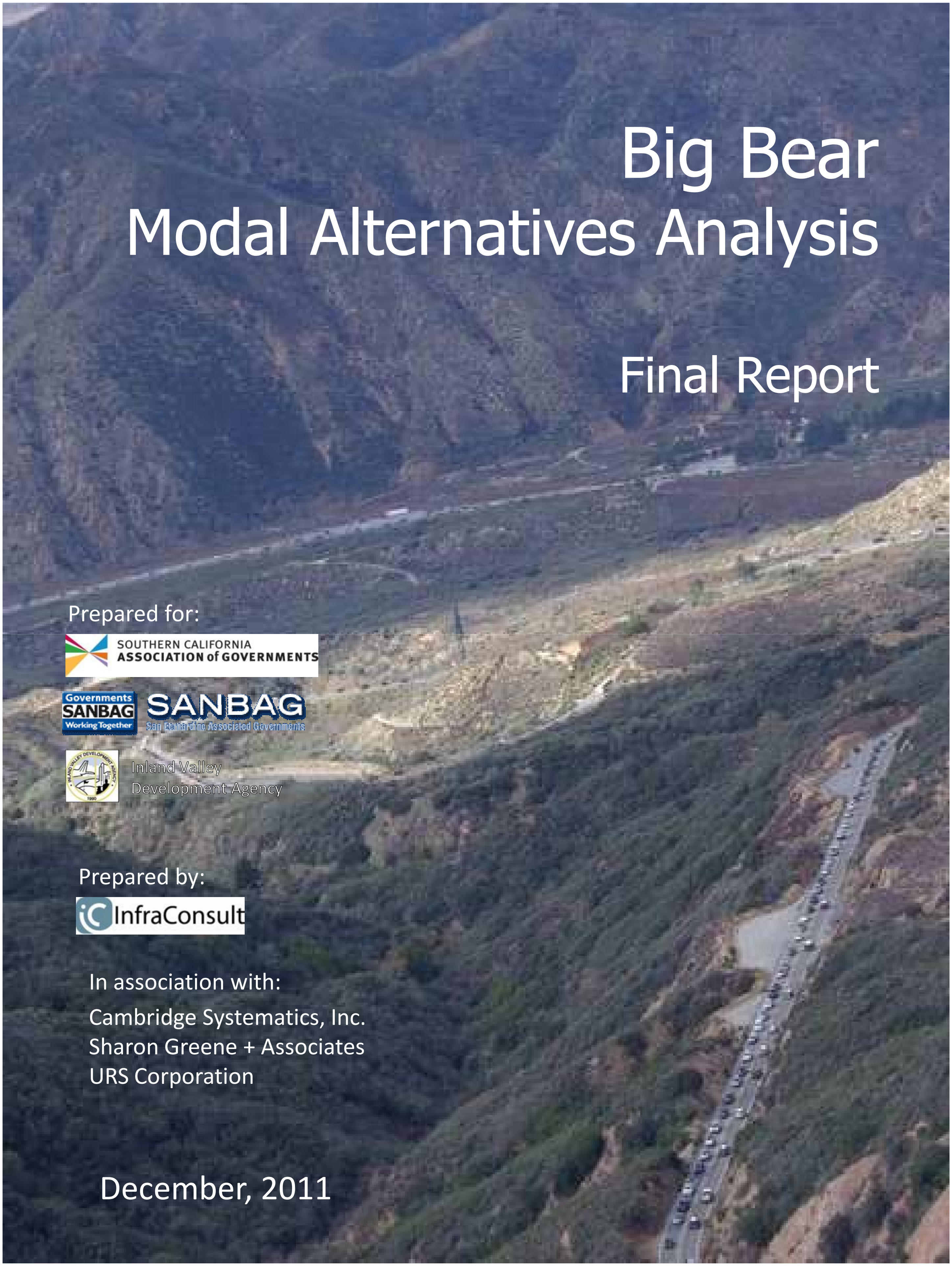

Big Bear
Modal Alternatives Analysis

Final Report

Prepared for:

SOUTHERN CALIFORNIA ASSOCIATION of GOVERNMENTS

SANBAG San Bernardino Associated Governments

Inland Valley Development Agency

Prepared by:

InfraConsult

In association with:

Cambridge Systematics, Inc.
Sharon Greene + Associates
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EXECUTIVE SUMMARY

ES.1 Background

Society is increasingly recognizing the need for man to live in balance with the environment, using the earth's natural assets in ways that will sustain a high-quality living standard over time without depleting essential resources. Planners of future transportation can contribute to a sustainable culture by developing systems that provide mobility with less reliance on fossil fuels, increased use of renewable sources, less disruption of the natural environment, and fewer emissions of pollutants and greenhouse gases. In few places around Southern California are these issues more relevant than in the mountain travel corridor between the Los Angeles Basin and the communities around Big Bear Lake.

Located high in the San Bernardino National Forest, the Big Bear Valley is both an active community and a popular recreation destination throughout the year. Primary access to Big Bear from the San Bernardino Valley and the greater Los Angeles metropolitan area is limited to three state highway routes through National Forest land, with just two lanes of capacity through most of the mountain areas. These routes have been increasingly plagued by a number of challenges that inhibit safe and convenient travel. Sections with steep grades, frequent switchback curves, limited sight distance, and slow-moving vehicles can make these roads a challenging drive under even the best of conditions. During winter snow storms, when travel demand is at its peak, travel is especially arduous due to icy conditions, chain requirements, and all-too-frequent traffic incidents. Access to the mountains has been affected by road closures for extended periods due to heavy snow, earth movement covering or undermining the road, and wildfire.

Without improvements to the system, traffic and maintenance-related problems can be expected to worsen. Weekend traffic congestion on the state highways can be expected to increase, resulting in longer periods of congestion during peak times. As traffic volumes and congestion levels increase, collision rates also typically increase. As the roadway and drainage system continues to age and deteriorate, road closures are likely to become more frequent and longer.

In addition, the future potential of the Big Bear Valley is constrained by the access limitations imposed by the highway system. No significant improvements to the roadway system are currently programmed or planned due to public sector financial constraints and the substantial environmental impact that would be associated with any major roadway capacity project in the mountains.

Various types of roadway-based strategies have been suggested to help address the system's capacity deficiencies. Each approach would increase capacity, improve roadway operations and safety, or make better use of existing capacity, but all have significant financial, environmental, or community impact issues that make them unsatisfactory approaches to addressing the long-term access needs.

On the other hand, adding capacity by developing an alternative (non-roadway) transportation mode offers advantages that a roadway improvement could not:

- An alternative system could provide convenient mountain access with minimal or no auto driving for people throughout the greater Los Angeles metropolitan area via a connection to Metrolink in San Bernardino.
- An alternative system would enable the mountains to accommodate more users for skiing, snow play, and summer recreation without the need to expand roads or parking areas.

- An alternative system could be developed along a different alignment than the existing roadway system. Therefore it might be usable during an emergency (such as wildfire or earthquake) for evacuating people or bringing in emergency personnel and equipment even if the roadways were shut down.
- An alternative system would be operable after a major snowstorm or during other types of road closures, so people and goods could move up and down the mountain even if one or all of the key mountain access roads are closed.
- The new system itself would be a tourist attraction, providing additional ridership and revenue, and providing an economic boost to areas where stations are located.
- For some types of goods, an alternative system might provide a cheaper and more efficient means of shipment to the mountain communities.

In addition, an alternative mode would likely be a more environmentally friendly alternative than road improvements.

- It would have a smaller environmental “footprint” than roads, so it would be expected to have less impact on the lands it passes through.
- It would emit fewer vehicular and greenhouse gas emissions than carrying the same number of people in autos and other vehicles.
- It would operate using a “greener” energy source (likely electricity) than the internal combustion engine.
- It would provide opportunities for transit-oriented development near mountain stations, making it possible for people to live and work and travel without need for a car.

Because of these factors, the Cities of Big Bear Lake, San Bernardino, and Highland, and the County of San Bernardino have partnered with the region’s transportation planning agencies (the San Bernardino Associated Governments, the Southern California Association of Governments, and Caltrans) and the Inland Valley Development Agency to explore the feasibility of non-roadway alternatives for future transportation of people and goods between the San Bernardino and Big Bear Valleys. This study, and a similar effort completed in 1996, explores the feasibility of developing a non-roadway mountain transportation alternative, based on the recognition that a prosperous future in the Big Bear Valley depends upon the Southern California Region's ability to take advantage of the four-season recreational assets of the San Bernardino Mountains.

ES.2 Opportunities and Constraints

Demographics

The full-time population in Big Bear is forecast to grow slowly, so visitors and part-time residents represent the demographic groups with the most future growth potential. In the City of Big Bear Lake, over 70% of the housing units are not occupied year-round and serve either as second homes or seasonal rentals; in the surrounding unincorporated areas, the percentage is approximately 50%.

Travel Conditions

Traffic congestion and road closure problems combine to indicate a clear need for additional transportation capacity to accommodate future growth in travel to and from the mountains. An alternative transportation system is an attractive alternative to adding roadway capacity because it could:

- Provide transportation of people and goods in all kinds of weather;
- Provide an alternative mode and/or route of access during an emergency;
- Have a smaller environmental “footprint” than building new roads or widening existing roads; and
- Facilitate expanded recreation opportunities in the mountains without proportional expansion of roadway and parking capacity.

Moving People with an Alternative System

The following are important factors to consider when implementing alternative methods to transport people:

Competitiveness with auto travel: To be able to attract significant numbers of riders, the new system would need to provide an overall travel time that is competitive with auto travel. This will be a determining factor in the selection of appropriate technologies.

Convenience of transporting personal belongings: To be attractive for carrying leisure travelers (weekend visitors to the mountains) or recreational trips (skiers, snow play visitors, and summer recreation visitors), the system will need to have a convenient process for loading and unloading personal belongings such as luggage and ski equipment. Since much of the corridor travel involves leisure or recreational trips, for the system to be successful it will need to conveniently serve this user group.

Distribution of people and goods: The system for distributing people (and their belongings) at the mountain end of the trip will be an important factor in attracting riders. While some destinations may be within walking distance of the stations, many destinations are dispersed throughout the mountains, so planning for an alternative system will need to include consideration of methods for moving people between the stations and their ultimate destinations. Likewise, a convenient and efficient method of moving freight from stations to its destination will be important for capturing a portion of the goods movement market.

Physical Factors

The following are important physical factors to consider:

Grades: The rapid elevation changes encountered in the mountains dictate that an alternative transportation system use a technology than can safely negotiate steep grades.

Environmental factors: When evaluating potential alignments, several environmental factors should be considered, and avoided to the extent possible, including potential landslide areas, earthquake fault zones, potential liquefaction areas, high fire hazard areas, flood plains, water courses, species habitat, and cultural resources.

Station locations: Communities to be served with stations should be selected to provide accessibility to the developed mountain communities and activity centers in the corridor; ideally, therefore, mountain stations would be located in Running Springs, Snow Valley, and Big Bear Lake (the Village area and the China Gardens/Interlaken area). Valley stations should provide park-and-ride opportunities, potential for goods movement transfers, and connections to public transportation. Stations in Highland, at San Bernardino International Airport, and at the proposed downtown Metrolink station would serve these functions.

Right of Way Issues

Coordination and consultation with the US Forest Service will be essential for the project to be successfully implemented.

Land Acquisition will likely be necessary in the developed mountain areas, where potential station sites may be located. In the San Bernardino Valley portion of the corridor, considerations for property acquisition or operating easements will also influence project viability.

ES.3 Technologies

The study identified and evaluated the range of available technological alternatives that could provide passenger and freight service from the San Bernardino Valley to Big Bear Valley. These included:

- Aerial ropeway systems with self-propelled vehicles
- Cable-propelled systems
- Suspended monorails
- Cog railways
- Funicular railways
- Air travel

Various alignments incorporating these technologies were examined in the 1996 Study to service a wide range of topographical characteristics from level grade urbanized areas to mountainous steep-grade terrain. This analysis updated the technology review performed in the 1996 Study, and sought out the latest technological advances by establishing contact with manufacturers of fixed-guideway transit systems to identify contemporary applications that would be relevant to the Big Bear corridor.

Route Length: One of the most significant challenges is the scale of the proposed Big Bear project. Most of the existing aerial transportation systems are much shorter in length/distance than the 35+/- mile system being contemplated for Big Bear. In fact, the longest elevated ropeway system that the project team was able to identify is in Sweden and is approximately nine miles in length.

Topography: Another challenge of the Big Bear project is the steep mountain grades. Preliminary alignments include areas with grades exceeding 20%, and both at-grade and aerial systems have the capability of operating at this level of incline. However, for optimal passenger comfort and operations, systems are typically designed for no more than an 8% grade. After review of the Big Bear conceptual system needs, lengths and gradients, and discussions with representatives from Dopplemayr LLC, the analysis concluded that aerial ropeway systems are best suited for shorter distances, and developing and operating a 30+ mile systems using aerial ropeway technology is not recommended.

Freight Capabilities: Research has revealed that most areas rely on trucking for freight hauling to mountain destinations, with fixed-guideway systems limited to passenger travel. All of the systems evaluated have the potential to carry freight, with varying capacities. Cog rail systems offer good freight capacity and capabilities. Self-propelled aerial ropeway technology has the capability but is unproven, while the elevated monorail and aerial cable propelled systems have limited cargo hauling capacity.

Travel Speeds: Cable propelled ropeway systems have limited speed capability, and vehicles would need to transfer between rope systems several times over the length of the corridor, so this technology could not be at all competitive with automobile travel. Elevated monorail and self-propelled ropeway technology have the potential for competitive speeds, but there have been no installations of these technologies in a corridor this long to demonstrate their capability. Cog rail operates at competitive speeds over long distances through the Alps.

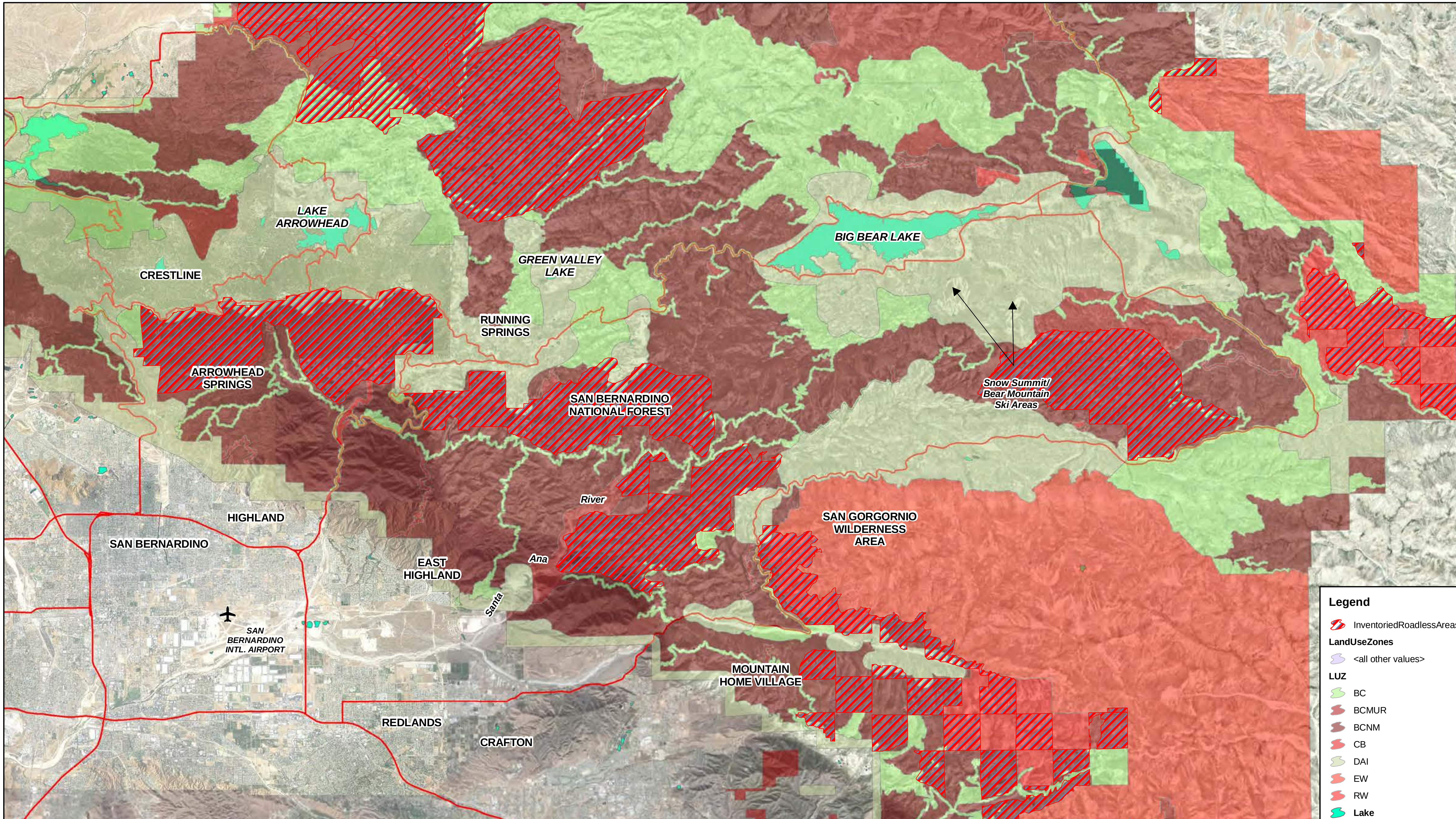
Technology Recommendation: Only the cog rail technology, which has demonstrated abilities to operate long distances through steep mountain terrain and inclement weather, is recommended to be carried forward for additional analysis and system planning.

ES.4 Alignment Alternatives

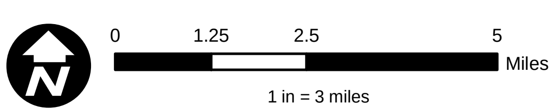
The 1996 study evaluated a number of potential alignment options through the mountain portion of the corridor from Highland to Big Bear Lake. Consultations with local US Forest Service representatives brought out the fact that the nine alternative alignments studied in 1996 pass through National Forest areas designated as incompatible with transportation uses. USFS representatives have indicated that, while it would be possible to obtain approval for a new transportation system through these areas, it would involve an extensive review and approval process within the Forest Service.

Because the National Forest land use conflicts could represent a significant impediment to the original nine alignments, the study team and Technical Advisory Committee (TAC) identified additional alignments that would eliminate or minimize corridor intrusion into roadless and non-motorized areas. Using the Forest Service mapping of compatible land use areas (shown in green colors in Figure ES.1) and non-compatible areas (shown in browns and reds), the study team and TAC identified six alternative corridors for further study, with potential variations in four of the six corridors. The alternative corridors (shown in Figure ES.2) are numbered from 1 to 6 from west to east. With variations, a total of 13 alignment alternatives were carried forward into the evaluation of system alternatives.

Figure ES.1 - USFS Land Uses



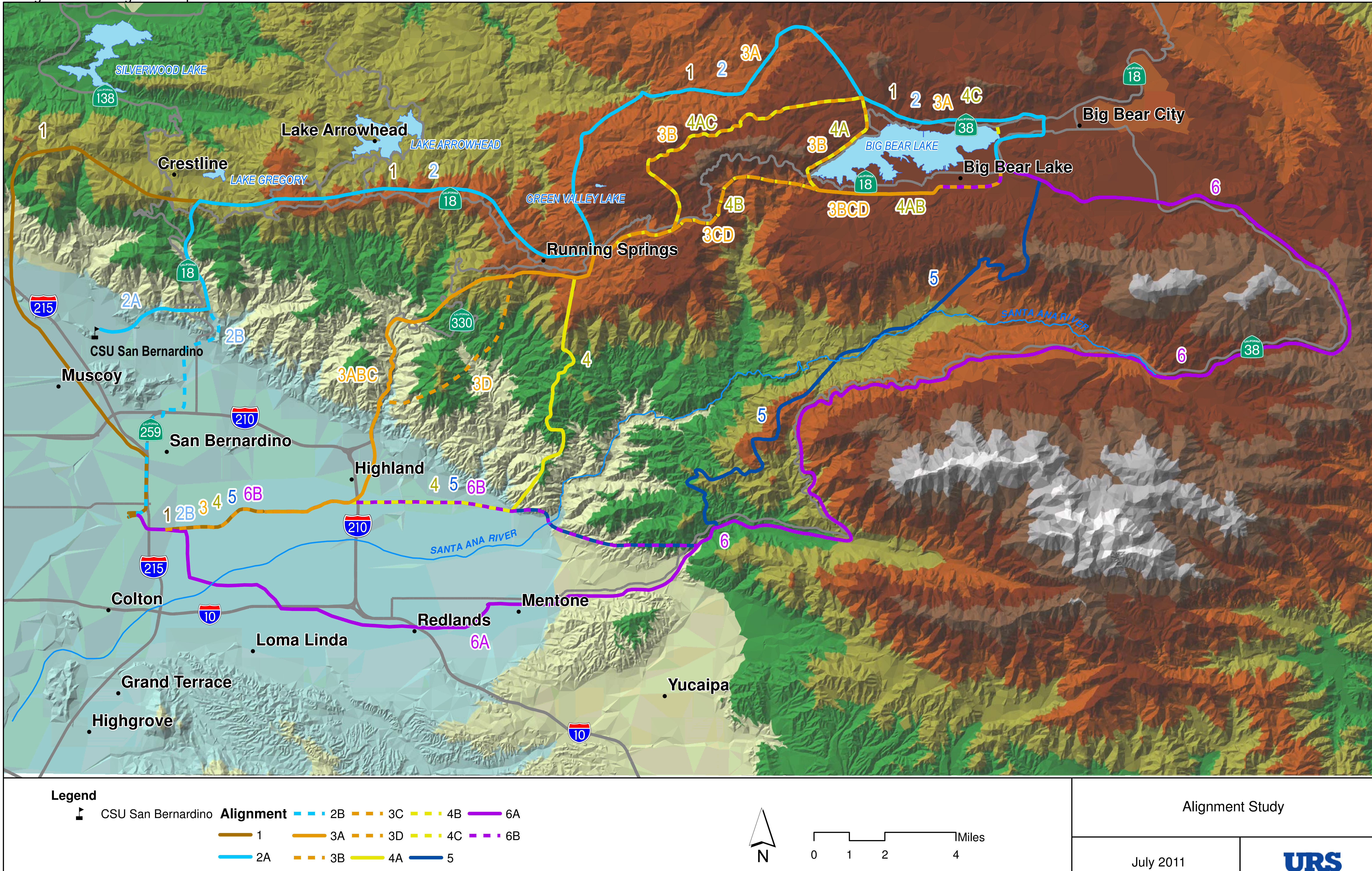
Source: USGS National Hydrography Dataset



Big Bear Modal Alternatives 2010

USFS Roadless Areas
USFS Land Use Zone (LUZ)
Green: transportation allowed
Red: transportation not allowed

Figure ES.2 - Alignment Options



ES.5 Evaluation Results

The evaluation analyzed each of the 13 system alternatives in regard to capital costs, annual operating costs, total travel time from San Bernardino to Big Bear Lake, portion of the alignment requiring cog rail operation (greater than 8% slope), estimated annual ridership and passenger revenue, estimated weekly tonnage of goods movement and annual freight revenue, the portion of the alignment crossing roadless or non-motorized areas of the National Forest, the portion crossing sensitive habitat areas, and the portion crossing geologically unstable areas. To provide a snapshot of the magnitude and range of results, Table ES.1 depicts the performance results of the alternatives with the best and worst performance for each criterion. Table ES.2 summarizes the results for each criterion and each of the 13 alternatives.

Table ES.1 - Range of Performance Results

Criterion	Best Alternative Result	Worst Alternative Result
Length of Alignment	30 miles	58 miles
Capital Cost (2011 $)	$2.8 – 5.0 billion	$5.2 – 9.6 billion
Annual Operating Cost	$11.8 million	$13.8 million
Total travel time	72 minutes	114 minutes
Cog rail operation	0 miles (of 54 total miles)	7.5 miles (of 37 total miles)
Estimated 2035 annual passengers Annual passenger revenue	981,000 $16.5 million	575,000 $9.6 million
Weekly goods movement Annual freight revenue (high rate freight strategy)	870 tons $6.7 million	525 tons $5.5 million
Roadless & non-motorized areas: Distance across Distance adjacent to	 0 miles (of 57 miles total) 0.6 miles (of 32 miles total)	 9.2 miles (of 32 miles total) 17.9 miles (of 54 miles total)
Distance across sensitive habitat areas	0.5 miles (of 40 total miles)	5.2 miles (of 41 total miles)
Distance across Very High Landslide Risk areas	2.0 miles (of 51 total miles)	22.6 miles (of 54 total miles)

Table ES.2
Big Bear Modal Alternatives Analysis
Evaluation Results Summary Matrix

Alternative	**1**	**2A**	**2B**	**3A**	**3B**	**3C (original Alt. 3)**	**3D (original Alt. 4)**	**4A**	**4B (original Alt. 5)**	**4C**	**5**	**6A**	**6B**
Description													
Corridor	Devore	Waterman	Waterman	Highland/ SR-330	Highland/ SR-330	Highland/ SR-330	Highland/ SR-330	East Highland	East Highland	East Highland	Radford Camp Rd.	SR-38	SR-38
Route		To CSUSB	To SR-210	Via City Creek, 2W03, Division	Via City Creek, 2N13, BB Dam	Via City Creek, Arctic Circle	Via Plunge Creek, Arctic Circle	Via 2N13, BB Dam	Via Arctic Circle	Via 2N13, Division		Via Redlands	Via East Highland
Alignment Length (miles)	57	42	51	41	39	31	30	40	32	39	37	58	54
# of Stations	7	5	8	6	7	7	7	7	7	7	5	5	6
Stations/Communities Served	SB Intl. Airport Downtown SB SB Metrolink Crestline Running Springs Big Bear China Garden Big Bear Village	CSU San Bernardino Crestline Running Springs Big Bear China Garden Big Bear Village	SB Intl. Airport Downtown SB SB Metrolink SB E St./SR-210 Crestline Running Springs Big Bear China Garden Big Bear Village	Downtown SB SB Intl. Airport Highland SR-330 Running Springs Big Bear China Garden Big Bear Village	Downtown SB SB Intl. Airport Highland SR-330 Running Springs Snow Valley Big Bear Village Big Bear China Garden	Downtown SB SB Intl. Airport Highland SR-330 Running Springs Snow Valley Big Bear Village Big Bear China Garden	Downtown SB SB Intl. Airport Highland SR-330 Running Springs Snow Valley Big Bear Village Big Bear China Garden	Downtown SB SB Intl. Airport Highland Greenspot Running Springs Snow Valley Big Bear Village Big Bear China Garden	Downtown SB SB Intl. Airport Highland Greenspot Running Springs Snow Valley Big Bear Village Big Bear China Garden	Downtown SB SB Intl. Airport Highland Greenspot Running Springs Snow Valley Big Bear Village Big Bear China Garden	Downtown SB SB Intl. Airport Highland Greenspot Big Bear Village Big Bear China Garden	Downtown SB [intermediate stops] Redlands Angelus Oaks Big Bear China Garden Big Bear Village	Downtown SB SB Intl. Airport Highland Greenspot Angelus Oaks Big Bear China Garden Big Bear Village
Total One-Way Travel Time end to end (min)	114	90	106	92	94	73	72	93	78	91	85	114	114
Average speed (mph)	30	28	29	27	25	25	25	26	25	26	26	31	28
Steep Slopes Requiring Cog Rail (miles, slope > 8%)													
8-14%	0.0	0.0	0.0	0.0	2.5	0.0	6.0	2.5	0.0	2.5	7.5	0.0	0.0
14-25%	3.5	2.0	2.0	2.5	2.5	2.5	0.0	2.5	2.5	2.5	0.0	0.0	0.0
Capital Costs ($ millions)													
Low estimate	$5,225	$4,140	$4,685	$3,860	$3,610	$2,810	$2,760	$3,685	$2,885	$3,535	$3,170	$5,345	$5,120
High estimate	$9,600	$8,100	$8,600	$7,200	$6,700	$5,100	$5,000	$6,600	$5,000	$6,300	$5,200	$9,400	$9,100
Annual Operating Costs ($ millions)													
Rail system	$13.8	$12.0	$13.8	$13.6	$13.6	$11.8	$11.8	$13.6	$11.8	$13.6	$12.0	$13.8	$13.8
Feeder bus system	$4.7	$4.7	$4.7	$4.2	$4.9	$4.9	$4.9	$4.9	$4.9	$4.9	$2.7	$3.3	$3.3
TOTAL ANNUAL O&M	$18.5	$16.7	$18.5	$17.8	$18.5	$16.7	$16.7	$18.5	$16.7	$18.5	$14.6	$17.1	$17.1
Estimated Annual Ridership, 2035 (valley-mountain riders)	756,000	704,000	818,000	769,000	855,000	981,000	981,000	855,000	981,000	855,000	641,000	575,000	575,000
Estimated Annual Revenue, 2035 (in millions of 2010 $)	$11.5	$10.7	$12.5	$12.9	$14.3	$16.5	$16.5	$14.3	$16.5	$14.3	$10.8	$9.6	$9.6
Estimated Weekly Tonnage of Goods Movement, 2035													
Low-Rate Strategy	2,230	1,487	2,230	1,515	1,515	1,515	1,515	1,515	1,515	1,515	1,335	1,415	1,415
High-Rate Strategy	870	580	870	595	595	595	595	595	595	595	525	555	555
Estimated Annual Value of Goods Movement, 2035 (in millions of 2010 $)													
Low-Rate Strategy	$3.4	$2.3	$3.4	$2.9	$2.9	$2.9	$2.9	$2.9	$2.9	$2.9	$2.8	$2.8	$2.8
High-Rate Strategy	$6.7	$4.5	$6.7	$5.8	$5.8	$5.8	$5.8	$5.8	$5.8	$5.8	$5.5	$5.6	$5.6
Portion of Alignment Crossing or Between Roadless or Non-Motorized Areas (miles)													
Crosses Roadless or Non-Motorized Areas	0.0	0.0	0.0	0.6	0.6	3.9	8.3	5.9	9.2	5.9	1.1	0.9	0.9
Alignment Between Roadless or Non-Motorized Areas	5.0	5.0	5.0	8.0	7.4	3.6	0.9	4.4	0.6	4.4	9.8	17.9	17.9
Portion of Alignment Crossing Critical Habitat Areas (miles)	1.4	1.6	1.7	5.2	3.9	4.0	1.7	0.5	0.6	0.5	1.3	1.7	2.1
Portion of Alignment Crossing Geologically Unstable Areas (miles)													
Very High Landslide Risk	4.1	2.1	2.0	5.5	6.8	7.4	8.8	8.0	8.5	6.3	14.2	21.8	22.6
High Landslide Risk	31.1	31.1	30.3	19.1	20.1	11.7	7.1	19.2	10.8	18.0	8.8	11.6	11.1

Table ES.3 presents a graphic comparison of the results, using a color scale to show the relative performance of each alternative for each criterion. Alternatives receiving a blue dot have the best performance for that criterion, those receiving a red dot have the poorest performance for that criterion, and the intermediate color scale (from green to yellow to orange) indicates decreasing level of performance relative to the other alternatives.

Table ES.3 – Qualitative Summary Evaluation of Alternatives

	ALTERNATIVE												
CRITERIA	1	2A	2B	3A	3B	3C	3D	4A	4B	4C	5A	6A	6B
Capital Costs	worst	poor	poor	average	good	best	best	good	best	good	best	worst	worst
O&M Costs	worst	average	worst	poor	worst	average	average	worst	average	worst	best	average	average
Steep Slopes	average	good	good	good	poor	good	poor	poor	good	poor	worst	best	best
Communities Served	good	poor	good	good	best	best	best	best	best	best	worst	average	average
Travel Time	worst	average	poor	average	average	best	best	average	best	average	good	worst	worst
Ridership & Revenue	average	poor	average	average	good	best	best	good	best	good	poor	worst	worst
Goods & Revenue	best	worst	best	good	good	good	good	good	good	good	average	average	average
Land Use Compatibility	best	best	best	average	good	good	poor	average	average	average	worst	worst	worst
Critical Habitat	good	good	good	worst	poor	poor	good	best	best	best	good	good	average
Landslide Risk	best	best	best	best	good	average	good	average	average	best	poor	worst	worst

● = best ● = good ● = average ● = poor ● = worst

ES.6 Financial Analysis

The financial analysis considers the financial requirements of the project (capital and operating costs) and evaluates possible funding and financing scenarios to determine how much of project costs can be covered by project revenues (passenger fares and freight fees), how much revenue could be generated from new sources of funding (excluding government grants), how project financing terms will affect the overall financial picture, and how much would still be required in government grants if the other funding sources are insufficient to cover the entire cost.

The financial analysis starts with definition of a baseline scenario. The baseline scenario assumes that a medium-length (approximately 37 miles) system alternative is to be built, with capital and operating unit costs at the higher end of the cost range ($6 billion in capital costs and $18.5 million in annual operating costs). Operating revenues are $20.1 million annually in 2035, a surplus of $1.6 million over the annual operating costs. (This assumed system for the financial analysis is generally comparable to Alternative 4C in the evaluation of alternatives.) No new non-grant revenue sources are adopted, and traditional tax-exempt bonds are used for project capital financing. In this Baseline scenario, the annual revenue stream needed to cover debt service is $478 million, so with an operating surplus of just $1.6 million the annual revenue gap is $476 million. To fill this gap, almost $6 billion of public sector grants would be needed.

To test the financial implications of different revenue and financing scenarios, three alternative scenarios were analyzed with varying cost, revenue, and financing assumptions applied to the same assumed 37-mile system. Table ES.4 summarizes the assumptions in the four scenarios.

Table ES.4 - Cost and Revenue Estimates Applied to Each Financial Scenario

Financial Scenario	Baseline	#1	#2	#3
Scenario Description	**Base Case**	**Least Optimistic Case**	**Mid-Range Case**	**Most Optimistic Case**
Capital Cost	$6.0 billion	$6.2 billion	$4.7 billion	$3.1 billion
Net Annual Operating Income	$1.6 million	$14.0 million	$29.8 million	$62.6 million
Potential New Revenue Sources	None	$24.5 million	$44.0 million	$63.5 million

In Scenario #1 ("Least Optimistic Case") the capital and operating costs were held at the higher end of the cost range; passenger and freight revenues were assumed to be higher than the baseline scenario due to higher system usage attributable to increased energy costs; total capital costs were increased to pay for additional vehicles to provide reduced headways; a low level estimate of new revenue sources was included; and financing with traditional tax-exempt bonds was assumed. (New revenue sources could include things like a portion of mountain road tolls, a benefit assessment district, a fee on lodging or recreation area use, or a portion of a countywide vehicle license fee.)

In Scenario #3 ("Most Optimistic Case") a set of optimal assumptions was applied: capital costs were assumed to be at the low end of the unit cost range, hourly operating costs are the average for light rail in the US rather than the high end, passenger ridership was assumed to be 17.5% of corridor travelers, freight revenues were based on carrying all the corridor's package freight as a result of air quality and energy factors, a high level of new revenue sources was included, and financing was assumed with zero-interest bond financing based on the "America Fast Forward" transit financing proposal being proposed to Congress by the Los Angeles County MTA.

Scenario #2 ("Mid-Range Case") represents a mid-range capital cost and revenue scenario between #1 and #3, financed with traditional tax-exempt bonds.

Table ES.5 summarizes the results of the financial analysis. Of the four scenarios, only the Most Optimistic Case Scenario could be fully funded without public sector grants, assuming a low-end cost scenario, the highest passenger and freight revenue scenarios, the highest rates for supplementary revenue sources, and the lowest interest rates on bonding. For all other scenarios, the annual shortfall needed to finance additional bond proceeds is projected to range from $301 million per year to $459 million per year, which indicates that a substantial public sector grant ($3.8 – 6 billion) would be needed in all scenarios except the Most Optimistic Case.

Table ES.5 - Calculation of Annual Funding Gap/Surplus

Scenario	Base	#1	#2	#3
Scenario Description	**Base Case**	**Least Optimistic Case**	**Mid-Range Case**	**Most Optimistic Case**
Assumed Alignment Length	37 miles	37 miles	37 miles	37 miles
Capital Cost ($2011, millions)	$6,000.0	$6,250.0	$4,710.0	$3,070.0
Financing Method	traditional tax-exempt	traditional tax-exempt	traditional tax-exempt	QTIBs 0% interest
Annual revenue stream needed to cover debt svc	($477.7)	($497.6)	($375.0)	($107.4)
Passenger and Freight Revenues	$1.6	$14.0	$29.8	$62.6
New revenue sources	$0.0	$24.5	$44.0	$63.5
Total available annual revenue sources available for debt svc	$1.6	$38.5	$73.8	$126.1
Annual revenue (gap)/surplus	**($476.1)**	**($459.1)**	**($301.2)**	**$18.8**
Bonding Capacity of Total Available Revenue Sources	$20.1	$483.9	$926.8	$3,606.7
Additional Public Funding/Capital Cost Reductions Needed or (Bonding Capacity Surplus)	$5,980.0	$5,766.1	$3,783.2	($536.7)

The key findings of the financial analysis are as follows:

- The high capital cost and the project financing cost (assuming traditional tax-exempt debt) are the most significant financial impediments to financing a feasible project.
- The project could generate an operating surplus under the following conditions:
    - the corridor alignment follows one of the shorter or medium length routes;

    - the system includes stations that provide: a direct connection to Metrolink, convenient transloading for goods movement, a convenient park and ride lot at the base of the mountains, and intermediate stations in the mountain area (such as Running Springs and Snow Valley);
    - the system's hourly operating costs are toward the middle or lower end of the cost range for light rail systems in the United States; and
    - the system operation includes a package shipping operation that can successfully attract an adequate share of the market.
- Other additional sources of revenue (besides passenger fares and freight revenue) will be needed in order to have a sufficient revenue stream to pay for capital costs through bond financing. Various types of new revenue sources are possible, though relatively few could generate sufficient ongoing revenue to meaningfully contribute to debt payments for a project of this magnitude. For those sources that are capable of generating a significant revenue stream, support from the public and elected officials will be required to achieve their adoption.
- Even with very optimistic assumptions regarding operating revenues and additional revenue sources, the project's financial viability depends on getting either low interest bond financing or a multi-billion dollar government grant to help defray the capital costs.

For the project to be financially feasible without requiring significant government grants:

- The estimated capital cost will need to be toward the lower end of the range estimated in this study. More detailed study will be needed to identify an alignment that: follows a reasonably direct routing between San Bernardino and Big Bear Lake, has relatively limited need for elevated segments or structures, avoids environmentally sensitive areas, and minimizes right-of-way costs.
- Operating revenues will need to be maximized. A significantly higher-than-typical passenger mode share will need to be captured because of factors like substantial increases in fuel prices or extended road closures in the mountains. A very high level of freight movement activity will need to be captured because of factors like substantial increases in fuel prices, extended road closures in the mountains, or vehicle technology requirements that limit trucks' ability to climb mountain grades.
- Substantial new sources of funds will be needed to help defray capital costs.
- Very low interest bond financing will need to be secured for most of the project's capital cost.

ES.7 Key Findings

This section highlights the study's key findings that will significantly affect/determine the desirability and feasibility of implementing an alternative mode in this corridor and the conditions under which it would be feasible.

Transportation System Constraints

1. The mountain highway routes that provide access to the Big Bear Valley experience traffic congestion on weekends throughout the year, and experience high levels of congestion for extended periods of time on holiday weekends and winter weekends with good snow conditions.
2. The mountain access roads are increasingly vulnerable to closure or restriction because of adverse weather, traffic accidents, rockfall, landslides, or wildfire.
3. These impediments to mountain access act as constraints to growth and development in the Big Bear Valley, and to the Southern California Region's ability to take advantage of the mountain area's four-season recreational assets.
4. The feasibility of adding significant capacity to existing highways or constructing a new road facility is doubtful because of both environmental and financial constraints.
5. A non-roadway transportation alternative could increase transportation system capacity, reduce traffic congestion, operate in adverse weather or when roads are closed, and help accommodate long-term growth in mountain area population and visitation, and would likely have less environmental impact than road improvements that would provide comparable system capacity.

Technology Issues

6. Only one non-roadway transportation technology currently exists and has demonstrated in commercial operation its capability to safely transport large numbers of people across the kinds of distances and the steep terrain encountered in this corridor at speeds and costs that are competitive with automobile travel (and could therefore attract significant numbers of riders). For these reasons, the current preferred feasible technology for this corridor is light rail technology with a rack (cog) system that can engage on steep slopes.
7. Self-propelled aerial ropeway technology has shown the potential to have competitive operating characteristics with a lower initial capital cost, but has only been built and operated on a limited basis and is not currently in commercial operation.

Corridor Alignment Considerations

8. Certain alignment and station options are important to the success of the system and to best achieve the purpose and need:
    a) a reasonably direct alignment between San Bernardino and Big Bear Lake, because a long alignment would substantially increase the project's capital cost and the overall travel time, which would make the system less attractive to potential riders and reduce operating revenues;
    b) an alignment that serves intermediate mountain communities such as Running Springs and Snow Valley, because it would increase ridership and revenue and would substantially increase the number of travelers for whom an alternative system could be a viable travel option;
    c) a station with direct connection to Metrolink, to provide convenient transit access to Big Bear Lake from much of the greater Los Angeles metropolitan area;
    d) valley and mountain stations that provide convenient transloading for goods movement, so the system can compete effectively in the freight shipping market; and
    e) a convenient station/park-and-ride lot at the base of the mountains, to attract auto users that prefer not to navigate the mountain roads.
9. More detailed engineering studies will need to be undertaken in order to confirm feasible alignments. In particular, detailed study will be needed to find alignments that avoid sensitive

habitat areas, minimize needs for environmental mitigation, and are not unreasonably subject to landslide risk.

10. Much of the corridor will pass through the San Bernardino National Forest. Regardless of the specific alignment selected, it will traverse areas currently designated as incompatible with a new transportation system, since extensive areas of the National Forest have been designated to remain roadless or as appropriate only for non-motorized transportation. US Forest Service representatives have indicated that an extensive review and approval process within the Forest Service would be required to obtain approval for a change to accommodate a new transportation system through these areas.

Financial Considerations

11. For the project to be financially feasible:
    a) The estimated capital cost will need to be toward the lower end of the range estimated in this study. More detailed study will be needed to identify an alignment that: follows a reasonably direct routing between San Bernardino and Big Bear Lake, has relatively limited need for elevated segments or structures, avoids environmentally sensitive areas, and minimizes right-of-way costs.
    b) Operating revenues will need to be maximized. Changing conditions in the coming years are expected to lead to increasing interest in, and demand for, and alternative transportation mode to the mountains; these include increasing fuel prices, environmental regulations that affect vehicle technology (limiting the ability of trucks to ascend steep grades), and more frequent mountain road closures. These factors could enable a new transportation system to capture a significantly higher-than-typical passenger mode share and a high level of freight movement activity in the corridor, and generate a substantial positive stream of net operating revenue.
    c) Substantial new revenue sources will be needed at the local or regional level to provide a reliable funding stream so the project sponsor can issue long-term bonds to satisfy the upfront capital needs.
    d) Very low interest bond financing will need to be secured for most of the project's capital cost.
    e) If all of the above factors do not materialize, substantial supplemental sources of traditional grant funding will likely be necessary to help defray capital costs in addition to any new revenue sources implemented at the local and/or regional level to support the project.

ES.8 Recommendations

In short, the analysis has found that an alternative transportation system would be a good solution to help address future transportation needs between the San Bernardino Valley and Big Bear Lake; however, the system's technical and financial feasibility depends on the convergence of a number of political, financial, and operational conditions. Changing circumstances associated with energy costs, fuel sources, vehicle technology, air quality regulation, and transportation project funding and financing could create a situation in which an alternative transportation mode would be financially feasible. The following recommendations for further action are designed to increase understanding about the evolving status of circumstances that would be necessary for the project's success, while developing more specific information about system alignments, technologies, and operations that could help define a specific project proposal that is consistent with the requirements for success.

Next Steps

A. Outreach

1. Conduct a dialogue with the corridor's key elected officials and opinion leaders to determine the current level of interest in, and support for, the project.
2. Conduct an ongoing dialogue with the US Forest Service to develop a better mutual understanding of future transportation needs through the San Bernardino National Forest and how to serve them.
3. Work with USFS staff to develop a description of the requirements and process that would be involved in order for the Forest Service to be able to approve an alternative transportation system through the San Bernardino National Forest.
4. Monitor the progress of legislation in Congress that could present opportunities for grant funding.
5. Monitor the progress of the Fast Forward America legislation in Congress, and identify the potential and conditions for zero- or very-low interest financing for this project.
6. Monitor technological progress toward commercial operation of high-speed, high-capacity transportation technologies that can travel long distances and traverse steep grades through the mountains at overall speeds competitive with automobile travel.
7. Explore the potential to enter into a project development agreement with a light rail vehicle or other equipment manufacturer who may be interested in bringing its technology to market and may be willing to co-fund a Major Investment Study.
8. Conduct a dialogue with other resort access corridors that face similar transportation access challenges (Sacramento - Lake Tahoe, CA; Salt Lake City - Cottonwood Canyons UT; and Denver - Rocky Mountain Resorts, CO). Identify common issues and explore possibilities for benefits from cooperation.

B. Project Phasing/Early Action Opportunities

1. Evaluate potential project phasing to ascertain the viability of developing a first phase of the project before the entire system.
2. Identify potential early action projects that could serve as initial steps toward a new mountain access system.

C. Cost and Revenue Refinement

1. Undertake a conceptual engineering study or Major Investment Study to determine the location and cost of alignment alternatives that serve intermediate mountain communities, avoid sensitive habitat and minimize environmental mitigation, and avoid unnecessary risk of landslides.
2. Develop a better understanding of the geotechnical issues, constraints, and risks involved with developing a cog rail system through the corridors identified as alternatives for Alignments 3 and 4, for the purpose of helping to identify a lower-risk alignment that follows a relatively direct route from San Bernardino to Big Bear Lake.
3. Develop refined estimates of potential ridership and farebox revenues, as well as potential freight shipments and revenue.
4. Develop a more refined concept for passenger access to and from the mountain stations in the system. Identify an operational concept that is well suited to the access and distribution needs of potential passengers, as well as estimates of capital costs, operations and maintenance costs, and potential revenues.
5. Develop a more specific understanding of current goods movement activity through the corridor, including the types and volumes of commodities being carried and how the goods are distributed to mountain destinations.

6. Develop a more refined concept of how a cog rail system could serve the mountain corridor's goods movement needs effectively and efficiently. Include determination of types of goods to be carried, feasible and effective operational strategies, and a concept for distributing goods from mountain stations to their destinations.
7. Evaluate the potential ridership and farebox revenue within catchment areas of the corridor (i.e., trips between valley stations and between mountain stations), including potential increases if more stations are added to the alignment.
8. Investigate the reasons for differences in hourly operating costs for light rail systems in the United States, and develop a refined operating cost scenario for a light rail/cog rail system in the San Bernardino – Big Bear Lake corridor.

1. INTRODUCTION

1.1 Background of Project

Southern California is known for an excellent quality of life and the ability to “surf in the morning, ski in the afternoon.” In fact, there is no better example of this than going from Los Angeles beaches to Big Bear Valley’s ski slopes. As more people have begun to discover the region as a place to live, work and play, the problems associated with big cities have begun to overwhelm the areas surrounding Los Angeles, including air pollution, traffic congestion, road safety, and limited access. The usual solution to problems such as these is to widen roads, expand public transit options and limit growth. However, the usual solutions aren’t always the best solutions, which is especially so in the case of Big Bear.

Located in the San Bernardino National Forest, the Big Bear Valley is both a thriving community and a popular recreation destination throughout the seasons. Access from the San Bernardino Valley and greater Los Angeles metropolitan area is limited to mostly two-lane state highways through National Forest land, and further expansion of these roads is unlikely. SR-18, SR-38 and SR-330 wind their way through mountainous terrain and scenic vistas, and part of SR-38 has been designated a state scenic highway. Currently, over 50% of traffic from the Los Angeles Basin to Big Bear Valley utilizes SR-18. Challenging grades, frequent switchback curves, and limited sight distance make this road a challenging drive under the best of conditions; during the frequent snow storms in the winter months, when demand for access is at its peak, travel along this route can be arduous as well as dangerous. Weather, peak season travel, goods movement, air quality, and environmental concerns are all issues adding to the need for an alternative transportation mode into and out of the Big Bear Valley.

