictive	≥ 8	All LOS	0.80
III	None or non-restrictive	≥ 4	D-F	0.80
III	Restrictive	≥ 8	All LOS	0.80
All cases not included above =				1.00

Exhibit 18. Pedestrian LOS Adjustment Factors for Bus LOS (PLOSAdj).

Pedestrian LOS	Adjustment Factor
A	1.15
B	1.10
C	1.05
D	1.00
E	0.80
F	0.55

Exhibit 19. FDOT Bicycle and Pedestrian LOS Score Thresholds.

LOS	Score
A	< 1.5
B	> 1.5 and < 2.5
C	> 2.5 and < 3.5
D	> 3.5 and < 4.5
E	> 4.5 and < 5.5
F	> 5.5

Conceptual planning analysis evaluates urban street facility level of service on a segment by segment basis. The segment levels of service for auto and bus are averaged (weighted by length) to obtain a facility LOS for each mode. For pedestrians and bicycles, the facility LOS is the average of the segment LOS for the single worst segment of the facility and the length weighted average segment LOSs for all of the other segments of the facility. The level of service at points (intersections) within the facility is not taken into account in the estimation of facility LOS.

Bicycle LOS

Florida's quality of service perspective is based on the bicyclists' perspective of the safety of sharing the roadway environment with motor vehicle traffic. This is based on the Bicycle LOS Model, originally developed by Sprinkle Consulting Inc. (SCI), and which has been applied to more than 200,000 miles of roadways in the United States (including throughout Florida) and Canada. In the Bicycle LOS Model, bicycle levels of service are based on five variables with relative importance ordered (according to relative absolute value of "t" statistics) in the following list:

- Average effective width of the outside through lane,
- Motorized vehicle volumes,
- Motorized vehicle speeds,
- Heavy vehicle (truck) volumes, and
- Pavement condition.

Average effective width is largely determined by the width of the outside travel lane and [any attendant bicycle lane] striping, but also includes other factors such as the effects of on-street parking and drainage grates. Each of the variables is weighted by coefficients derived by stepwise regression modeling. A numerical LOS score, generally ranging from 0.5 to 6.5, is determined and stratified to a LOS letter grade. Thus, unlike the determination of automobile LOS in the HCM2000, in which there is usually only one service measure (e.g., average travel speed), bicycle LOS is determined based on multiple factors.

The facility segment bicycle LOS score (BLOS) is estimated according to the following equation and the equivalent letter grade LOS is reported according to Exhibit 19.

$$BLOS = 0.507 \ln (Vol_{15}/L) + 0.199SP_t(1 + 10.38HV)^2 + 7.066(1/PR_5)^2 - 0.005(W_e)^2 + 0.760 \quad \text{(Eq. 3)}$$

Where
$BLOS$ = Bicycle level of service score
$\ln$ = Natural log
Vol_{15} = Directional motorized vehicle count in the peak 15 minute time period
L = Total number of directional through lanes
SP_t = Effective speed factor = $1.1199 \ln(SP_p - 20) + 0.8103$
SP_p = Posted speed limit (a surrogate for average running speed)
HV = Percentage of heavy vehicles
PR_5 = FHWA's five point pavement surface condition rating
W_e = Average effective width of outside through lane

Many of the factors in the Bicycle LOS Model equation are also used to determine automobile LOS in the HCM2000 methodology and are either logarithmic or exponential functions. Logarithmic and exponential functions make the importance of the variables differ significantly depending on the precise value. For example, the bicycle LOS drops dramatically as motorized vehicle volumes initially rise, but then tends to deteriorate more slowly at higher volumes. Another example is the effect of motorized vehicle speed. At low speeds, the variable is not as significant in determining bicycle LOS, but at higher speeds it plays an ever-increasing role.

Pedestrian LOS

The pedestrian LOS model was developed for FDOT in a manner similar to that for the bicycle model. The pedestrian LOS model reflects the perspective of pedestrians sharing the roadside environment with motor vehicles and has been applied to cities in Florida and elsewhere in the United States. Pedestrian levels of service are based on four variables in the following list:

- Existence of a sidewalk,
- Lateral separation of pedestrians from motorized vehicles,

- Motorized vehicle volumes, and
- Motorized vehicle speeds.

Each of the variables is weighted according to stepwise regression modeling: A numerical LOS score, generally ranging from 0.5 to 6.5, is determined along with the corresponding LOS letter grade. Thus, like the bicycle LOS approach (but unlike the automobile approach), pedestrian LOS is determined based on multiple factors.

In developing the pedestrian LOS Model, the researchers, SCI staff under contract with FDOT, conducted stepwise regression analyses using 1,315 real-time observations from a research effort conducted in 2000 in Pensacola, Florida.

Many of the terms in the pedestrian LOS model equation are also used to determine automobile LOS in the HCM methodology and bicycle LOS in the bicycle LOS model. The logarithmic and exponential functions make the importance of the variables differ significantly depending on the precise value.

The pedestrian LOS score (PLOS) is estimated according to the equation below. (This formula differs from the formula originally produced as part of the Pensacola survey. FDOT has retained the variables from the original survey but the coefficients and constant have been changed. See Phillips, Karachepone, and Landis [**9**] for original PLOS equation.) The PLOS score is entered in the above table to obtain the equivalent LOS letter grade.

$$PLOS = -1.2276 \ln (W_{ol} + W_l + f_p \times \%OSP + f_b \times W_b + f_{sw} \times W_s) + 0.0091 (Vol_{15}/L) + 0.0004\, SPD^2 + 6.0468 \quad \text{(Eq. 4)}$$

Where

PLOS = Pedestrian level of service score

Ln = Natural log

W_{ol} = Width of outside lane

W_l = Width of shoulder or bicycle lane

f_p = On-street parking effect coefficient (=0.20)

%OSP = Percent of segment with on-street parking

f_b = Buffer area barrier coefficient (=5.37 for trees spaced 20 feet on center)

W_b = Buffer width (distance between edge of pavement and sidewalk, feet)

f_{sw} = Sidewalk presence coefficient (= 6 – 0.3Ws)

W_s = Width of sidewalk

Vol_{15} = Count of motorized vehicles in the peak 15 minute period

L = Total number of directional through lanes

SPD = Average running speed of motorized vehicle traffic (mi/hr)

2.2 Evaluation Against NCHRP 3-70 Framework Objectives

This section evaluates the three major guidebooks on level of service against the NCHRP 3-70 objectives for a multimodal level of service framework for urban streets. Exhibit 20 summarizes the conclusions. The following paragraphs explain these conclusions in more detail.

Highway Capacity Manual

Exhibit 21 critiques the LOS criteria used in the *Highway Capacity Manual*. Exhibit 22 critiques the intermodal relationships incorporated in the *Highway Capacity Manual*.

Exhibit 20. Evaluation of Major LOS Manuals Against NCHRP 3-70 Framework Objectives.

Framework Objective	HCM	TCQSM	FDOT Q/LOS
1. National Application	Designed for Nation	Designed for Nation	Designed for State
2. LOS is Travelers' Perspective	Claimed, but no proof	A blend of traveler and operator perspectives	A blend of HCM, TCQS and traveler surveys
3. Applicable to Urban Streets	Yes	Yes	Yes
4. Considers All factors within ROW	Many factors considered, but not all	Many factors considered, but not all	Many factors considered, but not all
5. Safety and Economic Factors	No	No	Perceived safety included
6. Comparable Modal LOS	Uses speed for auto, bike, and pedestrian, but not transit	Only considers transit	Different LOS measures by mode
7. Modal Interactions	Some but not all–See table below.	Some but not all–See table below.	Some but not all–See table below.
8. LOS Reflects All Movements	Only Through	Yes, all bus service on arterial is counted	Only Through
9. No Averaging Across Modes	Does not average	Considers only single mode	Does not average
10. Not Limited by HCM Limits	Limited by HCM	HCM limits not applicable	Limited by HCM

ROW = Right of Way
HCM = Highway Capacity Manual
LOS = Level of Service

Exhibit 21. HCM LOS Criteria for Urban Street.

Mode	LOS Criterion	Comments
Auto	Mean auto speed for through traffic	Applies only to arterials, not collector or local streets
Transit	Hours of Daily Service, Reliability	These are the two segment LOS criteria for availability and comfort/convenience
Bicycle	Mean speed of bicycle through traffic	Applies only if designated bicycle lanes are present
Pedestrian	Mean speed of pedestrian through traffic	Applies only if sidewalk is present

National Multimodal Application: The HCM is designed to be applied nationally for all four modes (i.e., auto, transit, bicycle, and pedestrian).

Level of Service from a Traveler's Perspective: The HCM claims to predict LOS from the traveler's perspective, but there is little evidence to support this claim. The service measures were developed in committee without specific research of traveler opinions to support the selected service measures.

Applicable to Urban Streets: The HCM is designed to be applied to urban arterials where the through movement is the only function of the street. It may be less applicable to collectors where both through movement and access are important functions of the street.

Considers All Factors Within Right of Way: The auto LOS methodology incorporates all geometric and signal operation factors considered relevant to the prediction of auto speed. The transit LOS method does not yet have a methodology for incorporating the effects of signal operation, traffic flow, and other factors in the right of way that can influence bus service reliability. The pedestrian and bicycle LOS

Exhibit 22. The Modal Operational Inter-Relationships in the HCM.

Mode	Auto	Transit	Bicycle	Pedestrian
Auto	Higher auto volumes reduce auto LOS.	The effect cannot be computed. Higher auto volumes may reduce reliability, but no estimation method is available in the HCM. Higher auto volumes have no direct effect on span of transit service.	Higher auto volumes indirectly affect bicycle LOS by affecting delays at signals.	For signalized intersections, higher auto volumes indirectly affect pedestrian LOS by affecting delays at signals. For unsignalized intersections, higher auto volumes directly affect pedestrian delays and, therefore, pedestrian LOS.
Transit	Higher transit volumes reduce capacity and increase delays at signalized intersections	The effect cannot be computed. Higher bus volumes may reduce reliability, but no effect on span of service.	Higher transit volumes reduce capacity and increase delays at signalized intersections	Higher transit volumes reduce capacity and increase delays at signalized intersections
Bicycle	Higher bicycle volumes reduce capacity and increase delays at signalized intersections	The effect cannot be computed. Heavy bicycle volumes may reduce reliability, but no impact on span of service.	Higher bicycle volumes reduce mean segment speed which reduces LOS (HCM Exhibit 19-3)	Higher bicycle volumes have **NO** effect on walk speed or delay at signals.
Pedestrian	Higher pedestrian volumes reduce capacity and increase delays at signalized intersections	The effect cannot be computed. Higher pedestrian flows may affect reliability but not span of service.	Pedestrian flows between 1 and 60/hr. may indirectly affect bicycle LOS by affecting delays at signals. Higher volumes have **NO** effect.	The effect is indirect except at unsignalized crossings where higher pedestrian flows affect the group critical gap and therefore pedestrian delay.

Shaded boxes indicate weak or non-existent inter-relationships. No effect means that a change in modal volume has no effect on LOS as computed per the HCM.

methodologies incorporate the effects of intersections on average pedestrian and bicycle speeds, but do not consider other potential factors (such as interference).

Safety and Economic Factors: Safety and economic factors are not included in any of the LOS methodologies.

Comparable Modal LOS: The HCM uses the same service measure, speed, to predict traveler LOS on urban streets for auto, bicycle, and pedestrians. Transit does not use speed for LOS at the urban street level. However the LOS thresholds for each mode were selected by committee and are not backed up by research indicating comparability of LOS values across modes.

Modal Interactions: The HCM incorporates many but not all of the potential cross-modal influences on level of service. Exhibit 21 highlights the key LOS criteria for each mode. Exhibit 22 then shows how the various modes can affect each of these key LOS criteria.

The HCM takes into account the effects of pedestrians, bicycles, and transit on auto delay at signalized intersections. The signalized intersection delay in turn affects the estimated mean speed of through traffic on the urban street. The mean speed is the LOS criterion for an urban street in the HCM.

Higher auto volumes indirectly affect bicycle and pedestrian LOS in the HCM method by affecting the signal timing at the intersections. Longer cycle lengths and longer red times would increase bicycle and pedestrian delay and reduce their level of service on the street.

Higher auto volumes would indirectly affect transit reliability by increasing the probability of congestion, but the HCM provides no method for estimating this effect. Thus the effect of auto volumes on transit LOS cannot currently be accounted for using the available HCM procedures.

The effects of pedestrians on bicycle level of service and the effects of bicycles on pedestrian level of service are accounted for in the analysis of off-street facilities, but not for on-street facilities in the HCM.

Higher transit volumes, by reducing capacity and increasing congestion, can adversely affect bicycle and pedestrian LOS in the HCM method by affecting the cycle length and red times at signalized intersections.

LOS Reflects All Movements: The HCM focuses on predicting urban street LOS only for the through movement for auto, bicycle, and pedestrian. The transit LOS includes any service on the street and at each stop.

Averaging LOS Across Modes: The HCM does not average LOS across modes.

HCM Limitations: The HCM lists nine conditions (p. 15-1) that are not accounted for in the current urban streets methodology for auto LOS:

1. Presence or lack of on-street parking;
2. Driveway density or access control;
3. Lane additions leading up to or lane drops leading away from intersections;
4. The effects of grades between intersections;
5. Any capacity constraints between intersections (such as a narrow bridge);
6. Mid-block medians and two-way left-turn lanes;
7. Turning movements that exceed 20 percent of the total volume on the street;
8. Queues at one intersection backing up to and interfering with the operation of an upstream intersection; and
9. Cross-street congestion blocking through traffic.

Transit TCQSM Critique

Exhibit 23 critiques the intermodal relationships in the *Transit Capacity and Quality of Service Manual.*

National Multimodal Application: The TCQSM is designed to be applied nationally for transit only.

Level of Service from a Traveler's Perspective: The TCQSM LOS measures are based on surveys that identified service factors important to traveler perceptions. The LOS E/F thresholds were set based on a project team/project panel consensus of undesirable service from a passenger standpoint; the other thresholds ideally represent points where a noticeable change in service quality occurs (e.g., when no more seats are left), and otherwise represent even ranges of the service measure between LOS A and LOS F.

Applicable to Urban Streets: The TCQSM is oriented to the transit service features, not the street facility. LOS measures are provided for stops, routes, and the system as a whole. The measures must be adapted for use on a specific street facility.

Considers All Factors Within Right of Way: The TCQSM does not currently provide a methodology for taking into account the effects of street facility characteristics on transit LOS. Walk and drive accessibility are currently not included in bus stop level of service. No methodology is currently available for estimating the effect of traffic congestion and signal operation on transit service reliability.

Safety and Economic Factors: Safety and economic factors are not included in the LOS methodology.

Comparable Modal LOS: The TCQSM focuses on transit. The selected service measures are specific to transit and are not comparable with those for other modes.

Modal Interactions: The TCQSM incorporates many but not all of the potential cross-modal influences on level of service. Exhibit 23 shows how the various modes can affect the key LOS criteria for transit.

LOS Reflects All Movements: The transit LOS includes any service on the street and at each stop.

Averaging LOS Across Modes: The TCQSM does not average LOS across modes.

Exhibit 23. The Modal Operational Inter-Relationships in the TCQSM, Second Edition.

Mode	Auto	Transit	Bicycle	Pedestrian
Auto	Not Applicable	Higher auto volumes may reduce reliability, but no estimation method is available in the TCQSM. Reduced reliability affects passenger loads. Auto volumes, street width, and signal timing affect street crossing difficulty which can reduce service coverage. Higher auto volumes reduce bus speed, which affects transit-auto travel time, but no estimation method is available in the HCM or TCQSM.	Not Applicable	Not Applicable
Transit	Not Applicable	Higher bus volumes reduce bus speed, which affects transit-auto travel time. High bus volumes relative to bus capacity affect reliability, but no estimation method is available in the TCQSM.	Not Applicable	Not Applicable
Bicycle	Not Applicable	No estimation method is available in the HCM or TCQSM for the effect of bikes on bus speed or reliability.	Not Applicable	Not Applicable
Pedestrian	Not Applicable	Pedestrian crossing volumes affect right-turn capacity, which affects bus lane capacity, which affects bus travel time and reliability, but no estimation method is available in the TCQSM.	Not Applicable	Not Applicable

Shaded boxes indicate weak or non-existent inter-relationships. No effect means that a change in modal volume has no effect on LOS as computed per the TCQSM.

HCM Limitations: The HCM limitations are irrelevant to the TCQSM.

Florida DOT Q/LOS Handbook

Exhibit 24 critiques the LOS criteria in the Florida DOT Q/LOS Handbook. Exhibit 25 critiques the intermodal relationships in the Florida DOT Q/LOS Handbook.

National Multimodal Application: The FDOT Q/LOS Handbook is designed to be applied statewide for all four modes (i.e., auto, transit, bicycle, and pedestrian).

Level of Service from a Traveler's Perspective: The Q/LOS Handbook is a blend of local research on bicycle/pedestrian perceptions of LOS and the two national manuals—the HCM and TCQSM. The Q/LOS Handbook thus shares some of the weaknesses of the national manuals. The HCM claim that auto LOS accurately reflects traveler perception has not been verified. The TCQSM transit LOS is a blend of traveler perceptions and transit operator objectives. The pedestrian and bicycle LOS measures have been experimentally verified against traveler perceptions.

Applicable to Urban Streets: The FDOT Q/LOS Handbook is designed to be applied to urban arterials where the through movement is the only function of the street. It may be less applicable to collectors where both through movement and access are important functions of the street.

Considers All Factors Within Right-of-Way: Like the HCM, the FDOT Q/LOS Handbook auto LOS methodology incorporates all geometric and signal operation factors considered relevant to the prediction of auto speed. The transit LOS method does not yet have a methodology for incorporating the effects of signal operation, traffic flow, and other factors in the right-of-way that can influence bus service reliability. The pedestrian and bicycle LOS methodologies incorporate all factors related to the right-of-way that were found to significantly affect perceived LOS.

Safety and Economic Factors: Economic factors are not included in any of the LOS methodologies. Perceived safety is an underlying factor in the pedestrian and bicycle LOS methods.

Comparable Modal LOS: The FDOT Q/LOS Handbook measures for pedestrian and bicycle modes are probably comparable in terms of their measurement of degree of satisfaction, but no actual tests of this conjecture have been performed. The auto and transit LOS measures are generally not comparable with the pedestrian and bicycle LOS measures.

Exhibit 24. FDOT LOS Criteria for Urban Street.

Mode	LOS Criterion	Comments
Auto	Mean auto speed for through traffic	
Transit	Frequency of Service	Has modifiers for walk access and hours of service
Bicycle	Index	Based on design and traffic volumes
Pedestrian	Index	Based on design and traffic volumes

Exhibit 25. The Modal Operational Inter-Relationships in the FDOT Q/LOS Handbook.

Mode	Auto	Transit	Bicycle	Pedestrian
Auto	Higher auto volumes reduce auto LOS	Higher auto flows have **NO** effect on transit frequency, span of service, or walk access	Higher auto volumes and/or higher speeds reduce bicycle LOS	Higher auto volumes and/or higher speeds reduce pedestrian LOS
Transit	Higher transit volumes reduce capacity and increase delays at signalized intersections	Higher bus volumes mean higher frequencies, which increases transit LOS	Higher heavy vehicle volumes reduce bicycle LOS	Higher heavy vehicle volumes reduce pedestrian LOS
Bicycle	Higher bicycle volumes reduce capacity and increase delays at signalized intersections	Higher bike flows have **NO** effect on transit frequency, span of service, or walk access barriers	Higher bicycle volumes have **NO** effect on BLOS. Better design affects BLOS.	Higher bicycle volumes have **NO** effect on PLOS. Better bike design may affect PLOS.
Pedestrian	Higher pedestrian volumes reduce capacity and increase delays at intersections	Higher pedestrian volumes have **NO** effect on transit LOS. Better pedestrian facilities improve transit LOS.	Higher pedestrian volumes have **NO** effect on BLOS. Better pedestrian design may affect PLOS.	Higher pedestrian volumes have **NO** effect on PLOS. Better design affects PLOS.

Shaded boxes indicate weak or non-existent inter-relationships. No effect means that a change in modal volume has no effect on LOS as computed per FDOT.

Modal Interactions: The FDOT Q/LOS Handbook incorporates many but not all of the potential cross-modal influences on level of service. Exhibit 24 highlights the key LOS criteria for each mode. Exhibit 25 shows how the various modes can affect each of these key LOS criteria.

2.3 Conclusions

Current Agency Practices

Public agencies make extensive use of the *Highway Capacity Manual* and the Florida *Quality/Level of Service Handbook* for planning and designing urban streets. The *Transit Capacity and Quality of Service Manual* is a recent development and has not yet seen extensive adoption by public agencies.

Level of service is used on a daily basis in most public agencies to assess the adequacy of the design of urban streets, to assess the effects of new development on urban street operations, and to identify the appropriate mitigation measures for new development. These analyses however focus primarily on auto level of service.

The survey of current agency practices found little actual use of level of service for the planning or design of urban streets for transit, bicycle, and pedestrian modes, except in the State of Florida where it is a recent development. There is, however, a great deal of interest among public agencies in acquiring the ability to estimate and forecast level of service for all four modes, especially if the issue of comparability of results across modes can be achieved.

The Major Level of Service Manuals

The existing LOS frameworks outlined in the major LOS manuals generally do not provide comparable LOS results across modes. This is due to different definitions of level of service and different measurement scales used by the various manuals for each mode:

1. The HCM Urban Street LOS measures are not based on surveys of traveler satisfaction and thus cannot be compared with the traveler satisfaction based LOS measures contained in the TCQSM and FDOT manuals.
2. The TCQSM provides no single LOS result for transit but several different dimensions of LOS making mode-to-mode comparisons difficult. The TCQSM LOS measures are derived from surveys of traveler satisfaction.
3. The FDOT multimodal framework, because it relies on the HCM and TCQSM manuals for auto and transit, suffers from the same comparability limitations as those manuals. The auto LOS in particular is not comparable with the bike and pedestrian LOS scales, because they are based on different dimensions of perceived and measured traveler satisfaction.

The major existing LOS manuals are spotty in their incorporation of known modal interactions on modal LOS. Either the selected modal LOS measure (such as hours of bus service) is insensitive to the effects of other modes or an accepted methodology has not yet been established for predicting the intermodal effects.

The Florida bicycle and pedestrian level of service models have a strong scientific basis, but their incorporation in the national manuals has been hindered by the perception (valid or not) that they are based strictly on data from a single city in a single state, even though they have been applied in many jurisdictions around the United States. There are also concerns at the national level (valid or not) that the level of service measured in Florida for bicycles and pedestrians is a different dimension of traveler satisfaction not related to traditional traffic operations analysis and, therefore, incompatible with the national manuals.

Implications for Research Project

The major issues for establishing a multimodal level of service framework are as follows:

1. Establishing comparability of meanings for LOS grades across modes,
2. Establishing models for predicting LOS that reflect the interactions among modes in an urban street setting, and
3. Establishing a credible national basis for the multimodal LOS framework and models.

CHAPTER 3

Literature Review

This chapter reviews the recent published research into multimodal level of service. The literature review is grouped by research into traveler perceptions of level of service for auto, transit, bicycle, and pedestrian, and research into multimodal level of service frameworks.

3.1 Auto Driver Perceptions of LOS

Researchers have focused on auto driver perceptions of quality of service for urban streets, signalized intersections, and rural roads. Researchers have used field surveys (where subjects are sent into the field to drive a fixed course) and video laboratories and have laboratory interviews to identify key factors affecting perceived LOS and to obtain LOS ratings for different field conditions.

Level of service has been defined by researchers in various ways. For example, LOS A may be defined as "excellent," "best," or "very satisfied" depending on the researcher. Others have defined LOS in terms of hazards and conflicts (e.g., number of vehicle-to-vehicle and vehicle-to-pedestrian conflicts).

Some have developed models that predict the average LOS rating, while others have developed models that predict the percentage of responses for each LOS grade.

Several researchers have noted that drivers do not perceive six levels of service. Some researchers have proposed as few as three levels of service, while one researcher suggested a shift of the entire LOS spectrum by one level of service so as to combine LOS A and B and subdivide LOS F.

Some of the latest research incorporates "fuzzy logic" in the translation of user perceptions into letter grade levels of service.

Urban Street LOS

While the HCM's focus on measuring delay, percent of time spent following, and average travel speed (to name a few) offers a conceptual link to how the user perceives the transportation system's level of service, a review of the existing literature by Flannery et al. (2005) [**10**] found little research that empirically investigates these links. Flannery et al. conclude that a comprehensive research approach is needed to identify and prioritize the factors important to drivers followed by research that models and calibrates these factors.

In a study comparing users' perceptions of urban street service quality, Flannery et al. (2004) [**11**] found that HCM 2000 methods only predicted 35 percent of the variance in mean driver ratings, suggesting LOS does not completely represent driver assessments of facility performance.

Colman [**12**] sent 50 students to drive various arterial streets and compare the HCM level of service (based on speed) against their own perception of quality of service. The student's perceived speed thresholds for urban street level of service tended to be 4% to 24% higher than the HCM speed thresholds. They expected better service for a given letter grade than the HCM.

Seeking to identify the key factors that influence user perceptions of urban street LOS, Pecheux et al. (2004) [**13**] used an in-vehicle survey and interview approach to determine the factors that affect drivers' perceptions of quality of service. They identified 40 factors that are relevant to these perceptions, including roadway design, urban street operations, intersection operations, signs and markings, maintenance, aesthetics, and the behaviors of other road users. A study by Flannery et al. (2005) provides support for this collection of important factors. Flannery et al. had drivers rate video segments of travel on urban streets and then select and rank from a list of 36 factors the 3 factors that they considered to be most important to LOS. Mean driver ratings had statistically significant correlations with operational and design characteristics, and aesthetics, including the following variables: travel time, average travel speed, number of stops, delay, number of signals, lane width, the presence of trees, and quality of landscaping.

An FHWA-sponsored study of customer satisfaction (SAIC [**14**]) sought to determine what factors influence perceived driver satisfaction on urban streets. Drivers drove with two researchers in their vehicle and talked aloud about the factors that made them feel satisfied or dissatisfied with the drive they were experiencing in real time. The study was conducted in four locations and one pilot study location. The locations consisted of two small urban areas (Tallahassee, Florida, and Sacramento, California) and two large urban areas (Chicago, Illinois, and Atlanta, Georgia). In each location, routes requiring approximately 30 to 40 minutes of drive time were selected. Each of the routes incorporated characteristics included in Exhibit 26, taken from the HCM 2000. In small urban areas, the focus was on suburban and intermediate characteristics; in large urban areas, the focus was on intermediate and urban characteristics. Twenty-two participants were in the four study locations; their characteristics are described in Exhibit 27.

The findings from this study resulted in 42 Quality of Service (QOS) factors for urban streets that can be categorized into several investment areas. Exhibit 28 contains the identified factors according to driver transcripts and completed surveys.

The researchers further refined the identified QOS factors into nine proposed measures of effectiveness (MOEs) shown in Exhibit 29. The proposed MOEs reflect the input provided by the participants in the study, but combine like QOS factors into, for the most part, measurable performance measures. For example, participants in the study often commented negatively when they were forced to slow down or stop because of poor arterial design that did not provide for bus pullouts, turning facilities, on-street parking maneuvers, and poor access management that created many merge/diverge situations. The authors of this study have concluded that the MOE number of stops best represents the views of the participants in this study.

Intersection LOS Research

Sutaria and Haynes [**15**] focused on determining the different levels of service at signalized intersections. The researchers investigated 30 signalized, isolated, fixed-time intersections in the Dallas-Fort Worth area and determined that only 1 intersection experienced the full range of LOS categories (then based on Load Factor defined as the ratio of the total number of green signal intervals fully utilized by traffic during the peak hour to the total number of green intervals). The intersection of Lemmon and Oaklawn Avenues in Dallas

Exhibit 26. Route Characteristics.

Criterion	Route (Design) Category: Suburban	Intermediate	Urban
Driveway/access density	Low density	Moderate density	High density
Arterial type	Multilane divided; undivided or two-lane with shoulders	Multilane divided or undivided; one-way two-lane	Undivided one-way, two-way, two or more lanes
Parking	No	Some	Significant
Separate left-turn lanes	Yes	Usually	Some
Signals/mile	1-5	4-10	6-12
Speed limit	40-45 mph	30-40 mph	25-35 mph
Pedestrian activity	Little	Some	Usually
Roadside development	Low to medium density	Medium to moderate density	High density

Exhibit 27. Participant Characteristics.

Field Site	Number of Participants	Ages	Sex
Northern Virginia (Pilot location)	4	2 20 - 30 year olds 2 35 - 50 year olds	2 women 2 men
Chicago	5	2 20 - 30 year olds 3 35 - 50 year olds 0 60 - 75 year olds	3 women 2 men
Tallahassee	5	1 20 - 30 year old 2 35 - 50 year olds 2 60 - 75 year olds	3 women 2 men
Atlanta	6	0 20 - 30 year olds 3 35 - 50 year olds 3 60 - 75 year olds	3 women 3 men
Sacramento	6	1 20 - 30 year old 3 35 - 50 year olds 2 60 - 75 year olds	4 women 2 men

Exhibit 28. Driver-Identified QOS Factors For Urban Streets.

Investment Area	QOS Factor	
Cross-Section Roadway Design	Lane width Pedestrian/bicyclist facilities # of lanes/roadway width Bus pull-outs Turning lanes/bays	Parking Lane drop/add Access management Medians Two-way center left turn lane
Arterial Operations	Number of traffic signals Presence of large vehicles Volume/congestion	Travel time Traffic flow Speed
Intersection Operations	Signal failure/inefficient signal timing Turning	Timing of signals Traffic progression
Signs and Markings	Quality of pavement markings Advance signing Lane guidance—signs Too many signs	Lane guidance—pavement markings Sign legibility/visibility Sign presence/usefulness
Maintenance	Pavement quality	Overgrown foliage
Aesthetics	Presence of trees Medians with trees Visual clutter	Cleanliness Roadside development
Other Road Users	Illegal maneuvers Careless/inattentive driving Driver courtesy Use of turn signals	Aggressive drivers Pedestrian behavior Improper/careless lane use Blocking intersection
Other	Intelligent transportation systems	Roadway lighting Planning

Exhibit 29. Proposed MOEs For Urban Streets.

MOEs	QOS Factors
Number of stops	Turning lanes/bays Bus pull-out areas On-street parking Two-way center left-turn lane Access management Lane drop/add
Urban street capacity	Heavy vehicles Lane width Number of lanes/roadway width
Intersection efficiency	Signal timing (cycle length/cycle split) Provision for turning vehicles
Urban street efficiency	Progression Number of traffic signals Travel time Travel speed
Traffic volume	Volume/congestion Traffic flow Speed Travel time
Positive guidance	Quality of pavement markings Sign legibility/visibility Sign presence/usefulness Lane guidance—signs Lane guidance—pavement markings Advance signing Too many signs (clutter/distracting) Visual clutter
Pavement quality	Pavement quality
Perceived safety	Presence of medians Lane width Pedestrian/bicycle facilities Access management
Area type	Roadside development Cleanliness Trees Visual clutter

was filmed using 16mm cameras for several hours to gather several film clips ranging from A to E Level of Service. For the study, 14 film clips, ranging from 42-193 seconds, were shown to the participants. The film clips were broken into two groups: microviews that showed the traffic situation from the view of an individual driver seated in an automobile and macroviews that showed the overall traffic situation on a given approach from high above. Seven clips, ranging from LOS A to LOS E, in each group were shown to participants.

There were 310 participants in the study. The participants were given a questionnaire about their perceptions of signalized intersections before viewing the films collected in the field. The participants were asked to indicate, in order of importance, the factors that affect their perceived views of quality of flow at signalized intersections. They were given five factors to rank: delay, number of stops, traffic congestion, number of trucks/buses, and difficulty in lane changing. It does not appear that definitions of the factors were provided to the participants.

Before viewing the films, the participants ranked the factors as follows:

1. Delay,
2. Number of stops,
3. Traffic congestion,
4. Difficulty in lane changing, and
5. Number of trucks/buses.

After viewing the films, the rankings changed slightly as follows:

1. Delay,
2. Traffic congestion,
3. Number of stops,
4. Difficulty in changing lanes, and
5. Number of trucks/buses.

After viewing each of the 14 film clips, the participants were also asked to score the service quality of the various film segments on two different opinion scales: a 6-point scale (Scale A) and one of five descriptions (Scale B) (See Exhibits 30 and 31.)

Based on input gathered from this study, the researchers developed a nomograph that depicted the relationship between Average Intersection Delay (AID), Load Factor (LF), and volume-to-capacity ratio (v/c) to perceived or rated level of service. The researchers went on to make three recommendations:

Exhibit 30. Sutaria and Haynes Scale A —Point Rating.

Rating	Description
5	= Excellent
4	= Very Good
3	= Good
2	= Fair
1	= Poor
0	= Very Poor

- AID should be used to predict level of service.
- Similar studies should be conducted on signalized intersections without full actuation.
- Simultaneous filming and field studies should be conducted to allow for accurate measurement of traffic engineering measures captured on film.

Based on the findings of this single research study, the Highway Capacity and Quality of Service Committee overhauled the 1985 HCM to represent level of service at signalized intersections by AID versus LF.

The authors state, "Field studies and the attitude survey provided data for the development of two psychophysical models. Statistical analysis indicated that average individual delay correlated better with level of service rating than with measured load factor and encompassed all levels of service. Of all parameters affecting levels of service, load factor was rated highest by road users."

Ha, Ha, and Berg [**16**] developed models for predicting the number of conflict opportunities (potential conflicts) at an intersection as a function of signal timing, intersection geometry, and turn volumes. Based on a review of previous investigations, they limited their analysis to left-turn and rear-end accident analyses. The "total hazard" at an intersection is the sum of the likely number of rear-end and left-turn accidents multiplied by their severity. The total hazard is converted to a hazard index by dividing by the number of vehicles. The

Exhibit 31. Sutaria and Haynes Scale B – Descriptive Rating.

Description Rating of Quality of Service
I would describe the traffic situation presented in this film segment as a condition of:
• Free flow or as "free flowing" as can be expected if there is a traffic signal at the intersection under study. OR
• Tolerable delay, and nearly as good as could be expected at a signalized intersection. OR
• Considerable delay but typical of a lot of ordinary signalized intersections during busy times. OR
• Unacceptable delay and typical of only the busiest signalized intersections during the rush hour. OR
• Intolerable delay and typical only of the worst few signalized intersections I have seen.

letter-grade level of service is then determined from a hazard index look-up table.

Zhang and Prevedouros [17] developed a model of vehicle-to-vehicle and vehicle-to-pedestrian conflicts and blended it with the existing HCM delay LOS criteria for signalized intersections to obtain an LOS model that combines safety risk with traditional delay measures of LOS. Two delay and safety indices are computed—one for pedestrians, the other for vehicles. Each index is computed as a weighted sum of potential conflicts and delay. The weights are analyst specified. The two indices are then weighted by pedestrian and vehicle volumes, respectively, to obtain a weighted average delay and safety index for the intersection. No surveys of traveler perception were performed. This paper was oriented toward methodological approaches rather than traveler perception.

Several recent studies of intersection LOS have also cast some doubt on the HCM's methods. Zhang and Prevedouros (2004) [18] investigated motorists' perceptions of LOS at case study signalized intersections and found that, although the HCM 2000 predicts that permitted left-turn phases provide a higher level of service, users ranked protected left-turn phased intersections higher. This finding suggests that users may be including the perceived safety benefits of protected phasing at these case study locations in their assessments of LOS, in addition to delay. In a follow-up study, Zhang and Prevedouros (2005) [19] surveyed users' perceptions of service quality at intersections and found that users consider multiple factors beyond delay (as calculated by the HCM 2000), including signal efficiency, left-turn treatment, and pavement conditions. Delay scored relatively low among important factors. Drivers prefer to make left turns under protected left-turn signals, especially at large intersections. Safety was stated to be 3 to 6 times more important than delay, depending on the type of conflict.

The importance of safety in determining the level of service offered by an intersection is reflected in a study by Li et al. (2004) [20]. Li et al. used a "gray system" theory-based method to rank and evaluate the operational and safety performance of signalized intersections in mixed traffic conditions. The degree of saturation, average stopped delay, queue length, conflict ratio, and separation ratio are all used as parameters. Results of application in the urban area of Changsha, China, show that the method can be used to conduct a comprehensive (safety and operations) performance under mixed traffic conditions.

Pecheux, Pietrucha, and Jovanis [21] addressed users' perception of level of service at signalized intersections. The research objectives were to examine delay distributions, assess the accuracy of delay estimates, determine if current levels of service are appropriate, and identify factors affecting perceptions. The research used a video laboratory to show 100 participants (in groups of 7 to 10) a tape of a series of signalized intersections. The intersections portrayed on the tape were chosen in cities outside the local area to eliminate familiarity by the subjects, but in a location nearby so that local conditions were represented. The results of the study showed that, on average, subjects' delay estimates were fairly accurate, but widely variable on an individual basis. The study also showed that subjects perceived three or four levels and were more tolerant of delays than suggested by the HCM. At least 15 factors emerged from the group discussions that subjects identified as influential in their LOS ratings. These included delay, traffic signal efficiency, arrows/lanes for turning vehicles, clear/legible signs and road markings, geometric design of intersection, leading left-turn phasing scheme, visual clutter/distractions, size of intersection, pavement quality, queue length, traffic mix, location, scenery/aesthetics, and presence of pedestrians.

Use of Fuzzy Logic for LOS Modeling

Recent research has begun to use "fuzzy logic" to identify delay thresholds for rating the level of service of signalized intersections.

Fang and Pecheux [22] conducted a video laboratory of 98 subjects assessing the quality of service on 24 signalized intersection approaches. Cluster analysis (employing fuzzy thresholds) revealed that their subjects' quality of service assessments did not distinguish between the delays at HCM LOS A or B. The LOS ratings of their subjects, however, did distinguish two classes of delay for delays at HCM LOS F.

Zhang and Prevedouros [23] conducted a web-based stated preference survey of 1,300 volunteers. Their survey identified delay, pavement markings, presence of exclusive left-turn lanes, and protected left-turn phases, as factors significantly affecting the perceived level of service at a signalized intersection. Fuzzy inference was used to identify a distribution of LOS responses for a given physical condition. A percent confidence level was then reported for each LOS letter grade.

Lee, Kim, and Pietrucha [24] exposed 27 subjects to video clips of 12 signalized intersections. Subjects were asked to (1) rate their intersection experience as "poor," "acceptable," or "good" and (2) describe the relative importance of six criteria to their rating of the intersections. The six criteria evaluated were delay, gaps in cross street traffic while waiting, efficiency of traffic signal operation, visibility of signal, signing/markings, and physical features of the intersection.

Rural Road Research

Nakamura, Suzuki, and Ryu [25] conducted a field driving survey on a rural motorway section under uncongested traffic flow conditions and measured the driver's satisfaction with the road. The test area was a 9.3-km, 4-lane, rural basic motorway section between an on-ramp and an off-ramp. Twenty-four participants drove subject vehicles in both directions in the study segment for a total of 105 test runs. Videocameras were mounted on the test vehicle to record travel time, number of lane changes, time of a car-following situation by lane, and elapsed travel time by lane. The factor that most influenced driver satisfaction was traffic flow rate. The number of lane changes, the elapsed time of a car-following situation, and the driver's experience also affected the driver's evaluation of traffic conditions.

3.2 Transit Passenger Perceptions of LOS

Recent transit LOS research has focused on developing methods that incorporate more than just the characteristics of the available transit service, but measures of the environment in which that service operates. Fu et al. [**26**] developed a Transit Service Indicator (TSI) that recognizes that quality of service results from the interaction of supply and demand. The proposed index uses multiple performance measures (e.g., service frequency, hours of service, route coverage, and various travel-time components as well as spatial and temporal variations in travel demand). Tumlin et al. [**27**] developed a method that assesses transit performance in the context of different transportation environments. Quality of service criteria and scores reflect system performance in each area as well as provide for an aggregate measure of transit quality of service.

Other transit LOS research efforts have focused on developing or refining measures that can be easily calculated using existing transit agency data sources. Xin et al. [**28**] applied the recent edition of the TCQSM to evaluate the quality of transit service on several travel corridors in an urbanized area. Findings indicate that TCQSM measures (e.g., service frequency, hours of service, service coverage, and transit-auto travel time) are sensitive to planning/design variables (e.g., service headway, route structure, and service span) and, therefore, can be easily calculated by transit agencies using readily available data. Furth and Muller [**29**] noted that traditional transit service quality measures analyze waiting time and service reliability separately, underestimating the total costs of service unreliability which cause patrons to budget extra time waiting for transit to account for unreliability. Using AVL data, actual plus budgeted waiting time were measured and converted to costs. Findings indicate that service reliability improvements can reduce waiting cost as much as large reductions in service headways.

A Handbook for Measuring Customer Satisfaction

Morpace [**30**] presents a methodology for measuring customer satisfaction on an ongoing basis and the development of transit agency performance measures in response research findings.

The authors point out that the results of a customer satisfaction measurement program cannot be expected to drive agency decisions. Agency personnel must choose between improvements to address customer expectations and better education of customers about service parameters. They state the premise that, "Customers must always be first, [but] customers may not always be right".

They identify 10 Determinants of Service Quality, which are applicable to most service industries. The contention is that consumers use basically similar criteria in evaluating service quality. The 10 criteria are as follows:

1. Reliability (consistent and dependable);
2. Responsiveness (timeliness of service, helpfulness of employees);
3. Competence (able to perform service);
4. Accessibility;
5. Courtesy;
6. Communication;
7. Credibility;
8. Security;
9. Understanding the Customer; and
10. Tangibles.

They identify four transit market segments:

1. Secure customers very satisfied, definitely would repeat, definitely would recommend;
2. Favorable customers;
3. Vulnerable customers; and
4. At-risk customers.

They recommend that telephone benchmark surveys be used to establish baseline customer satisfaction with the transit service. These surveys are fairly expensive, so they also recommend a simpler survey approach, based on "impact scores," be used for tracking progress regularly.

The "impact score survey" is administered on-board and distributed to transit riders annually or biennially. The goal is to identify those attributes that have the greatest negative effect on overall customer satisfaction and also affect the greatest number of customers.

They suggest the use of an "Impact Score Technique" to identify the effect on customer satisfaction of "Things Gone Wrong" with the service. The score weights the effect of a service problem on customer satisfaction by the percentage of customers experiencing the service problem. The resulting score gives the expected change in the customer satisfaction index for the operator.

The steps to developing an impact score system are as follows:

1. Identify attributes with most impact on overall customer satisfaction. Compute gap scores.
2. Identify percent of customers who experienced the problem.
3. Create a composite index by multiplying gap score by incidence rate. Result is attribute impact score.

Example:

> Overall satisfaction rating for attribute 1 is
>
> 6.5 for those experiencing problem past 30 days
> 8.5 for those with no problem past 30 days
>
> The Gap score is 2.0 (8.5 – 6.5). If 50% of customers report having the problem, then the composite impact score is 2.0 * 50% or 1.00.

A Guidebook for Developing Transit Performance Measurement System

Although focused on implementing and applying a transit performance-measurement program, the *Guidebook for Developing a Transit Performance Measurement System* [**31**] provides useful information on more than 400 transit performance measures (including some for which levels of service have been developed) and on various means of measuring transit performance. The processes of developing customer satisfaction surveys and passenger environment surveys (a "secret shopper" approach to evaluating comfort-and-convenience factors) are summarized. Performance measures discussed in the guidebook cover the passenger, agency, community, and driver/vehicle points of view. Twelve case studies are presented in the guidebook on how agencies measure performance; 18 additional case studies are presented in a background document provided on an accompanying CD-ROM.

Application of Transit QOS Measures in Florida

Perk and Foreman (2001) [**32**] evaluated the process and results of the first year's application of the quality of service measures contained in the TCQSM by 17 metropolitan planning organizations (MPOs) in the state of Florida. Each MPO evaluated transit LOS in terms of service coverage, service frequency, hours of service, transit travel time versus auto travel time, passenger loading, and reliability.

The evaluation procedure balanced comprehensiveness (covering as much of the area as possible) with cost. Service coverage and transit-auto travel time were evaluated for the system. For the remaining measures, 6 to 10 major activity centers within the region, resulted in 30 or 90 combinations of trips between activity centers. Service frequency and hours of service were evaluated for all origin-destination (O-D) combinations. Passenger load and on-time performance data were collected for the 15 O-D combinations that had the highest volumes (total of all modes), as determined from the local transportation planning model. Transit travel times, hours of service, and frequencies were obtained from local transit schedules. The travel demand between centers was obtained from the local travel model. Field measurements were required to obtain reliability data and passenger loading data.

The authors point out that there were issues with the selection of major activity centers, including a general bias toward selecting for analysis those activity centers with the best existing transit service for analysis. The authors also found that the activity center selection method resulted in work ends of trips being over-represented and home ends of trips being under-represented

There were also various issues with the difficulty and cost of data collection (e.g., the validity of mixing field data on passenger loads and transit travel times with model estimates of travel times and demand for the computation of some of the level of service measures). Training to improve consistency and reduce wasted efforts was also necessary. There was a strong concern about the costs of collecting and processing the data without receiving additional state funding to cover those costs. MPO-estimated costs ranged from "negligible" to $50,000, with most in the $4,000-$5,000 range. The $50,000 cost reflects an MPO that waited until the last minute to start the work and ended up contracting the work out.

3.3 Bicyclist Perceptions of LOS

Researchers have used various methods to measure bicyclist satisfaction with the street environment. Methods have included field surveys (e.g., having volunteers ride a designated course), video laboratories, and web-based stated preference surveys. One researcher intercepted bicycle riders in the middle of their trip in the field.

Petritsch et al. [**33**] compared video lab ratings with field ratings of segment LOS and found they were similar.

Some researchers have asked bicyclists which factors are most important to the perception of quality of service. Other researchers have derived the factors by statistically fitting models of level of service to the bicyclist-reported level of service. Some researchers have used both methods.

Many researchers have fitted models that predict the mean level of service that would be reported by bicyclists. Some have fitted ordered cumulative logit models that predict the percentage of bicyclists who will report a given LOS grade. The final LOS grade is then the one for which at least 50% of the responses were equal to or greater than that LOS grade.

Some researchers (particularly the FDOT-sponsored research—See Landis for example) have defined LOS A as being the best and LOS F as being the worst. Others have defined LOS A as being "very satisfied" and LOS F as being "very unsatisfied" (see the Danish research reported by Jensen, below). Zolnick and Cromley [**34**] developed a bicycle LOS model based on the probability of bicycle/motor vehicle collision frequency and severity. One pair of researchers (see Stinson and Bhat below) sought to obtain measures of bicycle perceptions of quality of service by asking route choice questions. Their theory was that bicyclists will select the route that gives them the greatest satisfaction.

Most of the research has focused on predicting bicycle level of service for street segments between signalized intersections. A few research projects have focused on predicting the overall arterial street level of service.

An Arterial LOS Model Based on Field Surveys and Video Lab

Petritsch et al. [**35**] developed an arterial LOS model for bicyclists based on a mix of video laboratory and field surveys. LOS observations were obtained from 63 volunteers who rode the 20-mile course in Tampa, Florida, in November 2005. An LOS rating was obtained for each of the 12 sections of the course. A total of 700 LOS ratings were obtained. The average ratings for each section rated in the field ranged from LOS B to LOS E.

The volunteers identified bike lanes, traffic volume, pavement condition, and available space for bicyclists as their most important factors for rating section LOS. The recommended arterial LOS model for bicyclists is as follows:

$$\text{BLOS Arterial} = 0.797\ (\text{SegLOS}) + 0.131\ (\text{unsig/mile}) + 1.370 \qquad \text{(Eq. 5)}$$

Where

SegLOS = the segment level of service numerical rating ($A \le 1.5, B \le 2.5, C \le 3.5, D \le 4.5, E \le 5.5$)

Unsig/mile = Number of two-way stop controlled intersections per mile (arterial does not stop).

$$\text{SegLOS} = 0.507 * \ln(\text{Vol15/lane}) + 0.199\ \text{SPt}\ (1 + 10.38\ \text{HV})^2 + 7.066\ (1/\text{PC5})^2 + -0.005\ (\text{We})^2 + 0.760 \qquad \text{(Eq. 6)}$$

Where

Vol 15 = volume of directional traffic in 15-minute time period

L = total number of through lanes

SPt = effective speed limit (see below)

$= 1.12\ln(\text{SPP} - 20) + 0.81$

And SPP = Posted speed limit (mi/h)

HV = percentage of heavy vehicles

PC5 = FHWA's five point surface condition rating

We = average effective width of outside through lane

Petritsch [**36**] documented the video laboratory portion of the research. Seventy-five volunteers were shown video of eleven sections. The total viewing time for the video was 47 minutes. Comparison of the 615 LOS ratings by the video and the field participants found that the null hypothesis that there was no difference in the mean ratings between the field and video lab participants could not be rejected at the 5% probability of a Type I error (rejecting the null hypothesis when it is really true).

Segment LOS Models Based on Field Surveys or Video Lab

Jensen [**37**] showed 407 people video clips of 56 roadway segments (38 rural, 18 urban) in Denmark. A total of 7,724 LOS ratings were obtained for pedestrian LOS. Another 7,596 LOS ratings were obtained for bicycle LOS. A 6-point satisfaction scale was used (very satisfied, moderately satisfied, a little satisfied, a little dissatisfied, moderately dissatisfied, very dissatisfied). Jensen noted that walking against traffic, sounds other than traffic, weather, and pavement quality all affected perceptions of either bicycle or pedestrian LOS, but these variables were dropped from the model because they were not considered useful to the road administrators who would apply the models. Cumulative logit model forms were selected for both the bicycle and pedestrian LOS models. These models predicted the percentage of responses for each of the 6 levels of service. The single letter grade LOS for the facility was determined by the worst letter grade accounting for over 50% of the predicted responses for that letter grade and better (For example, if over 50% responded LOS B or better and less than 50% responded LOS A, then the segment LOS was B).

Landis et al. [**38**] documented a field survey of 60 bicyclist volunteers riding a 27-km (17-mi) course, in Orlando, Florida. The course included 21 intersections, of which 19 were signal controlled, 1 stop controlled, and 1 a roundabout. The volunteers ranged from 14 to 71 years of age (individuals 13 years and under were prohibited from participating because of safety concerns); 34 percent of the volunteers were female. Most of the volunteers were "experienced" bicycle riders (i.e., those riding more than 200 miles per year). Riders with over 1,000 miles per year of riding experience represented a disproportionate share of the volunteers.

The course consisted of roadways ranging from two to six lanes with average daily traffic (ADT) from 800 to 38,000 vehicles per day on the day of the survey. The percentage of trucks ranged from zero to 8.1. The posted speed limits ranged from 25 to 55 mph.

Participants were given a score card to carry with them and instructed to "circle the number that best describes how comfortable you feel traveling through the intersection" immediately after crossing each subject intersection. The researchers defined Level A for the participants as "the most safe or comfortable." Level F was defined for the participants as "the most unsafe or uncomfortable (or most hazardous)."

Videocameras were used to record (1) participant numbers and time at each intersection and (2) traffic conditions at the actual moment when the rider crossed the intersection. Machine road tube counters were used to collect volumes at the time of the survey. Turn-move counts were also collected on the day of the survey.

Participant starts were spaced so that bicycle-to-bicycle interference would not influence the LOS ratings.

The letter grades were converted to numerical values (e.g., A = 1, F = 6) (see Exhibit 32) and a hypothesis test was performed to determine if sex had a significant effect on the mean LOS ratings. The mean rating for the 20 female participants was 2.86. For the 39 male participants, the mean rating was slightly lower—2.83 (The lower rating implies better perceived LOS). A t-test indicated that this difference was not significant at the 5% Type I error level.

A second hypothesis test was made for delay. The 26 riders having to stop for the signal gave the intersections an average 2.93 rating, while the 33 not stopping rated the intersections 2.94 (the higher rating implied worse perceived LOS). This difference was also insignificant at the 5% Type I error level. Those stopping at a signal were delayed an average of 40 seconds.

A third test was for the effect of rider experience. The 55 experienced bicyclists reported an average LOS rating of 2.80. The four inexperienced cyclists reported an average LOS rating of 3.42 (the higher rating implied worse perceived LOS). This difference was found to be statistically significant. However, the four inexperienced cyclists' results were included with the experienced cyclists' results for the purpose of model development.

The level of service model is as follows:

$$LOS = -0.2144Wt + 0.0153CD + 0.0066(Vol15/L) + 4.1324 \quad \text{(Eq. 7)}$$

Where

LOS = perceived hazard of shared-roadway environment for bicyclists moving through the intersection.

Wt = total width of outside through lane and bike lane (if present).

CD = crossing distance, the width of the side street (including auxiliary lanes and median)

Vol15 = volume of directional traffic during a 15-minute time period.

L = total number of through lanes on the approach to the intersection.

The researchers reported a correlation coefficient (R-square) of 0.83 against the average repored LOS for each of 18 signalized intersections. The table below shows the author's proposed correspondence between LOS letter grade and the scores reported by the volunteers. The authors selected the breakpoints. They are not based on an analysis of the reported scores.

The lowest possible score that an individual could report was 1.00, so a preponderance of 1.00 responses was required for the average response to be less than 1.5. It was harder to get LOS A or LOS F than the other levels of service, because A and F require more agreement among the respondents than for the other levels of service.

Harkey, Reinfurt, and Knuiman [**39**] developed a model for estimating bicycle level of service, based on users' perceptions. The model, known as the Bicycle Compatibility Index (BCI), was designed to evaluate the ability of urban and suburban roadways to accommodate both motor vehicles and bicyclists. The study included 202 participants, ranging from 19 to 74 years of age; approximately 60 percent were male. The expertise level of the participants ranged from daily commuters to occasional recreational riders. The participants were surveyed in Olympia, Washington; Austin, Texas; and Chapel Hill, North Carolina. The study consisted of showing participants a series of stationary camera video clips taken from 67 sites in

- Eugene and Corvallis, Oregon;
- Cupertino, Palo Alto, Santa Clara, and San Jose, California;
- Gainesville, Florida;
- Madison, Wisconsin; and
- Raleigh and Durham, North Carolina.

Exhibit 32. Correspondence Between LOS Grade and LOS Numerical Score (Landis).

LOS	Model Score
A	≤ 1.5
B	> 1.5 and ≤ 2.5
C	> 2.5 and ≤ 3.5
D	> 3.5 and ≤ 4.5
E	> 4.5 and ≤ 5.5
F	> 5.5

The video clips showed various characteristics, including a range of curb lane widths, motor vehicle speeds, traffic volumes, and bicycle/paved shoulder widths.

Participants were asked to rate their comfort level based on a 6-point scale in the following categories: volume of traffic, speed of traffic, width or space available for bicyclists, and overall rating. In the end, eight variables were found to be significant in the BCI regression model:

- Number of lanes and direction of travel;
- Curb lane, bicycle lane, paved shoulder, parking lane, and gutter pan widths;
- Traffic volume;
- Speed limit and 85 percentile speed;
- Median type (including two-way left turn lane);
- Driveway density;
- Presence of sidewalks; and
- Type of roadside development.

Given that this research was done in a laboratory setting, the subjects could not take into account the comfort effects of pavement condition, crosswinds, and suction effects caused by high-speed trucks and buses. These factors consequently either do not show up or show up to a lesser extent in the BCI model.