Over the past decade, growth in the region has continued in both permanent residents and seasonal visitors. As a result, more vehicles are traversing the winding access roads than ever before, including an increased number of trucks. Congestion and seasonal road blockages caused by winter conditions have resulted in the mountain communities expressing an interest in potential partnerships with SCAG and SANBAG to address the issues of mountain community accessibility for both people and goods.

1.2 Location, Character of Study Area

The Big Bear study area is located within the County of San Bernardino, which lies in the northeast portion of Southern California. San Bernardino County is bounded by Riverside County to the south, Los Angeles County to the southwest, Kern County to the northwest and Inyo County to the north. The Big Bear Valley is a four-season mountain recreation area with proximity to the nearly 20 million people residing in Southern California. Figure 1.1 below illustrates the study area.

Figure 1.1 – Big Bear Vicinity Map

There are three distinct segments of the study area. These three segments reflect the vast differences in the natural, physical, and socio-economic conditions of the corridor. The following paragraphs summarize the character of each of the three segments.

San Bernardino Valley – Portions of the Cities of San Bernardino, Highland and Redlands, as well as the community of East Highland, are located in this segment of the study area. This portion of the study area is generally urbanized and has grown at a rapid pace over the past two decades. One of the most significant transportation improvements to San Bernardino is the Metrolink commuter rail line between Los Angeles and San Bernardino. This is the most heavily traveled line in the Metrolink system. In addition, the San Bernardino International Airport Authority has completed construction of a passenger terminal on the western portion of the former Norton Air Force Base for the San Bernardino International Airport.

San Bernardino National Forest – The center portion of the study area encompasses several mountain communities, including Running Springs, Arrowbear, and Snow Valley, which includes a ski resort. Lake Arrowhead, which is also a popular destination and residential community, lies approximately five miles to the northwest of Running Springs. This portion of the study area lies within the San Bernardino National Forest service boundaries, and with the exception of certain land areas under County of San Bernardino jurisdiction, is primarily under the jurisdiction of the United States Forest Service (USFS), which is part of the federal Department of Agriculture.

Big Bear Mountain Recreation Area – The upper portion of the study area contains the City of Big Bear Lake, as well as the unincorporated area of San Bernardino County known as Big Bear City. The north shore of Big Bear Lake is largely under the jurisdiction of the USFS. Bear Mountain and Snow Summit are the major ski resorts in the area.

1.3 Rationale for Studying a Non-Roadway Transportation Mode

This study explores the feasibility of non-roadway alternatives for the future transportation of people and goods between the San Bernardino and Big Bear valleys. This analysis, and a similar effort undertaken about 15 years ago, recognizes that growth and development in the Big Bear Valley, as well as the Southern California Region's ability to take advantage of its four-season recreational assets, are constrained by the capacity limitations of its conventional mountain highway access routes and their vulnerability to closure or restriction because of adverse weather, severe accidents, rockfall, and wildfire. The feasibility of adding significant capacity to existing highways or constructing a new road facility is doubtful because of both environmental and financial constraints. For these and other reasons noted below, the concept of a non-road alternative to the highways for transport of people and goods is attractive if its feasibility can be demonstrated.

The 1996 analysis identified alternative technologies capable of providing access to Big Bear and corridors compatible with those technologies. In the intervening years, the continued growth of Big Bear and the greater Southern California region, as well as maturation of transit connections to the San Bernardino Valley from Los Angeles and Orange Counties, suggest that the potential market for the proposed modal alternative is markedly larger now than in the 1990s. At the same time, the cost to implement such a transport facility is almost certainly higher. These are among the issues and tradeoffs to be considered in assessing the feasibility of a new mode to Big Bear.

The existing transportation system between San Bernardino and Big Bear Lake faces several problems/challenges:

- Traffic congestion: The key mountain access roads (SR-330 and SR-18 from Running Springs to Big Bear) regularly experience traffic congestion due to the volume of traffic during peak hours. On typical winter and summer weekends, the roads are congested inbound (to the mountains) on Friday afternoon and Saturday morning, and outbound on Saturday and Sunday afternoon. Peak weekends (with good snow conditions or holiday crowds) are highly congested for several hours.
- Safety: The mountain access roads experience collision rates that are 1.5 to 2 times the rates on similar highways around the state.
- Road closures: Because of maintenance needs and emergency closures (landslides and wild fires), the primary mountain access roads are sometimes totally shut down for extended periods of time. Historical data show that they are closed for these reasons between 5-10% of the days in a given year, and the closure of SR-330 for several months beginning in December 2010 is a recent example of the potential for long-term closures. In addition, the roads are closed occasionally by traffic accidents and major snow storms – storm closures can sometimes last for several days, as they did during the winter of 2010. After any significant snowfall, traffic operations are substantially hindered by drivers needing to install and drive with chains.
- Public transportation: Service currently consists of 2-3 bus trips per day between Big Bear Lake and San Bernardino (three round trips per day on weekdays, two on weekends). Funding is very constrained, especially for bus operations, so significant expansion of capacity would not be

possible without a new source of funding. In addition, bus transit is subject to the same challenges (above) that plague vehicle traffic.

The future of Big Bear depends on the transportation system:

- The future potential of the Big Bear Valley is constrained by the access limitations imposed by the highway system. Without a significant upgrade or enhancement of the mountain access system, new development is therefore likely to be modest and incremental.
- Current forecasts estimate fairly modest growth, with the number of housing units in the City of Big Bear Lake projected to increase by 31% over the next 25 years and employment by 23%.
- In the absence of any factors that would significantly change travel patterns or mountain visitation patterns, these forecasts indicate that current traffic volumes can be expected to grow by 25-30% by the Year 2035.

No significant improvements to the roadway system are currently programmed or planned. Without improvements, existing problems can be expected to worsen:

- With this amount of growth, weekend traffic congestion on SR-330 and SR-18 can be anticipated to increase, so there would be longer periods of congestion during peak times. Other than Friday afternoon, weekday volumes would not typically be high enough to cause recurring congestion.
- As traffic volumes and congestion levels increase, collision rates also typically increase. Without physical improvement of roadway geometrics, the high collision rates might get worse.
- As the roadway and drainage system continues to age and deteriorate, road closures are likely to become more frequent and longer.

Various types of roadway-based strategies have been suggested to help address the system's existing capacity deficiencies. Each approach would increase capacity, improve roadway operations and safety, or make better use of existing capacity, but all have significant shortcomings that make them unsatisfactory approaches to addressing the corridor's long-term needs. The benefits and shortcomings of the four roadway-based strategies are outlined below:

1. Achieve better utilization of available road capacity to/from Big Bear via SR-38 and SR-18E.
   Benefits: These two routes have available capacity when SR-330 and SR-18 become congested, and some drivers already use them as alternate travel routes between the San Bernardino Valley and Big Bear even though the normal driving time is about 30 minutes longer.
   Shortcomings: SR-38 and SR-18E are not convenient routes for trips to intermediate destinations (such as Running Springs, Arrowbear, and Snow Valley) which attract almost half the traffic using SR-330.

2. Add passing lanes; realign existing roads. This improvement would enhance highway operations by adding passing lanes where possible to SR-330 and SR-18 and realign the "13 curves" section of SR-18 between Running Springs and Snow Valley. In 1996 the construction cost of these improvements was estimated to be $50 to $53 million.
   Benefits: This level of improvement:
   - Would improve traffic operations in the corridor, enabling cars to pass slow-moving vehicles on many of the grades, and increasing travel speeds in the critical bottleneck area between Running Springs and Snow Valley, thereby increasing the number of vehicles that could pass through this area during periods of congestion.

- o Would probably reduce accident rates in areas realigned or improved, but would not address the high accident rates in unimproved areas.

  Shortcomings: This level of improvement would not increase the capacity of the system. Even with the addition of passing lanes and elimination of the critical bottleneck, the roadway system capacity would still be constrained to the capacity of two-lane mountain roads on SR-330 and on SR-18 between Running Springs and Big Bear.

3. Widen the existing roads (SR-330 and SR-18) to provide additional capacity.
   Benefits: This option would increase the carrying capacity of the mountain access roadways.
   Shortcomings: This option was not evaluated in the 1996 study, and is impractical for a number of reasons:
   - o To provide appropriate geometrics so that the roads would carry four lanes of traffic, especially when snow is on the ground and piled at the side of the road, would require significant realignments of road segments as well as widening to a greater width than is typical for a four-lane arterial.
   - o Through the developed communities, the widening would likely affect many homes and businesses. Through undeveloped areas, the widening would affect the forest areas adjacent to the road.
   - o Widening would cost at least as much, probably more, than adding the same capacity by building a new two-lane road on a new alignment (Approach #4).
   - o Unless the roadway is reconstructed, widening would not address the major repair and maintenance needs that increasingly affect the existing mountain roads.
   - o Widening would not reduce the high collision rates, and would possibly worsen them unless the existing geometrics were substantially improved at the same time.

4. Build a new two-lane road through the front range of the mountains. The 1996 study identified a potential alignment for such a road, and assumed that it would be operated essentially as a one-way pair with SR-330 and SR-18 from Highland to the Big Bear Dam.
   Benefits: This option would increase the carrying capacity of the mountain access roadways.
   Shortcomings: The additional capacity through the corridor would come at a substantial cost (monetary and environmental):
   - o The 1996 study estimated that constructing a new road would entail a capital cost comparable to that estimated for a cog rail system.
   - o The new road would have a very significant impact on the environment, with a 40-foot wide roadway in an 84-foot wide right-of-way along a 20-mile corridor from Highland to the Big Bear Dam.
   - o If the two roads (the old road and the new road) were to be operated as a one-way pair for operating efficiency, there would need to be crossover road connections developed so that drivers would not be forced to drive long distances out of their way if their destination is adjacent to the opposite roadway. Conversely, if the two roads were operated as individual roads with two-way traffic there would be less capacity, and traffic operations would be much less efficient.

Adding capacity by developing an alternative (non-roadway) transportation mode has advantages that a roadway improvement could not offer:

- An alternative system would provide convenient mountain access with minimal or no auto driving for people throughout the greater Los Angeles metropolitan area via a connection to Metrolink in San Bernardino.

- An alternative system would enable the mountains to accommodate more users traveling for skiing and snow play without the need to expand roads or parking areas.
- An alternative system would be developed along a different alignment than the existing roadway system. Therefore, the system might be usable during an emergency (such as wildfire or earthquake) for evacuating people or for bringing in emergency personnel and equipment, even if the roadways needed to be closed.
- An alternative system would be operable after a major snowstorm or during other types of road closures, allowing people and goods to move up and down the mountain regardless of whether or not the key mountain access roads are closed. The new system itself would be a tourist attraction (somewhat like the Palm Springs Aerial Tramway – a nice ride through a scenic area), providing additional ridership and revenue, and providing an economic boost to areas with stations, particularly to downtown San Bernardino.
- For some types of goods, an alternative system might provide a cheaper and more efficient means of shipment to the mountain communities.

An alternative mode would likely be a more environmentally friendly alternative than road improvements.

- It would have a smaller environmental "footprint" than roads, so it would be expected to have less impact on the lands it passes through. A cog rail right-of-way would be 15 feet wide for a single track and 30 feet wide in areas that require double-tracking; rope-propelled systems would impact the ground only where towers, switching facilities or cable drive and return buildings, and stations are constructed.
- It would emit fewer vehicular and greenhouse gas emissions than carrying the same number of people in autos and other vehicles.
- It would operate using a "greener" energy source (likely electricity) than the internal combustion engine.
- It would provide opportunities for transit-oriented development near mountain stations, making it possible for some people to live and work and travel without need for a car.

An alternative mode is more likely to be implementable than new road capacity (either a new road or widening existing roads) because:

- It would likely attract more public support because of its lesser environmental impact.
- It offers greater potential for attracting the needed funding (for construction, operations, and maintenance), since an alternative mode has greater potential for attracting private investment through a public private partnership.

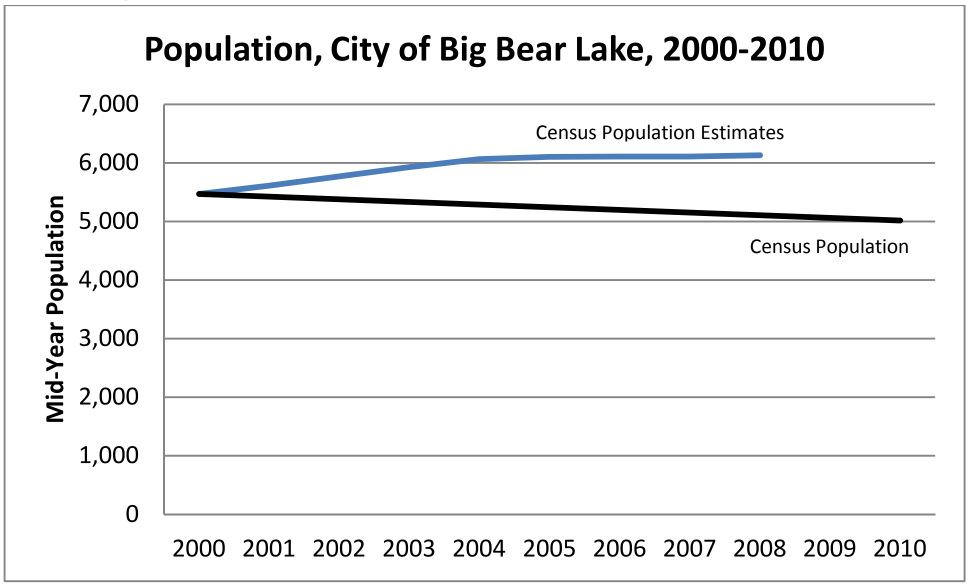
2. BACKGROUND CONDITIONS

2.1 Demographics

2.1.1 Population and Housing

According to the 2000 US Census Bureau, the population of the City of Big Bear Lake was 5,438 persons. As shown in Figure 2.1, the Census Bureau estimated that the population grew through 2004 and then leveled off to reach just over 6,100 persons in 2008. The overall compound annual growth rate (CAGR) was 1.71% for that 8-year period. Just before this report was prepared, the Census Bureau's official 2010 data were published, showing that the city's population had actually decreased to 5,019 since 2000.

Figure 2.1 – City of Big Bear Lake Population, 2000 - 2008



2.1.2 Housing Units

The San Bernardino Associated Governments (SANBAG) provided housing and employment data by traffic zone for Big Bear Lake and surrounding areas of San Bernardino County for 2008 existing conditions and 2035 forecasts. Housing units were divided into single family units and multi-family units. Employment was broken down into Retail and Non Retail employees.

Figure 2.2 illustrates existing and future housing units by type for the City of Big Bear Lake and for the adjacent areas of San Bernardino County. These are occupied year-round, and do not include second homes or seasonal rentals. The chart shows that there are many more housing units in the county areas (green bar) than in the city (blue bar); also that there are many more single-family than multi-family units in both the city and county areas. New housing growth up to year 2035 in the city is forecasted to continue to be in single family homes, but in the adjacent county new multi-family units will predominate.

Figure 2.2 – Comparison of Single and Multi-family Housing Units

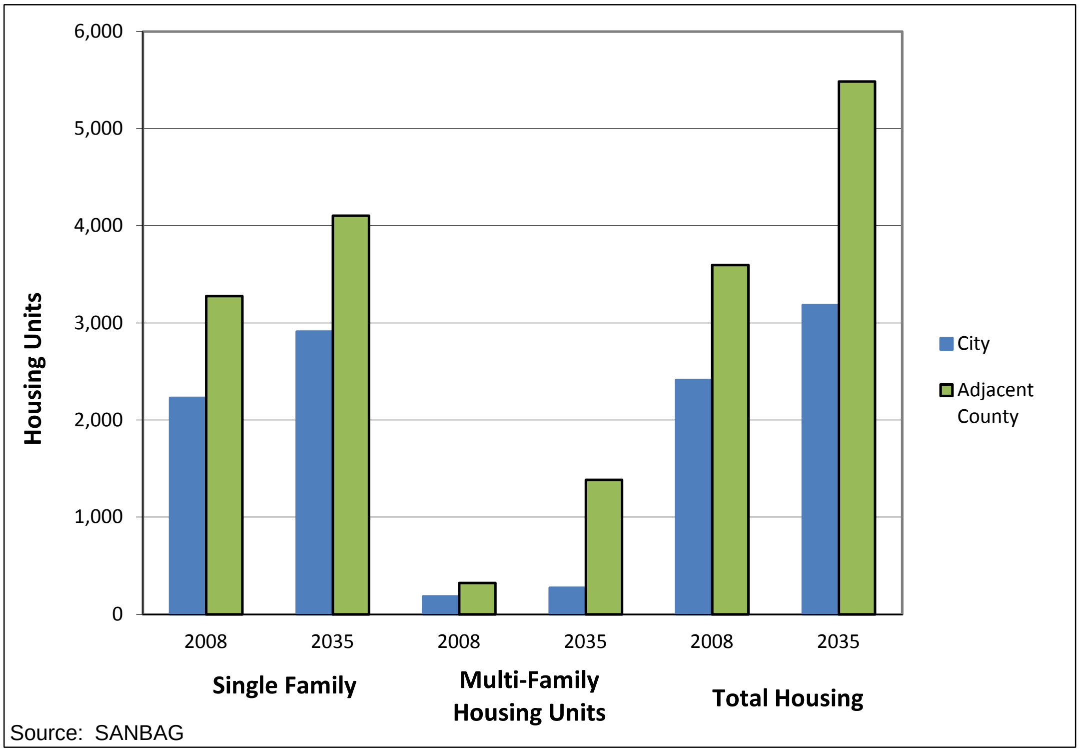


Table 2.1 lists 2008 and projected 2035 housing units, occupied and total, and total employment for the City of Big Bear Lake. Although this does not include the adjacent areas of the county, the city limits were chosen to provide a sound comparison with US Census data. According to the Census, there were 2,343 occupied units and 8,705 total units in Big Bear Lake in 2000. This translates into a ratio of 3.72 total-to-occupied dwelling units, and an average vacancy rate of 73% reflecting the large number of second homes and rental units in the ski resort area. This ratio was used to estimate total housing units for the 2035 forecast year.

Table 2.2 shows similar information for the entire Big Bear Valley, including the city and adjacent portions of the county.

Table 2.1 – Estimated Housing Units and Employment, 2008 and 2035, City of Big Bear Lake

Year	Occupied Housing Units	Total Housing Units	Population	Total Employment
2008	2,412	8,961	6,234	6,015
2035	3,185	11,833	8,365	7,295
CAGR*	1.04%	1.035%	1.095%	0.717%
*CAGR: Compounded Annual Growth Rate				

Table 2.2 – Estimated Housing Units and Employment 2008 and 2035 in Big Bear Valley (City of Big Bear Lake and Adjacent Unincorporated Areas)

Year	Occupied Housing Units	Total Employment
2008	3,597	7,402
2035	5,484	9,034
CAGR*	1.58%	0.74%

*CAGR: Compounded Annual Growth Rate

2.1.3 Employment

Employment data were provided by SANBAG for the base year 2008 and a forecast year 2035. As indicated in Tables 2.1 and 2.2, there are approximately 6,015 jobs in the City of Big Bear Lake with a total of 10,717 jobs in the Big Bear Valley region. Going forward, citywide employment is expected to grow at 0.7% per year to 7,295 employees by 2035, and the valley is forecasted to grow to 9,034 jobs.

2.1.4 Big Bear Tax Receipts

Sales and use taxes are a measure of economic activity in an area and can additionally be a strong indicator for total traffic generation. Figure 2.3 illustrates the trend in general sales taxes in the City of Big Bear Lake for 2002-2009. Sales tax revenues grew from 2002 to 2005, but have declined at a rate of 7% per year since then. Figure 2.4 illustrates the trend in the Transient Occupancy Tax receipts for the City of Big Bear Lake, which has grown at an average rate of 5.9% per year. In November 2008, Voters passed Measure Y which increased the tax from 6% to 8%, to be implemented in two steps – in January 2009 it was increased to 7% and in January 2010 it was increased to 8%.

Tax receipts are available by quarter and are illustrated in Figure 2.5 below. The greatest variation is in the Transient Occupancy Tax, which changes from 35% in the first quarter to 14% in the second quarter. This quarterly variation may prove useful as a surrogate for estimating seasonal variations in traffic to and from Big Bear.

Figure 2.3 – Sales Tax Trend for City of Big Bear Lake, 2002 -2009

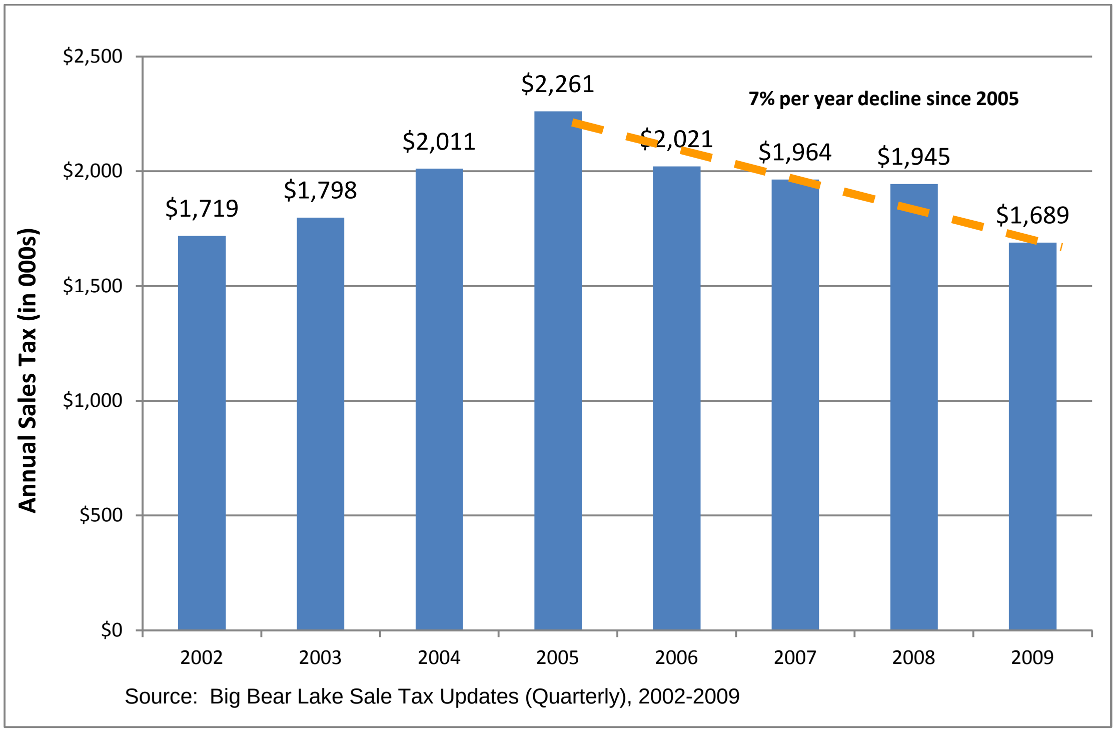


Figure 2.4 – Transient Occupancy Tax Trend, 2003 - 2009

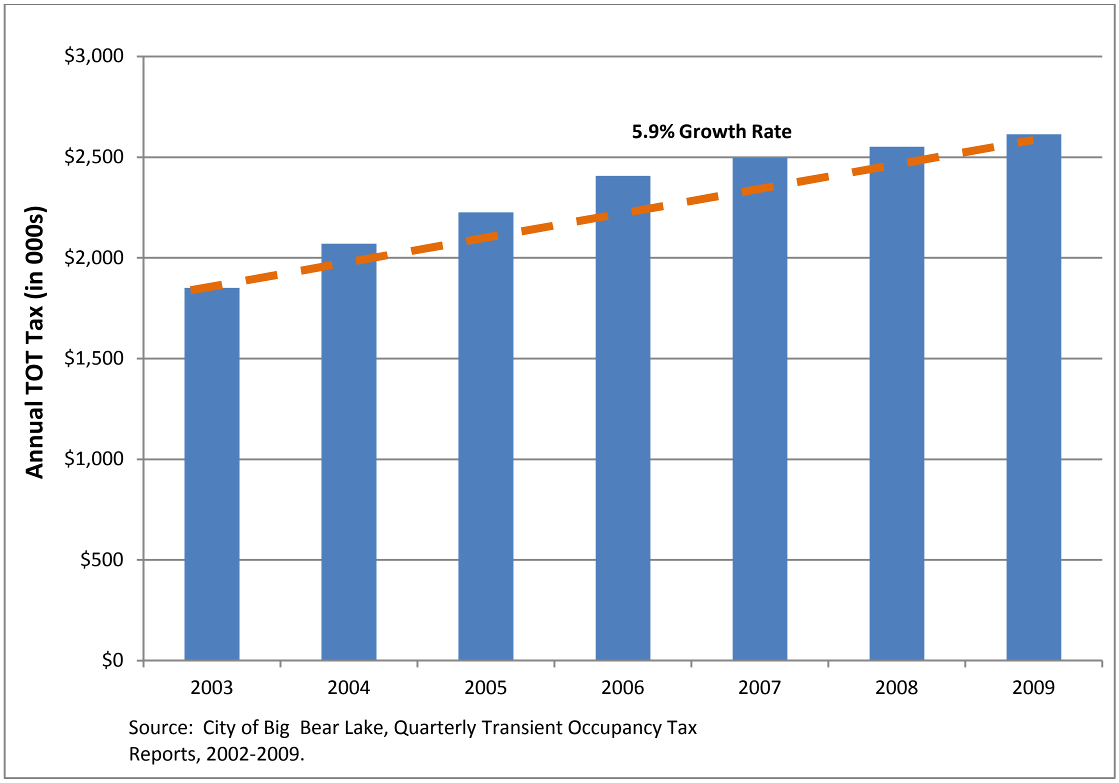
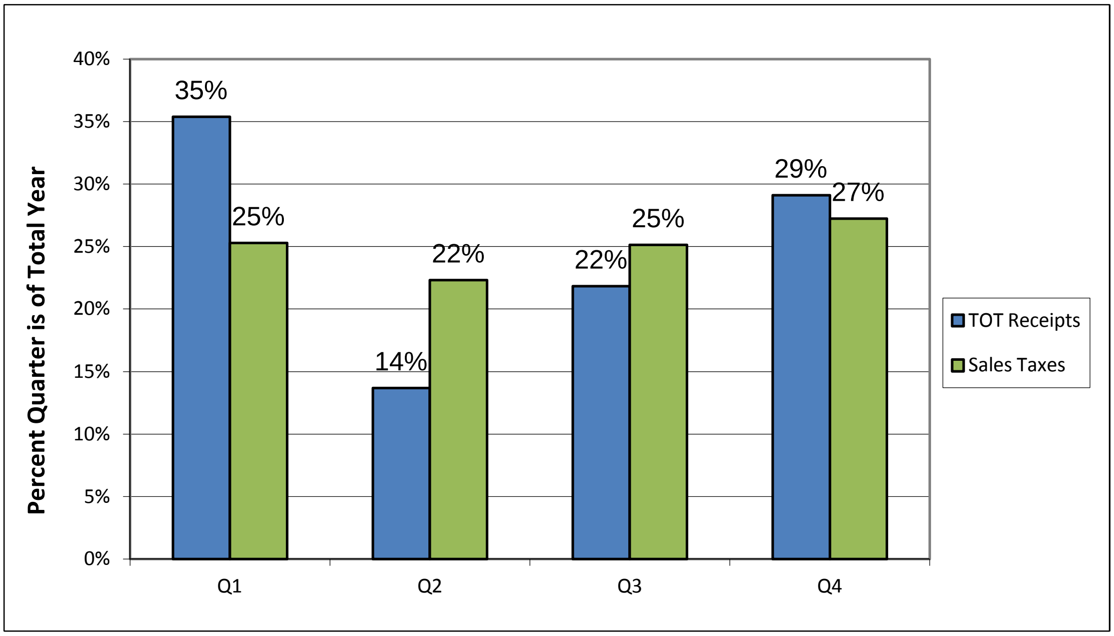


Figure 2.5 – Seasonal Variations in Tax Receipts



2.2 Existing Roadway System

2.2.1 Existing Streets and Highways

There are four two-lane state highways which provide access to the City of Big Bear Lake and the surrounding recreational and residential areas. In January 2011, SR-330 closed due to weather-related damage. Today, the route remains closed while Caltrans makes emergency repairs, placing a heavier congestion burden on the alternate routes. Including the temporarily-closed SR-330, the existing access routes are:

- SR-18 (W) from the west and south, also serving Snow Valley, Arrowbear, Running Springs, Lake Arrowhead, Crestline, and San Bernardino
- SR-18 (E) from the north and east toward Victorville and Lucerne Valley
- SR-38 from the south and east from Mentone and Redlands as well as I-10
- SR-330 from the south and west from Highland and San Bernardino; SR-330 joins SR-18 west of Big Bear Lake in Running Springs

These routes and other key roadways in the Big Bear area are shown earlier in Figure 1.1. This map also presents 2008 Average Annual Daily Traffic volumes (AADT) on selected road segments.

Table 2.3 lists key road segments on State Routes 18, 38, and 330 in the study area. Segments are classified by their number of lanes and terrain they pass through. Current (2008 AADT) traffic volumes from Caltrans Traffic Counts data files[9] are shown by segment for peak month and typical peak hour.

[9] Caltrans 2008 traffic counts, available at: http://traffic-counts.dot.ca.gov/

More than 75% of traffic to the Big Bear Lake area uses SR-18/330 from the Westside (San Bernardino and beyond); traffic on SR-18 from the north and east (Lucerne Valley) accounts for only 18% of Big Bear daily traffic. SR-18 serves 12,600 AADT to/from Big Bear Lake east of Big Bear Dam, or 57% of the daily total of 22,000 AADT. SR-38 at the Santa Ana River Bridge carries 3,800 AADT, and SR-18 (E) carries 5,600 AADT, or 26% of the total Big Bear traffic.

SR-18 connects with SR-330 at Running Springs where SR-330 carries 12,700 AADT west of Running Springs. East of Running Springs the combined SR-18/330 volume is 12,600 AADT implying that Running Springs and other developments along SR-330 generate about 8,600 AADT.

Table 2.3 – Existing Roadway Conditions and Traffic Volumes

Facility/Segment	Facility Type	Peak Month ADT	Peak Hour Traffic
State Route 18			
San Bernardino, SR 30 to 40th Street	4 Lane Highway	31,000	2,500
40th Street to Crestline, SR 138	4 Lane Highway	18,500	1,650
Crestline, SR 138 to Lake Arrowhead, SR 173	2 Lane Mountain Highway	12,700	1,600
Lake Arrowhead, SR 173 to Running Springs, SR 330	2 Lane Mountain Highway	8,500	1,100
Running Springs, SR 330 to Big Bear Dam	2 Lane Mountain Highway	12,600	1,550
Big Bear Dam to Mill Creek Road	2 Lane Mountain Highway	11,900	1,250
Mill creek Road to Pine Knot Avenue	2 Lane Roadway	13,700	1,650
Pine Knot Avenue to Stanfield Cutoff	4 Lane Major Road	32,500	4,000
Stanfield Cutoff to North Shore Drive	2 Lane Roadway	21,000	2,550
North Shore Drive to Lucerne Valley, SR 247	2 Lane Rolling Highway	5,600	520
State Route 38			
Redlands, I-10 to Orange Street	2 Lane Roadway	16,800	1,550
Orange Street to SBNF Boundary	2 Lane Rolling Highway	14,600	1,500
SBNF Boundary to Santa Ana River bridge	2 Lane Mountain Highway	3,750	590
Santa Ana River bridge to Greenspot Road	2 Lane Mountain Highway	8,800	1,200
Greenspot Road to Greenway Drive	2 Lane Roadway	16,800	1,500
Greenway Drive to Big Bear Dam	2 Lane Roadway	3,800	540
State Route 330			
San Bernardino, SR 30 to Running Springs, SR 18	2 Lane Mountain Highway	12,700	1,500

The driving time on the SR-18/330 between Big Bear Lake and San Bernardino is reported to take about 45 minutes. However, in bad weather this route becomes so slow and congested that the SR-38 route becomes the shorter time access.

Although it carries more than half of the Big Bear traffic, “Caltrans considers this route [SR-18/SR-330] to be the least favorable route because of substantial grades, winding curves, unsafe sight distance restrictions, and its susceptibility to land and rock slides.”[10]

2.2.2 Traffic Congestion on Big Bear Access Routes

As will be discussed later in more detail, traffic volumes vary widely on State Routes 18, 38, and 330 in terms of time of day, directional split, average weekday or average weekend, and season of the year. During peak times, the trip from Big Bear to San Bernardino can stretch to two hours from the typical 45-minute off-peak driving time. Traffic engineers have developed a measure called Level of Service (LOS) to objectively measure congestion and delay on highways and at intersections. For two lane rural highways, LOS is more dependent on physical characteristics (e.g., slope, available passing sight distance, lane and shoulder width, etc.) than on strictly traffic volumes. LOS ranges from LOS A (free flow) to LOS F (start-and-stop conditions, long delays).

The two-way hourly capacities in Table 2.4 are based on the 2000 Highway Capacity Manual, and the volume-to-capacity (v/c) ratios are consistent with those applied in the 1996 Big Bear Access Study[11]. The table shows LOS values in terms of facility type, terrain, and volume-to-capacity ratio (v/c).

Table 2.4 – Roadway Level of Service Standards

Facility Type	Capacity (VPH)	A	B	C	D	E
4 Lane Highway	5600	0.07	0.19	0.35	0.53	0.92
2 Lane Mountain Highway	3200	0.02	0.12	0.20	0.37	0.82
2 Lane Rolling Highway	3200	0.10	0.23	0.39	0.57	0.94
2 Lane Roadway	1600	0.40	0.60	0.80	0.90	1.00
4 Lane Major Road	3200	0.40	0.60	0.80	0.90	1.00

As shown in Table 2.5, most segments of SR-18 and SR-330 are at LOS E of LOS F using typical peak hour volumes reported by Caltrans. Most of these segments will operate at LOS F during Average Weekends during the winter month ski season and holiday periods (e.g., July 4th) during the summer season. LOS E and LOS F conditions are generally termed as “unacceptable” by most motorists and they will divert to parallel routes if there are reasonable alternatives. At some point, the overall congestion becomes so great as to discourage discretionary trips such as those for recreational activities.

[10] Ibid, page 14
[11] Ibid, page 16.

Table 2.5 – Level of Service

Facility/Segment	Facility Type	Peak Month ADT	Peak Hour Traffic	Capacity	v/c Ratio	2008 LOS
State Route 18						
San Bernardion, SR 30 to 40th Street	4 Lane Highway	31,000	2,500	5600	0.45	C
40th Street to Crestline, SR 138	4 Lane Highway	18,500	1,650	5600	0.29	C
Crestline, SR 138 to Lake Arrowhead, SR 173	2 Lane Mountain Highway	12,700	1,600	3200	0.50	E
Lake Arrowhead, SR 173 to Running Springs, SR 330	2 Lane Mountain Highway	8,500	1,100	3200	0.34	D
Running Springs, SR 330 to Big Bear Dam	2 Lane Mountain Highway	12,600	1,550	3200	0.48	E
Big Bear Dam to Mill Creek Road	2 Lane Mountain Highway	11,900	1,250	3200	0.39	E
Mill creek Road to Pine Knot Avenue	2 Lane Roadway	13,700	1,650	1600	1.03	F
Pine Knot Avenue to Stanfield Cutoff	4 Lane Major Road	32,500	4,000	3200	1.25	F
Stanfield Cutoff to North Shore Drive	2 Lane Roadway	21,000	2,550	1600	1.59	F
North Shore Drive to Lucerne Valley, SR 247	2 Lane Rolling Highway	5,600	520	3200	0.16	C
State Route 38						
Redlands, I-10 to Orange Street	2 Lane Roadway	16,800	1,550	1600	0.97	E
Orange Street to SBNF Boundary	2 Lane Rolling Highway	14,600	1,500	3200	0.47	D
SBNF Boundary to Santa Ana River bridge	2 Lane Mountain Highway	3,750	590	3200	0.18	C
Santa Ana River bridge to Greenspot Road	2 Lane Mountain Highway	8,800	1,200	3200	0.38	E
Greenspot Road to Greenway Drive	2 Lane Roadway	16,800	1,500	1600	0.94	F
Greenway Drive to Big Bear Dam	2 Lane Roadway	3,800	540	1600	0.34	C
State Route 330						
San Bernardino, SR 30 to Running Springs, SR 18	2 Lane Mountain Highway	12,700	1,500	3200	0.47	E

2.3 Transit System

This section describes existing transit services in the Big Bear Lake area and those providing connections to potential riders to other parts of the region. The Mountain Area Regional Transit Authority (MARTA) provides Dial-a-Ride, local fixed route transit services within Big Bear Valley, and Off-the-Mountain (OTM) connections to San Bernardino. MARTA also provides the Crestline and Lake Arrowhead communities with similar services. In San Bernardino, MARTA connects with the Metrolink commuter rail service and Omnitrans bus routes.

2.3.1 MARTA

MARTA operates two local fixed routes within Big Bear: Route #1 (See Figure 2.6) operates between Boulder Bay and Erwin Lake from 6:15 AM to 5:30 PM on average weekdays and 8:30 AM to 5:30 PM on average weekends. Hourly service is provided on both average weekdays and average weekends. Route #1A (See Figure 2.7) operates between Mountain Meadows and Gold Mountain with hourly headways from 10 AM to 3 PM average weekdays only. Fares are $1.50 per trip ($0.75 for seniors) on each route.

MARTA also provides local fixed route service in the Crestline/Lake Arrowhead area. RIM Route #2, shown in Figure 2.8, runs between Lake Arrowhead Village and the Valley of Enchantment with hourly headways Monday through Friday only. RIM Route #4 (See Figure 2.9) provides service between the Mountain Community Hospital and Running Springs, also with hourly headways Monday through Friday only. The fare is $1.00 per zone.

MARTA's Big Bear Valley Off-the-Mountain (OTM) route connects Big Bear Lake with the Metrolink rail service and Omnitrans bus routes in downtown San Bernardino. (See Figure 2.10) The route makes three runs on Weekdays and two runs on Weekends. The fare is $10.00. MARTA provides similar OTM service from Lake Arrowhead to San Bernardino shown in Figure 3.7. On Weekdays, there are 4 round-trips between 5:30 AM and 8:10 PM; there are only two round trips on weekends. Both routes provide regional connections to Metrolink, Greyhound and Omnitrans.

MARTA's Dial-a-Ride (DAR) service is available for seniors, disabled persons, and anyone living more than 1/4 mile beyond the MARTA fixed route. DAR service is a shared ride system: DAR passengers may be picked up or dropped off while a vehicle is in route to another passenger pick-up. DAR connects with MARTA's fixed route at various stops within Big Bear Valley. The fare is $5.00 for regular passengers and $2.50 for Senior/Disabled passengers.

Figure 2.6 – Big Bear Valley Fixed Route #1

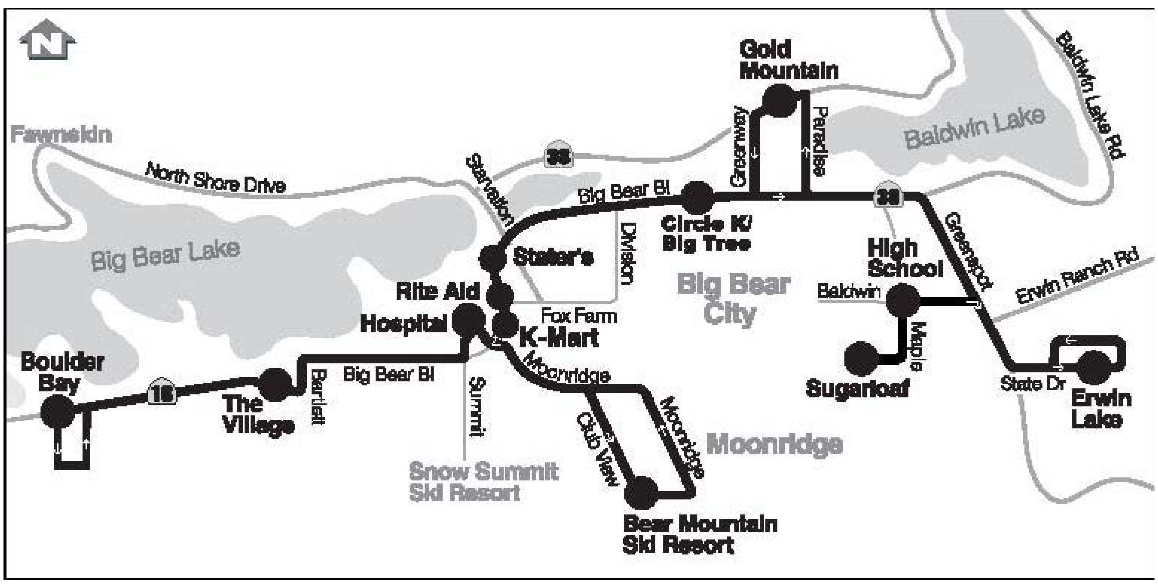


Figure 2.7 – Big Bear Valley Fixed Route #1A

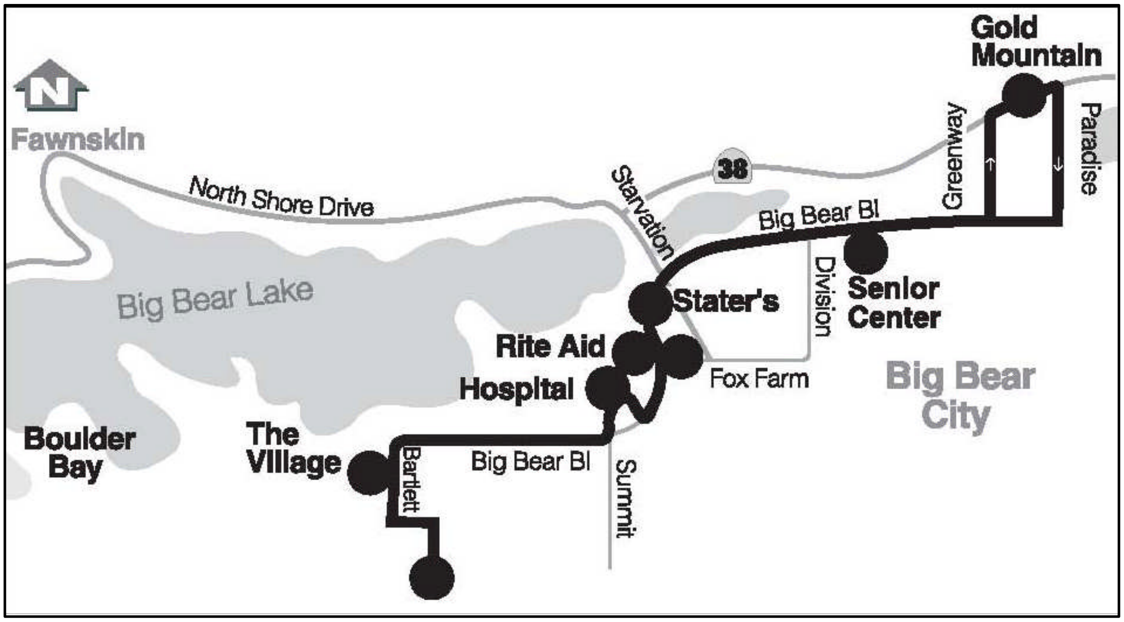


Figure 2.8 – RIM Fixed Route #2

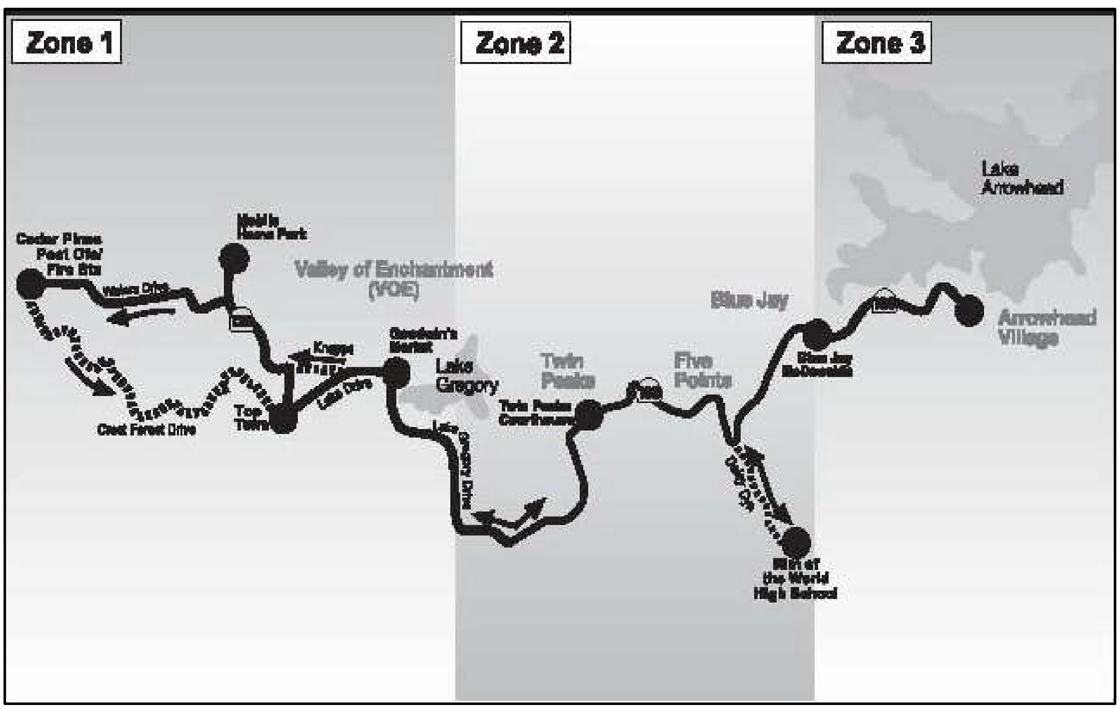


Figure 2.9 – RIM Fixed Route #4

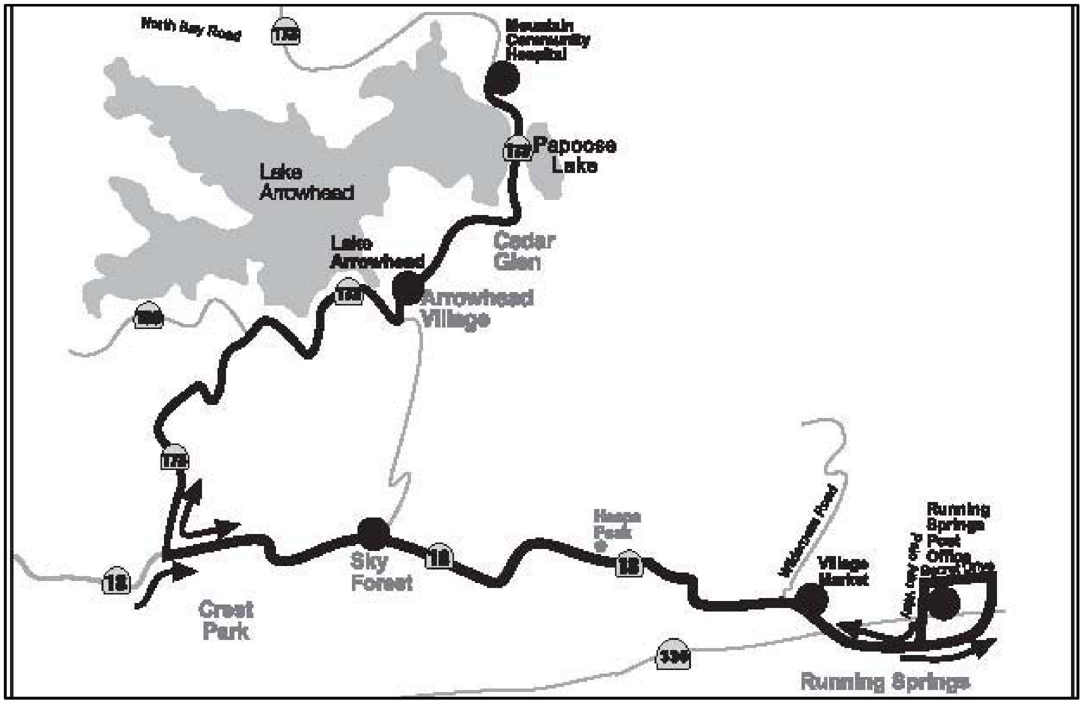


Figure 2.10 – Big Bear Valley Off The Mountain Route (OTM)