Landis et al. [**40**] conducted a field survey of nearly 150 bicyclists who rode a 27-km (17-mile) course in Tampa, Florida. The subjects ranged in age between 13 and over 60 years of age, with 47 percent being female and 53 percent being male. The range of cycling experience was also broad—25 percent of the participants rode less than 322 km (200 miles) yearly to approximately 39 percent of the participants riding over 2,414 km (1,500 miles) yearly. In the study, participants were asked to evaluate the quality of the roadway links, not the intersections, on a 6-point scale (A to F) as to how well they were served as they traveled each segment. They were asked to only include conditions within or directly adjoining the right of way and to exclude aesthetics of the segments. Several significant factors were found to influence bicyclists' perceived quality of service or perceived hazard rating:

- Volume of directional traffic in 15-min period;
- Total number of through lanes;
- Posted speed limit;
- Percentage of heavy vehicles in the traffic stream;
- Trip generation intensity of the land adjoining the road segment;
- Effective frequency per mile of non-controlled vehicular access (e.g., driveway and on-street parking spaces);
- FHWA's five-point pavement surface condition rating; and
- Average effective width of the outside through lane.

Between the two bicycle quality of service studies, the laboratory study conducted by FHWA found very similar factors that influenced quality of service ratings. However, the field studies revealed variables that would be difficult to simulate in a laboratory setting, such as percentage of heavy vehicles and pavement surface condition. The participants in the field study rode alongside traffic and rated the percentage of heavy vehicles as one of the top important factors followed by the condition of the pavement. This comparison of data collection opportunities is the only one that can be made at this time for similar modes of travel, but may provide insight into the limitations of laboratory studies as compared with field studies.

Measuring LOS Through Route Choice

Stinson and Bhat [**41**] conducted a web-based stated-preference survey of 3,145 individuals. The individuals were recruited through announcements placed with 25 bicyclist-oriented listservers in the United States. Additional announcements were made to a few non-bicyclist-oriented e-mail lists. The sample of respondents was heavily weighted toward members of bicycling groups.

The authors identified 11 link and route attributes (each with multiple levels) for testing. To avoid participant overload, no more than four attributes were considered in any given survey instrument; thus, nine different instruments were required so as to cover the full range of attributes (and levels) of interest.

The respondent characteristics were as follows:

- 91% were experienced bicycle commuters.
- 22% were female.
- About 9% lived in rural areas, 39% lived in urban areas, the rest of the respondents lived in suburbs.

Stinson and Bhat identified travel time as the most important factor in choosing a route, followed by presence of a bicycle facility (striped lane or a separate path). Road class (arterial or local) was the third most important factor.

Stinson and Bhat obtained 34,459 observations of route choice and found that the best model of route choice considered the interactions between the bicyclist characteristics (e.g., age, residential location, and experience bicycling) and the route attributes. Stinson and Bhat noted however that the attributes of the route had a greater effect on route choice than the characteristics of the bicyclists themselves.

Models of Rural Road Bicycle LOS

Jones and Carlson [**42**] developed a rural bicycle compatibility index (RBCI) following a similar approach as that used to generate the FHWA BCI (see Harkey). They employed a web-based survey consisting of questions and thirty-two 30-second video clips.

The 30-second video clips were edited from 15-minute videos shot with image stabilization from a car moving 10 mph at a height 4.5 feet above the ground. Given that overtaking motor vehicle traffic tended to give wide clearance to the slow moving car on the shoulder, the video clips tended to show over-taking vehicles giving bicyclists more clearance than they would in reality. The clips were digitized in Windows Media Player compressed format for easy downloading by survey participants.

Participants for the web-based survey were recruited through letters to various bicycle groups, flyers distributed at popular recreational bicycling facilities, and personal recruiting by the authors.

A total of 101 participants (of which 56 were classified as experienced) successfully completed the survey. The experience level of the respondents was determined by induction from the responses to a few key questions. Slightly fewer than 20% of the respondents were female. None were under 18 years of age.

Three linear regression models (one for experienced riders, one for casual riders, and one for all riders) were fitted to the mean responses for each video clip. The best model included all bicyclists. The compatibility index in this model was a function of only two factors: shoulder width, and the volume of heavy vehicles traveling in the same direction as the bicyclist. The model had an R-square value of 0.67.

Jones and Carlson intentionally excluded pavement condition from the survey because of various data difficulties (including the difficulty of representing rough pavement in a video shot from a camera mounted on a car). All sites had relatively level grades, only two traffic lanes, and speed limits in excess of 50 mph.

Noel, Leclerc, and Lee-Goslin [**43**] recruited bicyclists already using various rural routes to participate in a survey of bicycle compatibility. A total of 200 participants were recruited at 24 sites. Bicyclists were stopped at the start of each test segment and asked to participate in the study. Those consenting were then interviewed to determine their characteristics (e.g., age and city of residence). Participants were given segment and junction rating cards to evaluate six sites on each segment. The cards were collected at the end of the segment and the participants were then asked about various potential factors affecting safety at the junctions.

The respondents were grouped into three experiential types: sport cyclists, moderate cyclists, and leisure cyclists. The survey found the following key factors affecting perceived comfort and safety (ranked by order of importance): riding space available to cyclist, traffic speed, presence of heavy vehicles, pavement conditions, presence of junctions, and finally, vertical profile of the route.

The proposed CRC index includes the following variables:

- Quality of Paved Shoulder;
- Size of Cycling Space;
- Auto Speed;
- Auto Flow;
- Truck Flow;
- Roadside Conditions (e.g., sand, gravel, and vegetation);
- Roadside Development;
- Vertical Profile;
- Longitudinal Visibility; and
- Major Intersections.

3.4 Pedestrian Perceptions of LOS

Researchers have used field intercept surveys and closed course surveys in the field to measure pedestrian perceptions of level of service. Some distributed questionnaires in the field to be returned later via the mail.

Various definitions of level of service have been developed (e.g., LOS A is defined as "best," "most safe," "very satisfied," or "excellent" depending on the researcher).

Some researchers have asked pedestrians to directly rate the level of service of a sidewalk or intersection, while others have sought to derive the LOS rating indirectly from the pedestrian's choice of which sidewalk and crosswalk to use.

Several researchers have focused on the intersection crossing environment. Most have looked at the sidewalk environment. A few have looked at mid-block crossings in between intersections.

None of the researchers have incorporated Americans with Disabilities Act (ADA) considerations in their measurement or prediction of pedestrian LOS. None of the research is specifically applicable to individuals with disabilities.

Intersection Crossing LOS Studies

Several studies focused on specific pedestrian facility types to identify the key variables that determine level of service there. Some focused on methods of determining LOS for pedestrians at crossing locations.

Hubbard, Awwad, and Bullock [**44**] developed a signalized intersection model for pedestrian LOS based on the percentage of pedestrian crossings affected by turning vehicles.

Chilukuri and Virkler [**45**] sought refinements to the HCM 2000 equation for pedestrian delay at signalized intersections, which assumes pedestrians arrive at an intersection randomly. They performed a study of coordinated signal intersections and found that pedestrian delays were significantly different at these locations than expected if arrivals were random. The authors concluded that the HCM pedestrian delay equation should be improved to incorporate the effects of signal coordination.

Clark et al. [46] developed a pedestrian LOS method based on discrete pedestrian crossing outcomes: non-conflicting, compromised, and failed. Their case study results found that the greatest incidence of failed and compromised pedestrian crossings was observed was a moderately high number of vehicular right turns were served by an exclusive right-turn lane that subtended an obtuse angle with a large turning radius.

Lee et al. [47] also looked at crossing LOS using a stated-preference survey. They found that the key determinants of LOS at signalized intersections were area occupancy, pedestrian flow, and walking speed. Similarly, Muraleetharan et al. [48] identified the factors that describe pedestrian LOS at crosswalks and found that the most important factor was the presence of turning vehicles. While confirming these findings, Petritsch et al. [49] provided additional insights into the critical factors that determine pedestrians' perceptions of LOS at signalized intersection crossings. They found that right-turn-on-red volumes for the street being crossed, permissive left turns from the street parallel to the crosswalk, motor vehicle volumes on the street being crossed, midblock 85 percentile speed of the vehicles on the street being crossed, the number of lanes being crossed, the pedestrian's delay, and the presence or absence of right-turn channelization islands were primary factors for pedestrians' LOS at intersections.

Sidewalk and Path LOS Studies

Other studies focused on measuring pedestrian LOS on sidewalks or paths. Analysis of the results of these studies suggests that the most important variables that determine pedestrian LOS—and therefore, the very definition of pedestrian LOS itself—change depending on the context.

As described in more detail under the bicycle LOS model section, Jensen [50] used video lab observations to develop a pedestrian segment LOS model for Denmark.

Bian et al. [51] conducted a sidewalk intercept survey to measure pedestrian perceptions of sidewalk LOS in Nanjing, China. A total of 501 people were interviewed on nine sidewalk segments. They identified lateral separation from traffic, motor vehicle volume and speed, bicycle volume and speed, pedestrian volume, obstructions, and driveway frequency as the factors influencing pedestrian LOS. They defined LOS 1 as "excellent," LOS 2 through 6 are "good," "average," "inferior," "poor," and "terrible," respectively. A linear regression model was fitted to the data to predict the mean LOS rating. The numerical score predicted by the model was converted to a letter grade using the following limits: LOS A <= 1.5, LOS B <= 2.5, LOS C <= 3.5, LOS D <= 4.5, LOS E <= 5.5.

Byrd and Sisiopiku [52] compared the more commonly accepted methods of determining pedestrian LOS for sidewalks, including the HCM 2000, Landis, Australian, and Trip Quality methods. The comparison found that it is possible to receive multiple LOS ratings for the same facility under the same conditions from these methods and the paper concludes that a combined model could be developed that synthesizes the quantitative and qualitative factors that affect pedestrian operations.

Muraleetharan and Hagiwara [53] used a stated preference survey to identify the variables most important to a pedestrian's perception of the utility of the walking environment. A revealed preference survey with 346 respondents was used to develop a utility model that predicts which route a pedestrian will prefer to walk. LOS A was assigned to the maximum computed utility among all of the sidewalks and crosswalks evaluated. LOS F was assigned to the lowest computed utility among all of the sidewalks and crosswalks evaluated.

Muraleetharan et al. [48] found that the "flow rate" is the most important factor that determines pedestrian LOS on sidewalks. Hummer et al. [54] studied pedestrian path operations and found that the path width, the number of meeting and passing events, and the presence of a centerline were the key variables that determined pedestrian path users' perceptions of quality of service. However, Patten et al. [55] noted that when paths are shared between pedestrians and bicyclists, estimating LOS for each user group and designing a new facility to the appropriate width and whether to separate these different users on the right-of-way becomes difficult. Sponsored by FHWA, they developed a bicycle LOS estimation method for shared-use paths to overcome these limitations by integrating a path user perception model with path operational models developed in the project's earlier phases. Petritsch et al. [56] found that traffic volumes, a sidewalk's adjacent roadway width, and the density of conflict points along it (e.g., the number of driveways) are the most important factors determining pedestrian LOS along urban arterials with sidewalks.

Taking a step back to revise the theoretical perspective on pedestrian LOS, Muraleetharan et al. [57] used conjoint analysis to develop a pedestrian LOS method based on total utility value. They found that total utility value can be used as an index of pedestrian LOS of sidewalks and crosswalks.

Sisiopiku et al. [58] reviewed recent research on pedestrian level of service. Their critique can be summed up as follows:

1. Non-HCM methods need to take into account the effect of platooning on pedestrian LOS.
2. All methods need to consider a variety of pedestrian groups. Different groups have different needs.

3. All methods need to be applicable to a full range of pedestrian facility types. Presence of sidewalk should not be a prerequisite.
4. The scale methodologies, although innovative, need further work to overcome problems with overlap of factors, small sample sizes, and nonlinear performance.
5. There is a need to consider a full and far broader range of factors for determining LOS.

Landis et al. [**59**] developed a method to measure pedestrian LOS, to aid in design of pedestrian accommodations on roadways, that is based on field measurements of pedestrian perceptions of quality of service.

The survey included 75 volunteer participants walking a 5-mile (8-km) looped course consisting of 48 directional segments. Traffic volumes ranged between 200 and 18,500 vehicles on the day of the survey. Heavy vehicles accounted for 3% or less of the traffic that day. Traffic running speeds ranged from 15 to 75 mph (25-125 km/h).

The participants were asked to evaluate each segment according to a 6-point (A to F) scale (see Exhibit 33) how safe/comfortable they felt as they traveled each segment. Level A was considered the most safe/comfortable (or least hazardous). Level F was considered the least safe/comfortable (or most hazardous).

Scoring fatigue was noticed as segment scores decreased as each participant walked the length of the course (Participant's expectations for the quality of the service drifted downward as they walked the course. Initial segments were rated more critically than later segments. It required about 2 hours to walk the length of the course). This problem was dealt with by walking people in opposite directions over the looped course and letting the fatigue effect cancel itself out through averaging of the responses.

After eliminating outliers, a total of 1,250 observations were available for analysis. A stepwise linear regression was performed. The resulting equation had an R-square value of 85%, but later researchers have noted that this value was for the ability of the model to predict the average LOS for a segment, not the actual LOS values reported by each individual participant.

Human factors are completely absent from the pedestrian LOS model. Age, sex, physical condition, experience, and residential location (i.e., urban, suburban, or rural) have no effect on the perceived LOS in this model. Crowding and intermodal conflicts with bicycles using the same facility are among the operational factors not included in the model. Grades, cross-slopes, and driveways are among the physical factors not included in the model.

$$\text{Ped LOS} = -1.2021 \ln (W_{ol} + W_l + f_p \times \%OSP + f_b \times W_b + f_{sw} \times W_s) + 0.253 \ln (Vol_{15}/L) + 0.0005\, SPD^2 + 5.3876 \quad \text{(Eq. 8)}$$

Where

W_{ol} = Width of outside lane (feet)
W_l = Width of shoulder or bike lane (feet)
f_p = On-street parking effect coefficient (=0.20)
%OSP = Percent of segment with on-street parking
f_b = Buffer area barrier coefficient (=5.37 for trees spaced 20 feet on center)
W_b = Buffer width (distance between edge of pavement and sidewalk, feet)
f_{sw} = Sidewalk presence coefficient = 6 – 0.3Ws (3)
W_s = Width of sidewalk (feet)
Vol_{15} = Traffic count during a 15-minute period
L = total number of (through) lanes (for road or street)
SPD = Average running speed of motor vehicle traffic (mi/hr)

Use of Visual Simulation

Miller et al. [**60**] describes the use of computer-aided visualization methods for developing a scaling system for pedestrian level of service in suburban areas. A group of test subjects was presented with simulations (computer animations and still shots) of scenarios of improvements to a suburban intersection at an arterial. The subjects were asked to rate each option from A (best) to E (worst) and also to give a numerical score from 1 to 75. These ratings were compared with a set of LOS ratings derived from a scale in which points were assigned based on various intersection characteristics: median type, traffic control, crosswalks, and speed limits. The results of the experiment led to a substantial revision of the scale ranges that correspond to specific levels of service. The authors concluded that, although visualization cannot replace real-world experience, it can be an appropriate tool for site-specific planning. The methods discussed are ". . . inexpensive, practical, and original ways of validating a scale that help ensure that the pedestrian environment is not unnecessarily compromised, especially on automobile-dominated arterials."

Midblock Crossing LOS Studies

Chu and Baltes [**61**] developed a LOS methodology for pedestrians crossing streets at mid-block locations.

Exhibit 33. LOS Categories.

LOS	Model Score
A	≤ 1.5
B	> 1.5 and ≤ 2.5
C	> 2.5 and ≤ 3.5
D	> 3.5 and ≤ 4.5
E	> 4.5 and ≤ 5.5
F	> 5.5

Thirty-three mid-block locations in Tampa and St. Petersburg were identified to be included in the study. A total of 96 people were hired by a local temp-worker agency to test the mid-block crossings. They ranged in age from 18 to 77 years with a mean of 42.7 years of age. Sixty-eight percent of the participants were female and 32 percent were male.

The participants were bused to each site and asked to observe mid-block crossings for 3-minute periods and then rate the difficulty of crossing on a six-point scale (A to F). Crossing difficulty was defined as the risk of being hit by a vehicle, the amount of time to wait for a suitable gap in traffic, presence of a median or other refuge, parked cars, lack of an acceptable (wide enough) traffic gap, or anything else that might affect crossing safety in determining the crossing difficulty. It was stressed to the participants to only consider their crossing difficulty, not for others that might cross the roadway. A total of 767 observations were made. Results of the study showed that the level of crossing difficulty tended to increase with the width of painted medians, signal spacing, and turning movements, and that the presence of pedestrian signals lowered the perception of crossing difficulty. The presence of pedestrian signals and cycle length were also shown to be statistically significant. The final linear regression model had an R-square value of 0.34 and contained 15 variables relating to traffic volumes, turning volumes, age of pedestrian, average vehicle speed, crossing width, presence of pedestrian signal, cycle length, and signal spacing.

Chu, Guttenplan, and Baltes [**62**] placed 86 people at 48 intersection and mid-block locations and asked them to identify one of six routes they might take to cross the street. They obtained a total of 1,028 observations of 4,334 cases. They fitted a 2-level nested logit model to the survey responses. The first level predicted whether they would cross at an intersection or cross mid-block. The lower level then predicted which of various mid-block crossing routes they might pick. The significant explanatory factors were starting or ending point of trip, walking distance, crosswalk marking, and presence of traffic or pedestrian signal. Less significant factors included in the model were traffic volume and shoulder/bike lane width. Delay at the signal was not an explicit factor. The presence of a signal positively encouraged crossings at the intersection.

3.5 Multimodal LOS Research

Recent work on developing a method to estimate multimodal LOS appears to wrestle with the issue of defining what LOS means in a multi-modal context. Several of these studies are working to establish a "common denominator" that can be used to compare the performance of different modes without unintentionally favoring one mode over the others. Winters and Tucker [**63**] reported on their work for the Florida Department of Transportation (FDOT) to develop a new approach to assess levels of service for automobile, bicycle, pedestrian, and transit modes of travel equally. To even the playing field among modes, they postulated a hierarchy of transportation user needs based on Abraham Maslow's theory of personality and behavior. This transportation theory would consist of five levels: safety and security (the most basic need), time, social acceptance, cost, and comfort and convenience (the least basic need). Perone et al. [**64**] provide an update to this FDOT work in their final project report. Their final multi-modal model is based on the work of Maslow as well as Alderfer and his Existence, Relatedness and Growth (ERG) Theory. The project provides evidence for the existence of such a hierarchy in which most participants chose Existence over Relatedness over Growth needs and found that a lower motivator need not be substantially satisfied before one can more onto higher motivators.

Dissatisfied with inadequacies of auto-based (i.e., HCM) and other multi-modal measures of LOS for project-level environmental impact reviews, Hiatt [**65**] reports on the City of San Francisco's efforts to develop an alternative method for use in that city's urban, multi-modal context. The paper discusses a proposed alternative to modal-based LOS measures that calculates automobile trips generated that would vary by land use typology and parking supply, and reflect expected mode shifts associated with projects such as bicycle or transit lanes.

Winters et al. [**66**] looked at various methods for achieving comparability of LOS significance across modes. They identified the issue of different letter grades implying "traveler satisfaction" for the various modes. LOS D for highway facilities is considered satisfactory by many public agencies for facility planning purposes. However, LOS D for bicycles may be a facility that only the hardiest bicyclists dare use. LOS D may not be a satisfactory level of service for planning bicycle facilities.

The authors conducted a literature review and then developed various options for reconciling the meaning of LOS across modes to an advisory panel of stakeholders consisting of potential technical users of the LOS methodology for state and local agency facility planning purposes.

The authors looked at how the various modal measures of LOS addressed different degrees of travelers' needs. Some, like FDOT's bicycle and pedestrian LOS measures are based on travelers' perception of safety, which is a higher priority need than "convenience" which is implicit in the auto LOS measure of speed.

They suggested offsetting the scales against some standard of traveler satisfaction, i.e., using a sliding scale. LOS D is the threshold of acceptability for auto, but LOS C is the threshold of acceptability for bicycles. The advisory panel accepted (with reservations) this slide rule method, but recommended that additional data be acquired for identifying common denominators across modes for level of service.

Crider, Burden, and Han [**67**] developed a conceptual framework for the assessment of multimodal LOS at intersections and bus stops for the transit, bicycle, and pedestrian modes. For transit, a bus stop LOS measure based on frequency and pedestrian accessibility was recommended. For bicycles and pedestrians, intersection LOS measures based on conflicts, exposure, and delay to through movements were recommended. Various techniques for surveying traveler perceptions were considered and a selected set of techniques was recommended.

Dowling [**68**] developed a methodology for assessing multimodal corridor level of service involving parallel facilities. The methodology generally relied on existing FDOT methods for estimating facility LOS and created new LOS measures to address aspects of corridor LOS not covered by current methods. New LOS measures included difficulty of crossing of freeway LOS, freeway HOV lane LOS, rail LOS, off-street bike/pedestrian path LOS, and a congestion-based measure of auto LOS (i.e., the ratio of congested speed to free-flow speed).

Phillips, Karachepone, and Landis [**69**] documented the results of a project to develop planning analysis tools for estimating level of service for transit, pedestrian, and bicycle modes. This research built on prior research by Sprinkle Consulting and Kittelson & Associates and was adapted for use in the Florida Quality/Level of Service Handbook.

The Phillips, Karachepone, and Landis report defined Quality of Service as "The overall measure or perceived performance of service from the passenger's or user's point of view." The report defined Level of Service as "A range of six designated ranges of values for a particular aspect of service, graded from "A" (best) to "F" (worst) based on a user's perception." It defined Performance Measures as "A quantitative or qualitative factor used to evaluate a particular aspect of service." The distinction between "service measures" and "performance measures" was that service measures represented only the passenger or user's point of view, while performance measures could consider a broader range of perspectives, especially those of the public agency.

Guttenplan et al. [**70**] discussed methods developed by FDOT to determine level of service to through vehicles, scheduled fixed-route bus users, pedestrians, and bicyclists on arterials. FDOT was concerned that the HCM assessment of arterial LOS focuses primarily on the automobile; LOS designations for pedestrians and bicycles are based primarily on facility crowding. Recent research, however, has found that quality of service for pedestrians and bicyclists depends more on lateral separation of the mode, motorized vehicle volumes and speeds, and transit frequency of service.

This paper presented the methods used by FDOT to calculate LOS for bicycles, pedestrians, and transit. For each mode, a score is computed using various characteristics of the roadway and traffic; LOS thresholds are used to transform the scores into LOS measures. Bicycle LOS depends primarily on effective width of the outside through lane (including bicycle lane width) and the volume of motorized vehicles. Pedestrian LOS depends on sidewalk presence, roadway widths, separation from traffic, and vehicle speeds and volumes. Transit LOS depends on service frequency, adjusted for pedestrian LOS and hours of service per day.

The methods described in the paper are primarily segment-based; additional research is under way to expand the applicability of the method (e.g., to area wide and point-level analyses). Separate LOS measures are provided for the different modes; but FDOT does not provide a single LOS measure that combines all modes because doing so could mask the effect of less-used modes. A key feature of the method is that it captures interactions between modes, including the interactions of pedestrians and transit.

Guttenplan et al. [**71**] describes the development of a multimodal areawide LOS methodology based on the FDOT Q/LOS Handbook procedures for individual facilities and modes. The steps of the methodology are

1. Define major modal facilities within study area.
2. Determine percentage of households and employment located within service areas of each major modal facility. The percentage of households and employment served by the major modal facilities sets the ceiling for the best possible areawide LOS for the mode.
3. Determine modal LOS for each major modal facility.
4. Compute mean modal LOS across all major modal facilities in the study area.
5. Select the lower of mean modal facility LOS or the percentage households and employment served LOS value.

CHAPTER 4

Data Collection

The literature review found that various methods have been used to measure traveler perceptions of quality of service (i.e., field surveys, video laboratory surveys, simulator surveys, telephone surveys, and web surveys). The literature review revealed the wide range of customer satisfaction measurements used and the wide range of variables that researchers had determined to be critical for predicting or measuring traveler perceptions of quality of service. Some of the differences could be attributed to differences in survey methods. Other differences could be attributed to differences in the situations to which the survey participants were exposed. Still other differences could be attributed to differences in how quality of service was defined (or left undefined) for the participants. In addition, all surveys were limited to a single metropolitan region, so it was not possible to rule out the potential effects of geographic location on the reported LOS models.

The objective of the data collection task was, therefore, to develop and execute a set of quality of service surveys that could be uniformly and consistently implemented across all modes and in several different metropolitan areas of the United States.

All prior quality of service surveys had been limited to a single site in a single urban area. One of the major purposes of the new data collection under NCHRP Project 3-70 was to gather data using a consistent method across multiple urban areas to determine if LOS perceptions vary significantly across urban areas of the United States.

The data collection task of this project was conducted in two phases. Various data collection methods were pilot tested during Phase 1. The data collection effort for the project was completed in Phase 2.

4.1 Selection of QOS Survey Method

Several different methods have been used in the literature to measure traveler perceptions of satisfaction. These methods include traveler intercept surveys, field laboratory studies, and video laboratory studies. Introductory material on customer satisfaction survey techniques can be found in Trochim [**72**].

- **Traveler Intercept Surveys** directly measure the LOS perceptions of actual travelers making real trips. These surveys intercept travelers mid-trip and either orally interview them on the spot or give them a postcard to report their LOS perceptions at a convenient time after they have completed their trip. The Noel, Leclerc, and Gosselin [**73**] study of rural bicycle LOS used this method to measure bicycle LOS on rural roads.
- **Field Laboratory Studies** recruit subjects (paid or unpaid volunteers) to travel over a fixed course in the field and report their LOS perceptions at strategic points along the course. The "Bike for Science" and "Walk for Science" studies by Landis et al. [**74**] [**75**] are examples of this approach to measuring traveler perceptions of level of service.
- **Video Laboratory Studies** show recruited subjects film clips of various street situations in a video laboratory setting. The Pecheux et al. [**76**] and Sutaria and Haynes studies [**77**] for intersection level of service are two examples of this approach to measuring traveler perceptions of level of service.

The level of service research to date is split fairly evenly between the use of field laboratory settings and video laboratory settings for measuring traveler perceptions of level of service (see Exhibit 34). Traveler intercept surveys have been used by a few researchers to measure traveler LOS.

Traveler Intercept Surveys, Field Laboratory Studies, and Video Laboratories Studies each have their relative strengths and weaknesses (see Exhibit 35).

The traveler intercept surveys can gather responses from large numbers of individuals, but only for the particular trip that they made on the facility—the researcher obtains only one data point for each individual responding to the survey.

Exhibit 34. Traveler Perception Survey Methods in the Literature.

Research Team	Data Collection Method	LOS Model
Auto		
Hall, Wakefield, and Kaisy [78]	Focus Group Discussions	Freeway
Pecheux et al.79]	Video Laboratory (100 subjects)	Signalized Intersection
Sutaria and Haynes [80]	Video Laboratory (310 subjects)	Signalized Intersection
Nakamura, Suzuki, and Ryu [81]	Field Laboratory (24 subjects)	Rural Road
Colman [82]	Field Laboratory (50 subjects)	Urban Street
Transit		
Morpace [83]	Traveler Intercept Survey on-board vehicle	Route
Bicycle		
Landis et al. [84]	Field Laboratory (60 subjects)	Intersection
Harkey, Reinfurt, and Knuiman [85]	Video Laboratory (202 subjects)	Segment
Jones and Carlson [86]	Video Lab. Over Web (101 subjects)	Rural Road
Noel et al. [87]	Traveler Intercept Survey (200 subjects)	Rural Road
Landis, Vattikuti, and Brannick [88]	Field Laboratory (150 subjects)	Segment
Stinson and Bhat [89]	Video Lab. Over Web (3,145 subjects)	Segment
Pedestrian		
Miller, Bigelow, and Garber [90]	Simulated Video Lab	Intersection
Landis et al. [91]	Field Laboratory (75 subjects)	Segment
Chu and Baltes [92]	Field Laboratory (96 subjects)	Mid-block Crossings
Nadeir and Raman [93]	3-D Video Simulator	Segment

Traveler intercept surveys may be the most realistic in that travelers are in an actual trip-making situation; however, the particular method used to intercept travelers may bias the results, especially, if the traveler is detained a long time or if certain "hard to stop" travelers are not interviewed or given a post card. Also, there may not be enough travelers on truly poor road sections to survey.

Although the initial investment for traveler intercept surveys, and the cost per each subject are quite low, the cost per data point obtained (i.e., the product of the number of individuals surveyed and the number of situations they were exposed to) is higher than for the other data collection methods (if one considers only the marginal costs and ignores the high initial investment costs of the video laboratory).

The field laboratory studies also have low initial investment costs, and they have the lowest cost per data point obtained. However, they are expensive to set up for a given site and have a high cost per subject. Each subject, however, is exposed to a wide variety of situations in the field, so this method generates numerous data points per individual.

Field laboratory studies are realistic in that they expose the volunteer subjects to the full sensory experience (all five senses) of field conditions; however, because there is no penalty for arriving late at one's appointment or job the realism of the trip experience is questionable.

Video laboratory studies require an initial investment to create the video clips. If there is doubt about the ability of the video to capture all of the factors affecting a traveler's perception of LOS, then there is also an added expense for calibration of the video lab LOS results to the field.

Once the video clip has been assembled and calibrated, the cost per data point obtained is lower than that for traveler intercept surveys, but higher than for field laboratory studies. The cost per subject though is higher than for the traveler intercept surveys, because video labs typically test fewer subjects than would be found in an intercept survey.

The video labs and field laboratories test fewer subjects than the traveler intercept surveys; however, both laboratory studies can expose single subjects to multiple conditions, thus enabling researchers to distinguish between a single subject's reaction to a range of situations and differences in multiple subjects' reactions to the same situation. This capability (highly valuable for model building) is not available in the traveler intercept surveys.

The traveler intercept surveys are better for general model validation than for detailed model development. Video laboratory and field laboratory studies are better for model development because they give researchers more control over the variability of the results.

Field surveys of traveler satisfaction, such as the FDOT/Sprinkle "Walk For Science" surveys, come closest to the real world experience of travelers while controlling for the range of conditions they experience. However, this survey method is expensive and prone to agency liability problems (caused by exposing the participants to specified field conditions they might not otherwise attempt on their own). Conducting field surveys of traveler satisfaction would have cost $150,000 per mode per site to set up and conduct. For four modes and four cities, the data collection cost alone would have exceeded the entire research project grant. Thus field surveys were deemed infeasible.

Exhibit 35. Validation Data Collection Options.

Survey Type	Strengths	Weaknesses	Cost
Traveler Intercept Surveys: Surveyors stop people mid-trip to distribute post cards or conduct survey.	1. Most realistic of all methods. Only method that captures traveler's response while making a real trip. 2. Can test for effects of travel time, wait time, and cost in combination with physical characteristics of facility.	1. No control over subject's exposure to facility conditions. 2. Limited information on extent of subject's exposure to facility. 3. Can't test the same person's response to conditions other than those of specific trip. 4. People don't like to be interrupted while traveling, which may bias results. 5. Can't sample extreme conditions. 6. Modal sample sizes depend on volumes. Bicycles are difficult to sample adequately.	**Initial Investment:** $20,000 to pilot-test intercept methods. **Data Collection:** $15,000 per site for four modes. $60 per data point (not counting initial investment)
Field Laboratory: Paid or unpaid volunteers travel specified course.	1. Second most realistic of survey types. It puts subjects in realistic physical situations, lacking only the realism of making the actual trip for an actual purpose (such as going to work). 2. Good control on subject exposure to facility.	1. Potential liability for accidents. 2. Can't expose subjects to conditions not present in community or at time of test, particularly true for surveys using weekend volunteers. 3. Because subjects are not actually going anywhere the usual factors that influence trip-making behavior (travel time, wait time, and cost) cannot be reliably included or ruled out. 4. Unpaid volunteers are self-selected.	**Initial Investment:** $-0- because method is well tested. **Data Collection:** $150,000 per site per mode. $10-$25 per data point. (not counting initial investment)
Video Laboratory: Selected subjects shown video clips in laboratory setting.	1. Controlled exposure of subjects to audio-visual aspects of travel. 2. Little liability exposure. 3. Can expose subjects to wide range of conditions and time periods, thus enabling more in-depth analysis for each individual.	1. Not as realistic as simulator or field tests. Some important aspects of trip are excluded (e.g., pavement condition and rumble and back draft from trucks passing the subject). 2. Factors that influence trip-making behavior (e.g., travel time, wait time, and cost) cannot be reliably tested. 3. Needs calibration/validation against field conditions. 4. Not realistic for Transit.	**Initial Investment:** $55,000 to develop videos for three modes. Another $125,000 to calibrate to field. **Data Collection:** $64,000 per lab site for three modes. $42 per data point (not counting initial investment)

Compared with the "Walk For Science" field surveys, traveler intercept surveys sacrifice the ability to "control" the range of physical conditions to which the participants are exposed. In addition, the travelers are self-selected (i.e., they would not be there to be intercepted, if it were not already their preferred mode and route). Nevertheless, among the remaining feasible survey methods, traveler intercept surveys were the best method for gathering transit rider quality of service perceptions. They were within the budget range of the research grant and travelers were exposed to the full physical experience of the transit experience.

The traveler intercept survey method however was problematic for auto and bicycle LOS because it is difficult to intercept auto drivers and bicyclists on the street without adversely affecting their perception of the quality of service. Consequently it was determined that this survey method could not be used for the auto or bicycle modes.

This left video lab surveys as the best remaining method for surveying auto and bicycle level of service, because of its relatively low cost, the ability to control the environment to which each participant was exposed, the elimination of research agency liability exposure, and the ability to expose different people from different geographic areas to the same perceived street environment.

Although it would have been feasible to use a traveler intercept survey method for pedestrians, the video lab survey method was considered superior because it would enable the team to expose survey participants to a controlled wider range of physical conditions (including lack of sidewalk) that would not be easy to find in the field.

The video lab approach also enabled testing of the significance of demographics and metropolitan area on the perceptions of quality of service.

4.2 Phase I Data Collection (Pilot Studies)

During Phase I, the video lab method for gathering traveler quality of service ratings was developed and tested. A video lab approach for measuring auto level of service was tested by George Mason University in Virginia. Sprinkle Consulting tested a similar video laboratory approach for pedestrian level of service in Florida.

For the transit mode, a rider intercept approach for transit level of service was tested in three metropolitan areas of the United States (Ft. Lauderdale, Florida; Washington, DC; and Portland, Oregon). A total of 1,320 people were surveyed, and 2,535 observations of quality of service were gathered during Phase 1. Exhibit 36 provides key statistics on this Phase 1 data collection effort.

The data gathered for each mode are summarized below.

Auto: Fourteen video clips were developed and shown to 75 research subjects in the Washington D.C. metropolitan area. The results showed that a single factor, average travel speed, explained 64% of the variation in LOS ratings reported by the laboratory participants.

Comparison of the video lab perceptions to field perceptions of LOS identified the same key factor influencing LOS in the field (speed) as was found in the video lab. The correlation of the lesser factors to LOS varied between the field and the lab. The influence of other operational factors (signals and stops), design, maintenance, and aesthetics on LOS was less pronounced in the field than in the lab. The one significant exception was pavement condition, which had a stronger influence in the field than in the lab (as expected, given that the video gives only a visual input on pavement condition, while the field gives both visual and tactile inputs).

The researchers noted that the limited number of video clips in the video library for Phase 1 resulted in some factors being spuriously correlated (for example: speed and the presence of trees). This makes it difficult to build statistically robust models of LOS from the video laboratory data that accurately reflect the separate contribution of each correlated factor to a person's perceived LOS. Thus for Phase 2 it was recommended that the video clip library be expanded to include a wider range of cases.

Transit: The Phase 1 data collection effort obtained a large amount of data (1,170 observations) for three urban areas (Miami; Portland; and Washington, DC). The research team noted that the specific routes surveyed in those metropolitan areas for Phase 1 did not exhibit significant crowding at the dates and times of the surveys. This gap in the transit data caused crowding to drop out as a significant explanatory factor of transit LOS. Therefore it was recommended that a few additional surveys be conducted in Phase 2 of more crowded bus routes with standees in one of the metropolitan areas.

Pedestrian: Eight video clips were developed and shown to 45 participants in one metropolitan area (Sarasota, FL). These clips, however, did not cover a very wide range of LOS conditions (most being LOS C according to the FDOT method). Thus the research team recommended that additional video clips of a wider range of conditions be obtained for Phase 2.

Bicycle: No data collection was performed for bicycles in Phase 1, so an entire new video clip library was developed for Phase 2.

4.3 Development of Video Clips

Auto Video Clips

Based on findings from Phase I, the most influential factors to driver perceived level of service were selected by the research team. These included in no particular order

- Presence of median (Yes/No);
- Landscaping (Yes/No);
- Progression (no progression is stopped at more than 50% of signals);
- Posted speed (surrogate for arterial type); and
- LOS depicted in clip using HCM methods.

Exhibit 36. Phase 1 Data Collection Efforts.

Contractor	Mode	Method	Number of Metro. Areas	Persons	Data Points	Cost
GMU	Auto	Video Lab	1	75	975	$ 75,660
KAI	Transit	Field Intercept	3	1,170	1,170	$ 40,000
SCI	Ped	Video Lab	1	45	360	$ 30,500
Total Phase I			5	1,290	2,505	$ 146,160

GMU = George Mason University, KAI = Kittelson Associates, SCI = Sprinkle Consulting
A data point is defined as one person providing an LOS rating for a single facility condition. Thus a person watching 10 video clips generates 10 data points.

These factors were chosen by the research team, with input from the project panel, as those factors that could most easily be measured by engineers, those that were most important to drivers (as determined in previous studies and Phase I of the study), and those that could be captured in the field through videotaping.

Arterials were selected in the Washington, DC, metropolitan area that captured the required combination of conditions. As noted, some of the video clips were developed in Phase I of the study; an additional subset of video clips were developed by GMU in the summer/fall of 2005 in preparation of the data collection in the summer of 2006.

As with the Phase I pilot test, videos were created for daylight conditions only. Taping was also limited to clear days without precipitation, and for the most part, snow is not a feature on the majority of tapes.

In order to film the video clips, the following testing materials were used:

- Vehicle;
- Two video cameras (one to capture the driver's perspective and one to capture the speedometer); and
- Two camera tripods.

Standard vehicles (e.g., station wagons, sedans, and, in a few cases, small sports utility vehicles) were used for videotaping. Vehicles were rented from the GMU motor pool so as to standardize the vehicle set up and ride quality.

Researchers set up two cameras and the GPS unit when they arrived at the vehicle rental location. A professional JVC digital videocamera, loaned to the project by the GMU Media Laboratory, was used to capture the roadway scene from the driver perspective (typically a full windshield view and peripheral views of the roadside) and a palm-sized digital videocamera was used to capture the speedometer view.

After the initial taping runs took place, the individual clips needed to be extracted. Based on the requirement of 1/2-mile on urban arterials (as determined through Phase I efforts), these clips were developed. The emphasis was on extracting segments from the videos that met several criteria including:

After the videotaping took place, the researchers used the following to extract the videos:

- Video editing decks available in the GMU Media Laboratory;
- Adobe Premiere 9.0 video editing software;
- Microsoft MapPoint;
- Microsoft Excel;
- Original mini-Digital Videos (DV) created in the field; and
- Mini-DV player.

In order to depict a consistent scene to study participants, it was necessary to identify video clips that had consistent cross section. For example, efforts were made to identify sections of video in which the roadway width did not change during the drive or that the sidewalk conditions were relatively consistent. Using a portable mini-DV player, students identified the portions of roadway to be made into a clip based on criteria such as arterial type, consistent cross section, lane position, and speed limit. After the general area of the clip was identified, the researchers turned to Microsoft MapPoint.

After each section of roadway was identified, individual clips needed to be made. The video feed needed to be synchronized with the speedometer feed. This was done using the mini-DV player and the time stamps on it. The field team had announced the run orally while the videocameras were filming the study arterials. The researcher's voice was used to synchronize time stamps of the videocameras. Then, the researchers found the location of the beginning and end of the proposed clip and determined the tape length equivalencies for the two video feeds, for example 1 minute 6 seconds into the tape was when the voice was first heard on tape 1, 1 minute 20 seconds into the tape was when the voice was first heard on tape 2.

After identifying the time stamps for both the road video and the speedometer, the team began editing using the video editing equipment available at GMU's Media Laboratory to cut the clips and merge the speedometer video into the lower righthand corner of the video screen to simulate driving the vehicle. Adobe Premiere 9.0 was used to merge the two videos and create each clip. Once all the clips were made, transitions were put in between each clip on the final media to help proctors and participants identify each clip (for example, Clip #3) using the same software package. Then, the clips were merged and burned onto DVDs.

Exhibit 37 summarizes the characteristics of the auto clips.

Bicycle Video Clips

Bicyclists are among the most vulnerable of travellers and are affected by a broader variety of traffic and roadway environmental factors (stimuli) than that of the motorized modes. Consequently, when collecting data and modeling perceptions, care must be taken to capture this sensitivity to the many environmental factors.

Previous research, model development, and nationwide deployment of non-motorized LOS mode models have demonstrated that field-based studies are desirable to capture accurate perceptions of bicyclists. Such studies place the participants in typical real-life situations and capture the participants' response to the host of stimuli present in roadway environments affecting bicyclists. However, field studies can be expensive and, depending on the range of conditions and variables being explored, represent the highest risk for participants of any method.

Exhibit 37. Summary of Auto Clip Characteristics.

Clip #	Clip Distance (miles)	Street Name	HCM Class	LOS as per HCM	Number of Through Lanes	Presence of Median	Total Travel Time (seconds)	Space Mean Speed	PED on sidewalk	# Stops (below 5 mph)	Total # of Signals	Pres. Of Ex. LT Lane - Signals	Pres. Of Rt Turn Lane-Signals	Tree Presence	Average Lane Width (ft)	Width of Median (ft)	Rigth Shoulder width (ft)	Left Shoulder Width (ft)	Width of parking lane (ft)	Width of sidewalk (ft)	Separation from right-of-way to sidewalk (ft)	Width of bike lane (ft)
1	0.50	Rt 234	1	1	3	3	119	15.1	0	1	2	1	1	2	12	54	0	3	0	4	3	0
2	0.46	Gallows Road	3	6	2	3	48	34.5	0	0	3	1	1	2	13	4	0	0	0	4	3	0
5	0.50	Wilson Blvd	3	5	2	3	60	30.0	2	0	3	1	1	1	14	0	0	0	7	10	0	5
6	0.43	Clarendon	3	3	2	1	87	18.3	2	1	2	1	0	1	14	0	0	0	7	4	0	0
7	0.48	Wilson Blvd	3	4	2	1	86	20.1	2	0	3	1	0	1	14	0	0	0	7	10	0	5
8	0.49	Wilson Blvd	3	2	2	1	130	13.6	2	2	5	1	1	1	12	0	0	0	8	14	0	6
10	0.53	Washington Blvd	3	3	1	0	113	16.9	2	2	3	0	0	3	12	0	0	0	8	6	0	0
12	0.47	Wilson Blvd	3	3	2	0	118	14.3	0	2	2	0	0	1	11	0	0	0	8	11	5	0
13	0.50	Washington Blvd	3	5	1	0	71	25.4	1	0	1	0	0	3	12	0	0	0	8	6	0	0
14	0.50	Glebe Road	2	1	3	3	161	11.2	2	3	3	1	1	1	11	4	0	0	0	8	0	0
15	0.50	Glebe Road	2	1	3	3	229	7.9	2	3	3	1	1	1	11	4	0	0	0	8	0	0
16	0.55	Fairfax Drive	3	1	2	3	163	12.1	2	4	4	1	1	1	11	10	0	0	8	16	0	5
19	0.52	23rd St	4	4	2	0	116	16.1	2	3	8	0	0	2	10	0	0	0	7	6	5	0
20	0.55	Rt 50	1	2	2	3	122	16.2	2	1	2	1	0	1	11	17	8	2	0	0	0	0
21	0.50	Rt 50	1	2	2	3	89	20.2	2	2	3	1	1	2	11	17	8	2	0	0	0	0
23	0.54	M St	4	2	2	0	243	8.0	2	3	8	0	0	1	10	0	0	0	10	10	0	0
25	0.54	M St	4	3	2	0	179	10.9	2	2	8	0	0	1	10	0	0	0	10	10	0	0
29	0.50	Rt 234	2	4	3	3	79	22.8	0	1	3	1	1	2	12	54	0	3	0	0	0	0
30	0.55	M St	4	1	2	0	298	6.6	2	8	8	0	0	1	10	0	0	0	10	10	0	0
31	0.50	M St	4	1	2	0	471	3.8	2	9	8	0	0	1	10	0	0	0	10	10	0	0
51	0.44	M St	4	1	2	0	240	6.5	2	4	9	0	0	1	10	0	0	0	10	10	0	0
52	0.41	M St	4	2	2	0	186	7.9	2	3	7	0	0	1	10	0	0	0	10	10	0	0
53	0.60	Prosperity	2	3	2	3	121	18.5	0	1	2	1	1	2	12	15	0	0	0	4	4	0
54	0.60	Lee Hwy	2	4	2	2	93	24.5	0	2	4	1	1	3	12	14	4	4	0	4	10	0
55	0.45	Braddock Rd	2	1	2	3	128	12.7	0	1	1	1	1	3	12	15	0	0	0	6	0	0
56	0.50	Sunset Hills Rd	2	4	2	3	77	23.1	0	1	1	1	0	3	12	8	0	0	0	0	0	0
57	0.61	Sunset Hills Rd	2	3	2	0	129	17.4	0	2	2	0	0	3	12	0	0	0	0	4	2	0
58	0.60	Sunrise Valley Rd	2	1	2	3	144	11.2	0	1	3	1	0	3	12	10	0	0	0	3	4	0
59	0.61	Sunset Hills Rd	2	1	2	0	182	12.1	0	3	2	0	0	3	12	0	0	0	0	4	4	0
60	0.50	Lee Hwy	2	2	2	2	120	15.0	0	1	3	1	0	1	12	14	0	0	0	4	4	0
61	0.70	Rt 50	1	4	3	0	91	27.7	0	1	3	1	0	3	12	0	0	0	0	0	0	0
62	0.50	Rt 50	1	5	3	0	49	36.7	0	0	2	1	0	3	12	0	0	0	0	0	0	0
63	0.50	Rt 50	1	6	2	3	53	41.9	0	0	2	1	1	3	12	6	4	4	0	0	0	0
64	0.50	Rt 50	1	2	2	3	92	19.6	0	1	3	1	0	3	12	6	0	0	0	0	0	0
65	0.50	Lee Hwy	2	6	2	2	50	36.0	0	0	3	1	0	2	12	14	0	0	0	0	0	0

Video simulation, however, potentially provides some significant advantages to real-time field surveys, particularly if the "moving camera" approach is used. The moving camera perspective gives the video simulation a greater reflection of reality as opposed to the stationary camera. Moving camera simulation also allows for a wider range of geographic participants and the testing of a greater range of variables, particularly the potentially hazardous higher truck volumes and the high frequencies of driveway/curb cut common in jurisdictions with minimal roadway access management practices. Finally, moving camera (video) simulation, if done based on lessons learned through previous bicycle research, can approximate real-time conditions without the real-life hazards to participants in field studies.

The research team chose to use a video simulation methodology for this effort. The bicycle LOS research methodology used was designed to achieve the following objectives:

- Obtain bicyclists' perceptions of the level of accommodation provided by arterial roadways using a real-time field-data collection event;
- Coincident with the field data collection event, use video simulations to obtain bicyclists' perceptions of the level of accommodation provided by arterial roadways;
- Develop an equation to correlate the video simulation responses to the real-time event responses; and
- Provide the information necessary to develop the research team's initially proposed model form.

For this NCHRP Project 3-70, a video simulation was used to collect data for the bicycle LOS model development. However, the research team took advantage of a coincident bicycle facility LOS project being conducted by FDOT's Central Office and District 7 which combined approach of field based studies with video simulation. This timely FDOT study involved a real-time event in which bicyclists rode a study course and evaluated facilities along the course. As part of this project, we filmed moving camera videos of the event route under similar conditions expected for the actual event. The videos were edited into digital sequence videos for the creation of simulation videos for video-to-field calibration.

Following the FDOT project, NCHRP Project 3-70 produced additional video for testing in a separate video simulation laboratory effort to obtain responses from additional users. To ensure the consistency of the NCHRP research video survey results, the original Ride for Science (described below) video clips were re-edited to match the format of those produced specifically for NCHRP 3-70. The NCHRP 3-70 laboratory simulation clips were shown at four locations across the United States.

Because the video simulation and its fidelity to a real-time event was an important consideration and because the NCHRP Project 3-70 team was able to take advantage of the FDOT study, the real-time event and coincident video simulation are described below.

Staff from Dowling & Associates and Sprinkle Consulting, Inc., initially developed a matrix with 30 specific combinations ("runs") of geometric and operational criteria. The matrix is provided as Exhibit 38.

The research team used the matrix as a guide to identify filming candidate locations in Tampa. Dr. Huang and Mr. Petritsch field-checked the locations to verify their geometric and operational characteristics. Some runs identified when filling out the matrix involved unlikely combinations (for example, Run #11, which specified traffic volume in outside lane > 800 vph and speed limit < 30 mph).

Consequently, some of the combinations of variable ranges were not taped for the NCHRP project 3-70 study. After discussions with Mr. Reinke, the research team selected alternative locations so that there would be locations for each value of each criterion. For example, traffic volumes of < 400, 400-800, and 800+ vph were all represented.

Theo Petritsch of Sprinkle Consulting, Inc. and Mr. Michael Munroe (a professional videographer) videotaped the bicycle locations during March and April 2006. The video platform used was a Viewpoint bicycle with Glidecam, as described above and shown in Exhibit 39.

All traffic laws were obeyed during the filming of the bicycle clips. To ensure a consistent recording methodology, and one which reflects typical bicyclists' scanning behavior, a protocol was developed, tested, and used by the researchers and videographer for proper camera panning techniques and to keep the roadway ahead in the right-center of the frame to focus on the roadway and capture driveway conditions while not focusing on objects outside the right of way.

One or two "takes" were filmed at each location. The researchers started about one city block upstream of the intersection, taped while riding at approximately 12 mph, and finished about one city block downstream of the intersection. The team also used several video clips from those filmed for the video simulation portion of the Ride for Science 2005. Those were filmed using the same procedures.

With guidance from Mr. Petritsch, Dr. Huang selected 30 bicycle clips for inclusion in the bicycle DVD. The geometric and operational characteristics of the locations depicted in these clips are shown in Exhibit 40.

Pedestrian Video Clips

Pedestrians are among the most vulnerable of travellers and are affected by a broader variety of traffic and roadway environmental factors (stimuli) than that of the motorized

Exhibit 38. Bicycle Video Clip Sampling Plan.

Run	Segment variables				Intersection variables	
	Width of outside lane (ft)	Presence / width of bike lane (ft)	Veh flow in outside lane (vph)	Speed limit (mph)	Crossing width (ft)	Control delay (s)
1	< 12	No bike lane	400 - 800	30 - 40	36 - 60	No stop
2	< 12	No bike lane	800+	< 30	60+	No stop
3	< 12	No bike lane	< 400	30 - 40	< 36	< 40
4	< 12	No bike lane	400 - 800	< 30	36 - 60	< 40
5	< 12	No bike lane	800+	40+	60+	< 40
6	< 12	≤ 4	< 400	< 30	36 - 60	40+
7	< 12	≤ 4	400 - 800	30 - 40	60+	40+
8	< 12	≤ 4	800+	40+	< 36	40+
9	< 12	≤ 4	< 400	40+	36 - 60	No stop
10	< 12	≤ 4	400 - 800	30 - 40	60+	No stop
11	< 12	≤ 4	800+	< 30	< 36	No stop
12	< 12	> 4	< 400	30 - 40	60+	< 40
13	< 12	> 4	400 - 800	< 30	< 36	< 40
14	< 12	> 4	800+	40+	36 - 60	< 40
15	< 12	> 4	400 - 800	30 - 40	< 36	40+
16	< 12	> 4	800+	40+	36 - 60	40+
17	12 +	No bike lane	400 - 800	30 - 40	36 - 60	No stop
18	12 +	No bike lane	800+	< 30	60+	No stop
19	12 +	No bike lane	< 400	30 - 40	< 36	< 40
20	12 +	No bike lane	400 - 800	< 30	36 - 60	< 40
21	12 +	No bike lane	800+	40+	60+	< 40
22	12 +	≤ 4	400 - 800	30 - 40	60+	40+
23	12 +	≤ 4	800+	40+	< 36	40+
24	12 +	≤ 4	< 400	40+	36 - 60	No stop
25	12 +	≤ 4	400 - 800	30 - 40	60+	No stop
26	12 +	≤ 4	800+	< 30	< 36	No stop
27	12 +	> 4	400 - 800	< 30	< 36	< 40
28	12 +	> 4	800+	40+	36 - 60	< 40
29	12 +	> 4	< 400	< 30	60+	40+
30	12 +	> 4	800+	40+	36 - 60	40+

modes. Previous research, model development, and nationwide deployment of non-motorized LOS mode models have demonstrated that field-based studies are the most desirable means to capture accurate perceptions of pedestrians. They place the participants in typical real-life situations and capture the participants' response to the host of stimuli present in urbanized roadway environments affecting pedestrians. However, field studies can be expensive and, depending on the range of conditions and variables being explored, represent the highest risk for participants of any method.

Exhibit 39. Bicycle Video Camera Mount.

Video simulation, however, potentially provides some significant advantages to real-time field surveys, particularly if the moving camera approach is used. The moving camera perspective gives the video simulation a greater reflection of reality than the stationary camera. Moving camera simulation also allows for a wider range of geographic participants and the testing of a greater range of variables, particularly the potentially hazardous higher truck volumes and high driveway/curb cut frequencies common in jurisdictions with minimal roadway access management practices. Finally, moving camera (video) simulation, if done based on lessons learned through recent pedestrian research, can approximate real-time conditions without the real-life hazards to participants in field studies.

Given these advantages of video simulation, the project team used video simulation to collect data for the pedestrian LOS model. Video clips were created and then shown to participants in video simulation laboratories.

Exhibit 40. Characteristics of Bicycle Video Clips.

Clip #	Start Clip	End Clip	Location	Comments	Width of outside lane	Presence/width of bike lane	Traffic volume	Speed limit	Crossing width	Control delay
1	8:00.55	8:03.05	Fowler Ave between River Hills Dr and Gillette Dr		12	9	609	50	27	No stop
2	8:01.34	8:02.04	Fowler Ave at North Dr	More traffic than Clip #3	12	9	840	50	27	No stop
3	8:16.13	8:16.43	Fowler Ave at North Dr	Less traffic than Clip #2	12	9	60	50	27	No stop
4	8:28.55	8:30.41	Collins Blvd at Alumni Dr, E side		12	3.5	136	30	65	56
5	8:32.27	8:33.34	Collins Blvd at Alumni Dr, W side		12	3.5	322	30	65	16
6	8:37.25	8:38.03	Alumni Dr at Magnolia Dr, N side	Shorter delay than Clip #7	11	4	0	30	72	0
7	9:02.46	9:04.05	Alumni Dr at Magnolia Dr, N side	Longer delay than Clip #6	11	4	46	30	72	40
8	9:04.42	9:06.00	Holly Dr at Magnolia Dr, N side		10	0	0	20	86	23
9	9:13.53	9:15.01	Holly Dr at Laurel Dr, S side		10	0	0	20	52	8
10	9:15.45	9:16.45	Fletcher Ave at Sebring Blvd, S side		11.5	0	600	40	53	No stop
11	9:20.02	9:20.45	15th St at 7th Ave, W side		12	0	0	25	33	14
12	9:21.22	9:22.43	7th Ave between 17th St and 14th St, N side		12	0	0	25	49	9
13	9:23.00	9:23.45	21st St at 7th Ave, W side		10	0	0	30	33	11
14	1:29.48	1:30.52	56th St at Busch Blvd, W side	Shorter delay than Clip #23	12	0	0	45	142	0
15	2:12.05	2:13.35	Busch Blvd at 26th St, N side		11	0	0	45	80	29
16	2:12.30	2:13.12	Busch Blvd at 26th St, N side		11	0	0	45	80	29
17	3:11.10	3:12.05	US 41 at Dover St, E side		12	0	131	55	36-60	No stop
18	3:32.30	3:33.20	US 41 at 31st St, W Side		12	0	0	55	<36	0
19	4:15.08	4:15.31	Fletcher Ave at North Palm Dr, S side		12	5	1096	45	53	0
20	4:18.00	4:18.55	Fletcher Ave at 50th St, S side		12	5	785	45	64	0
21	4:18.29	4:20.19	Fletcher Ave between 50th St and 56th St, S side		12	5	884	45	78	No stop
22	5:14.50	5:15.40	56th St at 98th Ave, W side		12	0	432	45	38	No stop
23	5:16.50	5:19.10	56th St at Busch Blvd, W side	Longer delay than Clip #14	12	0	26	45	142	80

Staff from Dowling & Associates and Sprinkle Consulting, Inc., initially developed a matrix (see Exhibit 41) with 22 specific combinations ("runs") of geometric and operational criteria to represent the typical ranges of urban arterials in metropolitan areas throughout the United States.

The research team used the matrix as a guide to identify candidate locations in Tampa and San Francisco. Herman Huang, Ph.D., of Sprinkle Consulting, Inc., field-checked the Tampa locations and Dowling & Associates staff field-checked the San Francisco locations to verify their geometric and operational characteristics. Some runs involved unlikely combinations (for example, Run #11, which specified sidewalk width < 4ft and high pedestrian volumes) and so were not included in the data collection video simulation video. After discussions with David Reinke of Dowling & Associates, the research team selected alternative locations so that there would be locations for each

Exhibit 40. (Continued).

Clip #	Start Clip	End Clip	Location	Comments	Width of outside lane	Presence/width of bike lane	Traffic volume	Speed limit	Crossing width	Control delay
24	5:23.16	5:25.46	Bullard Pkwy at 56th St		12	4	120	45	87	70
25	5:23.40	5:25.22	Bullard Pkwy at 56th St		12	4	106	45	87	70
26	6:01.46	6:02.10	S 7th St at Pasco Ave, W side		12	0	0	30	36-60	0
27	6:17.35	6:18.30	W University Ave at 10th St, S side		12	0	65	30	36-60	3
28	1:02.40	1:04.35	N Village Dr between Cypress Cir and S Village Dr, N side		12	4	63	30	36-60	No stop
29	3:30.51	3:32.27	Ehrlich Rd between Turner Rd and S Village Dr, S side		12	4	188	45	>60	50
30	3:35.55	3:37.35	N Village Dr between S Village Dr and Cypress Cir, S side		12	4	108	30	36-60	0

Note: The traffic volume is the number of vehicles in the outside lane that passed the videographer in the clip, converted to an hourly volume.
In some clips few or no vehicles in the outside lane passed the videographer due to reasons such as inherently low traffic volumes
or vehicles passing the videographer in the inside lane.

Exhibit 41. Pedestrian Sampling Plan.

Run	Segment variables					Intersection variables	
	Sidewalk width (ft)	Separation of walkway from traffic	Traffic speed (mph)	Traffic volume outside lane (vph)	Pedestrian volumes	Number of lanes crossed	Signal delay (sec)
1	< 4	No	30-40	400-800	Medium	2	< 30
2	4+	No	40+	800+	High	2	< 30
3	No sidewalk	No	< 30	400-800	High	2	< 30
4	4+	No	40+	< 400	Medium	2	< 30
5	No sidewalk	No	< 30	800+	Medium	4+	< 30
6	< 4	No	30-40	< 400	High	4+	< 30
7	4+	No	40+	400-800	Low	4+	< 30
8	< 4	No	40+	< 400	Medium	4+	< 30
9	4+	No	<30	400-800	High	4+	< 30
10	No sidewalk	No	30-40	800+	Medium	4+	< 30
11	< 4	No	40+	< 400	High	4+	< 30
12	4+	Yes	<30	800+	Medium	2	> 30
13	< 4	Yes	40+	800+	Low	2	> 30
14	4+	Yes	<30	< 400	Medium	2	> 30
15	< 4	Yes	<30	800+	Medium	2	> 30
16	4+	Yes	30-40	< 400	High	2	> 30
17	< 4	Yes	<30	800+	High	4+	> 30
18	4+	Yes	30-40	< 400	Low	4+	> 30
19	< 4	Yes	<30	< 400	Low	4+	> 30
20	4+	Yes	30-40	400-800	Medium	4+	> 30
21	< 4	Yes	<30	400-800	High	4+	> 30
22	4+	Yes	30-40	800+	Low	4+	> 30

value of each criterion. For example, traffic volumes of < 400, 400-800, and 800+ vph were all represented. The locations with high pedestrian volumes were mostly in San Francisco, as many parts of San Francisco are characterized by high levels of pedestrian activity. The locations with high traffic speeds and traffic volumes were mostly in Tampa, as many parts of Tampa are characterized by high speeds and volumes.

Dr. Huang and a professional videographer videotaped the pedestrian locations in Tampa and San Francisco during March and April 2006. The filming protocol followed that pioneered and tested in 2004 by Sprinkle Consulting in their research Arterial Level of Service for Arterials project for FDOT. Videotaping was performed with a steady-cam unit. A stereo microphone mounted on the camera was used during videotaping. The videographer filmed the environment while walking the intersections and facilities, obeying all pedestrian signals in the process, while Dr. Huang provided recommendations concerning filming protocol and start and end points and served as a safety coordinator (see Exhibit 42). To ensure a consistent recording methodology that reflected typical pedestrians' scanning behavior, the research team developed, tested, and used a protocol for proper camera panning techniques to keep the sidewalk on the right edge of the frame to focus as much as possible on the roadway, rather than objects outside the right-of-way.

At each location, the researchers filmed multiple "takes," each with a different length of signal delay. The researchers started about 100 yards upstream of the intersection, taped while walking at a normal (approximately 4 ft/sec) pedestrian speed, and finished about 100 yards downstream of the intersection.

Exhibit 42. Pedestrian Video Camera Mount.

Dr. Huang selected 32 of the video pedestrian clips for inclusion in the DVD that would be used during the pedestrian roadway LOS data collection events. Exhibit 43 lists the geometric and operational characteristics of the locations shown in these clips.

Development of Master DVDs

The research team members decided in the spring of 2006 that a maximum of 10 video clips for each mode were to be viewed in each study location and ratings gathered for each from participants. The decision to limit the videos to 10 clips per mode was partially based on the need to maintain the attention of study participants and also to maintain a total testing time of between 2 and 3 hours, including time for an informal focus group. The team also decided to select four specific clips for each mode to be shown in each of the four cities, so that one could later attempt to isolate the influence of variables such as population density, population, and expectation of travel conditions on traveler ratings of LOS across the four cities. Next, six additional clips per mode were selected to be shown in each of the four study locations. Finally, a pilot test clip for each mode was selected and shown in each of the fours cities to help orient participants to the mode they were to rate for that portion of the study.

Exhibit 44, Exhibit 45, and Exhibit 46 show the specific sequence of video clips shown in each of the four study locations. Clips shown in all four locations are highlighted—they show up at different points in the sequence. The specific sequence of clips shown in each city was intentionally randomized so as to minimize the likelihood of respondent fatigue biasing the results. Efforts were made to normalize the length of testing time in each of the four study locations while providing a range of factors to participants in each study location.

Using the GMU Media Laboratory facilities and staff, a set of master DVDs was created for each of the four testing locations. Efforts were made to maintain the highest possible quality of video to enhance the video presentation portion of the study; this requirement resulted in the creation of one DVD per mode per city, resulting in 12 master DVDs, which were later used in the data collection process.

To maintain consistency among the clips, GMU Media Laboratory staff worked with the video production crew hired by Sprinkle Consulting to ensure that video clips had the same look and feel of those created by GMU. GMU Media Laboratory staff provided detailed editing instructions, which were followed perfectly by the production crew in Florida, while creating the pedestrian and bicycle clips. Each video clip was edited to include an opening title which read "Clip XXX" on a black background, next the title would fade out and the video clip showing a particular trip would begin. At

Exhibit 43. Geometric & Operational Characteristics of Pedestrian Video Clip Locations.

Clip #	Start Clip	End Clip	Location	Direction	Comments	Sidewalk width	Separation	Traffic speed	Traffic volume	Ped volume	Number of lanes	Signal Delay
201	10:01.10	10:02.53	Holly Dr at Magnolia Dr, N side	WB, with traffic		No sidewalk	No	20	175	Low	4	36
202	10:01.37	10:02.35	Holly Dr at Magnolia Dr, N side	WB, with traffic		No sidewalk	No	20	248	Low	4	36
203	10:28.51	10:30.08	Collins Blvd at Alumni Dr, E side	NB, with traffic	Shorter delay	10	Yes	30	234	Medium	4	14
204	10:31.27	10:33.37	Collins Blvd at Alumni Dr, E side	NB, with traffic	Longer delay	10	Yes	30	83	Medium	4	65
205	11:04.40	11:05.50	Alumni Dr at Magnolia Dr, N side	WB, with traffic		10	Yes	30	206	Low	4	0
206	12:03.45	12:06.30	Fowler Ave at 56th St, S side	EB, with traffic		5	Yes	50	567	Low	9	78
207	12:04.13	12:06.12	Fowler Ave at 56th St, S side	EB, with traffic		5	Yes	50	605	Low	9	78
208	12:20.15	12:22.10	Fletcher Av at Bruce B Downs Blvd, S side	WB, against traffic	Longer delay	No sidewalk	No	45	939	Low	8	40
209	12:23.10	12:24.30	Fletcher Av at Bruce B Downs Blvd, S side	WB, against traffic	Shorter delay	No sidewalk	No	45	514	Low	8	9
210	12:35.15	12:36.40	Magnolia Dr at Holly Dr, W side	SB, with traffic		No sidewalk	No	30	212	Medium	4	23
211	13:03.20	13:04.20	Bearss Ave at North Blvd, N side	WB, with traffic		4	Yes	45	660	Low	3	0
212	13:22.00	13:24.10	Dale Mabry Hwy at Ehrlich Rd, W side	SB, with traffic		5	Yes	45	388	Low	7	47
213	13:33.01	13:35.56	Dale Mabry Hwy at Tampa Bay Blvd, E side	SB, against traffic	Longer delay	9.5	Yes	45	638	Low	7	98

(continued on next pg)

Exhibit 43. (Continued).

Clip #	Start Clip	End Clip	Location	Direction	Comments	Sidewalk width	Separation	Traffic speed	Traffic volume	Ped volume	Number of lanes	Signal Delay
214	14:05.23	14:07.53	Dale Mabry Hwy at Tampa Bay Blvd, E side	SB, against traffic	Shorter delay	9.5	Yes	45	792	Low	7	55
215	14:13.50	14:15.30	7th Ave at 15th St, N side	WB, with traffic		8	Yes	25	180	Medium	2	35
216	14:21.44	14:22.44	21st St at 7th Ave, W side	SB, with traffic		6	No	30	360	Medium	2	0
217	14:24.02	14:25.42	21st St at 7th Ave, W side	SB, with traffic		6	No	30	72	Medium	2	32
218	15:02.35	15:04.05	Market St at Kearney St, N side	EB, against traffic		15-18	Some separation (bus bays, stops, meters)	<30	80	High	4-PM peak; 2 otherwise	22
219	15:31.10	15:33.04	Stockton St at Clay St, E side	NB, with traffic	Longer delay	6-10	Yes	<30	126	High	3-PM peak; 2 otherwise	43
220	15:38.41	15:39.49	Stockton St at Clay St, E side	NB, with traffic	Shorter delay	6-10	Yes	<30	0	High	3-PM peak; 2 otherwise	0
221	16:06.10	16:07.40	Stockton St at Washington St, E side	NB, with traffic		4 at narrowest	Yes	<30	0	High	2	0
222	16:22.11	16:24.15	Stockton St at Broadway St, E side	NB, with traffic	Longer delay	6	Yes	<30	116	High	5-AM peak; 6-PM peak; 4 otherwise	54
223	16:36.01	16:37.17	Stockton St at Broadway St, E side	NB, with traffic	Shorter delay	6	Yes	<30	0	High	5-AM peak; 6-PM peak; 4 otherwise	0
224	17:18.30	17:19.55	Grant Ave at Jackson St, E side	SB, against traffic		4 at narrowest	Yes	<30	85	High	2	29

Exhibit 43. (Continued).

Clip #	Start Clip	End Clip	Location	Direction	Comments	Sidewalk width	Separation	Traffic speed	Traffic volume	Ped volume	Number of lanes	Signal Delay
225	17:23.17	17:24.45	Geary Blvd at Divisadero St, S side	EB with traffic	Shorter delay	8-10	Yes	40+	205	Medium	4	18
226	17:25.51	17:27.38	Geary Blvd at Divisadero St, S side	EB with traffic	Longer delay	8-10	Yes	40+	303	Medium	4	39
227	18:20.35	18:21.40	Grant Ave at California St, E side	SB, against traffic		6	Yes	<30	277	High	5-AM peak; 6-PM peak; 4 otherwise	0
228	18:30.31	18:32.30	Post St at Stockton St, S side	WB, against traffic		6+	Yes	Unknown	121	Low	3	43
229	19:00.57	19:03.00	Post St at Stockton St, S side	EB, with traffic		6+	No	Unknown	88	Low	3	40
230	20:25.35	20:27.00	3rd St at Mission St, E side	NB, with traffic		6+	Yes	Unknown	0	High	4+	20
231	2:19.00	2:21.55	Dale Mabry Hwy, between State St and Carmen St, W side	SB, with traffic		5	Yes	35	370	Low	2	0
232	2:11.25	2:14.40	Hillsborough Ave, between Armenia Ave and Tampania Ave, N side	WB, with traffic		6+	No	45	880	Low	2	0

Note: The traffic volume is the number of vehicles that passed the videographer in the clip, converted to an hourly volume.
In some clips few or no vehicles passed the videographer due to reasons such as inherently low traffic volumes or vehicles queued at a light.

Exhibit 44. Pedestrian Clip Sequence at Testing Locations.

Presentation Order	Location of Video Laboratory – Pedestrian Clips Shown			
	New Haven, CT	Chicago, IL	Oakland, CA	College Station, TX
Pilot Clip	212	212	212	212
1	223	201	215	208
2	208	226	220	217
3	226	225	206	215
4	204	208	201	214
5	205	219	227	201
6	203	228	226	230
7	201	211	209	218
8	231	215	216	232
9	215	229	224	226
10	210	222	208	221
Total Clip Time	16.2 min	18 min	16 min	19.4 min

Note: Table shows the sequence of clips shown in each city. Entries are the clip identification numbers. Shaded clips were shown in all four cities. Sequence of clips shown was intentionally randomized in each city to counteract fatigue effects.

the conclusion of each video clip, GMU Media Laboratory staff looped the DVD back to a consistent title page which included a complete list of the video clips on each of the DVDs. This allowed the operator to then click the mouse on the next appropriate clip when participants were ready to begin rating the next video clip. Using the information provided in Tables 3-3 through 3-5, one DVD per mode per city was generated, resulting in 12 unique DVDs. These DVDs were then labeled by the GMU Media Laboratory staff to ensure ease of selection by the facilitator of each laboratory session.

4.4 Video Lab Protocol

Selection of Video Lab Cities

Four metropolitan areas were selected for the Phase 2 auto, bike, and pedestrian video labs. They were Chicago, Illinois; San Francisco, California; New Haven, Connecticut; and College Station, Texas. They were selected to obtain a range of population and climates of the United States based on the hypothesis to be tested that the population of the urban area and the climatic area of the US might influence the degree of satisfaction reported by subjects in the video laboratories.

There are 922 urban areas in the United States with a population of at least 10,000 (U.S. Census [**94**]). These urban areas are ranked by population and then stratified into four groups, each group representing approximately one-quarter of the urban area population in the United States. The results are as shown in Exhibit 47.

The eight largest metropolitan areas of the United States (i.e., New York, Los Angeles, Chicago, Philadelphia, Dallas, Miami, Washington DC, and Houston) hold one-quarter of the urban area population of the United States. Chicago was selected to represent these largest metropolitan areas of the United States.

Exhibit 45. Bicycle Clip Sequence at Testing Locations.

Presentation Order	Location of Video Laboratory – Bicycle Video Clips Shown			
	New Haven, CT	Chicago, IL	Oakland, CA	College Station, TX
Pilot Clip	326	326	326	326
1	301	319	302	311
2	323	308	310	328
3	321	306	305	324
4	320	309	324	315
5	317	320	327	309
6	312	318	321	313
7	309	304	309	303
8	307	324	322	319
9	314	321	330	320
10	324	329	320	321
Total Clip Time	13 min	13 min	13 min	13 min

Note: Table shows the sequence of clips shown in each city. Entries are the clip identification numbers. Shaded clips were shown in all four cities. Sequence of clips shown was intentionally randomized in each city to counteract fatigue effects.

Exhibit 46. Automobile Clip Sequencing at Testing Locations.

Presentation Order	Location of Video Laboratory – Auto Clips Shown			
	New Haven, CT	Chicago, IL	Oakland, CA	College Station, TX
Pilot Clip	25	25	25	25
1	21	20	12	15
2	55	56	56	7
3	52	10	8	52
4	60	51	65	13
5	53	14	59	58
6	56	2	29	56
7	54	62	6	2
8	2	63	15	1
9	15	52	2	61
10	57	15	52	64
Total Clip Time				

Note: Table shows the sequence of clips shown in each city. Entries are the clip identification numbers. Shaded clips were shown in all four cities. Sequence of clips shown was intentionally randomized in each city to counteract fatigue effects.

The next-largest metropolitan areas hold another quarter of the urban area population in the United States: Detroit, Boston, Atlanta, San Francisco, Riverside, Phoenix, Seattle, Minneapolis, San Diego, St Louis, Baltimore, Pittsburgh, Tampa, Denver, Cleveland, Cincinnati, Portland, Kansas City, Sacramento, San Jose, San Antonio, Orlando, Columbus, Providence, Virginia Beach. San Francisco was selected to represent this group of large metropolitan areas.

The other 800+ metropolitan areas constituting the remaining 50% of the U.S. urban area population are too numerous to conveniently list here. The research team selected from the Census list of these cities the following two metropolitan areas to represent the lesser populated metropolitan areas of the United States: New Haven, Connecticut (population between 300,000 and 1.5 million), and College Station, Texas (population under 300,000).

Thus, the four metropolitan areas for the Phase 2 auto, bike, and pedestrian video labs were Chicago, Illinois; San Francisco, California; New Haven, Connecticut; and College Station, Texas.

IRB Review

Most research institutions require, when working with human or animal subjects, that the study undergo a review by an independent review board to ensure that no undue harm will occur to study participants. George Mason University has its own Internal Review Board (IRB) to oversee research studies within the University. The effort to obtain approval to proceed with the study included

- Completing the IRB application for approval of study
- Providing the IRB with an overview of the study protocol
- Providing the IRB with sample survey instruments and testing material

Researchers for this study received approval from the GMU IRB in June of 2006 to proceed with the study as described. Appendix B includes the materials submitted to the IRB including Study Protocol and the Application for Human Subjects Research Review.

Recruitment

Based on input from the team and ultimately the project's Principal Investigator, a decision was made that the minimum number of participants in each location was 30 and a maximum of 35 participants was budgeted for each study location. Phase I study results revealed that, although age influenced participant ratings—which is consistent with studies con-

Exhibit 47. Stratification of MSAs Into Equal Population Groups.

Group	Population Range	Number of SMSAs	Total Population	Percentage of U.S. Population
1	Pop.> 5M	8	65,154,790	24.9
2	1.5M < Pop < 5M	25	64,389,536	24.6
3	300K < Pop < 1.5M	104	66,586,646	25.5
4	13K < Pop < 300K	785	65,404,019	25.0
Total		922	261,534,991	100.0%

MSA = Metropolitan Statistical Area, as defined by U.S. Census ducted by Sprinkle Consulting, gender was not found to be a statistically significant contributor to participant ratings. Based on these findings, the study team determined that recruiting of participants should be based on the following criteria in order of importance:

- Age (seek equal distribution between young, middle, and older aged participants)
- Gender (equal distribution between males and females)
- Regular users of modes other than private vehicle, in particular bicyclists

Dr. Flannery of GMU recruited subjects in each location by establishing contact through the following:

- Community senior citizen centers
- Bicycle clubs
- Community/neighborhood associations

To assist in recruiting, posters and flyers, developed for each location, included all relevant information for the study (e.g., location, time, date, and participant requirements). These posters and flyers were sent to the contacts established through the various organizations. Posters also included tear-off contact information to register for the study. Appendix C contains an example flyer used in the Chicago location.

Exhibit 48 breaks down the participants by age and gender in each of the four study locations.

From the demographic survey, information was extracted on the regularity of participants to use modes other than private automobile in their travel. Researchers sought to include participants who regularly take non-recreational bike and pedestrian trips, as well as, regular transit users.

Exhibits 49 through 51 show a breakdown of participant mode use by study location. Chicago had the highest percentage of daily walkers among the cities surveyed. Oakland had the highest percentage of daily bicycle riders. College

Exhibit 48. Characteristics of Participants.

Age Group (years of age)	New Haven, CT		Chicago, IL		San Francisco, CA		College Station, TX		Total
	Male	Female	Male	Female	Male	Female	Male	Female	
Young (18-35)	2	4	4	4	6	12	3	5	40
Middle (36-50)	9	8	9	6	9	8	8	6	63
Older (60+)	2	9	6	6	1	2	6	10	42
Total	13	21	19	16	16	22	17	21	145

Exhibit 49. Non-Recreational Pedestrian Travel By Participants (More than Two Blocks).

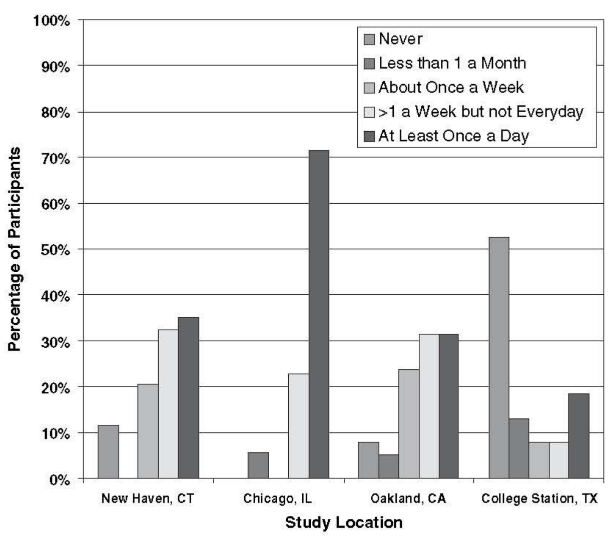


Exhibit 50. Non-Recreational Bicycle Usage By Participants.

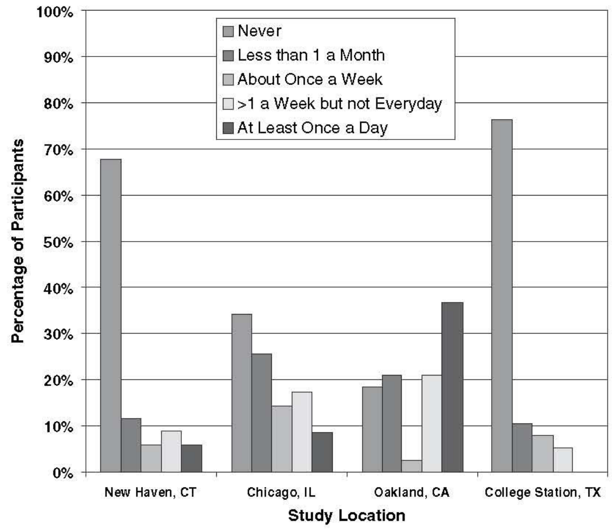


Exhibit 51. Transit Usage By Study Participants.

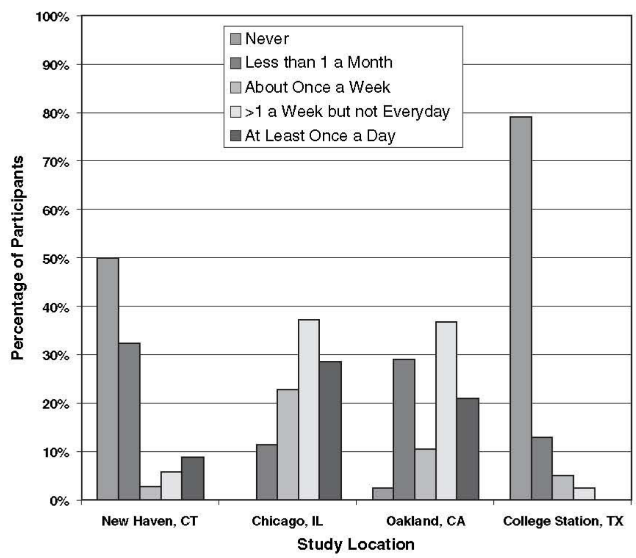


Exhibit 52. Comparisons of Socioeconomic Characteristics of Sample with National Averages.

Group	National Average	Sample	Bias in results?
Male	49%	45%	No, video lab participants mirror national average.
Age over 60	16%	29%	The video lab oversampled people over 60, which might possibly have a slight positive effect on LOS ratings for the bicycle video clips.
Single-family detached dwelling unit	60%	36%	The video lab undersampled people living in single-family homes, which might possibly have a slight positive effect on LOS ratings for the pedestrian video clips.
Has vehicle available	90%	91%	No, video lab participants mirror national average.

Source for national averages: US Census, 2000, American Fact Finder, Tables P8, H32, and H44.

Station had the highest percentage of participants who never walked, never biked, and never rode transit.

Validity of Video Lab Respondent Sample

The selected demographic characteristics of the video lab participants were compared with national averages (presented in Exhibit 52). With the exception of seniors (who were oversampled) and single-family home residents (who were undersampled), the video labs generally secured a representative national average of participants.

Survey Instrument

Survey instruments were developed to standardize data collection of input from the study participants. Study participants were asked to rate 10 video clips per mode on a six-point scale (A-F). Study participants were instructed that the A to F scale was similar to that used in grade school in which A was to represent the highest performance and F to represent the worst performance.

Pilot tests conducted by GMU in Phase I of NCHRP 3-70 revealed that trip purpose (i.e.,leisure versus time-constrained trips) influenced participant ratings of service quality; as a result, the team decided to focus study participants on time-constrained trips to better align with procedures in the HCM which are typically focused on peak-hour conditions. Study participants were instructed to choose the rating that best represented their assessment of quality as a commuter after watching each video clip.

A demographic survey instrument was also developed by team members for use in data analysis to better understand the motivation for responses by groups or individual participants. The survey contains questions about participant age group, gender, typical travel mode, and the use of all modes (including transit) during a typical day, week, and month. The survey instruments were developed to be easily understood and easily completed by the participants. Appendix A includes the survey instruments created for the study.

Pilot Tests

Pilot test sessions, using 14 GMU graduate students, were held to test the study methodology, to ensure that the surveys were easily understood by the participants, to refine our presentation of the materials, and to refine the study materials (such as how many clips to show and needing to increase font size for older drivers). Pilot test session data will not be included in the final database, but is available for review in hard copy format.

One of the primary goals of the pilot test sessions was to determine if the order of video presentation by mode influenced ratings. For example, should the videos be shown in the order Auto Driver, Bicycle Rider, Pedestrian or in the order Pedestrian, Bicycle Rider, Auto Driver? To control for the order, one order was presented to one study group and the other order was presented to the second study group. It was determined that order of presentation had a slight influence on participant ratings, in particular for the auto video clips. Using this information, the team determined that the videos needed to be shown in a consistent order at each of the four locations to control for potential mode order bias in participant ratings. The pilot sessions also revealed that the study materials were understandable to the participants, but that the font needed to be increased in some cases to account for vision loss in older participants. In addition, some of the questions in the demographic survey were rearranged to provide better consistency in terms of those questions that required filling in a blank versus circling a response.

Video Lab Sessions

Laboratory sessions were held in four locations, as previously noted. The study locations selected (large hotels in each of the four cities) had access to transit facilities, as well as, available parking; this provided the participants with easy to reach locations as well as a sense of security. Two study sessions were held in each location to enable older participants to attend daytime sessions (to address their desired times of arrival) and to enable working professionals to attend evening sessions. In each location, the daytime session was held from 10am-12:30pm and the evening session was held from 6:00-8:30pm.

Hotel meeting rooms were set up classroom style with two participants seated at each roughly 10-ft-long table. There was an aisle between two rows of tables in which the video equipment was placed, and a large-screen projector screen was set up at the front of the room. Light refreshments were provided during each session.

As participants arrived, they were given a unique identifier code which was written on their survey sheets for them and also corresponded to the receipt sheets generated for each location. The unique identifier scheme is required by GMU to keep the participants' information confidential while allowing the researchers to later make correlations between responses and some other demographic (i.e., age or sex). The participants were then asked to complete a demographic questionnaire while waiting for the remaining participants to arrive. Once all participants had arrived, Dr. Flannery thanked them all for attending and gave a short introduction to help them understand the task at hand. The opening remarks explained the study's purpose, who the study sponsor was, general procedures, location of facilities, explanation of the forms (survey forms, Informed Consent Form), their rights as study participants, and the schedule of the study. The clips were shown in the order of pedestrian mode, bicycle mode, and finally auto mode. Participants were asked to keep their opinions to themselves during the study so as to not influence their neighbors and were informed that, at the end of the clips, a short focus group would be conducted in which they could provide more details on their opinions.

A practice clip was shown to participants at the beginning of each mode to familiarize them with the task at hand. Questions were clarified, if needed, once participants had completed rating the practice clip. The participants were not informed what specifically to rate each clip on—only that they should rate the clip on how satisfied as a traveler. Upon completion of each mode, typically 20 to 25 minutes after the session had started, the participants had a 10- to 15-minute break before beginning the next mode video session. After all video clips had been rated by the participants, a short break was taken to set up for the focus group session. During the focus group session, participants were asked to discuss what factors greatly influenced their ratings in each of the mode video sessions. These comments were noted by Dr. Flannery on her laptop, and efforts were made to focus the participants on one mode at a time and to complete discussion of that mode before moving to the next.

At the end of the session, the participants were allowed to ask questions and then were compensated for their time with a $75.00 honorarium paid in cash and required to sign a receipt. Then forms were collected, and participants were thanked for their contribution to the study.

4.5 Effects of Demographics on LOS

This section presents the results of an investigation into the effects of various socioeconomic and location factors on clip ratings for auto, bicycle, and pedestrian modes. The effects of metropolitan area location on transit LOS ratings could not be tested because of differences in the transit services provided in each metropolitan area.

For each of the auto, bicycle, and pedestrian modes, four common film clips were shown in each of the four metropolitan regions. We used the ratings on these clips to test for effects of socioeconomic and location factors.

For each factor, we divided the respondents into a test group and a control group. The test group contained those respondents for which the factor was present (e.g., persons having one or more cars available); the control group contained those respondents for which the factor was not present (e.g., persons not having a car available).

Once the groups were defined, we used a nonparametric randomization (bootstrap) (see Davison and Hinkley [**95**]) test to determine whether the difference in mean ratings for an individual clip was significant. The sample size is denoted by N and the size of the control group is denoted by k. For hypothesis testing, the bootstrap method works as follows:

1. Compute the difference in means between the test group and the control group.
2. Generate a random permutation of cases. For each permutation, compute the mean for the first k cases and the last $N - k$ cases. If the difference is greater than or equal to the difference computed in Step 1, add 1 to an indicator variable X. Repeat this step B times.
3. Divide X by $B - 1$. The result is the estimated probability that the difference computed in Step 1 results from chance alone.

The bootstrap method has significant advantages over traditional hypothesis testing, mainly because it is nonparametric and, therefore, makes no assumptions about the shape of the distribution of responses.

For this analysis, we defined significance to be at the 10% level (i.e., the probability that the difference in ratings could have arisen by chance alone is less than 10%.). We judged the bootstrap test to be superior to other tests that might be used for the following reasons:

- Standard analysis of variance requires that cell sizes be equal, or nearly so (see Searle [**96**]). This assumption is violated for all the tests considered.
- Classic hypothesis tests (e.g., the t-test) assume that responses are normally distributed.

For each clip, we defined an indicator variable *y* as follows:

- $y = +1$ if the mean rating for the test group is *higher* than the mean rating for the control group, and the difference is significant.
- $y = -1$ if the mean rating for the test group is *lower* than the mean rating for the control group, and the difference is significant.
- $y = 0$ if the mean rating for the test group is not significantly different from the mean rating for the control group.

The scores for each of the four control clips for a given mode were added to form a *cumulative score* for the individual factor for that mode. Given that there were four common clips for each mode, the score for each factor for a given mode could range from –4 to +4. A factor was deemed to be *significant* if the score for that mode was –3 or +3; this meant that for three of the four common clips for that mode, the differences in ratings between the test and control groups were significant and in the same direction. A factor was deemed to be *highly significant* if the score for that mode was –4 or +4; this meant that for all four common clips for that mode, the differences in ratings between the test and control groups were significant and in the same direction.

The tested socioeconomic factors are listed in Exhibit 53.

Effects of Demographics on Auto LOS Ratings

Significant differences in auto clip ratings are shown in Exhibit 54. Although there were several significant differences (three of the four clips consistently rated higher or lower), none was highly significant.

Exhibit 53. Test and Control Groups for Socioeconomic and Location Factors.

Test group	Control group
Metro area is New Haven	Metro area is Chicago
	Metro area is San Francisco Bay Area
	Metro area is College Station
	All other regions
Metro area is Chicago	Metro area is San Francisco Bay Area
	Metro area is College Station
	All other regions
Metro area is San Francisco Bay Area	Metro area is College Station
	All other regions
Metro area is College Station	All other regions
Metro area population ≥ 1 million	All other respondents
Age is 18 - 35	All other respondents
Age is 36 - 60	All other respondents
Age is 60+	All other respondents
Sex is male	All other respondents
Has a vehicle available	All other respondents
Has a bike available	All other respondents
Respondent is employed	All other respondents
Dwelling unit is single-family home	All other respondents
Respondent owns the home	All other respondents
Walks non-recreational > 2 blocks more than once a week	All other respondents
Cycles non-recreational > 2 blocks more than once a week	All other respondents
Uses transit more than once a week	All other respondents
Commutes by auto (drive alone or shared ride)	All other respondents
Commutes by transit	All other respondents

Exhibit 54. Significant Differences in Ratings—Auto.

Group		Group Sample Size		Mean Rating Difference[a]
Test	Control	Test	Control	
Highly Significant Differences				
None				
Significant Differences				
Metro area is New Haven	Metro area is College Station	34	38	-1.02
Metro area is New Haven	All other respondents	34	111	-0.85
Metro area is New Haven	Metro area is Chicago	34	35	-0.84
Has a vehicle available	All other respondents	132	13	0.67
Region is College Station	All other respondents	38	107	0.50

[a] Mean of test group rating minus control group rating

The following are the main findings for auto:

- Respondents in the New Haven metro area consistently rated the clips lower than did respondents from other metropolitan areas.
- Respondents with a vehicle available tended to rate the clips higher than did respondents from other metropolitan areas.
- Respondents from the College Station metro area tended to rate the clips slightly higher than did other respondents.

However, none of these differences were found to be "highly significant," thus all data from all metropolitan areas and demographic groups were pooled for auto LOS model development.

Effects of Demographics on Bicycle LOS Ratings

Significant differences in bicycle clip ratings are shown in Exhibit 55. The following factors resulted in highly significant differences in the LOS ratings:

- Respondents from the New Haven metro area consistently rated the clips lower than did respondents from the other metropolitan areas.
- Male respondents tended to rate the clips slightly higher than did female respondents.
- Respondents from metro areas with a population of over 1 million (Chicago and San Francisco Bay Area) tended to rate the clips slightly higher than did respondents from the other two metro areas.

The following factor was found to be significant:

- Respondents aged over 60 tended to rate the clips slightly higher than did other respondents.

For these reasons "metropolitan area" was included as an explanatory variable for the bicycle LOS model development. However, analysts would not generally have information on the sexual split between bicyclists, so sex was excluded from the bicycle LOS model development.

Effects of Demographics on Pedestrian LOS Ratings

Significant differences in pedestrian clip ratings are shown in Exhibit 56. The following factors resulted in highly significant differences in the pedestrian LOS ratings:

- Respondents who walk more than two blocks for non-recreational purposes more than once a week tended to rate the clips lower than did other respondents.

The following factors resulted in significant differences in the LOS ratings:

- Respondents from the College Station metro area tended to rate the clips higher than did other respondents.
- Respondents from the Chicago metro area tended to rate the clips lower than did respondents from the College Station metro area.
- Respondents who have a bicycle available tended to rate the clips slightly lower than did other respondents.
- Respondents who live in single-family detached dwelling units tended to rate the clips slightly higher than did other respondents.

Only the extent of non-recreational walking was a highly significant factor affecting pedestrian LOS ratings. However, this a demographic variable unlikely to be known by analysts using the pedestrian LOS method. Consequently, this variable was excluded from the pedestrian LOS model.

Exhibit 55. Significant Differences in Ratings—Bicycle.

Group		Group Sample Size		Mean Rating Difference[a]
Test	Control	Test	Control	
Highly significant differences				
Metro area is New Haven	Metro area is San Francisco Bay Area	34	38	-0.87
Metro area is New Haven	All other respondents	34	109	-0.75
Metro area is New Haven	Metro area is College Station	34	36	-0.71
Metro area is New Haven	Metro area is Chicago	34	35	-0.68
Male	All other respondents	65	78	0.47
Metro area population ≥ 1 million	All other respondents	73	70	0.40
Significant differences				
Age is 60+	All other respondents	42	101	0.61

[a] Mean of test group rating minus control group rating

Exhibit 56. Significant Differences in Ratings – Pedestrian.

Group		Group sample size		Mean rating difference[a]
Test	Control	Test	Control	
Highly significant differences				
Walks non-recreational > 2 blocks more than once a week	All other respondents	97	48	-0.60
Significant differences				
Metro area is College Station	All other respondents	38	107	0.78
Metro area is Chicago	Metro area is College Station	35	38	-0.77
Has a bike available	All other respondents	107	38	-0.76
Dwelling unit is single-family home	All other respondents	52	93	0.36

[a] Mean of test group rating minus control group rating

The metropolitan area showed up as a significant factor affecting pedestrian LOS ratings for a couple of metropolitan areas, so this factor was included in the pedestrian LOS model development.

4.6 Transit On-Board Surveys

The transit survey methodology used for this project was designed to achieve the following objectives:

- Confirm the quality of service factors important to passengers who have already decided to make a trip by transit;
- Ask questions in a form relevant to passengers (relating to their trip), but provide results in a form relevant to the project (relating to a specific urban street facility);
- Maximize the amount of useful information that could be gleaned from a limited number of survey locations; and
- Provide the information necessary to develop the project team's initially proposed transit model form, while also providing data that could be used to develop alternative model forms, if necessary.

Agency Coordination

Five transit agencies were contacted to obtain permission to conduct surveys: TriMet in Portland, Oregon; Washington Metropolitan Area Transit Authority (WMATA) for Northern Virginia; Broward County Transit (BCT) for the Fort Lauderdale, Florida area; the San Francisco Municipal Railway (MUNI) (which operates bus and rail services within the City of San Francisco); and AC Transit (which operates express and local bus services in and between several cities in the San Francisco metropolitan area). These agencies were chosen for geographic variety, a range of service and demand conditions, and their proximity to research staff offices. All of the agencies were provided with an explanation of the purpose and expected outcomes of the NCHRP 3-70 project, a draft copy of the survey form, and the route(s) desired to be surveyed. All readily agreed to participate.

Under TriMet's union contract, drivers of buses on which surveys will occur must be notified in advance, which required that specific trips to be surveyed had to be identified well in advance. This requirement did not exist at the other agencies; however, the drivers there were also given advance notice, so that they would be aware that the surveys would be occurring. Surveyors at all sites carried a letter from the transit agency authorizing them to be on the bus, in case a driver had any questions. WMATA also required that the names of the surveyors be provided in advance so that they could be listed on the letter.

Field Data Collection

The following roadway-related information was collected along the entire route:

- Average stop spacing (bus stops/mile);
- Stop-specific data:
  - Presence of shelter (yes/no);
  - Presence of bench (yes/no) [including a bench inside a shelter];
  - Presence of sidewalk or path (yes/no);
  - Presence of ditch or other obstacle between sidewalk and street (yes/no);
  - Bus stop waiting area separation from auto traffic (curb-tight, sidewalk set back from street, on median or traffic island, off-street);
  - Street width (lanes);
  - Median type (raised/painted/none);
  - Traffic control at stop (signal/all-way stop/bus street stops/side street stops/roundabout/mid-block location/off-street location); and
  - Crosswalk type at stop (marked/unmarked/no legal crosswalk).

The following transit-related information was collected:

- Stop location for each stop on the surveyed routes;
- Survey route frequency—peak and midday (bus/h);

- Effective frequency on arterial—peak and midday (bus/h);
- Survey route service span (h/day);
- Effective service span on arterial (h/day);
- Scheduled bus arrival/departure times;
- Number of seats on the bus; and
- Available standee area on bus.

"Effective frequency" and "effective span" included all routes along a portion of the urban street serving the same destination as the surveyed route. For example, if the survey route operated two trips per hour during the peak hour, and another route on the same street serving the same destination also operated two trips per hour during the peak hour, the effective peak-hour frequency was four trips per hour.

Survey Form Development

An initial draft of the survey form was described in the Phase 1 "Transit Data Collection Plan" memo and subsequently approved by the project panel. In working with TriMet to obtain permission to conduct surveys on their buses, TriMet's Marketing Information Department offered to review and comment on the survey form, based on their experience conducting on-board surveys. Their review resulted in wording changes to some of the questions to shorten the descriptions, while keeping the original meaning. A Spanish version of the pilot survey was also developed.

The revised survey form and the survey procedures were pilot tested on April 22, 2004, on TriMet Line 15. Based on user feedback, the final question on the pilot survey, which asked persons to rank the quality of service factors most important to them, was substantially changed to reduce confusion. In addition, the number of factors presented on the final version of the survey was reduced from 29 to 17 by eliminating factors that received few to no responses among users' five most important factors. Spanish and large-print (22-point font) versions of the final survey were also developed.

TriMet requested that the survey form used on their buses resemble an official TriMet survey, so the TriMet logo, a TriMet-tailored explanation of the survey purpose, and a TriMet information phone number were included on the TriMet survey form. The other agencies wanted the surveys distributed on their buses to *not* resemble official agency surveys, so a generic survey purpose description resembling the one shown on the initial survey draft was used for those agencies.

The final version of the Phase 1 survey forms are given in Exhibit 57, reduced in size from legal-size paper. Each survey was given a unique four-digit serial number, with the first digit indicating the route it was used on:

- Portland: Line 15 (pilot test)
- Portland: Line 14
- Portland: Line 44
- Northern Virginia: Line 38B
- Northern Virginia: Line 2B
- Broward County: Line 18

The questions asked on the Phase 1 survey were as follows:

1. The stop where the person would get off the bus. (Surveyors recorded the stop where each passenger boarded and received a survey, using the survey's serial number, eliminating the need to ask persons where they boarded.)
2. The number of times a week the person rode the bus.
3. The major reason why the person chose to ride the bus (had a car but preferred the bus, chose not to own a car because bus service was available, did not own a car, didn't drive or know how to drive).
4. The person's satisfaction with their trip *today* on the bus, using a 1 (very dissatisfied) to 6 (very satisfied) scale:
   a. Getting to the bus stop
   b. Waiting for the bus
   c. Riding on the bus
   d. The overall trip
5. The person's satisfaction *in general* with the following aspects of the bus route, using the same 1-to-6 scale:
   a. Close to home
   b. Close to destination
   c. Sidewalk connects to stop
   d. Crossing street to stop is easy
   e. Shelter is provided
   f. Bench is provided
   g. Frequency of buses
   h. Times of day the route operates
   i. Reliability of service
   j. Seat available
   k. Wait time for bus
   l. Not overcrowded
   m. Friendly drivers
   n. Amount of time to reach destination
   o. Seat comfort
   p. Smooth ride
   q. Temperature inside bus is comfortable
6. Finally, persons were asked to rank up to five factors from the above list that were the most important to them.

In Phase 2, the length of the survey was substantially reduced by eliminating questions 5 and 6. As described in Section 3 of this working paper, the Phase 1 responses to these questions confirmed the importance of the quality-of-service factors given in the TCQSM, and it was not thought necessary to continue to ask these questions. In addition, one objective of the Phase 2 surveys was to sample more crowded routes than were sampled in Phase 1, and it was thought that a shorter survey

Exhibit 57. Phase 1 Transit Survey Form.

TRIMET

2«Serial

Please take a few minutes to fill out this TriMet survey.
The purpose of the survey is ask your satisfaction level with bus service on this route.
When finished, please place the survey in the envelope near the door.
Thank you for riding TriMet.

1. **First, where will you get off this bus?** ______________________________
(Street & cross-street)

2. **How often do you ride a TriMet bus/MAX/streetcar in a typical week?** *(Check one box.)*
☐1 1 day a week or less ☐2 2 to 4 days a week ☐3 Every weekday or more

3. **What is the major reason you are using the bus for this one-way trip?** *(Check one best answer.)*
☐1 I do have a car but prefer to use TriMet
☐2 I don't have a car because I prefer to use TriMet
☐3 I don't have a car available for me to use
☐4 I don't drive or don't know how to drive

4. **How satisfied are you with your trip today on this bus?**
Please answer using this 6-point scale where 1 means very dissatisfied and 6 means very satisfied. *(Circle one answer for each statement.)*

	Very Dissatisfied					Very Satisfied
a) Getting to the bus stop	1	2	3	4	5	6
b) Waiting for the bus	1	2	3	4	5	6
c) Riding on this bus	1	2	3	4	5	6
d) Your overall trip today	1	2	3	4	5	6

5. **How satisfied are you in general with this bus route?**
Please answer using this 6-point scale where 1 means very dissatisfied and 6 means very satisfied. *(Circle one answer for each statement.)*

	Very Dissatisfied					Very Satisfied
A) Close to home	1	2	3	4	5	6
B) Close to destination	1	2	3	4	5	6
C) Sidewalk connects to stop	1	2	3	4	5	6
D) Crossing street to stop is easy	1	2	3	4	5	6
E) Shelter is provided	1	2	3	4	5	6
F) Bench is provided	1	2	3	4	5	6
G) Frequency of buses	1	2	3	4	5	6
H) Times of day the route operates	1	2	3	4	5	6
I) Reliability of service	1	2	3	4	5	6
J) Seat available	1	2	3	4	5	6
K) Wait time for bus	1	2	3	4	5	6
L) Not over-crowded	1	2	3	4	5	6
M) Friendly drivers	1	2	3	4	5	6
N) Amount of time to reach destination	1	2	3	4	5	6
O) Seat comfort	1	2	3	4	5	6
P) Smooth ride	1	2	3	4	5	6
Q) Temperature inside bus is comfortable	1	2	3	4	5	6

6. **Of the factors listed above in Question #5, please rank the ones that are the most important to you, starting with the most important, then listing the next most important, and so on.**
(Write in the letter corresponding to each factor. If there are fewer than five factors that are important to you, leave the remaining lines blank. If a factor important to you is not listed, please write it in, instead of a letter.)

Most important factor______
2nd most important factor______
3rd most important factor______
4th most important factor______
5th most important factor______

503-238-RIDE (7433) TTY 503-238-5811 trimet.org **Thank you** 4/04 would be easier to administer under crowded conditions. Exhibit 58 shows an example of the Phase 2 survey form.

In order to cover the different groups in the San Francisco Bay Area adequately, Spanish and Mandarin Chinese versions of the questionnaire were also produced.

On the Phase 2 survey form, surveyors wrote a unique bus trip ID number in the upper right-hand corner for all questionnaires collected from that one-way bus trip. This ID number was then used to tie in the individual questionnaire to a unique bus route, direction, and time period.

Survey Distribution

In Phase 1, surveyors worked in teams of two. Two teams were assigned to a given route in Portland and Virginia, while three teams were assigned in Broward County, due to the longer route length. The teams started during the a.m. peak hour (around 7 a.m.) and rode their assigned bus route back and forth, for approximately 4 hours. The surveyors rode the Portland and Virginia routes from end-to-end and rode the Broward County route for most of its length within the county (about three-quarters of its total length, which extends just over the county line to the north and several miles beyond the county line to the south).

On the bus, the first surveyor sat immediately behind the driver and was responsible for (1) handing out surveys and golf pencils as persons boarded the bus, (2) occasionally removing surveys and pencils from the collection envelopes, and (3) cleaning up any surveys or pencils that passengers might have dropped on the floor. Surveys were handed out in numerical order. The first surveyor also had self-addressed stamped envelopes to hand to passengers wishing to complete the survey later, as well as large-print versions of the survey for riders with visual impairments. TriMet also required that the first surveyor carry a TriMet-designed card that provided both printed and Braille information instructing riders with visual impairments to call TriMet's information line to complete the survey. For this survey, TriMet's operators were instructed to take the person's name, phone number, and a call-back time and to pass the information to the researchers to complete the survey. Although cards were handed out, no one called TriMet to participate in the survey.

Exhibit 58. Phase 2 Transit Survey Form.

SERVICE QUALITY SURVEY

Please take a few minutes to fill out this survey.
We want to know how satisfied you are with service on this bus.
When finished, please hand this form back to the survey taker.

1. Where did you get on this bus? ____________________
(Street & cross street)

2. Where will you get off this bus? ____________________
(Street & cross street)

3. How often do you ride Muni?

- ☐ 5 or more days per week
- ☐ 1 – 2 days per week
- ☐ 3 – 4 days per week
- ☐ Less than 1 day per week

4. Could you have used a car for this trip?

- ☐ Yes
- ☐ No

5. How satisfied are you with your trip today on this bus?
Please circle a number below for each answer, where
1 means very dissatisfied and
6 means very satisfied.

	←← Dissatisfied				Satisfied →→	
	Very dissatisfied					Very satisfied
a) Getting to the bus stop	1	2	3	4	5	6
b) Waiting for the bus	1	2	3	4	5	6
c) Riding on this bus	1	2	3	4	5	6
e) This bus trip overall	1	2	3	4	5	6

The second surveyor sat in the first seat on the right side of the bus and was equipped with forms listing all of the bus stops served by the route in each direction. This surveyor was responsible for recording the number of people getting on and off at each stop and for recording the last survey serial number handed out at each stop. One team per route also carried a GPS unit that generated a log file recording the bus' position and speed every second; the second surveyor was responsible for using it. A new log file was generated for each trip. The GPS unit used was tested in an automobile prior to use and worked as expected; however, when used on buses, the unit sometimes had problems receiving satellite signals. As a result, GPS data were not available for all bus trips. In Portland, the handheld GPS data were supplemented with archived data from TriMet's automatic vehicle location system.

For the Phase 2 surveys, one surveyor was assigned per door to each bus that was surveyed; for example, two surveyors were assigned to regular buses, while three surveyors were assigned to articulated buses. Surveyors handed out a questionnaire to each person boarding the bus. Surveyors also attempted to interview standing passengers, asking them questions while the bus was in motion; consequently, surveyors with multi-lingual capability were assigned to specific routes that carry large numbers of non-English-speaking passengers.

Exhibit 59 shows the number of surveys distributed and returned in each location. Not all returned surveys were filled out completely. For Phase 2, surveyors were unable to keep track of the number of surveys distributed due to the heavy workload on crowded buses.

Route Characteristics

Routes were selected to create variety in (1) particular route characteristics that previous research had determined to be important (e.g., the TCQSM's LOS factors), and (2) specific pedestrian environment characteristics not previously researched. In addition, the routes selected in Northern Virginia included urban street segments also being used by GMU for the automobile LOS element of this project.

In Northern Virginia, WMATA Route 2B starts in the dense urban portions of Arlington (Ballston-MU Metrorail) and travels past sprawling residential neighborhoods, golf courses, cemeteries, office parks, and strip commercial uses in Falls Church and Fairfax. Route 2B stops at several auto-oriented Metrorail stations (i.e., East Falls Church, Dunn Loring-Merrifield, and Vienna/Fairfax-GMU) before completing its trip at the Fair Oaks Shopping Center in Fairfax. Some peak-period trips operate as Route 2G, deviating to serve an AT&T office building, but otherwise serving the same route. The eastern half of the route is duplicated by Route 2C, which effectively doubles the service frequency on that portion of the route.

WMATA's Route 38B also starts at the Ballston-MU Metrorail station, but travels through the most dense, transit-oriented portions of Arlington, stopping near three Metrorail stations (i.e., Clarendon, Court House, and Rosslyn) surrounded by mixed uses and high-rise buildings, before crossing the Francis Scott Key Bridge into Washington's dense Georgetown neighborhood and ending at Farragut Square, just two blocks from the White House. Route 38B is the only all-day WMATA route crossing the Key Bridge, although one of the Georgetown Metro Connection routes also crosses the bridge.

In Portland, Route 14 is one of TriMet's most frequent bus routes (eight buses per hour peak, five buses per hour midday) and has one of the longest service spans. Route 14 runs from the I-205/Foster Road interchange in southeast Portland (no park-and-ride provided) into downtown Portland via the Hawthorne Bridge (a drawbridge) and then runs along the downtown bus mall to Union Station. East of downtown, the street frontage is primarily commercial or mixed-use office and commercial in multiple-story buildings. Some low- to medium-density multi-family residential buildings also front the streets served by the transit route. Past the immediate transit street frontage, land uses are primarily medium- to high-density single-family residential.

TriMet Route 44 connects Portland Community College's Sylvania campus in southwest Portland to downtown and Union Station via the bus mall, passing through the commercial districts of Multnomah Village and Hillsdale. Outside the commercial areas, land uses served by the route are a mix of medium-density single-family residential and low-density multi-family residential. A 1-mile section of the route south of Multnomah Village lacks sidewalks. The route is also one of many serving Portland State University at the south end of downtown. Service from Hillsdale into downtown is duplicated by several other routes, creating a better effective frequency.

Exhibit 59. Transit Survey Distribution.