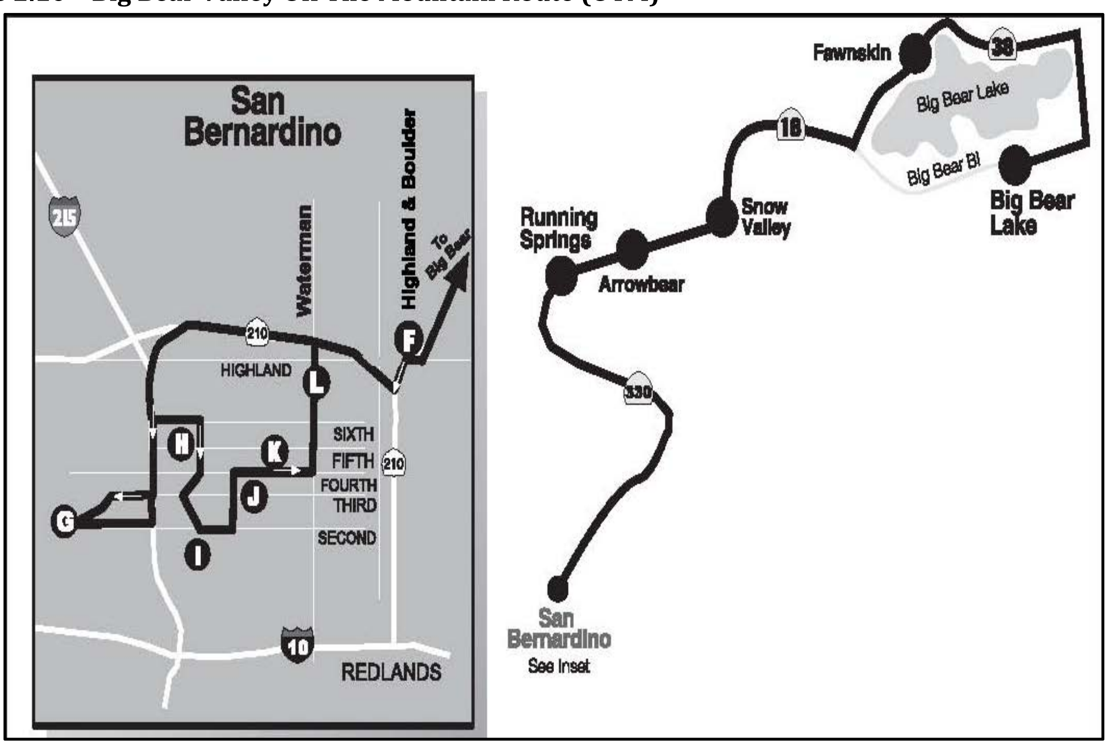
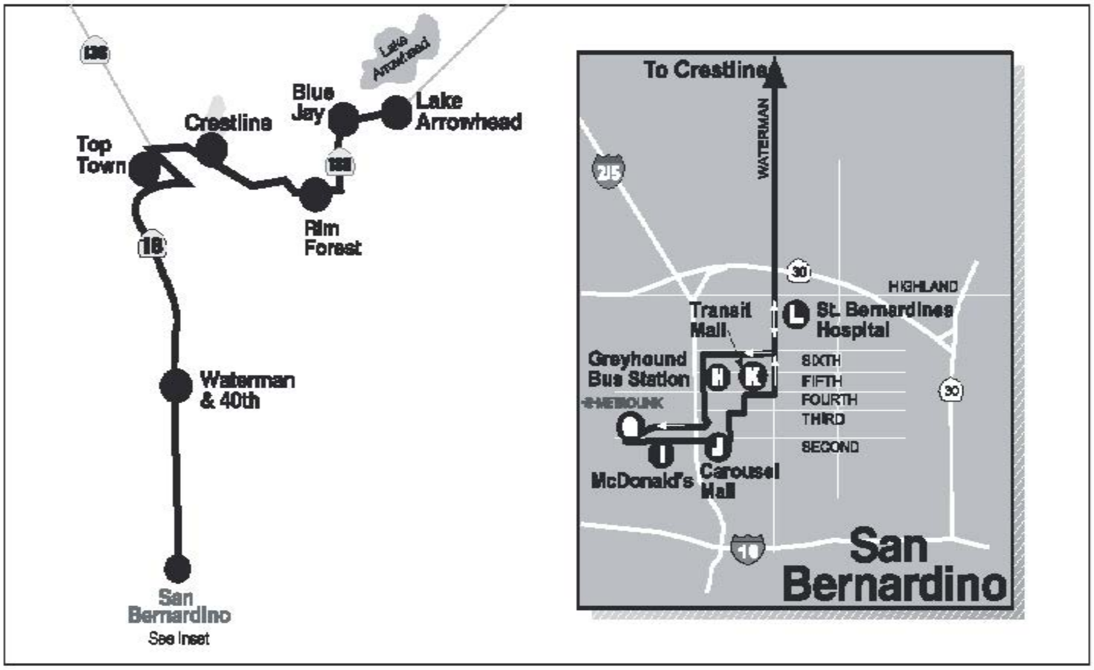


Figure 2.11 – RIM Off-the-Mountain Route

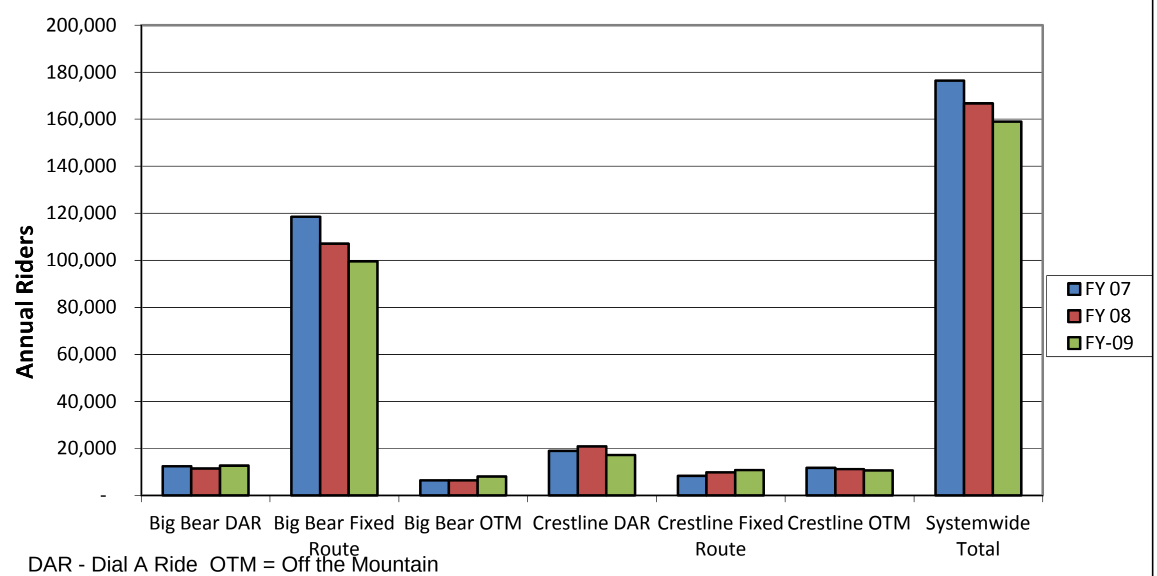


As shown in Table 2.6, ridership on most MARTA services has been declining in recent years. Overall, system ridership fell by 6% in FY 2008 and 5% in FY 2009. Only the Big Bear OTM and Crestline Local Fixed Route services showed ridership gains in FY 2009. These trends are illustrated in Figure 2.12.

Table 2.6 – MARTA Ridership Data 2007 - 2009

Route Group	FY-07	FY-08	% Increase/ Decrease	FY-09	% Increase/ Decrease
Big Bear DAR	12,420	11,453	-8%	12,670	11%
Big Bear Fixed Route	118,552	107,046	-10%	99,618	-7%
Big Bear OTM	6,496	6,403	-1%	8,037	26%
Crestline DAR	18,911	20,817	10%	17,169	-18%
Crestline Fixed Route	8,352	9,805	17%	10,786	10%
Crestline OTM	11,729	11,133	-5%	10,632	-5%
System-wide Total	**176,460**	**166,657**	**3%**	**158,912**	**17%**

Figure 2.12 – MARTA Annual Ridership by Route, FY 2007 - 2009



DAR - Dial A Ride OTM = Off the Mountain
Source: MARTA, May 2010.

Figures 2.13 and 2.14 illustrate monthly ridership for the Big Bear Valley Off-the-Mountain and Local Fixed Routes, respectively. These graphs reinforce the annual trends in Table 2.4. OTM ridership peaks consistently in December, and it shows that ridership was higher in FY 2008-09 than it had been in previous years. Figure 3.10 illustrates how local fixed route ridership peaks each year in January and has overall declined since FY 2006-07.

Figure 2.13 – Monthly Ridership on Big Bear Valley OTM Route

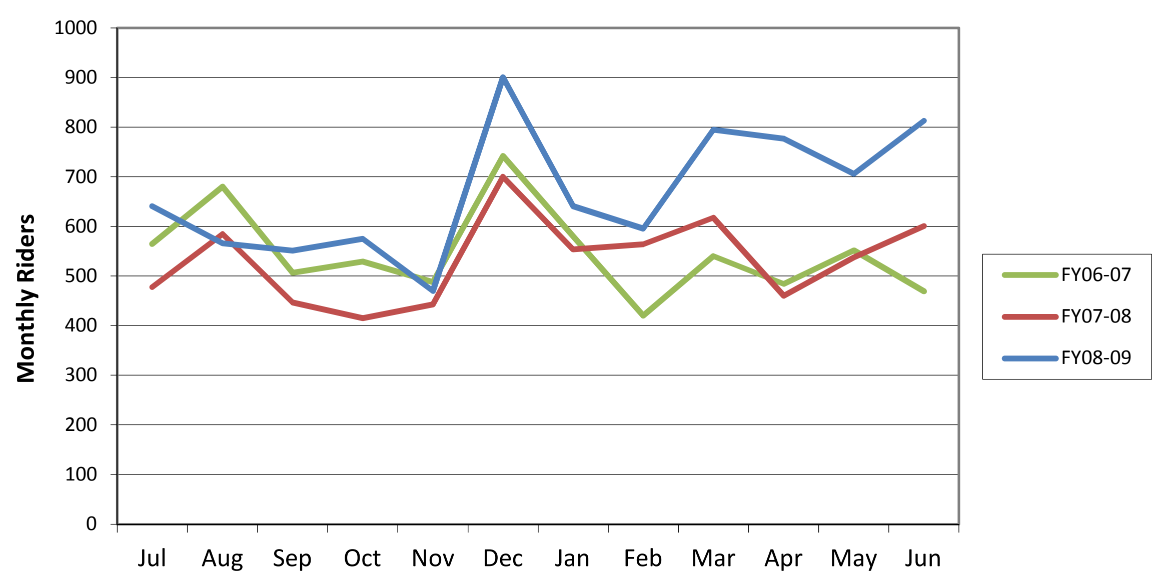
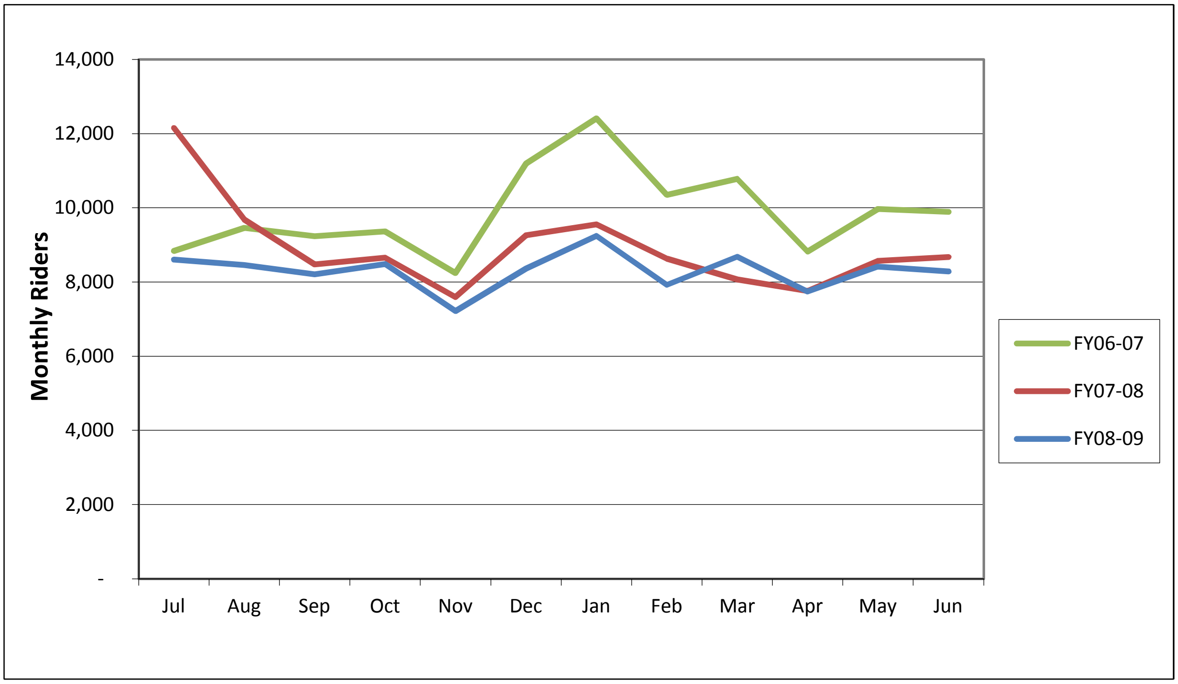


Figure 2.14 – Monthly Ridership on Big Bear Valley Local Fixed Route Services



2.4 Travel Patterns

2.4.1 Origin-Destination Patterns

No origin-destination studies have been performed in the Big Bear study area since the 1992 study described in the 1996 BRW Big Bear Alternative Access Study. The winter survey conducted at Snow Summit, Bear Mountain, and the Big Bear Visitors' Bureau (results reported in Section 4.6) yielded the following distribution of home locations:

Table 2.7 – Percentage of Respondents Surveyed from Origin-Destinations

Home Location	% of Respondents
Los Angeles County	34%
Orange County	23%
Inland Empire (incl. desert)	10%
San Bernardino Mountains	8%
San Diego County	19%
Ventura/Santa Barbara Counties	3%
Rest of United States	2%
Foreign	1%

2.4.2 Key Travel Generators

The following are the key traffic generators in the Big Bear Study Area:

City of Big Bear Lake
- Bear Mountain Ski Area
- Snow Summit Ski Area
- The Village (downtown)
- Interlaken (commercial area)

Unincorporated mountain communities
- Big Bear City (unincorporated)
- Running Springs
- Snow Valley Ski Area

City of Highland
San Manuel Indian Reservation and Casino
City of San Bernardino
- Downtown San Bernardino (including planned Metrolink station)
- San Bernardino International Airport

The three ski areas are the major travel attractions during the winter months. Although actual traffic counts for these generators are not available, ticket sales combined with average vehicle occupancies can be used to approximate average weekday and average weekend day vehicle trips. These are shown in Table 2.8.

Table 2.8 – Estimated Traffic Volumes at Big Bear Ski Areas

	2009 Weekday			2009 Weekend Day		
Ski Area	Ticket Sales	Occupancy	Estimated Daily Traffic	Ticket Sales	Occupancy	Estimated Daily Traffic
Bear Mountain	1,000	1.49	700	5,000	1.88	1,700
Snow Summit	1,500	1.49	1,000	7,000	1.88	3,700

2.4.3 Trends in Daily Traffic Volumes

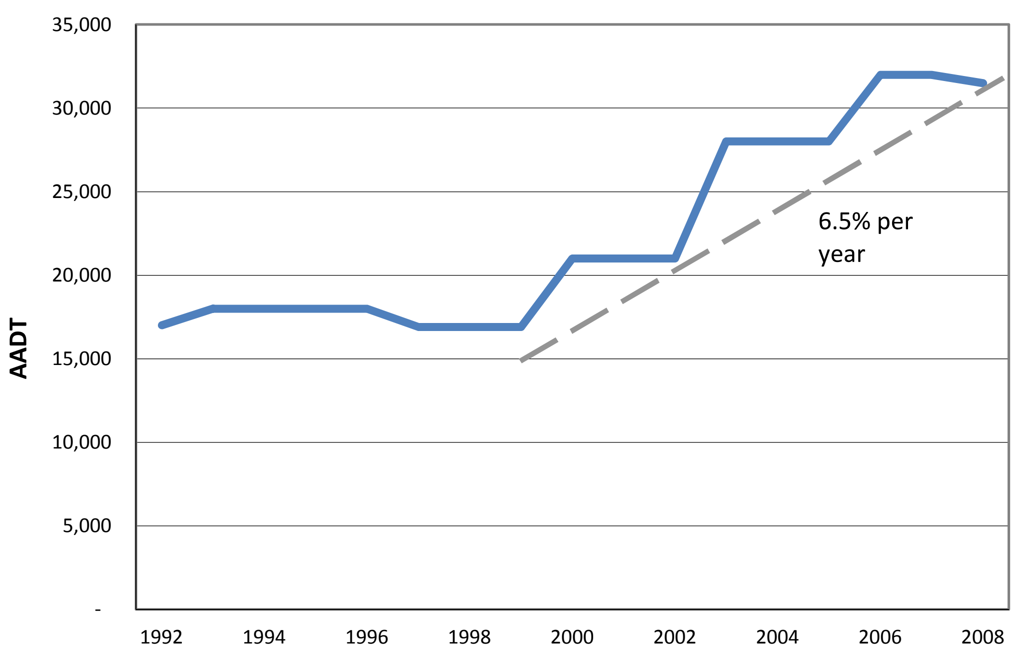
Estimates of Annual Average Daily Traffic are available from Caltrans Traffic Data Branch (on the Web at traffic-counts.dot.ca.gov) for many road segments in the Big Bear area. Table 2.9 summarizes counts at selected locations for 2008 (the latest year available) from the Caltrans data and presents the results of traffic counts taken in the summer of 2009 for the City of Big Bear Lake.

Table 2.9 – Big Bear Traffic Count Summary for 2008 and Summer 2009

	2008 Traffic Data			Summer 2009 Traffic Counts			
Location	Peak Hour	Peak Month	Annual ADT	Weekday Peak Hour	Weekday ADT	Weekend Peak Hour	Weekend ADT
SR-18 East of SR-38 (at Dam)	520	5,600	5,400	586	6,761	1,075	10,077
SR-18 East of SR-330	1,550	12,600	10,300	1,021	12,846	1,521	16,400
SR-18 East of Pine Knot Ave.	4,100	33,500	31,500	1,707	20,788	2,199	27,804
SR-18 East of Blue Jay Rd.	870	7,600	6,200	661	7,755	1,175	11,534
SR-18 East of Mill Creek Rd.	1,050	10,000	8,200	977	11,802	1,477	16,630
SR-18 North of Paine Rd.	1,350	12,600	10,300	1,115	13,314	1,372	17,226
SR-18 East of Moonridge Rd.	4,000	32,500	30,500	1,984	24,296	2,444	29,728
SR-18 East of Stanfield Cut-Off	2,550	21,000	19,700	1,529	19,466	1,564	21,384
SR-18 North of SR-38	520	5,600	5,400	408	4,664	551	5,914
SR-18 North of Holcomb Valley Rd.	230	2,550	2,450	n/a	n/a	n/a	n/a
SR-38 East of SR-18	1,500	16,800	16,000	1,447	17,701	1,502	18,688

The 2008 Caltrans AADTs and the actual traffic counts in 2009 are relatively consistent, with the exception of SR-18 east of Pine Knot Avenue. This location was estimated at 31,500 AADT in 2008 but only 20,800 AADT for an average weekday in the summer of 2009. This discrepancy may be due to the exact location of the traffic counters in 2009. This location has seen continuous growth of 6.5% per year in the Caltrans traffic counts since 1999, and the trend seems well established to support the higher volume as shown in Figure 2.15. The trend also reflects a growing internalization of trips in Big Bear as more local retail and service opportunities are offered.

Figure 2.15 – AADT on SR-18E of Pine Knot Avenue, 1992 – 2007



Source: City of Big Bear Lake

Figure 2.16 illustrates long-term trends on Big Bear access routes: SR-18, SR-18E, SR-38, and SR-330. There was a jump in traffic on SR-18 from 1994 to 1996, but traffic declined back to the long-term trend after 1997. Traffic on all four routes has been relatively constant or even declined slightly since 2000.

Figure 2.16 – AADT on Access Routes to Big Bear Lake

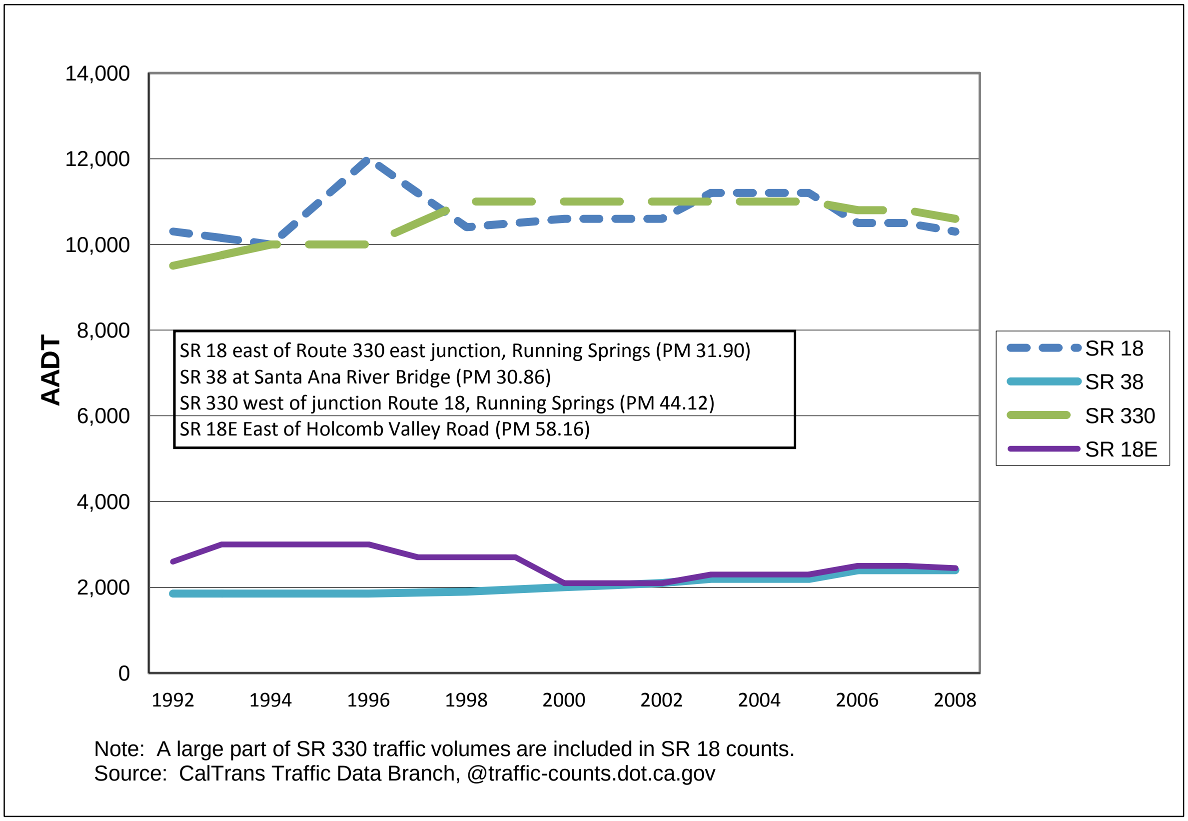
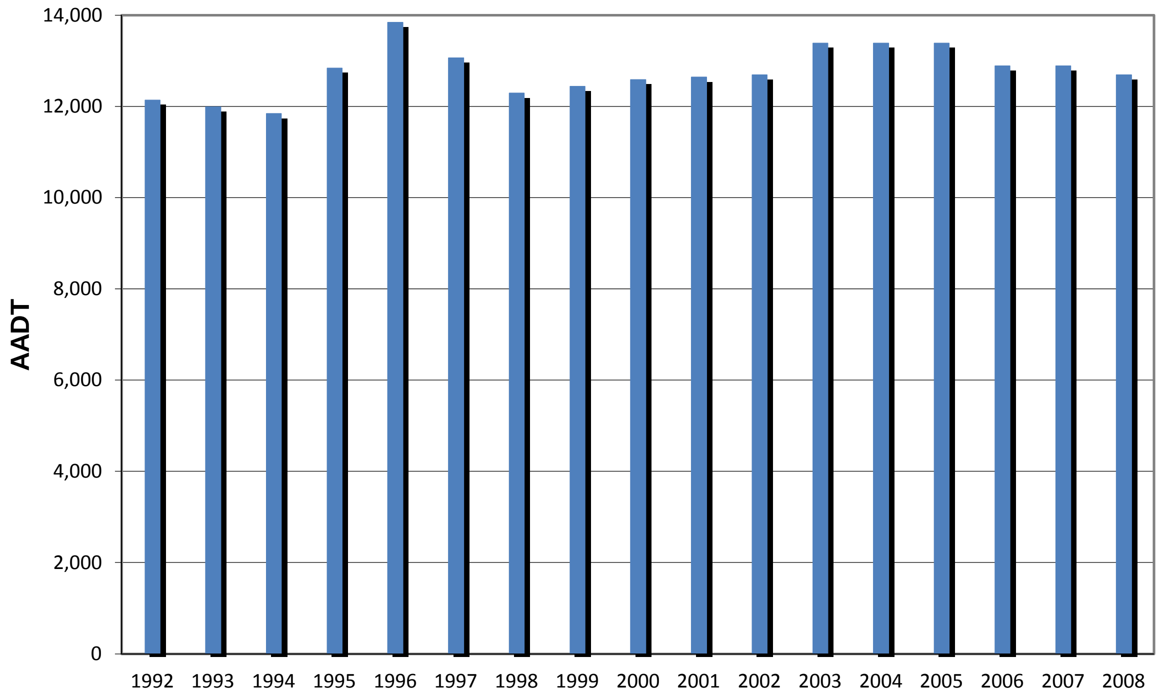


Figure 2.17 summarizes Caltrans counts on the Westside access routes: SR-18 east of Running Springs and SR-38 at the Santa Ana River Bridge. The combined totals show a cyclical pattern with traffic volumes rising from 1994-96, declining 1996-1998, rising again to a peak in 2004, and declining since then. Based on these data, 1996 was the peak year for traffic to and from Big Bear Lake.

Figure 2.17 – Total AADT on Westside Access Routes, 1992 - 2007



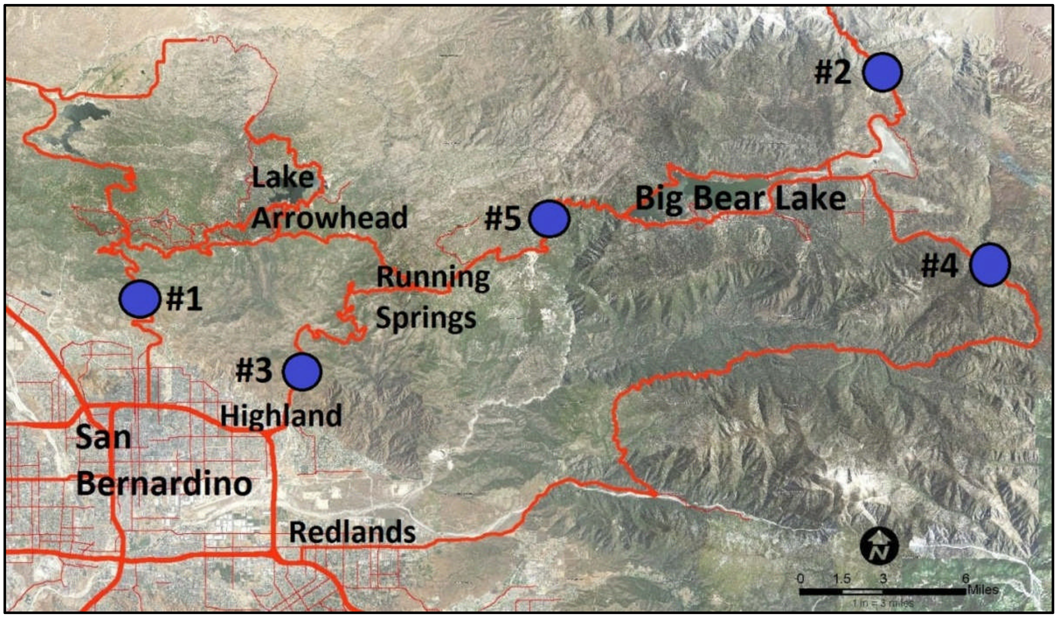
Note: Total AADT is the sum of SR 18 east of Runnning Springs and SR 38 at the Santa Ana
Source: CalTrans Traffic Data Branch, @traffic-counts.dot.ca.gov

2.4.4 Project Traffic Counts

Winter 2010 traffic counts were undertaken at five locations during the week of Saturday, March 13, through Friday, March 19, 2010. The locations were (see Figure 2.18):

1. SR-18 between Old Waterman Canyon Road & SR-138
2. SR-18E between Camp Rock Road & Baldwin Lake Road
3. SR-330 between Highland Avenue and Live Oak Drive
4. SR-38 between Heart Bar Campground turnoff & Lake Wood Drive
5. SR-18 between Snow Valley Ski Area and the Big Bear Dam

Figure 2.18 – Locations for 2010 Traffic Counts



Note: count locations shown are approximate.

The count on SR-330 (#3) was interrupted by a construction closure that took effect on Wednesday afternoon and continued beyond the end of the counts. Therefore the only complete counts were for Saturday through Tuesday. The counters on SR-18 east of Snow Valley (#5) were lost due to snow plowing, so no data were obtained for this location. Traffic count data can be found in Appendix A.

Additional traffic counts were conducted at all five locations from Wednesday, June 16, through Tuesday, June 23, 2010. The locations included the four March locations referenced above plus SR-18 between Snow Valley Ski Area and SR-38. Detailed results from each count period are provided below.

March Traffic Counts

Daily Traffic Variations

Daily traffic variations on SR-18, SR-38, SR-330, and SR-18E are shown in Figures 2.19 through 2.22, respectively. Where the data are available, these charts show that Friday is the peak traffic day since it combined both the daily commuters and the Average Weekend vacationers.

Figure 2.19 – Daily Traffic on SR-18, March 2010

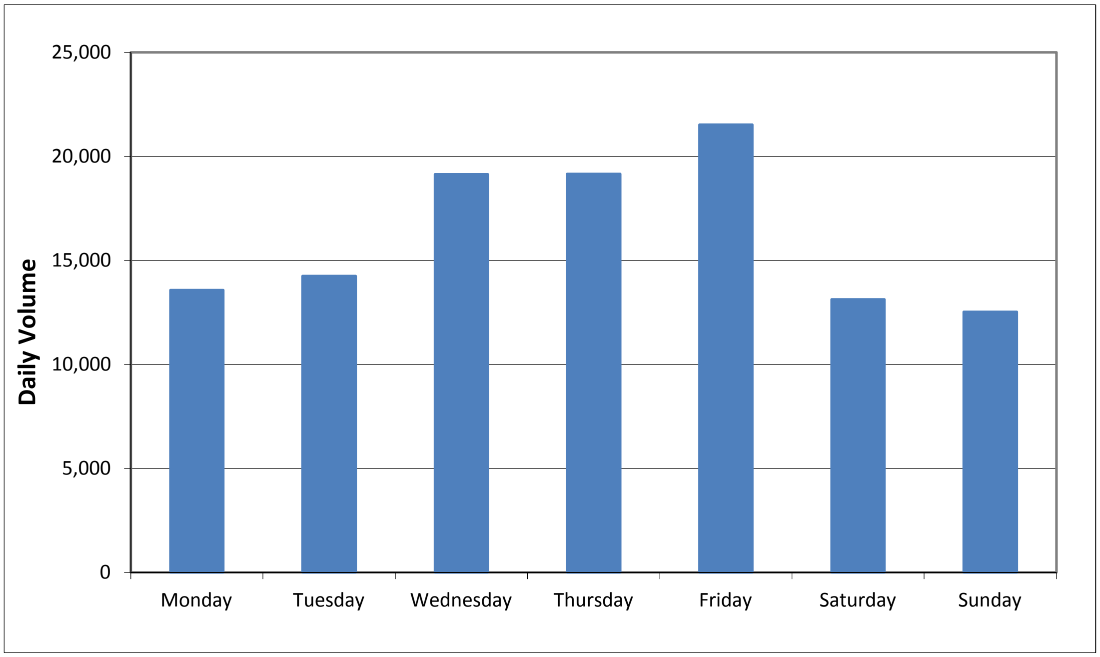


Figure 2.20 – Daily Traffic on SR-38, March 2010

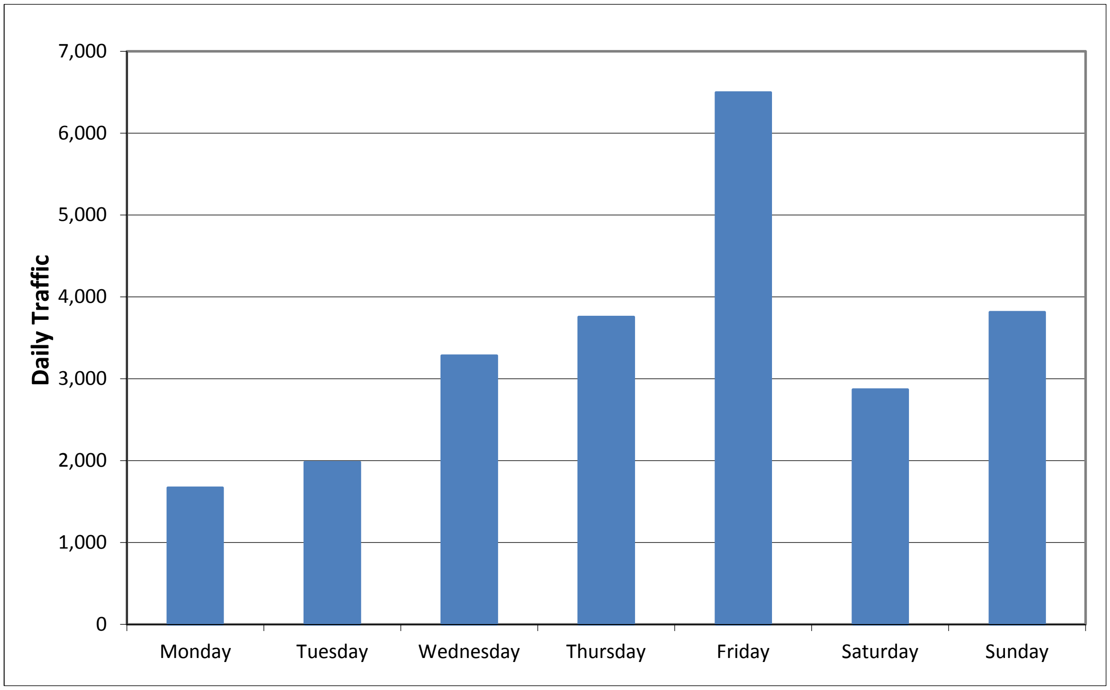
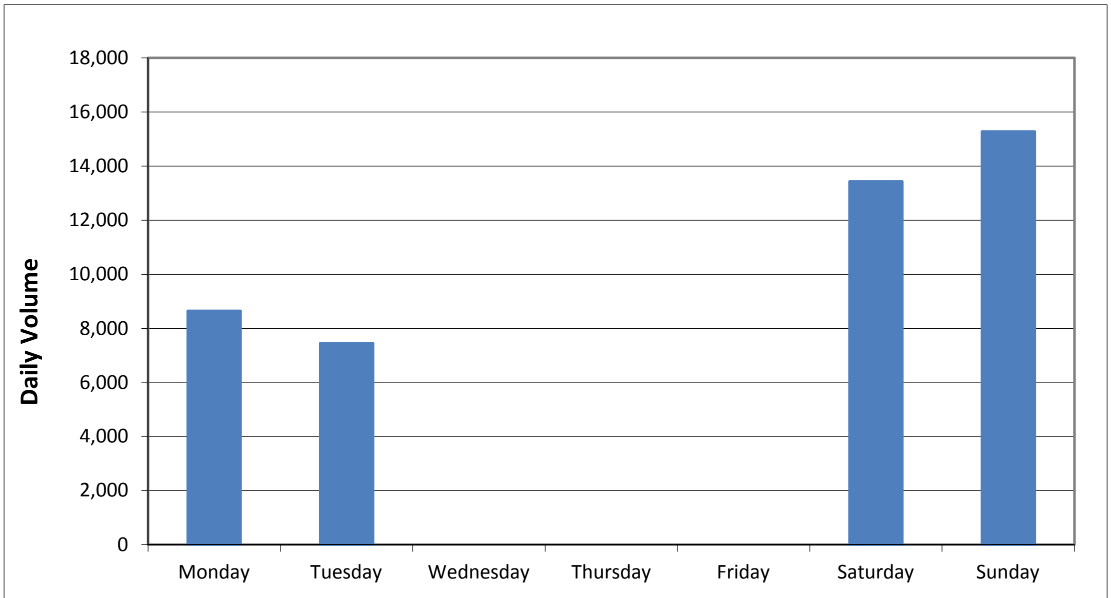
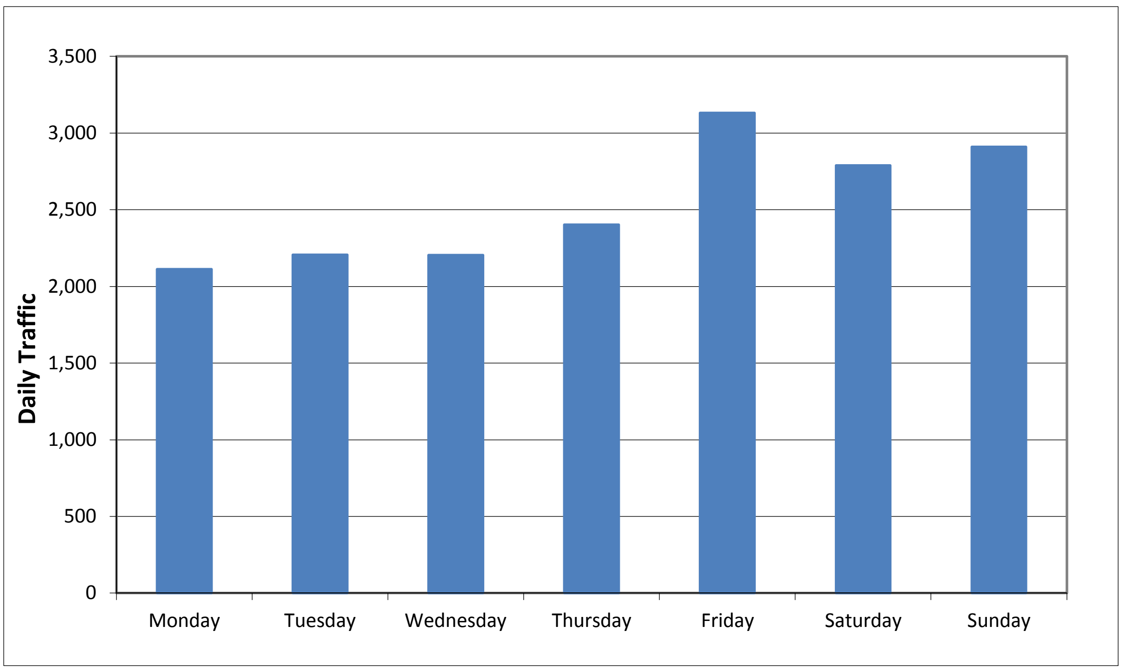


Figure 2.21 – Daily Traffic on SR-330, March 2010



Note: SR 330 Closed Wednesday through Friday.

Figure 2.22 – Daily Traffic on SR-18E, March 2010



Hourly Traffic Volumes

Figures 2.23 through 2.30 present hourly traffic volumes for March average weekdays and March average weekend days for the Big Bear Lake access routes. In Figure 2.23, SR-18 shows a typical peaking pattern of high outbound traffic in the AM and peak inbound traffic in the PM for an average weekday. The average weekend pattern shown in Figure 2.24 is similar but without the sharp peaks between inbound and outbound; traffic is steadier in both directions.

Figure 2.23 – Hourly Traffic on SR-18 March Average Weekday

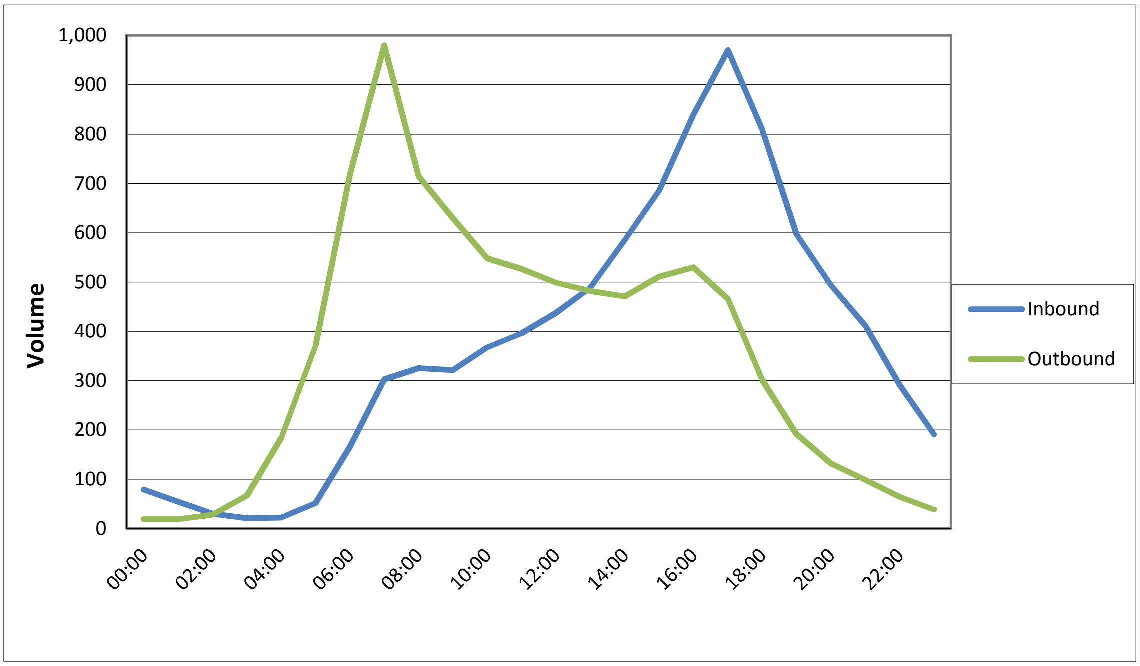
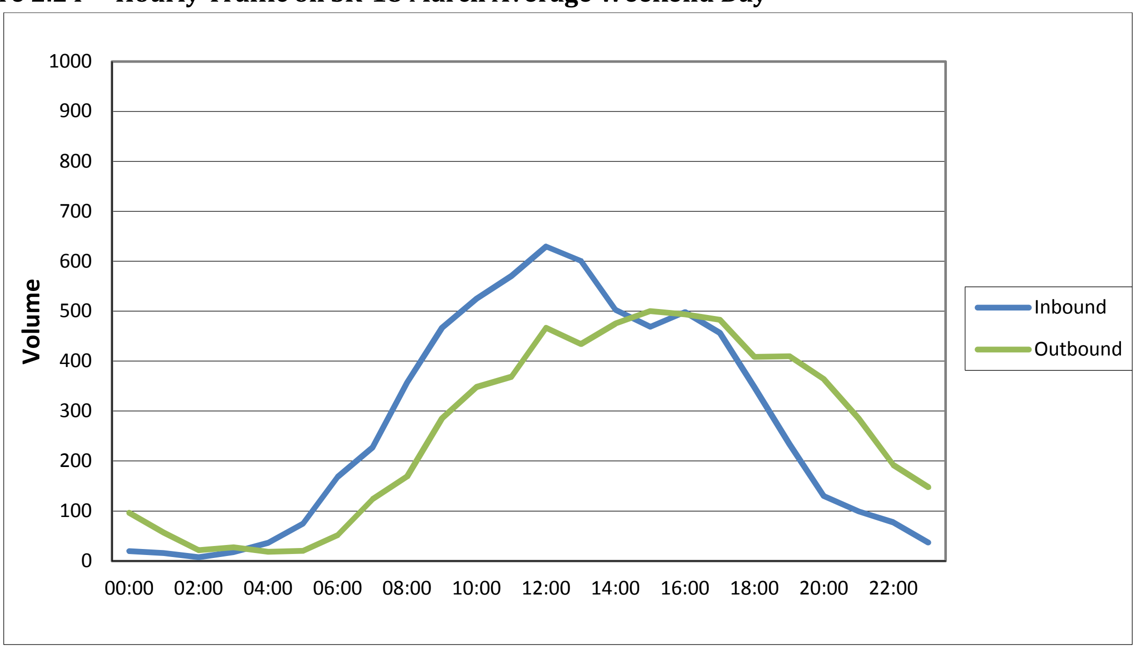


Figure 2.24 – Hourly Traffic on SR-18 March Average Weekend Day



As shown in Figure 2.25, there is little difference between inbound and outbound patterns on SR-38, but the total volumes are much lower than those on SR-18. Figure 2.26 shows the average weekend patterns on SR-38, where there is a significant outbound peak in the afternoon.

Like SR-38, there little difference between inbound and outbound average weekday volumes on SR-330 (Figure 2.27), but the average weekend patterns are typical of a recreation area with a peak inbound in the morning and a peak outbound in the afternoon.

As shown in Figures 2.23 and 2.24, the directional patterns on SR-18E are similar to those on SR-330 but the volumes are much lower.

Figure 2.25 – Hourly Traffic on SR-38 March Average Weekday

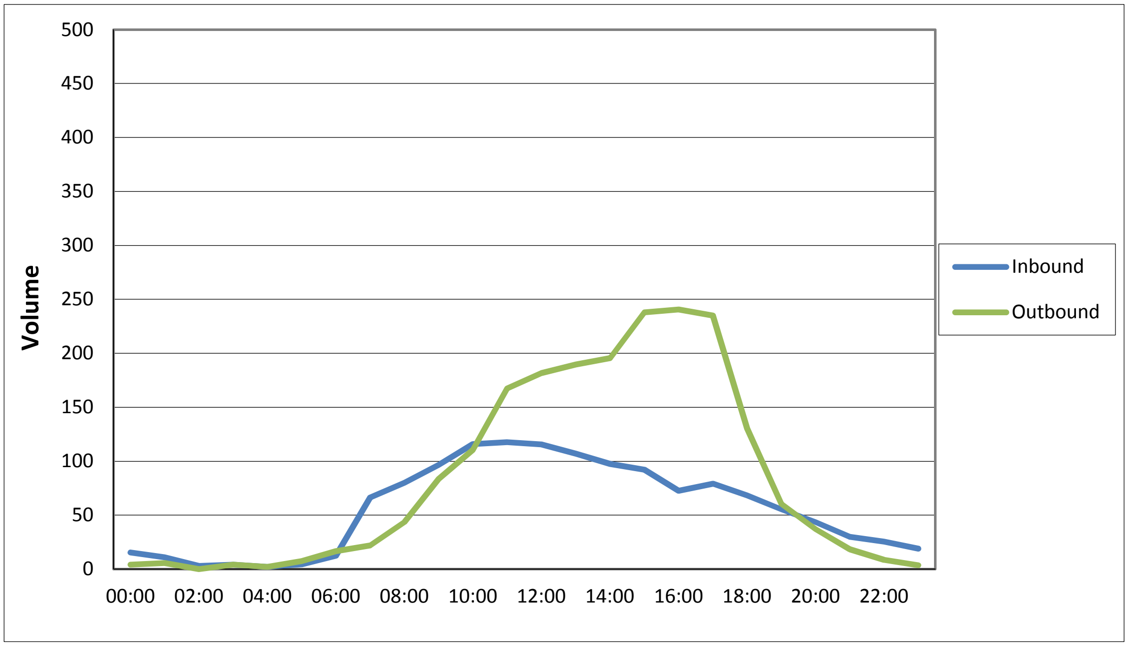


Figure 2.26 – Hourly Traffic on SR 38 March Average Weekend Day

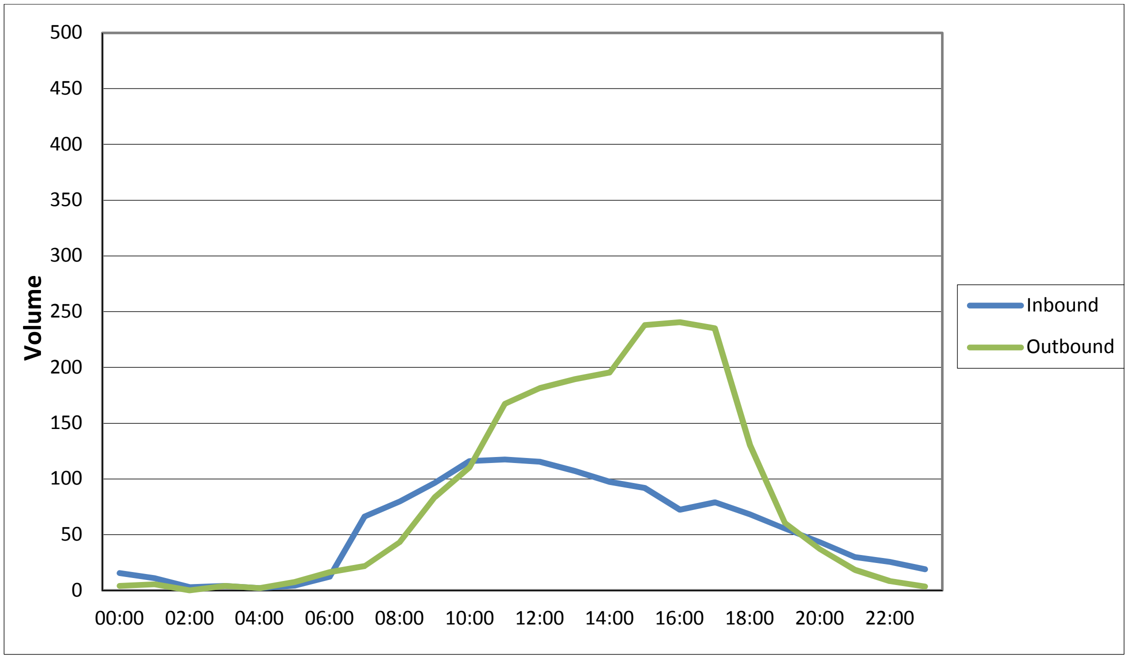


Figure 2.27 – Hourly Traffic on SR-330 March Average Weekday

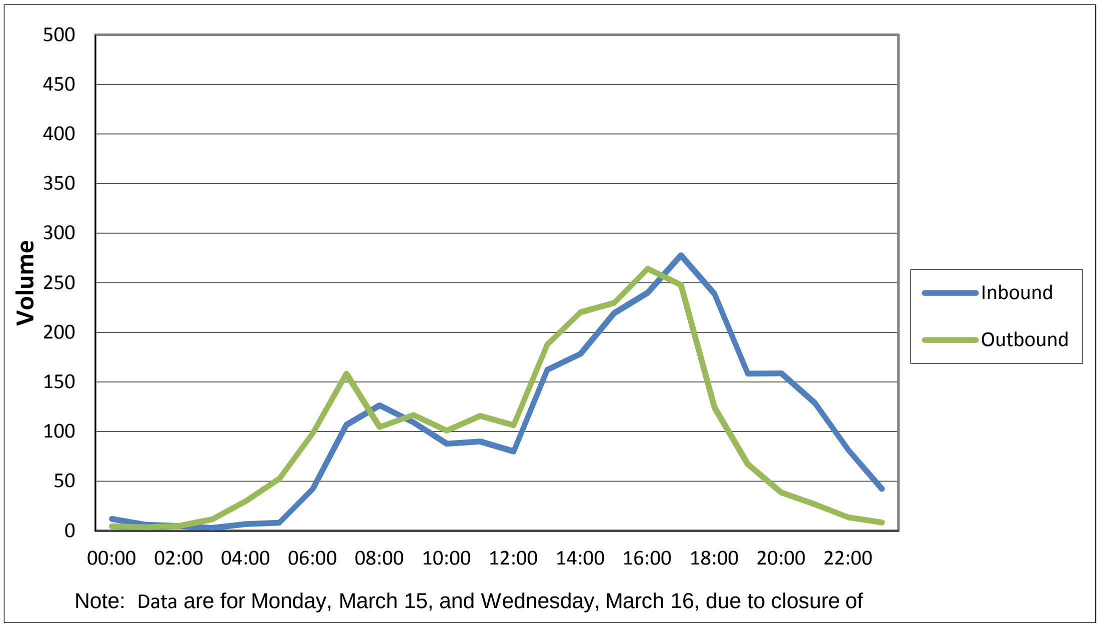


Figure 2.28 – Hourly Traffic on SR-330 March Average Weekend Day

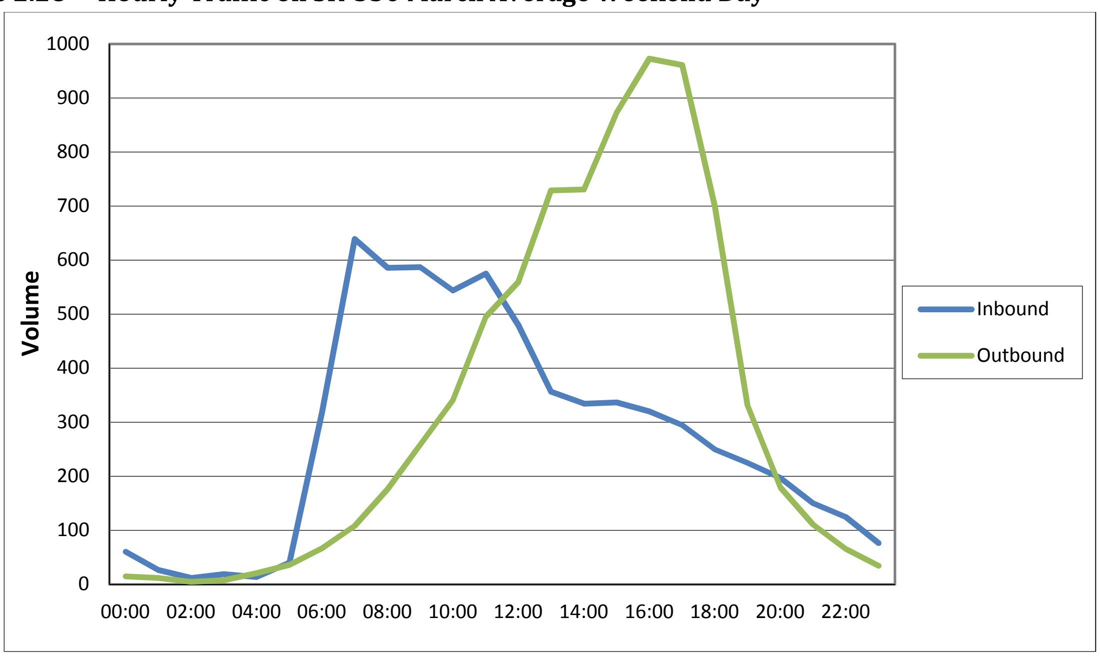
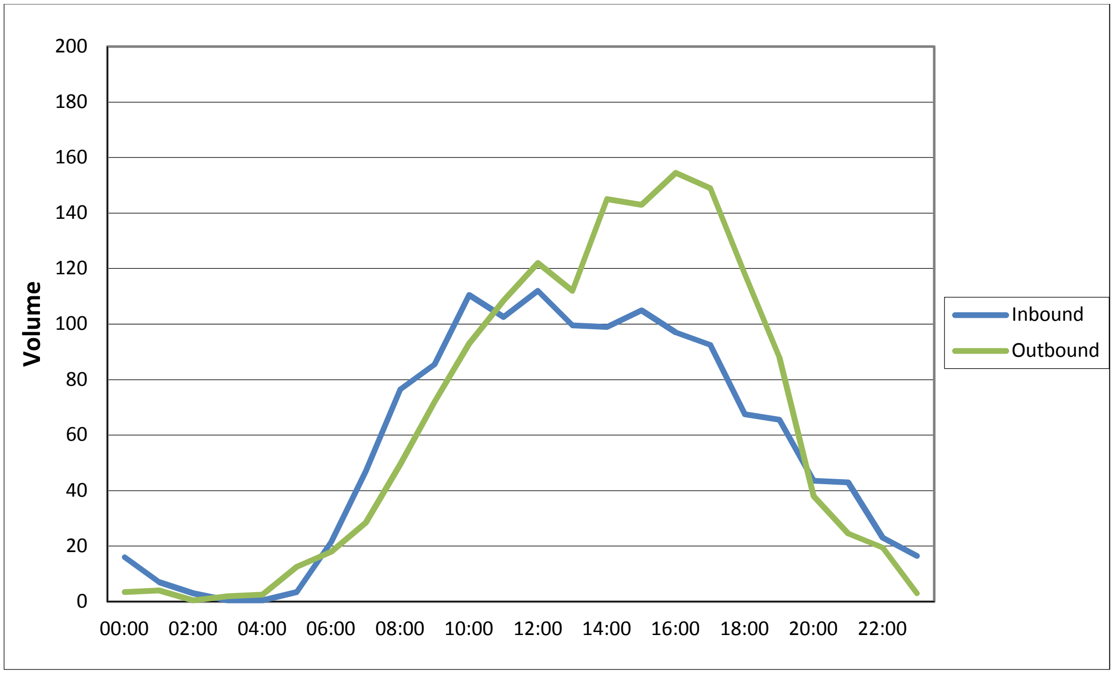


Figure 2.29 – Hourly Traffic on SR-18E March Average Weekday

Figure 2.30 – Hourly Traffic on SR-18E March Average Weekend Day



Appendix B includes charts showing directional hourly traffic volumes by day of week for each of the traffic count locations.

June Traffic Counts

Daily traffic variations are shown in Figures 2.31 through 2.35. These graphs compare June counts with March counts – Figure 2.31 shows the combined ADT on the four routes up the mountain, and the following four charts show the volumes on each individual route. Overall, the June counts are higher than the March counts, except for Sunday. The March closure of SR-330 for much of the counting period resulted in mostly higher March counts on the individual routes.

Figure 2.31 – Total Daily Traffic on all four Mountain Access Roads (SR-18, SR-18E, SR-330, SR-38)

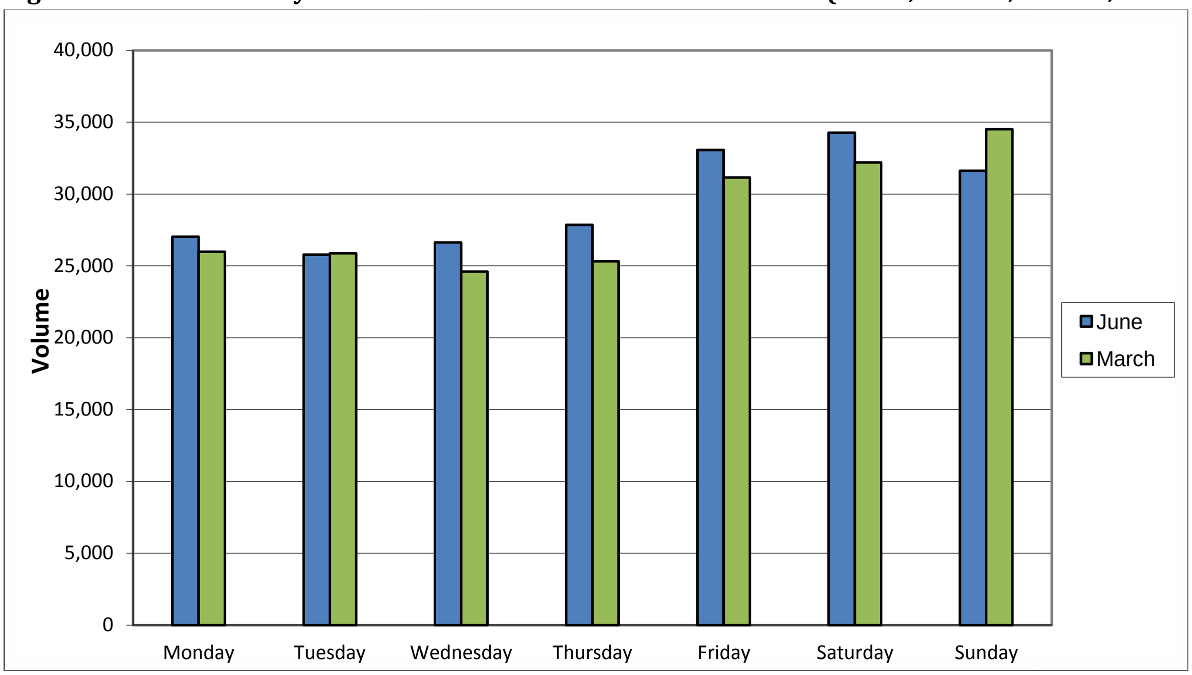


Figure 2.32 – Daily Traffic on SR-18 south of SR-138, June 2010

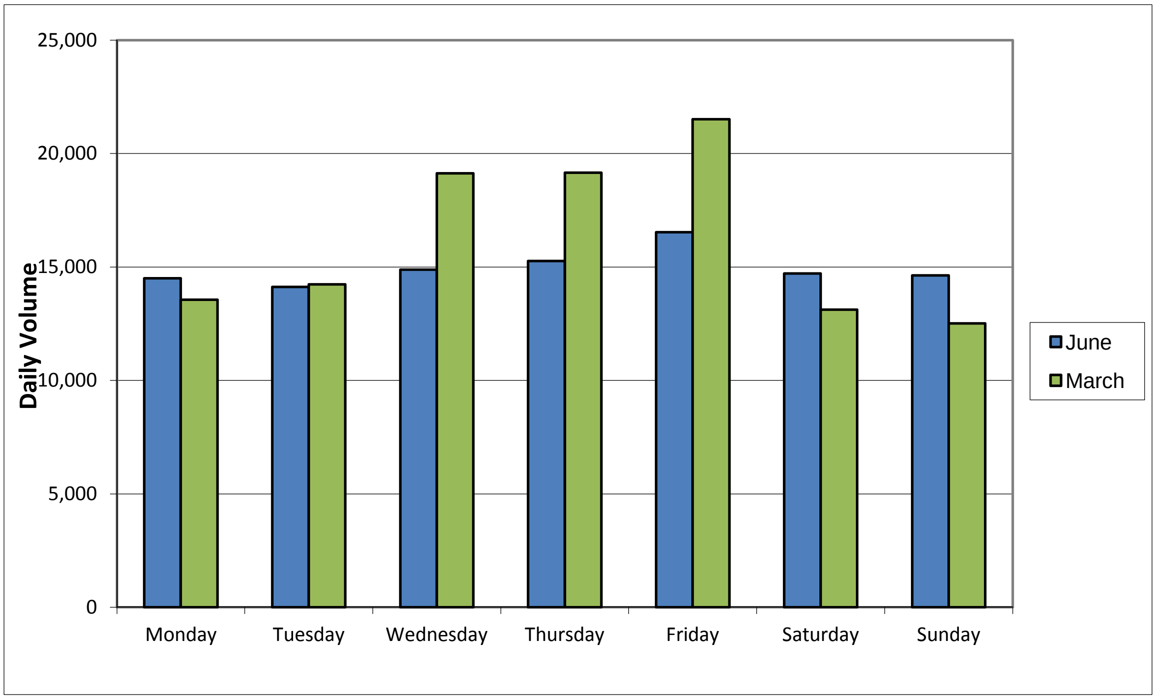


Figure 2.33 – Daily Traffic on SR-38, June 2010

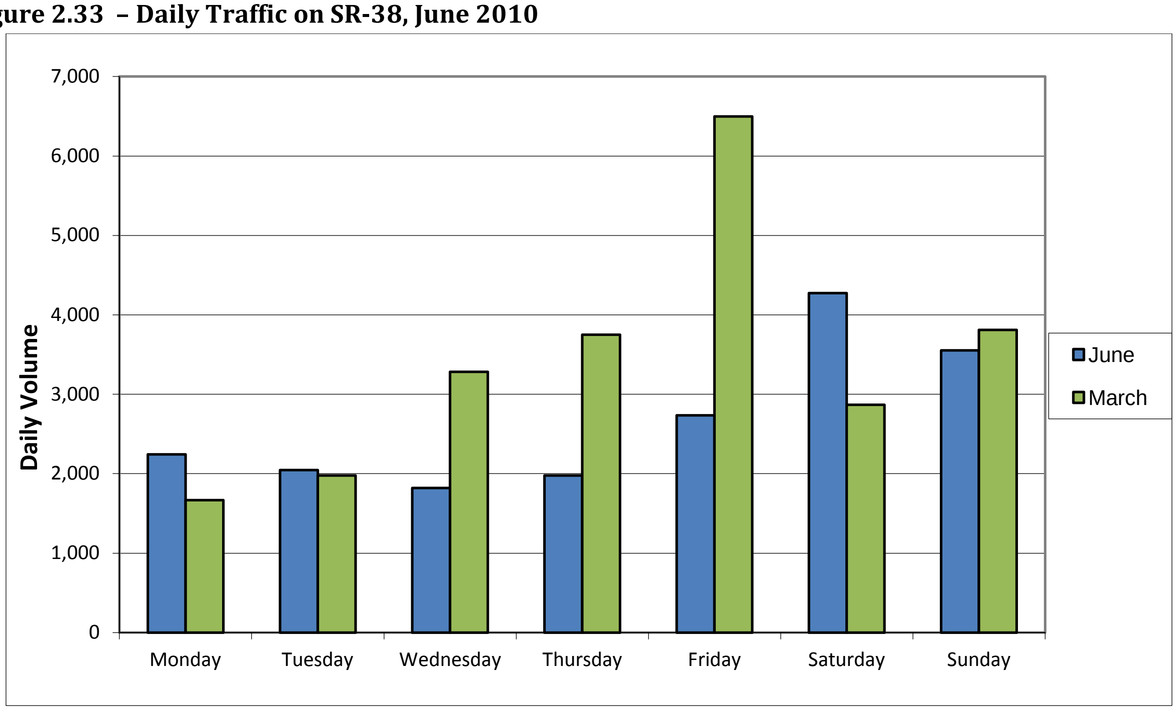


Figure 2.34 – Daily Traffic on SR-330, June 2010

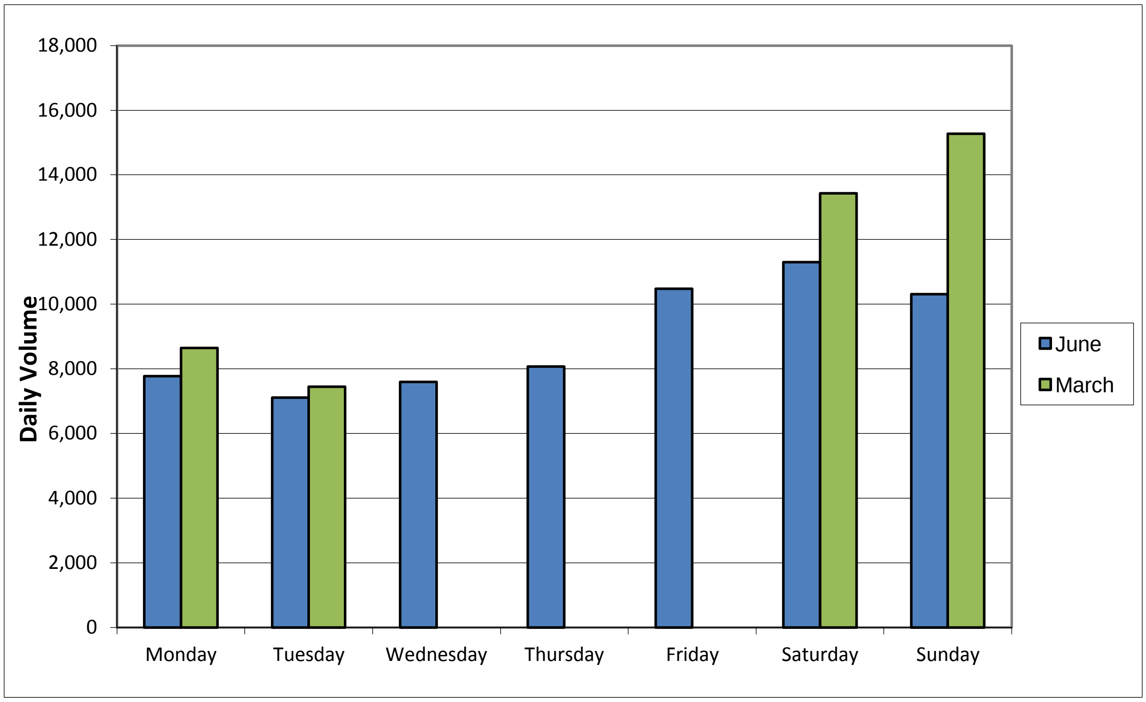
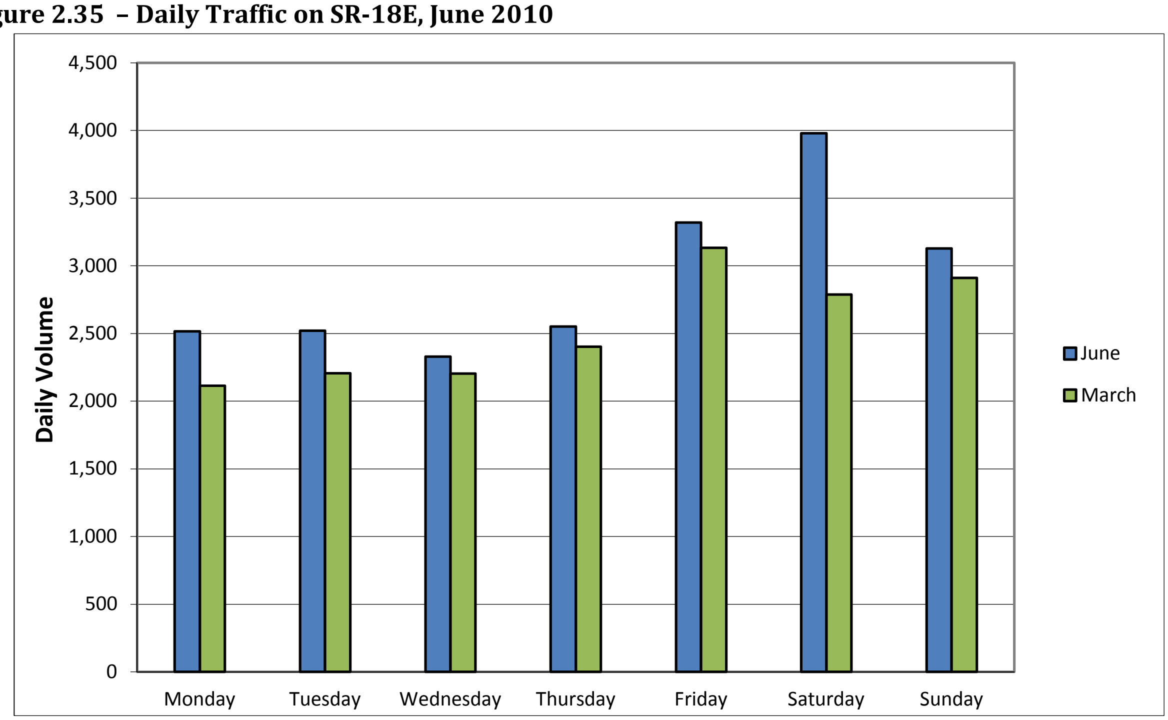


Figure 2.35 – Daily Traffic on SR-18E, June 2010



Hourly Traffic Volumes

Figures 2.36 through 2.46 show hourly traffic volumes for June average weekday and June average weekend days for the five count location

Figure 2.36 – Hourly Traffic on SR-18 south of SR-138 on an Average June Weekday

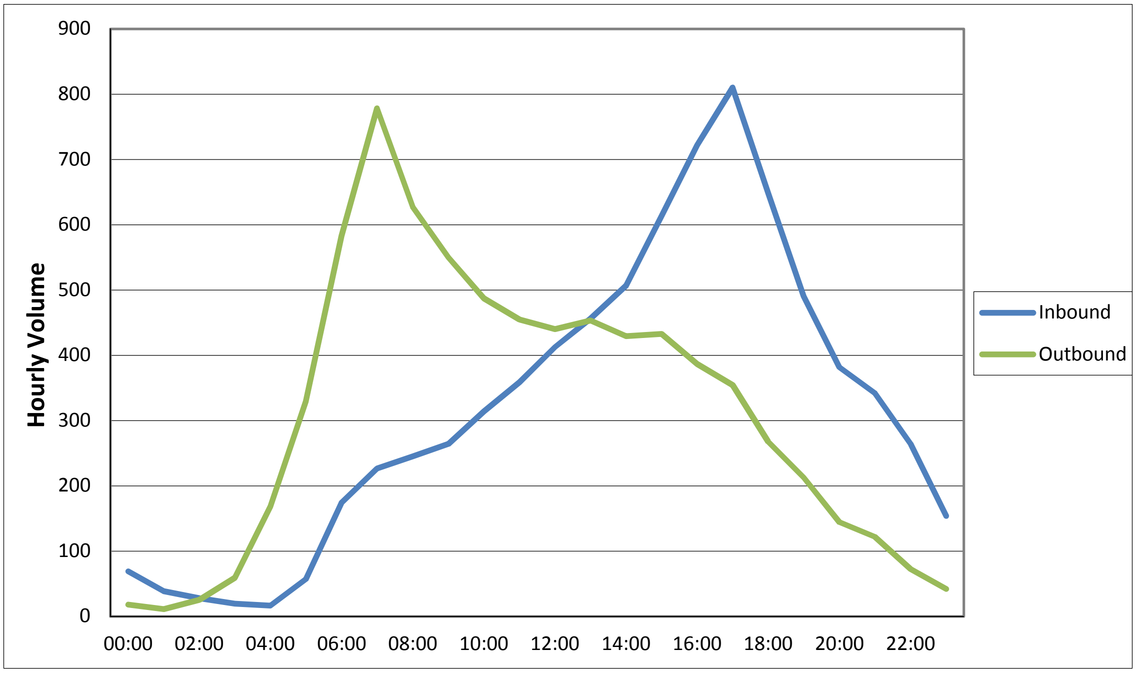


Figure 2.37 – Hourly Traffic on SR-18 south of SR-138 on an Average June Weekend Day

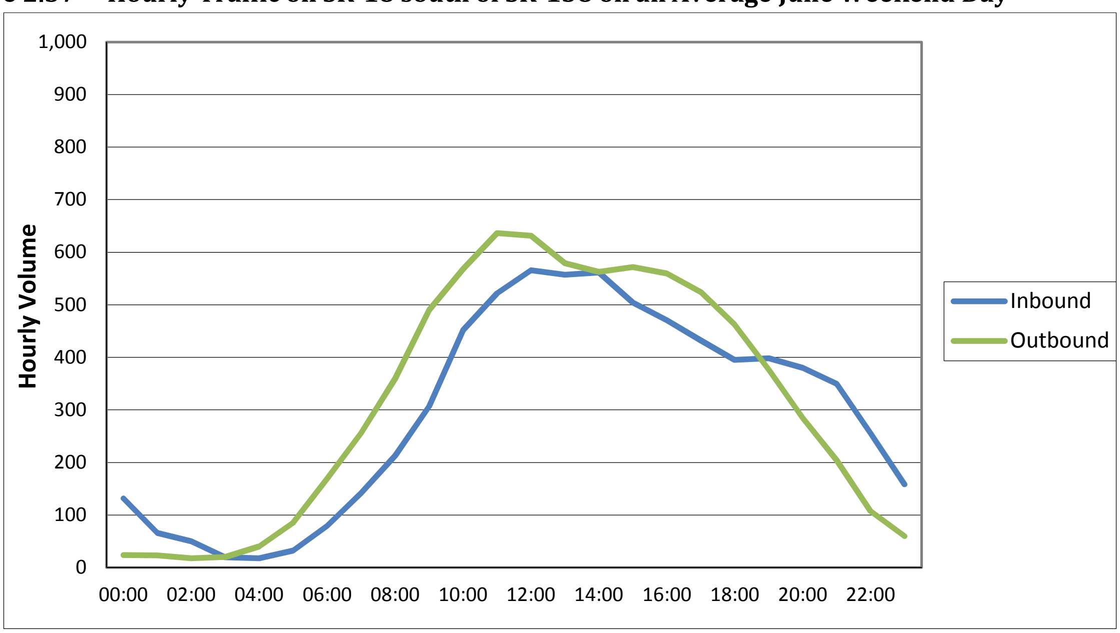


Figure 2.38 – Hourly Traffic on SR-18 east of Snow Valley on an Average June Weekday

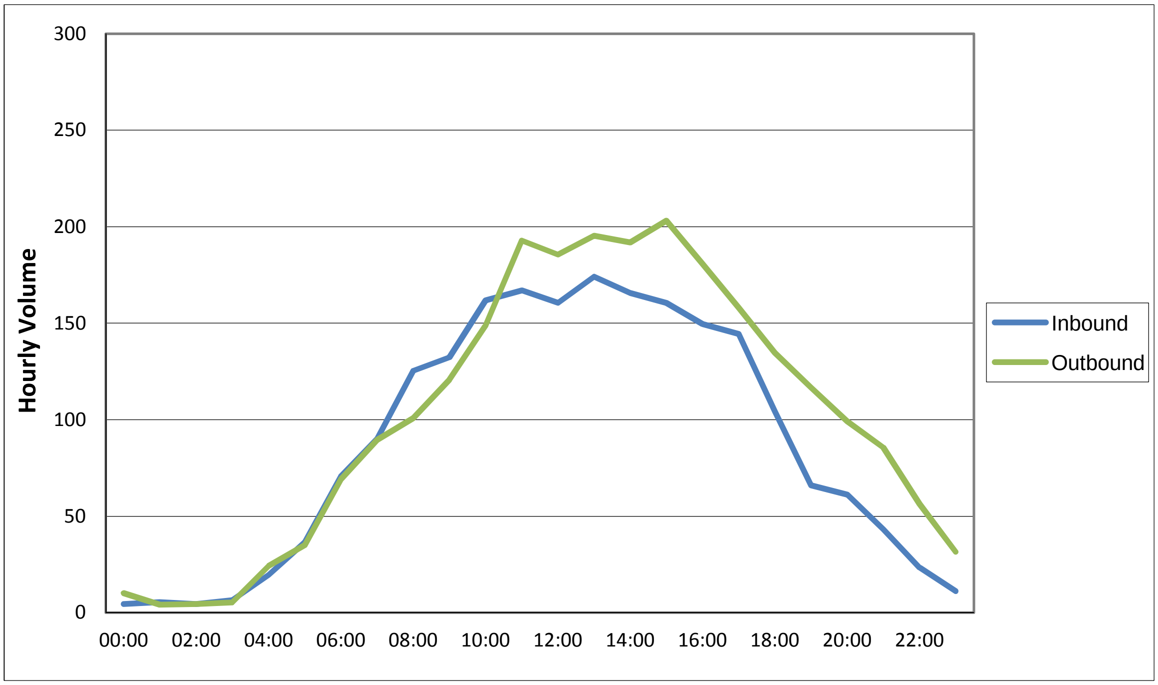


Figure 2.39 – Hourly Traffic on SR-18 east of Snow Valley on an Average June Weekend day

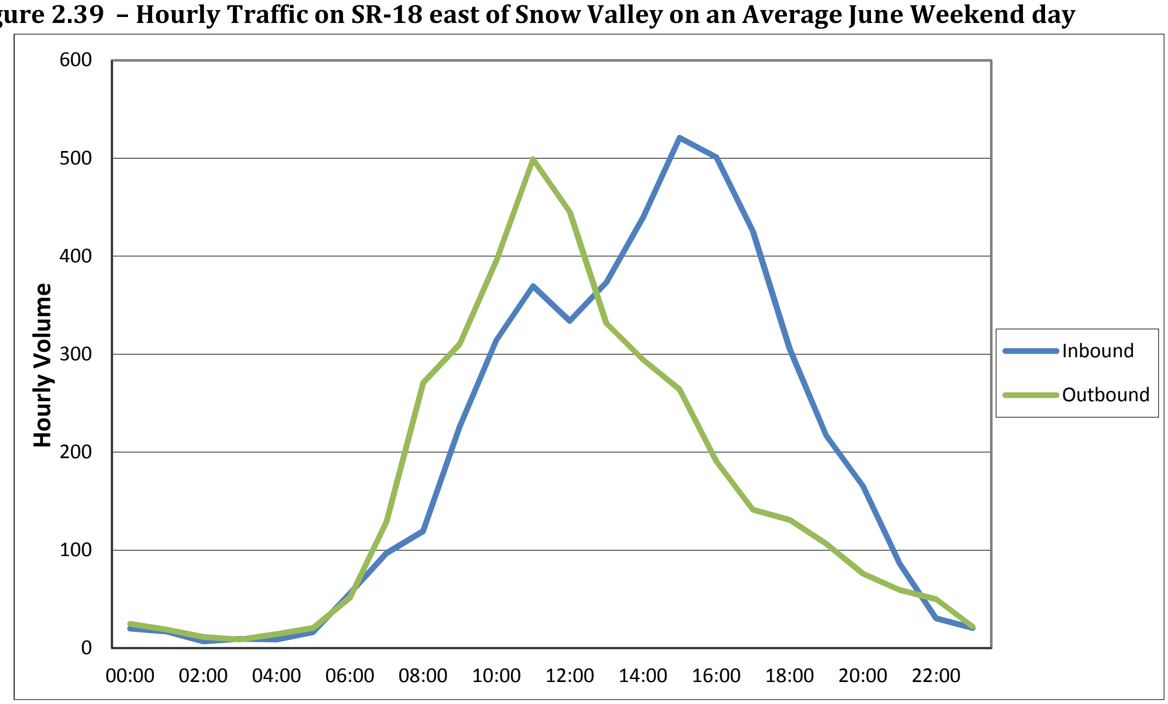


Figure 2.40 – Hourly Traffic on SR-38 June Average Weekday

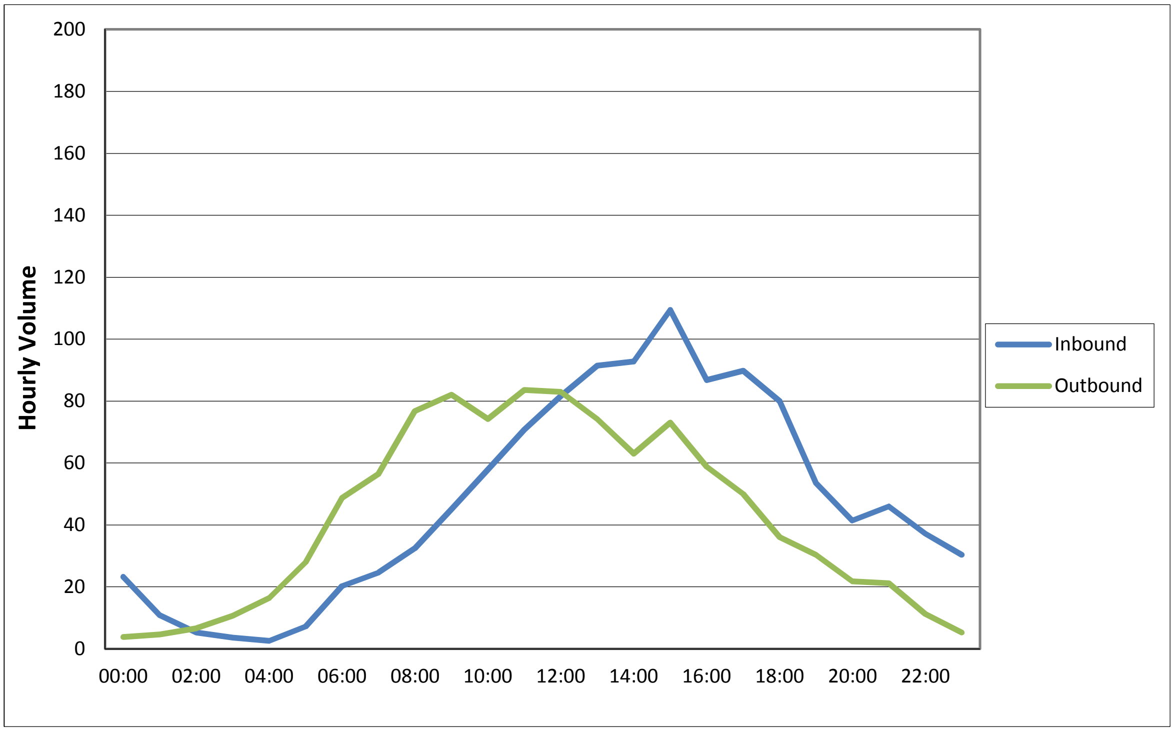


Figure 2.41 – Hourly Traffic on SR-38 June Average Weekend day

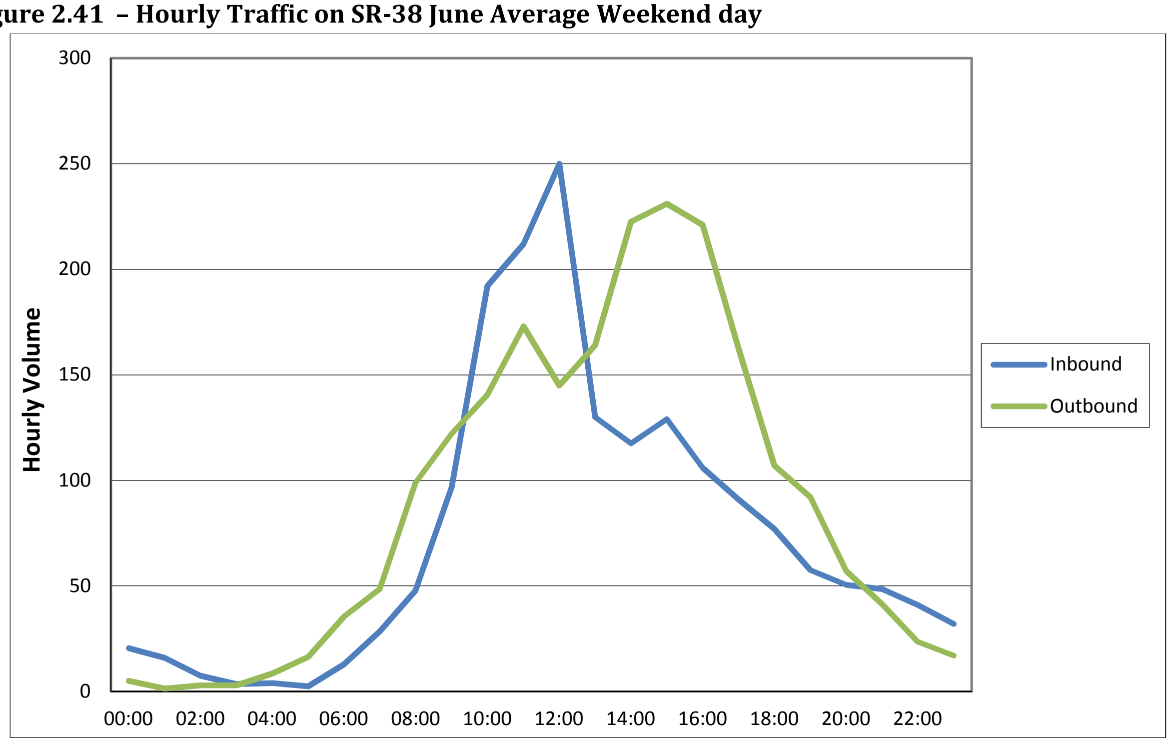


Figure 2.42 – Hourly Traffic on SR-330 June Average Weekday

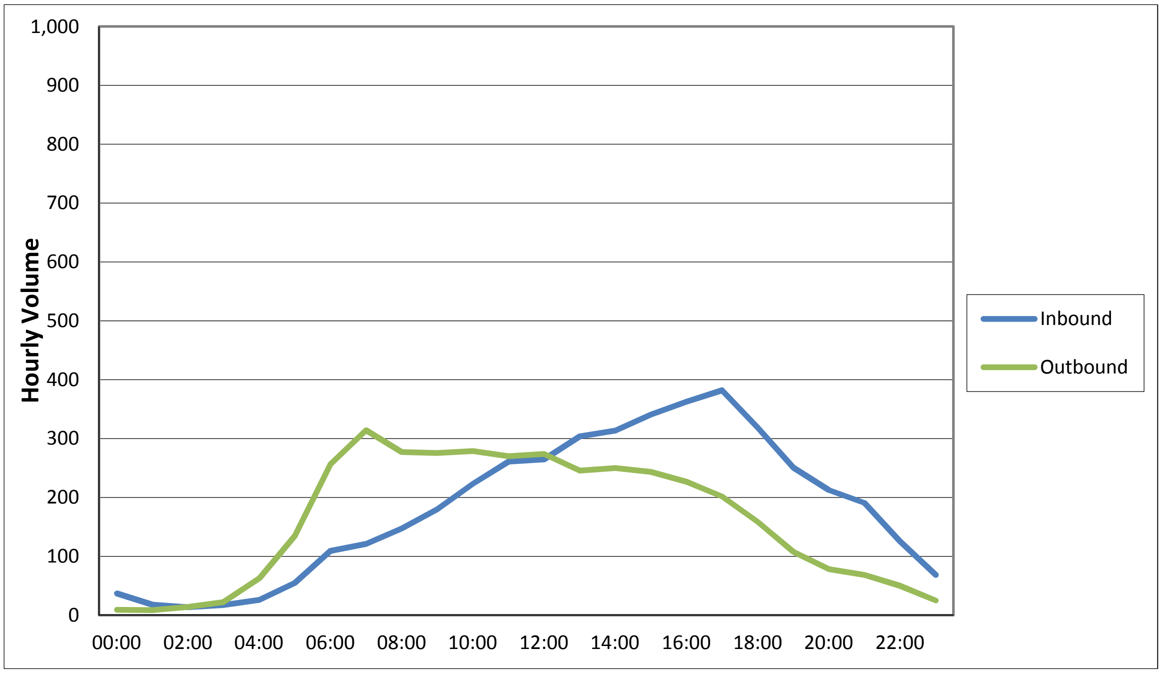


Figure 2.43 – Hourly Traffic on SR-330 June Average Weekend Day

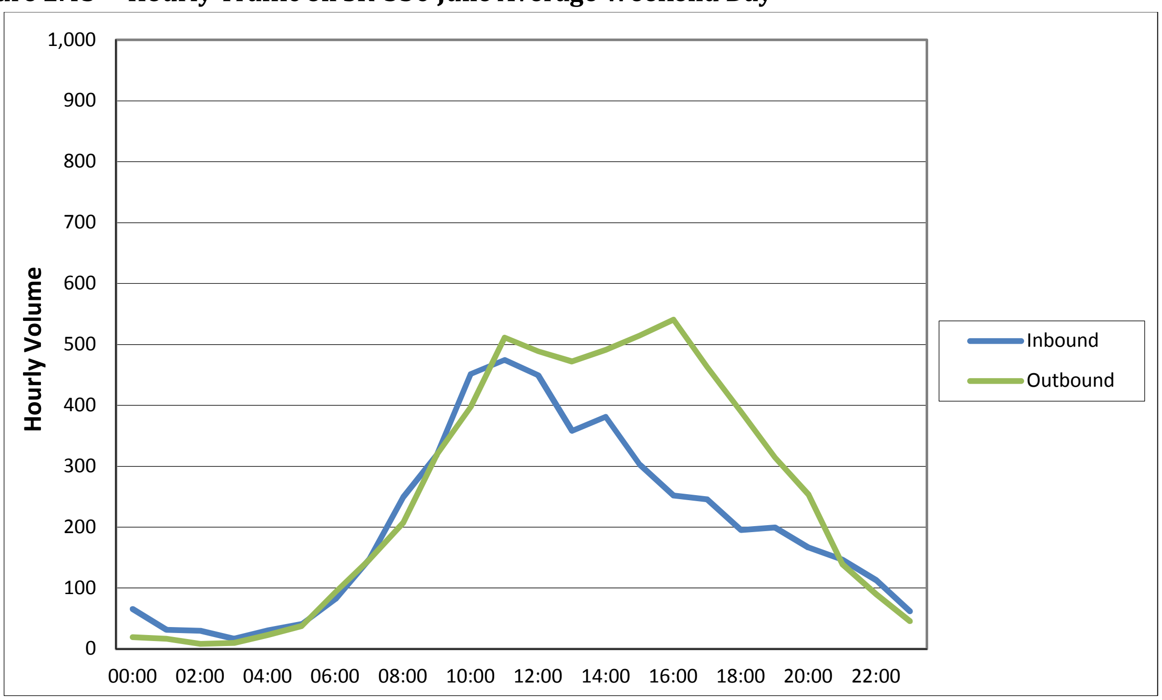


Figure 2.44 – Hourly Traffic on SR-18E June Average Weekday

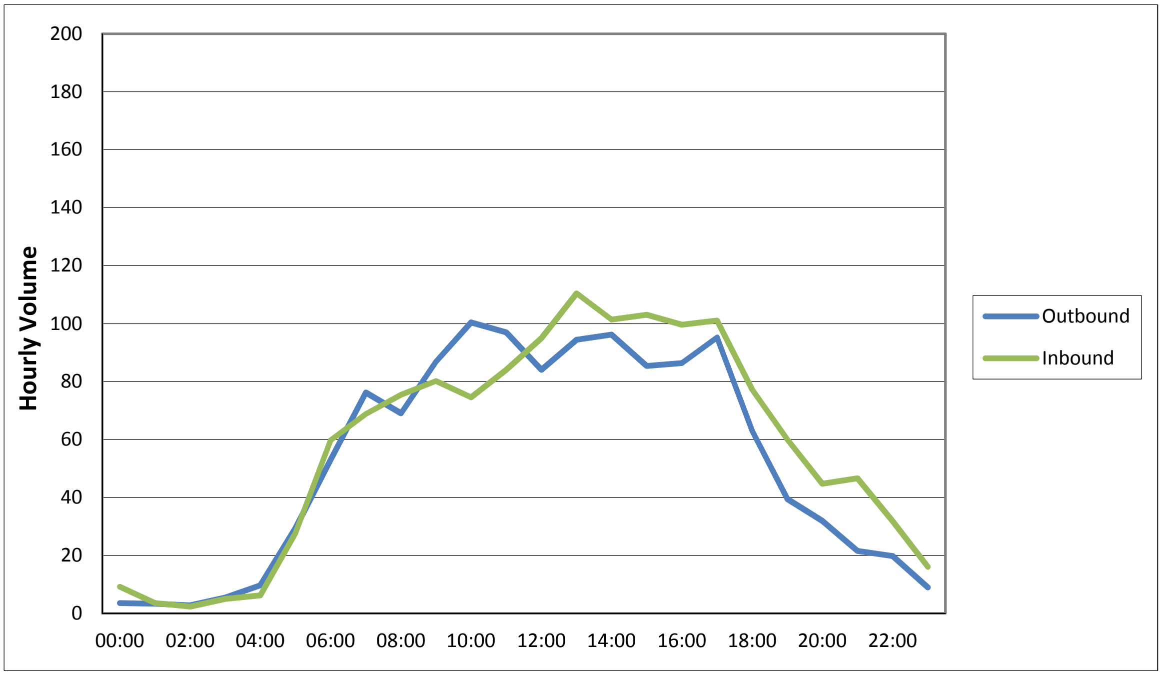
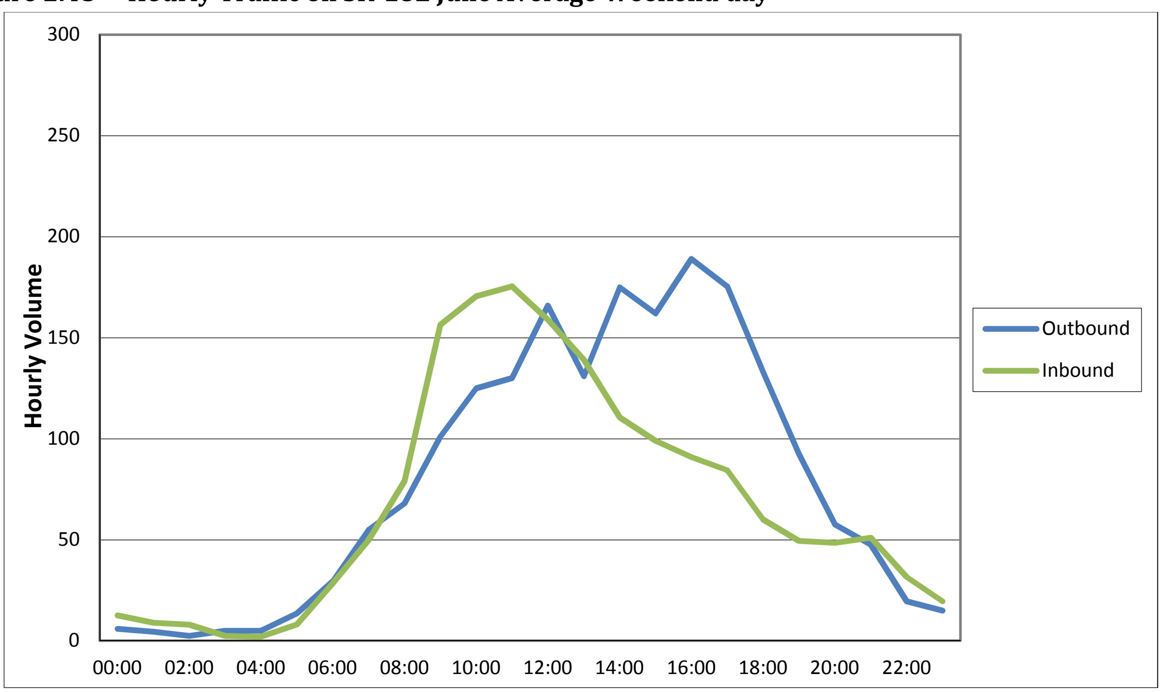


Figure 2.45 – Hourly Traffic on SR-18E June Average Weekend day



Hourly Traffic Summaries
Appendix B includes charts showing directional hourly traffic volumes by day of week for each of the traffic count locations.