Location (Route)	Distributed	Returned	Usable
Virginia (2B)	186	182	172
Virginia (38B)	181	166	154
Portland (14)	218	204	198
Portland (44)	268	262	255
Florida (18)	306	276	165
San Francisco Muni (1)	NA	NA	201
San Francisco Muni (14)	NA	NA	366
San Francisco Muni (30)	NA	NA	112
San Francisco Muni (38)	NA	NA	339
San Francisco Muni (38L)	NA	NA	153
AC Transit (51)	NA	NA	199
AC Transit (72)	NA	NA	239
AC Transit (72R)	NA	NA	101
AC Transit (218)	NA	NA	24
Total	NA	NA	2,678

TriMet Route 15, used for the pilot test, runs from the Parkrose/Sumner transit center, light rail station, and park-and-ride lot in northeast Portland south to Mall 205 (a small shopping center). The route continues west through downtown Portland (at right angles to the bus mall), past a hospital, and ends in northwest Portland. Alternate trips terminate in a residential area of northwest Portland or at Montgomery Park, a large office building (the surveyed trips went to Montgomery Park). Land uses vary along the route and include medium- to high-density single-family residential, low- to medium-density multi-family residential, and office and commercial uses.

In Broward County, Route 18 runs north-south the length of the county along U.S. 441, from the south edge of Palm Beach County to the Golden Glades park-and-ride lot in northern Miami-Dade County, where transit connections can be made for trips continuing south. Service is provided at 15-minute headways during peak and midday periods. A weekday peak-period limited-stop version of the route (Route 18LS, not surveyed) duplicates all but the very northern end of the route and operates at 45-minute headways.

Phase 2 sample selection was guided by the results of analysis of the Phase 1 data set. Based on that analysis, it was determined that the Phase 2 sample should be designed to round out the characteristics of the Phase 1 data set. In particular, we sought a sample that included routes with one or more of the following characteristics:

- Moderate to severe crowding, with load factors greater than 1;
- High-demand density;
- Frequent service;
- Operation on reserved bus lanes; and/or
- Low frequency.

The San Francisco Bay Area has two transit agencies that operate routes with these characteristics. The San Francisco Municipal Railway (Muni) operates service within the City and County of San Francisco, with over 800,000 boardings on an average weekday. The Alameda-Contra Costa Transit District (AC Transit) operates service in the East Bay; cities within its service area include Oakland, Berkeley, Richmond, Hayward, and Fremont.

For all routes surveyed on Muni and AC Transit, surveys were taken on bus trips in both directions during the AM peak and PM peak. The following routes were selected for the sample:

- The Muni 1 California, a trolley bus, operates from the San Francisco Financial District westbound through Chinatown, Pacific Heights, and Laurel Heights to the Inner Richmond district. Surveyors rode the bus only from the Financial District to Laurel Heights. The bus runs on between 8 and 9-minute headways during the peak periods.
- The Muni 14 Mission begins in the downtown Financial District and runs through the Mission District to Daly City. This is Muni's busiest route, carrying over 60,000 passengers on an average weekday. Although articulated buses are used on this route, buses are frequently crowded, with most passengers standing. This bus runs on a priority bus lane (buses and right turns only) along Mission St. to about 10th St., but the bus lane is frequently violated by cars.
- The Muni 30 Stockton, a trolley bus, runs from the Caltrain Depot at 4th and Townsend north through the Financial District, then through Chinatown and North Beach to the Marina District. Buses frequently bunch up; because it is a trolley bus, buses cannot pass each other. Buses move especially slowly through Chinatown, where there are large numbers of boardings and alightings. The bus operates on 9-minute headways during the peak periods.
- The Muni 38 Geary and 38L Geary Limited operate from the Transbay Terminal along Market St., then along Geary to western San Francisco. Past 33rd Avenue, the route splits into three branches. This is one of Muni's busiest routes, carrying about 60,000 passengers per day. Buses are articulated, but are frequently crowded with most passengers standing. Effective headways east of 33rd Avenue are between 4 and 8 minutes, depending on whether the local or limited service is used. The bus runs on dedicated priority bus lanes (buses and right turns only) from downtown to Van Ness Avenue, but these are frequently violated.
- AC Route 51 Broadway, one of the busiest routes on the AC Transit system, runs from Alameda (an island off of Oakland) through the Posey Tube through downtown Oakland, then north along Broadway and College Avenue to Berkeley, and then west to the western part of Berkeley. This route serves the UC Berkeley campus, so many of the riders are UC students or faculty. The bus operates on about 8-minute headways during the peak periods.
- AC Route 72 San Pablo runs along San Pablo Avenue from downtown Oakland along San Pablo Avenue through Berkeley to Hilltop Mall in Richmond. The 72 operates on 30-minute headways throughout the day, but service is paralleled by the 72M, which also operates on 30-minute headways on the part of the route that was surveyed.
- AC Route 72R San Pablo Rapid is a new rapid bus service that runs from downtown Oakland along San Pablo Avenue through Berkeley to Contra Costa College. Stops are spaced about every half mile. The bus operates on 12-minute headways throughout the day.
- AC Route 218 Thornton was chosen to provide a sample on a long-headway route (1 hour). The 218 runs from Ohlone College in Fremont to the Lido Faire shopping center in Newark.

Exhibits 60, 61, and 62 summarize key characteristics of the selected routes.

Exhibit 60. Route Characteristics—Phase 1.

Characteristic	Route: Virginia 2B	Virginia 38B	Portland 14	Portland 44	Florida 18
Peak frequency (bus/h)	2	4	8	4	4
Off-peak frequency (bus/h)	1	2	5	4	4
Maximum eff. frequency (bus/h)	4	7	38	38	5
Service span (h/day)	16.5	22	20.5	16	19.5
Stops with shelter (%)	13%	29%	34%	30%	23%
Stops with bench (%)	15%	26%	47%	41%	75%
Street width range (lanes)	2–9	1–7	2–6	1–6	5–9
Stops at traffic signals (%)	40%	68%	48%	40%	48%
Stops with sidewalks (%)	89%	99%	99%	81%	88%
Stops without legal crosswalks (%)	53%	19%	6%	9%	51%
Average load (p/bus)	11	14	10	16	**
Average maximum load (p/bus)	18	28	27	25	**
Maximum load (p/bus)	34	44	37	42	**

**Due to a data collection problem, loads cannot be calculated for all trips. A few surveyed trips had standing loads.

4.7 Representation of Survey Results By A Single LOS Grade

The automobile, transit, bicycle, and pedestrian surveys produced distributions of LOS ratings for any given condition. However, a distribution of LOS results for any given mode on any given street is less convenient for decisionmakers than a single-letter LOS grade as is customary in the HCM). The HCM does not report the distribution of LOS grades for a given situation. The HCM reports a single LOS grade for a given situation. This research project was, therefore, confronted with the issue of how to convert the distribution of LOS grades reported by the public into a single LOS grade for a given situation.

In statistics, various single-value measures can be used to represent a distribution. The two most common single-value measures are the "mean" and the "mode" of the distribution.

The mode is appealing, because it represents the most frequent LOS response of the public. However, the mode has one weakness, in that it is possible for a distribution with two "camel humps" to have two modes. It is possible for both humps to be an identical percentage of the total distribution, in which case, one cannot report a single LOS result.

The mean is appealing because it always results in a single LOS grade, regardless of the distribution. However the mean has a major weakness in that it can reach LOS A or LOS F only in the rare cases when there is almost complete agreement by the members of the public that the LOS is A or F. Even if most respondents pick LOS A or F, it takes few dissenters to drag the mean LOS from A or F (see Exhibit 63).

As shown for Distribution #1 in Exhibit 63, even when 50% of the people choose LOS A, the mean will still be 1.65, which is closer to 2.00 (LOS B) than to 1.00 (LOS A). The "mode" performs as desired for these example distributions, however; we have ruled it out because of its inability to resolve a tie.

The row labeled LOS 1 converts mean values to a letter grade using the same values of LOS A through LOS F that were used to compute the mean (see Exhibit 64). As can be seen, this approach cannot get LOS A for the mean of

Exhibit 61. Route Characteristics—Phase 2, San Francisco.

Characteristic	Route: 1 California	14 Mission	30 Stockton	38 Geary	38 Geary Limited
Peak frequency (bus/h)	20	10	7	8	9
Off-peak frequency (bus/h)	10	7	7	8	9
Maximum eff. frequency (bus/h)	20	10	27	10	12
Service span (h/day)	20	24	20	24	14
Stops with shelter (%)	44	54%	44%	68%	84%
Stops with bench (%)	44	56%	44%	69%	86%
Street width range (lanes)	2 – 5	2 – 4	2 – 7	2 – 8	2 – 8
Stops at traffic signals (%)	58%	91%	54%	63%	75%
Stops with sidewalks (%)	NA	NA	NA	NA	NA
Stops without legal crosswalks (%)	2%	1%	1%	3%	0%
Average load (p/bus)	NA	NA	NA	NA	NA
Average maximum load (p/bus)	NA	NA	NA	NA	NA
Maximum load (p/bus)	NA	NA	NA	NA	NA

Exhibit 62. Route Characteristics—Phase 2, AC Transit.

Characteristic	Route			
	51 Broadway	72 San Pablo	72R San Pablo Rapid	218 Thornton
Peak frequency (bus/h)	8	4	5	1
Off-peak frequency (bus/h)	8	4	5	1
Maximum eff. frequency (bus/h)	8	4	5	1
Service span (h/day)	19	18	14	15
Stops with shelter (%)	28%	39%	74%	11%
Stops with bench (%)	51%	46%	75%	15%
Street width range (lanes)	2 – 7	2 – 5	2 – 5	2 – 6
Stops at traffic signals (%)	67%	60%	85%	60
Stops with sidewalks (%)	NA	NA	NA	NA
Stops without legal crosswalks (%)	0%	8%	4%	18%
Average load (p/bus)	NA	NA	NA	NA
Average maximum load (p/bus)	NA	NA	NA	NA
Maximum load (p/bus)	NA	NA	NA	NA

distribution #1, but otherwise, performs reasonably for the other five example distributions.

The row labeled LOS 2 converts the mean values to a letter grade using a shifted set of thresholds that divide at the midpoint between each LOS value. Unfortunately, this approach results in Distribution #6 being converted to LOS E, instead of the desired F and does not solve the problem of producing LOS B for Distribution #1, when LOS A is the desired result.

The row labeled LOS 3 shows the results when a compressed range of thresholds is used to convert the mean values to letter grades. The compressed range squeezes together the thresholds for LOS B to LOS E, so that wider ranges are available for LOS A and LOS F. Under this scheme, LOS A ranges from a mean of 1.0 to a mean of 2.0; LOS F ranges from a mean of 5.0 to 6.0. These larger ranges for the extreme LOS grades ensure that extreme LOS grades will be output for distributions where a large portion of the responses are at the extreme LOS grades.

The LOS3 threshold scheme was tested on the auto video clip results and was found to produce a reasonable range of LOS A through F results for the mean LOS values for the video clips that were representative of the distribution of the reported LOS results. This threshold scheme was adopted for reporting the data collection results and for reporting single-letter grade results from the various LOS models developed under this research.

Exhibit 63. Example Distributions and Mean of Level of Service.

LOS	Dist 1	Dist 2	Dist 3	Dist 4	Dist 5	Dist 6
A	**50%**	25%				
B	35%	**50%**	25%			
C	15%	25%	**50%**	25%		
D			25%	**50%**	25%	15%
E				25%	**50%**	35%
F					25%	**50%**
Mean	1.65	2.00	3.00	4.00	5.00	5.35
Mode	1	2	3	4	5	6
LOS 1	B	B	C	D	E	F
LOS 2	B	B	C	D	E	E
LOS 3	A	B	C	D	E	F

Exhibit 64. LOS Mean Value Threshold Schemes.

LOS	Numerical Value	LOS 1 Straight Thresholds	LOS 2 Thresholds Shifted to Midpoints	LOS 3 Compressed Ranges
A	1	Mean ≤ 1.00	Mean ≤ 1.50	Mean ≤ 2.00
B	2	> 1.00 to ≤ 2.00	> 1.50 to ≤ 2.50	> 2.00 to ≤ 2.75
C	3	> 2.00 to ≤ 3.00	> 2.50 to ≤ 3.50	> 2.75 to ≤ 3.50
D	4	> 3.00 to ≤ 4.00	> 3.50 to ≤ 4.50	> 3.50 to ≤ 4.25
E	5	> 4.00 to ≤ 5.00	> 4.50 to ≤ 5.50	> 4.25 to ≤ 5.00
F	6	Mean > 5.00	Mean > 5.50	Mean > 5.00

CHAPTER 5

Auto LOS Model

5.1 Model Development

Identification of Key Variables

A correlation analysis was performed to determine what relationships may exist between the dependent variable (i.e., individual participant ratings of LOS) and a dataset of 78 independent variables represented in the video clips or transformations of said variables (i.e., log of mean travel speed). The correlation analysis revealed that no less than 69 variables had a statistically significant relationship with individual participant ratings of LOS.

Exhibit 65 summarizes the correlation analysis, including Kendall's tau rank correlation coefficients. Some variables have not been included in order to reduce the size of the table. For example, transformations of variables have not been included because they tend to have the same or similar tau rank correlation coefficient patterns and significance values. Care was taken in selecting explanatory variables included in the modeling effort so as to avoid including variables that were highly correlated with each other.

Exhibit 66 illustrates the correlation analysis done of the explanatory variables to understand the relationships between these variables. In this table, the tau rank correlation coefficients are shown for correlations between space mean speed and the previously listed explanatory variables. In this table, all significance values are <0.10, meaning the relationships are statistically significant at the 90% level.

Linear Regression Tests

Linear regression techniques were first explored to determine if a multiple linear relationship might exist that could estimate the mean rating obtained for each video clip shown in Phase I and/or II of the study.

Independent variables to be used to estimate the dependent variable (mean clip rating) were selected from the larger set of explanatory variables. This was done by controlling for redundant explanatory variables (e.g., average travel speed and number of stops) and by retaining those explanatory variables that were highly correlated with the mean clip rating. The explanatory variables included in the stepwise regression exercise were as follows:

- Space mean speed,
- Number of stops,
- Stops per mile,
- Presence of median,
- Presence of exclusive left-turn lane,
- Presence of trees rating, and
- Pavement quality rating.

Forward stepwise regression techniques were used to allow for the inclusion of variables into the model only if they could increase the ability of the model to predict the dependent variable shown through the increase in R-square value. The results of the stepwise multiple linear regression are shown in Exhibit 67. The adjusted R-square value for the overall model is 0.673.

The model is

$$\begin{aligned} \textit{Mean Auto LOS} = {} & 3.8 - 0.530(\textit{Stops}) - 0.155(\textit{Median}) \\ & + 0.355(\textit{Left-Turn Lane}) + 0.098(\textit{Trees}) \\ & + 0.205(\textit{Pavement Quality}) \end{aligned} \quad \text{(Eq. 9)}$$

Where

Mean Auto LOS = 6.0 for LOS A and 1.0 for LOS F

Stops = number of times in video clip that auto speed drops below 5 mph.

Median = 3 if raised median (curbs between opposing traffic streams), 2 if two-way left-turn lane, 1 if no opposing traffic stream (one-way street), 0 if no separation between opposing traffic streams.

Left-Turn Lane = one if present, zero otherwise. Exclusive left-turn lane can be of any length or

Exhibit 65. Correlation Between Explanatory Variables and LOS Ratings.

Variable	tau Rank Correlation Coefficient	Significance p-value
Space Mean Speed	0.317	0.000
Total Travel Time	-0.315	0.000
Lane Width	0.307	0.000
Number of Stops per Mile	-0.307	0.000
Sign Quality	0.268	0.000
Tree Presence	0.248	0.000
Sidewalk Width	-0.244	0.000
Has Ex Left-Turn Lane	0.223	0.000
Pedestrian Presence	-0.218	0.000
Number of Signals per Mile	-0.217	0.000
Control Delay per Mile	-0.210	0.000
Speed Limit	0.198	0.000
Median Presence	0.175	0.000
Stops per Signal	-0.159	0.000
Lane Marking Quality	0.110	0.000
Median Width	0.107	0.000
Variation in Speed	-0.084	0.000
Number of Through Lanes	-0.065	0.003
Separation Between Sidewalk and Travelway	0.055	0.010

width. Two-way left-turn lanes do not count as exclusive left-turn lanes.

Trees = 3 if many, 2 if some, 1 if few or none

Pavement Quality = 4 if new, 3 if typical, 2 if cracked, 1 if poor.

The R-square statistic for this model equals 0.673, meaning 67 percent of the variation in mean participant ratings can be estimated by the model; however, several variables included in the model do not contribute significantly to the overall model predictive power, as indicated by their high *p*-values.

To address the inclusion of variables that are not statistical contributors to the model, another regression model was developed that included only the number of stops and the presence of an exclusive left-turn lane, those variables which were significant in Model 1. This new model's details are provided in Exhibit 68.

In this model each of the two variables, number of stops, and presence of an exclusive left-turn lane were significant at the 0.05 level resulting in the following:

$$\text{Mean Auto LOS} = 4.327 - 0.622\,(\text{Stops}) + 0.293\,(\text{Left Turn Lane}) \qquad \text{(Eq. 10)}$$

Where

Mean Auto LOS = 6.0 for LOS A and 1.0 for LOS F

Stops = Number of times in video clip that auto speed drops below 5 mph.

Exhibit 66. Correlation Between Space Mean Speed and Other Explanatory Variables.

Variable	tau Rank Correlation Coefficient
Space Mean Speed	1.00
Total Travel Time	0.617
Lane Width	-0.694
Number of Stops per Mile	0.270
Sign Quality	0.442
Tree Presence	0.474
Sidewalk Width	-0.423
Has Ex Left-Turn Lane	0.264
Pedestrian Presence	-0.445
Number of Signals per Mile	-0.270
Control Delay per Mile	-0.721
Speed Limit	0.381
Median Presence	0.147
Stops per Signal	-0.462
Lane Marking Quality	0.111
Median Width	0.117
Variation in Speed	-0.287
Number of Through Lanes	-0.222
Separation Between Sidewalk and Travelway	0.104

Exhibit 67. Multiple Linear Regression Model #1.

Variable	Standard Coefficient	t-Statistic	Statistical Significance (p-value)
Constant	3.8	9.832	0.00*
Number of Stops	-0.530	-4.154	0.00*
Median Presence	-0.155	-0.898	0.377
Presence of Ex. Left-Turn Lane	0.355	1.903	0.067*
Tree Rating	0.098	0.816	0.421
Pavement Quality	0.205	1.556	0.130

*Statistically Significant at the 0.10 confidence interval

Left-Turn Lane = Presence of exclusive left-turn lane at all intersections. Equals one if present, zero otherwise. Exclusive left-turn lane can be of any length or width.

This second model has an adjusted R-square value of 0.647, slightly inferior to Model 1.

Similar model formats were attempted using average space mean speed as the primary predictor of mean participant rating; however, the adjusted R-Square values were lower at 0.545, meaning only 54.5% of the variation in mean participant ratings could be explained by the model. For this model, explanatory variables space mean speed, presence of an exclusive left-turn lane, and tree rating were included in the stepwise regression analysis. In this case, tree rating did not contribute significantly to the prediction power of the model and so was removed. Exhibit 69 contains statistical information for Model 3.

The end result is a model of the following form

$$\text{Mean Auto LOS} = 2.673 + 0.479\,(\text{Speed}) + 0.403\,(\text{Left-Turn Lane}) \qquad \text{(Eq. 11)}$$

Where

Mean Auto LOS = 6.0 for LOS A and 1.0 for LOS F

Speed = average space mean speed in mph.

Left-Turn Lane = Presence of exclusive left-turn lane at all intersections. Equals one if present, zero otherwise. Exclusive left-turn lane can be of any length or width.

This model has an adjusted R-square value of 0.545, inferior to Models 1 and 2. The lowest value that this model can produce is 2.673, the value of the constant. Thus the LOS could never be below LOS E.

Limitations of Linear Regression Modeling

Linear regression techniques are not particularly the best model specification choice when modeling ordered response variables in that linear regression models attempt to determine the best-fitting linear equation according to the least-square criterion, such that the sum of the squared deviations of the predicted scores from the observed scores is minimized to give the most accurate prediction. This assumes that, for a measured change in the explanatory variables, there is a measured linear change in the dependent variable, namely the mean participant rating. Linear regression models also predict a continuous variable, which is different than what was asked of participants in the study. For example, linear regression models will also predict values such as 3.42 LOS, lying between LOS C and D.

These limitations led the research team to investigate the use of cumulative logistic regression, which can predict the

Exhibit 68. Multiple Linear Regression Model #2.

Variable	Standard Coefficient	t-Statistic	Statistical Significance (p-value)
Constant	4.327	16.428	0.00*
Number of Stops	-0.622	-5.152	0.00*
Presence of Ex. Left-Turn Lane	0.293	2.427	0.021

*Statistically Significant at the 0.05 confidence interval

Exhibit 69. Multiple Linear Regression Model #3.

Variable	Standard Coefficient	t-Statistic	Statistical Significance (p-value)
Constant	2.673	10.483	0.00*
Space Mean Speed	0.479	3.657	0.01*
Presence of Ex. Left-Turn Lane	0.403	3.075	0.004*

*Statistically Significant at the 0.05 confidence interval probability of responses within each LOS based on a combination of explanatory variables. This characteristic also allowed the research team to make use of the nearly 1,650 observations contained in the modeling database rather than just 35 mean estimates of LOS (1 mean LOS for each video clip shown), and to predict the discrete outcome (i.e. 1,2, . . ., 6) as generated from the video lab surveys.

Cumulative Logistic Regression

For the auto LOS survey, the overall ratings (RatingNum) have a hierarchical ordering that varies from 1 (worst rating, or LOS F) to 6 (best rating, or LOS A). The discrete nature of RatingNum rules out the use of ordinary Linear Regression, because it requires the response to be a continuous variable. Cumulative logistic regression addresses the issue of modeling discrete variables with hierarchical ordering.

Consider the following cumulative probability $P(Y \le j \mid \mathbf{x})$ and define the logistic model for this probability as

$$Ln\frac{P(Y \le j \mid x)}{1-P(Y \le j \mid x)} = \beta'(x) \qquad \text{(Eq. 12)}$$

In general, $P(Y = j \mid \mathbf{x}) = 1 - P(Y \le j - 1 \mid \mathbf{x})$, so estimated probabilities for all scores can be obtained. The vector β' represents the vector of coefficients for both LOS ranges (there are $6 - 1 = 5$ such intercept coefficients designated as α's) as well as the coefficients of the independent variables considered in the model (designated as β's). Equation 12 can be rewritten as

$$P(Y \le j \mid \mathbf{x}) = \frac{\exp(\beta'\mathbf{x})}{1+\exp(\beta'\mathbf{x})}(\mathbf{3}) \qquad \text{(Eq. 13)}$$

Each cumulative probability has its own intercept α_j; the values of α_j are increasing in j since $P(Y \le j \mid \mathbf{x})$ increases in j for fixed $\mathbf{x}$. The model assumes the same effects $\beta_{tree\_presnce}$, $\beta_{stops\_per\_mile}$ and $\beta_{Pres\_\_Of\_Ex\_\_LT\_Lane}$ for each j.

In order to have an appropriate interpretation of the intercept values, consider Model 3 for two scores j and k with $j < k$ and assume values = 0 for the two dummies tree_presence and Pres__Of_Ex__LT_lane. After some algebraic manipulations we have

$$P(Y \le k \mid \text{stops\_per\_mile}) = P(Y \le j \mid \text{stops\_per\_mile} + (\alpha_k - \alpha_j) / \beta). \qquad \text{(Eq. 14)}$$

Cumulative probability for j is the same as the cumulative probability for k but evaluated at a stops_per_mile value displaced by an amount dependent on the positive difference between intercepts at score j and k, and the parameter β.

Exhibit 70 illustrates this model with increasing values of each α_j and positive value of β for stops_per_mile. The model coefficients, estimated using the Maximum Likelihood estimation methods, and their significance are shown in Exhibit 71.

What the increasing value of the intercept guarantees in this case is that for each (integer) value of RatingNum the sequence of cumulative probabilities for a certain value l of stops_per_mile are in the right order, meaning that,

$$\begin{aligned} &P(Y \le 1 \mid stops\_by\_mile = l) \le P(Y \le 2 \mid stops\_by\_mile = l) \\ &\le P(Y \le 3 \mid stops\_by\_mile = l) \le P(Y \le 4 \mid stops\_by\_mile = l) \\ &\le P(Y \le 5 \mid stops\_by\_mile = l) \le 1 \end{aligned} \qquad \text{(Eq. 15)}$$

A positive slope is evident in Exhibit 70 as the increment in the cumulative probability for a particular RatingNum score when stops_per_mile value increases. The difference between successive curves for RatingNum scores determines the probability $P(Y = j \mid \text{stops\_per\_mile})$ for an individual RatingNum score given a fixed value of stops_per_mile. For instance, the value of $P(Y \le 1) = P(Y = 1)$ is higher when stops_per_mile = 18 than when stops_per_mile = 1 and the value of $P(Y = 5) = P(Y \le 5) - P(Y \le 4)$ is higher when stops_per_mile = 1 than for stops_per_mile = 18, so it appears that, with higher probability, high ratings in LOS are given to trips with fewer stops per mile. Also shown in the exhibit are the marginal probabilities of the various levels of service (A to F) when the number of stops per mile is fixed at 2.

Best Candidate Auto LOS Models

Preliminary modeling analysis has resulted in two fairly strong models, one which uses number of stops per mile and the other which uses average space mean speed as the primary explanatory variable. Both models perform well. Both models are presented with "trees" or "no trees" options. The recommended models are shown in Exhibits 72 through 74.

The Pearson Correlation measures the ability of each model to reproduce the observed video clip ratings of level of service. A higher value indicates a better model fit. The highest possible value is 100%.

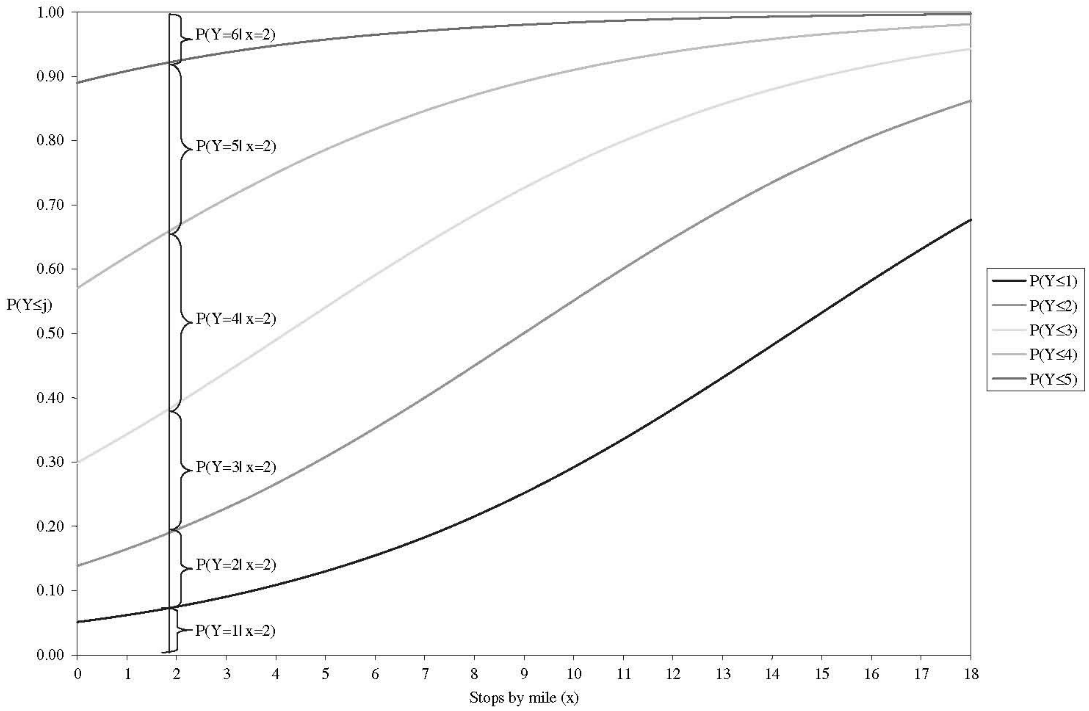
The Akaike Information Criterion (AIC) represents how close fitted values are to actual values taking into account the number of parameters included in each model (Agresti, 2002 [**97**]). Lower values indicate a superior model of the data.

Model 4 (stops per mile, presence of an exclusive left-turn lane and presence of trees) reported the lowest AIC measure and the highest Pearson correlation.

Performance of Candidates

A preliminary analysis of the ability of Models 4, 5, and 6 to predict the distribution of ratings of LOS as reported by participants was also undertaken. (The performance of Model 7 is presented in a later section describing refinement options for the recommended Auto LOS Model.)

Exhibit 70. Example Cumulative Logit Distribution of LOS.



Because the strength of the cumulative probability models lies in their ability to predict the distribution of LOS ratings for a particular combination of explanatory variables, the models were tested to determine their ability to accurately predict a distribution of responses as compared with those collected at the four study sites. One-third of the auto response dataset was reserved to test the fit of various models developed in this study and was not used in the model calibration. A subset of four clips was chosen to be shown in each of the four study sites in Phase II of the study. These four clips resulted in the largest number of observations in the test dataset, so only these four clips have been tested with Models 4, 5, and 6. The remaining clips in the test database do not have enough observations to develop a robust distribution of response data. Clips 2, 15, 52, and 56 are discussed in the following analysis.

Exhibits 75 through 78 compare the observed LOS rating distributions to those predicted by Model 4 (Stops/Mile; left-turn lane presence; tree presence index), Model 5 (Space Mean Speed; median presence index; tree presence index)

Exhibit 71. Maximum Likelihood Estimates for Model #4.

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	1	-2.9189	0.2270	165.4053	<.0001
Intercept	2	1	-1.8273	0.2075	77.5198	<.0001
Intercept	3	1	-0.8529	0.2009	18.0246	<.0001
Intercept	4	1	0.2832	0.2005	1.9951	0.1578
Intercept	5	1	2.0937	0.2091	100.3006	<.0001
stops_per_mile		1	0.2033	0.0184	122.3357	<.0001
Pres__Of_Ex__LT_Lane		1	-0.5218	0.1111	22.0627	<.0001
Tree_Presence		1	-0.3379	0.0612	30.4761	<.0001

Parameters for Cumulative Regression Model Applied to Auto LOS—Stops per Mile Model– Model 4

Exhibit 72. Recommended Auto LOS Models.

Parameter	Model 4	Model 5	Model 6	Model 7
Intercept LOS E, Alpha1=	-2.92	-0.73	-3.80	-1.19
Intercept LOS D, Alpha2=	-1.83	0.28	-2.70	-0.20
Intercept LOS C, Alpha3 =	-0.85	1.21	-1.74	0.71
Intercept LOS B, Alpha4=	0.28	2.32	-0.62	1.80
Intercept LOS A, Alpha5=	2.09	4.16	1.16	3.62
Stops Per Mile, Beta1 =	0.20		0.25	
Presence of Left-Turn Lanes, Beta2 =	-0.52		-0.34	
Mean Speed (mph), Beta1 =		-0.063		-0.084
Median Presence (0-3), Beta2 =		-0.33		-0.22
Presence of Trees, Beta3 =	-0.34	-0.42		
Pearson Correlation=	79%	76%	77%	N/A
Akaike Information Criterion (AIC)	4944.0	5034.1	5022.8	5076.4

Exhibit 73. Test Clip Characteristics.

Clip Number	Number of Stops/Mile	Average Space Mean Speed (mph)	Median Presence (0-No 1-One-way Pair 2-TWCLTL 3-Raised	Ex. Lt.-Turn-Lane Presence (0-No 1-Yes)	Tree Presence (1-Few 2-Some 3-Many)	HCM LOS
2	0	34.5	3	1	2	A=6
15	6	7.86	3	1	1	F=1
52	7	7.9	0	0	1	E=2
56	2	23.1	3	1	3	C=4

Exhibit 74. Correlation Coefficients of Auto LOS Models.

Models Compared	Pearson Correlation Coefficient
HCM LOS to Mean Observed LOS	0.465
Mean Observed LOS to Mean LOS – Model 4	0.787
Mean Observed LOS to Mean LOS – Model 5	0.764
Mean Observed LOS to Mean LOS – Model 6	0.770

Exhibit 75. Evaluation of Models Against Clip 2 Ratings.

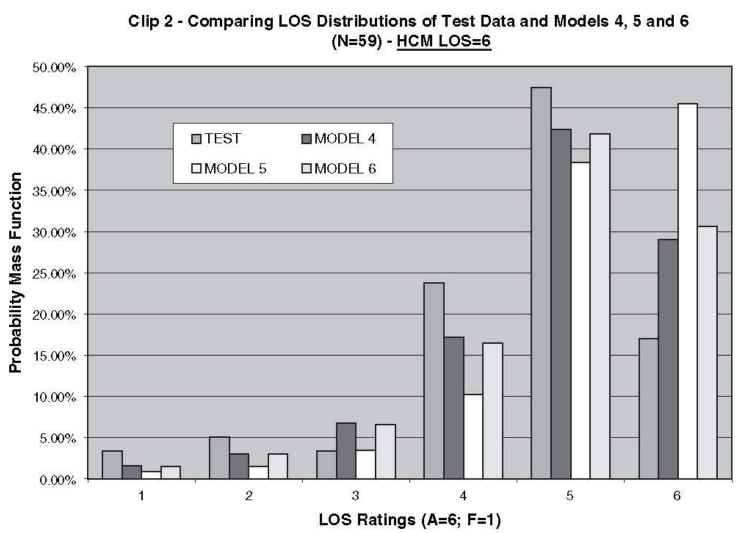
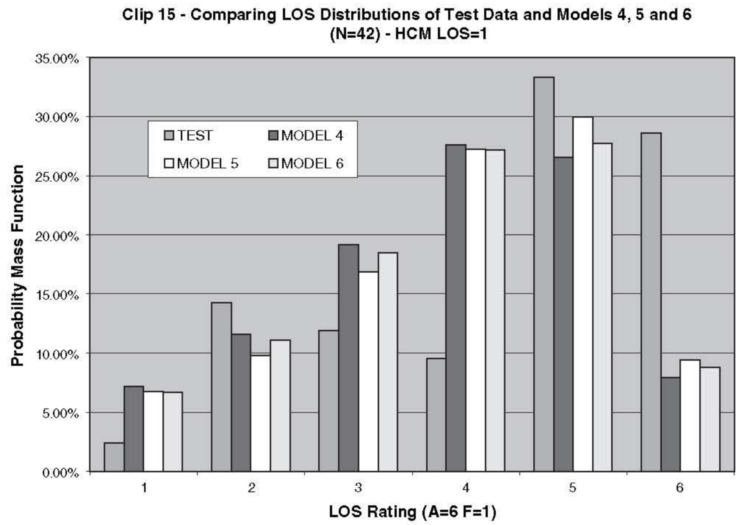


Exhibit 76. Evaluation of Models Against Clip 15 Ratings.



and Model 6 (Stops per mile; left-turn lane presence) for the four video clips. Exhibit 73 lists the conditions depicted in each of the four clips and the current HCM-estimated LOS.

Overall the models appear to track comparatively well with each other and with the data, in that there is a general increase/decrease in the estimation of LOS probability. Model 4 has slightly higher predictive power—it tends to track slightly closer to the test dataset represented by the periwinkle bar. For Clip 15, there is a definite difference between the HCM LOS of F and the distribution of LOS as provided by the study participants, which is shifted toward the right, meaning higher LOS ratings. In this clip, there are many stops along a short arterial, however, there is only low to moderate traffic congestion so that the test vehicle is always in the first position of the queue

Exhibit 77. Evaluation of Models Against Clip 52 Ratings.

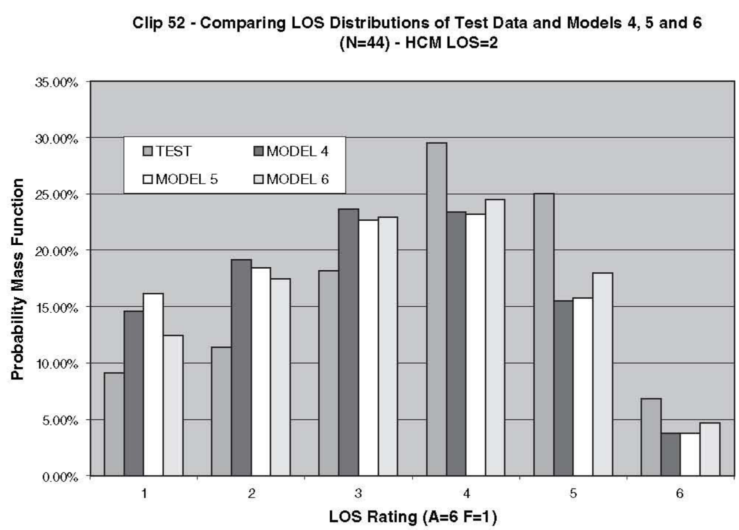
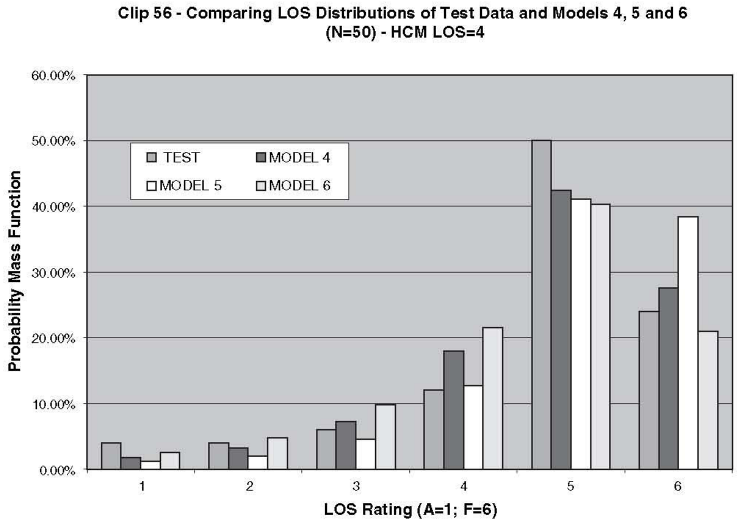


Exhibit 78. Evaluation of Models Against Clip 56 Ratings.



at each signal. In addition, it is a relatively clean and newly built out area in the Washington, DC, suburb of Arlington, VA. This combination of factors may have led participants to rate the video higher, despite the overall low space mean speed of 7.86mph and the high number of stops (6/mile).

Comparing the mean LOS as observed, the HCM LOS, and the model performance for Models 4, 5, and 6 we find that the HCM overall tended to underpredict the mean LOS as observed in the video laboratories. Model 6 also tends to underpredict mean observed LOS.

A correlation analysis of the various models and the test dataset shows that Models 4, 5, and 6 all have superior correlation to the mean video clip ratings than the HCM (see Exhibit 74).

Essentially the models all show a positive correlation, in that the compared models track the same in the positive or negative direction. The current HCM LOS method can only explain approximately 46 percent of the variation in mean observed LOS ratings. The three models developed for this study all perform much better and can explain, on average, approximately 75 percent of the variation in mean observed LOS ratings. The best fitting model is Model 4, which uses stops per mile, presence of an exclusive left-turn lane and the presence of trees to estimate the observed LOS ratings.

5.2 Recommended Auto LOS Model

The recommended auto LOS model (Model 6 above) predicts the *average* degree of satisfaction rating for the facility, where LOS A is "very satisfied" and LOS F is "very dissatisfied."

$$AutoLOS = Mean\ (LOS) \qquad \text{(Eq. 16)}$$

The average or "mean" LOS rating is the sum of the probabilities of an individual giving a facility a given LOS rating multiplied by the numerical equivalent of that LOS rating (J) (worst = 1, best = 6).

$$Mean(LOS) = \sum_{J=1}^{6} \Pr(LOS = J) * J \qquad \text{(Eq. 17)}$$

Where
J = 1 for the worst LOS rating and 6 for the best LOS rating.

The Mean LOS number is converted to a mean letter grade for the facility according to Exhibit 79.

The numerical thresholds for converting the mean score to the mean LOS letter grade differ from the scores (J) used to compute the mean score. Section 4.7 explained why different thresholds are used to convert the mean result to a letter grade.

The probability that a person will rate a given facility as exactly LOS J is computed by subtracting the cumulative probability of

Exhibit 79. Auto LOS Thresholds for Mean Numerical Scores.

LOS	Mean Numerical Score
A	≤ 2.00
B	>2.00 and ≤ 2.75
C	>2.75 and ≤ 3.50
D	>3.50 and ≤ 4.25
E	>4.25 and ≤ 5.00
F	> 5.00

giving the facility a lower LOS rating from the cumulative probability of giving the facility a LOS J rating or worse.

$$\Pr(LOS = J) = \Pr(LOS \le J) - \Pr(LOS \le J - 1) \quad \text{(Eq. 18)}$$

The probability that a person will rate a given facility as LOS J or worse is given by the ordered cumulative logit model as shown below:

$$\Pr(LOS \le J) = \frac{1}{1 + \exp(-\alpha_{(J)} - \sum_k \beta_k x_k)} \quad \text{(Eq. 19)}$$

Where

Pr(LOS<=J) = Probability that an individual will respond with a LOS grade J or worse.

exp = Exponential function.

α_J = Alpha, Maximum numerical threshold for LOS grade J (see Exhibit 80).

β_K = Beta, Calibration parameters for attributes (see Exhibit 80).

X_K = Attributes (k) of the segment or facility (see Exhibit 80).

Two ordered cumulative logit models are recommended, both using the same form.

Model 1, derived from a statistical analysis of the video lab data, predicts auto LOS as a function of the number of stops per mile and the presence of exclusive left-turn lanes.

Model 2 was created to provide a speed-based model option for auto LOS. Model 2 predicts auto LOS as a function of the percent of free-flow speed and the type of median. The parameters for this model were first derived statistically from the video lab data. The resulting model, however, did not produce a full LOS A to LOS F range of results for the streets in the video lab sample. Given that public agencies may be reluctant to adopt a LOS model that cannot predict LOS A, the LOS intercept values for the model were modified manually to obtain a full LOS range of results for the streets in the video clip sample while attempting to maintain as high a match percentage with the video lab results as possible.

Model 1 provides a greatly superior statistical fit with the video lab data, however; this model does not produce LOS A for the streets contained in the video lab sample. Model 2 provides an inferior statistical fit with the data, but provides numerous LOS A results for the streets in the video lab sample. Both models predict LOS F for one or more of the streets in the video lab sample.

The attribute, stops per mile, is the number of times a vehicle decelerates from a speed above 5 mph to a speed below 5 mph, divided by the length of the urban street segment under consideration.

The attribute, Left-Turn-Lane Presence, takes on the following values:

- 1 if exclusive left-turn lane at intersections,
- 0 if not.

If the exclusive left-turn lanes do not provide sufficient storage for left-turning vehicles, then the number of stops per mile would be affected, which would, in turn, adversely affect the perceived level of service.

The attribute, Percent Speed Limit, is the ratio of the actual average speed (distance traveled divided by the average travel time for the length of the arterial including all delays) to the posted speed limit for the street.

The attribute, Median Type, is equal to

- 0 if no median,
- 1 if one-way street,
- 2 if a painted median is present, and
- 3 if a raised median is present.

The threshold values, α_j, and the attribute equation coefficients, β_k, of the ordered cumulative logit function are calibrated using the maximum likelihood estimation (MLE) process applied to paired data of facility characteristics and perceived LOS collected from people participating in the video laboratory surveys.

Exhibit 80. Alpha and Beta Parameters for Recommended Auto LOS Models.

Parameter	Model 1	Model 2
Alpha Values		
Intercept LOS E =	-3.8044	1.00
Intercept LOS D =	-2.7047	2.00
Intercept LOS C =	-1.7389	2.50
Intercept LOS B =	-0.6234	3.00
Intercept LOS A =	1.1614	4.00
Beta Values		
Stops/Mile=	0.2530	N/A
Left-Turn-Lane Presence (0-1), =	-0.3434	N/A
Percent Speed Limit	N/A	-5.74
Median Type (0,1, 2, 3)	N/A	-0.39

5.3 Performance of Auto LOS Models

Exhibit 81 shows how the mean LOS values produced by the recommended auto LOS model compare with the mean LOS values reported by the video lab participants. The HCM-predicted LOS is included as well. The HCM matched the video labs 26% of the time, while the proposed auto LOS Model 1 (stops) matched the video labs 69% of the time. The alternate proposed auto LOS Model 2 (speed) matched 37% of the video clip mean LOS ratings.

Model 2 ranges from LOS A to F, while Model 1 ranges from LOS B to F. Model 1 fits the video clip data better but does not achieve LOS A for the streets in the video clip sample. Model 2 has a significantly poorer fit with the data (but still better than the HCM); however, it does produce LOS A for nine of the streets in the video clip sample.

Several different sections or time periods of the same street were used for many of the clips.

Exhibit 81. Evaluation of Proposed Auto LOS Models.

Clip #	Street	Art Class	Spd Lim (mph)	Actual (mph)	Stops (stps/mi)	Left Ln (%)	Med (1,2,3)	Video LOS	HCM LOS	Model 1 LOS	Model 2 LOS
61	Rt 50	1	50	28	1.4	100%	0.00	A	C	B	C
56	Sunset Hills Rd	2	40	23	2.0	100%	3.00	A	C	B	A
2	Gallows Road	3	35	35	0.0	100%	3.00	B	A	B	A
65	Lee Hwy	2	40	36	0.0	100%	2.00	B	A	B	A
63	Rt 50	1	50	42	0.0	100%	3.00	B	A	B	A
5	Wilson Blvd	3	35	30	0.0	100%	3.00	B	B	B	A
62	Rt 50	1	50	37	0.0	100%	0.00	B	B	B	A
13	Washington Blvd	3	35	25	0.0	0%	0.00	B	B	B	A
7	Wilson Blvd	3	35	20	0.0	100%	1.00	B	C	B	B
54	Lee Hwy	2	40	25	3.3	100%	2.00	B	C	B	A
53	Prosperity	2	40	19	1.7	100%	3.00	B	D	B	B
6	Clarendon	3	35	18	2.3	100%	1.00	B	D	B	B
10	Washington Blvd	3	35	17	3.8	0%	0.00	B	D	C	C
20	Rt 50	1	50	16	1.8	100%	3.00	B	E	B	C
64	Rt 50	1	50	20	2.0	100%	3.00	B	E	B	B
58	Sunrise Valley Rd	2	40	11	1.7	100%	3.00	B	F	B	C
1	Rt 234	1	50	15	2.0	100%	3.00	B	F	B	C
29	Rt 234	2	40	23	2.0	100%	3.00	C	C	B	A
19	23rd St	4	30	16	5.8	0%	0.00	C	C	C	C
12	Wilson Blvd	3	35	14	4.3	0%	0.00	C	D	C	D
60	Lee Hwy	2	40	15	2.0	100%	2.00	C	E	B	C
21	Rt 50	1	50	20	4.0	100%	3.00	C	E	C	B
8	Wilson Blvd	3	35	14	4.1	100%	1.00	C	E	C	C
52	M St	4	30	8	7.3	0%	0.00	C	E	D	E
55	Braddock Rd	2	40	13	2.2	100%	3.00	C	F	B	C
59	Sunset Hills Rd	2	40	12	4.9	0%	0.00	C	F	C	E
15	Glebe Road	2	40	8	6.0	100%	3.00	C	F	C	D
14	Glebe Road	2	40	11	6.0	100%	3.00	C	F	C	C
57	Sunset Hills Rd	2	40	17	3.3	0%	0.00	D	D	C	D
16	Fairfax Drive	3	35	12	7.3	100%	3.00	D	F	C	C
51	M St	4	30	7	9.1	0%	0.00	D	F	D	E
25	M St	4	30	11	3.7	0%	0.00	E	D	C	D
23	M St	4	30	8	5.6	0%	0.00	E	E	C	E
30	M St	4	30	7	14.5	0%	0.00	F	F	F	E
31	M St	4	30	4	18.0	0%	0.00	F	F	F	F
% Exact Match To Video								100%	26%	69%	37%
% Within 1 LOS of Video								100%	46%	94%	89%

CHAPTER 6

Transit LOS Model

6.1 Model Development

The Transit Capacity and Quality of Service Manual (TCQSM) provides a family of LOS models for dealing with several dimensions of transit service at different levels of geographic aggregation. The TCQSM is oriented to the entire service area, the entire route, or the bus stop. It was necessary to extract a subset of these quality-of-service measures that were most appropriate for a single urban street. The urban street is at a level of aggregation that is greater than the bus stop level and incorporates multiple routes using the street, but it covers just the portion of the routes that actually use the street. Thus a different geographic focus was necessary in the development of the Urban Street transit level of service model.

Transit riders were surveyed on portions of routes using a specific urban street to determine what factors most significantly influenced their perceived quality of service. It was quickly discovered that passengers were basing their LOS ratings on their entire trip experience up to that point and not just the portion of their trip on a specific urban street. In addition, an on-board survey can survey only those that eventually chose to ride transit; it cannot take into account the opinions of those who chose not to ride that bus or selected a different route. Consequently, the surveys were used to identify the key factors influencing perceptions of quality of service, but LOS models were not fitted to the on-board survey levels of service.

An alternative source of data on traveler preferences was necessary to construct an urban street level of service model for transit. The working hypothesis of the research team was that "people vote with their feet." When confronted with a choice, people will pick the service that gives them more of what they value, in our case, quality of service. Thus, standard models of transit mode choice were consulted to identify the relationships between various service characteristics and the likely proportional increase in ridership.

LOS E was set for a hypothetical, base transit service on an urban street. A mode choice model would then be used to compare the ridership for the actual transit service to that for the hypothetical base case. An increase in ridership over the hypothetical base case would be interpreted as an indication of a preference for the actual service over the base case. The actual service would be assigned a level of service superior to E. Similarly, lesser ridership would be interpreted as an indication of poorer quality of service and would be assigned a level of service inferior to E.

The application of mode choice models at the urban street level was considered impractical, so mode choice models were replaced with elasticities derived from typical mode choice models. The elasticities predict the percent increase in ridership as a function of percent change in the transit service characteristics.

Selection of Explanatory Variables for LOS

The Phase 1 surveys asked passengers to rate their satisfaction with 17 specific aspects of their trip. A multiple linear regression model was developed that related individual factor ratings to the overall satisfaction rating. The factors that added significance to the model were

- Close to home rating;
- Close to destination rating;
- Frequency rating;
- Reliability rating;
- Driver friendliness rating;
- Seat availability rating; and
- Travel time rating.

Of these factors, "close to home" and "close to destination" relate to getting to the stop, "frequency" and "reliability" relate to waiting at the stop, and "driver friendliness," "seat availability," and "travel time" relate to the ride on the bus.

Other considerations also had to be taken into account during this factor selection process:

1. The factors included in the model should be under the control of either the transit operator or the roadway owner;
2. To the extent possible and warranted, the factors as a whole should reflect the influence of other modes on transit quality of service;
3. The factors should be readily measurable in the field;
4. The factors should reflect conditions existing within the urban street right-of-way; and
5. The factors should have a documented impact on some aspect of customer satisfaction.

Based on these criteria, "driver friendliness" was dropped from consideration. Although partially under the control of the transit operator, this factor can only be measured through a customer satisfaction survey, which we felt made it impractical to include. In addition, we are not aware of any research relating different levels of driver friendliness to some measurable aspect of satisfaction (for example, increased ridership).

The factors "close to home" and "close to destination" generated considerable discussion among the project team. Walking distance to the stop depends on a number of factors beyond the urban street right-of-way, including land use patterns, street connectivity, transit route structure, stop locations, and sidewalk provision on connecting streets, which would tend to suggest not including these factors. At the same time, there are known relationships that describe how bus patronage declines the farther one has to walk to a stop.

One potential surrogate measure identified through initial statistical modeling is "number of stops per mile"—the more stops per mile, the shorter the distance passengers may have to walk to get to a stop once they reach the street with transit service. However, there are two potential difficulties with this measure. First, the more stops per mile, the slower the bus travel time. Travel time is already identified as a potential factor, so adding stops per mile to the model would be redundant. Second, long stop spacing may or may not be inconvenient to passengers, depending on how convenient the stops are to where passengers actually want to go. Without knowing something about adjacent land development patterns (which takes the analyst beyond the urban street right-of-way), it is hard to make a judgment about the impact of stop spacing on customer access.

Another potential surrogate measure would be the distance of the bus stop from the nearest intersection. This is something that may be influenced by the auto mode—for example, traffic engineers frequently do not want far-side bus stops located adjacent to intersections, in situations where buses must stop in the travel lane, because of the potential for cars to stop behind the bus and block the intersection. Moving the stop farther from the intersection increases walking distances for passengers arriving from three of the four directions at the intersection, which can be related to walking time. On the other hand, near-side/far-side stop location trade-offs can be evaluated through changes in travel speed, using methodologies found in the TCQSM.

A third potential surrogate, and the one recommended by the project team, is pedestrian LOS. Pedestrian LOS relates to the ease of access to and from destinations along the urban street, the quality of pedestrian facilities serving the bus stop, and the difficulty of crossing the street. It will be a part of the multimodal urban street LOS methodology; therefore, no additional data collection will be required. It is a measure of the impact of another mode on the transit mode and can be impacted by roadway agency actions. In short, it meets all of the criteria set out above.

The TCQSM provides an areawide measure, "service coverage," that addresses the "close to home" and "close to destination" factors. This measure accounts for land use patterns, street connectivity, and street-crossing difficulty, at the cost of requiring more data than is desirable for an urban street analysis.

The four remaining candidate factors are travel time, reliability, seat availability, and frequency. All are impacted by conditions on the urban street, or by transit or roadway agency actions. All are related to TCQSM measures, which is important from a consistency standpoint. The first three factors can be related to travel time, which addresses a panel request to consider travel speed in the transit LOS model. The key remaining question is: Do relationships exist between passenger satisfaction and different values of these factors?

The answer to this question appears to be "yes." Considerable research has been conducted on traveler ridership responses to changes in service frequency and travel time. (Both *TCRP Report 95: Traveler Response to System Changes,* and the Victoria Transport Policy Institute's *Online TDM Encyclopedia* provide extensive summaries of the literature pertaining to ridership responses to transit system changes.) For example, as bus headways decrease from 60 minutes to 30 minutes, from 30 minutes to 15 minutes, and so on, ridership increases, although in an ever-decreasing proportion to the amount of added service. All other things being equal, the relative amount of ridership one would expect at a given headway, compared to a 60-minute headway, is reflective of the difference in customer satisfaction between the two headways.

There is comparatively little research on the impacts of reliability and crowding on ridership. However, reliability can be converted to an "excess wait time"—the average additional amount of time one would wait for a bus as a result of non-uniform headways. The excess wait time can, in turn, be converted into a perceived wait time, with an impact greater than the actual wait time [**98**]. Time spent standing or even seated in a crowded transit vehicle is also perceived by passengers as being more onerous than the actual travel time (See, for example, Balcombe [**99**]). Thus, the level of crowding on a bus can be used to convert an actual in-vehicle travel time to a perceived in-vehicle travel time. Furthermore, variable headways result in uneven loadings on buses, with the result that late buses are more crowded than would be suggested by an average peak-hour or peak-15-minute load. Finally, research exists to document how certain kinds of stop amenities can help reduce the perceived waiting time at bus stops.

Therefore, the recommended factors to include in the transit LOS model are the following:

- Service frequency (headways);
- Travel time (speed);
- Crowding;
- Reliability (headway variability);
- Presence of stop amenities documented to reduce perceived wait time; and
- Pedestrian LOS.

Proposed General Model Form for Transit LOS

The proposed general form for the transit LOS model is a linear combination of the quality of service accessing the bus stop on foot and the quality of service involved in waiting for and riding the bus. It is similar to many transit mode choice models incorporating the factors of accessibility, wait time, and travel time to predict the probability of choosing transit. This model form varies slightly from traditional mode choice models in that it blends wait time and travel time into a single factor before adding the result to the accessibility. Only pedestrian accessibility is considered (as opposed to auto accessibility) because this model is designed for application in an urban street environment where park and ride is less likely a phenomenon.

$$\text{Transit LOS} = a1 * \text{Pedestrian Access} + a2 * \text{Transit Wait/Ride} \qquad \text{(Eq. 20)}$$

Where:

a1, a2 = calibration parameters
Pedestrian Access Score = A measure of the pedestrian level of service for the street.
Transit Wait/Ride Score = A measure of the quality of transit ride and waiting time.

The quality of the pedestrian access can be conveniently obtained by employing the pedestrian level of service score for the street.

The quality of the transit wait/ride experience would be measured based on the average wait time for a bus and the perceived travel time on the bus.

The ratio of transit patronage for the actual wait time divided by the patronage for a base wait time gives an indication of the perceived quality of the service provided relevant to the wait time.

The ratio of transit patronage for the perceived travel time rate (minutes per mile, the inverse of the speed) divided by the patronage for a base travel time rate gives an indication of the perceived quality of the service provided relevant to the travel time rate of service.

The patronage ratios are estimated based on patronage elasticities obtained from various research, as explained in the following sections.

Elasticity Concept

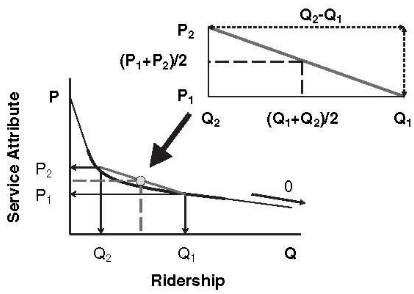
For practical purposes it is not feasible to apply full mode choice models to an isolated urban street (because the mode choice models are designed to consider the entire trip while the street is limited to portions of the trip). Elasticities were adopted instead since they can be used to predict changes in ridership without having to consider the full length of the trip.

A basic, hypothetical transit service for the urban street is assumed which would provide LOS E as far as transit patrons are concerned. The difference between the actual service and the hypothetical service is converted into an estimated percentage change in ridership to determine by how much the actual service LOS exceeds (or falls below) LOS E.

The two key components of the *TransitWaitRideScore* are the headway factor and the perceived travel time factor. These in turn, are related to documented traveler responses to changes in headway and changes in travel time. These responses are quantified in terms of elasticities.

Transit elasticities reflect the percent change in transit ridership resulting from a 1% change in an attribute of the service (e.g., fare, frequency, travel time, service hours, etc.). The relationship between demand and service attribute need not be linear. This is the case with service frequency: doubling the frequency from one bus to two buses an hour on a route has a much greater percentage impact on ridership than doubling the frequency from six buses to twelve buses an hour. Thus, the value of elasticity, *E,* may be different depending on where one starts from and where one ends up. *TCRP Report 95,* the source of many of the elasticity values used for the transit model, uses the concept of *mid-point arc elasticity* to approximate this relationship, based on average before-and-after values of the two variables, ridership and service attribute [**100**]. These relationships are illustrated in Exhibit 82 and expressed mathematically in the equation below.

Exhibit 82. Mid-Point Arc Elasticity.



$$E = \frac{\Delta Q}{(Q_1+Q_2)/2} \div \frac{\Delta P}{(P_1+P_2)/2} = \frac{\Delta Q(P_1+P_2)}{\Delta P(Q_1+Q_2)} = \frac{(Q_2-Q_1)(P_1+P_2)}{(Q_1+Q_2)(P_2-P_1)} \qquad \text{(Eq. 21)}$$

Where
E = mid-point arc elasticity;
P = the before (P_1) and after (P_2) prices (e.g., fare, headway, travel time); and
Q = the before (Q_1) and after (Q_2) ridership demand.

Elasticity is relative—the actual ridership of a route is determined by many factors, including the type and density of adjacent land uses, the demographic characteristics of persons living near the route (e.g., age and vehicle ownership), and the ease of access to bus stops. However, given no changes in these external factors, one can estimate the change in a route's ridership resulting from a change in a single service attribute under the control of a transit or roadway agency. Whether the resulting change in ridership is from 100 to 150 riders, or from 1,000 to 1,500 riders makes no difference—one can still estimate how much more attractive (satisfactory) one level of a particular service attribute to passengers is compared to another.

Bus Frequency Elasticity

Elasticities related to how often bus service is provided can be expressed as frequency elasticities (using positive numbers—increased frequencies result in increased ridership) or as headway elasticities (using negative numbers—decreased headways result in increased ridership). Trends identified in *TCRP Report 95* suggest that frequency elasticities can be +1.0 or greater, in situations where the original service was very infrequent (60-minute headways or longer), that is, doubling the frequency may more than double the ridership in those situations. With more frequent service as a starting point, typical frequency elasticities are in the +0.3 to +0.5 range, dropping to as low as +0.2 with very frequent service (i.e., service every 10 minutes or better).

The recommended transit LOS model uses the following frequency elasticity values, based on typical values reported in *TCRP Report 95*: +1.0 for 1–2 buses/hour, +0.5 for 2–4 buses/hour, +0.3 for 4–6 buses/hour, and +0.2 for 6 or more buses/hour. Solving for Q_2 in Equation 1, one can estimate future ridership demand based on a given starting demand and an assumed elasticity, as shown Equation 22 below.

$$Q_2 = \frac{((E-1)P_1Q_1)-((E+1)P_2Q_1)}{((E-1)P_2)-((E+1)P_1)} \qquad \text{(Eq. 22)}$$

Thus, with an elasticity of +1.0, a route with a ridership of 100 passengers at 60-minute headways (P_1 = 1 bus/hour) would be expected on average to have a ridership of 133 passengers if headways improved to 45 minutes (P_2 = 1.33 bus/hour), and a ridership of 200 passengers if headways improved to 30 minutes. With the decreased response to frequency changes assumed to begin at 30-minute headways, ridership would increase to 244 passengers at 20-minute headways (E = +0.5, Q_1 = 200 passengers, P_1 = 2 buses/hour, and P_2 = 3 buses/hour), 280 passengers at 15-minute headways, 316 passengers at 10-minute headways, and 379 passengers at 5-minute headways. For any given frequency or headway, one can estimate the ridership relative to a 60-minute headway and, thus, the relative attractiveness of the service. In this example, 10-minute headways produce 3.16 times the number of passengers compared to 60-minute headways, all other things being equal; therefore, the value of f_h that would be used for 10-minute headways would be 3.16.

If local data were available, local elasticities could be substituted for the typical national values used in the model.

Travel Time Elasticity

A review of transit travel time elasticities in the literature, conducted by TCRP Project A-23A (Cost and Effectiveness of Selected Bus Rapid Transit Components), found a typical range of -0.3 to -0.5 (that is, for every 1% decrease in travel time, ridership increases by approximately 0.3 to 0.5%) [**101**]. The *TCRP Report 95* chapter on Bus Rapid Transit, where travel time elasticities will probably be covered, has not yet been published.

Assuming some baseline travel time that passengers would be satisfied with, additional travel time above this baseline value would be less satisfactory, while a reduction in travel time would be more satisfactory. The relative satisfaction of passengers associated with a given travel time can be expressed in terms of the ridership expected at the actual travel time, relative to the ridership that would occur at the baseline travel time. For example, a route with an average passenger travel time of 25 minutes would be expected to have 10% higher ridership than a route with an average passenger travel time of 30 minutes, all other things being equal, assuming an elasticity of -0.5. (This value is calculated using Equation 2, rather than by taking a 16.7% difference in travel times and multiplying by 0.5). Therefore, if a 30-minute travel time was set as the baseline, the value of f_{ptt} would be 1.10 for 25-minute travel times, assuming for the moment no other influences on perceived travel time.

Because urban street LOS focuses on the quality of urban street segments, rather than the bus trip as a whole, the alternative transit LOS model works with travel time rates (e.g., 6 minutes per mile) instead of travel times (e.g., 30 minutes) or travel speeds (e.g., 10 mph). Travel time rates are the inverse of speeds and, over a given distance, change at the same rate that travel times do. For example, if a bus' travel time to cover 2 miles decreases from 12 to 11 minutes, the travel time decreases by 8.3% and so does the travel time rate (from 6 minutes per mile to 5.5 minutes per mile). Because the rate of change is the same, travel time elasticities should also apply to changes in travel time rates.

The f_{ptt} factor serves to increase or decrease LOS when transit service is particularly fast or slow, compared with some neutral, baseline value. The f_{ptt} and f_h factors, in combination, produce a *TransitWaitRideScore* that represents the percent increase in ridership for a particular headway and perceived travel time rate, compared with a baseline of 60-minute service at a baseline speed.

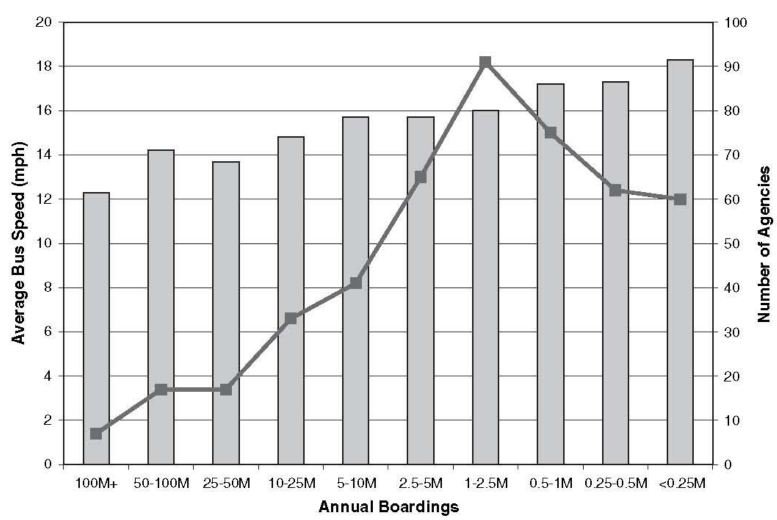
Selection of a Baseline Travel Time Rate

Originally 6 minutes/mile (10 mph) was proposed as a preliminary value for the baseline travel time rate, based on LOS ranges given in *TCRP Report 26* [**102**]. Testing of the preliminary model using real-world data for the entire TriMet bus system in Portland, Oregon, found that the travel time rate of 6 minutes/mile resulted in LOS ratings for Portland that were too high (62-69% of all street segments ended up as LOS A).

The National Transit Database (NTD) can be used to calculate a systemwide average bus speed, in terms of revenue miles operated divided by revenue hours operated. "Revenue service" consists of the time a bus is in passenger operation—it does not include travel to or from the bus garage, but does include driver layover time at the end of the route. To eliminate the effect of layover time on average speed, we assumed that layover time was 10% of total revenue hours, which is a typical transit industry standard, although local contracts with the bus drivers' union may specify a different value.

For all bus systems reporting to the NTD, the median speed is 15.2 mph. As shown in Exhibit 83, average speed is a function of city size: the larger the city, the lower the speed. For the seven largest bus operators (serving 100 million or more annual boardings), the mean speed was 12.3 mph; for the 60 smallest bus operators reporting to the NTD (10 or more buses in service and fewer than 250,000 annual boardings), the mean speed was 18.3 mph. The 33 bus operators in the 10 to 25 million boardings category (Montgomery

Exhibit 83. Average System Bus Speed by Number of Annual Boardings.



County, Maryland, and Cincinnati, Ohio are toward the top of this group) had a mean speed of 14.8 mph, while the 91 bus operators in the 1 to 2.5 million boardings category (Appleton, Wisconsin, and Pueblo, Colorado are toward the bottom of this group) had a mean speed of 16.0 mph. In total, 247 bus agencies out of 468 reporting (53%) are represented by groups with mean speeds within 1 mph of the median speed of 15.2 mph; thus, this median value is representative of most U.S. bus agencies.

When a baseline travel time rate of 4 minutes/mile (15 mph) was tested against the Portland data, a much better distribution of LOS grades was obtained, with only 30 to 39% of route segments receiving LOS A grades, depending on whether route-average or segment-specific speeds were used in the calculation.

However, a baseline travel time rate of 4 minutes/mile, when applied to the San Francisco surveys, results in LOS grades that were too low relative to the frequency of service provided. This suggests that a different baseline travel time rate may be appropriate for dense urban areas such as San Francisco or downtown Washington, DC. Further testing of the speed elasticity used in the model would also be appropriate.

Reliability

One way that the TCQSM measures transit reliability is through the *coefficient of variation of headway deviations*—the standard deviation of headway deviations divided by the mean scheduled headway. (A headway deviation of a given bus is the actual headway minus the scheduled headway. When buses arrive exactly on schedule every time, $cv_h = 0$; when two buses consistently arrive together, $cv_h = 1$.)

Some believe that a better reflection of headway reliability from a passenger point-of-view is given by *excess wait time* (e.g., Furth and Miller (previously cited) and Transport for London's transit performance standards), which is the average additional time a passenger must wait for a bus to arrive because of non-uniform headways. When passengers arrive randomly at a stop—the case when service is relatively frequent (the TCQSM suggests this occurs at headways of 10 to 12 minutes or less)—the average passenger will wait half a headway for a bus to arrive. When a bus is late, passengers will wait longer than half a headway on average. The difference in these two times is the excess wait time.

For random passenger arrivals, excess wait time is calculated as half the scheduled headway multiplied by the square of the coefficient of variation of headways (or headway deviations) [**103**, **104**]. For non-random arrivals (i.e., for longer headways, when passengers would be expected to be familiar with the schedule and arrive a few minutes before the scheduled departure time), excess wait time is the average number of minutes that buses are behind schedule. Buses more than a minute early can be treated as being one headway behind schedule, because passengers arriving near the scheduled departure time would have to wait for the next bus. Excess wait time adds to a passenger's overall wait time; it also affects a passenger's perceived wait time. A common value in the literature is that passengers perceive or value wait time approximately twice as much as in-vehicle time; Furth and Muller suggest a value of 1.5 and suggest accounting for "potential wait time," an allowance a rider makes to show up earlier for service known to be unreliable, with a value of 0.75 of in-vehicle time [**98**].

Excess wait time makes a passenger's trip take longer than intended (i.e., the perceived speed or travel time rate for the trip is slower). However, the effect of excess wait time on the travel time rate varies depending on the length of the trip: a 2-minute excess wait has a bigger proportional effect on a 10-minute trip than a 2-minute wait for a 20- or 30-minute trip. The difficulty is in determining what an appropriate trip length should be.

The recommended solution is to compare the excess wait time with the average trip time. The NTD provides information on weekday boardings and passenger miles by mode each year for most transit systems; an average trip length (miles/boarding) can be computed from these two variables. (This calculation assumes that trip lengths are consistent throughout the day, which may or may not be the case. Passenger miles are only available as daily values. Although the NTD allows agencies to report boardings in smaller time increments than a day (e.g., AM peak, midday, etc.), most choose not to.)

Dividing the excess wait time (minutes) by the computed average trip length (miles) provides the average effect on the overall travel time rate (minutes/mile), which can then be converted to a perceived travel time rate. For example, if the analysis were being performed in Portland, the average weekday passenger miles in 2003 were 765,100, while the average weekday boardings were 214,158, resulting in an average trip length of 3.57 miles. If the average excess wait time was 2 minutes, the additional travel time rate would be (2 / 3.57) = 0.56 minutes/mile. The *perceived* additional travel time rate could be up to twice this value, or 1.12 minutes/mile.

Effect of Stop Amenities on Perceived Waiting Time

Research presented in *TRL Report 593* suggests that certain stop amenities, including shelters, lighting, and seating, can reduce perceived journey time by providing a more comfortable waiting environment. Exhibit 84 presents these values, converted from pence to in-vehicle time, using an in-vehicle time value of 4.2 pence per minute.

Some authors have suggested that real-time displays at bus stops showing the number of minutes until the next bus arrival

Exhibit 84. In-Vehicle Time Value of Stop Amenities.

Amenity	In-Vehicle Time Value (min)
Shelter with roof and end panel	1.3
Shelter with roof	1.1
Lighting at bus stop	0.7
Molded seats	0.8
Flip seats	0.5
Bench seats	0.2

SOURCE: Calculated from Steer Davies Gleave, *Bus passenger preferences. For London Transport buses.* (1996) in Balcombe, R. (editor), **[105]**.

should reduce, if not eliminate, the perceived travel time penalty. (In other words, perceived excess wait time would be the same as actual excess wait time when real-time bus-arrival information is provided.) Although this seems to be a reasonable hypothesis, to date, the project team has not seen any literature documenting such an effect.

Crowding

Perceived Travel Time Effects

In the same way that passengers perceive or value wait time more than in-vehicle time, passengers also perceive or value time spent in crowded conditions more than time spent in uncrowded conditions. Exhibit 85 presents values of train crowding used in Great Britain.

To demonstrate how the Exhibit 85 information could be applied, consider a situation where a train is operating with a passenger load that is 120% of its seating capacity (i.e., a load factor of 1.20). In the absence of crowding, rail commuters value in-vehicle time at 7.2 pence/minute. At a load factor of 1.20, seated commuters experience a penalty of 1.6 pence/minute due to the more crowded conditions, while standing commuters experience a penalty of 7.5 pence/minute (i.e., standees perceive their time spent standing as being more than twice as onerous as being seated in an uncrowded carriage). The weighted average penalty for all passengers in the

Exhibit 85. British Crowding Penalties for Rail Passengers.

	Crowding Penalty (pence/min)	
Load Factor (p/seat)	Seated Passengers	Standing Passengers
≤ 0.80	0.0	--
0.90	0.4	--
1.00	0.8	6.5
1.10	1.2	7.0
1.20	1.6	7.5
1.30	2.0	8.0
1.40	2.4	8.5
1.50	--	9.0
1.60	--	9.5

NOTE: The baseline value of in-vehicle time for rail passengers is 7.2 pence/minute, in 2000 prices. Intermediate values are obtained through linear interpolation. The baseline value of in-vehicle time for bus passengers is 4.2 pence/minute; no corresponding crowding penalties are available.
SOURCE: Derived from Balcombe **[106]**.

train would be 2.58 pence/minute, corresponding to a value of time 36% higher than in uncrowded conditions. This value-of-time factor, 1.36, corresponds to factor a_1 in the perceived travel time rate equation. In application, the transit LOS model would provide a lookup table based on a similar calculation using bus passenger value-of-time to directly provide a_1. Section 6.10 provides an example of such a lookup table.

No corresponding British values exist for bus crowding penalties and no American work was found that could be used to compare U.S. rail crowding perceptions to U.K. perceptions. Additional research would be needed to establish U.S. crowding penalty values. In the absence of other data, the recommended transit model uses a combination of U.K. bus value-of-time data and rail crowding penalties.

Load Variability Effects

Unreliable operations tend to result in higher levels of crowding on buses that are running late, because these buses pick up not only their own passengers, but passengers who have arrived early for the following bus. For existing-condition analyses, this crowding can be measured directly. For future-condition analyses, for frequent service (i.e., headways approximately 10 minutes or less), this additional crowding can be estimated as the mean load multiplied by $(1 + cv_h)$ (Derived from the TCQSM, Part 4, Appendix E, Equations 4-22 and 4-23). At long headways, a late bus will pick up its normal load, because passengers will have timed their arrival at the bus stop to the expected departure time (Furth and Miller, previously cited). There is also an intermediate range of headways with a mix of randomly and non-randomly arriving passengers [**107**]. This late-bus load can be used in the perceived travel time calculation described in the previous section, thus incorporating the effect of unreliable service's crowding into the LOS measure.

The literature review uncovered no information directly relating overcrowding and/or reliability to transit demand. In the United States, the San Francisco County Transportation Authority appears to be the only agency to have documented a test of reliability and crowding factors for use in a travel demand model. The tested values were based on a stated-preference telephone survey, but were not incorporated in the final model because the predicted number of boardings did not reasonably match the observed number of boardings [**108**].

6.2 Recommended Transit LOS Model

The recommended transit LOS model predicts the average quality of service rating that transit riders would give the bus service on an urban street. The model is as follows:

Transit LOS Score = 6.0 – 1.50 * TransitWaitRideScore + 0.15 * PedLOS (Eq. 23)

Where

PedLOS = The pedestrian LOS numerical value for the facility (A=1, F=6).

TransitWaitRideScore = The transit ride and waiting time score, a function of the average headway between buses and the perceived travel time via bus.

The computed transit LOS score is converted to a letter LOS grade using the equivalencies given in Exhibit 86. These are the same thresholds as used for auto.

Estimation of the Pedestrian LOS

The pedestrian LOS for the urban street is estimated using the pedestrian LOS model described in a later chapter.

Estimation of the Transit Wait Ride Score

The transit wait and ride score is a function of the headway between buses and the perceived travel time via bus for the urban street.

TransitWaitRideScore = $f_h * f_{ptt}$ (Eq. 24)

Where

f_h = headway factor = the multiplicative change in ridership expected on a route at a headway *h,* relative to the ridership at 60-minute headways;

f_{ptt} = perceived travel time factor = the multiplicative change in ridership expected at a perceived travel time rate *PTTR,* relative to the ridership expected at a baseline travel time rate.

The baseline travel time rate is 4 minutes/mile except for central business districts of metropolitan areas with over 5 million population, in which case it is 6 min/mile.

Exhibit 87 provides f_h values for typical bus headways.

The perceived travel time factor is estimated based on the perceived travel time rate and the expected demand elasticity for a change in the perceived travel time rate.

$$F_{PTTR} = \frac{[(e-1)BTTR-(e+1)TTR]}{[(e-1)TTR-(e+1)BTTR]} \quad \text{(Eq. 25)}$$

Exhibit 86. Transit LOS Thresholds.

LOS	Numerical Score
A	≤ 2.00
B	>2.00 and ≤ 2.75
C	>2.75 and ≤ 3.50
D	>3.50 and ≤ 4.25
E	>4.25 and ≤ 5.00
F	> 5.00

Exhibit 87. Headway Factor Values.

Headway (min)	Frequency (bus/h)	f_h
60	1	1.00
45	1.33	1.33
40	1.5	1.50
30	2	2.00
20	3	2.44
15	4	2.80
12	5	2.99
10	6	3.16
7.5	8	3.37
6	10	3.58
5	12	3.79

NOTE: The following frequency elasticities are assumed: +1.0 for 1-2 buses/hour, +0.5 for 2-4 buses/hour, +0.3 for 4-6 buses/hour, and +0.2 for 6 or more buses/hour. Elasticities derived from data reported in *TCRP Report 95,* Chapter 9.

Where

F(PTTR) = Perceived Travel Time Factor

PTTR = Perceived Travel Time Rate (min/mi)

BTTR = Base Travel Time Rate (min/mi). Use 6 minutes per mile for the main central business district of metropolitan areas with population greater than or equal to 5 million. Use 4 minutes per mile for all other areas.

e = ridership elasticity with respect to changes in the travel time rate. The suggested default value is –0.40, but local values may be substituted.

Exhibit 88 below illustrates the application of this equation for selected perceived travel time rates and a selected elasticity.

The perceived travel time rate (PTTR) is estimated based on the mean speed of the bus service, the average excess wait time for the bus (due to late arrivals), the average trip length, the average load factor for the bus service, and the amenities at the bus stops.

Exhibit 88. Example Perceived Travel Time Factors (F(PTTR)).

	F(PTTR)	
BTTR:	4 min/mi	6 min/mi
PTTR (min/mi)		
2	1.31	1.50
2.4	1.22	1.41
3	1.12	1.31
4	1.00	1.17
6	0.85	1.00
12	0.67	0.76
30	0.53	0.58

Notes:

- *F*(PTTR) = Perceived Travel Time Factor
- PTTR = Perceived Travel Time Rate.
- BTTR = Base Travel Time Rate (default is 4 minutes per mile. 6 minutes per mile BTTR is used for the central business districts (CBDs) of metropolitan areas with 5 million or greater population).
- Based on default value of –0.40 for elasticity.

$$PTTR = a_1 * IVTTR + a_2 * EWTR - ATR \quad \text{(Eq. 26)}$$

Where
PTTR = perceived travel time rate.
IVTTR = actual in-vehicle travel time rate, in minutes per mile.
EWTR = excess wait time rate due to late arrivals = excess wait time (minutes) / average trip length (miles).
a_1 = passenger load weighting factor (a function of the average load on buses in the analysis segment during the peak 15 minutes).
a_2 = 2 = wait time factor, converting actual wait times into perceived wait times.
ATR = amenity time rate = perceived travel time rate reduction due to the provision of certain bus stop amenities = in-vehicle travel time value of stop amenities (minutes) / average trip length (miles).

In-Vehicle Travel Time Rate

The in-vehicle travel time rate is equal to the inverse of the mean bus speed converted to minutes per mile.

$$IVTTR = \frac{60}{Speed} \quad \text{(Eq. 27)}$$

Where
IVTTR = In-Vehicle Travel Time Rate (min/mi)r.
Speed = Average speed of bus over study section of street (mph).

When field measurement of mean bus speed is not feasible, the mean schedule speed can be used. Identify two schedule points on the published schedule for the bus route(s). Measure the distance covered by the bus route(s) between the two points. Divide the measured distance by the scheduled travel time between the two schedule points. The bus speed estimation procedure given in Chapter 27 (Transit) may be used to estimate future bus speeds.

The in-vehicle travel time rate is multiplied by a passenger load weighting factor (a_1) to account for the increased discomfort when buses are crowded. Values of the passenger load weighting factor (a_1) are given in Exhibit 89.

Excess Wait Time Rate

The excess wait time is the sum of the differences between the scheduled and actual arrival times for buses within the study section of the street divided by the number of observations. Early arrival without a corresponding early departure is counted as being on-time. However, early arrival with an early departure is counted as being "one headway" late for the purposes of computing the average excess wait time for the street.

Exhibit 89. Passenger Load Weighting Factor (a_1).

Load Factor (pass/seat)	a_1
≤0.80	1.00 default
1.00	1.19
1.10	1.41
1.20	1.62
1.30	1.81
1.40	1.99
1.50	2.16
1.60	2.32

Notes:
Load factor is the average ratio of passengers to seats for buses at the peak load point within the study section of the street.If bus load factor is not known, a default value of 1.00 can be assumed for the load weighting factor (a_1).

The excess wait time rate is the excess wait time (in minutes) divided by the mean passenger trip length for the bus route(s) within the study section of the street.

For average passenger trip length, a default value can be taken from national average data reported by the American Public Transit Association (APTA) http://www.apta.com/research/stats/ridership/trlength.cfm). In 2004, the mean trip length for bus passenger-trips nationwide was 3.7 miles.

More locally specific values of average trip length can be obtained from the NTD. Look up the annual passenger miles and annual unlinked trips in the transit agency profiles stored under NTD Annual Data Publications at http://www.ntdprogram.gov/ntdprogram/pubs.htm#profiles. The mean trip length is the annual passenger-miles divided by the annual unlinked trips.

Amenity Time Rate

The amenity time rate is the time value of various bus stop improvements divided by the mean passenger trip length. The mean passenger trip length is the same distance used to compute the Excess Wait Time Rate (described above).

$$ATR = \frac{1.3 * Shelter + 0.2 * Bench}{ATL} \quad \text{(Eq. 28)}$$

Where
ATR = Amenity Time Rate (min/mi)
Shelter = Proportion of bus stops in study section direction with shelters
Bench = Proportion of bus stops in study section direction with benches
ATL = Average passenger trip length (miles)

Notes:
1. Shelters with benches are counted twice—once as shelters, once as benches.
2. Coefficients adapted from Steer Davies Gleave, *Bus passenger preferences. For London Transport buses.* (1996) in Balcombe, R. (editor) [**109**].

6.3 Performance of Transit LOS Model

Exhibit 90 compares the ability of the existing TCQSM LOS models and the proposed transit LOS model to predict the mean LOS response for each bus route obtained from the field surveys.

None of the models reproduce the mean levels of service reported by passengers in the on-board surveys very well. Both the FDOT LOS and proposed LOS model match the passenger surveys about 21% of the time. Although a better match might have been desirable, the on-board survey results indicate a high degree of acceptance for a wide range of conditions. It is thought that passengers not satisfied with the service are less likely to ride the buses and thus were undersampled in the survey. Consequently, it was considered acceptable that the proposed transit LOS model should predict poorer levels of service than obtained in the on-board surveys.

The scope of the TCQSM LOS model is quite a bit different than the urban street. The TCQSM is designed to represent the entire trip, while this research is limited to transit service on a given street. Also, the TCQSM provides six different letter grade levels of service, depending on the geographic scope and aggregation of the analysis. Only the worst result is shown in the table.

Both the FDOT LOS model and the proposed transit LOS model predict a range of LOS A to E for the transit routes surveyed. All three LOS models, FDOT, TCQSM, and the proposed transit LOS model, tend to agree that WMATA Route 2B and AC Transit Route 218 are LOS D/E, which passengers rated as LOS A.

Exhibit 90. Evaluation of Proposed Transit Model and TCQSM against Field Survey Results.

Operator	Rte	Freq. (bus/h)	Spd (mph)	OTP %	Shelter (%)	Bench (%)	LF (p/seat)	Ped LOS	CBD	Survey LOS	FDOT LOS	TCQSM LOS	Model LOS
TriMet	14	8	11.8	75%	34%	47%	0.55	C	No	A	A	C	A
TriMet	44	4	14.8	76%	30%	41%	0.83	C	No	A	B	D	A
AC Transit	72R	5	15.7	66%	74%	75%	1.10	D	No	A	B	D	B
AC Transit	72	4	12.1	53%	39%	46%	1.10	D	No	A	B	D	B
WMATA	38B	4	10.1	46%	29%	26%	0.38	D	No	A	C	D	B
WMATA	2B	2	14.0	67%	13%	15%	1.10	D	No	A	E	D	D
AC Transit	218	1	15.1	72%	11%	15%	1.10	C	No	A	E	E	E
AC Transit	51	8	11.8	54%	28%	51%	1.10	D	No	B	A	C	A
SF Muni	14	10	9.2	57%	54%	56%	1.30	E	Yes	B	A	C	C
SF Muni	30	7	7.4	59%	44%	44%	1.30	E	Yes	B	A	C	D
SF Muni	1	20	8.8	63%	44%	44%	1.30	C	Yes	B	A	C	A
SF Muni	38	8	9.8	59%	68%	69%	1.30	F	Yes	B	B	C	D
SF Muni	38L	9	12.1	48%	84%	86%	1.10	F	No	B	B	C	A
Broward	18	4	13.6	65%	23%	75%	1.10	E	No	B	C	D	B
% Exact Match										100%	21%	0%	21%
% Within 1 LOS										100%	86%	43%	71%

Notes:
1. OTP = on time performance with 5 minutes late considered on-time.
2. LF = load factor
3. Shelter = percent of bus stops with shelters.
4. Bench = percent of bus stops with benches.
5. Survey = the mean level of service reported in the field survey.
6. FDOT = Florida Quality/Level of Service Handbook method.
7. TCQSM = Transit Capacity and Quality of Service Manual. The TCQSM does not produce a single letter grade LOS for transit routes. The letter grade reported here is an average, a grade point average (GPA) of the numerous LOS ratings that the TCQSM reports for any given transit route.
8. Model LOS = the letter grade predicted by the recommended transit LOS model.

CHAPTER 7

Bicycle LOS Model

7.1 Development

Two basic forms were considered for the bicycle LOS for arterials model. The first was an aggregate model using the outputs from existing segment and intersection LOS models to determine the arterial LOS. The other was an agglomerate model considering the independent characteristics of the roadway environment to calculate an arterial LOS for bicyclists directly. Both forms were preliminarily evaluated during model development.

The aggregate model was chosen for refinement for several reasons. The stepwise approach to an aggregate model is useful because it allows the practitioner to address concerns at individual intersections or along specific segments. The aggregate model also retains all the terms found both intuitively and mathematically to be significant to bicyclists riding along a roadway. The agglomerate model would not retain all the terms as significant. Consequently, we focused on the aggregate model in model development efforts.

We considered various functional techniques for model development, including linear regression and ordered probit. We performed linear regression modeling because it is more intuitive than probit modeling in practice and non-modelers better understand the sensitivity of the regression model. These reasons are particularly important in that these models are most frequently used: the development or analysis of specific design options or in the development of bicycle facility community master plans with presentations to interested citizens and public officials. To ensure the validity of the results of the linear regression modeling results, we evaluated the ordered probit model form as well. The results of both the linear regression and ordered probit modeling efforts are described below.

Before starting correlations analysis and modeling, we created two data subsets from the overall dataset. The total dataset was sorted by city and LOS grade responses. A random sampling of 20% of the data representing each city and LOS grade response was taken from the overall dataset for model validation. The balance of the data, 80% of the total dataset, was used for model development.

SPSS 14.0 was used to conduct Pearson correlation analysis on the extensive array of geometric and operational variables. Subsequently, we selected the following relevant variables for additional testing:

- Segment LOS—The bicycle LOS for roadway segments (see below).
- Intersection LOS—The bicycle LOS for signalized intersections (see below).
- Conflicts per mile—The total conflicts per mile represent the motor vehicle conflicts resulting from motorists turning across the bicycle facility at unsignalized locations.
- Size of the city in which the data collection took place—The Metropolitan Statistical Area (MSA) population was used to represent the size of each city.

At the panel's request, the MSA variable was dropped from further consideration. Other variables were dropped from further consideration because of their poor correlation with the dependent variable or because of their colinearity with more strongly correlated variables. After testing numerous combinations of variables and variable transformations, we determined the aggregate model using two constituent sub-models would be the most theoretically valid.

7.2 Recommended Bicycle LOS Model

The recommended bicycle LOS model is a weighted combination of the bicyclists' experiences at intersections and on street segments in between the intersections. Two models of the same form were evaluated, but with different parameters:

Bicycle LOS Model 1

$$\text{Bicycle LOS \#1} = 0.160*(\text{ABSeg}) + 0.011*(\exp(\text{ABInt})) + 0.035*(\text{Cflt}) + 2.85 \quad \text{(Eq. 29)}$$

Bicycle LOS Model 2

$$\text{Bicycle LOS \#2} = 0.20*(\text{ABSeg}) + 0.03*(\exp(\text{ABInt})) + 0.05*(\text{Cflt}) + 1.40 \quad \text{(Eq. 30)}$$

Where

ABSeg = The length weighted average segment bicycle score

Exp = The exponential function, where e is the base of natural logarithms.

ABInt = Average intersection bicycle score

Cflt = Number of unsignalized conflicts per mile, i.e., the sum of the number of unsignalized intersections per mile and the number of driveways per mile

The output of either model is a numerical value, which must be translated to a LOS letter grade.

Exhibit 91 provides the numerical ranges that coincide with each LOS letter grade.

The first model provides a better fit with the numerical scores given by the video lab participants to the video clips. This model was derived based on a statistical fitting process to the video clip data. However, this first model does not predict LOS A or B for the video clips. Consequently the second model was developed.

The second model has an inferior numerical fit with the video lab data (measured in terms of squared error) but produces the full range, LOS A through F, for the video clips. The second model was derived from the first model by reducing the constant so that the second model would predict LOS A for video clips #328 and #330. The other parameters in the model were then manually adjusted until the second model could produce LOS F for one or more of video clips #314, 317, 323, and 324 (which were rated LOS F by the video lab participants).

Both models use the same bicycle segment and bicycle intersection submodels.

Bicycle Segment LOS

The segment bicycle LOS is calculated according to the following equation:

Exhibit 91. Bicycle LOS Numerical Equivalents.

LOS	Numerical Score
A	≤ 2.00
B	>2.00 and ≤ 2.75
C	>2.75 and ≤ 3.50
D	>3.50 and ≤ 4.25
E	>4.25 and ≤ 5.00
F	> 5.00

$$\text{BSeg} = 0.507 \,\text{Ln}\,(V/(4*\text{PHF}*L)) + 0.199\text{Fs}*(1 + 10.38\text{HV})^2 + 7.066(1/\text{PC})^2 - 0.005(\text{We})^2 + 0.760 \quad \text{(Eq. 31)}$$

Where

BSeg = Bicycle score for directional segment of street.

Ln = Natural log

PHF = Peak Hour Factor (see Chapter 10 for default values)

L = Total number of directional through lanes

V = Directional motorized vehicle volume (vph). (Note: $V > 4 * \text{PHF} * L$)

Fs = Effective speed factor = $1.1199 \,\text{In}(S - 20) + 0.8103$

S = Average running speed of motorized vehicles (mph) (Note: $S >= 21$)

HV = Proportion of heavy vehicles in motorized vehicle volume.
Note: if the auto volume is < 200 vph, the %HV used in this equation must be <= 50% to avoid unrealistically poor LOS results for low volume and high percent HV conditions.

PC = FHWA's five point pavement surface condition rating (5=Excellent, 1=Poor) (A default of 3 may be used for good to excellent pavement)

We = Average effective width of outside through lane (ft)
= $Wv - (10\text{ft} \times \%OSP)$ (ft) ** If $W1 < 4$
= $Wv + W1 - 2\,(10 \times \%OSP)$ (ft) ** Otherwise

%OSP = Percentage of segment with occupied on-street parking

W1 = width of paving between the outside lane stripe and the edge of pavement (ft)

Wv = Effective width as a function of traffic volume (ft)
= Wt (ft) ** If $V > 160$ vph or street is divided
= $Wt*(2 - (0.005 \times V))$ (ft) ** Otherwise

Wt = Width of outside through lane plus paved shoulder (including bike lane where present) (ft)
Note: parking lane can be counted as shoulder only if 0% occupied.

Bicycle Intersection LOS

The intersection bicycle LOS is calculated according to the following equation:

$$\text{IntBLOS} = -0.2144\text{Wt} + 0.0153CD + 0.0066\,(Vol15/L) + 4.1324 \quad \text{(Eq. 32)}$$

Where

IntBLOS = perceived hazard of shared-roadway environment through the intersection

Wt = total width of outside through lane and bike lane (if present)

CD = crossing distance, the width of the side street (including auxiliary lanes and median)

Vol15 = volume of directional traffic during a 15-minute period

L = total number of through lanes on the approach to the intersection

7.3 Performance of Bicycle LOS Model on Video Clips

Exhibit 92 compares the ability of the existing HCM speed-based LOS model and the proposed bicycle LOS models against the mean LOS response for each video clip. The HCM matched the video clips 15% of the time. The proposed LOS models matched the clips between 27% and 46% of the time. The second model had the highest percentage match because it can predict LOS A and B. The first model is better at predicting the poorer levels of service (E and F) than the second model.

Exhibit 92. Evaluation of Proposed Bike Models and HCM against Video Lab Results.

Clip	Location	Outside Lane (ft)	Bike/Shldr Lane (ft)	Through Lanes	Divided (D/UD)	Pk Hr. Vol. (vph)	Heavy Veh (%)	Spd Lim (mph)	Pavement Rate (1-5)	% OSP	Sig. Int X-Dist (ft)	Unsig. Conf Per Mile	Video LOS	HCM LOS	Model #1 LOS	Model #2 LOS
328	N Village, Cypress/S Vill.(N)	12	4	1	U	79	0%	30	4.0	0%	0	5.5	A	B	C	A
330	N Village, S Vill./Cypress (S)	12	4	1	U	136	0%	30	4.0	0%	0	6.7	A	B	C	A
306	Alumni at Magnolia (N)	11	4	2	U	717	0%	30	4.0	0%	72	0.0	B	B	C	B
305	Collins at Alumni (W)	12	3.5	2	D	813	8%	30	3.5	0%	65	0.0	B	C	D	B
307	Alumni at Magnolia (N)	11	4	2	U	757	0%	30	4.0	0%	72	0.0	B	D	C	B
304	Collins Blvd at Alumni (E)	12	3.5	2	D	428	0%	30	3.5	0%	65	0.0	B	E	C	B
303	Fowler Ave at North	12	5	3	D	1211	0%	50	4.0	0%	0	26.4	C	B	D	C
319	Fletcher, North Palm (S)	12	5	2	D	2961	0%	45	4.0	0%	53	0.0	C	B	D	D
311	15th St at 7th Ave, (W)	12	8	1	U	631	0%	25	3.5	70%	33	13.2	C	D	D	C
329	Ehrlich, Turner/S Village (S)	12	4	2	D	1261	0%	45	3.5	0%	61	8.8	D	B	D	C
302	Fowler Ave at North	12	5	3	D	2119	0%	50	4.0	0%	0	26.4	D	B	D	C
327	W University at 10th (S)	12	8	2	U	165	0%	30	3.0	40%	40	20.8	D	C	D	C
309	Holly at Laurel , (S)	10	0	2	U	134	0%	20	4.0	0%	52	0.0	D	D	C	B
313	21st St at 7th Ave, (W)	10	0	3	OW	536	0%	30	3.5	0%	33	24.0	D	D	E	D
308	Holly at Magnolia , (N)	10	0	2	U	407	0%	20	4.0	0%	86	0.0	D	D	D	C
320	Fletcher Ave at 50th (S)	12	5	2	D	1898	0%	45	4.0	0%	64	0.0	E	B	D	B
321	Fletcher, 50th to 56th (S)	12	5	2	D	2146	0%	45	4.0	0%	0	15.2	E	B	D	C
318	US 41 at 31st St, (W)	12	0	3	D	182	100%	55	3.5	0%	35	24.0	E	B	F	F
322	56th St at 98th Ave, (W)	12	0	3	D	1544	0%	45	3.5	0%	0	28.7	E	B	E	D
310	Fletcher at Sebring, (S)	11.5	0	2	D	1589	0%	40	4.0	0%	0	37.0	E	B	F	E
301	Fowler, River H./Gillette	12	5	3	D	2549	0%	50	4.0	0%	0	28.9	E	B	E	D
312	7th Ave, 17th to 14th (N)	12	0	1	U	631	0%	25	3.5	0%	49	5.0	E	C	D	C
317	US 41 at Dover St, (E)	12	0	2	D	495	17%	55	3.0	0%	0	11.5	F	B	E	D
314	56th St at Busch (W)	12	0	2	D	638	0%	45	3.5	0%	142	28.7	F	B	F	F
323	56th St at Busch (W)	12	0	3	D	357	0%	45	3.5	0%	142	28.7	F	E	E	F
324	Bullard at 56th St	12	4	3	D	636	0%	45	4.0	0%	87	19.6	F	E	D	C
	% Exact Match to Video												100%	15%	27%	46%
	% Within 1 LOS of Video												100%	50%	85%	77%

CHAPTER 8

Pedestrian LOS Model

8.1 Model Development

Two basic forms were considered for the pedestrian LOS for arterials model. The first was an aggregate model that used the outputs from existing segment and intersection LOS models to determine the arterial LOS. The other was an agglomerate model that considered the independent characteristics of the roadway/walkway environment to calculate an arterial LOS for pedestrians directly. Both were preliminarily evaluated during model development.

The aggregate model was chosen for refinement for several reasons. The stepwise approach to an aggregate model is useful because it allows the practitioner to evaluate the effect of improvements at individual intersections or along specific segments on the overall LOS of the facility. The aggregate model also retains all the terms found both intuitively and mathematically validated to be significant to pedestrians walking within an urban environment. The agglomerate models form was tested during our preliminary models and did not retain all the terms as significant. Consequently, we focused on the aggregate model in our model development efforts.

We considered various functional techniques for model development, including linear regression and ordered probit. We performed linear regression modeling because it is more intuitive than probit modeling in practice and non-modelers better understand the sensitivity of the regression model. These reasons are particularly important in that these models are most frequently used: the development or analysis of specific design options or in the development of pedestrian facility community master plans with presentations to interested citizens and public officials. To ensure the validity of the results of the linear regression modeling results, we evaluated the ordered probit model form as well. The results of both the linear regression and ordered probit modeling efforts are described below.

For both modeling efforts the dependent variable, Observed pedestrian LOS, was defined as the score that a participant assigned to a specific video clip. The scores were on a scale of A (best) through F (worst). For modeling purposes, the letter grades were converted to numerical scores: A=1, B=2, C=3, D=4, E=5, and F=6.

Before starting correlations analysis and modeling, we created two data subsets from the overall dataset. The total dataset was sorted by city and LOS grade responses. A random sampling of 20% of the data representing each city and LOS grade response was taken from the overall dataset for model validation. The balance of the data, 80% of the total dataset, was used for model development.

We used SPSS 14.0 to conduct Pearson correlation analysis on the extensive array of geometric and operational variables. Subsequently, we selected the following relevant variables for additional testing:

- Segment LOS—The pedestrian LOS for roadway segments (see below).
- Intersection LOS—The pedestrian LOS for signalized intersections (see below).
- Midblock Crossing LOS—The LOS associated with midblock crossings (see below).
- Total Pedestrians—The total number of pedestrians encountered in the video clip; a measure of pedestrian space, which is an input to the existing pedestrian LOS methodology in the HCM.
- Conflicts per mile—The total conflicts per mile represent the motor vehicle conflicts resulting from motorists turning across the pedestrian facility at unsignalized locations.
- Size of the city in which the data collection took place—The MSA population was used to represent the size of each city.

The panel asked that MSA be dropped from further consideration as a variable. Other variables were dropped from further consideration because of their poor correlation with the dependent variable or because of their colinearity with more strongly correlated variables. Also, variables such as traffic volume, sidewalk width, and signal delay, are components of the segment LOS or the intersection LOS, so we did not model them independently.

Several variables were evaluated for inclusion as additional terms in the model. Frequency of unsignalized conflicts (intersections and driveways) per mile was tested for its correlation and significance to the arterial LOS for pedestrians and was not found to be a significant factor. Additionally, the density of pedestrians on the sidewalk (the current HCM measure of LOS) was not found to be significant for this model, within the low range of density values available in the video clips.

8.2 Recommended Pedestrian LOS Model

The proposed pedestrian level of service predicts the mean level of service that would be reported by pedestrians along or across the urban street. The average pedestrian LOS for the urban street facility is a function of the segment level of service, the intersection level of service, and the mid-block crossing difficulty.

Overall Pedestrian LOS Model

The overall pedestrian level of service for an urban street is based on a combination of pedestrian density and other factors. The level of service according to density is computed. Then the pedestrian LOS according to other factors is computed. The final level of service for the facility is the worse of the two computed levels of service.

Ped LOS = Worse of (Pedestrian Density LOS, Ped Other LOS) (Eq. 33)

Where

Ped LOS = The letter grade level of service for the urban street combining density and other factors.

Ped Density LOS = The letter grade level of service for sidewalks, walkways, and street corners based on density

Ped Other LOS = The letter grade level of service for the urban street based on factors other than density

Pedestrian Density LOS Model for Sidewalks, Walkways, Street Corners

The methods of Chapter 18 of the HCM are used to compute the pedestrian density for the sidewalks and the pedestrian waiting areas at signalized intersection street corners. The LOS thresholds given in that chapter for these facilities are used to determine the level of service. The thresholds for sidewalks and walkways are given in Exhibit 93.

Pedestrian Other LOS Model

The pedestrian LOS for the facility that is representative of non-density factors is computed according to either of the two models below:

Pedestrian Other LOS Model 1

$$OtherPLOS\ (\#1) = (0.318\ PSeg + 0.220\ PInt + 1.606) * (RCDF) \quad \text{(Eq. 34)}$$

Pedestrian Other LOS Model 2

$$OtherPLOS\ (\#2) = (0.45\ PSeg + 0.30\ PInt + 1.30) * (RCDF) \quad \text{(Eq. 35)}$$

Where

OtherPLOS = Pedestrian non-density (other factors) LOS
PSeg = Pedestrian segment LOS value
PInt = Pedestrian intersection LOS value
RCDF = Roadway crossing difficulty factor

The first model provides the better statistical fit with the video lab data. However, this model does not produce LOS F for the streets in the video clip data set. The second model is a manual modification of the parameters of the first model so that the second model will produce a full range of LOS A to F for the streets in the video clip data set. The constant was

Exhibit 93. Pedestrian Walkway LOS (Density).

LOS	Minimum Pedestrian Space Per Person	Equivalent Maximum Flow Rate per Unit Width of Sidewalk
A	> 60 SF per person	≤ 300 peds/hr/ft
B	>40	≤ 420
C	>24	≤ 600
D	>15	≤ 900
E	>8	≤ 1380
F	≤ 8 SF	> 1380

Source: Exhibit 18-3 HCM 2000 [110]

manually adjusted downward and the other parameters were adjusted upward until the second model produced LOS F for at least one of the streets in the data set.

Although none of the video clips actually produced a LOS A or F rating (on average) from the video lab participants, the second model was developed to address potential public agency acceptance issues that might arise with adopting the first LOS model for pedestrians that might not produce LOS A and LOS F for at least some streets in the jurisdiction. The second model produces a full range of LOS A to F results for a reasonable range of street conditions typical of urban areas of the United States.

The output of both of these models is a numerical value, which must be translated to a LOS letter grade. Exhibit 94 provides the numerical ranges that coincide with each LOS letter grade. These thresholds are the same as for the other modes.

Pedestrian Segment LOS

The segment pedestrian LOS is calculated according to the following widely used equation [111]:

$$PLOS = -1.2276 \ln (f_{LV} \times W_t + 0.5W_l + f_p \times \%OSP + f_b \times W_b + f_{sw} \times W_s) + 0.0091 (V/(4*PHF*L)) + 0.0004\, SPD^2 + 6.0468 \quad (Eq.36)$$

Where

- Ped SegLOS = Pedestrian level of service score for a segment
- ln = Natural log
- f_{LV} = Low volume factor (=1.00 unless average annual daily traffic (AADT) is less than or equal to 4,000, in which case f_{LV}=(2 - 0.00025 * AADT)
- W_t = total width of outside lane (and shoulder) pavement
- W_l = Width of shoulder or bicycle lane, or, if there is un-striped parking and %OSP=25 then W_l=10ft to account for lateral displacement of traffic
- f_p = On-street parking effect coefficient (=0.50)
- %OSP = Percent of segment with on-street parking
- f_b = Buffer area coefficient
  = 5.37 for any continuous barrier at least 3 feet high separating walkway from motor vehicle traffic. A discontinuous barrier (e.g. trees, bollards, etc.) can be considered a continuous barrier if they are at least 3 feet high and are spaced 20 feet on center or less.
- W_b = Buffer width (distance between edge of pavement and sidewalk, in feet)
- f_{sw} = Sidewalk presence coefficient(f_{sw}=6-0.3W_s if W_s=10, otherwise f_{sw} = 3.00)
- W_s = Width of widewalk
  For widths greater than 10 feet, use 10 feet.
- V = Directional volume of motorized vehicles in the direction closest to the pedestrian (vph)
- PHF = Peak hour factor
- L = Total number of through lanes for direction of traffic closest to pedestrians.
- SPD = Average running speed of motorized vehicle traffic (m/h)

Exhibit 94. Pedestrian "Other" Model LOS Categories.

LOS	Numerical Score
A	≤ 2.00
B	>2.00 and ≤ 2.75
C	>2.75 and ≤ 3.50
D	>3.50 and ≤ 4.25
E	>4.25 and ≤ 5.00
F	> 5.00

Pedestrian Intersection LOS

The intersection LOS for pedestrians is computed only for signalized intersections according to the following equation developed by Petritsch et al.[12]:

$$\text{Ped Int LOS (Signal)} = 0.00569(RTOR + PermLefts) + 0.00013(PerpTrafVol*PerpTrafSpeed) + 0.681(LanesCrossed^{0.514}) + 0.0401\ln(PedDelay) - RTCI(0.0027PerpTrafVol - 0.1946) + 0.5997 \quad (Eq. 37)$$

Where

- RTOR +PermLefts = Sum of the number of right-turn-on-red vehicles and the number of motorists making a permitted left turn in a 15-minute period
- PerpTrafVol*PerpTrafSpeed = Product of the traffic in the outside through lane of the street being crossed and the midblock 85th percentile speed of traffic on the street being crossed in a 15-minute period
- LanesCrossed = The number of lanes being crossed by the pedestrian
- PedDelay = Average number of seconds the pedestrian is delayed before being able to cross the intersection
- RTCI = Number of right turn chanmelization islands on the crossing.

Pedestrian Midblock Crossing Factor

The pedestrian Roadway Crossing Difficulty Factor (RCDF) measures the difficulty of crossing the street between signalized intersections. The RCDF worsens the pedestrian LOS if the crossing difficulty is worse than the non-crossing LOS for the facility. It improves the pedestrian LOS if the crossing difficulty LOS is better than the non-crossing difficulty LOS. The factor is based on the numerical difference between the crossing LOS and the non-crossing LOS. The pedestrian RCDF is limited to a maximum of 1.20 and a minimum of 0.80.

$$RCDF = Max[0.80, Min\{[(XLOS\# - NXLOS\#)/7.5 + 1.00], 1.20\}] \quad (Eq. 38)$$

Where

- RCDF = Roadway crossing difficulty factor
- XLOS# = Roadway crossing difficulty LOS Number
- NXLOS# = Non-crossing Pedestrian LOS number
  = (0.318 PSeg + 0.220 PInt + 1.606)

Pseg = Ped. Segment LOS number (computed per equation #20)
Pint = Ped. Intersection LOS number (computed per equation #21)

The crossing difficulty LOS number is computed based on the minimum of the waiting-for-a-gap LOS number and diverting-to-a-signal LOS number.

XLOS = Min [WaitForGap, DivertToSignal] (Eq. 39)

Where
XLOS = Crossing LOS score (based on Exhibit 96)
WaitForGap = Delay waiting for safe gap to cross.
DivertToSignal = Delay diverting to nearest signalized intersection to cross.

The delay is converted into a LOS numerical score based on the minimum of the mean delay waiting for a gap or diverting to a signal, according to the values given in Exhibit 95.

Wait-For-Gap LOS Calculation

The Wait-For-Gap LOS is computed based on the expected waiting time required to find an acceptable gap in the traffic to cross the street. The acceptable gap is computed as a function of the number of lanes, their width, and the average pedestrian walking speed, with 2 seconds added.

Acceptable Gap = (Number of Lanes * 12 feet/lane) / 3.5 feet/second + 2 seconds (Eq. 40)

The expected waiting time until an acceptable gap becomes available is computed as follows:

$$MeanWait = \frac{1}{\lambda}[\exp(\lambda t) - 1] - t \quad \text{(Eq. 41)}$$

Where
t = The acceptable gap plus the time it takes for a vehicle to pass by the pedestrian.
The average pass-by time = Average Vehicle Length/ Average Speed, converted to seconds.
λ = The average vehicle flow rate in vehicles per second.
Exp = The exponential function

Exhibit 95. Pedestrian Crossing LOS Score.

Minimum of Wait or Divert Delay (Seconds)	XLOS Score
10	1
20	2
30	3
40	4
60	5
> 60	6

Using the numerical cutoffs shown in Exhibit 96 the final numerical score is then interpolated between the cutoff values based on the probability of obtaining an adequate gap within the allowed time.

For this calculation, the increasing LOS numerical score is assumed to become logarithmic beyond LOS F.