August Traffic Counts

In early August, additional traffic counts were conducted to supplement the summer counts collected in June and to determine whether the June counts reflected typical summer traffic volumes. The August counts were collected from Thursday August 5 through Monday August 9 at four of the locations counted in March and June:

- SR-18 West between San Bernardino and Crestline
- SR-330 between Highland and Running Springs
- SR-38 between the Santa Ana River Bridge and Big Bear City; and
- SR-18 between Snow Valley and Big Bear Dam

The charts below compare the total daily volumes at these locations by day of the week in March, June, and August.

The August volumes are generally somewhat higher than the June volumes, except that the Saturday volumes were higher in June than in August.

The summer volumes were generally slightly higher than the March volumes, except for the weekend counts on SR-330 because of the good spring skiing conditions when the March counts were collected. (Note: The Wed/Thurs/Fri volumes in March on SR-18W and SR-38 were higher than the June and August volumes because SR-330 was closed for repairs on those days in March and the traffic that would normally use SR-330 used those two roads instead.)

Figure 2.46 – SR-18: San Bernardino to Crestline

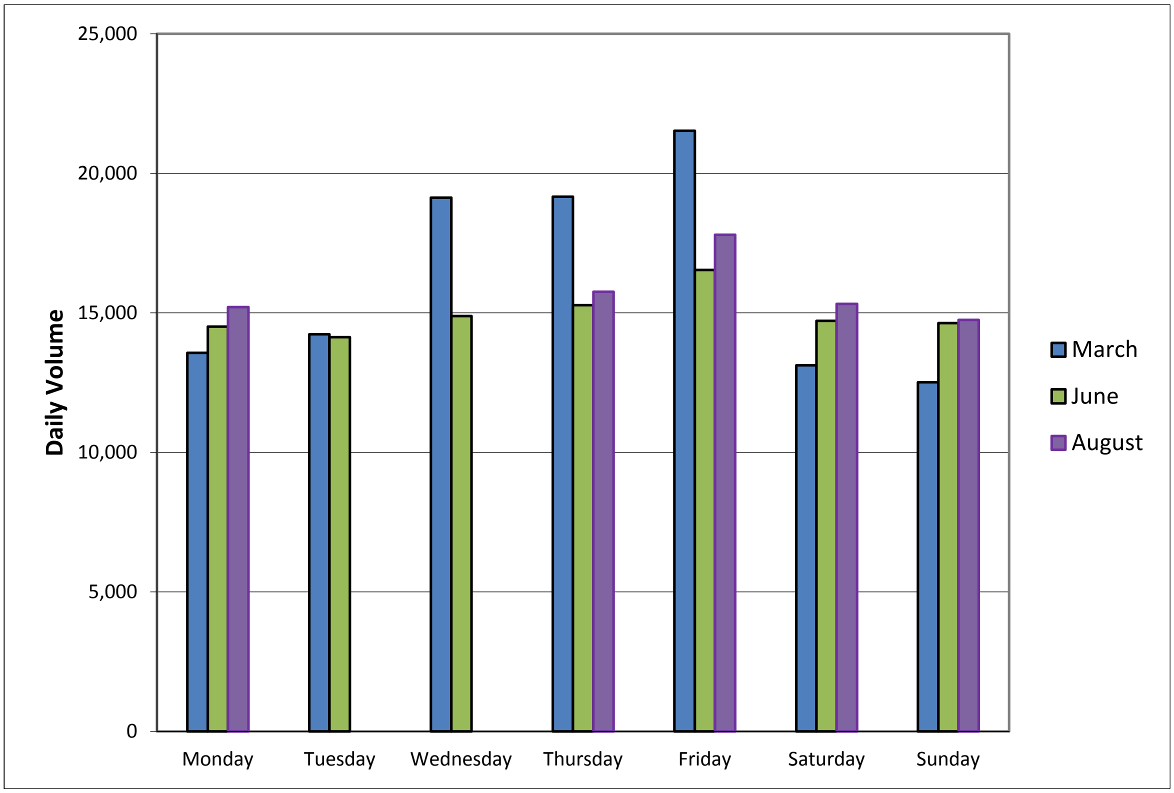


Figure 2.47 - SR-330: Highland to Running Springs

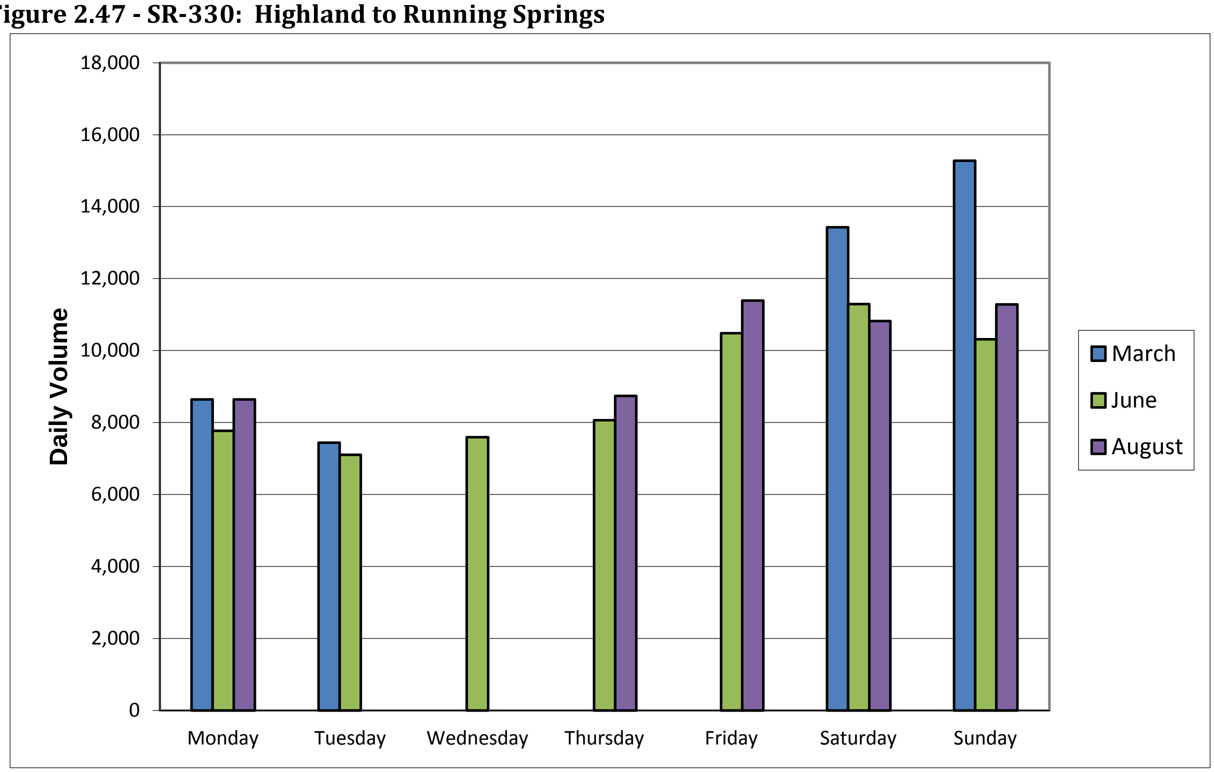


Figure 2.48 - SR-38: Santa Ana River to Big Bear City

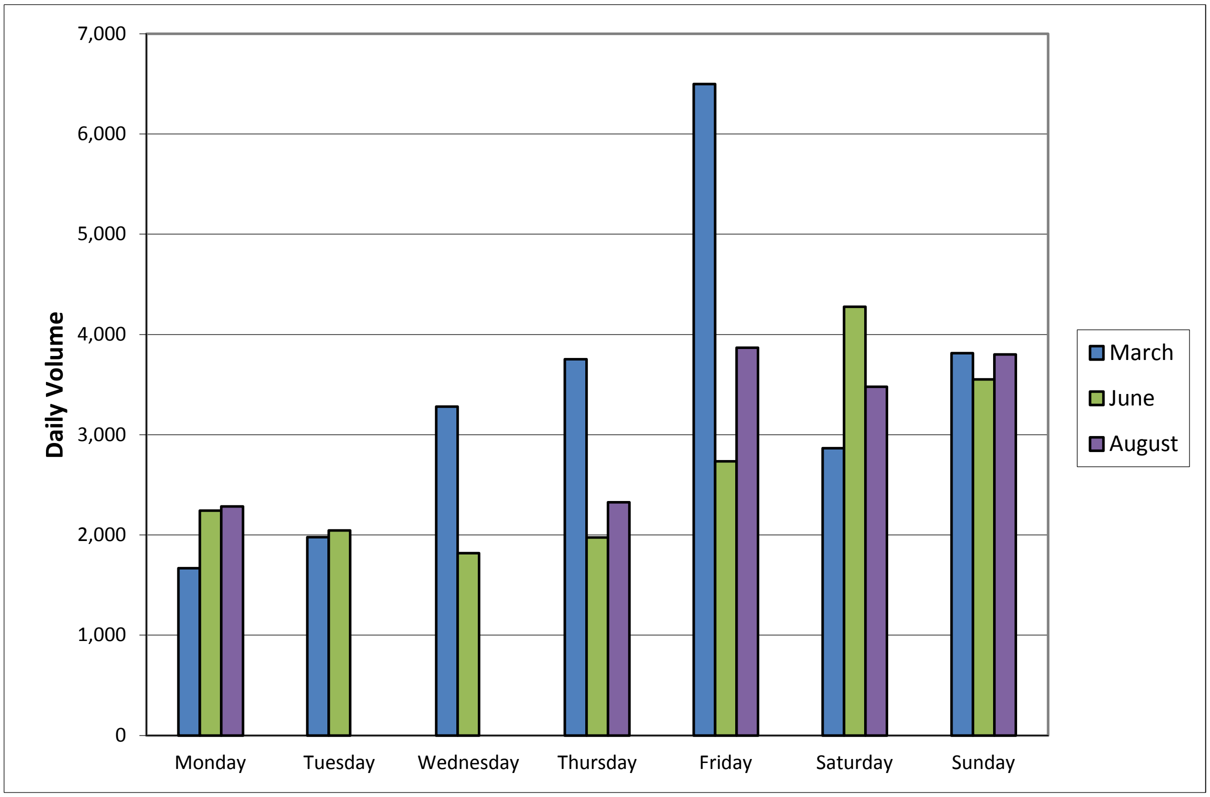
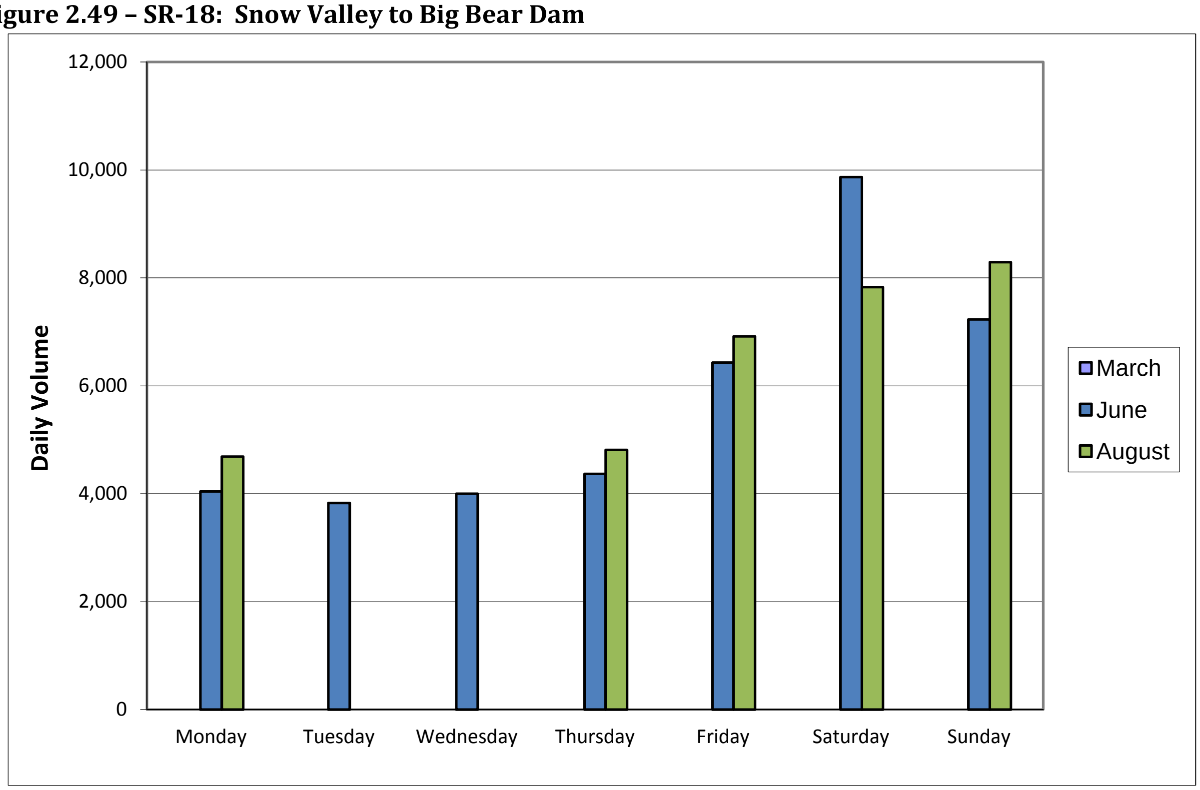


Figure 2.49 – SR-18: Snow Valley to Big Bear Dam



Vehicle Occupancy Patterns

Vehicle occupancy counts were taken on SR-18 on Wednesday, April 7, and on SR-38 on Friday afternoon, April 2, and Saturday morning, April 3. Table 2.10 shows the average occupancies for each of the count periods by direction. Saturday morning inbound has the highest occupancy at 1.96 persons per vehicle; Saturday afternoon outbound has the second highest at 1.86 persons per vehicle. This is consistent with the recreational nature of the Big Bear area.

Figures 2.50 through 2.53 show vehicle occupancy by time of day for each time period and location.

Table 2.10 - Average Vehicle Occupancies

		Persons per Vehicle	
Location	Time Period	Inbound	Outbound
SR-18	Wednesday Morning	1.43	1.26
SR-18	Wednesday Afternoon	1.27	1.55
SR-38	Friday Afternoon	1.8	1.8
SR-38	Saturday Morning	1.96	1.86

Figure 2.50 - SR-18 Vehicle Occupancies, Wednesday Morning

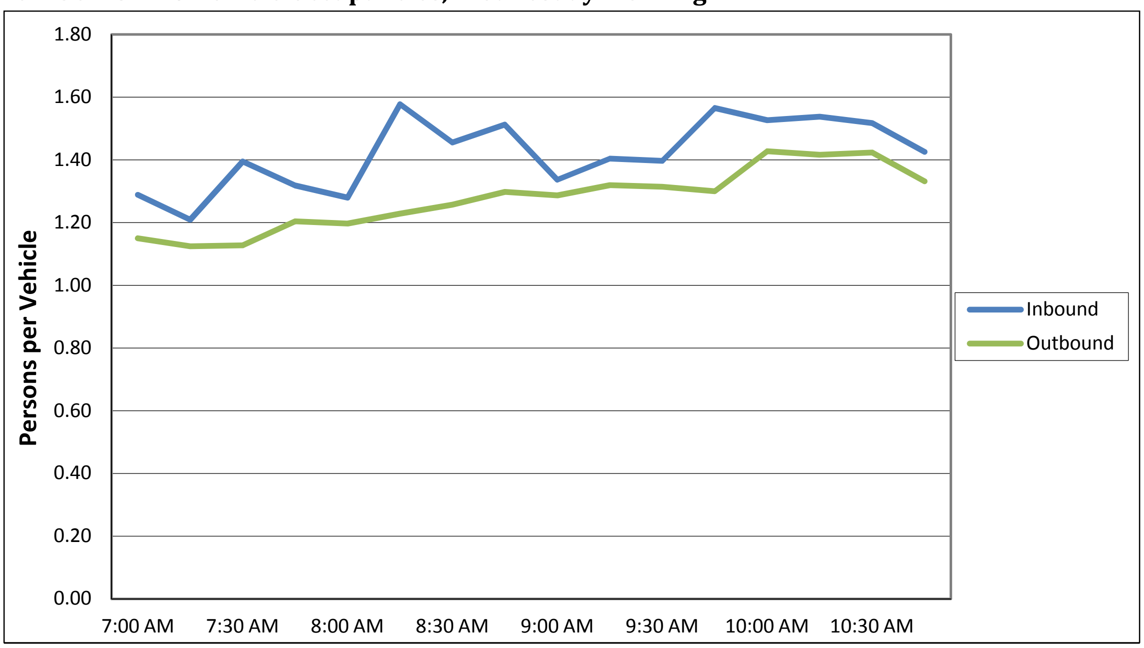


Figure 2.51 - SR-18 Vehicle Occupancies, Wednesday Afternoon

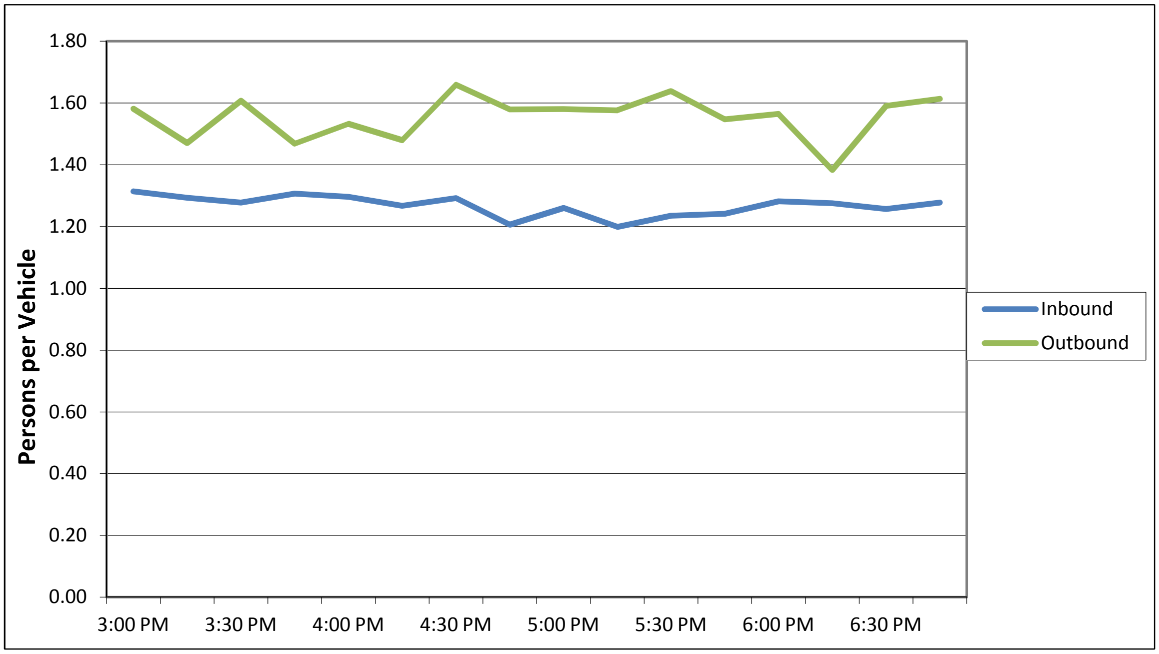


Figure 2.52 - SR-38 Vehicle Occupancies, Friday Afternoon

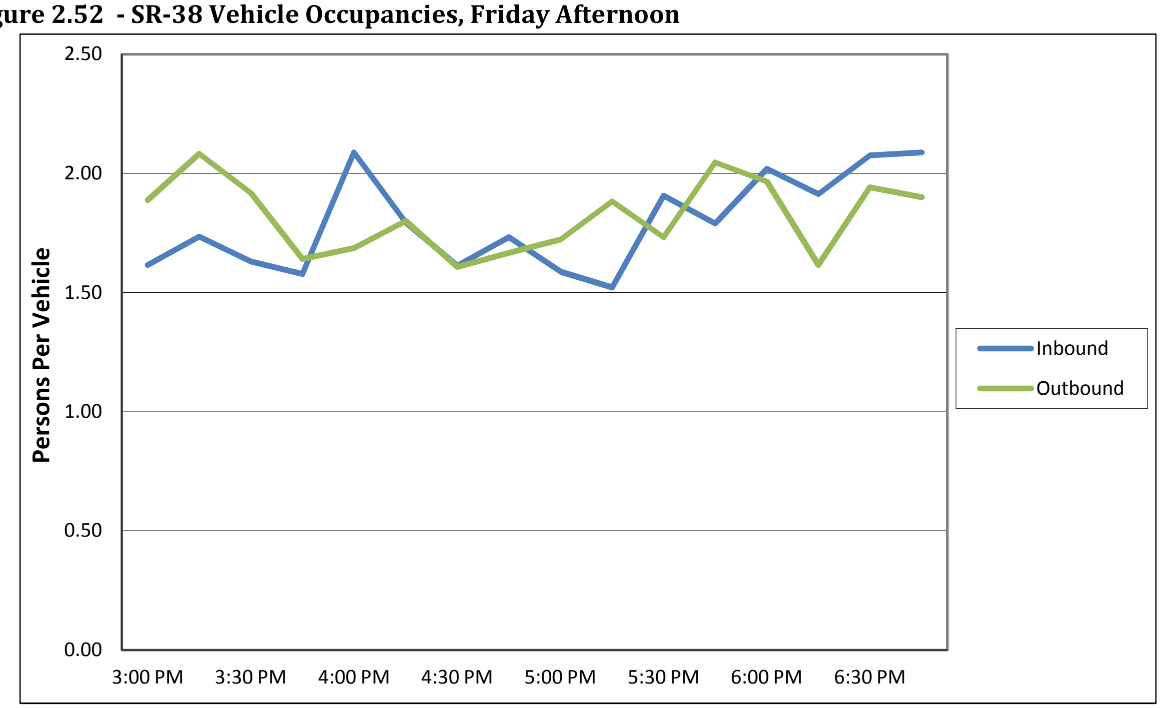
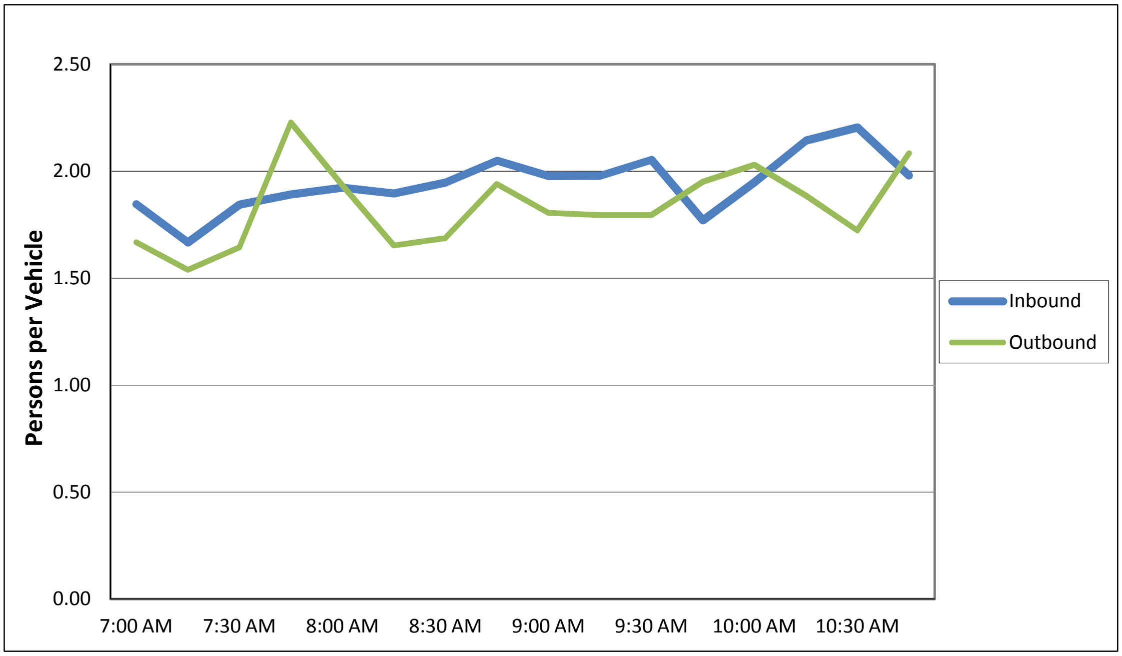


Figure 2.53 - SR-38 Vehicle Occupancies, Saturday Morning



2.4.5 Accidents and Safety Issues

Table 2.11 – Collision Rates on Mountain Access Roads, 2007-09

	From:	To:	Actual			Average			Ration (Actual/Average)		
Highway	Road	Road	Fatal	F+I	Total	Fatal	F+I	Total	Fatal	F+I	Total
SR-18	Sierra Way (San Bernardino)	SR-138 (Crestline)	0.065	0.48	1.03	0.013	0.32	0.79	5.00	1.50	1.30
	SR-138 (Crestline)	SR-330 (Running Springs)	0.064	0.99	2.16	0.028	0.45	0.99	2.29	2.20	2.18
	SR-330 (Running Springs)	SR-38 (Big Bear Dam)	0.045	1.07	2.56	0.029	0.49	1.08	1.55	2.18	2.37
	SR-38 (Big Bear Dam)	SR-38 (Big Bear City)	0	0.63	1.67	0.019	0.59	1.46	0.00	1.07	1.14
	SR-38 (Big Bear City)	Marble Canyon Rd (Lucerne Valley)	0.040	1.00	2.02	0.04	0.82	1.66	1.00	1.22	1.22
SR-38	SR-18 (Big Bear Dam)	SR-18 (Big Bear City)	0.034	1.20	2.26	0.033	0.69	1.56	1.03	1.74	1.45
	SR-18 (Big Bear City)	Santa Ana River Bridge	0.008	0.59	1.13	0.026	0.44	1.00	0.31	1.34	1.13
	Santa Ana River Bridge	Bryant Street (Mentone)	0.085	1.24	2.18	0.042	0.85	1.69	2.02	1.46	1.29
SR-330	SR-210 (Highland	SR-18 (Running Springs)	0.029	0.6	1.25	0.022	0.37	0.87	1.32	1.62	1.44

Table 2.11 presents a summary of 2007-09 collision rates on selected roadway segments leading to Big Bear. The values are collisions per million vehicles traversing the segment over the three-year period.

The table shows actual collision experience on the identified segments, the statewide average rates for similar roads, and the ratio of actual to average rates for the selected period.

Almost all segments had collision rates significantly higher than the statewide average (based on a criteria ratio >1.25) (see Appendix D). Fatal collisions are the most critical category due to the impact of loss of life, followed by fatal+injury collisions. As Table 2.11 shows, three segments of SR-18 each had fatal, fatal+injury, and total collision rate significantly higher than the state average:

- SR-18 from San Bernardino to Crestline
- SR-18 from Crestline to Running Springs
- SR-18 from Running Springs to Big Bear Dam.

Generally lower collision rates and lower ratios in all categories were observed on two segments of SR-18:

- From Big Bear Dam through the City of Big Bear Lake into Big Bear City; and
- From Big Bear City toward the Lucerne Valley.

For SR-38, all segments in the study area had higher than average collision rates, and the section from the Santa Ana River Bridge to Mentone has an observed fatality rate more than twice the statewide average. SR-330 from SR-210 to SR-18 had collision rates higher than the statewide average with ratios from 1.32 to 1.66 times the average collision rates.

2.4.6 Road Closures

Road closures are an important impediment to travel between San Bernardino and Big Bear Lake. When one of the access roads must be closed, people and goods must make their trip via a longer and more circuitous route, or they may be totally precluded from reaching their destination for a period of time if other access roads are closed as well. A listing of road closures can be found in Appendix E.

Closures can be caused by several different things:

- Landslides can occur without notice and close roads for days at time. (This is a particular problem on SR-330.)
- Repairs and maintenance of the roadway infrastructure sometimes requires closures that last for weeks. Two recent examples include the closure of SR-330 for several weeks during the spring of 2010 to repair a failing culvert and the months-long closure of SR-330 starting in December 2010 caused by heavy rains undermining a portion of the roadway.
- Accidents on the narrow, winding mountain roads sometimes require closure of a lane or the entire roadway, which can last for hours.
- Heavy snowfall can close the roads for hours or even days, as it did in the winter of 2010. Even when the roads are opened, the requirement for vehicles to use chains in snowy and icy conditions significantly disrupts traffic operations.

Caltrans was able to research the history of emergency-related closures of SR-330 for use in this study. The records show that SR-330 has had four emergency closures over the past ten years – three involving emergency storm water repairs and one related to wildfire in the area. Each closure lasted between one and two months. Based on this information, Caltrans concludes that SR-330 has been closed an average of eighteen days per year for emergency situations, or about 5% of the time. This does not include closures for routine landslides, scheduled maintenance, accidents, or snowfall (for which closure data are not available). The closures are summarized in Table 2.12 and Figure 2.54.

Table 2.12 - State Route 18 & 330 Road Closures (2005-2010)

State Route	Year	Duration of Closure
18	2005	246d 12h
18	2006	7d 20h
18	2007	38d 11h
18	2009	7d 15h
18	2010	5d 21h
Average percentage of closure for 5 year period (2005-2010) 16%		
330	2005	8d
330	2006	43d 8h
330	2007	12d
330	2009	5d 12h
330	2010	55d 18h
Average percentage of closure for 5 year period (2005-2010) 7%		

Figure 2.54 - Vicinity Map with Road Closures

2.4.7 Sewer Usage

Data on sewer usage was obtained from the City of Big Bear Lake as an additional source of data on seasonality patterns. The available data include monthly usage within the City of Big Bear Lake (CBBL) and the unincorporated Big Bear City Community Services District (BBCCSD). Figure 2.55 shows the CBBL monthly flows from 2000 through March 2010. Figure 2.56 shows the BBCCSD monthly flows for the same period. Both parts of the Big Bear Valley experience a substantial peak in flows during the winter months, with the peak times corresponding to periods of heavier snowfall (and visitor levels) in the mountains. Summer flows (July and August) exceed spring and fall flows, but are substantially less than the peak winter flows.

Figure 2.55 - CBBL Monthly Sewage Flows

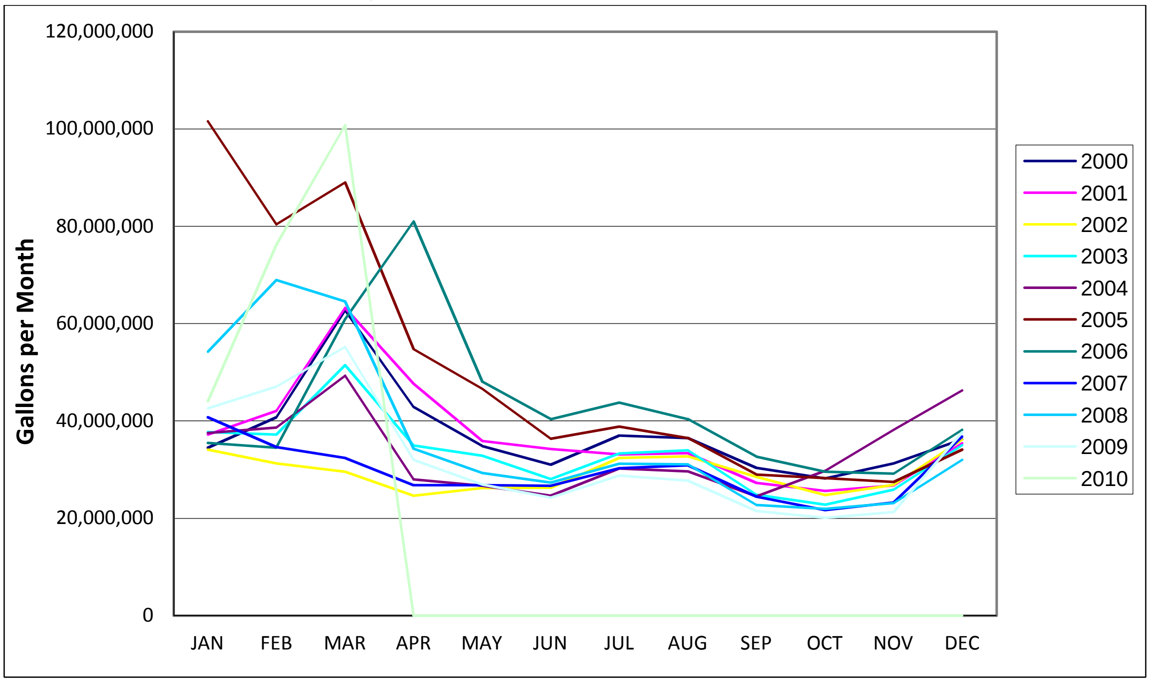


Figure 2.56 - BBCCSD Monthly Sewage Flows

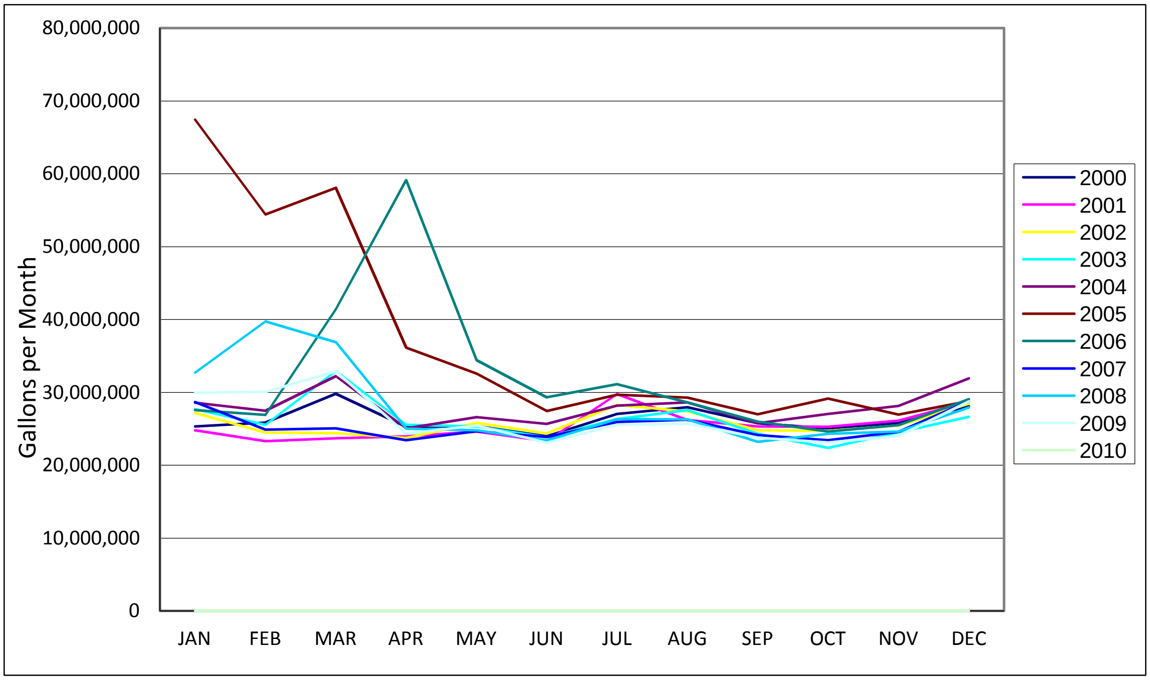
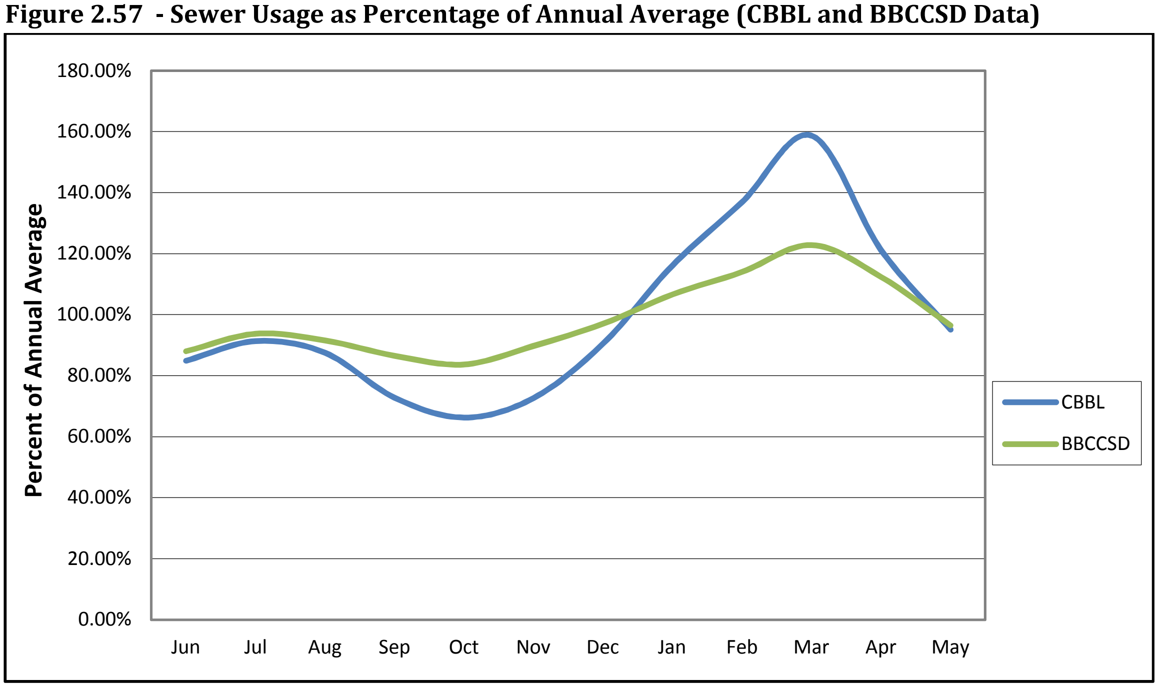


Figure 2.57 shows sewer usage by month as a percentage of the annual average. When averaged out in this manner, the sewer usage data peaks in March. Flows are above the average in the winter/early spring months of January through April. For the remaining months of the year, sewage flows are below the monthly average.

Figure 2.57 - Sewer Usage as Percentage of Annual Average (CBBL and BBCCSD Data)



2.4.8 Wind Conditions

For an aerial technology such as a gondola, high winds could be a factor in determining system operability, so available wind speed data was assembled from the website of the National Weather Service. Data were obtained from two observation stations in the front range area of the San Bernardino Mountains, though not within the study corridor. From these data, the number of days with observed wind speeds exceeding 40 miles per hour (the typical threshold for shutting down gondola operations in ski areas) was noted. Table 2.13 summarizes the results of this analysis, which indicates that high wind speeds occur on a very small percentage of the days for which data are available.

Table 2.13 – Wind Conditions

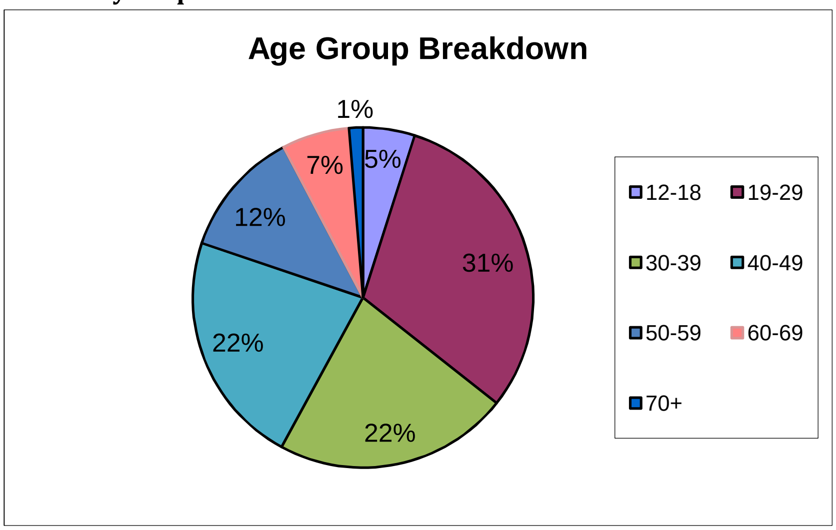
	San Sevaine Peak				Yucaipa Ridge			
	34d 12' 49" N, 117d 29' 58" W; elev 5651'				34d 03' 46" N, 116d 53' 33" W; elev 9020			
	4 miles west of 15/215 Devore interchange				2.5 miles ENE of Oak Glen; 1/3 mile west of Little San Gorgonio Peak			
	# of Days with observations	Dates with observations	# of Days with wind speed recorded over 40 mph	%	# of Days with observations	Dates with observations	# of Days with wind speed recorded over 40 mph	%
1998	287	3/18 - 12/31	3	1.00%	--	--	--	
1999	355	1/1 - 12/31	7	2.00%	--	--	--	
2000	364	1/1 - 12/31	4	1.10%	--	--	--	
2001	294	1/1 - 10/23; 12/30 - 12/31	1	0.30%	121	8/15 - 12/21	0	0.00%
2002	323	1/1 - 10/25; 12/5 - 12/31	1	0.30%	191	5/17 - 11/25	0	0.00%
2003	209	1/1 - 3/19; 8/22 - 12/31	1	0.50%	194	6/12 - 12/31	0	0.00%
2004	323	1/1 - 7/17; 8/28-12/31	9	2.80%	49	1/1 - 2/20	0	0.00%
2005	364	1/1 - 12/31	2	0.50%	0	--	--	
2006	244	1/1 - 6/1; 6/12 - 6/14; 7/30 - 7/31; 9/27 - 12/31	2	0.80%	325	2/10 - 12/31	0	0.00%
2007	364	1/1 - 12/31	0	0.00%	359	1/1 - 12/31	1	0.30%
2008	366	1/1 - 12/31	1	0.30%	359	1/1 - 12/31	6	1.70%
2009	362	1/1 - 12/31	0	0.00%	363	1/1 - 12/31	5	1.40%
2010	153	1/1 - 6/3	0	0.00%	145	1/1 - 6/3	0	0.00%
TOTAL	4008		31	0.80%	2106		12	0.60%

2.4.9 Winter Survey

A survey was developed and administered in Big Bear Lake to provide some indication of potential user preference information to help with the forecasts of potential ridership. The survey was distributed by the Snow Summit and Bear Mountain ski resorts and by the Big Bear Visitors' Bureau. A total of 541 survey responses were received – 298 from Snow Summit, 197 from Bear Mountain, and 46 from the Visitors' Bureau. (The survey form is included as Appendix F to this report.) The responses are summarized below.

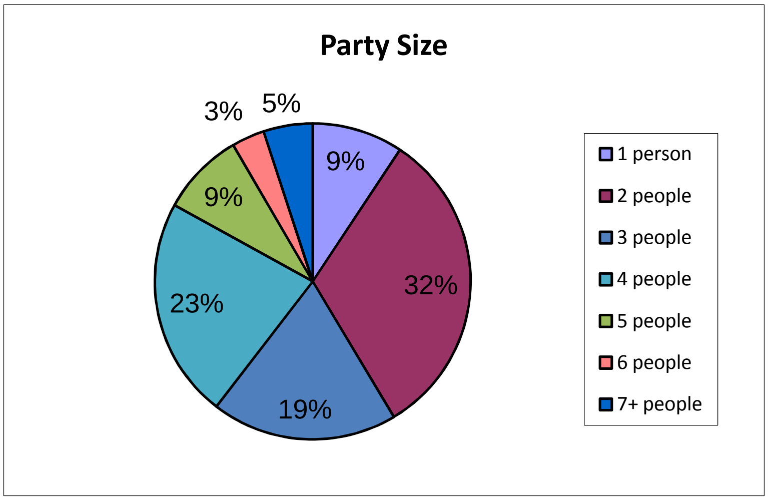
Three-fourths of the survey respondents were in the age range of 19-49, with 32% between the ages of 19 and 29, 22% between the ages of 30 and 39, and 22% between the ages of 40 and 49 (see Figure 2.58).

Figure 2.58 - Age of Survey Respondents



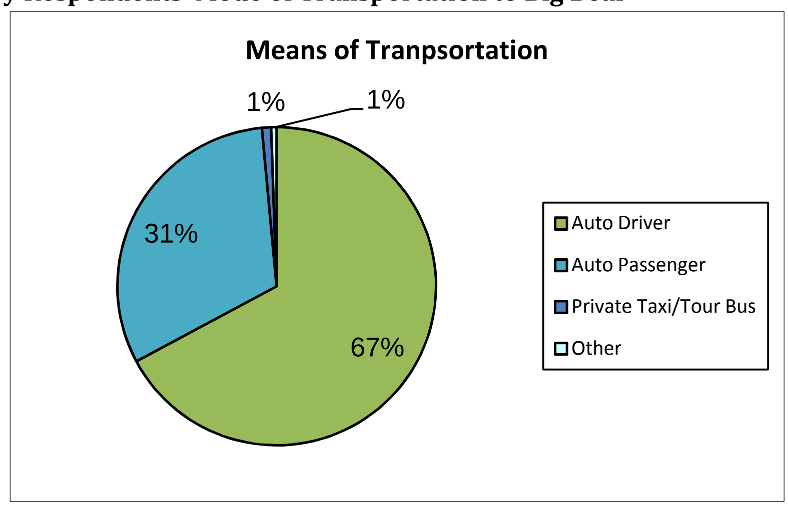
Three-fourths of the respondents were in parties of two, three or four, with 32% in parties of two, 19% in parties of three, and 23% in parties of four (Figure 2.59).