Divert To Signal LOS

The LOS rating for diverting to the nearest traffic signal to cross the street is computed as a function of the extra delay involved in walking to and from the mid-block crossing point to the nearest signal and the delay waiting to cross at the signal.

The geometric delay associated with a pedestrian deviation is the amount of time it takes the pedestrian to walk to a controlled crossing and back. To calculate this delay, one must first determine the distance to the nearest crossing. For this methodology, this was assumed as one third of the block length. This distance is then divided by the pedestrian's walking speed (assumed to be 3.5 feet/second) to obtain the geometric delay:

Ped Geometric Delay = 2/3 * (Block Length)/ Ped Walking Speed (Eq. 42)

The control delay at the intersection is calculated as shown in the HCM [**113**]:

Ped Control Delay = (Cycle Length − Green Time)^2/ (2*Cycle Length) (Eq. 43)

The total delay is the sum of the two:

Total Ped Deviation Delay = Ped Geometric Delay + Ped Cycle Delay (Eq. 44)

Exhibit 96. Pedestrian LOS and Delay Thresholds.

Pedestrian LOS	Delay Threshold Seconds	Equivalent LOS Numerical Score Range	Equivalent LOS Midpoint Score
A	10	≤ 1.5	1
B	20	>1.5 and ≤ 2.5	2
C	30	> 2.5 and ≤ 3.5	3
D	40	> 3.5 and ≤ 4.5	4
E	60	> 4.5 and ≤ 5.5	5
F	> 60	> 5.5	6

For this calculation, the increasing LOS numerical score is assumed to become logarithmic beyond LOS F.

Exhibit 97. Evaluation of Proposed Pedestrian Model and HCM Against Video Lab Results.

Clip	Location	Sidewalk Width (ft)	Pedestrian Flow Rate (pph)	Outside Lane (ft)	Shoulder Width (ft)	On-Street Parking (%)	Barrier (Y/N)	Buffer Width (ft)	Dir. Vol. (vph)	Traffic Lanes (lanes)	Traffic Speed (mph)	Video LOS	HCM LOS	Model #1 LOS	Model #2 LOS
215	7th Ave at 15th St, N side	8	60	12	0	50%	Yes	7	170	1	25	B	E	B	B
227	Grant Ave at California St, E side	6	200	16	0	0%	Yes	4	630	2	30	B	B	C	C
230	3rd St at Mission St, E side	6	220	12	0	0%	No	5	220	2	30	B	D	C	D
221	Stockton St at Washington St, E side	4	640	16	0	0%	Yes	3	0	1	30	B	E	B	B
224	Grant Ave at Jackson St, E side	4	1320	12	0	100%	Yes	2	80	1	30	B	E	B	B
228	Post St at Stockton St, S side	6	180	10	0	40%	Yes	1	370	1	30	B	D	B	C
226	Geary Blvd at Divisadero St, S side	9	190	20	0	50%	Yes	5	1180	2	40	B	D	D	D
232	Hillsborough, Arm. to Tamp., N side	6	0	16	4	0%	No	0	540	1	45	B	B	D	D
229	Post St at Stockton St, S side	6	280	10	0	40%	Yes	0	310	1	30	B	D	B	B
205	Alumni Dr at Magnolia Dr, N side	10	0	12	4	0%	No	10	200	2	30	C	B	C	C
211	Bearss Ave at North Blvd, N side	4	0	12	0	0%	No	5	570	1	45	C	A	B	C
214	Dale Mabry at Tampa Bay, E side	9.5	0	12	5	0%	No	35	2030	3	45	C	E	D	E
225	Geary Blvd at Divisadero St, S side	9	280	20	0	50%	Yes	5	1050	2	40	C	C	D	D
218	Market St at Kearney St, N side	15	340	12	0	0%	No	12	60	1	30	C	C	B	B
222	Stockton St at Broadway St, E side	6	610	16	0	50%	Yes	3	220	2	30	C	E	C	C
219	Stockton St at Clay St, E side	7	640	16	0	100%	Yes	4	150	1	30	C	E	B	B
220	Stockton St at Clay St, E side	7	820	16	0	100%	Yes	4	150	1	30	C	D	B	B
223	Stockton St at Broadway St, E side	6	1600	16	0	50%	Yes	3	0	2	30	C	D	A	A
210	Magnolia Dr at Holly Dr, W side	0	0	12	0	0%	No	0	160	2	30	C	C	C	C
216	21st St at 7th Ave, W side	6	0	12	0	0%	No	0	360	1	30	C	A	C	C
217	21st St at 7th Ave, W side	6	0	12	0	0%	No	0	300	1	30	C	E	B	C
203	Collins Blvd at Alumni Dr, E side	10	0	12	4	0%	No	15	270	2	30	D	D	C	C
204	Collins Blvd at Alumni Dr, E side	10	0	12	4	0%	No	15	160	2	30	D	E	B	C
231	Dale Mabry, State to Carmen, W side	5	0	12	0	0%	No	6	570	1	35	D	B	D	D
201	Holly Dr at Magnolia Dr, N side	0	0	10	0	0%	No	0	270	2	20	D	E	D	E
209	Fletcher at Bruce B Downs, S side	0	0	12	4	0%	No	0	2170	4	45	D	A	E	F
206	Fowler Ave at 56th St, S side	5	0	12	5	0%	No	23	1690	4	50	E	E	D	E
208	Fletcher at Bruce B Downs, S side	0	30	12	4	0%	No	0	1750	4	45	E	C	E	F
	% Exact Match to Video Rating											100%	25%	43%	43%
	% Within 1 LOS of Video Rating											100%	43%	86%	79%

Notes:

- On-Street Parking = Percent of on-street parking lane occupied by parked vehicles.
- Barrier is presence of trees, or other barrier between pedestrian sidewalk and street.
- Traffic lanes is number of lanes in direction of travel closest to pedestrian.
- Video LOS is the mean of the letter grade LOS ratings reported by subjects in video lab.
- Model LOS is the LOS grade predicted by the proposed pedestrian LOS model.

The total delay is then converted into a numerical LOS score by linearly interpolating numerical scores on the scale provided in Exhibit 96.

8.3 Performance Evaluation of Pedestrian LOS Model

Exhibit 97 compares the performance of the proposed pedestrian LOS model (with the mid-block crossing factor) to the mean LOS rating for each pedestrian video clip. The video clips did not expose lab subjects to any arterial mid-block crossing situations. Although the HCM reproduces the mean video lab ratings for each video clip 25% of the time, the two proposed pedestrian LOS models (1 and 2) both reproduce the mean video clip ratings 43% of the time. The difference is that Model 2 produces LOS A to F results for the streets in the video clip data set. Model 1 produces LOS A to E results for the same streets.

CHAPTER 9

Integrated Multimodal LOS Model Framework

This section provides an overview of the proposed urban street LOS framework and the proposed LOS modeling system.

9.1 The Framework

The proposed multimodal LOS framework for urban streets reports a single average level of service for each of four modal users of the urban street:

1. Auto drivers,
2. Bus passengers,
3. Bicycle riders, and
4. Pedestrians.

The individual modal levels of service are NOT combined into a single comprehensive level of service for the facility because this would disguise the disparities in the perceptions of quality of service for the four modes.

The urban street LOS for a given mode is defined as the *average* degree of satisfaction with the urban street that would be reported by a large group of travelers using that mode of travel *if they had traveled the full length* of the study section of the street. The video lab research showed that the degree of satisfaction experienced by an individual traveler for a given situation varies widely across individuals. Consequently, this framework focuses on predicting the average degree of satisfaction of a large group of people exposed to the same urban street experience. Due to fatigue effects, travelers actually traveling the full length of the facility would forget key aspects of their experience and report a different level of service than would several travelers traveling short lengths of the facility. This framework takes the LOS perceptions of travelers on short sections of urban street and compiles them into an estimate of LOS for the full length of the street.

The six-letter grade A-F LOS structure of the HCM has been preserved. Many of the statistical results suggest that people can actually distinguish only two to three levels of service. However, public agency planners and engineers need to be able to predict how close a facility is to an unacceptable level of service. So the six levels have been retained for agency planning purposes, rather than because people actually can distinguish among them.

Level of service is defined for each mode as shown in Exhibit 98.

9.2 The Integrated LOS Modeling System

The proposed LOS modeling system relies on 37 variables to predict the perceived degree of satisfaction experienced by travelers on the urban street. These variables consist of four basic types: facility design, facility control, transit service characteristics, and the volume of vehicle traffic on the facility.

Input Variable Interactions Among Modes

Exhibit 99 lists the input variables and their major interactions. Minor interactions are not shown in this exhibit, but are discussed below.

The Auto LOS Model 1 uses two variables: Auto Stops Per Mile, and Presence of Left-Turn Lanes.

- The presence of a left-turn lane is a facility design feature.
- The stops per mile are directly influenced by the intersection control type and the settings of the traffic signal. High auto and transit volumes can increase the probability of stopping. Pedestrian and bicycle volumes at intersections reduce the saturation flow rate, which reduces speed and increases stops.

The Auto LOS Model 2 uses two variables: Percent of Posted Speed Limit, and Median Type.

Exhibit 98. Definition of LOS by Mode.

Level of Service	Auto	Transit	Bicycle	Pedestrian
A	Best Performance	Very Satisfied	Best Performance	Best Performance
B				
C				
D				
E				
F	Worst Performance	Very Dissatisfied	Worst Performance	Worst Performance

Exhibit 99. Interaction of Modal LOS Model Inputs.

Inputs to LOS Models	Facility Design	Facility Control	Transit Service	Auto Volume	Transit Volume	Bicycle Volume	Pedestrian Volume
Auto LOS Model #1							
Auto Stops (or Delay)		XXX		XXX	XXX	XXX	XXX
Left Turn Lanes	XXX						
Auto LOS Model #2							
Mean Speed		XXX		XXX	XXX	XXX	XXX
Median Type	XXX						
Transit LOS Model							
Pedestrian LOS	XXX	XXX		XXX	XXX		XXX
Bus Headway			XXX				
Bus Speed		XXX		XXX	XXX	XXX	XXX
Bus Schedule Adherence			XXX	XXX	XXX	XXX	XXX
Passenger Load					XXX		
Bus Stop Amenities	XXX						
Bicycle LOS Models							
Bike-Pedestrian Conflicts*	XXX					XXX	XXX
Driveway Conflicts/Mile	XXX						
Vehicles Per Hour				XXX	XXX		
Vehicle Through Lanes	XXX						
Auto Speed	XXX	XXX		XXX	XXX		
Percent Heavy Vehicles				XXX	XXX		
Pavement Condition	XXX			XXX	XXX		
Width of Outside Lane	XXX						
On-Street Parking Occupancy	XXX	XXX					
Cross Street Width	XXX						
Pedestrian LOS Models							
Pedestrian Density	XXX						XXX
Pedestrian-Bike Conflicts*	XXX					XXX	XXX
Width of Shoulder	XXX						
Width of Outside Lane	XXX						
On-Street Parking Occupancy	XXX						
Presence of Trees	XXX						
Sidewalk Width	XXX						
Distance To Travel Lane	XXX						
Vehicles Per Hour				XXX	XXX		
Vehicle Through Lanes	XXX						
Average Vehicle Speed	XXX	XXX		XXX	XXX	XXX	XXX
Right Turns On Red	XXX	XXX		XXX			XXX
Cross Street Speed	XXX	XXX					
Cross Street Vehicles/Hour				XXX	XXX		
Cross Street Lanes	XXX						
Crossing Delay		XXX					
Right-Turn Channelization	XXX						
Block Length	XXX						
Signal Cycle Length		XXX		XXX	XXX		XXX
Signal Green Time		XXX		XXX	XXX		XXX

"XXX" indicates that input variable is influenced by that factor.
* Ped/bike conflicts come into play only for paths outside of roadway but within right-of-way of street.

- The Median Type is a facility design feature.
- The percent of posted speed limit that traffic is able to travel the full length of the street is directly influenced by the intersection control type and the settings of the traffic signal. High auto and transit volumes can reduce the mean speed. Pedestrian and bicycle volumes at intersections reduce the saturation flow rate, which reduces mean auto speed.

The Transit LOS Model uses 6 variables: Pedestrian LOS, Bus Headway, Bus Speed, Bus On-Time Performance, Passenger Load, and Bus Stop Amenities.

- The pedestrian LOS is determined by the facility design, intersection controls, the volume of auto and transit traffic, and the pedestrian volume (pedestrian volumes influence signal timing, which affects signal delay for pedestrians, which affects pedestrian LOS).
- The bus headway is determined by the transit service provider, which is related to the passenger loads.
- Bus speed is determined by the facility controls (signal settings), the amount of auto and transit traffic, and the number of boarding passengers at each stop. Bicycles in the travel lanes may delay buses. Heavy pedestrian volumes at intersections (or mid-block) may delay buses.
- Bus on-time performance is determined by the service provider (e.g., number of back up buses, and maintenance to prevent breakdowns). It is also influenced by the auto, bicycle, and pedestrian volumes on the street.
- Passenger load is determined by the density of development in the area, the relative convenience of other modes of travel, and the bus headways provided by the transit operator.
- Bus stop amenities are a design feature of the facility.

The Bicycle LOS Model uses the following variables: Driveway Conflicts/Mile, Vehicles Per Hour, Vehicle Through Lanes, Speed Limit, Percent Heavy Vehicles, Pavement Condition, Width of Outside Lane, On-Street Parking Occupancy, and Cross Street Width.

- Bicycle-Pedestrian Conflicts (only if bicycles share the pedestrian facility).
- Driveway Conflicts/Mile are a design feature.
- Vehicles Per Hour is determined by the auto, truck, and transit volumes.
- Vehicle Through Lanes is a design feature of the facility.
- Speed Limit is a control feature of the facility. It is influenced by the facility design.
- Percent Heavy Vehicles is influenced by the auto, truck, and transit volumes.
- Pavement Condition is a facility maintenance feature. It is influenced by auto, truck, and transit volumes and the pavement design.
- Width Of Outside Lane is a design feature.
- On-Street Parking Occupancy is determined by the parking controls, available off-street parking, and the density of land uses in the area. Facility design determines whether a parking lane is provided and whether or not parking is prohibited during peak hours.
- Cross Street Width is determined by the facility design.

The Pedestrian LOS Model uses the following variables: Pedestrian Density, Bicycle-Pedestrian Conflicts (if facility is shared), Width of Shoulder, Width of Outside Lane, On-Street Parking Occupancy, Presence of Trees, Sidewalk Width, Distance To Travel Lane, Vehicles Per Hour, Vehicle Through Lanes, Average Vehicle Speed, Right-Turns on Red, Cross Street Speed, Cross Street Vehicles/Hour, Cross Street Lanes, Crossing Delay, Right-Turn Channelization, Block Length, Signal Cycle Length, Signal Green Time

- Pedestrian Density (Computed according to HCM).
- Bicycle-Pedestrian Conflicts (only if bicycles share the pedestrian facility).
- Width of Shoulder is a design feature.
- Width of Outside Lane is a design feature
- On-Street Parking Occupancy is determined by the parking controls, available off-street parking, and the density of land uses in the area. Facility design determines whether a parking lane is provided and whether or not parking is prohibited during peak hours.
- Presence of Trees is a design feature.
- Sidewalk Width is a design feature.
- Distance to Travel Lane is a design feature.
- Vehicles Per Hour is determined by the auto, truck, and transit volumes.
- Vehicle Through Lanes is a design feature of the facility.
- Average Vehicle Speed is determined by the facility design, the facility control (speed limit), and the auto, bus, bicycle, and pedestrian volumes on the facility, to the extent that bicycles and pedestrians share (or cross) the traveled way used by motor vehicles.
- Right-Turns on Red are determined by the facility control (are they allowed?). They are influenced by the auto and transit volumes. Heavy pedestrian volumes may reduce the ability of autos or buses to turn right on red.
- Cross Street Speed is determined by the design and control of the cross street. It is influenced by cross-street volumes. Heavy pedestrian or bicycle volumes may reduce the cross street speed.
- Cross Street Vehicles/Hour is determined by the auto and transit volume.
- Cross Street Lanes is a design feature. It is influenced by the auto and transit volumes.
- Crossing Delay is determined by the intersection control (signal timing), which in turn is influenced by auto, bus, and pedestrian volumes.

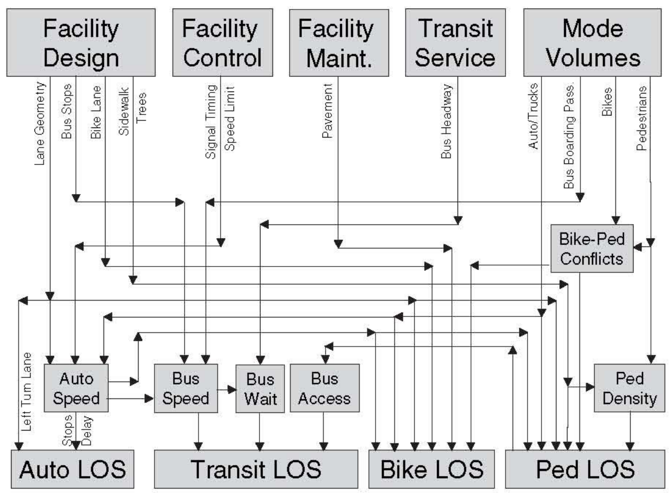
- Right-Turn Channelization is a design feature.
- Block Length is a design feature
- Signal Cycle Length is a facility control feature. It is influenced by the facility design, auto and transit volumes, and the pedestrian volumes.
- Signal Green Time is a facility control feature. It is influenced by the facility design, auto and transit volumes, and the pedestrian volumes.

Interactions Among Modal LOS Results

Exhibit 100 shows the major interactions among the input variable types, the modal LOS models, and the modal LOS model results.

To estimate the variables required by the LOS models, the analyst first collects data on facility design, facility control, facility maintenance, transit service, and the volume for each mode. The analyst uses these data to estimate various modal performance characteristics (auto speed, bus speed, bus wait, bus access, bicycle-pedestrian conflicts if a shared facility is present, and pedestrian density). Once the modal performance characteristics are known, then the methods of NCHRP 3-70 are used to estimate auto LOS, transit LOS, bicycle LOS, and pedestrian LOS for the urban street. The bicycle-pedestrian conflict LOS is estimated using procedures in Chapters 18 and 19 of the HCM.

Exhibit 100. LOS Model Interactions.



CHAPTER 10

Accomplishment of Research Objectives

Exhibit 101 illustrates how the recommended modeling system meets the research objectives.

Exhibit 101. Satisfaction of Research Objectives by the Recommended Modeling System.

Research Objective	Degree Accomplished By Proposed Model System
1. Produce updated chapter on multimodal LOS analysis for urban streets for Highway Capacity Manual. Produce sample problems. Produce software engine.	Draft chapter, sample problems, and software engine delivered to panel in June 2007 and to Highway Capacity Committee in July 2007. Final Report delivered February 2008.
2. Establish a scientific basis for evaluating level of service as a function of traveler satisfaction.	The research has established a measurable definition of level of service and a reproducible method for measuring it. The model system is based on video labs and field surveys conducted in several cities in the United States.
3. Create a consistent set of modal LOS models allowing for comparison of degrees of modal traveler satisfaction across of modes.	The uniform definition of LOS used in the models provides a consistent basis for comparing levels of service across modes.
4. Provide a multimodal LOS system that takes into account interactions among modes in the urban street environment.	The multimodal LOS system takes into account the impacts of autos, buses, bicycles, and pedestrians on the perceived LOS for each mode. Many cross-modal factors are taken into account directly, others are incorporated indirectly. Explicit numerical methodologies do not yet exist for incorporating the indirect effects into the LOS models, but the "hooks" are in place in the LOS models for future incorporation of new methods for estimating the indirect effects.
5. Create a multimodal LOS system that is applicable to arterials and major collectors	The LOS system is applicable to arterials and major collectors.
6. Create a multimodal LOS system that addresses all vehicle and pedestrian movements.	The multimodal LOS system concept allows the consideration of all movements by vehicles and pedestrians. The LOS models themselves have been implemented primarily for through travel along the arterial or collector. The pedestrian model, in addition, incorporates mid-block crossing.
7. Create a multimodal LOS system that can be used to evaluate micro-peaks (less than 15 minutes).	The LOS system can be applied to peaks shorter than 15 minutes; however, the models that implement that system are designed for 15 minute peaks.
8. Incorporate safety and economic aspects only insofar as they influence perceptions of LOS.	Safety and economic effects have not been explicitly included or excluded from the LOS models. Laboratory and field survey participants were allowed to consider any aspect of the service provided in determining their perceived levels of service.
9. Overcome the nine limitation of the HCM listed in Chapter 15 of the HCM.	a. The presence or lack of parking is included in the bicycle and pedestrian LOS models. It indirectly affects the auto and transit LOS models. b. Driveway density and access control is included in the bicycle LOS model. c. Short lane additions and drops are not explicitly included in any of the LOS models. d. The impacts of road gradients are not included in the currently proposed LOS models, but could be added. e. Capacity constraints between intersections are taken into account to the extent they affect stops by autos or delay bus service. f. Two-way left turn lanes and medians are not explicitly included in the LOS models but can indirectly affect auto and bus LOS by reducing stops, or increasing bus speeds. g. High percentage turning movements explicitly affect pedestrian LOS. They indirectly affect auto and bus LOS. h. Multi-block queues will cause problems for the auto LOS model, which considers only stops. Under the recommended model, a single stop for a long queue gives better auto LOS than multiple stops for several short queues. i. Cross street congestion blocking through traffic will indirectly affect auto and bus LOS and will directly impact pedestrian LOS.

References

1. *The Highway Capacity and Quality of Service Manual*, Transportation Research Board, National Research Council, Washington, DC (2000).
2. *TCRP Web-Only Document 6: Transit Capacity and Quality of Service Manual*, Transportation Research Board, National Research Council, Washington, DC (1999).
3. *2002 Quality/Level of Service Handbook*, Florida Department of Transportation, Office of the State Transportation Planner, Systems Planning Office, Tallahassee, FL (January 7, 2003). (http://www11.myflorida.com/planning/systems/sm/los/)
4. Rouphail, N., et al. "Recommended Procedures for Chapter 14, Bicycles, of the Highway Capacity Manual." *Report FHWA-RD-98-108*. FHWA, U.S. DOT (1998).
5. Rouphail, N., et al. "Recommended Procedures for Chapter 13, Pedestrians, of the Highway Capacity Manual." *Report FHWA-RD-98-107*. FHWA, U.S. DOT (1999).
6. Fruin, J. *Pedestrian Planning and Design*. Metropolitan Association of Urban Designers and Environmental Planners, New York, NY (1971).
7. Botma, H. "Method to Determine Level of Service for Bicycle Paths and Pedestrian Bicycle Paths." *Transportation Research Record 1502*, Transportation Research Board, National Research Council, Washington, DC, pp. 38–44 (1995).
8. Pushkarev, B. and J. Zupan. *Public Transportation and Land Use Policy*, Indiana University Press, Bloomington, IN (1977).
9. Phillips, R., J. Karachepone, and B. Landis. Multi-Modal Quality of Service Project, Urban and Regional Planning Department, University of Florida, Gainesville, FL (March 2001).
10. Flannery, A., K. Wochinger, and A. Martin. "Driver Assessment of Service Quality on Urban Streets." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2005).
11. Flannery, A., et al. "Research Approaches to Assess Automobile Drivers' Perception of Quality of Service." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2004).
12. Colman, S. "Assessing Arterial Level of Service for Congestion Management Programs: A User Perspective," 1994 ITE International Conference, Institute of Transportation Engineers, Washington, DC (1994).
13. Pecheux, K., et al. "Automobile Drivers' Perceptions of Service Quality on Urban Streets." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2004).
14. Science Applications International Corporation, George Mason University, and Volpe National Transportation Systems Center. "Quality of Service and Customer Satisfaction on Arterial Streets: Final Report." FHWA, U.S. DOT, Washington, DC, June 13 (2003).
15. Sutaria, T., and J. Haynes. "Level of Service at Signalized Intersections," *Transportation Research Record 644*, Transportation Research Board, National Research Council, Washington, DC (1977).
16. Ha, T.-J., Tae-Jun Ha and W. Berg. "Development of Safety-Based Level-Of-Service Criteria for Isolated Signalized Intersections," *Transportation Research Record 1484*, Transportation Research Board, National Research Council, Washington, DC (1995).
17. Zhang, L., and P. Prevedouros. "Signalized Intersection LOS that Accounts for Safety Risk." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2003).
18. Zhang, L., and P. Prevedouros. "Signalized Intersection LOS that Accounts for User Perceptions." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2004).
19. Zhang, L., and P. Prevedouros. "User Perceptions of Signalized Intersection Level of Service." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2005).
20. Li, J., Z. Yue, and S. Wong. "Performance Evaluation of Signalized Urban Intersections under Mixed Traffic Conditions by Gray System Theory." *Journal of Transportation Engineering*, Vol. 130, No. 1, pp. 113-121 (2004).
21. Pecheux, K., M. Pietrucha, and P. Jovanis. "User Perception of Level of Service at Signalized Intersections: Methodological Issues," *Transportation Research Circular E-C018*, Fourth International Symposium on Highway Capacity, Transportation Research Board, Washington, DC (June 2000).
22. Fang, C., and K. Pecheux. "Analysis of User Perception of Level of Service Using Fuzzy Data Mining Technique." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2007).
23. Zhang, L., and P. Prevedouros. "Fuzzy Logic Based User Perceptions of Signalized Intersection Level of Service." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2007).
24. Lee, D., T.-G. Kim, and M. Pietrucha. "Incorporation of Transportation User Perception Into Evaluation of Service Quality of Signalized Intersections Using Fuzzy Aggregation." Presented

at the Transportation Research Board Annual Meeting, Washington, DC (2007).
25. Nakamura, H., K. Suzuki, and S. Ryu. "Analysis of the Interrelationship Among Traffic Flow Conditions, Driving Behavior, and Degree of Driver's Satisfaction on Rural Motorways," *Transportation Research Circular E-C018*, Fourth International Symposium on Highway Capacity, Transportation Research Board, Washington, DC (June 2000).
26. Fu, L., F. Saccomanno, and Y.Xin. "A New Performance Index for Evaluating Transit Quality of Service." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2005).
27. Tumlin, J., et al. "Performance Measures for the Urban Village Transit Network." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2005).
28. Xin, Y., L. Fu, and F. Saccomanno. "Assessing Transit Level of Service along Travel Corridors Using TCQSM – A Case Study." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2005).
29. Furth, P., and T. Muller. "Service Reliability and Hidden Waiting Time: Insights from AVL Data." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2006).
30. Morpace International, Inc., , *TCRP Report 47: A Handbook for Measuring Customer Satisfaction and Service Quality*, Transportation Research Board, National Research Council, Washington, DC (1999).
31. Kittelson & Associates, Inc., et al. *TCRP Report 88: A Guidebook for Developing a Transit Performance-Measurement System*, Transportation Research Board, National Research Council, Washington, DC (2003).
32. Perk, V., and C. Foreman, "Evaluation of First-Year Florida MPO Transit Capacity and Quality of Service Reports," *Report NCTR-473-02*, National Center for Transit Research, University of South Florida, Tampa, FL (2001).
33. Petritsch, T. "Video Simulation of Roadway Bicycling." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2007).
34. Zolnik, E., and E. Cromley. "Poisson Multilevel Bicycle Level-Of-Service Methodology for Road Networks." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2007).
35. Petritsch, T., et al. "Bicycle Level of Service for Arterials." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2007).
36. Petritsch, T. "Video Simulation of Roadway Bicycling." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2007).
37. Jensen, S. "Pedestrian and Bicycle Levels of Service on Roadway Segments." Presented at the Transportation Research Board Annual Meeting, Washington DC (2007).
38. Landis, B., et al. "Intersection Level of Service: The Bicycle Through Movement." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2003).
39. Harkey, D., D. Reinfurt, and M. Knuiman. "Development of the Bicycle Compatibility Index", *Transportation Research Record 1636*, Transportation Research Board, National Research Council, Washington, DC (1998).
40. Landis, B., V. Vattikuti, and M. Brannick. "Real-Time Human Perceptions: Towards a Bicycle Level of Service," *Transportation Research Record 1578*, Transportation Research Board, National Research Council, Washington, DC (1997).
41. Stinson, M., and C. Bhat. "An Analysis of Commuter Bicyclist Route Choice Using a Stated Preference Survey." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2003).
42. Jones, E., and T. Carlson. "Development of a Bicycle Compatibility Index for Rural Roads in Nebraska." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2003).
43. Noel, N., C. Leclerc, and M. Lee-Gosselin. "CRC Index: Compatibility of Roads for Cyclist in Rural and Urban Fringe Areas." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2003a).
44. Hubbard, S., R. Awwad, and D. Bullock. "New Perspective on Assessing Impact of Turning Vehicles on Pedestrian Level of Service at Signalized Intersections." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2007).
45. Chilukuri, V., and M. Virkler. "Validation of HCM Pedestrian Delay Model for Interrupted Facilities," *Journal of Transportation Engineering*, Vol. 131, No. 12, pp. 939–945 (2005).
46. Clark, Z., S. Hubbard, and D. Bullock. "Quantitative Measurement Procedures for Pedestrian Service at Signalized Intersections: A Case Study at a Skewed Intersection." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2006).
47. Lee, J., P. Goh, and W. Lam. "New Level-of-Service Standard for Signalized Crosswalks with Bi-Directional Pedestrian Flows." *Journal of Transportation Engineering*, Vol. 131, No. 12, pp. 957–960 (2005).
48. Muraleetharan, T., et al. "Evaluation of Pedestrian Level-of-Service on Sidewalks and Crosswalks Using Conjoint Analysis." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2004a).
49. Petritsch, T., et al. "Level of Service Model for Signalized Intersections for Pedestrians." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2005).
50. Jensen, S. "Pedestrian and Bicycle Levels of Service on Roadway Segments." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2007).
51. Bian, Y., et al. "Pedestrian Level of Service for Sidewalks in China." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2007).
52. Byrd, J., and V. Sisiopiku. "Comparison of Level of Service Methodologies for Pedestrian Sidewalks." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2006).
53. Muraleetharan, T., and T. Hagiwara. "Overall Level of Service of the Urban Walking Environment and Its Influence on Pedestrian Route Choice Behavior: Analysis of Pedestrian Travel in Sapporo, Japan." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2007).
54. Hummer, J., et al. "User Perceptions of the Quality of Service on Shared Paths." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2005).
55. Patten, R., et al. "Shared Use Path Bicycle Level of Service Procedure." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2005).
56. Petritsch, T., et al. "Pedestrian Level of Service Model for Urban Arterial Facilities with Sidewalks." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2005).
57. Muraleetharan, T., et al. "Method to Determine Overall Level-of-Service of Pedestrians on Sidewalks and Crosswalks Based on

Total Utility Value." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2004b).
58. Sisiopiku, V., X. Zhang, and M. Virkler. "Pedestrian Level of Service and Quality of Operations Assessment Methods." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2002).
59. Landis, B., et al. "Modeling the Roadside Walking Environment: Pedestrian LOS," *Transportation Research Record 1773*, Transportation Research Board, Washington, DC (2001).
60. Miller, J., J. Bigelow, and N. Garber. "Calibrating Pedestrian Level-of-Service Metrics with 3-D Visualization." *Transportation Research Record 1705*, TRB, National Research Council, Washington, DC (2000) pp. 9-15.
61. Chu, X., and M. Baltes. *Pedestrian Mid-block Crossing Difficulty*, National Center for Transit Research, University of South Florida, Tampa, FL (2001).
62. Chu, X., M. Guttenplan, and M. Baltes. "Why People Cross Where They Do, The Role of the Street Environment." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2003).
63. Winters, P. L., and L. E. Tucker. "Searching for Creative Solutions for Assessing Level of Service Equally Across Modes." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2004).
64. Perone, J., et al. "Assessing Hierarchy of Needs in Levels of Service." *FDOT BD 549-1*, National Center for Transit Research, Tampa, FL (2005).
65. Hiatt, R. E. "An Alternative to Auto LOS for Transportation Impact Analysis." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2006).
66. Winters, P., et al. *Assessing Level of Service Equally Across Modes*, Center for Urban Transportation Research, College of Engineering, University of South Florida, Tampa Bay, FL (December 2001).
67. Crider, L., J. Burden, and F. Han. Multimodal LOS: Point Level of Service Project Final Report, Department of Urban & Regional Planning, University of Florida, Gainesville, FL (August 2001).
68. Dowling, R., Florida Intrastate Highway System, Multi-Modal Corridor Level of Service Analysis, Final Report, Florida Department of Transportation, Office of the State Transportation Planner, Systems Planning Office, Tallahassee, FL (June 2001).
69. Phillips, R., J. Karachepone, and B. Landis, Multi-Modal Quality of Service Project, Urban and Regional Planning Department, University of Florida, Gainesville, FL (March 2001).
70. Guttenplan, M., et al. "Multimodal Level-Of-Service Analysis At Planning Level," *Transportation Research Record 1776*, Transportation Research Board, Washington, DC (2001).
71. Guttenplan, M., et al. "Planning Level Areawide Multi-Modal Level of Service (LOS) Analysis." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2003).
72. Trochim, W. *Research Methods Knowledgebase*, A web-based textbook, http://trochim.human.cornell.edu/kb/, Cornell University (2002).
73. Noel, N., C. Leclerc, and M. Lee-Gosselin. "CRC Index: Compatibility of Roads for Cyclist in Rural and Urban Fringe Areas." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2003).
74. Landis, B., et al. "Intersection Level of Service: The Bicycle Through Movement." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2003).
75. Landis, B., V. Vattikuti, and M. Brannick. "Real-Time Human Perceptions: Towards a Bicycle Level of Service," *Transportation Research Record 1578*, Transportation Research Board, Washington, DC (1997).
76. Pecheux, K., M. Pietrucha, and P. Jovanis. "User Perception of Level of Service at Signalized Intersections: Methodological Issues," *Transportation Research Circular E-C018*, Fourth International Symposium on Highway Capacity, Transportation Research Board, Washington, DC (June 2000).
77. Sutaria, T., and J. Haynes. "Level of Service at Signalized Intersections," *Transportation Research Record 644*, Transportation Research Board, Washington, DC (1977).
78. Hall, F., S. Wakefield, and A. Al-Kaisy, "Freeway Quality of Service: What Really Matters to Drivers and Passengers?" *Transportation Research Record 1776*, Transportation Research Board, Washington, DC (2001).
79. Pecheux, K., M. Pietrucha, and P. Jovanis. "User Perception of Level of Service at Signalized Intersections: Methodological Issues," *Transportation Research Circular E-C018*, Fourth International Symposium on Highway Capacity, Transportation Research Board, Washington, DC (June 2000).
80. Sutaria, T., and J. Haynes. "Level of Service at Signalized Intersections," *Transportation Research Record 644*, Transportation Research Board, Washington, DC (1977).
81. Nakamura, H., K. Suzuki, and S. Ryu. "Analysis of the Interrelationship Among Traffic Flow Conditions, Driving Behavior, and Degree of Driver's Satisfaction on Rural Motorways," *Transportation Research Circular E-C018*, Fourth International Symposium on Highway Capacity, Transportation Research Board, Washington, DC (June 2000).
82. Colman, S. "Assessing Arterial Level of Service for Congestion Management Programs: A User Perspective," 1994 ITE International Conference, Institute of Transportation Engineers, Washington, DC (1994).
83. Morpace International, Inc. *TCRP Report 47: A Handbook for Measuring Customer Satisfaction and Service Quality*, Transportation Research Board, National Research Council, Washington, DC (1999).
84. Landis, B. W., et al. "Intersection Level of Service: The Bicycle Through Movement." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2003).
85. Harkey, D., D. Reinfurt, and M. Knuiman. "Development of the Bicycle Compatibility Index," *Transportation Research Record 1636*, Transportation Research Board, Washington, DC (1998).
86. Jones, E., and T. Carlson. "Development of a Bicycle Compatibility Index for Rural Roads in Nebraska." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2003).
87. Noel, N., C. Leclerc, and M. Lee-Gosselin, "CRC Index: Compatibility of Roads for Cyclist in Rural and Urban Fringe Areas." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2003b).
88. Landis, B., V. Vattikuti, and M. Brannick. "Real-Time Human Perceptions: Towards a Bicycle Level of Service," *Transportation Research Record 1578*, Transportation Research Board, Washington, DC (1997).
89. Stinson, M., and C. Bhat. "An Analysis of Commuter Bicyclist Route Choice Using a Stated Preference Survey." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2003).
90. Miller, J., J. Bigelow, and N. Garber. "Calibrating Pedestrian Level-of-Service Metrics with 3-D Visualization." *Transportation Research Record 1705*, Transportation Research Board, National Research Council, Washington, DC, pp. 9-15 (2000).

91. Landis, B., et al. "Modeling the Roadside Walking Environment: Pedestrian LOS," *Transportation Research Record 1773*, Transportation Research Board, Washington, DC (2001).
92. Chu, X., and M. Baltes. *Pedestrian Mid-block Crossing Difficulty*, National Center for Transit Research, University of South Florida, Tampa, FL (2001).
93. Nadeir, J., and B. Raman, "Design Consideration in Simulating Interactive Virtual Pedestrian Environments." Presented at the Transportation Research Board Annual Meeting, Washington, DC (2002).
94. United States Census, Ranking Tables for Population of Metropolitan Statistical Areas, http://www.census.gov/population/www/estimates/metrodef.html) (2004).
95. Davison, A., and D. Hinkley. *Bootstrap Methods and their Application*. Cambridge, UK: Cambridge University Press (1997).
96. Searle, S.R. *Linear Models for Unbalanced Data*. New York: Wiley (1987).
97. Agresti, A. *Categorical Data Analysis*, Second Edition, John Wiley & Sons, Hoboken, NJ (2002).
98. Furth, P., and T. Miller. "Service Reliability and Hidden Waiting Time: Insights from AVL Data," *Transportation Research Record 1955*, Transportation Research Board, Washington, DC (2006).
99. Balcombe, R. (editor). "The demand for transport: a practical guide," *Report TRL593*, TRL Limited, Wokingham, UK (2004).
100. Pratt, R. *TCRP Research Results Digest 61: Traveler Response to Transportation System Changes—An Interim Introduction to the Handbook*, Transportation Research Board, Washington, DC (2003).
101. Kittelson & Associates, Inc., et al. *TCRP A-23A Bus Rapid Transit Practitioners Guide, Final Draft* (2006).
102. St. Jacques, K., and H. Levinson. *TCRP Report 26: Operational Analysis of Bus Lanes on Arterials*, Transportation Research Board, National Research Council, Washington, DC (1997).
103. Newell, G. "Dispatching Policies for a Transportation Route," *Transportation Science*, Vol. 5, pp. 91-105 (1971).
104. Mohring, H. "Optimization and Scale Economies in Urban Bus Transportation," *American Economic Review*, Vol. 62, No. 40, pp.591-604 (1972).
105. Balcombe, R. (editor). "The demand for transport: a practical guide", *Report TRL593*, TRL Limited, Wokingham, United Kingdom (2004a).
106. Balcombe, R. (editor). "The demand for transport: a practical guide", *Report TRL593*, TRL Limited, Wokingham, United Kingdom, Table 8.9, non-London commuter values (2004b).
107. Turnquist, M. "A Model for Investigating the Effects of Service Frequency and Reliability on Bus Passenger Waiting Times," *Transportation Research Record 663*, Transportation Research Board, National Research Council, Washington, DC (1978).
108. Outwater, M., and W. Charlton. "The San Francisco Model in Practice: Validation, Testing, and Application," presented at the Innovations in Travel Modeling 2006 Conference, Austin, Texas (May 21-23, 2006).
109. Balcombe, R. (editor). "The demand for transport: a practical guide," *Report TRL593*, TRL Limited, Wokingham, United Kingdom (2004).
110. *The Highway Capacity and Quality of Service Manual*, Transportation Research Board, National Research Council, Washington, DC (2000).
111. *2002 Quality/Level of Service Handbook*, Florida Department of Transportation, Office of the State Transportation Planner, Systems Planning Office, Tallahassee, FL, (http://www11.myflorida.com/planning/systems/sm/los/) (January 7, 2003).
112. Petritsch, T., et al. "Level-of-Service Model for Pedestrians at Signalized Intersections," *Transportation Research Record 1939*, Transportation Research Board, Washington, DC (2005).
113. *The Highway Capacity and Quality of Service Manual*, Transportation Research Board, Washington, DC, pg. 18-7 (2000).

APPENDIX A

Subject Data Collection Forms

Circle the letter grade that most represents your perceived service.
***A* = highest rating   *F* = lowest rating**
Please view the entire video clip before selecting a rating.

Pedestrian Presentation

Clip Number	Perceived Service Rating					
Practice Clip #212	A	B	C	D	E	F
#201	A	B	C	D	E	F
#226	A	B	C	D	E	F
#225	A	B	C	D	E	F
#208	A	B	C	D	E	F
#219	A	B	C	D	E	F
#228	A	B	C	D	E	F
#211	A	B	C	D	E	F
#215	A	B	C	D	E	F
#229	A	B	C	D	E	F
#222	A	B	C	D	E	F

Circle the letter grade that most represents your perceived service.
***A* = highest rating *F* = lowest rating**
Please view the entire video clip before selecting a rating.

Bicycle Presentation

Clip Number	Perceived Service Rating					
Practice Clip #326	A	B	C	D	E	F
#319	A	B	C	D	E	F
#308	A	B	C	D	E	F
#306	A	B	C	D	E	F
#309	A	B	C	D	E	F
#320	A	B	C	D	E	F
#318	A	B	C	D	E	F
#304	A	B	C	D	E	F
#324	A	B	C	D	E	F
#321	A	B	C	D	E	F
#329	A	B	C	D	E	F

Circle the letter grade that most represents your perceived service.
***A* = highest rating *F* = lowest rating**
Please view the entire video clip before selecting a rating.

Automobile Presentation

Clip Number	Perceived Service Rating					
Practice Clip #5	A	B	C	D	E	F
#20	A	B	C	D	E	F
#56	A	B	C	D	E	F
#10	A	B	C	D	E	F
#51	A	B	C	D	E	F
#14	A	B	C	D	E	F
# 2	A	B	C	D	E	F
#62	A	B	C	D	E	F
#63	A	B	C	D	E	F
#52	A	B	C	D	E	F
#15	A	B	C	D	E	F

104

Please circle the choice which best describes your characteristics.

1. Your age group: **18-35 years of age** **36-60 years of age** **60 and up years of age** 2. Gender: **Male** **Female**

3. Number of vehicles in your household: **0 1 2 3 or more** 4. Number of bicycles in your household: **0 1 2 3 or more**

5. Employment status: **Employed** **Unemployed** **Homemaker** **Retired**

6. Your primary residence is: **A. Single-family detached home** **B. Apartment/duplex/townhouse/condominium**
C. Group quarters such as a college dormitory or independent living facility **D. Other, please specify:** ________________

7. Do you rent or own your home? **A. Rent B. Own** 8. What is your primary residence/home zip code? ______________

9. If you are currently employed, what is your workplace zip code (or city of location): __________________________

10. How often do you walk more than two blocks a week for a non-recreational trip (for example, walk to work, walk to school, walk to a store)?
A. Never B. Less than once a month C. About once a week D. More than once a week but not every day E. At least once a day

11. How often do you walk more than two blocks a week for a recreational trip or for exercise?
A. Never B. Less than once a month C. About once a week D. More than once a week but not every day E. At least once a day

12. How often do you use a bicycle for a non-recreational trip (for example, ride a bike to work, ride a bike to a store)?
A. Never B. Less than once a month C. About once a week D. More than once a week but not every day E. At least once a day

13. How often do you use a bicycle outside of a gym for a recreational trip or for exercise?
A. Never B. Less than once a month C. About once a week D. More than once a week but not every day E. At least once a day

14. How often do you use transit (bus, subway, train)?
A. Never B. Less than once a month C. About once a week D. More than once a week but not every day E. At least once a day

15. How often do you use a car?
A. Never B. Less than once a month C. About once a week D. More than once a week but not every day E. At least once a day

16..What is your usual means of travel to work? **A. Auto, drive alone** **B. Auto, carpool** **C. Transit (bus, train, ferry or other)** **D. Walk**
E. Bike **F. Other:** ________________________

APPENDIX B

Study Protocol

PROTOCOL:

1. There are no direct benefits to the participants. The study is likely to yield general information about driver perception of quality of service of roadways. We will use the drivers' appraisal of streets as depicted on video clips to understand driver perception. Currently, there is no recognized methodology that measures the quality of service provided by transportation facilities from the drivers' perspective. We will recruit participants in four representative locations in the US through personal contact and limited advertising.
2. We will ask participants to read and sign an informed consent sheet (a representative copy is attached, which will be replaced by the approved informed consent form when approved by the HSRB). Participants who elect to be paid will receive a $75 cash payment upon completion of the study. Participants will be paid through the grant. Payment is required to compensate for the inconvenience and time required to participate in the study. Student participants will receive course credit.
3. No minors will be involved. Participants will be at least 18 years of age.
4. Participants will view a series of video clips using a large screen projection system and an LCD projector. The test will be conducted in two parts. In part 1 of the study travelers will be prompted to rate their overall level of satisfaction with the facility on an A-F scale. After viewing all of the clips (total viewing time less than 120 minutes with 2-3 10 minute breaks) part 2 of the study will begin. Part 2 of the study is a focus group that will involve a portion (6-7 participants) of the participants. The purpose of part 2 is to learn more about specific features or conditions that relate to driver ratings of performance as portrayed in the video clips.
5. Each subject will be assigned a unique ID number. However, the information connecting a person's ID to their name will be stored in a separate file until data collection for that subject is completed. At that time, person-identifiable information will be discarded, as it will no longer be needed. Thus, no person-identifiable data will be maintained once data collection has been completed.
6. This research poses no more risk than that which would ordinarily be encountered in daily life. The expected benefit of this research is an increase of knowledge about the factors underlying driver satisfaction with the quality of service on urban arterials.
7. The rating forms will be secured at the George Mason University Department of Civil, Environmental, and Infrastructure Engineering (identified by subject id number and date), and will not be shown to individuals or agencies outside of the research team. The forms will be stored in a secure, locked private office and labeled by subject number, date and location. Participants' names will not be written on the forms. The data on the forms will be entered on a computer spreadsheet, but subjects' names will not be entered in the spreadsheet.
8. There is no need to misinform, or to not inform subjects about the true nature of the project.

Informed Consent Form

The purpose of this project is to obtain driver opinion about roadway conditions and features in a multimodal environment. In the study, you will be asked to watch several video clips. Upon the completion of each video clip, you will be given the opportunity to write down your rating of the clip. Once you are finished rating a clip, the next clip will be shown and the process will be repeated. After about one hour, we will take a break and questions will be entertained. After the break, we will resume watching clips and you will rate the clips. The project can benefit drivers indirectly by helping traffic engineers further understand the features and factors on roadways that are important to the driving public. There are no direct benefits to you; however, the project may help traffic engineers further understand the features and factors on roadways that are important to the driving public.

The entire sessions should not last longer than three hours. Upon completion of the clip ratings, you will be asked to turn in your rating sheets. We will then provide you with an honorarium. At that time, we will answer any questions you may have about the project.

Please note the following:

- Your participation is voluntary. You may discontinue participation at any time without penalty or loss of benefits to which you are otherwise entitled.
- You will be provided with a $75 honorarium in recognition of the value of your contribution to the study.
- All data collected in this study are confidential. All surveys will be discarded after the data analysis.

This study is being directed by Aimee Flannery of the Civil, Environmental, and Infrastructure Engineering Department at George Mason University. Dr. Flannery may be contacted by email at aflanner@gmu.edu or at 703-993-1738 should any question arise. You may also contact the George Mason University Office of Sponsored Programs at 703-993-2295 if you have any questions or comments regarding your rights as a participant in this research. The project has been reviewed according to the George Mason University procedures governing your participation in research. The Transportation Research Board is funding this study.

I have read this form and agree to participate in the study.

Consent Signature: ____ Date: _____________

Witness Signature: ____ Date: _____________

George Mason University
Human Subjects Review Board

Application for Human Subjects Research Review

For OSP Use Only _GMU_
Protocol No. ___________ Proposal No. __________
Classified : ☐Exempt ___☐Non Exempt ☐Expedited
Signature Date

Federal Regulations and George Mason University policy require that all research involving humans as subjects be reviewed and approved by the University Human Subjects Review Board (HSRB). Any person, (GMU faculty member, staff member, student, or other person) wanting to engage in human subject research at or through George Mason University must receive written approval from the HSRB before conducting research. Human Subject is defined as a living individual about whom an investigator conducting research obtains a) data through intervention with the individual, or b) identifiable private information or records. Research is the systematic investigation, including research development, testing and evaluation, designed to develop or contribute to knowledge. Approval of this project by the HSRB only signifies that the procedures adequately protect the rights and welfare of the subjects and should not be taken to indicate University approval to conduct the research.

Please complete this cover page AND provide the Protocol information requested on the back of this form. Forward this form and all supporting documents to the Office of Sponsored Programs, Compliance Department, MS 4C6. **If you have any questions please feel free to contact the Compliance Department at 703-993-4121**

Project Title: NCHRP 370 Phase II Study 1 Multimodal Urban Street Level of Service

Required Data	Principal Investigator	Co-Investigator/Student Researcher
Name	Aimee Flannery, Ph.D., P.E.	
Department	Civil, Environmental, and Infrastructure Engg	
Mail Stop	4A6	
Phone	3-1738	
E-mail	aflanner@gmu.edu	
Status	◀ Faculty/Staff ☐ Other ______________________	☐ Doctoral Dissertation ☐ Masters Thesis ☐ Class Project(Specify Grad or Under Grad)

I certify that the information provided for this project is correct and that no other procedures will be used in this protocol. I agree to conduct this research as described in the attached supporting documents. I will request and receive approval from the HSRB for changes prior to implementing these changes. I will comply with the HSRB policy for the conduct of ethical research. I will be responsible for ensuring that the work of my co-investigator(s) /student researcher(s) complies with this protocol.

Aimee Flannery

Principal Investigator Signature **4/07/06 Date**

ABSTRACT: The abstract must appear here. Use a separate sheet for continuation. Refer to the guidelines on the reverse side.[4]
The project's goal is to obtain driver opinions and perceptions of the quality of service on urban streets, defined here as signalized, multi-lane highways with cross-streets placed ½ to 1 mile apart. Drivers' perceptions of service can be useful to traffic engineers in the design and improvement of roadways and can be used to supplement the Highway Capacity Manual.

The information obtained in the project will provide the academic and practitioner with a better understanding of driver perceptions about roadway quality of service. The project proposes to ask licensed drivers to view video taped segments of urban streets and rate the quality of service on the streets presented on the video. The drivers will complete a short rating form for each segment shown. The video tapes will be projected on a large screen in a classroom setting. Approximately 140 drivers are required for this project. The subjects will be licensed drivers aged 18-65 years of age. The criterion for inclusion for the subjects is a valid driver's license and willingness to participate in the study. Drivers will be paid for their participation or receive class credit.

The proposed research will involve the following **(check all that apply):**

VULNERABLE POPULATION:	PERSON IDENTIFIABLE DATA:	RESEARCH DESIGN:
__Fetuses/Abortuses/Embryos	__Audio taping	__ Questions on harm to self or others
__Pregnant women	__Video taping	__ Questions on illegal behavior
__Prisoners	__ Data collected via email	__ Deception
__Minors	__ Data collected via internet	__ Human/computer interaction
__Mentally retarded/disabled	__ Confidential electronic records	__ Collection and/or analysis of secondary data
__Emotionally disabled	__ Coded data linked to individuals	OUTSIDE FUNDING:
__Physically disabled	__ Human biological materials	Source ____Transportation Research Board______________________
__Psychology undergrad pool		
__Other:		

Revised March 2005

ABSTRACT

1. Describe the aims and specific purposes of the research project and the proposed involvement of human participants.
2. Describe the characteristics of the intended sample (number of participants, age, sex, ethnic background, health status, etc).
3. Identify the criteria for inclusion or exclusion. Explain the rationale for the involvement of special classes of participants (children, prisoners, pregnant women, or any other vulnerable population.
4. Describe your relationship to the participants if any.

PROTOCOL—Involving Human Participation

1. If there are direct benefits to the participants, describe the direct benefits and also describe t he general knowledge that the study is likely to yield. If there are no direct benefits to the participants, state that there are no direct benefits to the participants and describe the general knowledge that the study is likely to yield.
2. Describe how participants will be recruited. Note that all advertisements for participants must be submitted for review for both exempt and non-exempt projects.
3. Describe your procedures for obtaining informed consent. Who will obtain consent and how will it be obtained. Describe how the researchers will ensure that subjects receive a copy of the consent document.
4. State whether subjects will be compensated for their participation, describe the form of compensation and the procedures for distribution, and explain why compensation is necessary.

   State whether the subjects will receive course credit for participating in the research. **If yes**, describe the nonresearch option for course credit for the students who decide not to participate in the research. The nonresearch option for course credit must not be more difficult than participation in the research. Information regarding compensation or course credit, should be outlined in the Participation section of the consent document.
5. If minors are involved, their active assent to the research activity is required as well as active consent from their parents/guardians. This includes minors from the Psychology Department Undergraduate Subject Pool. Your procedures should be appropriate to the age of the child and his/her level of maturity and judgment. Describe your procedures for obtaining active assent from minors and active consent from parents/guardians. Refer to the Guidelines for Informed Consent for additional requirements if minors from the Psychology Subject Pool are involved.

6. Describe what participants will be asked to do. Include an estimate of the time required to complete the procedures.
7. Describe how confidentiality will be maintained. If data will be collected electronically (e.g. by email or an internet web site), describe your procedures for limiting identifiers. Note that confidentiality may have to be limited if participants are asked questions on violence toward self or others or illegal behavior. Contact the Office of Sponsored Programs for assistance.
8. Describe in detail any potential physical, psychological, social, or legal risks to participants and why they are reasonable in relation to the anticipated benefits. Where appropriate, discuss provisions for ensuring medical or professional intervention in case participants experience adverse effects. Where appropriate, discuss provisions for monitoring data collection when participants' safety is at risk.
9. If participants will be audio-or video-taped, discuss provisions for the security and final disposition of the tapes. Refer to #2 of the Guidelines for Informed Consent.
10. If participants will be misinformed and/or uninformed about the true nature of the project, provide justification. Note that projects involving deception must not exceed minimal risk, cannot violate the rights and welfare of participants, must require the deception to accomplish the aims of the project, and must include a full debriefing. Refer to #8 of the Guidelines for Informed Consent.

INFORMED CONSENT: Provide appropriate Proposed Informed Consent document(s).
See Guidelines for Informed Consent and Model Informed Consent Document for additional information.

INSTRUMENTS: Submit a copy of each instrument/tool you will use and provide a brief description of its characteristics and development. Submit scripts if information and/or questions are conveyed verbally.

APPROVAL FROM COOPERATING INSTITUTION/ORGANIZATION:
If a cooperating institution/organization provides access to its patients/students/clients/ employees/etc. for participant recruitment or provides access to their records, submit written evidence of the institution/organization human subjects approval of the project.

Note: If research involves use of existing records, please see guidelines on following page.
Revised March 2005

PROTOCOL—Involving Existing Records

(For the study of existing data sets, documents, pathological specimens, or diagnostic specimens.)

1. Describe your data set.
2. Provide written permission from the custodian of the data giving you access for research purposes at George Mason University if the data set is not publicly available.
3. Describe how you will maintain confidentiality if the data set contains person identifiable data.
4. Describe what you are extracting from the data set.

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation

Response to Comments from Bike Bakersfield (Dated January 22, 2012)

Thank you for your comments on the project.

Response to comment #1: The adequacy of the air quality and environmental justice analyses were addressed as responses to the Bike Bakersfield January 4, 2012, comment letter (response to comment #1). In summary, the current bike usage of State Route 58 is not substantial enough to alter the analysis in the draft initial study/environmental assessment. Even with the shoulders, this route has limited usage (between 0 and 4 bicyclists) based on the bike counts done as part of the responses to comments for this document (see response to comment #3, of the January 4, 2012, letter on page 632 of this final environmental document). The number of trips is too low to change the results of any of the analysis.

Response to comment #2: As indicated in the response to the Bike Bakersfield comments from January 4, 2012, the Federal Highway Administration policies regarding incorporation of bicycling and walking facilities into all transportation projects, unless exceptional circumstances exists, is noted. The City of Bakersfield and Kern County considered this point. The exceptional circumstances do apply for State Route 58. The decision not to reduce widths of all the travel lanes and provide a bike lane was because (1) State Route 58 is a designated truck route and carries a high volume of trucks; (2) the posted speed limit east of Mohawk Street is 50 miles per hour; (3) the median is a raised object next to the inside travel lane; and (4) there are a large number of driveways that take direct access from State Route 58. These considerations, together with the fact that there are alternative designated bike routes on parallel roads, were used when making the decision not to provide a bike lane on State Route 58.

Response to comment #3: It is recognized that having an effective alternative to motorized transportation can provide air quality benefits. To achieve that goal, the City of Bakersfield has worked to develop bike routes throughout the city. As indicated in the response to the Bike Bakersfield January 4, 2012, comments, the *Metropolitan Bakersfield General Plan* has designated bikeways on Brimhall Road and Hageman Road that run parallel to State Route 58. These parallel roadways provide more suitable routes because they carry less traffic and fewer trucks. Connecting bikeways from State Route 58 to the bikeways on both Brimhall Road and Hageman Road can be made via Allen Road, Calloway Drive, and Coffee Road. Additionally, though Mohawk Street currently ends at State Route 58, there are plans to extend Mohawk Street through to Hageman Road.

Comment from Planning Commission Meeting Transcript 1/5/12

BAKERSFIELD, CALIFORNIA

PLANNING COMMISSION MEETING

ROSEDALE HIGHWAY WIDENING PROJECT

PUBLIC HEARING

January 5, 2012

Transcribed by: Robin Saldana

SYLVIA MENDEZ & ASSOCIATES
Certified Shorthand Reporters
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CERTIFIED COPY

CHAIRMAN HADDOCK: Thank you. It's my pleasure to call to order the Planning Commission meeting of December -- no -- of January 5, 2012.

Madam Clerk, can you call the roll, please.

THE CLERK: Commissioner Haddock.

CHAIRMAN HADDOCK: Here.

THE CLERK: Commissioner Kirschenmann.

COMMISSIONER KIRSCHENMANN: Here.

THE CLERK: Commissioner Lomas.

COMMISSIONER LOMAS: Here

THE CLERK: Commissioner Tkac.

(No response.)

THE CLERK: Commissioner Wade.

COMMISSIONER WADE: Here.

CHAIRMAN HADDOCK: Please, stand for the Pledge of Allegiance. Thank you.

Before we proceed, I request you turn off all cellular telephones and personal pagers as a courtesy to others and to limit interference to our audio and video broadcast.

For safety reasons and as a courtesy to others, no signs are allowed in Council chambers. Also, please, be courteous in the use of any still cameras and video equipment.

Thank you for your cooperation....

(End of requested portion.)

(Begin next requested portion.)

....Under Item F. It's now time for the public hearing portion of the agenda. Before I open the public hearings, I want to state the presentation policy.

We will hear statements from those who wish to speak on the items scheduled for public hearing. You may pose questions during your statement, but they will not be answered until the public hearing is closed.

If you have written comments that are longer than your verbal statement, give it to the clerk, and she will provide copies to the Commission.

Again, please, be courteous to others who wish to speak and do not repeat the remarks of previous speakers.

Under Item 1, Draft Initial Study with Proposed Mitigated Negative Declaration/Environmental Assessment for Rosedale Highway Widening Project.

Mr. Eggert, could your staff tell us about this one?

MR. EGGERT: Yes, thank you. I'll just be real brief.

This is a kind of a unique thing. Usually the Commission hears the environmental public comments with projects like General Plan amendments and zone changes, but you're going to be seeing, in some instances, projects from other departments such as TRIP and probably in the future the Water Department where we use the Planning Commission as the public forum to take public comments. And so this is the first. I don't recall if we've had one of these for quite some time.

So just a kind of a brief introduction as to what's happening, and at the end we treat it just like any of the other CEQA documents is that we will take public comments, and then we will refer those back to staff for preparation of the final.

So at this time I'd like to introduce Ted Wright with the T.R.I.P. program to brief you on the project.

Thank you.

MR. WRIGHT: Thank you. Thank you, Jim. Thank you, Commissioner Haddock and planning members of the Commission. Thanks for allowing us to address you tonight and give you a brief overview of this project.

The Rosedale Highway Widening Project is one of the Thomas Road Improvement Program projects primarily funded with federal earmark funds. The City is the sponsoring agency, even though much of this route is -- or a lot of it is in the county outside the corporate limits of the city. The City is the sponsoring agency because the City is managing the earmarks.

And so, therefore, the City is the CEQA lead agency for this project, also, because the project is in the process of relinquishment -- part of Rosedale Highway is being relinquished to the City and County -- so, otherwise, Caltrans might be the lead CEQA agency. But Caltrans is the lead NEPA agency, which is the -- CEQA is the California Environmental Quality Act which would be kind of the state and local part of the environmental approval. NEPA is the National Environment Policy Act which is the federal side of the environmental approval. And because we have federal funds and this project, as with all T.R.I.P. projects, we are required to get both approvals, CEQA and NEPA.

Caltrans -- and the City will also be holding another meeting, and I will get to it momentarily for -- this is a CEQA hearing tonight -- for the NEPA hearing and another opportunity for comments to be received.

So why are we here tonight? To present to you and the public the Rosedale Highway Widening

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Project, provide some preliminary design diagrams showing the project, and briefly discuss the need for the project.

We're also here to receive oral and written comments. There are written comment forms in the lobby of Council chambers here as well as a deposit box for those comments. Comments can also be mailed to Bryan Apper, here's the address, Senior Environmental Planner in Fresno, or e-mail at the address at the bottom. And I believe these addresses and e-mails are on the comment forms, also; so you don't have to write them down. Comments must be received by the 24th of this month, January 24, 2012, and there is a sign-in sheet in the lobby. Anybody who would like to be informed of this project, we'd encourage a sign in into the -- on this sheet so we can get them up to date.

As I indicated, there will be another meeting next Tuesday, a public meeting at the Connection Assembly of God Church at 7220 Rosedale Highway from 4:00 to 7:00 p.m. This meeting will be primarily for the NEPA side of the approval. It is a different layout than this one. This one is a more of a formal public hearing. The meeting next week is more of a open-house-type of format. There will be a lot of staff there, a lot of exhibits. There won't be any presentation, per se, made, but there will be more exhibits and more availability for questions to be responded to and asked.

There will be -- a court reporter is here tonight. There will be a court reporter there if somebody wishes to make oral comments for the record as well as written comments will be accepted there, as well.

So I know most of you are aware of T.R.I.P., but if any in the audience is not, Thomas Roads Improvement Program was named in honor of Congressman William Thomas who is the primary force in obtaining federal earmarks in the amount of about 630 million in the metropolitan area. And T.R.I.P. is a cooperative effort between the City of Bakersfield and the County of Kern, Caltrans, and the Kern Counsel of Governments, and many of us are housed -- colocated in the office down the street on Truxtun here.

The purpose and need for the Rosedale Highway Widening Project is -- the purpose is to reduce existing and future traffic congestion on 58 -- State Route 58 between Allen and State Route 99 as well as to improve local and regional east/west traffic flow and the needs is to serve existing and projected travel demand along that state route as well as to provide access to jobs and commercial areas both within the city and county along that route.

The project limits for this widening project are from approximately State Route 99 at the east end to Allen Road at the west end. That's about 5.6 miles if my math is right there.

As I indicated earlier, a portion of this route is under relinquishment. Relinquishment should probably be completed either next month, February, or March. "Relinquishment" means Caltrans, basically, turns the route over -- the road over to the City and the County to operate and maintain. And there was a reason we did this that I'll get to in just a moment here. But they will maintain the portion of the project from State Route 99 to Mohawk. That will remain under Caltrans' control and operation.

So the project will increase Rosedale Highway from four lanes to six lanes, and there are two cross sections there, the cross section from 99 to Mohawk that will remain under Caltrans' operation and maintenance, meets their standards. So it's a wider footprint. You can see overall it's about 116 feet, but actually the pavement width where the curb line is out about eight feet on either side wider than the portion from Mohawk to Allen, which is in the top photo there. That top photo is per local standards, and that's one of the reasons -- the primary reason, really -- the only reason we went after -- pursued relinquishment of this route is so that we could construct this portion of the project with -- to local standards, which greatly lessened the impacts to adjacent businesses and property owners. It requires about eight feet less on either side of -- eight feet of actual roadway less. The right of ways is the only -- about three feet on each side, the right of way being the property.

You can see in this -- in this cross section here, there's -- behind this sidewalk, there's about six feet on either side in the top photo in the local standard. Yet there's only about one foot behind the sidewalk in either side with the State standards. So that's where that differential comes from.

For the project there's actually only one build alternative and one no-build alternative. So there's not -- as opposed to some builds like Centennial that I know you're aware of, there were several build alternatives. This project has just got one alternative. And the reason for that is it minimized -- by going straight down the center and widening each side, it minimized the impacts overall. We're basically dealing with sliver takes. And the attempt was, again, was to minimize, as much as possible, the right of way impacts of widening of the street.

There are three phases to this project. The first phase is from 99 to Calloway and, again, it includes both the cross sections you just saw. That first mile, the eastern mile is Caltrans' standard, the wider, and those subsequent three miles, I believe, is local standards.

Phase 2 is -- excuse me -- goes from Calloway to Allen Road, and the construction of that phase is going to be dependent upon funding and where we're at when we get here. The same earmarks are also funding the 24th Street Project. And so we'll -- we'll be going forward with Phase 1 immediately or right away, and the time lines we'll show you in a minute.

Phase 2 will probably be delayed some, depending upon funding as we get further in the program.

This third phase, which is the grade separation at Landco -- it's the San Joaquin Valley Railroad there, just west of Landco, and that is a future phase. That's 10 to 15 years out. It's being environmentally cleared with the current project. But it's not -- right now, there's not enough funding for that grade separation. So we're trying to get ourselves in a position, then, to pursue different funding alternatives for that by getting environmental clearance now.

Rosedale Highway is not listed. It's a little hard to see on here. It's right there in the orange. It's not listed on the Bikeway Master Plan of the General Plan. So while bikes are not prohibited from using the route, there are not separate designated bike lanes as a part of this project.

This is just a list of some of the technical studies that were done to develop the environmental document for this. I'm not going to read each one, but probably one of the biggest ones is the bottom one there, the Traffic Operations Report. And that's what this project is all about, is relieving congestion.

I think you're familiar with the levels of service for roadways. Level of Service A is just like grade school. "A" is good, and "F" is bad. "A" has no delays and then progressively gets worse down to "F" where you have significant delays, traffic flow has brief periods of stop and go, and it -- it -- a lot of delay.

So for the Rosedale Highway Widening Project, the current level of service today is shown on this slide here. Green is Level of Service A, B, or C, which is basically pretty good; yellow is Level of Service D, which is getting worse; and orange E and F, being the worst at Level of Service F.

And you can see where some of the bad spots are today. The top picture is the morning peak hour, the morning commute time, and the bottom is the evening commute time. And I would say, it seems like to me, there's a lot more red up there when I go through than this drawing shows. But this is what the study indicates today.

If we do nothing -- if we do not build the project and do no improvements, in 2035, which is the design year, whenever you have a project to be federally funded, you are required to show in 20 years you're -- still have -- it still operates well for traffic. And so we're using 2035 as the design year. So without any project at all, you can see all the red on this -- at least those of us that aren't color blind -- you can see all the red circles on there, which indicates Level of Service F, a lot of stop and go, much worse than it is today.

With the project, with the added lane and the

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improvements at the intersections, you can see it's vastly improved, mostly all green with a little yellow and one or two reds.

So what's next? We hope to complete the environmental document by this summer of 2012. That would be the final. This is the draft document today. Have the final certified this summer, and then we would go immediately into final design, preparation of construction plans, and the acquisition of the right of way. That's projected to take nearly two years to complete. So by spring of 2014 we hope to be completed with that and then by summer of 2014 begin construction. We're currently anticipating about a year for that construction. So this would be Phase 1. Again, Phase 2 could follow this. It's just going to be dependent upon funding as we get further into this and how much Phase 1 costs, and we are working, generally, east to west on this.

So the final phase, Phase 3, there's about a 10-year break there, that little break in the line, would be anticipating beginning construction on that grade separation in 2025, completing about two years later. Obviously, if funding became available earlier, then we'd construct it earlier.

So as indicated earlier, there will be

another -- another open-house-style meeting next week, next Tuesday the 10th at the Connection Assembly of God Church there on Rosedale Highway from 4:00 to 7:00. It is a less formal public hearing. There will be more staff available. We'll have exhibits -- boards for the public to look at, walk around, and a lot of staff there to talk to. They can still provide formal written comments that will be received as well as oral comments. As I indicated, the court reporter will also be there.

For additional information on the project, Paul Pinada is from Caltrans; his phone number is there, 326-3416, or by e-mail at Paul_Pineda.ca.gov. And further information on the Thomas Roads Improvement Program, Janet Wheeler is our public information leader with a phone number there. You can also go to our Web site at www.bakersfieldfreeways.us where you can actually download the environmental document. We have got a copy of it here. It's a fairly large, thick document. But you can download that off the Web site, as well.

So I'd like to thank you for the opportunity to address you tonight, and I'd ask that you open the public hearing and receive comments. All agency and public comments received become part of the public record. So the project development team will address those comments and provide written responses as part -- and be incorporated into the final environmental document and will be included in there.

The comment and response process includes selecting, normally, a preferred alternative. In this case we have one build alternative and one no-build alternative. So the process, I guess, is a little bit simpler from that standpoint of the -- you know, it's either a "yes" or "no."

Comments will be received until January 24th of this year. So that would be a highlight date to make sure -- and, again, that is either by e-mail or by regular mail or by oral, either here or at the meeting next Tuesday.

So, with that, thank you and turn it back to, I guess, the opening of the public hearing.

CHAIRMAN HADDOCK: Thank you.

Mr. Eggert, any other comments from staff or --

MR. EGGERT: Just a couple as far as procedure. Once you're -- once you have taken all the public comments, the commissioners also have the ability to make comments for the record, as well, since we did provide you with copies of the environmental document, the draft.

And then, also, for those in the audience and those who may be watching, if comments do come to the Planning Department, which were not listed on that slide, don't fret. We will make sure anything that we receive will also be forwarded to Ted's office for inclusion into their final document. So I think once in a great while we do have things come our way because people don't -- they either forget or they don't know where to send it. So we will make sure those comments do get to the appropriate group.

Thank you.

CHAIRMAN HADDOCK: What's the best -- if they do give information to the Planning Department, what's the best way to get it there?

MR. EGGERT: We do have our Web site and -- which is www.bakersfieldcity.us. And then our mailing address is 1716 Chester Avenue or even if somebody drops it by. And, again, as long as we get it before the 24th, we can make sure we get it forwarded to the T.R.I.P office.

CHAIRMAN HADDOCK: Great. Thank you, Mr. Eggert.

At this time I will open the public hearing and ask if there's anyone who wishes to address the adequacy of the proposed Negative Declaration Environmental Assessment.

As you step to the microphone, can you, please, identify yourself and proceed with your comments and questions.

MR. WILSON: My name is John Wilson. I'm an engineer here to Bakersfield. I'm here representing Independent Pipe and Steel. They're 5303 Rosedale Highway. We've prepared several pages of comments regarding the documents, which I'll leave here.

Generally, their largest concern is they're at Parker -- southeast corner of Parker and Rosedale. They've been there for almost 20 years. They have a very large pipe and steel business. They have approximately 50 to 75 large trucks a day go in and out of Rosedale Highway on Parker. With that median island being closed, the biggest concern is the trucks now have to travel east to go west. 80 percent of their trucks go west out of the facility. So in order to go west, they have to go approximately three quarters of a mile to the east, make a left on Gibson, go down through Fairhaven, come down back onto the highway. 1

The easiest way to access their site after the median is closed is 99 to Olive Drive, Olive Drive to Fruitvale, Fruitvale, and then easterly on Rosedale. It's -- for 50- to 75 percent of their trucks, it's backwards. 80 percent of the trucks come from the east, and 20 percent of the trucks come from the west. So the median closure is not only their problem but the other nine businesses through that area. So I'll leave this here. I'm not going to go through the whole thing. 1 cont.

Thank you very much.

CHAIRMAN HADDOCK: Thank you, Mr. Wilson.

Is there anyone else in the audience who would like to make a comment? And I'll say this over and over again.

Please identify yourself and proceed.

MR. JONES: My name is David Jones. I'm a resident off of Rosedale and Renfro. The comment I want to make is on the way of the alternatives for the mitigated project were chosen. It basically states on Page 19 that they looked at extending it four lanes past Allen and all the way out to 43 and to lesser extents than that. 2

And then one of the reasons they didn't continue with that alternative was that their traffic studies showed the improvements east of Allen Road would not be needed until after 2035. And they base

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that on their Level of Service Analysis which has some big flaws in it.

Back on Page 9, they're showing some of the traffic counts for existing, 2015, and 2035 for Jenkins -- between Jenkins and Allen Road. They're showing an 11 percent increase between the existing, between 2011 to 2015. But the level of service that they have on the next page shows that intersection going from a "C" to an "F" with 11 percent increase.

Then between 2015 and 2035, they have a 24.2 percent increase and show that same intersection but no improvements, improving from "F" to a "C" in 2035. Then when they do the alternative analysis, they looked at 2035. They say, "It's a 'C.' We don't need to do anything." Well, there's a mistake in there somewhere. And since there's no actual traffic counts associated with the level of service statements that are available on the pages I looked at -- I might have missed them -- but I couldn't see any other numbers for that actual build/no-build scenarios for some of those intersections. 2 cont.

So they're, basically, showing that, in their table on Page 11, Renfro and Jenkins getting worse in 2015, no improvements being made, traffic increasing, like I said, from that 2015 to 2035, probably about

25 percent. And all of a sudden it's going to be a "C" level. And that's how they threw out the alternative there.

So my point here is I think that there was another valid alternative that should have been analyzed in this report. They might not still have done it. There might have been other reasons. But I don't think they did a good job. I don't think they did a complete job of satisfying the alternative requirements under CEQA. 2 cont.

CHAIRMAN HADDOCK: Thank you, Mr. Jones.

Is there anyone else that would like to make a comment?

As you approach the microphone, please, identify yourself and proceed.

MR. KNIPP: My name is Gordon Knipp. I'm representing the Sierra Club. We'll turn in more detailed written comments before the deadline, but we'd like to make a couple of points tonight for your consideration. 3

First of all, there are several other planning efforts under way, major thrusts of which could be precluded by adoption of this Rosedale Highway Widening Project. For example, SB375 requires a sustainable community strategy, involving cutbacks in

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primarily traffic-related greenhouse gas emissions. The Rosedale Highway Widening Project would allow greenhouse gas emissions to increase, a potential conflict with the sustainable community strategy.

Work is presumably under way on a Climate Action Plan. The Rosedale Highway Widening Project, again, would allow greenhouse gas emissions to increase, potentially precluding certain approaches to achieving statewide goals and lowering our community's greenhouse gas footprint.

Work will soon begin on a new bicycle master plan. The Rosedale Highway Widening Project does not include bicycle lanes and would preclude the potential for safe bicycling on Rosedale Highway. 3 cont.

The Metropolitan Bakersfield General Plan is being updated, albeit, somewhat slowly. Rosedale Highway, of course, is a major transportation corridor. The Rosedale Highway Widening Project should be considered in the larger context of the Metropolitan Bakersfield General Plan Update on its growth inducement on the urban frame and the overall effects on our community.

This project should be addressed in an EIR for the Metropolitan Bakersfield General Plan Update. The Rosedale Highway Widening Project should be incorporated as part and parcel of other -- some of these other major planning efforts so as not to preclude more progressive approaches. 3 cont.

Another point I'd like to make. The environmental documents for the Rosedale Highway Widening Project are deficient in a number of ways. For example, since this project will make commuting easier, at least for a time, it likely will be growth inducing, leading to more residential growth on prime farmland. The Environmental Assessment Mitigated Negative Declaration contains no substantial evidence against such growth inducement, and it does not address the potential for farmland loss. 4

The environmental documents contained only two alternatives -- a build alternative and a no-build alternative. They should have an inter- -- another alternative -- one which I would like to think of as a sustainability alternative, an alternative that would include bicycle routes and enhance public transportation, including, perhaps, the potential for light rail. Such an alternative should encourage real in-fill around public transportation modes and discourage growth in the far Metro Bakersfield perimeter. The environmental documents are lacking in many ways. There should be a full upgraded EIR/EIS for 5

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this project. **5 cont.**

While we sympathize with the desire to reduce congestion on Rosedale Highway, we see this project as part of a business-as-usual cycle -- more roads to accommodate more sprawl; more traffic because of the increased sprawl; and more roads in to accommodate the increased traffic. More sprawl. More traffic congestion. More roads. So unless we break that cycle by reducing sprawl, it won't take long to have as much congestion on the new upgraded Rosedale Highway as there is now. **6**

We, as a community, should demand a more progressive approach that would help to reign in sprawl and help to build a more sustainable and livable Bakersfield.

Thank you.

CHAIRMAN HADDOCK: Thank you, Mr. Knipp.

Is there anyone else that would like to make a comment in the public?

Once again, approach the microphone and identify yourself and proceed.

MR. DINEO: My name is Dale Dineo.* And I'm representing the Rosedale Square Shopping Center, the northeast corner of Fairhaven and Rosedale. **7**

And I note that it appears that we're going

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*The commentor's name is spelled incorrectly in the transcript. The correct spelling is Dale Denio.

to have -- from Fairhaven will be -- access to Rosedale Highway from Fairhaven will be limited to westbound only, and that would severely impact the shopping center there and the tenants, also, impacting ability to get deliveries from trucks. All of the traffic going -- leaving that center in order to be able to go eastbound, would be forced to go down to Landco or Mohawk and make U-turns. We'd like to see a signal there at Fairhaven so that traffic could safely go either direction. **7 cont.**

Thank you.

CHAIRMAN HADDOCK: Thank you, Mr. Dineo.

Is there anyone else in the public that would like to make a comment?

I'll do the broken record, again. Would you approach the microphone and identify yourself and proceed.

MR. CANDEL: Good evening. My name is Steven Candel, and I'm the owner of Star Furniture. And one of the largest things that are of most concern for businesses is the short-term and relatively long-term impact of a year's worth of construction on Rosedale Highway and how that negatively impacts our financials, whether it's the traffic flow and traffic patterns, whether it's the long-term effect of eating **8** portions of our, you know, front area that's adjacent to the road as it exists now, and how people will make those turns in and out of our businesses. That is a tremendous burden to either small business or these big established businesses on Rosedale. And we just want to, at least, voice that concern that with all of this building and the idea that we do want to think about the long-term growth plans for Bakersfield, that we also don't do any detriment to those businesses that are existing in these tough times and are trying to find a way to not only work with the City to help achieve their goals but also to help us ensure that we can sustain ourselves while that process occurs. 8 cont.

And with regard to any of those details, we would also reserve some of that for written statements that we can also file at a later date.

Thank you.

CHAIRMAN HADDOCK: Thank you, Mr. Candel.

Is there anyone else from the public that would like to make a comment?

As you approach the microphone, please, identify yourself and proceed.

MR. SMITH: Thank you. I'm Bob Smith from Bike Bakersfield. Thank you for providing us with the opportunity to comment on the Rosedale Highway Project. 9

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We do not believe the environmental document accurately analyzes the impact on bicycle transportation. It is, therefore, flawed in its environmental analysis specifically as it relates to air quality and environmental justice.

The summary table lists the impact on bicycle facilities as no impact. This is not correct. The existing roadway has an eight-foot, paved shoulder using nationally accepted methods to calculate the bicycle level of service. The existing roadway provides a Level of Service B at a very high compatibility level. The proposed roadway has no shoulder and no bike lane. The level of service of the proposed roadway is "E" and very low compatibility. There were no level-of-service calculations included for bicycle transportation. What this project does is remove an existing biking facility, which is the main corridor from northwest Bakersfield to downtown and east Bakersfield; therefore, any existing and future nonmotorized, nonpolluting access is being eliminated.

9 cont.

This project will increase air pollution now and in the future. The estimated amount could be based on the expected future bicycle mode share if proper facilities were provided. Cities around the nation and state have seen exponential growth in bicycle trips when good facilities are installed. Many cities presently obtain a 5- to 8 percent mode share with goals of obtaining a 20- to 30 percent. The 20 percent mode share on Rosedale Highway could be obtained in the future and would be a very significant amount of air pollution reduction. The project's environmental justice analysis does not take into account the destruction of affordable transportation options in low-income commuters. Access to jobs on the corridor would be greatly diminished for these income groups.

Federal Department of Transportation has a policy statement that states:

"Bicycling and walking facilities will be incorporated into all transportation projects unless exceptional circumstances exist."

We do not believe those exceptions exist. Since this project is using federal money, it would seem that they would have to comply with this policy.

It seems that a simple solution to the widening of the project would be to narrow the travel lanes. It would not increase the cost of the project. The AASHTO recommended lane widths for arterials are from 10 to 12 feet. This project recommends the maximum 12 foot, which is the lane width used on freeways.

9 cont.

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The city of Bakersfield has many existing arterials with 10- and 11-foot travel lanes with no adverse effects. Caltrans highway design manual allows a reduction in the lane widths in order to accommodate bicycle lanes. Highway capacity manual factors for capacity do not change the lane widths between 10 and 12 feet; therefore, the capacity would not be changed by reducing lane widths.

Nationally recognized studies have shown that there's no safety difference between urban arterials with 10- to 12-foot wide lanes. Therefore, it would not affect the safety or capacity of automobile travel while providing for a nonmotorized option, as well. Whatever the solution is, there's no question that air quality will be enhanced by providing nonmotorized transportation options. 9 cont.

We appreciate the opportunity to comment on the environmental document and hope that the project can be improved through this process.

Thank you.

CHAIRMAN HADDOCK: Thank you, Mr. Smith.

So anyone else want to make a public comment?

Okay. I gave you your chance. Seeing none, I will close the public hearing and return the matter to the Commission for comment and action.

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Commissioner Kirschenmann.

VICE-CHAIR KIRSCHENMANN: Thank you, Chair Haddock.

I appreciate all the comments made by the public. Hopefully, they can be taken into consideration as the City prepares their final document.

A comment that I would like to make -- and I look at it from a planning perspective since I'm a planning commissioner. It's something that we've had to deal with in the past on a project that we approved a few months back, and that is parking along Rosedale Highway. And I'd like to get some information on -- maybe this is a question I can refer to Mr. Eggert. I don't know if this is the right time, but if, in fact, the right of way is taken along Rosedale Highway and you have a business that parks -- their customers park with their headlights facing out into the right of way, and then after this right of way it taken and -- you know, maybe they still have the opportunity to park there and then subsequent generations of a business that has to pull a building permit has to, you know, show that they've got enough right of way, landscaping in front of the street, I'm just worried that at some point the City might say, 10

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"Hey, guys," you know, "you don't have enough room for parking in this area." Do you see that as a possibility or if it's something we should watch out for?

10 cont.

MR. EGGERT: Actually, I'm not going to give you a direct answer to that, but what I'm going to do is, since that's been publicly stated, I will let the consultant for T.R.I.P. address that a little bit more comprehensively because it's got a lot of issues that could come up with it. And rather than me giving you one of those, which I could do, I would like to have them be able to address kind of the broader scenario if that's okay.

VICE-CHAIR KIRSCHENMANN: Fair enough. Thank you.

And another question that I had -- and maybe we can address this, as well, in the final document -- with ongoing road maintenance shared by the City and County, there are, as we all know, different parts of Rosedale Highway that are either in the city or the county, and now that we will be taking over the maintenance of the roadway from Caltrans, I would just like to have a good explanation on how the maintenance of the road -- the road surface, sidewalk, and how those would be formed and how those two jurisdictions

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would share the responsibility. Other than that, that's about all I have. Thank you. 11 cont.

CHAIR HADDOCK: Thank you, Commissioner Kirschenmann.

Commissioner Lomas.

COMMISSIONER LOMAS: Thank you, Chairman.

First, I'd like to say we all look forward to Rosedale Highway flowing better because we've all been stuck there. It will be really nice when the grade separation happens. We need to find that magic pot of money because nobody likes getting stuck behind a train.

So with the niceties out of the way, I've got some questions I'd like to address. I know we don't address them now, but I'd like to put them out there to be looked at. 12

One is -- dovetailing off David Jones' comments -- I, too, have some issues with the numbers. I'm not quite understanding where we're talking about level of service. And if you look at the tables and, also, the truck traffic -- going back up -- talks about truck trips, and it all remains pretty constant.

You start at today, and then we get to 2015, and it's the same level. But we're up -- but I never -- but I didn't see anywhere here where the new freeway -- once that gets into place, where that's affecting any of these numbers at all.

So when you start looking at your tables, without -- without the Kern River Freeway not being factored into the picture and no actual numbers for us to look at, it doesn't make a load of sense. When you're looking at level of service, I wish I could show you my forms here and where I'm looking.

The statement -- what got me going in this direction was the statement that the traffic study showed that the improvements west of Allen Road would not be needed until after 2035. Then when you look at the level of service projections, it's showing we're at Level of Service C at Renfro. We're at Level of Service B at Jenkins. And now we're at Level of Service C at Allen. But with improvements we're going to be at D, C -- D, E, C, and F, and where I'm getting tripped up is, logically, we're going to take a six-lane road -- brand new six-lane road and put it right into a two-lane road. And I don't see where that is not a problem until 2035. So maybe maybe I'm missing something with the numbers. I think that's all I have.

12 cont.

CHAIRMAN HADDOCK: Thank you, Commissioner Lomas.

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Any other comments?

I have a few comments myself.

Having been born and raised here in Bakersfield, I've watched Rosedale Highway change quite a bit in 40 years. I remember when it was a two-lane road, and it traveled out into the country. There wasn't much commercial property at all. I had friends that lived out there, and it was just a nice, peaceful road to drive out, and it was out in the country then.

I'm -- I'm a little concerned, as always, with how Bakersfield is reflected to the public, people who don't live here. So many friends that don't live in Bakersfield tell me, "Oh, yeah. I've been to Bakersfield. I stopped to get gas. It was hot, and I left." I would really not want Rosedale Highway to look like that. It's gotten wider. It's not a beautiful place. There's trees that have been removed, plants that have been removed. I'm concerned about lighting. 13

And I'm also concerned about the traffic. None of us like to be stopped there, but some of you know also that I was a reserve Kern County Deputy Sheriff. And being able to move emergency vehicles up and down that highway is very important for public safety. So I want to make sure that we are able to do 14

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that with any changes that we make. 14 cont.

Tonight I heard a couple of things that really caught my attention, and that was that east/west travel. I know that, myself, I pulled into a few of the places there, A-1 Battery, things like that. You've got to go west before you can go east, and the U-turns there are not safe. And we need to make sure that that kind of traffic is going to be planned for well. We heard about the possibilities of traffic lights. I'm not sure what it's going to take. 15

But as I mentioned earlier, having grown up here, I've known of a number of deaths that have occurred on Rosedale Highway because the traffic there and the way it moves is not always safe. So I just want to make sure that whatever we put in there is going to be safe for everyone that lives here.

Most of all I would still like it to be a beautiful place, and those are my comments. And since there are no other comments from the Commission that I'm seeing -- Commissioner Lomas.

COMMISSIONER LOMAS: One more thing. And also, too, in looking at the level of service, I forgot to mention Calloway. Calloway, as we all now know, is an "F," and our improvement under best-case scenario in 15 years is a "D." And it doesn't talk a lot about 16

16 cont.

Calloway, and I'm hoping that that's looked at.
Thank you.
CHAIRMAN HADDOCK: Thank you, Commissioner Lomas.
Any final comments from the Commission? Then -- yes, Commissioner Kirschenmann.
COMMISSIONER KIRSCHENMANN: I'll make a motion to refer the comments of staff -- to staff for preparation of the final environmental document.
CHAIRMAN HADDOCK: Can I have a second?
COMMISSIONER WADE: Second.
CHAIRMAN HADDOCK: Is this an individual?
Madam clerk, can we have a vote taken, please.
THE CLERK: Commissioner Haddock.
CHAIRMAN HADDOCK: Yes.
THE CLERK: Commissioner Kirschenmann.
COMMISSIONER KIRSCHENMANN: Yes.
THE CLERK: Commissioner Lomas.
COMMISSIONER LOMAS: Yes.
THE CLERK: Commissioner Wade.
COMMISSIONER WADE: Yes.
CHAIRMAN HADDOCK: Thank you.
(End of requested portion.)

STATE OF CALIFORNIA.)
) ss.
COUNTY OF KERN)

I, Robin Saldana, do hereby certify that I transcribed the foregoing-entitled matter; and I further certify that the foregoing is a full, true, and correct transcription of such proceedings.

Dated this Monday, January 23, 2012, in Bakersfield, California.

Robin Saldana

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Responses to Comments from the January 5, 2012 City of Bakersfield Planning Commission

A public meeting was held before the City of Bakersfield Planning Commission. A presentation was made by Mr. Theodore Wright, City Program Manager for the Thomas Roads Improvement Program. A court reporter prepared a transcript of the presentation and comments made on the project by members of the public and planning commissioners. This was the first review by the Planning Commission and no action or recommendations on the project or environmental document were being made at this meeting. Thank you to the participants for their comments on the project.

Response to Comment from John Wilson

Response to transcript comment #1: Page 41 of the initial study/environmental assessment (page 42 of the final initial study/environmental assessment) does identify that there would be an inconvenience factor associated with the construction of the median. Text will be added to the initial study/environmental assessment to indicate that the median closure may require that large trucks alter their approach or exit path from certain parcels due to the inability of large trucks to make U-turns. The inconvenience factor is often less for industrial uses than with commercial uses because the industrial users generally frequent the location consistently and factor access restrictions into their routing. State Route 58 is a designated conventional highway and a raised median between intersections is consistent with the design standards.

Response to Comment from David Jones

Response to transcript comment #2: The segment of State Route 58 from Allen Road to State Route 43 (Enos Lane) will eventually be widened from two to four lanes. The funding available for this project is insufficient to widen State Route 58 (Rosedale Highway) west of Allen Road. Given the funding limitations, Caltrans and the City of Bakersfield, in cooperation with Kern County and the Kern Council of Governments, prioritized this segment of roadway for improvements at this time. However, the long-term need for the improvements is recognized and funding has been incorporated into the Metropolitan Bakersfield Transportation Impact Fee program to widen State Route 58 west of Allen Road. The Kern Council of Governments’ Regional Transportation Plan identifies widening of State Route 58 from Allen Road to State Route 43 (Enos Lane) as an improvement in the 2021 to 2025 timeframe. Those improvements would be a separate project and have their own environmental document.

The initial study/environmental assessment (page 19 of the draft document and page 20 of the final document) should have stated that the improvements west of Allen Road were not expected to be needed until 2025, not 2035. The following correction is made to the final environmental document (new text shown in *italics* and deleted text shown in ~~strikeout~~): "Additionally, the traffic study showed that the improvements west of Allen Road would not be needed until *2025*. ~~after 2035~~"

Responses to Comments from Gordon Nipp Representing the Sierra Club

Response to transcript comment #3: It is acknowledged that there are a number of planning documents being developed. However, it is not reasonable to assume that all improvements would stop until these programs are developed. There will always be programs being developed or updated. This segment of State Route 58 is designated on the Metropolitan Bakersfield General Plan as a six-lane roadway. Land uses have been approved and developed with the assumption that the roadway would be widened. The improvements are limited to the area that is predominately built out and is currently experiencing a deficient level of service.

Response to transcript comment #4: The project goes through the more urbanized portion of Bakersfield. Within the project limits, there are opportunities for infill development; however, there are limited opportunities for new large scale development. It is clear that the area surrounding State Route 58 is envisioned as part of the urban core for city. To support that goal, the Metropolitan Bakersfield General Plan identified the need for State Route 58 to be a six-lane roadway. his project serves the current need. This project would not enhance circulation to the level that it would open new areas to development or encourage development on prime farmland. It is within the area currently developed as an employment and commercial center.

Response to transcript comment #5: The suggestion to provide an additional alternative that would encourage bicyclists, plus enhance public transportation and the potential for light rail, would require substantial impacts to existing land uses because of the lack of right-of-way.

As indicated in the Initial Study/Environmental Assessment, the *Metropolitan Bakersfield General Plan* does not designate any bike trails or paths along State Route 58 (page 80 of the draft document, page 82 of the final document). Given the right-of-way constraints, the high traffic volumes, high truck percentage of trucks, and number of driveway breaks, a dedicated bikeway is not proposed as part of the project. As with existing conditions, the project would not place any restrictions on the use of State Route 58 by bicyclists. The City of Bakersfield and Kern County do not encourage bicyclists to use State Route 58 because it is a designated truck route and carries a high volume of trucks. The *Metropolitan Bakersfield General Plan* has designated bikeways on Brimhall Road and Hageman Road that run parallel to State Route 58. These parallel roadways provide more suitable routes because they carry less traffic and fewer trucks. Connecting bikeways from State Route 58 to the bikeways on both Brimhall Road and Hageman Road can be made via Allen Road, Calloway Drive, and Coffee Road. Additionally, though Mohawk Street currently ends at State Route 58, there are plans to extend Mohawk Street through to Hageman Road.

Though there is not enough bicycle ridership to support the usage of State Route 58 as an important bicycle linkage, the lane widths will be reconfigured to provide a wider outside lane and shoulder. For the segment of roadway from Allen Road to Mohawk Street, rather than having three 12-foot travel lanes with a 2-foot outside shoulder, the width of the middle travel lane will be reduced to 11 feet. The additional foot will allow a 15-foot outside lane (12-foot travel lane and a 3-foot shoulder). This will not be considered a bike lane, but would provide additional area should a bicyclist decide to use State Route 58. The portion of the project east of Mohawk Street will provide 8-foot shoulders, which can accommodate bicyclists.

With regard to the suggestion that an alternative be provided that would allow for potential light rail, substantial land use intensification would be required to provide the demand necessary to sustain light rail. The project is a roadway project and does not involve any land use decisions. Most of the area surrounding the project site is developed. The City of Bakersfield currently does not have the land use densities required to support light rail. Not even the bus lines along State Route 58 have substantial ridership. According to Golden Empire Transit, as of 2012 the average number of passengers boarding the bus on a weekday is 167 riders for Route 18 and 556 riders for Route 14. These ridership numbers are for the entire route, not just the segment of State Route 58 that would be widened. The cost associated with providing light rail along State Route 58 would also be very high, as would the extent of impacts on surrounding land uses.

In addition, the changes in land uses necessary to develop a transit-oriented community is beyond the scope of this project and the authority of Caltrans. The City of Bakersfield is taking measures to incorporate the mixed-use concept into more recent development approvals, such as the Bakersfield Commons (a high intensity mixed-use project). However, the planning process has to balance the long-term vision with the needs of the development that is already here.

No significant project-related impacts have been identified either as part of the draft initial study/environmental assessment or the public review process that would require preparation of an environmental impact report needed by the California Environmental Quality Act or an environmental impact statement needed by the National Environmental Policy Act.

Response to transcript comment #6: Your concerns regarding long-range planning for the City of Bakersfield are acknowledged. However, as noted above, changes in land uses or planning policies are beyond the scope of this project and the authority of Caltrans. There are regional efforts to address the concerns identified.

Response to Comment from Dale Denio Representing the Rosedale Square Shopping Center

Response to transcript comment #7: A traffic signal is not proposed at the Fairhaven Drive intersection for two reasons: (1) traffic volume requirements and (2) the close spacing of the intersections. In order for a traffic signal to be installed on State Route 58, either existing or projected traffic volumes must meet a minimum of peak hour, four-hour, and eight-hour volumes (this level is known as a "signal warrant"). Both the existing and projected left-turn traffic volumes at the intersection of Fairhaven Drive do not meet these warrants. Having vehicles make a left turn across three lanes of traffic without having a place in the median to wait and safely merge with oncoming traffic can be a safety problem. Therefore, it was decided to provide westbound right-turn in, westbound right-turn out, and eastbound left-turn in to access land uses located on Fairhaven Drive.

The left-turn traffic would be required to make a right-turn onto westbound State Route 58 and make a U-turn at the Landco Drive intersection less than 0.25 mile to the west. Also, as indicated above, with existing traffic signals at both Gibson Street and Landco Drive, there is insufficient distance between Fairhaven Drive and Gibson Street for installation of a third traffic signal along this 0.4-mile section of State Route 58. With Fairhaven Drive only 650 feet west of Gibson Street, the ability to coordinate these closely spaced intersections would degrade operating conditions on State Route 58. In addition, eliminating the left turn from southbound Fairhaven Drive to eastbound State Route 58 would reduce delays and vehicles would be less likely to use the shopping center as a cut-through to State Route 58.

It should also be noted that in October 2004, when the development plans were being processed for the shopping center, Caltrans identified that a signal would not be allowed at Fairhaven Drive and that future plans included the installation of a raised median on State Route 58 that would eventually prohibit the left-turn movement out of Fairhaven Drive. This correspondence is attached in Appendix L.

Response to Comment from Steven Candel Representing Star Furniture

Response to transcript comment #8: It is acknowledged there will be some delays due to construction traffic, but State Route 58 will remain open during construction. There will be no road closures. To help reduce the impacts during constriction, a standard condition that would apply to the project is the preparation of a Traffic Management Plan (see Standard Condition SC-2). The Traffic Management Plan will, among other things, optimize roadway capacity, signal phasing, and timing during construction with the goal of ensuring safe and efficient traffic flow throughout the project study area during all phases of construction. Though construction activities do result in short-term traffic delays, it is intended that the business along State Route 58 will receive long-term benefits from improved traffic flow. The impact of not implementing any improvements would be long-term congestion throughout the State Route 58 corridor.

Responses to Comments from Bob Smith Representing the Bike Bakersfield

Response to transcript comment #9: As indicated in the initial study/environmental assessment, the *Metropolitan Bakersfield General Plan* does not designate any bike trails or paths along State Route 58 (page 80 of the draft document; page 82 of the final document). Given the right-of-way constraints, the high traffic volumes, high truck percentage of trucks, and number of driveway breaks, a dedicated bikeway is not proposed as part of the project.

As with existing conditions, the project would not place any restrictions on the use of State Route 58 by bicyclists. The City of Bakersfield and Kern County do not encourage bicyclists to use State Route 58 because it is a designated truck route and carries a high volume of trucks. The *Metropolitan Bakersfield General Plan* has designated bikeways on Brimhall Road and Hageman Road that run parallel to State Route 58. These parallel roadways provide more suitable routes because they carry less traffic and fewer trucks. Connecting bikeways from State Route 58 to the bikeways on both Brimhall Road and Hageman Road can be made via Allen Road, Calloway Drive, and Coffee Road. Additionally, though Mohawk Street currently ends at State Route 58, there are plans to extend Mohawk Street through to Hageman Road.

Though there is not enough bicycle ridership to support the use of State Route 58 as an important bicycle linkage, the lane widths will be reconfigured to provide a wider outside lane and shoulder. For the segment of roadway from Allen Road to Mohawk Street, rather than having three 12-foot travel lanes with a 2-foot outside shoulder, the width of the middle travel lane will be reduced to 11 feet. The additional foot will allow a 15-foot outside lane (12-foot travel lane and a 3-foot shoulder). This will not be considered a bike lane but would provide additional area should a bicyclist decide to use State Route 58.

Responses to Comments from Commissioner Kirschenmann

Response to transcript comment #10: The concern for loss of parking was addressed in the initial study/environmental assessment (page 79 of the draft document and page 81 of the final initial study/environmental assessment). With the Build Alternative, 15 parcels would have direct parking impacts from the roadway widening. Based on early design, the roadway widening would affect about 103 parking spaces. Of those, 73 spaces could be replaced through restriping of the existing parking lots. In accordance with Minimization Measure LU-2, should the loss of parking result in less parking than what is required by the applicable zoning code, the city or county should coordinate with the property owners to issue a variance. The variance process would also be applicable to an insufficient area for setbacks and landscaping.

Response to transcript comment #11: The relinquishment agreement that has been entered into among the City of Bakersfield, the County of Kern, and Caltrans identifies the local maintenance responsibilities.

Response to Comment from Commissioner Lomas

Response to transcript comment #12: Traffic analysis does show traffic volume increasing between the baseline conditions and 2015 and 2035. The confusion appears to be the network assumptions for each of the future periods, especially the changes between 2015 and 2035. As stated on page 72 of the draft initial study/environmental assessment (page 74 of the final initial study/environmental assessment), the traffic projections assume the roadway improvements proposed as part of the Kern Council of Governments Regional Transportation Plan, the Thomas Roads Improvement Program, and the Metropolitan Bakersfield Transportation Impact Fee program. Several key circulation improvements were identified that will influence the traffic volumes on this portion of State Route 58 (Rosedale Highway), most notably the West Beltway and the Centennial Corridor (Kern River Freeway). In addition, page 72 of the draft initial study/environmental assessment (page 74 of the final document) does indicate that the Metropolitan Bakersfield Transportation Impact Fee program includes a range of local street improvements designed to relieve traffic congestion, particularly in the western portion of the study area, including the widening of State Route 58 from Allen Road to State Route 43 (Enos Lane) in the 2021 to 2025 timeframe.

The Centennial Corridor will use the Westside Parkway currently under construction. The plan is to connect with the freeway portion of State Route 58 (East). The Centennial Corridor would provide a high-speed facility without the delays of stop lights about two miles south of the Rosedale Highway segment of State Route 58. With the construction of this major transportation facility, in addition to the other more localized improvements, there will be locations where the level of service in 2035 is projected to improve compared to 2015.

Additionally, as noted in response to transcript comment #2 (Mr. Jones' comment), the initial study/environmental assessment (page 19 of the draft document; page 20 of the final document) should have stated that the improvements west of Allen Road were not expected to be needed until 2025, not 2035. The Regional Transportation Plan does identify the widening of State Route 58 (Rosedale Highway) from State Route 43 (Enos Lane) to Allen Road in the 2021 to 2025 time frame.

Until State Route 58 is widened west of Allen Road, the transition of the six-lane road to the two-lane roadway would be done through the use signage and turn lanes. Currently, in the westbound direction at Allen Road, State Route 58 has a dedicated right-turn lane, a dedicated left-turn lane, and two through lanes. When the improvements are built, signage will inform drivers traveling in the westbound direction that the outside lane will become a right-turn only lane (onto northbound Allen Road). The remaining two through lanes will be able to pass through the intersection, then transition down to one westbound lane. This is consistent with the current configuration of the intersection. In the eastbound direction, the lane striping for the existing two through lanes will line up with the project lane striping and an additional travel lane will be provided.

Responses to Comments from Chairman Haddock

Response to transcript comment #13: The project will provide a uniform appearance to the roadway within the project limits. Existing landscaping and irrigation in the median along the project alignment would be replaced if damaged by construction. Lighting will be installed the length of the project.

Response to transcript comment #14: The project could result in short-term construction impacts to emergency access due to traffic delays. This would be for a short period. The preparation of a Traffic Management Plan requires coordination with emergency service providers and requires that these providers are notified of each construction stage and any expected traffic shifts. In the long term, the Build Alternative would serve to improve circulation and emergency response times along State Route 58.

Response to transcript comment #15: Though the raised median will improve traffic flow, it will limit the ability to make left-turns in and out of some locations. The traffic analysis does take this into account. Opportunities for U-turns at signalized intersections will provide safe locations for drivers needing to reverse their direction.

Responses to Comments from Commissioner Lomas

Response to transcript comment #16: Under current conditions, the Calloway Drive/State Route 58 intersection operates at level of service E in the morning peak hour and level of service F in the afternoon peak hour. With the No-Build Alternative, this intersection will be at level of service F in both the morning and afternoon peak hour for both 2015 and 2035. With the project, the intersection will operate at level of service D in both the morning and afternoon peak hour for both 2015 and 2035. Level of service D is considered acceptable for urban locations.

Transcript from Public Hearing 1/10/12

BAKERSFIELD, CALIFORNIA

ROSEDALE HIGHWAY WIDENING PROJECT

PUBLIC HEARING

Connections Assembly of God Church

January 10, 2012

Transcribed by: Robin Saldana

SYLVIA MENDEZ & ASSOCIATES
Certified Shorthand Reporters
330 H Street, Suite 1
Bakersfield, CA 93304
(661) 631-2904 · Fax (661) 631-2969

CERTIFIED COPY

MR. HAKIMI: My name is Ahron Hakimi, Caltrans manager for the T.R.I.P. program, and I'll officially open the public meeting at 3:47 p.m. on January 10, 2012.

MR. JONES: The comment I wanted to make is some of the background information, the actual traffic counts and studies, I thought, should have been made available online. I know they are available at the 1 libraries, but today, the way people operate, it would be much better if it took you to a link that supported numbers that are in the main document.

Specifically for me, it was the traffic studies assumption. And the comment I wanted to make is that we looked at stopping this project at Allen Road because of money, didn't have funding, and that there was properties encroaching on the roadway that would be difficult to widen. 2

The original idea would be to do four lanes past Allen Road, and that is dismissed in this study. And they're basing it on that the level of service of the intersection past Allen Road, specifically, Jenkins and Renfro, would be at C or better for level of service in 2035. But their document itself shows that the intersection is at level of service E and F in 2013. That was an improvement imposed for increasing the number of cars fed into the Allen Road intersection because it was -- will be six lanes instead of four. But the existing road to the west will still be two lanes, and they're assuming that traffic is going to improve at those westerly intersections in 2035.

And I've been told it's because of Westside Parkway. It may remove some of the traffic going east and west, but that's two miles south of there. It won't relieve all the traffic. There's other building that will clear out that area in 2035. Renfro is going to be made into a major north/south corridor the way the county has it designed and something-four lanes between Allen and Renfro would be more appropriate. **2 cont.**

And finally, in the Alternatives Analysis, they based their decision not to even look at Jenkins and Allen -- Jenkins and Renfro because of the level of service that they believe will be C or better in 2035, and that's not something that I see happening. They're assuming that increases in traffic for the Jenkins intersection alone will increase about 37 percent between current conditions and 2035. So I don't see how the intersection will continue to operate at a C level. **3**

MR. HAKIMI: My name is Ahron Hakimi,

Caltrans manager of the T.R.I.P. program, closing the public meeting at 7:00 p.m. on January 10, 2012.

(End of meeting.)

STATE OF CALIFORNIA.)
) ss.
COUNTY OF KERN)

I, Robin Saldana, do hereby certify that I transcribed the foregoing-entitled matter; and I further certify that the foregoing is a full, true, and correct transcription of such proceedings.

Dated this Monday, January 23, 2012, in Bakersfield, California.

Robin Saldana

Responses to comments from the January 10, 2012 Public Open House

A public meeting was held at the Connection Assembly of God Church, 7220 Rosedale Highway, Bakersfield, California, on January 10, 2012 from 4:00 p.m. to 7:00 p.m. The open-house format gave the public an opportunity to talk with staff and ask questions. A court reporter was present to take verbal comments. About 51 people attended the meeting. Thank you to the participants for their comments on the project.

Responses to Comments Provided by Mr. Jones

Response to comment #1: On January 18, 2012, in response to the request for technical studies be available online, Ms. Heather Ellison of the Thomas Roads Improvement Program office sent Mr. Jones an e-mail saying the studies had been posted on their website (www.BakersfieldFreeways.us).

Response to comment #2: The segment of State Route 58 from Allen Road to State Route 43 (Enos Lane) will eventually be widened from two to four lanes. The funding available for this project is insufficient to widen State Route 58 (Rosedale Highway) west of Allen Road. Given the funding limitations, Caltrans and the City of Bakersfield, in cooperation with Kern County and the Kern Council of Governments, prioritized this segment of roadway for improvements at this time. However, the long-term need for the improvements is recognized and funding has been incorporated into the Metropolitan Bakersfield Transportation Impact Fee program to widen State Route 58 west of Allen Road. The Kern Council of Governments' Regional Transportation Plan identifies widening of State Route 58 from Allen Road to State Route 43 (Enos Lane) as an improvement in the 2021 to 2025 timeframe. Those improvements would be a separate project and have their own environmental document.

The initial study/environmental assessment (page 19 of the draft document; page 20 of the final document) should have stated that the improvements west of Allen Road were not expected to be needed until 2025, not 2035. The following correction is made to the final environmental document (new text shown in *italics* and deleted text shown in ~~strikeout~~): "Additionally, the traffic study showed that the improvements west of Allen Road would not be needed until *2025*. ~~after 2035~~"

Response to comment #3: The limits of the project addressed in the initial study/environmental assessment are focused on the segment of State Route 58 from Allen Road to State Route 99 because that is the location with the greatest need for improvements. Given the funding limitations, Caltrans and the City of Bakersfield, in cooperation with Kern County and the Kern Council of Governments, prioritized this segment of roadway. As part of a future project, with its own environmental document, the portion of State Route 58 from State Route 43 (Enos Lane) to Allen Road will also be widened.

The level of service information provided in Table 2.10 of the environmental document indicates that, in 2015, the Jenkins Road/State Route 58 intersection will operate at level of service F in the afternoon peak period under both the Build and No-Build alternatives. In 2035, this improves to level of service C with both the Build and No-Build alternatives because other improvements are assumed in the 2035 transportation network. As stated on page 72 of the draft initial study/environmental assessment (page 74 of the final initial study/environmental assessment), the 2035 model roadway network assumptions include completion of the Thomas Roads Improvement Program projects as well as the roadway projects included in the regional traffic impact fee program. Two Thomas Roads Improvement Program projects that would affect State Route 58 are the completion of the Centennial Corridor and the West Beltway. The regional traffic impact fee program includes a range of local street improvements designed to relieve traffic congestion, including the widening of State Route 58 from Allen Road to State Route 43 (Enos Lane) in the 2021 to 2025 timeframe.

Appendix O Air Quality Conformity

U.S. Department of Transportation
Federal Highway Administration

Federal Highway Administration
California Division

650 Capitol Mall, Suite 4-100
Sacramento, CA 95814
(916) 498-5001
(916) 498-5008 (fax)

May 1, 2012

In Reply Refer To:
HDA-CA

File # Rosedale Hwy Project

Mr. Malcolm Dougherty, District Director
California Department of Transportation
District 6
P. O. Box 12616
Fresno, CA 93778-2616

Attention: Abdul Chafi

Dear Mr. Dougherty:

SUBJECT: Project Level Conformity Determination for the Rosedale HWY (SR 58) from Allen Rd to SR 99 Project (KER080110)

On April 10, 2012, the California Department of Transportation (Caltrans) submitted to the Federal Highway Administration (FHWA) a request for a project level conformity determination for the Rosedale HWY (SR 58) from Allen Rd to SR 99 Project (KER080110). The project is in an area that is designated Non-Attainment or Maintenance for Carbon Monoxide (CO), Ozone and Particulate Matter (PM_{10}, $PM_{2.5}$).