Figure 2.59 - Size of Survey Respondents' Parties



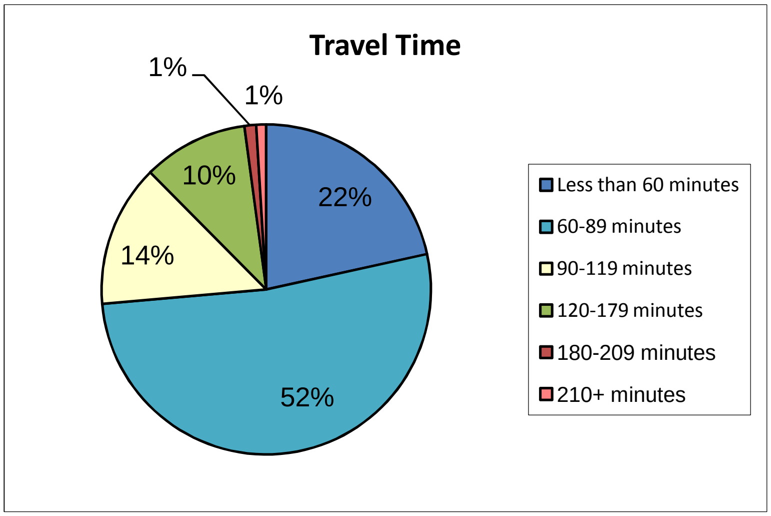
Almost all (98%) of the survey respondents traveled to Big Bear either as an auto driver or a passenger. Two-thirds of the respondents were drivers and 31% were passengers (Figure 2.60).

Figure 2.60 - Survey Respondents' Mode of Transportation to Big Bear



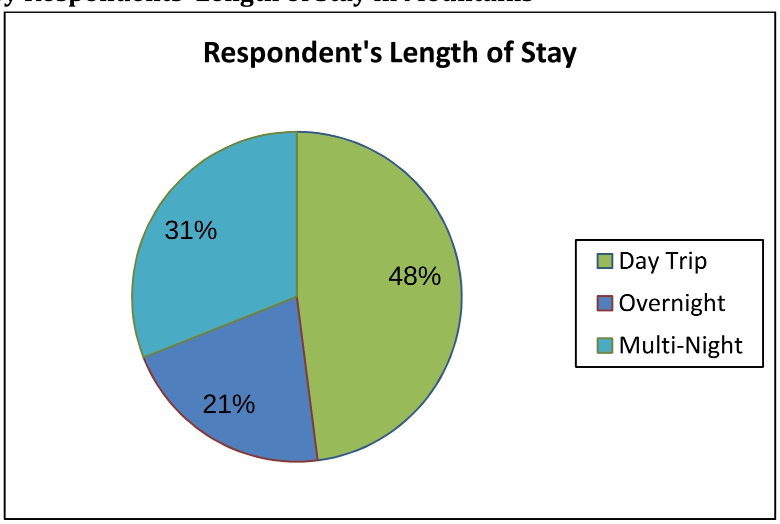
About half the survey respondents reported a travel time from San Bernardino to Big Bear of between an hour and 90 minutes. About a quarter of the respondents reported a travel time over 90 minutes (Figure 2.61).

Figure 2.61 - Survey Respondents' Travel Time from San Bernardino to Big Bear



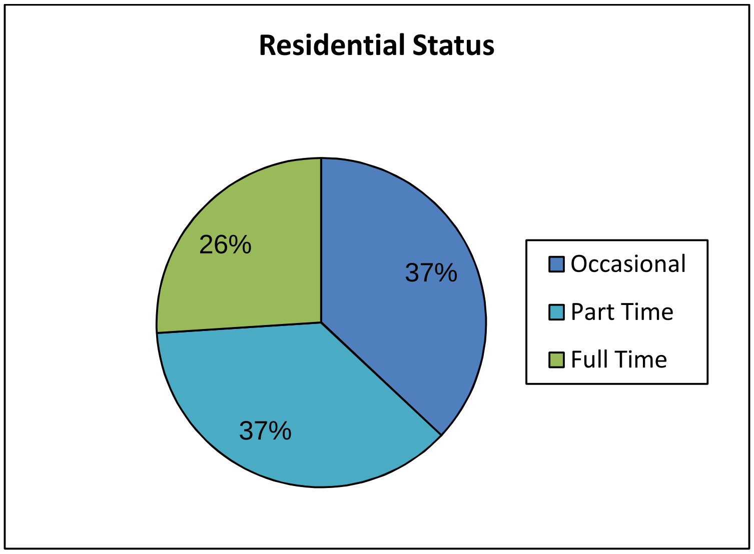
Visitors to the mountains comprised 86% of the survey respondents. Of these, about half (48%) were making a day trip, 21% were overnight visitors, and 31% were staying multiple nights (Figure 2.62).

Figure 2.62 - Survey Respondents' Length of Stay in Mountains



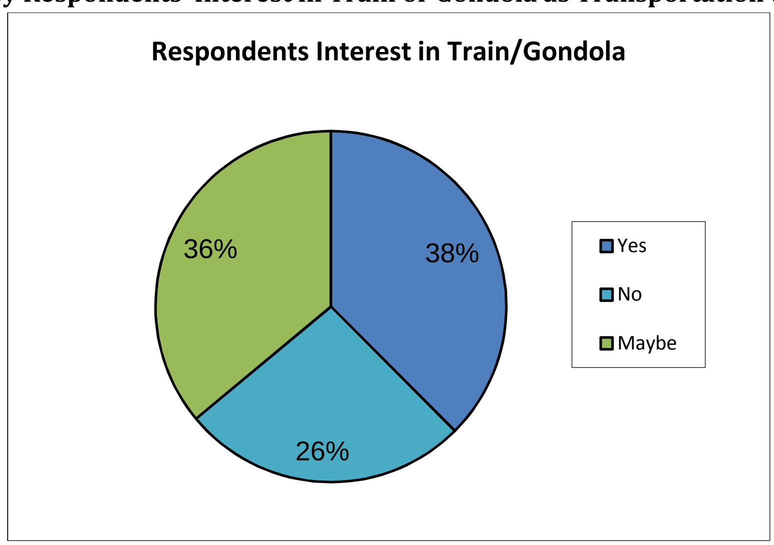
Additionally, 29% of the respondents reported that they have a home in the mountains. Of these, 26% are full-time residents of the mountains, 37% are part-time residents, and 37% are "occasional" residents.

Figure 2.63 - Survey Respondents with a Mountain Residence



Respondents were asked if they would have considered riding a train or gondola if it had been available for the trip to Big Bear instead of driving. Almost two-thirds of the respondents said “Yes” or “Maybe” (Figure 2.64)

Figure 2.64 - Survey Respondents’ Interest in Train or Gondola as Transportation to Big Bear



The respondents who expressed possible interest were then asked if they would have ridden the train or gondola if the travel time was the same as driving (Figure 2.65), 30 minutes longer than driving (Figure 2.66), or 60 minutes longer than driving (Figure 2.67). With the same travel time, almost all of the respondents were still interested. With a travel time from San Bernardino 30 minutes longer than driving, about two-thirds were still interested; with a travel time 60 minutes longer than driving, only 28% were interested.

Figure 2.65 - Survey Respondents' Interest if Travel Time same as Auto

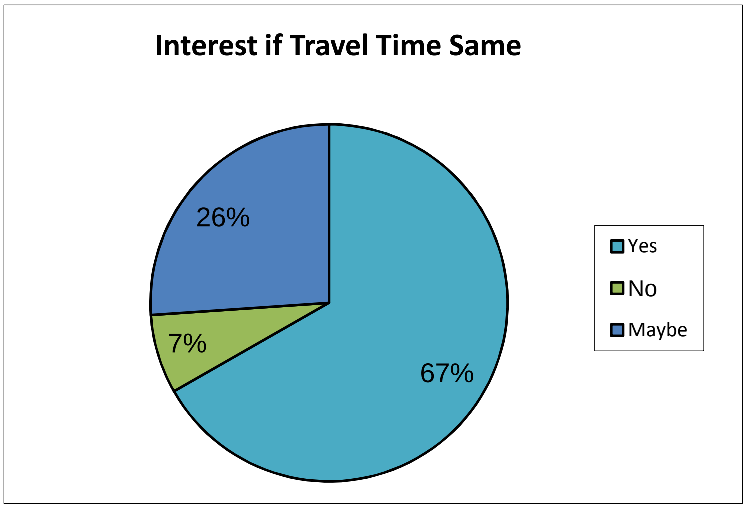


Figure 2.66 - Survey Respondents' Interest if Travel Time 30 minutes longer

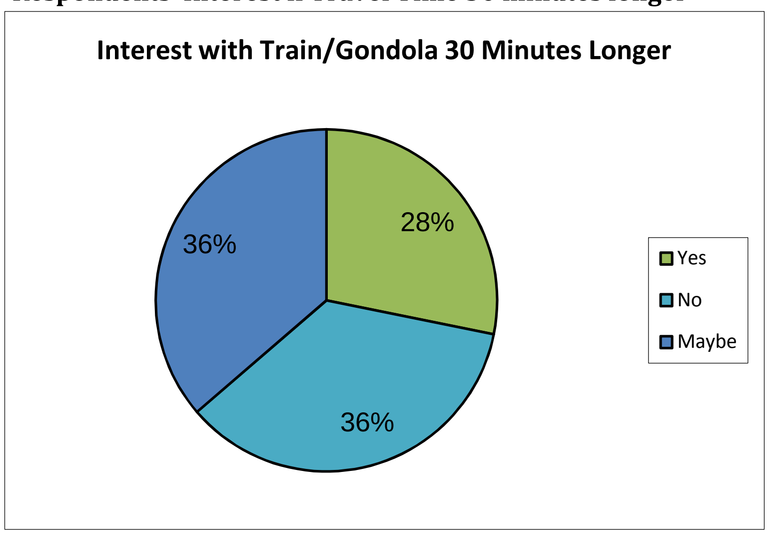
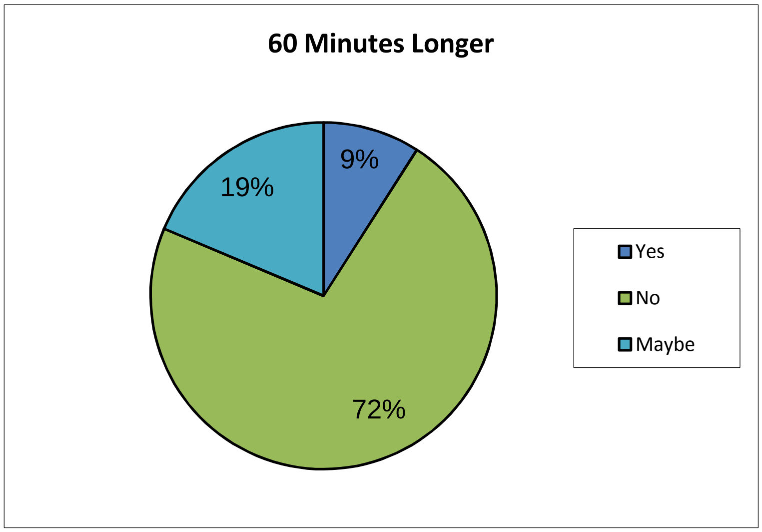


Figure 2.67 - Survey Respondents' Interest if Travel Time 60 minutes longer



The respondents who expressed possible interest were then asked if they would have ridden the train or gondola if the round trip fare was $40 (Figure 2.68), $60 (Figure 2.69), or $80 (Figure 2.70). With a $40 fare, almost three-fourths were still interested, but this level dropped to 28% with a fare of $60 and 11% with a fare of $80.

Figure 2.68 - Survey Respondents' Interest if round trip fare = $40

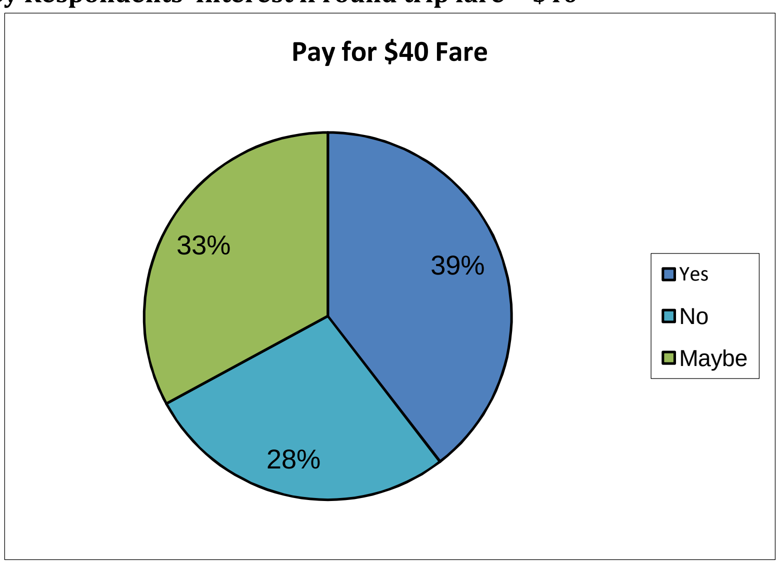


Figure 2.69 - Survey Respondents' Interest if Round Trip Fare = $60

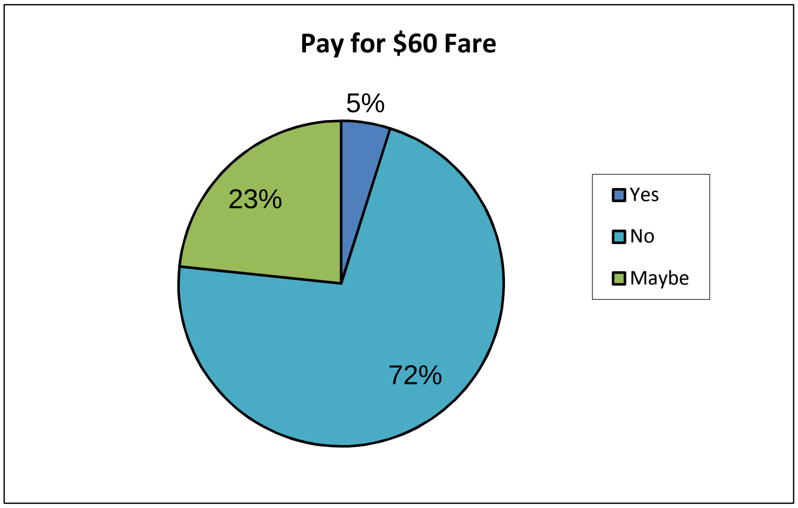
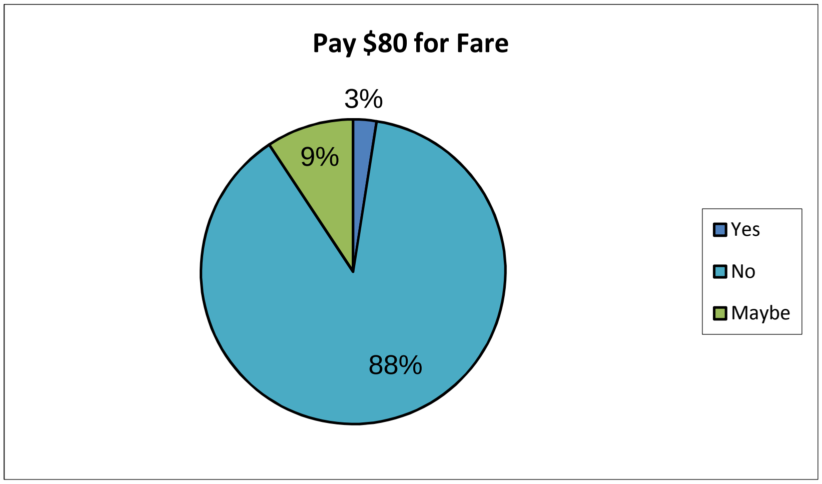


Figure 2.70 - Survey Respondents' Interest if Round Trip Fare = $80



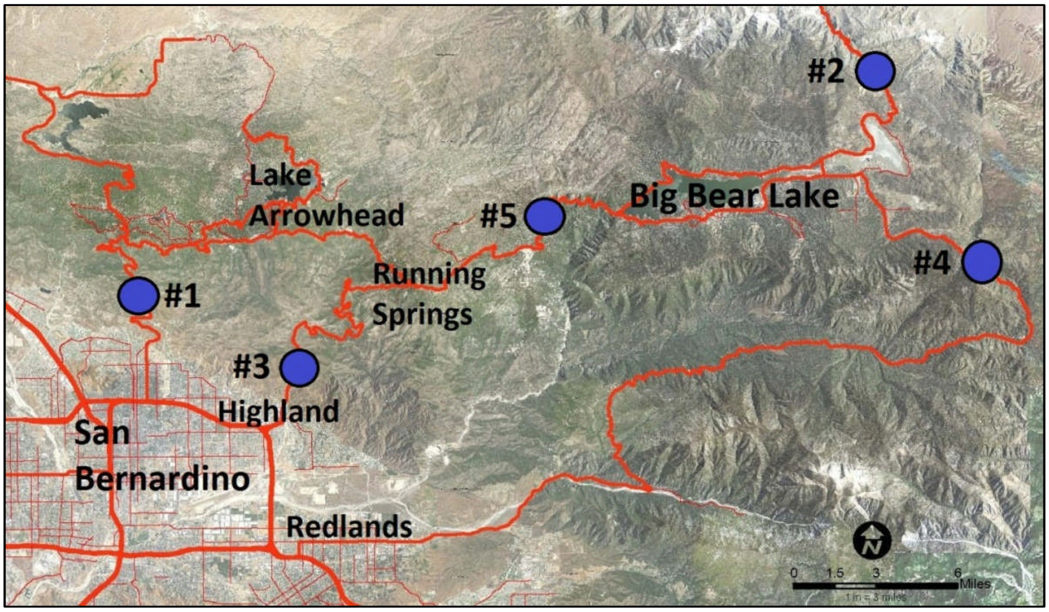
2.5 Shipping and Freight Movement

This section summarizes current freight traffic traveling to and from the Big Bear Mountain Recreation Area. The objective is to present a picture of the number of trucks and types of commodities traveling to and from the Big Bear area, along with more specific information relating to their logistics, such as time of travel, day of the week, and direction. Data for this section was gathered through traffic counts collected over a week-long period in March of 2010, and supplemented with manual truck counts that included more detailed description of the vehicles and their commodities. For purposes of this analysis, the generic term "truck" refers to vehicles of FHWA Class 5 and up.

2.5.1 Data Collection

Data was collected at five locations on the regional roadways used for travel between the Los Angeles Basin and the Big Bear mountain resort area, as illustrated in Figure 2.89. Pneumatic Road Tube Counters were used at each of the four locations to collect directional data by vehicle type, while manual truck counts were done at sites 3, 4, and 5. These locations cover all the major roadways leading to and from the Big Bear area.

Figure 2.71 - Data Collection Locations



Note: Counter locations are approximate

The 24 hour tube counters were employed for a week-long period from Saturday, March 13 through Friday, March 19. The data collected included motorcycles, passenger cars, light and heavy trucks, and buses in both directions.

The manual counts were done over three days, with one day for each of the three locations. Table 2.14 below shows the schedule for data collection at each of the locations. The AM and PM periods consisted of 4 hours, from 7 to 11 AM and from 3 to 7 PM. This data includes the type of heavy vehicle traveling (including buses) as well as the type of commodity that they were carrying. The data also included information on whether the vehicle was loaded or empty.

Table 2.14 - Manual Count Schedule

Counter #	Location	Day	Date	AM	PM
3	SR-330 bet. Highland Ave & Live Oak Dr	Friday	12-Mar		X
4	SR-38 bet. Lakewood & Heart Bar Campground	Saturday	20-Mar	X	
5	SR-18 bet. Snow Valley Ski Area& SR-38	Wednesday	24-Mar	X	X

2.5.2 Traffic Summary by Day

Figures 2.72-2.75 illustrate the truck traffic traversing Counters 1-4 throughout the week. The first counter location (near the intersection of State Routes 18 and 138) has the heaviest amount of traffic, registering over 1,100 heavy trucks and nearly 7 thousand light trucks over the 7 day period. Counter 3, located at SR-330 near Highland, was the second busiest with nearly 3,500 trucks. It should be noted that this road was closed from Wednesday-Friday during that week, which resulted in lower traffic numbers. Without the closure the total count would be roughly 2,000 trucks higher (these trucks likely were rerouted through one of the other counters). These two counters are located along are the two primary highways connecting the Big Bear area to San Bernardino and Los Angeles. Counters 2 and 4 are located on the eastern part of the Recreation Area and see much lower amounts of traffic, with each registering close to 2,000 trucks over the week, out of which 85% were 2-axle light trucks.

Overall, Friday is the busiest day of traffic for trucks with 21% of the traffic (excluding counter 3), which highlights the region's nature as a Recreational Area mostly busy during the weekends. Thursday (17%) and Wednesday (16%) are the second and third busiest days. The rest of the week sees 11-12 % of the traffic per day. See Figure 2.76 for a combined illustration of truck traffic by day and location.

Figure 2.72 - Truck Traffic by Day on SR-18 (location #1)

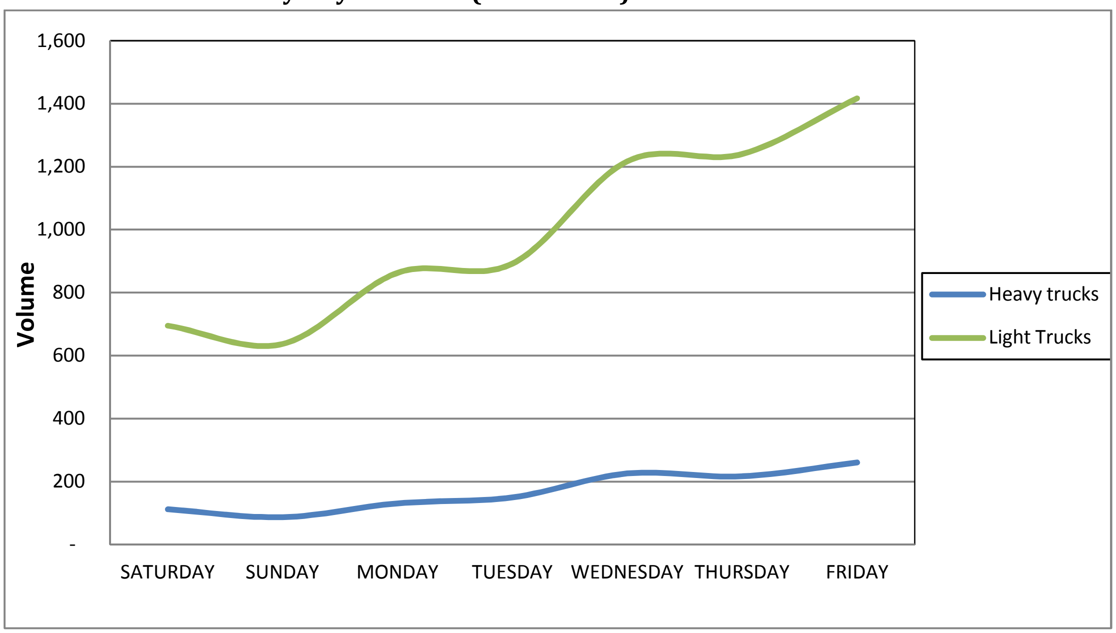


Figure 2.73 - Truck Traffic by Day on SR-18E (location #2)

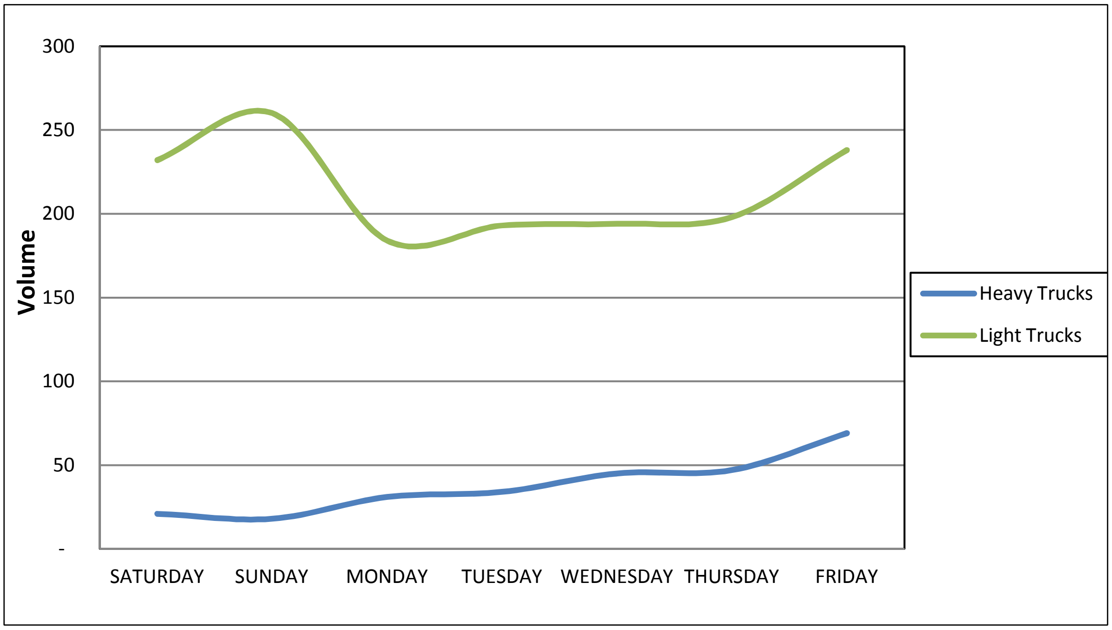
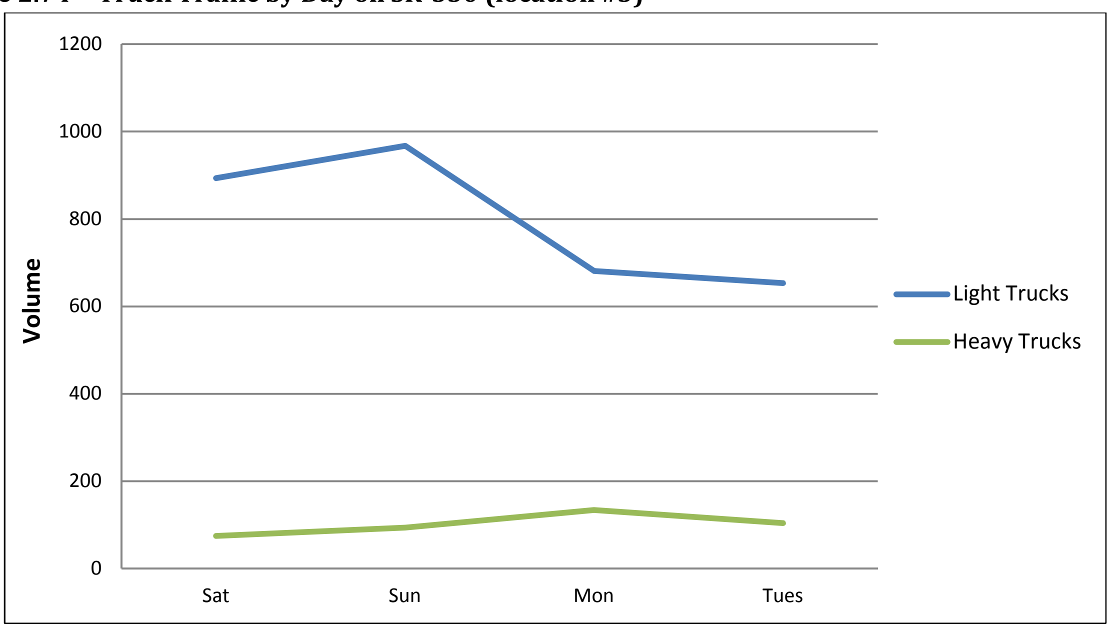


Figure 2.74 - Truck Traffic by Day on SR-330 (location #3)



Note: On Wednesday-Friday no data was collected due to road closure.

Figure 2.75 – Truck Traffic by Day on SR-38 (location #4)

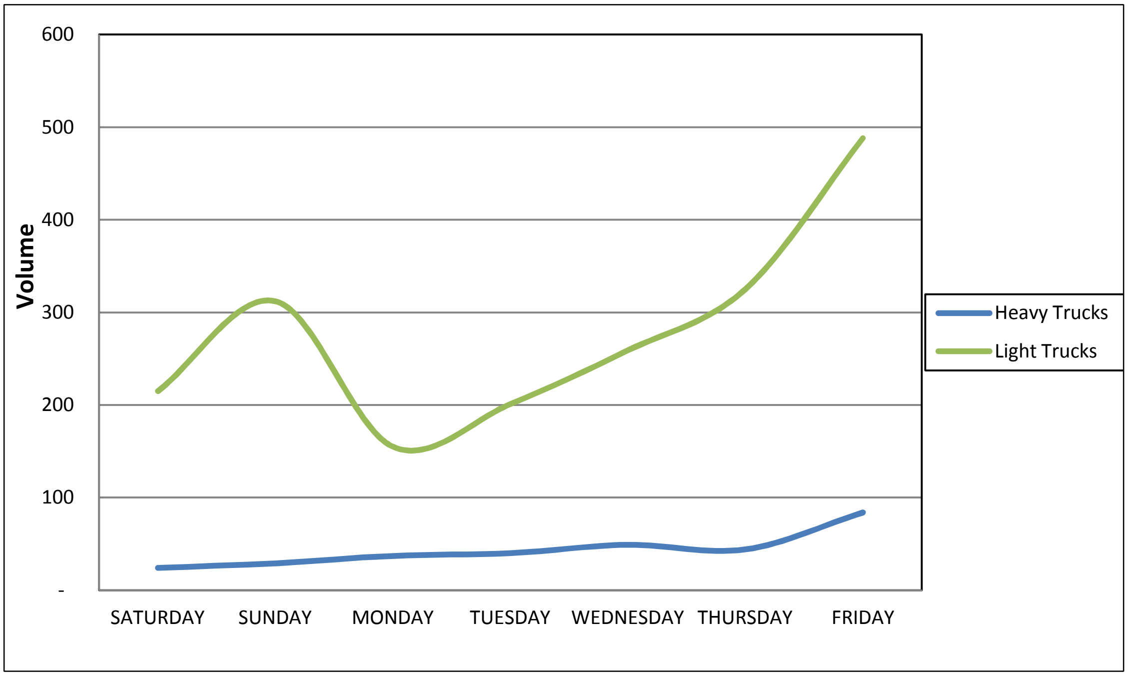
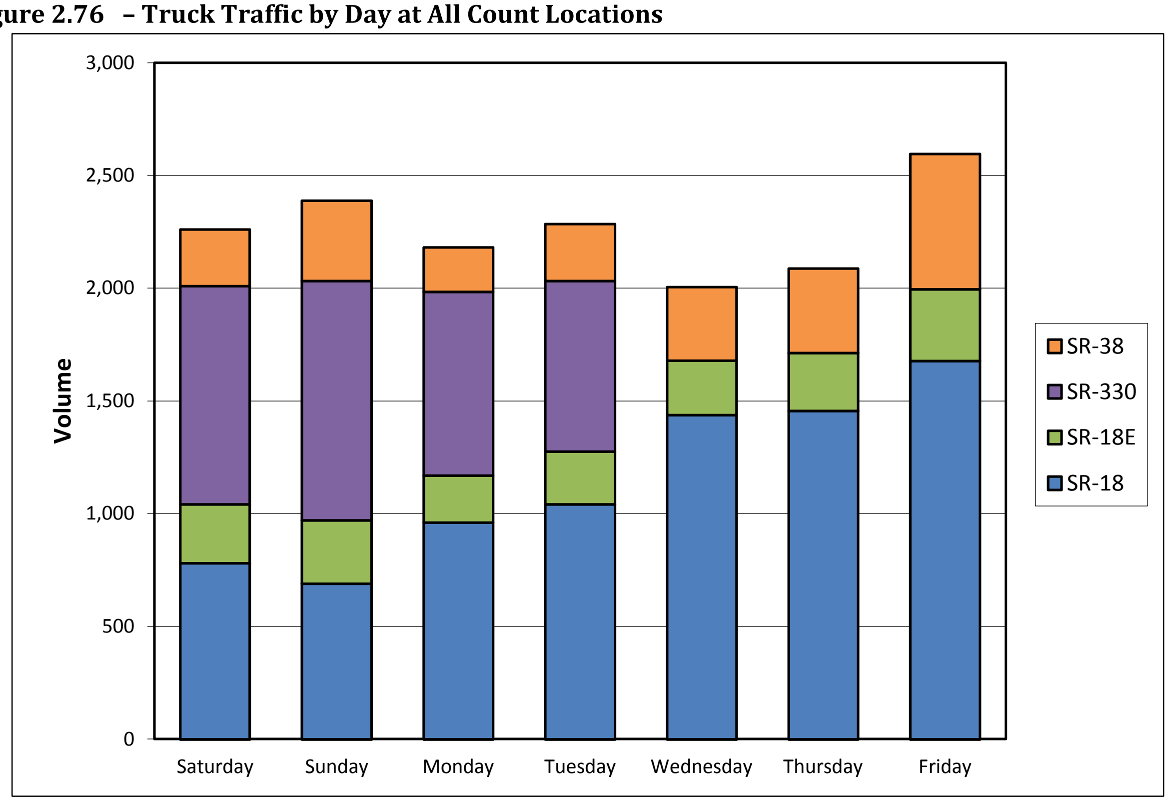


Figure 2.76 – Truck Traffic by Day at All Count Locations

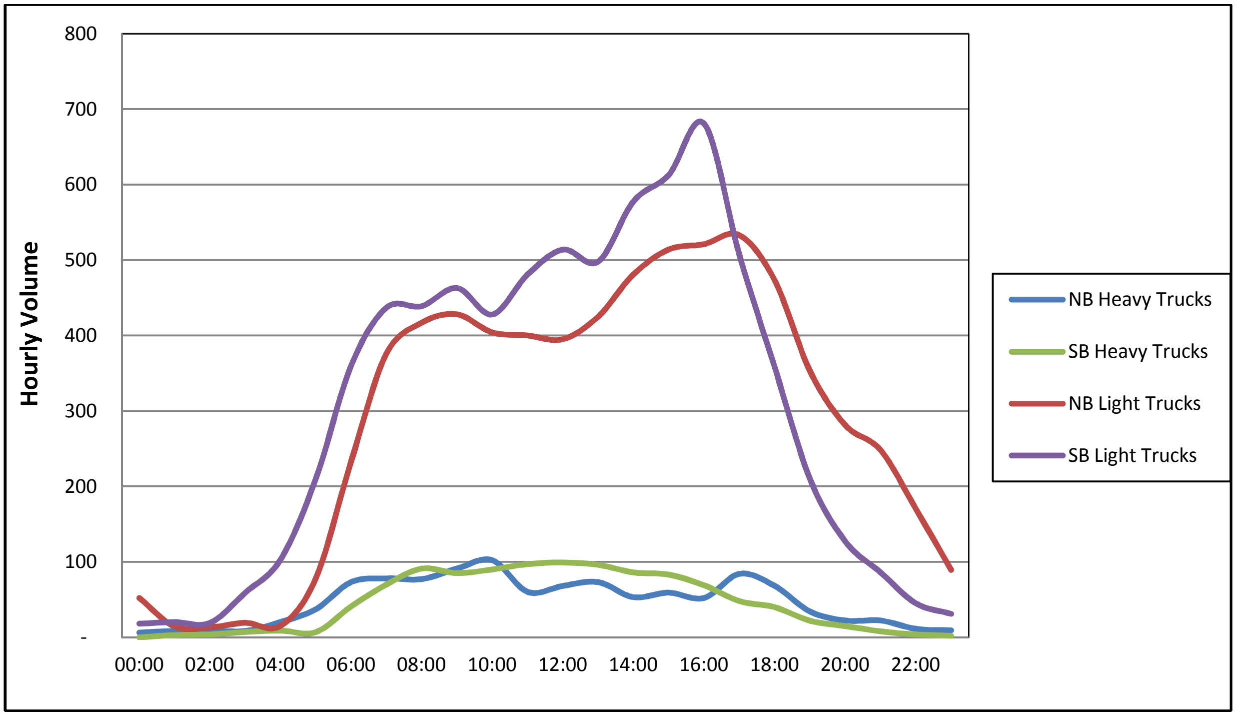


Note: On Wednesday-Friday no data was collected on SR-330 due to road closure.

2.5.3 Traffic Summary by Time of Travel

As Figure 2.77 illustrates, truck traffic starts to pick up at around 6 AM, with over 700 trucks traveling to and from the region. By 7 AM traffic reaches over 1,000 trucks per hour, and it gradually rises until it peaks at nearly 1,300 trucks at 4 PM, when it starts gradually declining until 5-6 PM and drops sharply thereafter. Southbound moves (down from the mountains) slightly exceed Northbound moves (up into the mountains) from the start of the day until 5PM. After this NB flows are higher by over 150 trucks per hour.

Figure 2.77 – Truck Traffic by Hour and Direction: Total of All Count Locations

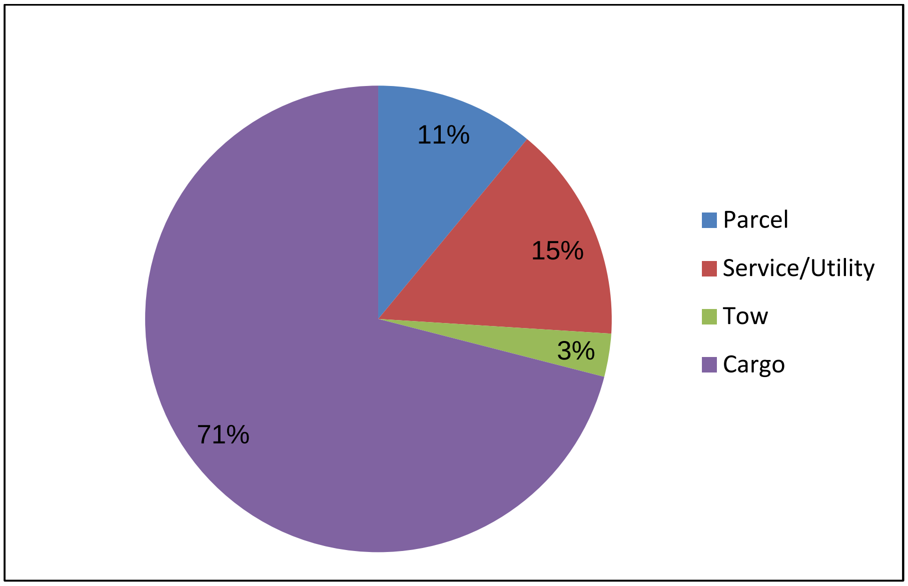


2.5.4 Traffic Summary by Commodity

The data from the tube counts summarized above is useful to understand the flow of truck units into and out of the region, however it does not include information about the type of cargo being transported. The data also do not differentiate between service and cargo trucks, and even within cargo trucks whether they are empty or loaded. To help fill these gaps, the study team conducted the manual counts at Stations 3, 4, and 5. This section summarizes the findings from these counts.

Observations were made for all heavy vehicles, including buses, which are not taken into account in this section. As shown in Figure 2.78, cargo trucks are the primary source of heavy vehicle traffic to and from the region, accounting for over 70% of flows. Service vehicles and parcel trucks accounted for 15% and 11% of observations respectively, while tow trucks made up the remaining 3%.

Figure 2.78 – Traffic by Truck Type (all locations)



The top commodities transported by cargo trucks include food and liquor, waste, home improvement goods, construction materials, and fuel. However empty trucks registered as the highest individual "commodity" type with approximately 1/3 of all observations. A summary by commodity is shown in Table 2.15 below; it should be noted however that this excludes unknown commodities, which made up almost half of all cargo truck observations.

Table 2.15 – Top Commodities Transported by Cargo Trucks

Commodity	% Share
Empty	34%
Food & Liquor	20%
Waste	14%
Home Improvement Goods	7%
Construction	5%
Fuel	3%
All Other	*17%*

Service and utility trucks consisted primarily of smaller vehicles, such as pickup and panel trucks, being used by mainly by construction, plumbing, roofing, and electrical companies/contractors. Parcel trucks were evenly split between UPS and FedEx.

2.6 Topographic and Geological Conditions

2.6.1 Introduction

The 1996 Big Bear study evaluated the project area's geologic and topographic conditions to assist in the selection of candidate corridors to deliver the most feasible all-weather, high capacity, non-auto transportation mode to the Big Bear area. In re-examining the project, the goal was to evaluate and validate the 1996 Study findings on geologic constrains and update the information using GIS technology to reflect any changed conditions since 1996. A series of GIS maps have been developed to aid in the analysis and provide a clear picture of the exiting environment for the alternatives analysis. The technical analysis complied geotechnical data on the following features and risks compiled from a variety of sources:

A. landslide risk,
B. earthquake faults,
C. liquefaction zones,
D. fire hazards,
E. flood plains, and
F. rivers/streams/waterways

The 1996 Study identified landslides as the primary geologic hazard in the project area, given the steep mountainous terrain. The prior report also identified a series of earthquake faults traversing the area, including the San Andreas Fault, which runs through the San Gorgonio Pass between the San Bernardino and San Jacinto mountains along the southern base of the San Bernardino Mountains. There have been periodic earthquakes in the area along the San Andreas and the other faults which bisect the study area.

Some key changes in existing conditions include:

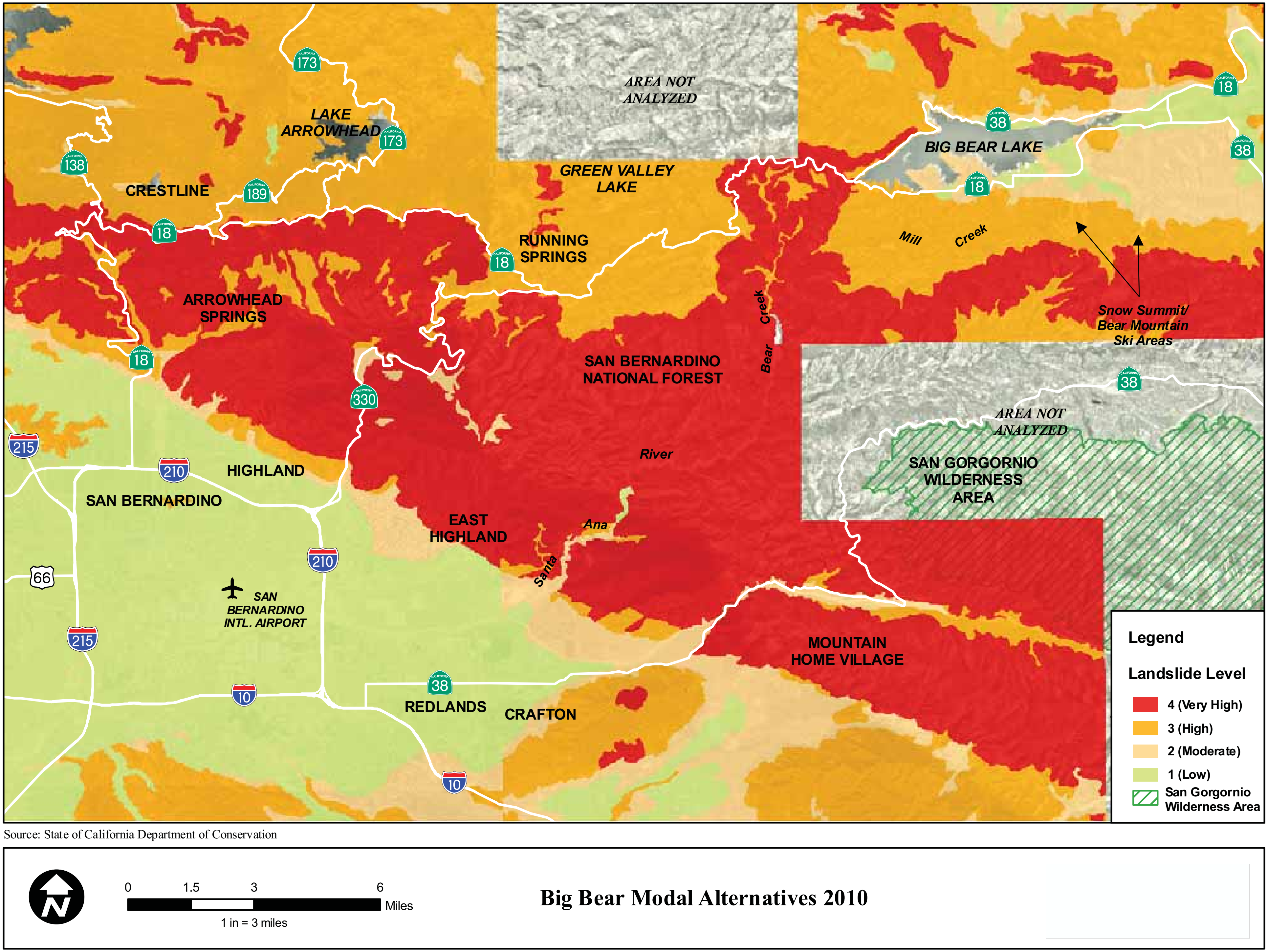
- further refinements in fault line definition throughout the project area;
- an assessment of wild fire hazards within the project area; and
- construction of the Seven Oaks dam facility in the Santa Ana River canyon.

The dam was completed in 1999 and is located approximately 3.5 miles northeast of the Redlands Municipal Airport providing flood control management for the Santa Ana River.

2.6.2 Landslide Risk

The project area is characterized by a mix of landslide risks. Not surprisingly, in the urbanized area of the San Bernardino valley, there is little risk of landslide. However, as the elevation rises to the north east, travelling toward Big Bear, the landslide risk categorized as high or very high encompasses nearly 100% of the mountain corridor analysis area. Figure 2.79 illustrates the levels of landslide risk as measured by the California Department of Conservation throughout the project area.