The project level conformity analysis submitted by Caltrans indicates that the project-level transportation conformity requirements of 40 CFR Part 93 have been met. The project is included in the Kern Council of Governments' (KCOG) current RTP and TIP, as amended. The design concept and scope of the preferred alternative have not changed significantly from those assumed in the regional emissions analysis.

As required by 40 CFR 93.116 and 93.123, the localized $PM_{2.5}$ and PM_{10} analyses are included in the documentation. The analyses demonstrate that the project will not create any new violations of the standards or increase the severity or number of existing violations.

Based on the information provided, FHWA finds that the Rosedale HWY (SR 58) from Allen Rd to SR 99 Project (KER080110), conforms with the SIP in accordance with 40 CFR Part 93.

If you have any questions pertaining to this conformity finding, please contact Joseph Vaughn at (916) 498-5346 or by email at Joseph.Vaughn@dot.gov.

Sincerely,

For
Vincent P. Mammano
Division Administrator

cc: (email)
Mike Brady, Caltrans
Ken Romero, Caltrans
Abdul Chafi, Caltrans
Jermaine Hannon, FHWA
Joseph Vaughn, FHWA

Jvaughn/km

Appendix P Biological Opinion

STATE OF CALIFORNIA—BUSINESS, TRANSPORTATION AND HOUSING AGENCY EDMUND G. BROWN Jr., Governor

DEPARTMENT OF TRANSPORTATION
DISTRICT 6
855 M STREET, SUITE 200
FRESNO, CA 93721-2716
PHONE (559) 445-6457
FAX (559) 445-6236
TTY (559) 488-4066

Flex your power!
Be energy efficient!

October 7, 2011

Mr. Thomas Leeman
Chief, San Joaquin Valley Branch
U.S. Fish and Wildlife Service
2800 Cottage Way, Suite W-2605
Sacramento, CA 95825-1846

Dear Mr. Thomas:

City of Bakersfield, in cooperation with the California Department of Transportation (Caltrans) and County of Kern, is proposing improvements to State Route 58 (known locally as Rosedale Highway) from west of Allen Road (post mile 46.1) to State Route 99 (post mile 51.7). The proposed work will include:

- Roadway widening from four-lanes to six-lanes
- Modify lane striping to modify lane configuration
- Modify lane striping on approaching side streets to provide turn an additional turn lane
- Construct a grade-separated rail crossing over the San Joaquin Valley Railroad rail line between Mohawk Street and Landco Drive
- Drainage and intersection improvements
- Utility relocations
- Sidewalk improvements and signalization

A "*May affect, Likely to Adversely Affect*" was made for the federally listed San Joaquin kit fox (*Vulpes macrotis mutica*).

Construction of the proposed project will result in the permanent loss of 1.21 acres and a temporary loss of 6.61 acres for a total loss of 7.82 acres of potential San Joaquin kit fox habitat. One potential kit fox den may also be directly affected.

Permanent impacts will be mitigated at a 3 to 1 ratio and temporary impacts at a 1.1 to 1 ratio. Total credits to be purchased through the Metropolitan Bakersfield Habitat Conservation Plan will be 10.90 acres.

Caltrans is initiating Formal Section 7 Consultation with the United States Fish and Wildlife

"Caltrans improves mobility across California"

Thomas Leeman
October 7, 2011
Pg 2

Service for the San Joaquin kit fox. Two (2) copies of the biological assessment are enclosed for your review. Please contact Javier Almaguer at 559-445-6481 (Javier_almaguer@dot.ca.gov) or myself if you have any questions or need additional information.
Sincerely,

Virginia Strohl
Acting Biology Branch Chief

Enclosure

"Caltrans improves mobility across California"

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

In Reply Refer To:
08ESMF00-2012-F-0049-1

APR 24 2012

Ms. Carrie Swanberg
Interim Branch Chief, Southern Central Region Biology
California Department of Transportation, District 6
855 M Street, Suite 200
Fresno, California 93721

Subject: Biological Opinion for the State Route 58 Rosedale Highway Widening Project (part of the Thomas Roads Improvement Program [TRIP]), City of Bakersfield, Kern County, California (California Department of Transportation EA 06-0F360; 06-0000-0076, 06-KER-58 PM 46.1/51.7)

Dear Ms. Swanberg:

This is the U.S. Fish and Wildlife Service's (Service) response to the California Department of Transportation's (Caltrans) request for initiation of formal consultation on the proposed State Route 58 Rosedale Highway Widening Project (project) in Kern County, California. Under the provisions of the July 1, 2007, Pilot Program Memorandum of Understanding between the Federal Highway Administration (FHWA) and Caltrans, FHWA assigned, and Caltrans assumed, FHWA's responsibilities under the National Environmental Policy Act (NEPA) as well as its responsibilities for environmental review, consultation, and coordination under other Federal environmental laws.

This project is part of the larger Thomas Roads Improvement Program (TRIP), a collection of six road improvement projects designed to meet the long-term transportation needs of the greater City of Bakersfield (City) area; one project has already completed consultation, two projects are engaged currently in consultation, and two future projects are in various stages of environmental planning and review. Your letter, dated October 7, 2011, was received in this office on October 11, 2011. At issue are potential effects to the federally-endangered San Joaquin kit fox (*Vulpes macrotis mutica*). This document represents the Service's biological opinion on the effects of the proposed project on this listed species. This document has been prepared in accordance with section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. § 1531 *et seq.*) (Act).

The findings and recommendations of this biological opinion are based on: (1) Caltrans' letter of request for formal consultation, dated October 7, 2011; (2) Caltrans' September 22, 2011, biological assessment (BA), entitled *State Route 58 Widening Project (Rosedale Highway)*, and prepared by the consultants, Bon Terra Consulting and AECOM; (3) the biological opinion for the first completed TRIP project, the Morning Drive/State Route 178 Interchange Project, issued to Caltrans on August 18, 2011; (4) the comprehensive *Draft Thomas Roads Improvement Program San Joaquin Kit Fox Effects Analysis, Mitigation Strategy, and Implementation Plan* (Draft Implementation Plan) dated February 2010; (5) the *Draft Thomas Roads Improvement Program Mitigation for Cumulative Effects to the San Joaquin Kit Fox* (Draft Sump Habitat Program (SHP) Plan), dated September 2, 2010, which outlines the basic conceptual framework for the proposed SHP; (6) the records from discussion and planning meetings held in person on September 10, 2009, March 11, 2010, May 11, 2010, July 14, 2010, August 18, 2010, June 22, 2011, and January 30, 2012, amongst Caltrans, the Service, the California Department of Fish and Game (CDFG), Parsons/TRIP, the City of Bakersfield, and AECOM; (7) electronic-mail (e-mail) correspondence and telephone exchanges between the Service and Caltrans; and (8) other information available to the Service.

Caltrans has determined that there will be no effect of the proposed action on five plant species, the California jewelflower (*Caulanthus californicus*), Kern mallow (*Eremalche kernensis*), San Joaquin woolly-threads (*Monolopia congdonii (=Lembertia congdonii)*), Bakersfield cactus (*Opuntia basilaris* var. *treleasei*), and San Joaquin adobe sunburst (*Pseudobahia peirsonii*), based on the results of protocol-level botanical surveys conducted during the spring of 2008-2009, which resulted in no detections of the species. However, because habitat in the project area is still considered to be suitable for these species, Caltrans has incorporated an additional minimization measure specifically addressing these plants, which is described under the *Proposed Avoidance and Minimization Measures* section.

The Service has reviewed the proposed project and concurs with Caltrans' determination that the project is likely to adversely affect the San Joaquin kit fox. The remainder of this biological opinion will address the effects of the proposed project upon this species.

Consultation History

<u>TRIP background and coordination</u>

November 20, 2007. The Service, Caltrans, AECOM, Parsons/TRIP, the CDFG, and the City (participating agencies) met at the Sacramento Fish and Wildlife Office (SFWO) to discuss TRIP. Parsons/TRIP requested that AECOM develop a strategy memo addressing compliance with the Act that could be later circulated among the other participants. Caltrans and the Service agreed that TRIP should take a project-specific approach. All participants agreed that a San Joaquin kit fox technical study for all TRIP projects should be conducted by AECOM, in conjunction with support from the Endangered Species Recovery Program (ESRP); such a study would be useful for supporting conclusions in future TRIP project BAs.

August 26, 2008. AECOM presented preliminary results of the San Joaquin kit fox surveys to the participating agencies at a meeting at the SFWO. This included a presentation of the methodologies, data, and effects analysis strategy and mitigation options. The Service identified habitat connectivity and the maintenance of corridors connecting San Joaquin kit fox populations as a major issue facing the species in Bakersfield. Participants discussed potential compensatory mitigation options, including culverts, refugia, and artificial kit fox dens.

September 10, 2009. The participating agencies met at the SFWO; the CDFG and the City joined via conference call. Discussion focused on the early July 2009, *Draft Thomas Roads Improvement Program San Joaquin Kit Fox Life History, Effects Analysis, and Conceptual Mitigation Strategy* (2009 Draft Strategy Plan).

October 7, 2009. The Service issued a concurrence letter approving the conceptual framework for the San Joaquin kit fox compensation strategy plan outlined in the 2009 Draft Strategy Plan.

February 26, 2010. The Service received two hard copies of the Draft Implementation Plan.

March 11, 2010. The participating agencies met at the CDFG office in Fresno to discuss the 2010 Draft Implementation Plan; topics included an overview of the plan, potential issues with the Metro-Bakersfield Habitat Conservation Plan (MBHCP) expiration date, and SHP funding.

April 12-13, 2010. AECOM e-mailed the Service and the CDFG regarding a template for developing a long term management plan for the SHP. AECOM suggested using the US Army Corps of Engineers' (Corps) template. The Service replied on April 13 to agree with using the Corps' template, and provided a management plan outline illustrating what the Service would expect to see in a potential management plan.

May 5, 2010. An informal conference call was held between AECOM and the Service to discuss recent developments that would be covered in the upcoming meeting that the Service would be unable to attend: Parsons/TRIP had successfully presented the six projects to the MBHCP Trust Group; the real estate meeting between AECOM and the City resulted in the discovery that four of the 19 easements on the sumps were owned outright by the City, four were owned by the City but with deed restrictions, and 11 were not owned by the City but still held easements. AECOM also had specific questions regarding what the Service would look for in the upcoming BA.

May 11, 2010. The participating agencies met at the CDFG office in Fresno to discuss the SHP.

July 14, 2010. A meeting was held at the SFWO amongst all the participating agencies. Parties agreed on the content of the project BA regarding avoidance and minimization measures and a general description of the SHP, compensation, eventual inclusion of a third chapter in the Draft Implementation Plan describing the finalized SHP in detail, endowment/easement updates, and schedules.

August 18, 2010. The participating agencies met at the CDFG's Fresno office to discuss the latest developments in compliance, BA preparation, and the SHP. Major topics included TRIP eligibility for participation in the MBHCP, BA content, and further details concerning the SHP (e.g. easement and program management, endowments, and sump selection.

Ms. Carrie Swanberg 4

September 15, 2010. The CDFG contacted the Service with information concerning language in accordance with the California Endangered Species Act (CESA) that the CDFG would like to see included in the project biological opinion so that it would be able to issue a Consistency Determination (CD) and avoid undertaking a lengthier 2081 Incidental Take Permit process. The Service responded to discuss.

September 30, 2010. The Service, AECOM, Parsons/TRIP, and Caltrans held a conference call to discuss paying MBHCP compensation fees for the six TRIP projects in advance of the 2014 MBHCP expiration. Although the construction schedule for at least one project is not anticipated to begin until after 2014, it still could be compensated for prior to the expiration date. In a revised September 1, 2010 letter, which included details of all six projects and compensation ratios, a blanket concurrence from the MBHCP Trust Group to use the MBHCP was given to the City and Caltrans. The Service suggested that an MOU with all parties involved could be implemented for paying fees in advance and provided an MOU template to AECOM.

October 22, 2010. The Service met internally to discuss the need for an MOU/memorandum of agreement (MOA) between the Service, Caltrans and the City regarding MBHCP compensation. It decided that it would be more appropriate to have an agreement between the City and Caltrans and the MBHCP Trust Group to avoid pre-decisional commitments by the Service.

December 8, 2010. The Service e-mailed Caltrans to request a copy of the Draft SHP Plan. Caltrans e-mailed a copy and stated this would later be incorporated into a third chapter in the Draft Implementation Plan.

January 20, 2011. The Service e-mailed Caltrans and AECOM to provide them with an update on what the SFWO had concluded regarding the concerns with CDs, CESA language, and BOs: the Service stated it would not include the CDFG's conditions in the Terms and Conditions of its biological opinions; however, the CDFG's conditions could be included in the project description and conservation measures. The Service does not have the authority to use the type of language the CDFG is looking for (e.g. fiscal assurances, letters of credit) as terms and conditions to minimize incidental take.

January 25, 2011. E-mails were exchanged between AECOM, the CDFG, and the ESRP concerning fence design for the SHP. The CDFG was concerned that the proposed 8x8 inch gaps were too big and would allow in predator species to the sump locations. The CDFG suggested that 4x6 inch or 5x5 inch gaps would be more appropriate. The ESRP responded that 4x6 inch openings would be fine, but 6x6 inch openings would be better for the San Joaquin kit fox and would still exclude predators. AECOM noted that the gap design objective for the sumps was different from that for the road design modifications (keeping predators out versus maintaining movement and permeability).

March 21, 2011. Caltrans informed the Service that following a meeting with the CDFG to discuss project matters, Caltrans had decided not to pursue a 2081 Incidental Take Permit or a CD under CESA with the CDFG, as it had determined that take of the San Joaquin kit fox, as defined under CESA, could be avoided.

June 22, 2011. A meeting was held at the SFWO and attended by the Service, AECOM, Parsons/TRIP, the City of Bakersfield, and Caltrans. Participants discussed updates regarding the status of the TRIP projects, the SHP, conservation easements and endowments, future work products, and possible additional funding support for the TRIP projects.

July 1, 2011. AECOM e-mailed draft notes from the June 22 meeting for circulation and comment.

January 30, 2012. A meeting was held at the SFWO and attended by the Service, AECOM, Parsons/TRIP, the City of Bakersfield, and Caltrans. Participants discussed updates regarding the status of all the TRIP projects, the resolution of encumbrances, options for providing long-term conservation assurances, potential funding mechanisms, the proposed schedule for continued development and eventual implementation of the SHP, and preparation of the Long-Term Management Plan.

February 20, 2012. AECOM e-mailed draft notes and action items from the January 30 meeting for circulation and comment.

Project-specific coordination

October 11, 2011. The Service received a letter from Caltrans requesting formal consultation for the project for the San Joaquin kit fox. Two copies of the September 2011 BA were included in the initiation package.

October 21, 2011. Caltrans forwarded an e-mail to the Service with attached draft biological opinions for the current project and several other future TRIP projects, as prepared by AECOM; these were sent with the intent to help expedite formal consultation for the TRIP projects.

November 28, 2011. The Service e-mailed Caltrans with questions and comments regarding the BA.

November 29, 2011. Caltrans e-mailed the participants of the TRIP program to remind everyone of consultation and NEPA delegation procedures and that there would be no further need for the draft biological opinion templates developed by AECOM.

December 12, 2011. Caltrans e-mailed the consultant's responses to the Service's earlier BA-related questions, which included weblinks to two reports on focused surveys for special status plant species (February 13, 2009, revised June 19, 2009; and November 16, 2009).

December 21, 2011. AECOM e-mailed the Service to inquire about setting up a meeting to discuss the status of the Sump Habitat Program. Attached was a copy of the notes from the previous meeting held June 22, 2011.

January 4, 2012. The Service e-mailed Caltrans an update on the status of the biological opinion and to ask several additional project questions (i.e. whether Caltrans was amenable to incorporating an additional minimization measure concerning plant surveys; and what updates there were regarding the SHP).

January 5, 2012. Caltrans telephoned the Service to provide some background on the issues concerning the SHP, which the City planned to discuss in further detail at the upcoming meeting at the end of January.

January 10, 2012. Caltrans e-mailed the Service to confirm that both Caltrans and the City approved of incorporating the additional minimization measure concerning proposed plant surveys into the biological opinion.

BIOLOGICAL OPINION

Description of the Proposed Action

The purpose of the project is to serve existing and projected travel demand along the State Route (SR) 58 corridor by improving east-west traffic flow on the local and regional transportation systems and to improve traffic operations to accommodate planned growth. The project site extends through the urban core area of metropolitan Bakersfield.

Caltrans, in cooperation with the City and the County of Kern, proposes to improve an approximately 5.6-mile segment of SR 58 (post miles (PM) 46.1 to 51.7), known locally as Rosedale Highway, from west of Allen Road to SR 99 in the Oildale and Rosedale United States Geological Survey (USGS) 7.5-minute quadrangles. This segment is located within unincorporated Kern County (County) and the City of Bakersfield. Two new lanes will be built to create a six-lane roadway; east of Gibson Street, lane-striping and the median will be modified in order to transition to the new lane configuration. Cross streets may also be restriped at their intersections with SR 58 in order to improve traffic operations. Construction depth for the roadway widening will be five feet or less.

Design features and construction activities of the proposed project include a grade-separated rail crossing that will be constructed between Mohawk Street and Landco Drive. As part of the first phase of improvement activities, the road will be widened to six lanes, the railroad gates will be installed, and 11 foot (ft.) turnouts will be provided to allow trucks and buses to move outside the traffic lanes. As part of the final phase of the project, a grade-separated rail crossing (in which the road goes over the railroad tracks) over the San Joaquin Valley Railroad will be constructed on the current SR 58 alignment. A temporary route located adjacent to the north side of the roadway will be provided during construction to maintain roadway function. As a result, additional ROW will need to be acquired to cover this area.

Caltrans will relinquish to the local City and County agencies the right-of-way (ROW) for the segment of the project between Allen Road and Mohawk Street; here, the roadway will be designed to local standards (e.g. the standard cross-section for this segment will be 110 ft.). Between Mohawk Street and SR 99, the roadway will be designed to State standards and therefore additional property will need to be acquired.

In addition to roadway widening, other proposed activities include:

- Widening of the bridge in two locations over the Calloway Canal and the installation of new bridge columns at the west crossing and at the proposed overcrossing; due to pile-driving, the maximum ground disturbance depth will be approximately 45 ft. The existing bridge over the Friant-Kern Canal is wide enough to accommodate the additional lanes so it is not necessary to widen this bridge.
- Relocation of traffic signals and signage
- Restriping of the approach lanes to provide an additional turn lane on the side street approaches to SR 58.
- Relocation of utilities and drainage facilities within the proposed ROW, such as power poles, underground utilities, and storm drain inlets. Relocations are expected to be completed without interrupting service. Drainage improvements will include installation of operational BMPs.
- Replacement of existing landscaping and irrigation in the median along the proposed alignment.

Scheduling

According to Caltrans' anticipated project schedule, construction is expected to be done in three phases: (1) Calloway Drive to SR 99; (2) Allen Road to Calloway Drive; (3) grade separation at the San Joaquin Valley Railroad. The first two phases are anticipated to begin in early 2014 and be completed in mid-2015. The grade separation is projected to start in 2025 and end in 2027. The roadway will be open through all phases of construction; no detours will be necessary.

Construction Staging and Site Access

The locations used for borrow material, disposal, staging and access areas, and utility relocations either will be within the footprint, or within nearby developed areas. Areas will be approved by a Service- and CDFG-approved biologist (agency-approved biologist) prior to use.

<u>Proposed Avoidance and Minimization Measures</u>

According to the BA, the Draft SHP Plan, the Draft Implementation Plan, measures previously established in the Morning Drive/SR 178 Interchange Project biological opinion, in addition to further discussion with Caltrans biologists and consultants, Caltrans, in coordination with the City, proposes to implement the following guidelines to minimize or avoid impacts to listed species that are known and/or have the potential to occur within the vicinity of the project area:

Construction Guidelines

1. Chemicals, lubricants, and petroleum products will be closely monitored and handling precautions will be used. All equipment will be maintained to prevent leaks of fluids,

such as gasoline, oils, or solvents. If any spills occur, cleanup will take place immediately.

2. Any sensitive sites will be designated as environmentally sensitive areas (ESAs) to prevent accidental construction-related effects.

3. Trees, shrubs, and other vegetation will be removed prior to the nesting season of migratory birds.

4. The contractor will at all times adhere to the *State of California, Department of Transportation Standard Specifications* for avoidance of water pollution (Section 7-1.01G; July 1, 2008). These measures include detailed recommendations for keeping heavy machinery out of the water, limiting the amount of material (excavated or construction materials) that enter the waterway, and maintaining flows at all times. Temporary measures may include, but are not limited to, the use of sediment basins, hay bales, and downstream silt catchment.

5. A Storm Water Pollution Prevention Plan (SWPPP) will be prepared prior to construction to reduce or eliminate any water quality reductions that might occur as a result of the project.

6. Staging and refueling areas for equipment will be located a minimum of 150 ft. away from any active stream channel. If equipment has to be washed, washing will occur where water cannot flow into a stream channel.

7. Soil exposure will be minimized through the use of BMPs, ground cover, and stabilization practices. Exposed dust-producing surfaces will be sprinkled daily with water until wet while avoiding producing runoff.

    a. The contractor will conduct maintenance of erosion and sediment control measures as needed. Inspectors will be on-site daily to monitor the need for these types of activities. All such measures will be removed after the area is stabilized or as directed by the resident engineer.

Proposed Conservation Measures for Listed Species

1. Caltrans will include Special Provisions that include the avoidance and minimization measures of this biological opinion in the contractor bid package during solicitation for bid information.

2. Caltrans will conduct updated full protocol-level botanical surveys during the appropriate blooming periods for the following five species: California jewelflower, Kern mallow, San Joaquin woolly-threads, Bakersfield cactus, and San Joaquin adobe sunburst. Surveys will be undertaken prior to the start of construction if a period of five years or more passes between the end of the original spring 2008-2009 focused botanical surveys and the construction start date in order to discover any future changes in, or new additions to, the floristic composition of federally-listed plant species at the project site.

3. Caltrans and the City will adhere to the standard construction and operational requirements described in the Service's most recent available guidelines for the San Joaquin kit fox; currently this is the revised January 2011 *Standard Measures for Protection of the San Joaquin Kit Fox Prior to or During Ground Disturbance Construction and Operation Requirements* (Standard Measures).

4. No less than 30 days but no more than 60 days prior to road construction, an agency-approved biologist will conduct preconstruction surveys for San Joaquin kit fox dens within 200 ft. of the construction footprint, inclusive of utility relocations. A letter report and map of known and potential San Joaquin kit fox dens will be submitted to the Service and the CDFG. Repeat clearance surveys will be conducted no more than 14 days before construction or after any delays in construction of over two weeks. Any new San Joaquin kit fox dens identified in the interim will be reported to the Service and the CDFG in a letter report and map. If no new San Joaquin kit fox dens are observed, an internal record will be kept that includes the survey date, the agency-approved biologist, and general survey findings. Records will be submitted to the Service and the CDFG upon request.

5. Disturbance to all San Joaquin kit fox dens will be avoided to the maximum extent possible. If dens or potential dens are identified within the footprint during the 60-day or 14-day preconstruction surveys, Caltrans will request to monitor and excavate those dens that are expected to be affected by the project. Active dens will not be excavated during the natal season (approximately January 1 - June 14). The agency-approved biologist will monitor potential dens for three consecutive nights and submit monitoring results in a letter report to the Service and the CDFG, and will also oversee the excavation of dens with no San Joaquin kit fox use following approval by the Service and the CDFG.

    a. Dens found within 200 ft. of project construction but which will not be affected by construction activities, will be monitored and buffered by an exclusion zone as measured outwards from the entrance or cluster of entrances: potential or atypical dens will be protected with a 50 ft. radius buffer, and known dens will be protected with a 100 ft. buffer.

    b. If natal/pupping dens are discovered within the action area or within 200 ft. of the action area, Caltrans will immediately notify the Service and CDFG.

6. The agency-approved biologist will conduct a worker environmental awareness program for all construction crews prior to ground-disturbing activities, with the purpose of informing all crew members of the potential for the San Joaquin kit fox to occur on-site and the effects on the species by construction activities. The training will be repeated to all new crew members and annually to all crew members working in San Joaquin kit fox habitat. Crew members will sign an attendance sheet and confirm that they understand the protection measures and construction restrictions. Training materials and records of attendees will be submitted to the Service and the CDFG.

7. The agency-approved biologist will monitor road construction activities once per day and will verify that construction complies with the measures laid out in this biological

opinion, as well as in the construction and operation requirements described in the revised 2011 Standard Measures. The agency-approved biologist will maintain a log of daily monitoring notes that can be summarized and transmitted to the Service and the CDFG by request.

8. Fencing is not proposed for any portion of the project's ROW. However, if it becomes necessary during a later planning stage, permeable fencing will be installed in all locations where permanent new fencing is required. One or a combination of three design options may be adopted to provide the San Joaquin kit fox with passage and movement opportunities, and to minimize the potential to disrupt north-south species movement and habitat fragmentation of the project area:

    a. Elevate the bottom of the fence five inches above ground to allow unobstructed movement by the San Joaquin kit fox under the fence.

    b. Install ground-level 8 x 8 inch wide gaps no more than 100 ft. apart along the length of the fence to allow for San Joaquin kit fox movement at regular intervals along the ROW.

    c. Install fencing with a minimum mesh size of 3.5 x 7 inches, preferably 5 x 12 inches, to allow unlimited movement through the fence.

9. Curbed medians are proposed to address public safety. Their height will be no greater than 10 inches. Ten-inch curbed medians will remain un-vegetated so as not to obstruct the visual field of the San Joaquin kit fox near the roadway. Curbed medians less than 10 inches in height and which require landscaping will be planted with low-level vegetation (i.e. less than six inches) that will not need mowing.

10. Landscaping will be designed in conjunction with the curbed median design in order to allow unobstructed visibility to the San Joaquin kit fox and to maintain and/or enhance opportunities for movement across the roadway. Three alternative strategies are proposed: 1) select plants that do not exceed six inches tall at maturity; 2) maintain vegetation height so that it does not exceed six inches; and/or 3) create gaps of no less than four ft. wide every 12 ft. in areas landscaped with trees and shrubs.

11. No median barriers are currently proposed; however, if taller median barriers are required in a later planning stage for purposes of public safety, Caltrans-designed modified median barrier type 60/S will be used. Caltrans' type 60/S design previously has been utilized (e.g. amended Biological Opinion for the State Route 99 Goshen to Kingsburg 6-Lane Project, Tulare and Fresno Counties; Service File number 81420-2009-F-0752) and includes 9-inch radius openings (semicircular openings 9 inches high x 18 inches wide) spaced every 150 ft. to allow passage by the San Joaquin kit fox. Maintaining permeability in this manner will also reduce the potential to disrupt north-south species movement and connectivity in the project area.

12. Existing San Joaquin kit fox movement corridors along the canals and railroad will be preserved through the use of existing bridges. The toe-of-road fill and bridge support walls will be maintained and new walls will be designed to be located no less than 20 ft. from the centerline of both canal access roads and the railroad.

13. Warning signs alerting east- and west-bound drivers to potential kit fox presence are proposed on Rosedale Highway at several locations. Intersections under consideration include Rosedale Highway and Calloway Drive, Coffee Road, and Landco Drive. The need for and number of appropriate signage at intersections will continue to be evaluated as the project design advances. Signage proposed will follow FHWA (2003) guidelines or other guidelines recommended by Caltrans.

The MBHCP Trust Group provided a letter to the City, dated December 3, 2010, in which it approved the ongoing use of the MBHCP for proposed compensation obligations for all TRIP projects; it also permitted payment to occur on an individual project basis after the approval of the final environmental document (FED) for each project. The City will pay the appropriate fee amount to the Trust Group and the Trust Group will acquire the required acreage amounts to be protected in perpetuity.

14. The City will compensate for the permanent loss of 1.21 acres (ac) and temporary disturbance to 6.61 ac of habitat suitable for the San Joaquin kit fox by funding the purchase of 10.90 ac (using a 3:1 compensation ratio for permanent effects and 1.1:1 compensation ratio for temporary effects) through the MBHCP.

    a. Prior to construction, the limits of impacted habitat acreage by vegetation type will be verified and delineated on a map, to be submitted for approval to the Service and the CDFG. This will be done prior to its submittal to the City of Bakersfield Planning Department for fee payment.

    b. All areas temporarily disturbed by project activities will be restored following the completion of construction.

The SHP will provide long-term habitat conservation for the urban San Joaquin kit fox population in the metro-Bakersfield area by focusing on sumps (i.e. stormwater drainage basins) as known and functional habitat for the species. The City, in coordination with Caltrans, proposes to utilize the SHP to compensate for collective effects to the San Joaquin kit fox engendered by all six TRIP road improvement projects. The SHP's conservation goals include measures addressing the installation of artificial dens in selected sumps, the enhancement of San Joaquin kit fox habitat by controlling vegetation in and around dens, the increase in San Joaquin kit fox accessibility to sumps through fence/gate openings (with proposed dimensions of 6 x 6 inches to exclude predators like coyotes (*Canis latrans*) and medium- to large-sized dogs), and the reduction in the potential for impacts to the San Joaquin kit fox associated with regular maintenance activities and predator access. The City provided a letter of commitment to the Service, dated August 10, 2010, fully supporting and providing assurance of the implementation and management of the SHP and its conservation efforts.

15. The basic conceptual framework for the SHP is described in the September 2010 Draft SHP Plan, which addresses five core conservation measures in detail that are integral to the implementation and success of the SHP: 1) the selection of sumps that maintain San Joaquin kit fox accessibility and/or habitat (i.e. those of high/medium conservation priority based on the relative potential for minimizing program-level effects); 2) the installation and maintenance of San Joaquin kit fox enhancement features (i.e. fence/gate gaps, artificial dens, conservation zones, signs, and enhancement maintenance and repair); 3) the management of sump vegetation compatible with San Joaquin kit fox presence and/or use (i.e. performance of routine maintenance outside the San Joaquin kit fox natal season and the use of hand tools in conservation zones and new active dens); 4) the biological monitoring and reporting of results (i.e. pre-maintenance surveys; den monitoring and supervised den excavation; environmental awareness training; maintenance monitoring; annual enhancement inspection; annual San Joaquin kit fox sump use monitoring; and annual reporting); and 5) the provision of long-term conservation assurances (i.e. individual conservation easements for each sump; a perpetual non-wasting endowment for management, maintenance, and monitoring costs associated with ongoing implementation; and an agency-approved Long-Term Management Plan. The proposed easement and endowment holder(s) must be Service-approved third-party organizations). Further details in regards to these five core measures can be found in the Draft SHP Plan.

    a. The SHP will continue to be updated, refined, and ultimately finalized through an ongoing collaborative consultation process involving Caltrans, the City, the Service, Parsons/TRIP, and AECOM, over the course of the four remaining TRIP projects.

    b. The finalized SHP will be established and implemented within one year of the approval of the FED for the last of the six TRIP projects. Caltrans will also fully fund the SHP within one year of this approval. Caltrans and the City will share responsibility for the SHP; Caltrans will adhere to the proposed avoidance and minimization measures and terms and conditions of this biological opinion and will be responsible for the overall implementation of the SHP, while the City will be responsible for enhancing sumps and conducting long term management of the SHP.

<u>Action Area</u>

The action area is defined in 50 CFR § 402.02, as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The action area for this project is composed of the project footprint, which consists of the existing 5.6 mi of Rosedale Highway hardscape and shoulders; new ROW acquisitions necessary for construction activities; and portions of non-native grassland, developed/ornamental lands, ruderal/disturbed lands, and open water/waterway habitats (i.e. Calloway Canal and Emery Ditch) in which permanent and temporary effects from construction will occur, including a total of 1.21 ac and 6.61 ac of permanently and temporarily affected habitat, respectively, due to activities associated with roadway lane expansion, bridge widening over the Calloway Canal, and the building of the grade-separated rail crossing. Additionally, the action area includes two potential sump locations identified for enhancement and preservation as part of the overall SHP.

Analytical Framework for the Jeopardy/No Jeopardy Determination

In accordance with policy and regulation, the following analysis relies on four components to support the jeopardy/no jeopardy determination for the San Joaquin kit fox: (1) the *Status of the Species*, which evaluates the species' range-wide condition, the factors responsible for that condition, and its survival and recovery needs; (2) the *Environmental Baseline*, which evaluates the condition of the species in the action area, the factors responsible for that condition, and the role of the action area in the species' survival and recovery; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the species; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the species.

In accordance with policy and regulation, the jeopardy/no jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the species' current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the San Joaquin kit fox in the wild.

The following analysis places an emphasis on consideration of the range-wide survival and recovery needs of the species and the role of the action area in meeting those needs as the context for evaluating the significance of the effects of the proposed Federal action, combined with cumulative effects, for purposes of making the jeopardy/no jeopardy determination. In short, a non-jeopardy determination is warranted if the proposed action is consistent with maintaining the role of habitat for the species' populations in the action area for the survival and recovery of the species.

Status of the Species

Refer to the *San Joaquin Kit Fox (Vulpes macrotis mutica) 5-Year Review: Summary and Evaluation* (Service, 2010) for the current Status of the Species. The 5-Year Review provides a description of the species, including its distribution, habitat requirements and other life history information, current threats, an analysis of progress made in recovering the species, and recommendations for recovery actions over a future five year period.

According to the CNDDB (2011) there are 24 documented sightings of the San Joaquin kit fox within the Oildale and Rosedale USGS 7.5-minute quadrangles, which cover the action area. Two of the most recent observations date from 2007. Of the total documented sightings, there are five records from the vicinity of the Rosedale Highway.

While we are not cognizant of prior or contemporaneously occurring State, local, or private actions in the vicinity of the action area, we are aware of two separate Federal actions concerning effects to the San Joaquin kit fox that have previously completed consultation with the Service: (1) the Westside Parkway SR 58 Project (Service File numbers 1-1-98-F-0139, 81420-2008-F-

0368; as amended 1-1-00-F-0185, 1-1-04-F-0194, 81420-2008-F-0368-27, 81420-2008-F-0368-28) – Phase 1 of the project, the Mohawk Street Extension, abuts the eastern portion of the present project's action area at the intersection of SR 58 and Mohawk Street; and (2) the Rosedale Union School District Proposal to Attain Incidental Take as an Addendum to the Section 10(a)(1)(B) MBHCP for two development actions on school grounds (Service File number 81420-2011-TA-0109), which is located in the western portion of the present project's action area, immediately east of Rosedale Middle School at the southwest corner of SR 58 and Old Farm Road.

As an area where the San Joaquin kit fox has adapted to the urban environment, traffic-related incidents have been and will continue to be the primary source of mortality in Bakersfield (Cypher, 2000; Bjurlin *et al.*, 2005). Other dangers posed by the urban environment of the metro-Bakersfield action area and its vicinity include predation from domestic dogs and entanglement in playing field and schoolyard equipment like soccer nets that are found in the grounds of schools like Rosedale Middle School.

Environmental Baseline

Prior to the expansion of urban development in northwestern Bakersfield and the original construction of SR 58, there existed many more tracts of undisturbed habitat suitable to the San Joaquin kit fox; however, ongoing urbanization has continued to result in its loss and fragmentation. Currently, non-native grassland areas are present in undeveloped lots interspersed with developed areas along SR 58; and ruderal and disturbed habitats are found in low-density industrial developments, landscaped vegetation and open space areas associated with the Rosedale Middle School and low-density commercial areas, vacant lots, and cleared roadsides. Calloway Canal and Emery Ditch are waterways present within the action area, and contain non-native grassland vegetation (no water was observed in them during the survey periods).

Despite the effects of continued habitat fragmentation and degradation, and roadway and vehicle-related risks, the action area still provides suitable denning and foraging habitat for the San Joaquin kit fox; furthermore, individuals and den sites are known to be present. There also exist potential movement corridors for the species in the form of the Friant-Kern Canal, the Calloway Canal, Emery Ditch, and the San Joaquin Valley Railroad line. The urban Bakersfield San Joaquin kit fox population is the only substantial population of the species known to occur outside the core areas of western Kern, Carrizo Plain Natural Area, and Ciervo-Panoche (Cypher and Warrick, 1993; Cypher *et al.*, 2000), which contain significantly greater areas of less disturbed natural habitat. The Bakersfield population therefore comprises an important satellite population also identified as significant for recovery area purposes.

The San Joaquin kit fox has been documented previously throughout the Rosedale action area. Data provided in the MBHCP's San Joaquin kit fox database maintained by the City's Planning Department were combined with the CNDDB records, and with the data from survey efforts conducted by the consultants, AECOM and Paul Pruett and Associates in the spring and summer of 2008, to obtain current information on the presence of the San Joaquin kit fox in the action area. Surveys for dens and sign were conducted in the action area following a methodology established for TRIP and approved by the Service and the CDFG as described in the Draft Implementation Plan. According to the BA, two discrete survey sessions were carried out in order to maximize the potential for kit fox detection during both denning (first survey period: May 20, June 1 and 17, July 7, 2008), and dispersal (second survey period: July 29-30, 2008). Surveys were conducted on all accessible parcels for which the property owner granted access; all proposed project impact areas were surveyed. One San Joaquin kit fox was observed at the Rosedale Middle School on the south side of SR 58, east of Allen Road and west of Old Farm Road. Four potential dens and four instances of scat were also observed in the area. One of these potential dens and one of these instances of fresh scat were observed north of Rosedale Middle School, north of SR 58. The second potential den was observed south of SR 58 and west of Jewetta Avenue. The third and fourth dens and the remaining three scat locations were observed in the eastern portion of the alignment just west of Mohawk Street. The San Joaquin kit fox appears to be present in the low-density industrial lands of the eastern segment of the action area and found in the vacant lots and middle school in the western segment. The San Joaquin kit fox is thus evidenced in the action area based on the biology and ecology of the species; the presence of suitable habitat for denning, foraging, and movement; and known occurrences and associated sign in the action area.

Effects of the Proposed Action

Habitat Loss and Disturbance

The proposed project will result in the permanent loss of 1.21 ac of suitable San Joaquin kit fox habitat due to widening activities to accommodate the two new Rosedale Highway lanes, the bridge widening over the Calloway Canal, associated various intersection improvements, new ROW limits, and the grade-separation rail crossing; this total is composed of 0.18 ac of non-native grassland, 1.00 ac of ruderal/disturbed land, and 0.03 ac of open water/waterways (in this case, the waterways are also considered to be suitable habitat for the species since non-native grassland rather than water was observed during surveys), all of which represent habitat for the San Joaquin kit fox to inhabit and utilize for shelter, escape cover, foraging, breeding, and other life cycle needs. Additionally, a total of 6.61 ac of suitable habitat, which is composed of 3.25 ac of non-native grassland, 3.30 ac of ruderal/disturbed areas, and 0.06 ac of open water/waterway areas, will be temporarily disturbed due to the relocation of utilities, access use, and the staging and lay-down of construction equipment.

One of the potential dens identified during the 2008 surveys is located within the project footprint and will likely be permanently destroyed during construction. This den loss is based on the current data provided, but losses may change if the San Joaquin kit fox either creates new dens within the footprint or abandons others. Regardless, den loss results in loss of cover and breeding/rearing space and leads to species displacement.

To help offset the loss of habitat, Caltrans proposes, through participation in the MBHCP, to purchase compensation acreage that is of commensurate or higher quality to the habitat lost due to project construction, ensuring that the species can continue to breed, feed, shelter, and meet all its life cycle functions. The MBHCP's goal is to acquire, preserve, and enhance large, contiguous native habitats that support listed and sensitive species like the San Joaquin kit fox.

Caltrans, in coordination with the City, is also developing the SHP, a comprehensive and extensive conservation plan to help address habitat loss and effects to the San Joaquin kit fox. The SHP intends to address collective construction effects deriving from the current project, four future TRIP projects, and one previously consulted-on TRIP project in the metro-Bakersfield area by protecting and enhancing sumps through easement holdings as a crucial habitat type for the urban Bakersfield San Joaquin kit fox population. Several of the SHP's proposed conservation measures include the installation of artificial dens, improved access to denning habitat, and security from predators at sump locations. Caltrans' compensation measures will help lead to preservation and enhancement of suitable San Joaquin kit fox habitat and will contribute to protecting and managing the habitat for the conservation of the species in perpetuity. These lands will also help maintain the geographic distribution of the species and will contribute to the recovery of the species by increasing the amount of habitat that is secure from development threats.

Displacement and Entombment

The risk of crushing and entombing the San Joaquin kit fox in its dens (both natural and man-made) during groundbreaking activities and major construction is a likely effect. Sizeable road and bridge widening activities using heavy machinery and equipment, as in this case, run the risk of burying or permanently displacing individuals, which can end up influencing local population abundance and distribution. Destruction of shelters could also affect San Joaquin kit fox survival by reducing the number and distribution of escape refuges from predators.

Road Mortality and Wildlife Crossing Viability

San Joaquin kit fox injury and mortality are very likely to occur when individuals attempt to cross roads. The type of roadway found in the action area combined with current traffic levels and the need to accommodate future increases in traffic levels through lane expansion, lead to the potential for increased vehicle strikes. Bjurlin *et al.* (2005) reported that the vehicular-based mortality of the San Joaquin kit fox occurred most frequently on major arterial roads with relatively high traffic volumes. Those with four or more lanes accounted for approximately 71 percent of the total, with collector roads, local roads, and highways accounting for less of the total. The authors further noted that strikes also occurred most frequently at intersections and in locations where the San Joaquin kit fox was abundant. The majority of strikes are likely to occur at night when individuals are most active. Driver visibility is lower at night, also increasing the potential for hits. Because this project will widen SR 58 through the addition of two new lanes and increase traffic volume, it is expected to indirectly increase San Joaquin kit fox mortality from vehicle strikes.

The efficacy of wildlife passageways and crossings in facilitating safe travel routes and preventing injury or mortality due to vehicle collisions remains an issue of ongoing discussion; many variables influence the value of such designs and whether species will utilize them. Such factors include the specific location in which a structure will be built based on wildlife habitat linkage and connectivity needs; the size and type of crossing structure design appropriate to the species and project needs; the degree of naturalness exhibited by the structure; the mode of approach species have towards a structure (e.g. presence of vegetation and line of sight); the materials used in the bottom of a crossing structure; and placement of fencing and types used (Ruediger & DiGiorgio, 2007). For example, specific utilization of culverts by the San Joaquin kit fox is ambiguous; on the one hand, some research indicates that strategies involving these crossing structures and exclusionary fencing are unlikely to benefit the San Joaquin kit fox in some instances (Cypher *et al.*, 2009). On the other hand, culvert usage has been documented by the ESRP, with Cypher (2000) reporting that culvert use was positively correlated with increasing culvert size. To reduce San Joaquin kit fox injury and mortality stemming from vehicle strikes, Caltrans has developed the best available information through discussions with the ESRP, the Service, the CDFG, and the City. Using various methods of on-site project design modifications relating to permeability, Caltrans has incorporated measures believed to present the greatest value to the species in the context of the project. Because the action area is known to be used and inhabited by the San Joaquin kit fox, and the areas north and south of SR 58 between Calloway Drive and Mohawk Street are known activity areas for the species, the primary objectives of these modifications are to provide opportunities for the San Joaquin kit fox to cross the highway in spite of construction impacts; to minimize the potential for an increase in vehicular injury and mortality; and to maintain San Joaquin kit fox movement through preserving existing physical corridors such as the two canals and ditch, the railway line, and culverts. Although the Service anticipates that these measures will reduce mortality from vehicle strikes, it is not possible to quantify the extent to which mortality will be reduced.

Trash

Since there is no specifically proposed disposal plan for trash and debris on the project site, we anticipate adverse effects resulting from predation, since abandoned trash items are likely to attract species such as coyotes and bobcats which prey opportunistically upon the species.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

The Service is not aware of any non-Federal actions currently planned in the action area that will further disturb the San Joaquin kit fox or directly remove its habitat.

Conclusion

Conservation measures set forth for implementation before, during, and following project work; project design modifications; and the SHP, which is intended to address the additive effects resulting from this and other TRIP projects in the metro-Bakersfield area, will all serve to minimize program and project-level effects and the extent of take associated with the San Joaquin kit fox. Effects and take amount also will be minimal in regards to the wider subpopulation of San Joaquin kit foxes present within the action area, within the wider metro-Bakersfield region, and within Kern County at large. After reviewing the current status of the San Joaquin kit fox, the environmental baseline for the action area for the species, the effects of the proposed project on the species, and the cumulative effects, it is the Service's biological opinion that the project, as proposed, is not likely to jeopardize the continued existence of the San Joaquin kit fox.

INCIDENTAL TAKE STATEMENT

Section 9(a)(1) of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened fish and wildlife species without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

The measures described below are non-discretionary, and must be implemented by Caltrans so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption under section 7(o)(2) to apply. Caltrans has a continuing duty to regulate the activity covered by this Incidental Take Statement. If Caltrans (1) fails to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

Amount or Extent of Take

The Service anticipates that incidental take of the San Joaquin kit fox will not be possible to quantify for the following reasons: when not foraging, mating, or otherwise being active on the surface, the San Joaquin kit fox inhabits dens, making consistent and accurate detection problematic; it may range over a large territory; it is primarily active at night; and it is an intelligent but shy animal likely to avoid human presence. Thus, the Service cannot quantify the exact number of San Joaquin kit foxes that are anticipated to be taken as a result of the proposed action. In instances when take calculations cannot be produced, the Service may quantify take in numbers of acres of permanently lost or degraded habitat; since take is expected to result from these impacts to habitat, the quantification of acreage becomes a direct surrogate for the species that will be taken. The Service therefore anticipates take incidental to the project as all San Joaquin kit foxes inhabiting, foraging in, or moving through a total of 7.82 ac of suitable habitat that will be permanently lost and temporarily disturbed. At least one San Joaquin kit fox den may be destroyed as a result of project construction and a small number of dens could be disturbed by the SHP. Upon implementation of the *Reasonable and Prudent Measures*, *Terms and Conditions*, and the *Proposed Avoidance and Minimization Measures* considered herein, incidental take within this acreage, and at sumps identified in the SHP, in the forms of harm and harassment due to roadway and bridge lane expansion, the construction of a grade-separated rail crossing, pile installation in one of the canals, sump activities, and other associated construction activities leading to habitat loss and disturbance, and in the forms of injury and mortality (an indeterminable, but likely small level) due to entombment in dens, vehicular strikes, and increased predation resulting from lack of trash disposal, will become exempt from the prohibitions described under section 9 of the Act.

Effect of the Take

In the accompanying biological opinion, the Service has determined that this level of anticipated take is not likely to jeopardize the continued existence of the San Joaquin kit fox.

Reasonable and Prudent Measures

The following reasonable and prudent measures are necessary and appropriate to minimize the effects of the proposed action on the San Joaquin kit fox.

1. All of the conservation measures proposed in the BA, the Draft SHP Plan, the *Description of the Proposed Action*, and as supplemented and modified in the Terms and Conditions below, must be fully implemented.

2. Trash must be handled in a manner so as to minimize the potential for take of the San Joaquin kit fox resulting from the increased presence of predator species attracted to the project site by inappropriately disposed-of waste items.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, Caltrans, as well as any contractor acting on its behalf, must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These Terms and Conditions are nondiscretionary.

The following Terms and Conditions implement Reasonable and Prudent Measure one:

1. Caltrans shall be responsible for implementing all measures described in this biological opinion. Terms and conditions, such as 2.b., that apply to contractor activities shall be conditioned in contracts for the work.

2. In order to monitor whether the amount or extent of incidental take anticipated from implementation of the project is approached or exceeded, Caltrans shall adhere to the following reporting requirements. Should this anticipated amount or extent of incidental take be exceeded, Caltrans must immediately reinitiate formal consultation as per 50 CFR 402.16.

    a. For those components of the action that will result in habitat degradation or modification whereby incidental take in the form of harm is anticipated, Caltrans shall provide weekly updates to the Service with a precise accounting of the total acreage of habitat impacted. Updates shall also include any information about changes in project implementation that result in habitat disturbance not described in the *Description of the Proposed Action* and not analyzed in this biological opinion.

b. For those components of the action that may result in direct encounters between listed species and project workers and their equipment whereby incidental take in the form of harassment, harm, injury, or death is anticipated, Caltrans shall immediately contact the Service's SFWO at (916) 414-6600 to report the encounter. If an encounter occurs after normal working hours, Caltrans shall contact the SFWO at the earliest possible opportunity the next working day. When injured or killed individuals of the listed species are found, Caltrans shall follow the steps outlined in the *Salvage and Disposition of Individuals* section.

c. Before construction starts on this project, the Service shall be provided with the final documents related to protection of conservation acres, including fee payment of compensation acreage. Proof of recorded easement and perpetual non-wasting endowment holdings for each sump included in the SHP have long-term conservation assurances in place, and do not need to be provided to the Service prior to construction of this project. Easement and endowment documentation, as part of the SHP, will be established following the approval of the FED for the last of the six TRIP projects. Caltrans will fully fund the SHP within one year of that approval.

d. A post-construction report detailing compliance with the project design criteria and proposed conservation measures described under the *Description of the Proposed Action* section of this biological opinion shall be provided to the Service within 30 calendar days of completion of the project. The report shall include: (1) dates of project groundbreaking and completion; (2) pertinent information concerning the success of the project in meeting compensation and other conservation measures; (3) an explanation of failure to meet such measures, if any; (4) known project effects on the San Joaquin kit fox, if any; (5) observed incidences of injury to or mortality of the San Joaquin kit fox, if any; and, (6) any other pertinent information.

e. New sightings of the San Joaquin kit fox or any other sensitive animal species shall be reported to the CNDDB. A copy of the reporting form and a topographic map clearly marked with the location in which the animals were observed also shall be provided to the Service.

f. Following project completion, any and all construction debris/stockpiled materials from the project site shall be removed.

The following Term and Condition implements Reasonable and Prudent Measure two:

1. To minimize opportunistic predatory effects to the San Joaquin kit fox, Caltrans shall condition contracts with contractors to require that trash be removed daily from project areas and disposed of off-site so as not to attract predator species to the project area.

Salvage and Disposition of Individuals

In the case of an injured and/or dead San Joaquin kit fox, the Service shall be notified of events within one day and the animal shall only be handled by an agency-approved, permitted biologist. Injured San Joaquin kit foxes shall be cared for by a licensed veterinarian or other qualified person. In the case of a dead animal, the individual animal shall be preserved, as appropriate; the animal shall be bagged and labeled (i.e. species type; who found or reported the incident; when the report was made; when and where the incident occurred; and if possible, cause of death). Individuals shall be held in a secure location, such as a freezer or cooler, until instructions are received from the Service regarding the disposition of the specimen or until the Service, or another appropriate agency or qualified person, takes custody of the specimen. Caltrans must report to the Service within one calendar day any information about take or suspected take of federally-listed species not exempted in this opinion. Notification must include the date, time, and location of the incident or of the finding of a dead or injured animal. The Service contacts are Daniel Russell, Deputy Assistant Field Supervisor, Endangered Species Program, Sacramento, at (916) 414-6600 and the Service's Law Enforcement Division at (916) 414-6660.

Any contractor or employee who, during routine operations and maintenance activities inadvertently kills or injures a listed wildlife species must immediately report the incident to his representative at his contracting/employment firm and to Caltrans. This representative must contact the Service within one calendar day.

CONSERVATION RECOMMENDATIONS

Conservation recommendations are suggestions of the Service regarding discretionary measures to minimize or avoid further adverse effects of a proposed action on listed, proposed, or candidate species or on designated critical habitat, or regarding the development of new information. They may also serve as suggestions on how action agencies can assist species conservation in furtherance of their responsibilities under section 7(a)(1) of the Act, or recommend studies improving an understanding of a species' biology or ecology. Wherever possible, conservation recommendations should be tied to tasks identified in recovery plans. The Service is providing you with the following conservation recommendations:

1. It is recommended that Caltrans continue to include culverts, tunnels, or other structures along roads and highways, particularly in core and satellite population areas to allow for the safe passage of the San Joaquin kit fox. Such crossing structures would create safe dispersal corridors for multiple wildlife species, and would help reduce road mortalities and enhance public safety. Caltrans is encouraged to explore designs and include photos, plans, and other information in its BAs concerning the incorporation of wildlife passageway designs into its projects.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION—CLOSING STATEMENT

This concludes the Service's review of the proposed SR 58 Rosedale Highway Widening Project, as outlined in your letter. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or an extent not considered in this biological opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this biological opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

Please contact Jen Schofield, Biologist, or Thomas Leeman, San Joaquin Valley Division Chief, at the letterhead address or at (916) 414-6600 if you have any questions regarding this letter.

Sincerely,

Susan K. Moore

Susan K. Moore
Field Supervisor

cc:
Annee Ferranti, CDFG, Fresno, California
Kirsten Helton, Caltrans District 6, Fresno, California
David Clark, Parsons Corporation/TRIP, Bakersfield, California
Leo Edson, AECOM, Sacramento, California

Literature Cited

Bjurlin, C.D., B.L. Cypher, C.M. Wingert, and C.L. Van Horn Job. 2005. *Urban Roads and the Endangered San Joaquin Kit Fox.* California State University-Stanislaus, Endangered Species Recovery Program, Fresno, CA.

(CNDDB) California Department of Fish and Game, Natural Diversity Data Base. 2011. Element occurrence reports. Biogeographic Data Branch. RareFind 4. Government Version - April 5, 2011. Accessed December 2011.

Cypher, B.L. 2000. *Effects of Roads on San Joaquin Kit Foxes: A Review and Synthesis of Existing Data.* Endangered Species Recovery Program, California State University, Fresno, California.

Cypher, B.L., and G.D. Warrick. 1993. *Use of Human-derived Food Items by Urban Kit Foxes.* 1993 Transactions of the Western Section of The Wildlife Society 29:34-37.

Cypher, B.L., C.D. Bjurlin, and J.L. Nelson. 2009. *Effects of Roads on Endangered San Joaquin Kit Foxes.* The Journal of Wildlife Management. 73(6): 885-893.

Cypher, B.L., G.D. Warrick, M.R.M. Otten, T.P. O'Farrell, W.H. Berry, E.C. Harris, T.T. Kato, P.M. McCue, J.H. Scrivner, and B.W. Zoellick. 2000. *Population Dynamics of San Joaquin Kit Foxes at the Naval Petroleum Reserve in California.* Wildlife Monographs 145. 43 pp.

Ruediger, B. and M. DiGiorgio. 2007. *Safe Passage: A User's Guide to Developing Effective Highway Crossings for Carnivores and other Wildlife.* The Southern Rockies Ecosystem Project (SREP). 19 pp.

(Service) U.S. Fish and Wildlife Service. 2010. San Joaquin Kit Fox (*Vulpes macrotis mutica*) 5-Year Review: Summary and Evaluation. Sacramento Fish and Wildlife Office, Sacramento, California. 122 pp.

List of Technical Studies that are Bound Separately