Figure 2.79 - Landslide Risk



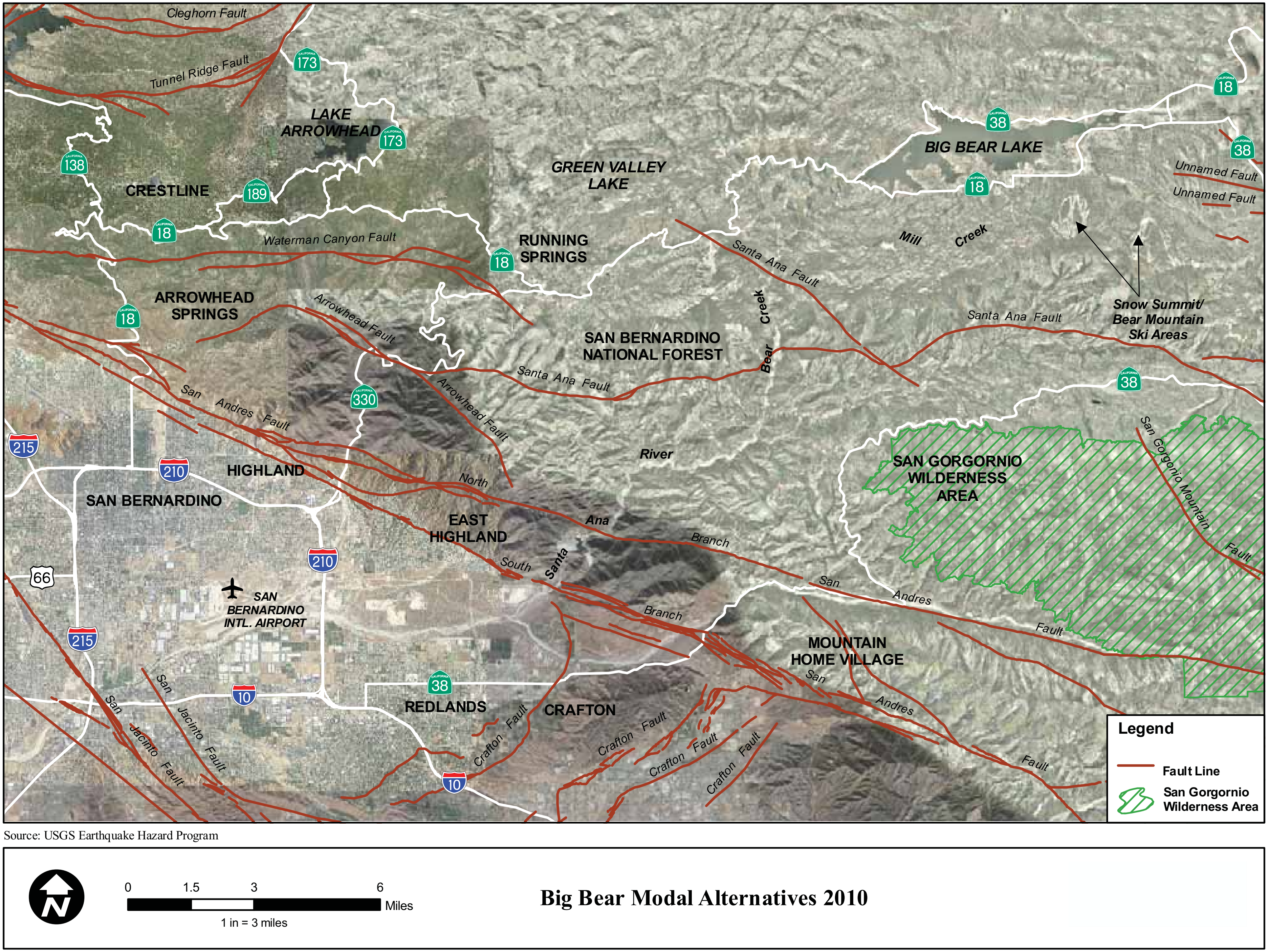
Source: State of California Department of Conservation

Big Bear Modal Alternatives 2010

2.6.3 Earthquake Faults

Seismic activity is common throughout the project area. Figure 2.80 identifies a series of earthquake faults traversing the area, including the San Andreas Fault, which runs through the San Gorgonio Pass between the San Bernardino and San Jacinto mountains along the southern base of the San Bernardino Mountains. There have been sporadic earthquakes in the area along the San Andreas, the Santa Ana, and the Waterman Canyon faults which bisect the study area.

Figure 2.80 - Earthquake Risk



Source: USGS Earthquake Hazard Program

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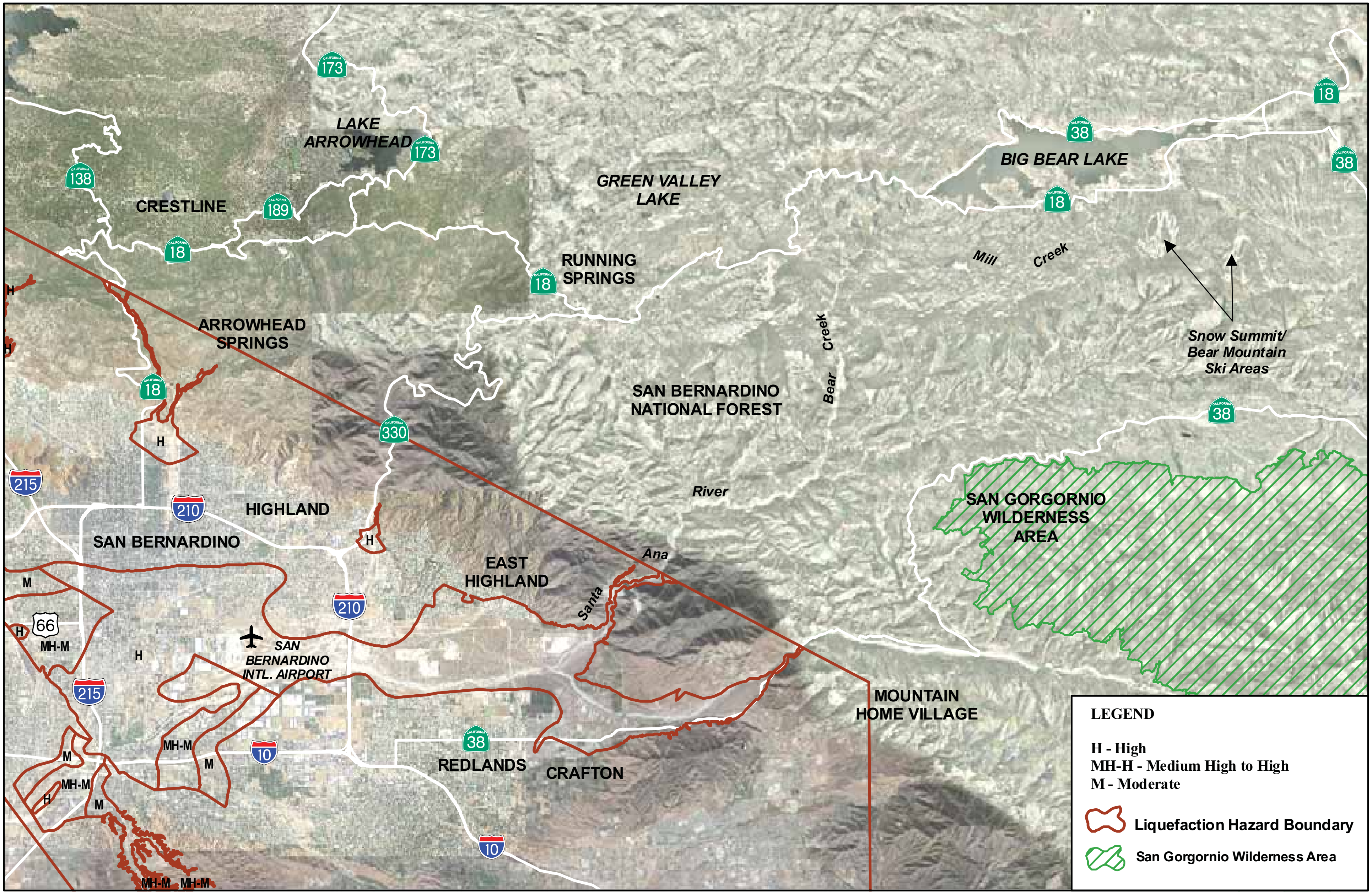
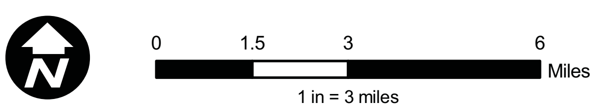
2.6.4 Liquefaction Risk Areas

Liquefaction is often associated with earthquake risk. Liquefaction occurs when soil stability, strength and stiffness is reduced by earthquake shaking, and is typically associated with saturated soils and areas in alluvial streambeds. With liquefaction, the strength of the soil decreases and the ability of a soil deposit to support structural foundations is marginalized. In the San Bernardino valley area, the liquefaction risks are highest through the Santa Ana River area, including the east-west potential corridor from Highland to the San Bernardino airport and east to the I-215 freeway as represented in Figure 2.81.

Figure 2.81 - Liquefaction Risk Areas



Source: State of California Department of Conservation



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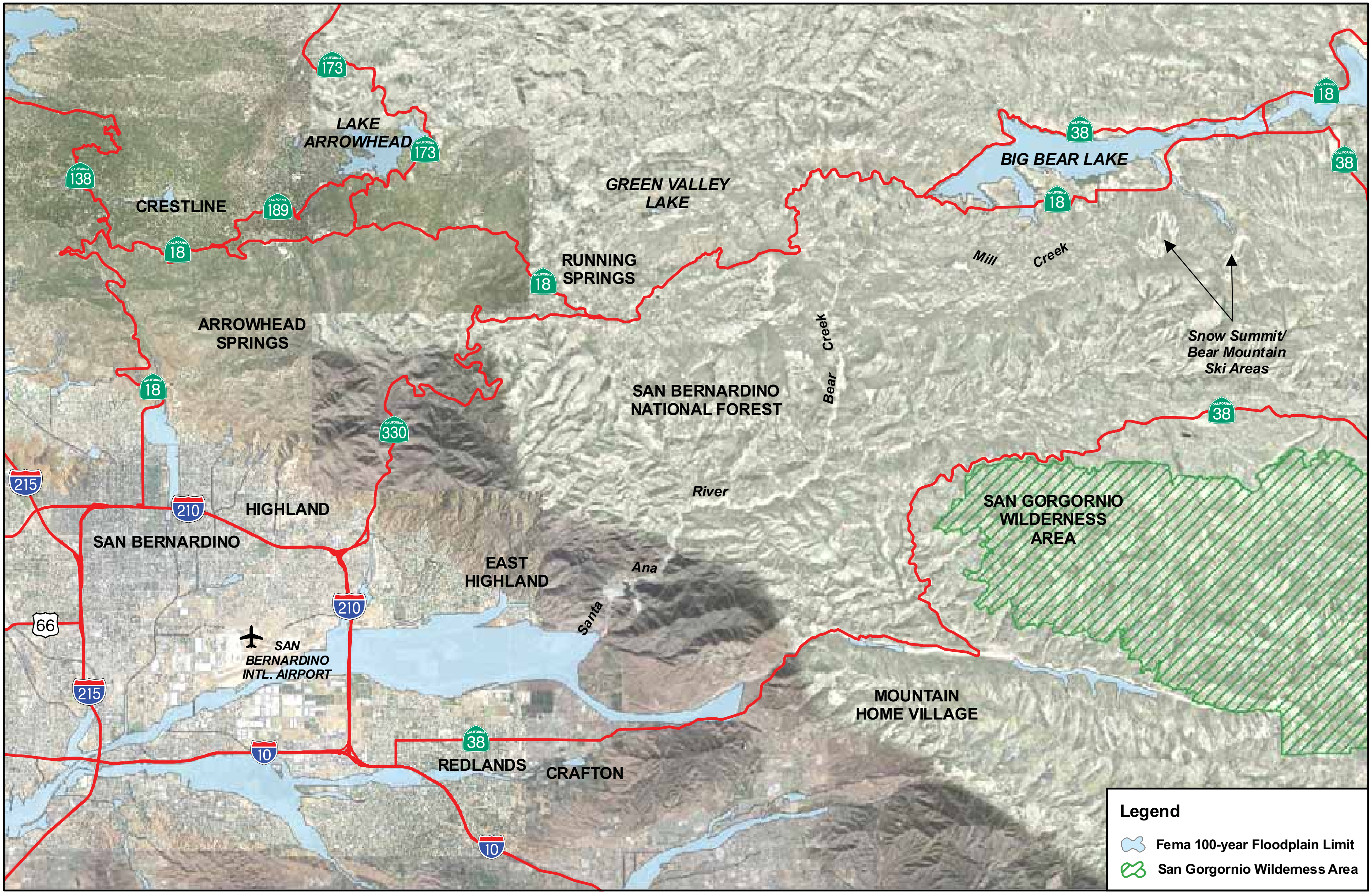
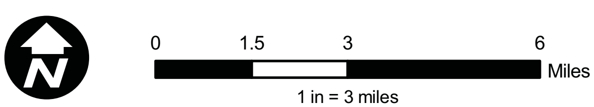
2.6.5 Flood Plains

Figure 2.82 depicts the flood plain zones with the project study area. There's little risk associated with encroachment in flood plain for the mountain corridor area, with the majority of the flooding potential in the San Bernardino valley, with a particular high intensity area located at the base of the Santa Ana River. The Seven Oaks dam is located within the Santa Ana River flood plain zone.

Figure 2.82 - Flood Plains



Source: Flood Insurance, Maps, and Information (FEMA)



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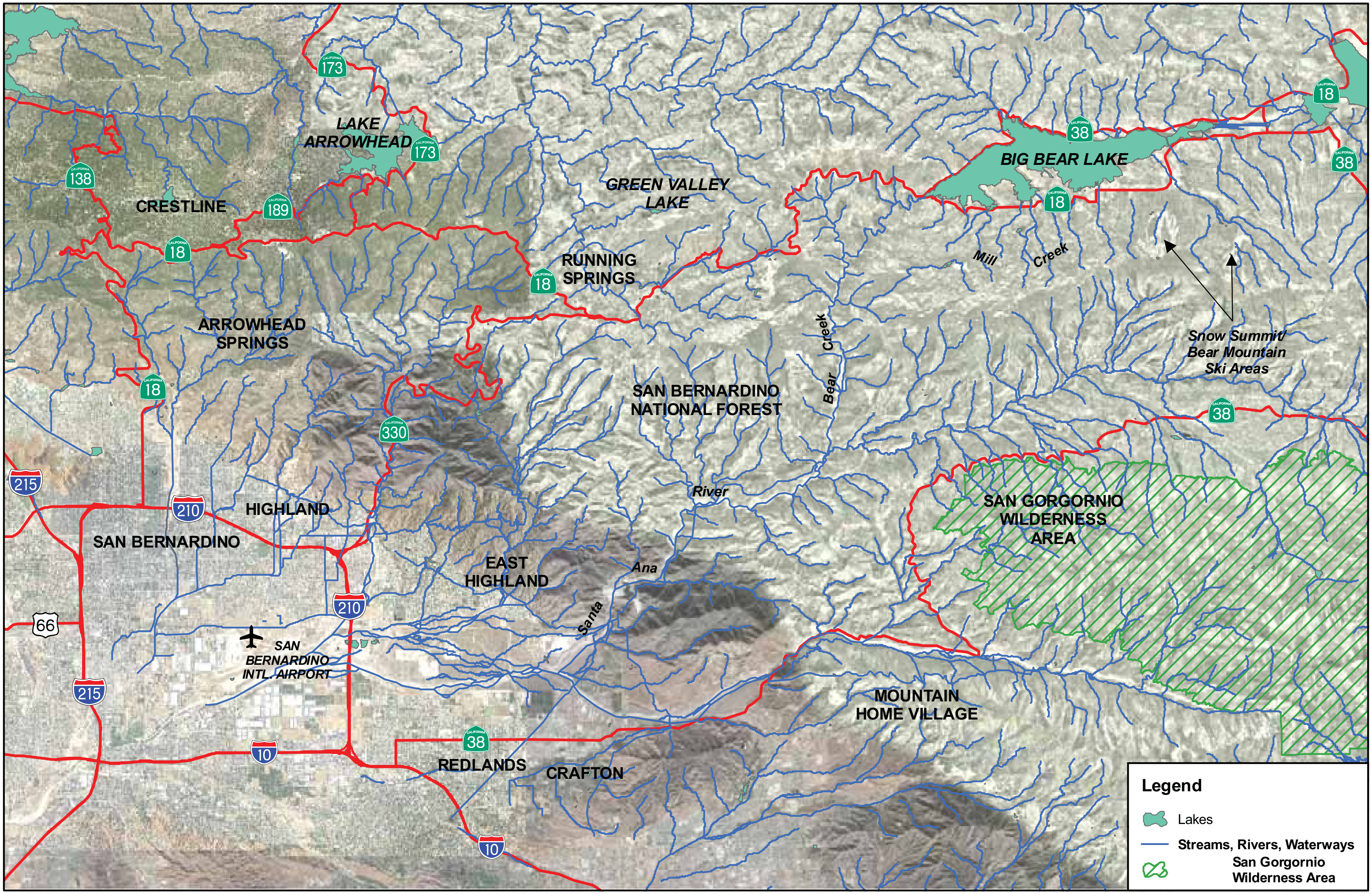
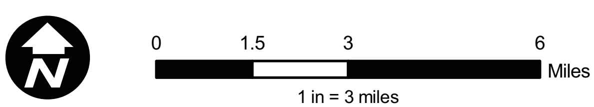
2.6.6 Rivers, Streams and Waterways

The Big Bear Lake and the Santa Ana River are the key watersheds in the project study area. Bear Creek is the major drainage system, flowing southerly to the Santa Ana River. In the 1996 Study, five other major and minor drainages were noted in discussions with the US Forest Service. Figure 2.83 depicts the USGS survey of all water features in the project area, rivers, streams and waterways. When considering alternative corridors, crossing streams and rivers will have impacts on riparian habitats and species which may be located in the area, and on system design, construction and cost.

Figure 2.83 - USGS Survey of Water Features



Source: USGS National Hydrography Dataset



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2.7 Right-of-Way

This study is evaluating potential corridors for a fixed guideway system to conduct a high level assessment of what impacts, challenges and opportunities the project will face. The corridors being evaluated are ½ mile wide at this conceptual phase of project assessment. As a result, specific right of way impacts are not assessed at this level of analysis. Rather, a discussion of the types of property needed and assumptions for property acquisition either through easements, leases or purchases is presented below.

There are three types of property owners throughout the project area: private, public, and tribal. The public lands are managed as part of the San Bernardino National Forest by the United States Forest Service (USFS) and encompass the vast majority of the study area. San Bernardino County also has responsibility for lands scattered throughout the study area. The tribal lands are part of the San Manuel Band of Mission Indians and are located just north of Highland, and a section of the project area is considered culturally affiliated with the tribe. Private property is most prevalent in the developed areas in the mountain sections at Running Springs, Big Bear Lake and Big Bear City, as well as throughout the San Bernardino Valley area, from Highland and westward to the E Street Transportation Center and Civic Center.

The 1996 Study assessed the opportunity for developing a transportation guideway in the National Forest and noted that lands within USFS management areas are generally not available for community expansion, but rights of way can be leased or land exchanged for a regional transportation improvement. In 2005, the USFS updated the Southern California National Forest Land Management Plan. The Plan's Vision statement discusses the challenges of urbanization of the management areas, and notes the following key issues:

"The challenge of urbanization manifests itself in many ways and can be summarized by asking the question: 'How will managers sustain the character of the national forests and maintain or improve forest ecosystems, while accommodating the demands of an increasing number of users in a large and growing urban area?"[12]

Management challenges related to urbanization include:

- Increasing numbers of people coming to the national forests for a growing number of activities. There are increased demands for a variety of high quality year-round recreation opportunities, especially day-use activities including picnicking, driving and trail use, as well as access to dispersed areas where people recreate.
- Accommodating the demand for recreation opportunities that meet the needs of diverse populations that have differing social and activity preferences.
- Providing environmental education for an urban population that may be unfamiliar with the national forest environment.
- Utilizing underserved community's input in the formulation and execution of project level work.

[12] United States Department of Agriculture, Forest Service, Pacific Southwest Region R5-MB-705 September 2005: USDA Land Management Plan Part 1 Southern California National Forest Vision, page 10-11

The 2005 USFS Land Management plan provides a structure for considering and evaluating projects that impact the national forest. Coordination and consultation with the USFS is the most critical element of considering the right of way impacts for the project, and ultimately, the viability of the project. In the developed mountain areas, where potential intermediate station sites may be located, property acquisition and displacements may be necessary for adequate station construction. Additionally, when evaluating the overall project cost, considerations for property acquisition or operating easements along the San Bernardino Valley operating segment will also influence project viability.

2.8 System Opportunities and Constraints

2.8.1 Demographics

The full-time population in Big Bear is growing slowly, so visitors and part-time residents represent the demographic groups with the most future growth potential.

Full-time population in the mountains is essentially the same as it was in 1996. In the City of Big Bear Lake, the permanent population is right around 6,100, and the 1996 study reported the permanent population of the City as 6,075. The number of households has increased slightly – from 2,500 in 1996 to 2,700 in 2008 – so the average household occupancy has decreased slightly.

As noted in the 1996 study, there are a high percentage of homes that are not occupied year-round and serve either as second homes or seasonal rentals. In the City of Big Bear Lake, 73% of the housing units fall in this category, and in the surrounding unincorporated areas, the percentage is approximately 52%. Additionally, employment has increased since 1996. In the City of Big Bear Lake, it has risen from 2,900 to 5,080, indicating significant growth in visitor levels while the permanent population has remained essentially unchanged.

The forecast for future permanent population is similar to what it was in 1996. At that time, the forecast of future households in Big Bear Lake (for Year 2020) was 4,500 households, and now the forecast for Year 2035 is 8,365 households.

The forecast for future employment has increased substantially since 1996. At that time, the employment forecast for Big Bear Lake (for Year 2020) was 4,426, and now the forecast for Year 2035 is 7295 employees.

The higher growth rate forecast for employment is an indicator that visitor levels are expected to continue growing faster than the permanent population.

2.8.2 Travel Conditions

Congestion and road closure problems combine to indicate a clear need for additional transportation capacity to accommodate future growth in travel to and from the mountains. An alternative transportation system is an attractive alternative to adding roadway capacity because it could:

- provide transportation of people and goods in all kinds of weather;
- provide an alternative mode and/or route of access during an emergency;
- have a smaller environmental "footprint" than building new roads or widening existing roads;

- facilitate expanded recreation opportunities in the mountains (particularly ski area expansion) without proportional expansion of roadway and parking capacity; and
- support development of new housing in mountain communities with less need for automobiles.

2.8.3 Moving People with an Alternative System

Below are some important factors to consider when implementing alternative methods to transport people:

Competitiveness with auto travel: The winter survey results demonstrate that, to be able to attract significant numbers of riders, the new system would need to provide an overall travel time that is competitive with auto travel. This will be a determining factor in the selection of appropriate technologies.

Convenience of transporting personal belongings: To be attractive for carrying leisure travelers (weekend visitors to the mountains) or recreational trips (skiers, snow play visitors, and summer recreation visitors), the system will need to have a convenient process for loading and unloading personal belongings such as luggage and ski equipment. Since much of the corridor travel involves leisure or recreational trips, for the system to be successful it will need to be able to conveniently serve this user group.

Distribution of people and goods: The system for distributing people (and their belongings) at the mountain end of the trip will be an important factor in attracting riders. While some destinations may be within walking distance of the stations, many destinations are dispersed throughout the mountains. Planning for an alternative system will need to include consideration of methods for moving people between the stations and their ultimate destinations.

2.8.4 Physical Factors

Below are additional important factors to consider when physically planning the alternate transportation system:

Grades: The rapid elevation changes encountered ascending and descending the mountains dictate that an alternative transportation system involve a technology than can safely negotiate steep grades.

Environmental factors: When evaluating potential alignments, several environmental factors should be considered, and avoided to the extent possible, including potential landslide areas, earthquake fault zones, potential liquefaction areas, high fire hazard areas, flood plains, water courses, species habitat, and cultural resources.

Station locations: Communities to be served with stations should be selected to provide accessibility to the developed mountain communities and activity centers in the corridor; ideally, therefore, stations would be located in Running Springs, possibly Arrowbear, Snow Valley, and Big Bear Lake (the Village area and the China Gardens/Interlaken area). Valley stations should provide park-and-ride opportunities, potential for goods movement transfers, and connections to public transportation. Stations in Highland, at San Bernardino International Airport, and at the proposed downtown Metrolink station would serve these functions.

2.8.5 Right of Way Issues

Key findings from the right-of-way analysis include:

Coordination and consultation with the US Forest Service: This is the most critical element of considering the right of way impacts for the project, and ultimately, the viability of the project.

Land Acquisition: In the developed mountain areas, where potential station sites may be located, property acquisition may be necessary for adequate station construction.

When evaluating the overall project cost, considerations for property acquisition or operating easements along the San Bernardino Valley operating segment will also influence project viability.

2.8.6 Financial Feasibility

Evaluation of projected system costs (capital and operating) and potential revenues will be a critical step in determining the viability of an alternative transportation mode. It is clear from the winter survey that potential patrons have a limited tolerance for fares, so farebox revenues will depend on fare levels as well as factors like convenience and travel time competitiveness that will determine ridership. There is potential revenue from freight shipments, but the system's success in attracting revenue from goods movement will be significantly determined by the available markets and the ease of transfer and distribution. Other revenue sources will need to be evaluated, including the potential for attracting private investment through public-private partnerships and opportunities for various types of public funding mechanisms.

3. TECHNOLOGY OPTIONS

3.1 Background

The 1996 Study assessed the feasibility of fixed-guideway transit options such as at-grade cog-rail alternatives and elevated alternatives including aerial ropeway systems and suspended monorails such as Aerobus, Aerorail, and TRASSE systems. As a follow-up to that extensive effort, this report builds upon the results of the 1996 Study

3.1.1 Goal of Literature Survey Report and Updated Technology Inventory

This literature review provides an update on the current state of technology being deployed in steep terrain, resort, people-mover environments, and alternatives for goods movement. It focuses largely on the technologies analyzed in the 1996 study, because it became apparent during the course of this review that while the technologies have improved with time, the alternatives for steep-terrain people-movers remain within the family of technologies studied in the 1996 Study. No significant new technologies have been implemented in the 14 years since the prior study was completed, however, incremental improvements in systems construction, maintenance and operations have been made.

At the request of the Technical Advisory Committee, this review also evaluates air service between San Bernardino and Big Bear airports as another non-highway alternative. A brief description of current air travel and opportunities and constraints is presented below.

This section also verifies and updates the freight-hauling capabilities of the fixed-guideway technologies to evaluate the opportunity for a goods movement element in the system to provide potential new operating revenue sources and reduce the level of truck traffic on the highway network serving Big Bear.

A summary of the operating characteristics of the technologies has been prepared, and an evaluation of the operating assumptions is included in this report. One of the most significant changes from the 1996 Study is the development of the future sbX rapid bus corridor through San Bernardino and new multi-modal transit connections planned in downtown San Bernardino. The future E Street TransCenter has been assumed for this review, and the subsequent impacts on station locations, the number of stations, and station patronage impacts has been considered.

3.1.2 Operating Concept

The 1996 Study contemplated two types of service: long trips on and off the mountain from Village Station to Highland Station characterized by less frequent trips (i.e., longer headways) and referred to as "line haul service", and shorter trips between the terminal segments operating more frequently and providing a "shuttle service" between the Village and China Gardens stations on the mountain, and between the Highland station, San Bernardino Airport station and the Metrolink station. This study focuses on line haul service to serve the needs of travelers between the valley and the mountains.

3.2 Technologies Assessed in 1996 Study and 2010 Update

The 1996 study analyzed four modal alternatives that could provide passenger and freight service from the San Bernardino Valley to Big Bear Valley utilizing Cog Rail, Aerobus, Aerorail, and TRASSE technologies. Various alignments incorporating these technologies were examined in the 1996 Study to service a wide range of topographical characteristics from the level grade, fully urbanized areas to mountainous steep-grade terrain.

This analysis provides a review and update of these systems and summarizes applicable issues and opportunities identified in the 1996 Study effort. In particular, this review sought out the latest technological advances by establishing contact with the largest manufacturers of fixed-guideway transit systems, and identifies contemporary applications that would be relevant to the Big Bear project.

3.2.1 Aerial Ropeway Systems

The 1996 study evaluated Aerobus systems. Aerobus[13] technology is defined as an aerial ropeway transit system. Aerobus utilizes slender steel pylons to elevate suspension cables similar to those used in the Golden Gate Bridge. The cables support an elevated aluminum track or guideway, hung from the pre-stressed cable suspension system. These cables support dedicated, very durable and lightweight, fixed-steel cable guideways that allow electric self-propelled vehicles to operate at any desired height above surrounding terrain. The articulated vehicles are suspended below the guideway, with traction wheels powered by electric motors that provide vehicle propulsion. The vehicles are electrically powered by catenary cabling or power rails, and can travel up to speeds of 40 mph. Normal grades for Aerobus technology range from 0 to 4%, with a maximum grade of 8%.

Top-suspended, Aerobus vehicles run on rubber tires which roll quietly and smoothly on aluminum tracks. Using conventional Aerobus technology, the pylons may be placed as far as 2,000 feet apart. This distance between supports is more than 15 times greater than other elevated systems. Therefore, in place of 60 to 100 traditional concrete or steel supports per mile, Aerobus uses between 5 and 10 supports to hold up either a single- or double-lane configuration. The widely spaced pylons provide flexibility, as Aerobus guideways can span lakes, rivers, wetlands, and deep canyons. In addition, lowering the number of support points means relatively lower cost of construction.

In addition, Aerobus technology utilizes a loop system at the terminal segments to provide frequent service on and off the mountain. For safety reasons, switches and curves require discontinuation of the cable-supported rail and transition to firm, elevated, fixed rail. This allows moving and locking into alternative positions under controls in fixed-rail segments. While one vehicle could head down the mountain as the line-haul service, the next vehicle could loop back in to provide increased flexibility and higher frequencies on and off the mountain. This type of technology could utilize a completely automated technology, or use a semi-automated system which includes vehicle operators. A guideway heating system is also used to allow for operations in adverse weather conditions.

Aerobus vehicles are modular. Anywhere from two to eight modules may be linked, providing a carrying capacity between 80 and 320 passengers. This includes the flexibility of moving cargo in both urban and suburban settings. The elevated suspension systems are limited to operating in winds below 40 mph for safety reasons.

Where needed, the articulated vehicles may be used to permit tight turns in crowded or space-cramped settings. It has been suggested by Aerobus engineers that with proper suspension and traveling on stiffer rails, speeds of 50 mph would be achievable (both the French Metro and VAL AGT system and the AEG-Westinghouse system perform successfully at 50 mph with rubber tires). This allows Aerobus

[13] Aerobus International, Inc. 2006. Available at: http://www.aerobus.com/.

vehicles to roll quietly on the aluminum tracks to deliver a smooth and comfortable ride. Five Aerobus systems were built and operated, however, none of the systems are in operation today as three of the systems were test tracks/facilities, one system was built as a temporary installation, and the fifth ceased operating when the ski resort the installation was serving closed in 1993. More recently, in 2007, the company began developing a 2.7 mile route for Weihai, China. Construction on this project has slowed due to changing political priorities and difficulties obtaining financing.

The Aerobus systems were significantly shorter than the proposed 37-mile Big Bear routes. The Aerobus ski resort installation in Quebec, Canada, spanned a total route distance of 0.5 miles. In Dietlikon, Switzerland, the system spanned a total route distance of 5.2 miles. The pictures below depict the Aerobus level-grade urbanized systems in Mannheim Germany that was built as a temporary transport system for a national event.

Figure 3.1 – Aerobus in Mannheim, Germany

Figure 3.2 – Aerobus in Mannheim, Germany

3.2.2 TRASSE Cable Propelled System

The second type of system considered in the 1996 Study was a TRASSE elevated guideway. The TRASSE system[14] is a fully automated, cable-propelled system for passenger transport which is monitored from a central console. The system uses a cable guideway that spans a range of 200 to 600 feet. Passenger vehicles are suspended from trolleys which move along two parallel track cables. The system is based on a bi-cable technology and a detachable grip. Separate cables carry out support and propulsion functions. The hauling cable is powered by a drive system at the end of line. The cable propelled systems requires that the vehicles change to the next cable loop every 3 to 4 miles. Because the line-haul segment of the Big Bear application is approximately 37 miles, the system would be required to slow down and change cables up to nine times, which results in slower travel times than the other alternatives. Research of the TRASSE systems in 2010 indicated that this is a type of system, rather than a specific product, that is characterized by vehicles with larger passenger carrying capacity than aerial ropeway rides. There are two major manufacturers of cable propelled systems, Doppelmayr and Pomagalski S.A. (also known as Poma). In Paradiski France, pictured below, Poma has a 1.13 mile long mountain installation that has large capacity vehicles, capable of carrying up to 200 people per vehicle in a two story configuration, with 87 passengers on the top level and 113 passengers on the bottom level.

[14] BRW.1996. Big Bear Enhanced Ground Access Feasibility Study.

Figure 3.3 – Poma TRASSE in Paradiski France

3.2.3 Aerial Ropeway Rides

Similar to the cable-propelled TRASSE system, aerial ropeway[15] technology operates on an aerial cable system with articulated vehicles suspended below the rope guideway. These systems are most commonly used for short-distance, steep-elevation, mountain resort transport and require the vehicle to attach and detach from the cable for boarding/alighting.

A gondola, or gondola "lift",[16] is a type of aerial lift which consists of a loop of steel cable that is strung between two stations, sometimes over intermediate supporting towers. The cable is driven by a bull wheel in the terminal which is connected to an engine or electric motor.

The gondolas[17] are attached to the haul rope with detachable grips for safe and easy loading and unloading, with the carriers travelling through the terminals at creep speed before accelerating to a line speed of up to 13 mph. Carrier capacity varies from four to fifteen people, and system capacity can be as much as 3,600 people per hour. The passenger cabin configuration allows seats to fold up with no pole obstruction, permitting the easy transport of cargo. In addition, semi-enclosed gondola lifts are easily attached to the ropeway system to transport passengers and baggage.

Gondola ropeways offer a comfortable ride and are the system of choice for feeder services in ski areas, tourist resorts, and the urban environment. The enclosed carriers provide full protection against the elements.

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[15] BRW.1996. Big Bear Enhanced Ground Access Feasibility Study.

[16] Search.com. 2010. Available at: http://www.search.com/reference/Gondola_lift, www.poma.net/en.

[17] Doppelmayr.CTEC. 2009. Available at: http://www.doppelmayrctec.com/.

The gondola "lift" installation in Hafjell, Norway, spans a total route distance of 1.5 miles. In Xiling Xue Shan, China, the system spans a total route distance of 1.3 miles. Because of the limited weight-carrying capacity of the passenger cabins and the short-distance nature of systems requiring multiple station transfers, gondola- and aerial tramway-type alternatives did not meet the purpose and need of the Big Bear alternatives analysis.

Figure 3.4 – Gondola in Zermatt, Switzerland

Figure 3.5 – Gondola Savoie, France

Figure 3.6 – Aerial Tramway in Arlberg, Austria

An aerial tramway consists of one or two fixed cables (called "track cables"), one loop of cable (called a "haulage rope"), and two passenger cabins. The fixed cables provide support for the cabins. The haulage rope, by means of a grip, is solidly connected to the truck (the wheel set that rolls on the track cables). The haulage rope is usually driven by an electric motor and is connected to the cabins, moving them up or down the mountain.

The aerial tramway may carry up to 100 passengers, and travel speeds of 22 mph are achievable with this technology.[18] Column span distances range from 695 feet to 3,455 feet.

The aerial tramway installation in Jackson Hole, USA, spans a total route distance of 2.4 miles. In Stateline (Heavenly Ski Resort, USA), the system spans a total route distance of 0.8 miles.

3.2.4 Funitel

The funitel is a form of advanced ropeway technology. A funitel consists of one or two loops of cable strung between two terminals over intermediate towers. In order to maximize the stability of the passenger cabins, the cables are arranged in two pairs moving in separate directions. Although it might appear that there are four cables in total, most of the time they are all connected as a single, long loop.

The passenger cabins are connected to a pair of cables with four spring-loaded grips (two to each cable). Because the cable runs at a speed faster than that at which most people would care to board or disembark, the cabins must be slowed down while in the terminals to allow passengers to get on and off. This is accomplished by detaching the cabin from the cable and slowing it down with progressively slower rotating tires mounted on the ceiling of the terminal. Once the cabin has reached a speed at which it is safe to load or unload passengers, the cabin is moved about the end turnaround by tires mounted on the floor. The cabin is then accelerated to line speed with a second set of rotating tires.

An individual special pneumatic cabin suspension has a capacity to seat 24 passengers. The maximum speed is 17 mph and may generate transport capacities of 3,200 - 4,000 people per hour.

[18] Doppelmayr.CTEC. 2009. Worldwide.

Figure 3.7 – Funitel in Veriber, Switzerland

The Funitel system offers lateral stability for operation at wind speeds of 62 mph or above. The use of two parallel haul ropes 10 feet apart makes it possible to achieve extremely long spans. The system functions on electricity and has the capacity to transport freight as well as recreation equipment. The cabin design configuration allows all seats to fold back with no pole obstruction to enable cargo and freight to be packed and delivered to the destination.

The Funitel system installation in Verbier, Switzerland, spans a total route distance of one mile. In Hintertux, Austria, the system spans a total route distance of 0.88 miles.

3.2.5 Suspended Monorails

The third type of elevated fixed guideway system evaluated in the 1996 Study was suspended monorail technology such as the Aerorail system. In these systems, vehicles are suspended from elevated guideways that closely follow the terrain. The carriages are enclosed and supported by a box-like track or beam, with an opening in the bottom. The rubber wheels of the train run inside the track, supported by flanges on the bottom of the beam. This enclosure serves to minimize noise and exposure to poor weather conditions. Motors and the vehicle drive steel wheels on steel meter-gauge rails to propel the vehicles. Monorail speeds may reach up to 37 mph with a passenger capacity of 130 people.

If passengers are standing, it is recommended that the maximum grade not exceed 8%. Grades of 15 to 20% are achievable, however the system becomes more expensive due to need of additional equipment. Alternatives utilizing Aerorail technology could use switches to loop back at the terminal segments to provide the conceptual shuttle service both on the mountain and in the city. While one vehicle could head down the mountain as the line-haul service, the next vehicle could loop back in to provide the shuttle service, thereby increasing flexibility and frequencies on and off the mountain.

The Suspended monorail installation in Wuppertal, Germany, spans a total route distance of 8.3 miles. The recent research revealed no noteworthy changes in the suspended monorail technology that would significantly change the 1996 Study's analysis or assumptions.

Figure 3.8 – Suspended Monorail in Düsseldorf, Germany

Figure 3.9 – Suspended Monorail in Wuppertal, Germany

3.2.6 Cog Railways

A cog rail system (also known as rack rail) was the fourth technology evaluated extensively in the 1996 Study. Cog rail[19] technology is similar in many respects to Light Rail Technology (LRT), and can use overhead electric catenary wires to supply power. At the time the 1996 Study was written, approximately 80% of cog railroads in operation were electrically powered. More recently, cog rail technology has evolved into energy-efficient battery/electric hybrid locomotives.[20] Some systems, like the Pikes Peak railway in Manitou Springs, Colorado pictured below, use diesel powered vehicles. While initial capital costs are typically high for cog rail, operations and maintenance costs are relatively consistent with LRT systems and equipment longevity is high. The Pikes Peak system is still operating train sets built in the 1960s.

Figure 3.10 – Cog Rail in Manitou Springs, Colorado (Pikes Peak)

The primary difference between cog rail and LRT is that a cog railroad uses a rack-and-pinion drive to operate on steep uphill and downhill gradients. Each cog rail vehicle is equipped with pinions, or "cogwheels," that engage a rackbar mounted permanently between the rails. Figure 3.11 illustrates rails with a rackbar[21].

[19] BRW.1996. Big Bear Enhanced Ground Access Feasibility Study.
[20] Absolute Astronomy. 2010. Available at: http://www.absoluteastronomy.com/topics/Rack_railway
[21] http://commons.wikimedia.org/wiki/File:Lausanne_Metro_Track_Closeup.jpg

Figure 3.11 – Rail with Rack Bar

Conventional pinions are designed to handle gradients between 7 and 30%, while gradients beyond 30% would require special provisions to ensure safety and passenger comfort. On level ground, the cogwheels are disengaged and operate in adhesion mode, similar to LRT trains. Cog rails can also be equipped with devices to remove snow on tracks, and continuous rail operations generally keep the tracks clear.

Cog rail systems are recommended to have a power supply of 1,500 volts DC which can be handled with reasonable effort in the vehicle equipment as well as by the overhead catenary wire systems. This power supply also allows a distance of approximately 2.5 to 3.1 miles between the electric substations. Each substation would require an approximately 30 by 30 footprint.

Unlike the elevated ropeway and fixed-guideway systems, existing cog railway systems have been developed that run for considerable distances. The Swiss Alps Matterhorn line, for example, is a network of routes that total some 144 km, or approximately 86 miles. This system started out many years ago as a series of shorter, independent routes that were connected over many decades. Commuters use this extended service to get from Zermatt to Goshenen (80 miles), Andermatt, and Disentis. Travel times vary for each of these city-to-city segments. A 37-mile cog railway system from San Bernardino up to Big Bear, while still quite a distance, is well within the practical limits of contemporary cog rail design and implementation. Since 1996, the key changes in cog railways have been upgrades to the electric propulsion systems, incremental improvements in vehicle design and capabilities, and the expansion and service integration of the Swiss railway network.

3.2.7 Funicular Railways

Figure 3.12 – Funicular in Los Angeles, CA

The last technology included in this review has limited scope and use for the Big Bear application and is not a recommended alternative, but an example operates within the Los Angeles basin, so a brief discussion of the system and attributes has been included. The Angel's Flight funicular rail system reopened on March 15, 2010, in downtown Los Angeles. Funiculars are cable railways used to traverse steep inclines.

A cable is attached to a pair of tram-like vehicles which moves them up and down a steep slope, simultaneously counterbalancing one another. Funicular operation entails two cars that are permanently attached to each other by a cable which runs through a pulley at the top of the incline. The counterbalancing of the two cars, with one ascending and one descending the slope, minimizes the energy needed to lift the ascending car. Winching is normally done by an electric drive working on the pulley. Sheave wheels guide the cable to and from the drive mechanism and the incline cars.

Maximum line speed is 31 mph[22], and car or train capacity can range between 20 and 400 people. Transport capacity can vary between 500 and 3,000 people per hour, depending on car capacity, line speed, and line length. The funicular system installation in Shenzhen, China spans a total route distance of 0.3 miles. In Juijiang, China, another system spans a total route distance of 0.9 miles. Because of the linked counter-balanced car operation, a funicular application would be impractical for the long-distance route identified for the Big Bear project.

[22] Doppelmayr.CTEC. 2009. Available at: http://www.doppelmayrctec.com/.

3.2.8 Air Travel to Big Bear

In addition to the fixed-guideway systems evaluated from the 1996 Study, an assessment of enhancing transportation to Big Bear using air travel was conducted. The goal of this evaluation was to identify current air travel patterns, and identify opportunities and constraints for increasing this as a viable alternative transportation mode between Big Bear and San Bernardino. Currently, there are no commercial flights to and from Big Bear and there are no air freight or cargo deliveries into Big Bear. Instead, Big Bear Airport provides services such as military aircraft landing and maintenance, general private aircraft maintenance, sightseeing flights, aircraft charter, aircraft sales and rentals, a flight school, emergency services, and aerial photography.

Big Bear Airport's primary runway is 5,850 feet in length and 75 feet in width.[23] The runway asphalt is currently in excellent condition, having been reconstructed in 2004. The airport is open for landing 24 hours a day, depending on weather conditions. Pacific Crest Aviation is the only agency that provides charter flights in and out of Big Bear. There is no helicopter service to and from Big Bear.

Local airports nearby such as San Bernardino and Ontario International Airports provide charter flights to Big Bear Airport. Flights for both airports may be arranged by local private charter air travel agencies. San Bernardino Airport covers 1,329 acres and has one runway.[24] This airport is a general aviation and cargo airport and runs 24 hours a day. Ontario Airport covers 1,700 acres and has two runways[25] and also runs 24 hours daily.

Research on charter flights to and from Big Bear, Ontario, and San Bernardino indicated very low demand for short-hop flights. The lack of demand for air travel between San Bernardino and Big Bear can be attributed to the relative short driving distance and reasonable travel time, the cost of air travel, and desire of most travelers to have a personal auto for travel within the Big Bear resort area. Additional flight operations are also limited by the same weather conditions that would interfere with driving. As a result, improved air connections would not meet one of the project needs—that of providing a reliable and operable transportation option in inclement weather. Flight connections would also not directly serve the inter-mountain stations at Running Springs, Snow Valley and China Gardens. Additional shuttle bus service would be required to distribute passenger to those areas.

The logistics and cost of providing air connections to Big Bear would vary greatly depending on the type of vehicle. Using the ridership projections from the 1996 Study, an estimated 6,600 trips per peak winter weekend would be made between Highland and Big Bear stations. The frequency and costs of providing sufficient flights to handle the 6,600 passengers would range significantly. For example, currently, the hourly cost to operate a 5-seat charter flight between Ontario Airport and Big Bear is $350. This includes fuel surcharges, overnight fees, airport fees, taxes, and airport landing fees. This type of aircraft would be too small to provide a practical solution, requiring 1,320 daily flights to carry the estimated passenger load. Comparatively, Southwest Airlines' small narrow-body Boeing 737's carry approximately 130 passengers. Using this type of aircraft, 50 flights would provide sufficient capacity to manage the weekend demand. In 2008, Southwest's average hourly cost for the 737 was $3,100. Additionally, the noise impacts of jet air travel on the Big Bear and San Bernardino areas would need to

[23] Big Bear City Airport. 2010. Available at: http://www.bigbearcityairport.com/.
[24] San Bernardino International Airport. 2005. Available at: http://www.sbdairport.com/.
[25] Ontario International Airport. 2007. Available at: http://www.ci.ontario.ca.us/index.cfm/17873.

be evaluated. For reference, the Long Beach Airport currently restricts flight operations to 41 jet and 25 commuter flights daily for noise abatement and mitigation.

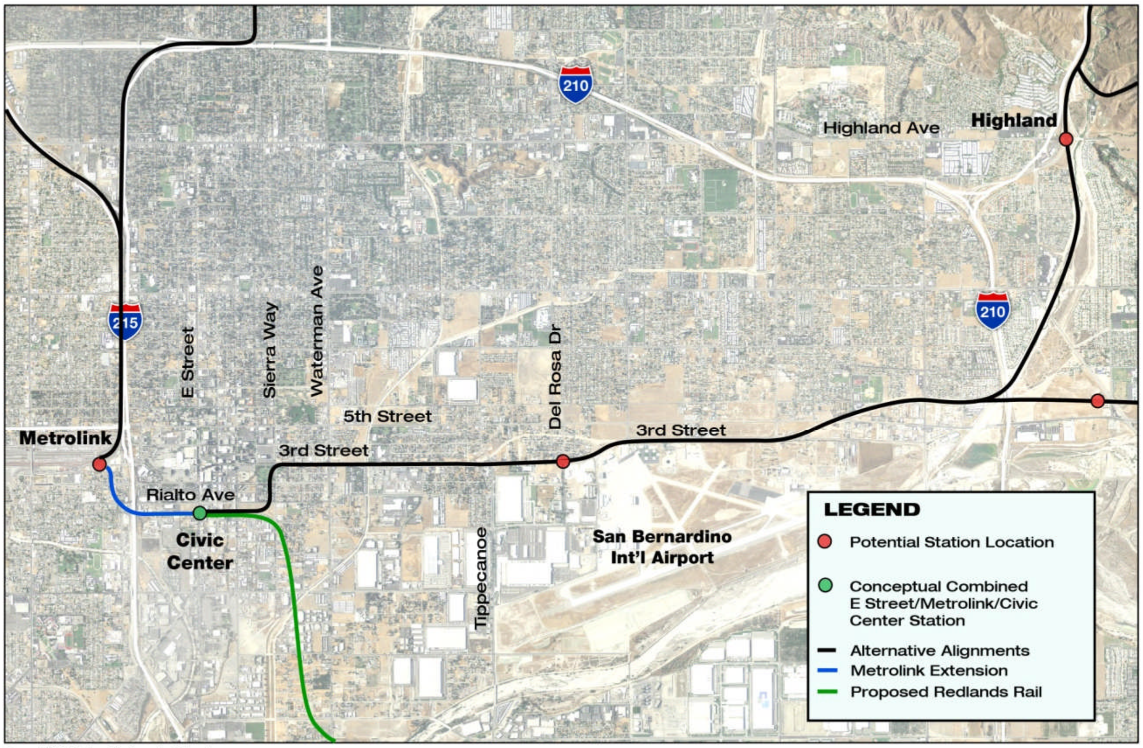
There are many issues related to providing direct flights between San Bernardino and Big Bear. The essential economics of demand for this type of service may be the most limiting factor. Because of the close proximity of the airports and the time required for flight check-in and pre-flight operations checks, there is no competitive advantage to flying versus driving.

3.2.9 Operating Characteristics

The 1996 Study included a comprehensive evaluation of operating characteristics of the four technologies, Cog Rail, TRASSE, Aerobus, and Aerorail. Based on the updated research conclusion that there have been incremental improvements, but no quantum leaps in systems designs, the operating characteristics of the technologies continue to be valid for study purposes, and a summary of these are provided in Section 2.2.11. However, with the introduction of Omnitrans' new rapid bus corridor, sbX, and a recommended relocation of the Metrolink station to E Street, some fundamental service characteristics should be re-evaluated.

3.2.10 Station Locations

In 1996, the origin station in San Bernardino was planned for the Metrolink commuter rail station located at the depot west of the I-215 on 3rd Street. Since then, plans have been developed to extend the Metrolink line to a new terminus station at E Street and Rialto Avenue in downtown San Bernardino. This multi-modal transit center will also be served by the new Omnitrans sbX rapid bus line (operating from Cal State San Bernardino through downtown to Loma Linda) and the proposed Redlands rail line. As a result, the terminus station location for the Big Bear alternative will also be assumed at this location, to connect to these services. The new station location has two significant advantages: 1) a new proposed fixed-guideway system will not have to cross (over/under) the I-215; and 2) the system will connect to an improved bus rapid-transit system. This new station is in close proximity to the Central City Mall/Civic Center. The 1996 study estimated the Mall/Civic Center station to generate 1,120 average daily boardings, and the Metrolink station to have 730 boardings. The new E Street station could serve as a combined station for both locations that would provide connections to the regional rail system and be within walking distance of the Mall and Civic Center. The Revised Metrolink/Civic Center Station Placement Map below depicts the new potential station location.



Source: USGS National Hydrography Dataset

0 0.25 0.5 1 Miles
1 in = 1 miles

San Bernardino Potential Alignments and Stations

Figure 3.13

Additionally, one of the project's key service characteristic assumptions is that the Big Bear system is intended to primarily serve mountain-oriented travel (between the Valley and the mountain communities). The 1996 study travel forecasts indicated that, at 2.1 million average daily trips, just over half the projected ridership for the system would be travel within the urban area, with no bearing on up/down mountain travel. The changes in bus transit service plans since 1996 and the potential for a fixed guideway along the Redlands subdivision (south of the proposed project alignment) probably also affect the desirability of having as many as seven stations in the Valley area. This analysis takes the approach of assuming station locations needed to serve the mountain-oriented trips.

3.2.11 System Configuration

The 1996 Study concluded that any of these technologies would require significant development of systems and other infrastructure. Clearly, the same would hold true in today's operating environment. Switches, maintenance facilities, and trackway/guideway would be required. Table 3.2, taken from the 1996 Study, presents the systems and infrastructure assumptions used to simulate transit operations for each of the technologies. The following tables summarize the differences in operations among the different technologies. System configuration, travel time, and freight capabilities are discussed in more detail below.

Table 3.1 - System Configuration and Technology Characteristics (1996 Study)

Description	Aerobus	Aerorail, Trasse	Cog Rail
Number of Stations*	11	11	11
Approximate Main Line Guideway or Trackway Length	36.3	37.2	37.2
Approximate Maintenance and Storage Guideway Length (miles)	1.4	1.4	1.4
Number of Track Switches(1) (to the maintenance and storage facility)	10	10	14
Type of Track	Elevated, Double Ropeway	Elevated, Double Guideway or Ropeway	At-grade Single Railroad with Bypasses
Type of Service	Shuttle and Line Haul		

(1) All systems would require additional track switches for operation with shorter headways on the Metrolink to Highland Station portion of the system.

* Station placement and number should be reviewed (2010); see discussion above

3.2.12 System Characteristics and Operating Assumptions

Table 3.2, also taken from the 1996 Study, presents the system characteristics assumed for each technology. System characteristics were developed with information from the suppliers of each of the technologies, as well as information on basic requirements for service levels. Parameters such as speed, station dwell time, and acceleration were assumed. Basic requirements established for the system include:

- Maximum of hourly headways between trains/vehicles;
- Cruise speed should be varied for different terrain conditions; and
- Dwell times would be longer than a typical bus because of luggage, number of patrons, etc.

Table 3.2 - System Characteristics and Operating Assumptions (1996 Study)

Characteristic	Cog Rail	Aerobus	Aerorail	TRASSE
Cruise Speed, mph (straight and level)	50	35	35(1)	30
Cruise Speed, mph (curves, shallow grades)	40	30	30	30
Cruise Speed, mph (steep grades)(2)	20(3)	30	25	30
Acceleration Rate, foot/second2 (all terrain)	1.1	3.4(4)	3.4	3.4
Dwell Time, seconds (intermediate stations)(5)	180	90	90	90
Dwell Time, seconds (end station)	360	180	180	180

(1) Technology capable of higher speeds, subject to demonstration.

(2) Limited to 8% grades for Aerobus, 12% grades for Aerorail.

(3) Average of uphill (25mph) and downhill (16 mph) speeds.

(4) System is capable of 4.8 f/sec/sec, limited to 3.4 ft/sec/sec for passenger comfort.

(5) The dwell time at the Central City Mall/Civic Center/County Administration, Waterman Avenue, and Lean Road Stations are reduced by one third compared to these values. The terrain is relatively flat and the station locations are closer in proximity.

3.2.13 Travel Time

Using the assumptions from the operating characteristics and the alignment configuration, operations were simulated for each of the technologies. Table 3.3 presents the estimated travel time and resulting system capacity for each option.

Table 3.3 - System Performance and Travel Time (1996 Study)

Characteristic	Cog Rail	Aerobus	Aerorail	Trasse
One-way Travel Time (minutes)(1)	76.8(2)	73.4	79.3	84.0
Required Capacity (pphpd)*	472	472	472	472
Train Type	Three Pairs (Six Cars)	Eight Module Train	Multi-Car Articulated	Single Vehicle
Train Capacity(3)	493	258	178	50
Departures/Hour	1**	2	3	10
Headway (Minutes)	60	30	20	6
System Capacity (pphpd)	493	516	528	500
Operating Speed mph	25	40	37	25
Required Number of Trains – Operational total, includes 10% spares	5	7	11	36
Power System	Electric and Diesel	Electric	Electric	Electric

(1) Travel times values represent the system between Metrolink and China Gardens

(2) Cog Rail value represents average of uphill and downhill trip times, and cog rail speeds vary maximums at 25 mph, downhill maximums at 12 mph, and up to 40 mph at level grade.

(3) Capacities are shown for "Seated/Standing"

* Passengers Per Hour Per Direction

** Representative of lower acceleration rates and longer station dwell times.

3.2.14 Freight Capabilities

According to the 1996 Study, the technologies considered for Big Bear appear well suited for even sophisticated freight-handling applications. For example, the Aerobus suspended system technologies can load and "drop" Unitized Load Devices (ULDs) more rapidly than bottom-supported vehicles such as cog rail systems. ULDs could be standard 20-foot or 40-foot containers, or smaller specialized container units designed for expediting loading and unloading. For the selected system to be efficient, it must be able to handle at least standard 20-foot rail/truck containers (ATA Type 1, ATA Type M2) weighing up to 15,000 lbs. The freight capabilities of each technology are described in the following sections

3.2.14.1 Aerial Ropeway (Elevated)

Aerobus has the capability to transport freight/cargo with load capacities up to 55,000 lbs. in standard 40 foot containers, although no systems are currently in operation. The cargo loading areas have separate designated ropeway lines integrated into the overall Aerobus system (see Figures 3.1 and 3.2). The Unitized Load Devices (ULDs) are locked and fastened by freight arms and suspension towers.[26] The ULDs are then lifted to the top of the cargo module and transported to the designated destination. The

[26] Aerobus. 2006. Available at: http://www.aerobus.com/multimedia.html.

freight/cargo modules may be integrated with passenger modules and the number and frequency of cargo modules are dependent on the system design and support tower spacing. Once cargo loaded, the overall system operates automatically and does not require operators for the line haul trip.

Aerial Ropeway ride systems and rides such as gondolas, aerial tramways, and funitels are designed to flexibly transport people, luggage, and recreational equipment. Each cabin configuration has no pole obstruction and seats fold and detach to allow maximum spatial utilization. As a result, there is very little information available on freight hauling capabilities of these systems, and no cargo specifications. These systems would have to be customized for freight hauling, so for planning and analysis, the freight load capabilities would be limited to the passenger load characteristics. For estimating purposes, this study has used the large passenger capacity of the Trasse type system in Paradiski France, which could accommodate a mix of passenger and freight in each vehicle, carrying a maximum weight load of 100 passengers and 15,000 lbs of cargo, or alternatively, a cargo-only vehicle trip of up to 30,000 lbs of freight.

3.2.14.2 Suspended Monorail (Elevated)

The 1996 Study reported that freight studies of the GRAIL and Transyt suspended monorail systems have been conducted. These studies showed that movement of freight by monorail is possible up to the beam-load limit, which varies by system design. However, Aerorail has not made freight design provisions at present. The Dusseldorf Airport and Dortmund suspended monorails only provide passenger transportation.[27]

3.2.14.3 Cog Rail (At-grade)

Cog rail systems in the United States currently utilize this technology for people transport systems and are mainly geared toward sightseeing and tourist activity transportation. In Germany, the Bavarian Zugspitzbahn Bergbahn AG (BZB) cog rail vehicles built by one of the primary cog (rack) rail suppliers, Stadler Rail (www.stadlerrail.com) offers a separate non-motorized car that can be pushed/pulled to haul cargo up and down the 11.6 mile route. However, useful details on the cargo capacity for cog systems were difficult to obtain. Using an estimate based on the passenger load capabilities of the Stadler Rail system, each train could accommodate and estimated 15,000 – 30,000 lbs of cargo along with the passenger load.

3.2 Summary

Operationally, each of the candidate systems meets the requirements of the Big Bear application; although some are clearly better suited than others. Table 3.4 below summarizes the attributes of each rail technology.

[27] Personal Communication with Frank Guzzo, Siemens Corporation (6.11.2010).

Table 3.4 - Summary of System Operational Applicability

Characteristic	Cog Rail	Aerial Ropeway Systems: Aerobus Self Propelled	Aerial Ropeway Systems: Cable Propelled	Aerorail (Suspended Monorail)
Trip Time	Good	Excellent	Fair	Good
Headway	Fair	Good	Excellent	Good
Convenience	Good	Excellent	Poor	Excellent
Expandability/Additional Capacity	Excellent	Good	Poor	Good
Freight Capability	Very Good	Good	Poor to Fair	Poor to Fair
Operation Experience	Excellent	Limited	Good	Good
Maximum Length	87 miles	5 miles	9 miles	8.3 miles

3.3 Key Findings

The project team conducted an extensive data and literature review to assess the current state-of-the-art for at-grade and elevated people-mover systems. It was apparent early in the review process that while improvements have been made to the pre-existing technologies that were contemplated in the 1996 Study, no new technology has been introduced that might be superior to the technologies presented in either the 1996 Study or in this analysis. Given that the operating characteristics of the technologies remain essentially unchanged, additional analysis of cog rail and aerial ropeway systems was conducted to determine capital and operating challenges specific to a Big Bear application.
The project team based this research on information obtained by professional contact with Doppelmayr[28], one of the world's leading manufacturers of ropeway and tram systems. Doppelmayr provides many of the systems that we have identified in this analysis, including ropeway trams and gondolas. They are the leading supplier of elevated trams and gondolas to ski resorts around the world. Additionally, the project team conducted research on cog rail systems through discussions with representatives from Stadler Rail, the leading builder of cog rail vehicles.

The technology inventory revealed the following key issues and challenges when considering a non-highway alternative for travel from the San Bernardino Valley to the Big Bear area:

Route Length and Topography: One of the most significant challenges to be considered in further analysis is the scale of the proposed Big Bear project. Most of the systems discussed in this analysis, as well as the earlier report, are much shorter in length/distance than the 37+/- mile system being contemplated for Big Bear. In fact, the longest elevated ropeway system that the project team was able to identify is in Sweden and is approximately 9 miles in length. At nearly 37 miles, the proposed Big Bear system would be orders-of-magnitude larger than any existing elevated system in the world.

Another challenge of the Big Bear project is the steep mountain grades. Preliminary alignments include areas over 20% grades, and both of the two at-grade systems and the aerial systems evaluated in the 1996 Study have the capability of operating at this level of incline. However, for optimal passenger comfort and operations, systems are typically designed for no more than an 8% grade. After review of the Big Bear conceptual system needs, lengths and gradients, and discussions with representatives from Dopplemayr LLC, the analysis concluded that aerial ropeway systems such as gondola and TRASSE are

[28] Personal communication with Jerry Van Osdol, Doppelmayr CTEC, Inc. (4.15.2010).

best suited for shorter distances, and developing and operating a 30+ mile systems using aerial ropeway technology is not recommended.[29]

Freight Capabilities: Research has revealed very limited goods movement in practice today, as most systems rely on trucking for freight hauling to the mountain destinations, and limit the fixed-guideway systems to passenger travel. All of the systems have the potential to carry freight, with varying capacities. Cog rail systems offer good freight capacity and capabilities. Aerobus type systems have the capability, but systems are unproven, and the elevated monorail and the aerial cable propelled systems have the most limited cargo hauling capacity.

System Route and Station Planning: The 1996 Study analyzed a 37 mile long route with 11 stations, with a system serving two distinct markets: city trips and mountain trips. Improvement is the fixed-route rapid bus network and changes in the Metrolink commuter rail San Bernardino origin station to E Street and Rialto Avenue in downtown San Bernardino may necessitate a re-evaluation of station location planning. In light of additional potential transit network improvements in San Bernardino, further consideration of the utility of the urbanized segment of the project and integration with the potential Redlands corridor strategic plan should also be assessed.

3.4 Recommendation

The 1996 Study concluded that the cog rail and Aerobus technologies performed the best of all the transit alternatives evaluated and were thus carried forward as the two potential technologies for application in the Big Bear study area. This update found these two technologies met the primary purpose and need for passenger delivery systems that can traverse the difficult terrain. However, Aerobus does not currently have any systems in operation, start-up plans for a new system in China have been halted, and plans for goods movement capabilities are conceptual. Furthermore, Aerobus has stated that their business development efforts will focus outside of the U.S. due to the challenges posed by domestic environmental regulations.[30] As a result, only the cog rail technology, which has demonstrated abilities to operate long distances through steep mountain terrain and inclement weather, is recommended to be carried forward for additional analysis and system planning.

[29] Personal communication with Jerry Van Osdol, Doppelmayr CTEC, Inc. (10.11.2010)
[30] Personal communication with Dennis Stallings, Aerobus Inc. (9.23.2010)

4. CORRIDOR ALIGNMENT ALTERNATIVES

4.1 Introduction

The 1996 study evaluated a number of potential alignment options through the mountain portion of the corridor from Highland to Big Bear Lake. This study reviewed those alignments to determine if they represented a sufficient range of options for consideration, then performed a screening analysis to determine which alignments would best meet the corridor objectives. Subsequent input received through consultation with the United States Forest Service (USFS) indicated that recent USFS land use regulations could make it difficult to develop a corridor along any of those nine alignments, so additional alignments were identified for evaluation in the analysis of alternative systems (Chapter 6).

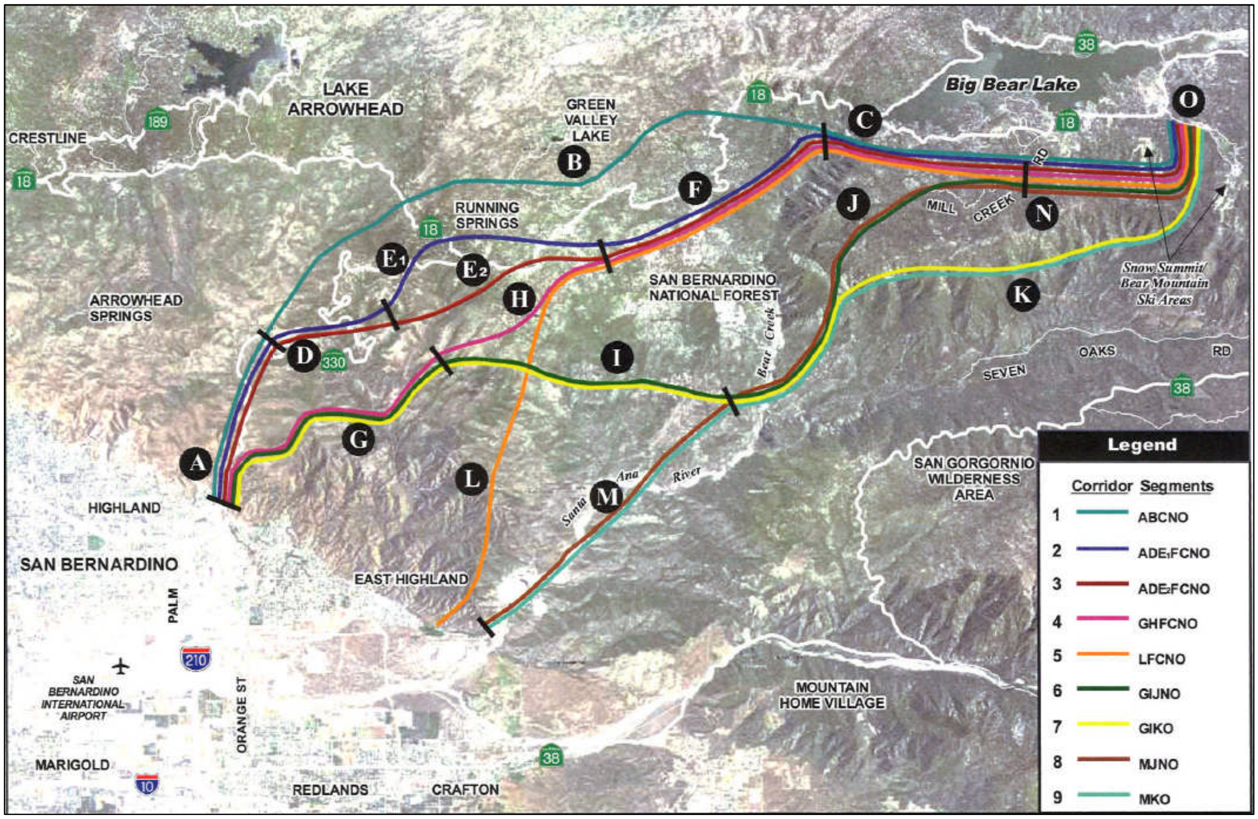
This chapter presents the results of the initial corridor screening analysis (the full screening evaluation is included in Appendix H), provides the land use compatibility information received from the US Forest Service, and presents the additional corridor options to be carried forward into the analysis of system alternatives.

4.2 Initial Corridor Screening

4.2.1 Screening Results

The 1996 study evaluated nine alternative corridors comprised of combinations of fifteen segments (see Figure 4.1). Review of current engineering and environmental databases found that these nine corridors reflect an appropriate range of alignment options for a fairly direct route from San Bernardino to Big Bear Lake, so these nine corridors were evaluated in relation to a list of criteria developed in consultation with the study's Technical Advisory Committee. A tenth alternative (utilizing an existing rail line that approaches Big Bear Lake from the desert (north) side) was also considered, but was not evaluated with all the criteria applied to the other nine because the evaluation quickly revealed some fundamental flaws that render this alignment infeasible.

Figure 4.1 – Corridors Analyzed in 1996 Study



The following discussion summarizes the results and recommendations of the screening analysis by corridor. The descriptions and analysis focus on the mountain portion of the route, as the corridors would all follow a similar alignment from downtown San Bernardino to Highland.

Corridor 1: The route begins at Highland at SR 330 and crosses SR 18 in northern Running Springs. The corridor can provide access to a potential station in Running Springs. The route does not reach Snow Valley, but can serve a station stop in the Big Bear Lake Village. Corridor 1 has significantly more potential encroachment into the Mountain Yellow-Legged Frog critical habitat area than other alternatives.

Recommendation: Remove Corridor 1 from further consideration as other options provide more intermediate station access with reduced potential impacts to sensitive biological resources.

Corridor 2: Corridor 2 also begins at Highland, and parallels SR 330 for a portion of the route. This option provides the best alternative for intermediate station access with good connections to Running Springs (with an approach near the intersection of SR 330 and SR 18) that offers two potential stop opportunity areas: Arrowbear, Snow Valley, and the Village. The route also has good access to existing improved and unimproved roads for construction and emergency response, and has the lowest percentage (35%) of the route traversing high landslide risk areas. The potential environmental impacts to critical habitat areas are less than other alternatives.

Recommendation: Retain Corridor 2 as an alternative as it provides the best intermediate station access and fewer environmental concerns than other options.

Corridor 3: Is very similar to Corridor 2 for a majority of the route but has less convenient access to the Running Springs/Arrowbear area than option 2. It could serve Snow Valley and the Village as intermediate stops. It has good access to existing improved and unimproved roads for construction and emergency response, but has a greater level of potential impact to the Mountain Yellow-Legged Frog habitat area than Corridor 2.

Recommendation: Retain Corridor 3 for continued analysis for the portion within the Running Springs area.

Corridor 4: This route also begins at Highland, but does not use the SR 330 path up the mountain. It travels eastward, with limited potential intrusion into the Mountain Yellow-Legged Frog critical habitat area. The route does not serve the Running Springs/Arrowbear area, but reaches Snow Valley and the Village. The route could access Running Springs/ Arrowbear area with some modifications to the alignment that was studied in 1996. Corridor 4 has a moderate level of landslide risk, traveling through approximately 11% of critical gradient area.

Recommendation: Retain Corridor 4 for continued analysis as it serves intermediate station areas and has less potential environmental impact than other alternatives.

Corridor 5: This route ascends into the mountains from East Highland. This alignment would serve Snow Valley and the Village. As studied in 1996 this alignment would not serve Running Springs/ Arrowbear, but it could be modified so that these communities would be served. The route has less impact to sensitive habitat areas than Corridors 8 and 9 which also originate in the East Highland area.

Recommendation: Retain Corridor 5 for continued analysis, as it could serve intermediate stations areas and has less potential environmental impact than other alternatives.

Corridor 6: This route begins at Highland, travels eastward, crossing Bear Creek and Siberia Creek, and travels north to enter the Big Bear area at the Village. The corridor provides no station access to Running Springs/Arrowbear or Snow Valley, but could serve the Village. The route passes through the San Bernardino Bluegrass critical habitat area. At 23.7 miles, it is the longest option.

Recommendation: Remove Corridor 6 as it has greater environmental impact potential and does not provide intermediate station access to the other mountain communities.

Corridor 7: This route would start in Highlands and travel eastward, crossing Bear Creek in the center of the project area. The route offers no intermediate station access. The corridor travels through very steep terrain, has a high landslide risk hazard potential, and crosses eight earthquake faults.

Recommendation: Drop Corridor 7 as it does not provide any intermediate station access and offers limited regional connectivity.

Corridor 8: This route starts in East Highland. There would be no Running Springs/Arrowbear access, but it does include a stop at the Village. The route is relatively short, at 19.2 miles. The route parallels the Santa Ana River, has greater impact to biological resources that other alignments and more liquefaction hazard risk present in the river. The route also passes through the San Bernardino Bluegrass critical habitat area and the Southwestern Willow Flycatcher critical habitat area.

Recommendation: Remove Corridor 8 from the alternatives as it does not provide intermediate station access and has a greater potential biological resources impact than other options.

Corridor 9: Corridor 9 also begins in East Highland, and as a result, offers no intermediate station access and would not serve the Village area. The corridor traverses very steep terrain with 95% of the corridor in high landslide risk. Similar to Corridor 8, it has a greater liquefaction hazard risk than other routes, however, it has only 2 fault crossings. The route parallels the Santa Ana River, has greater impact to biological resources, in particular, the Southwestern Willow Flycatcher critical habitat.

Recommendation: Remove Corridor 9 from the alternatives as it does not provide intermediate station access and has potential for significant environmental impact.

4.2.2 Recommended Corridors for Continued Study

The objective of this screening process is to reduce the number of potential alignments for more detailed analysis in the context of system performance. For several of the evaluation criteria, all corridors evaluated performed essentially the same, including Land Use and Planning, Wilderness Area Designation, Public Safety, and Socioeconomic. All corridors would be considered non-conforming with existing plans and would require amendments. All corridors avoid the San Gorgornio Wilderness Area, and all travel through high wildland fire hazard areas. Additionally, as the corridors studied are each ½ mile wide, all corridors have the potential to displace housing units or businesses as the routes enter the Big Bear Valley and intermediate stop areas. Additional options to reduce these impacts would be explored in future studies, when a more specific and detailed alignment analysis can be undertaken.

For the remaining criteria, each potential corridor performs differently. Based on the screening results, the following corridors are recommended to be carried forward in the study:

- Corridor 2
- Corridor 3 (portions of this corridor may be utilized in combination with Corridor 4 for improved access to Running Springs)
- Corridor 4
- Corridor 5 (including an alignment adjustment to serve Running Springs)

These corridors have the best potential to serve intermediate station stops, offering mobility and mode choice to multiple customer markets. With origins at Highland, they provide good connections to existing transit and proposed extension of the guideway system into downtown San Bernardino. These corridors have less potential for impact to sensitive biological species. All these corridors have critical gradients, but a reduced level of landslide risk than other alternatives. As a result, bridge construction or tunneling may be needed as the alignments are developed. Both bridges and tunnels can reduce the biological, environmental, and aesthetic impacts of guideway construction and operations.

4.2.3 Lucerne Valley Rail Alternative

The 1996 Study also evaluated an alternative that would use existing freight railroad tracks to access Big Bear from the north. The existing tracks travel from Hesperia eastward through the Lucerne Valley and end at a mining facility approximately 10 miles north of Big Bear, near the SR 18. The 1996 Study did not pursue this option because:

- More than 50% of the daily traffic entering Big Bear uses the SR 330/18 corridor, which is not served by this corridor.
- The major population and employment centers are located south and west of Big Bear rather than to the north.
- No intermediate mountain stops for Running Springs, Arrowbear or Snow Valley would be possible
- Travel time for visitors to access the system at Hesperia or other locations in the Lucerne Valley would be excessive and discourage ridership.

A variation of this alternative was suggested for this analysis. This alternative would offer rail service from San Bernardino, originating at the existing Metrolink station, and travel up the Cajon Pass to Hesperia using the freight railroad tracks. From Hesperia, the route would follow the existing rail line to the mine facility; from the mine, the rail line would need to be extended southerly up the mountain into Big Bear. This alignment presents a number of challenges that would require supplementary investigation and analysis. These include additional examination of the possibility of accessing the freight railroad to operate the service, rail vehicle technology, travel time and ridership demand estimates.

The Cajon Pass is the major transcontinental freight rail route for the Burlington Northern Santa Fe Railway (BNSF), and also carries freight rail traffic operated by Union Pacific (UP). An estimated 100 freight trains a day operate through this area. Obtaining operating rights to run frequent regularly scheduled service through the Cajon Pass would be very difficult, if not impossible, as well as costly. This would be the critical path item for testing this option's feasibility.

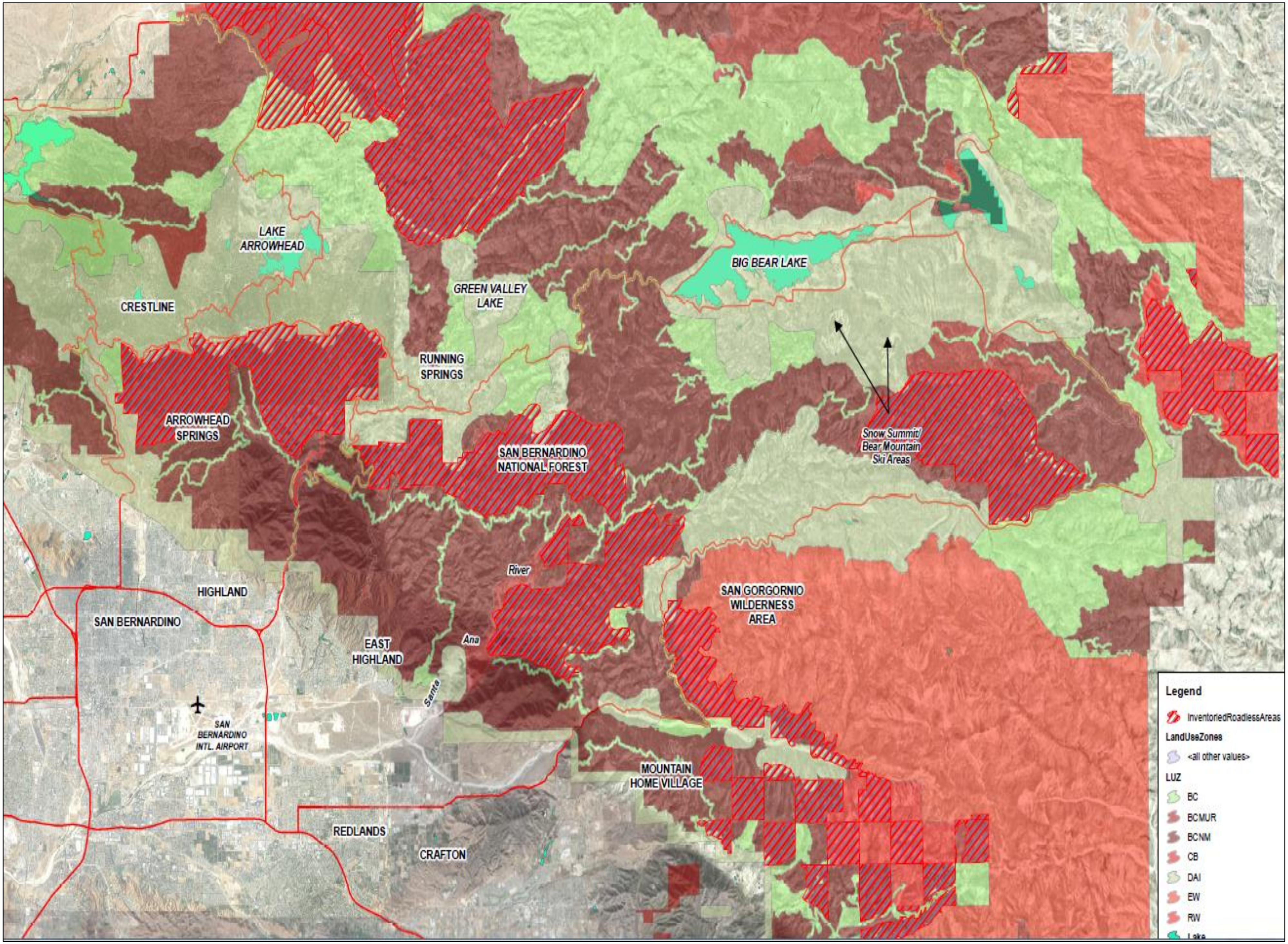
Additionally, a more detailed study of available rail technology would be needed to determine what type of equipment could operate on this route. Current cog rail technology, which could be needed to make the grade from the Lucerne Valley into Big Bear, would most likely not meet Federal Railroad Administration (FRA) standards regarding crash worthiness ("FRA Compliant" vehicles) required for operating passenger and freight rail service on shared facilities. If the grades and alignment would allow for conventional rail service using the "back way" into Big Bear, this equipment would most likely be diesel locomotives pulling rail cars. One of the early objectives of the study was to evaluate non-petroleum based, more environmentally friendly motive power sources, which may not be possible with this alternative.

Furthermore, with an alignment over 70 miles long and crossing steep mountain grades, the travel time for this service would be considerably greater than driving, even on the heavily congested peak winter weekend demand days. The long travel time would put this corridor at a competitive disadvantage compared to the automobile, and would likely result in much lower ridership than the more direct routes through the front range.

4.3 National Forest Land Use Compatibility Issues

Consultations with local US Forest Service representatives brought out information about some National Forest land use regulations that could render the preferred alignment options (indeed, all nine of the original options) difficult to implement. The alternative alignments pass through National Forest areas designated as incompatible with transportation uses. The USFS has designated certain areas as Inventoried Roadless Areas (IRAs) – lands without existing roads that are suitable for preservation as quasi-wilderness areas (shown as cross-hatched areas in Figure 4.2). In addition, the San Bernardino National Forest (SBNF) land use plan has designated certain areas as non-motorized (shown as brown or reddish areas in Figure 4.2). In either case, development of a new transportation system through these areas would not be compatible use with their current land use designation. USFS representatives have indicated that, while it would not be impossible to obtain approval for a change to accommodate a new transportation system through these areas, it would involve an extensive review and approval process within the Forest Service. The process would be somewhat simpler for traversing a non-motorized area, since it would be a local (SBNF) decision, whereas approval for passing through an IRA would require approval at a higher (district) level within the USFS.

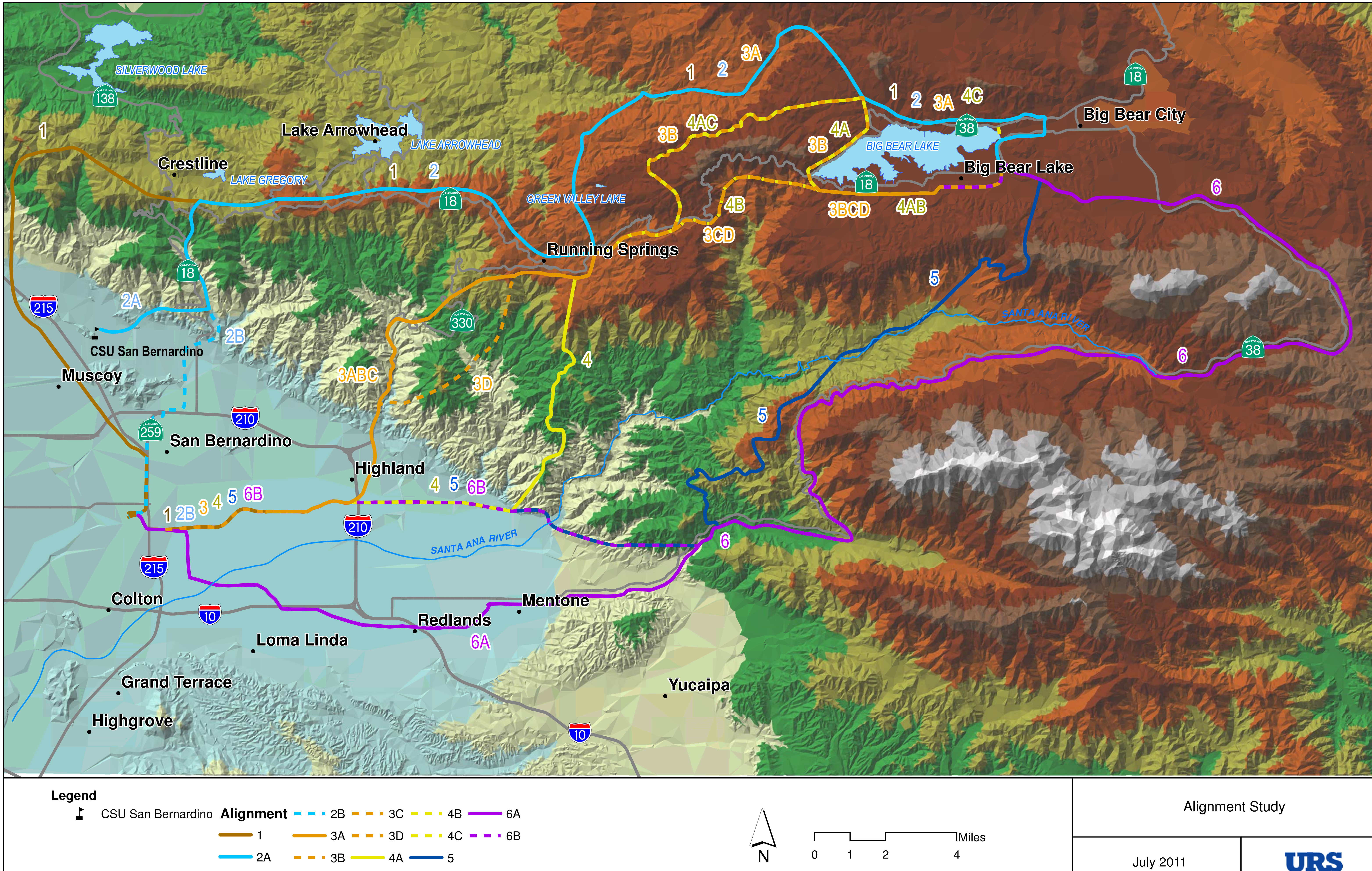
Figure 4.2 - Forest Land Use



4.4 Additional Alignments for Analysis

Because the National Forest land use conflicts could represent a fatal flaw for (or at least a significant impediment to) the original nine alignments, the study team and TAC determined that additional alignments should be identified that would eliminate or minimize corridor intrusion into roadless and non-motorized areas. Using the Forest Service mapping of compatible land use areas (shown in green colors in Figure 4.2 above) and non-compatible areas (shown in browns and reds), the study team and TAC identified six alternative corridors for further study, with potential variations in four of the six corridors. The alternative corridors (shown in Figure 4.3) are numbered from 1 to 6 from west to east, and are described below with their alignment variations:

Figure 4.3 - Alignments for Study



Alignment Study

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- Alternative 1 – Cajon Pass: goes northwest from San Bernardino toward Devore and Cajon Pass to avoid most of the roadless and non-motorized areas. Turns east and passes through Crestline and Running Springs. Approaches Big Bear Lake from the north.
- Alternative 2 – Waterman Avenue: parallels SR-18 going northerly out of San Bernardino. Joins the Alternative 1 alignment near Crestline. One variation originates in downtown San Bernardino, the other at Cal State San Bernardino.
- Alternative 3 – Highland (SR-330): Goes northeast from San Bernardino to Highland. Essentially follows SR-330 from Highland to Running Springs. Four variations were identified:
    - North of Running Springs, follows Forest Road 2W03 from Green Valley Lake area to north side of Big Bear Lake. Goes around east end of lake to reach south side.
    - From Running Springs, goes east to serve Snow Valley. Follows Forest Road 2N13 from Green Valley Lake area to north side of Big Bear Lake. Goes around west end of lake to reach south side.
    - From Running Springs, goes east to serve Snow Valley. Passes through the Arctic Circle area between Snow Valley and south side of Big Bear Lake. (Essentially the same as Alternative 3 in the original nine alignments.)
    - Between Highland and Running Springs, essentially follows Plunge Creek. Passes through the Arctic Circle area between Snow Valley and south side of Big Bear Lake. (Essentially the same as Alternative 4 in the original nine alignments.)
- Alternative 4 – East Highland: goes east from San Bernardino to East Highland, then north to Running Springs. Three variations were identified:
    - From Running Springs, goes east to serve Snow Valley. Follows Forest Road 2N13 from Green Valley Lake area to north side of Big Bear Lake. Goes around west end of lake to reach south side.
    - From Running Springs, goes east to serve Snow Valley. Passes through the Arctic Circle area between Snow Valley and south side of Big Bear Lake. (Essentially the same as Alternative 5 in the original nine alignments.)
    - From Running Springs, goes east to serve Snow Valley. Follows Forest Road 2N13 from Green Valley Lake area to north side of Big Bear Lake. Goes around east end of lake to reach south side.
- Alternative 5 – Santa Ana River Valley: goes through East Highland, then continues east and follows forest roads into the Santa Ana River valley and goes over the mountains south of Big Bear Lake.
- Alternative 6 – SR-38: essentially follows SR-38 and approaches Big Bear Lake from the east. Two variations were identified:
    - Follows the proposed Redlands Rail line from downtown San Bernardino to Redlands (service would be integrated with the Redlands Rail service). From Redlands, it follows SR-38.
    - Follows Alternatives 4 and 5 to East Highland, continues east with Alternative 5 to where it intersects SR-38, and has the same alignment as the other option from there to Big Bear Lake.

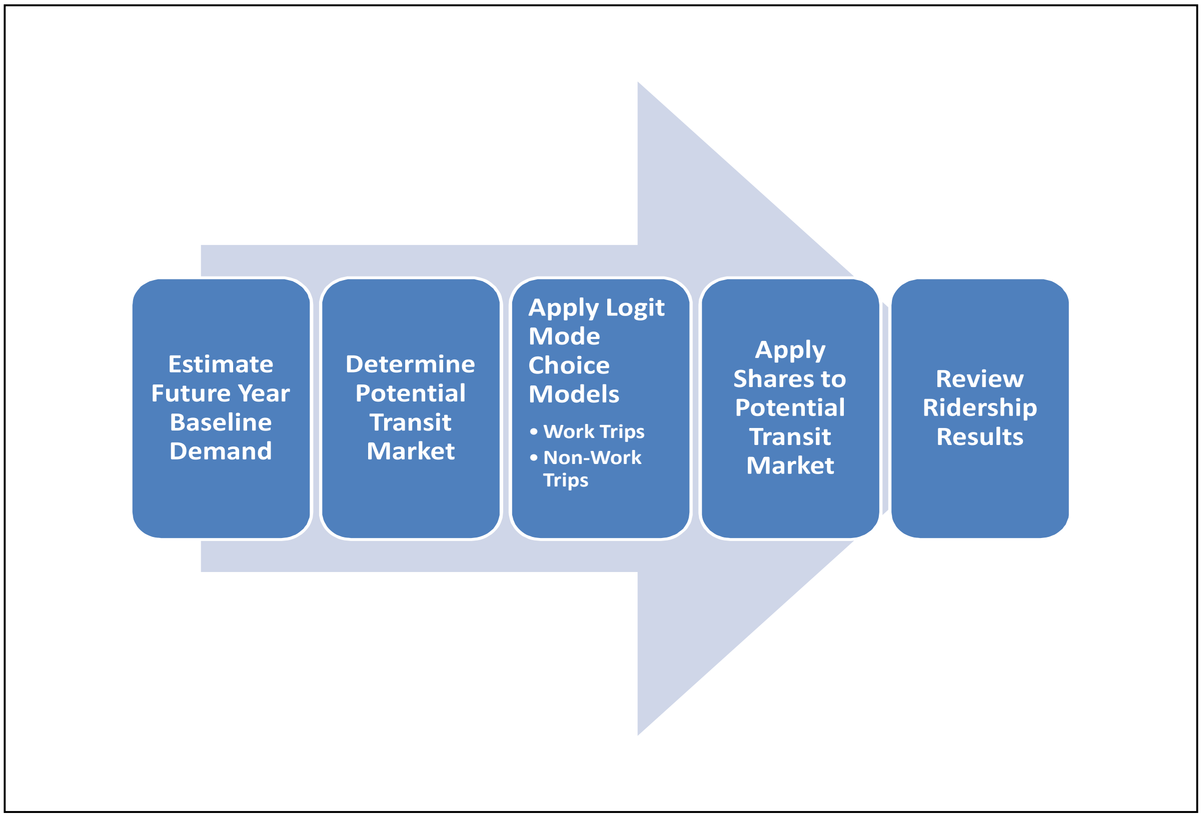
With the variations, there are a total of 13 alignment alternatives, which are carried forward into the evaluation of system alternatives in Chapter 6.

5. PASSENGER AND FREIGHT FORECASTS

5.1 Passenger Forecasts

This section discusses the assumptions, mode choice methodology, and preliminary results for the proposed fixed guideway alternatives from San Bernardino to the Big Bear mountain communities. Figure 5.1 below shows the overall process used to develop ridership estimates for the project.

Figure 5.1 - Flow Chart of Ridership Estimation Process



5.1.1 Future Baseline Demand

In order to estimate potential ridership that might be attracted to any proposed transit service between San Bernardino and the Big Bear Valley, an estimate of future year baseline demand is required. The first question is "how many persons are forecast to travel between the two areas?" The second question is "what percent of the total demand would represent a potential market for the proposed fixed guideway." Based on the available observed data, the study team used the following methodology to define the potential transit market for the system.

Seasonal traffic counts collected on SR-18, SR-18 East, SR-38, and SR-330 were converted to person demand using the observed average auto occupancies (AAO). The weekday AAO was between 1.27 - 1.55 and 1.80 - 1.96 on the weekend. For this analysis, a midpoint was selected for the average weekday and peak weekend condition.

Once the study team converted traffic counts into person demand using the AAO, growth factors were applied to the baseline demand in order to get an estimate of 2035 total demand. These growth factors were estimated by looking at the compounded annual average growth on the major facilities between the base year and future year SCAG and SANBAG travel demand models. While the SCAG Model showed an overall 60% increase, the SANBAG Model's 50% increase seemed more appropriate to the project team and subsequently was used for the forecasts.

The estimates in Tables 5.1 to 5.4 represent the total 2035 person demand between San Bernardino and the communities in the Big Bear Valley. Depending on the origin and destination of a trip, the traveler may or may not find a proposed transit investment an attractive option. For example, if a traveler began their trip in the Highland area and were destined to Angelus Oaks, they would not view the proposed system as competitive since none of the proposed stations would be remotely near the final destination of the traveler. Hence, only station locations that are relatively close to a person's final destination or origin would be included in the potential market. A feeder bus could make the system more attractive for travelers living further away from the station but as the distance increases, the potential demand would likely decrease.

Table 5.1 – 2035 Average Weekday Person Demand, Winter

Facility	2010 Average Weekday Count	Average Auto Occupancy	Average Weekday Person Demand	2035 Future Year Growth Percentage	2035 Weekday Person Demand
SR-18	17,507	1.33	23,284	35%	31,350
SR-38	3,004	1.33	3,995	91%	7,640
SR-330	7,446	1.33	9,903	58%	15,696
SR-18 East	2,271	1.33	3,020	45%	4,373
Total	30,228		40,203		59,059
w/o SR-18 E					54,686

Table 5.2 – 2035 Peak Weekend Person Demand, Winter

Facility	2010 Peak Weekend Count	Average Auto Occupancy	Peak Weekend Person Demand	2035 Future Year Growth Percentage	2035 Peak Weekend Person Demand
SR-18	21,521	1.88	40,459	35%	54,475
SR-38	6,407	1.88	12,045	91%	23,034
SR-330	15,276	1.88	28,719	58%	45,516
SR-18 East	3,132	1.88	5,888	45%	8,524
Total	46,336		87,112		131,550
w/o SR-18 E					123,026

Table 5.3 – 2035 Weekday Person Demand, Summer

Facility	2010 Average Weekday Count	Average Auto Occupancy	Average Weekday Person Demand	2035 Future Year Growth Percentage	2035 Weekday Person Demand
SR-18	14,685	1.33	19,531	35%	26,297
SR-38	2,163	1.33	2,877	91%	5,501
SR-330	8,203	1.33	10,910	58%	17,291
SR-18 East	2,647	1.33	3,521	45%	5,097
Total	27,698		36,838		54,186
w/o SR-18 E					49,090

Table 5.4 – 2035 Peak Weekend Person Demand, Summer

Facility	2010 Peak Weekend Count	Average Auto Occupancy	Peak Weekend Person Demand	2035 Future Year Growth Percentage	2035 Peak Weekend Person Demand
SR-18	16,535	1.88	31,086	35%	41,854
SR-38	4,276	1.88	8,039	91%	15,373
SR-330	11,296	1.88	21,236	58%	33,658
SR-18 East	3,979	1.88	7,481	45%	10,829
Total	36,086		67,842		101,715
w/o SR-18 E					90,885

5.1.2 Potential Transit Market

The potential market for transit was estimated by looking at the likely origin and destination for traffic using the various facilities. These person trips are subset of the total future year baseline demand and have trip ends in the same locations as the proposed stations.

- SR-18: travelers approaching from San Bernardino would be primarily traveling to Crestline, Lake Arrowhead, or Running Springs rather than Big Bear. This is confirmed from the ADT which shows 18,500 east of Crestline, 12,700 east of Lake Arrowhead, and 8,500 vehicles west of Running Springs. Using the relative size of the population of the major cities along SR-18, it seemed reasonable to conclude that no more than 25% of the travel demand would be originating/destined for the Big Bear area. If people drive up from San Bernardino, they will find using SR-38 or SR-330 is a much more direct route.

- SR-38: travelers using SR-38 from Redlands into Big Bear City would almost certainly be traveling to the Big Bear area. 85% of the SR-38 was included in the potential transit market.

- SR-330: the San Bernardino Model showed most of the demand using SR-330 either heading to Running Springs or Big Bear. 100% was included in the potential transit market.

- SR-18 East: the study team removed this demand from the potential transit market as the "backside" access to Big Bear would not see any fixed guideway option as a competitive option.

Tables 5.5 through 5.8 show the potential transit market that was used for the mode choice analysis.

Table 5.5 – 2035 Average Weekday Potential Transit Market, Winter

Facility	2035 Weekday Person Demand	Potential Transit Market	2035 Average Weekday Potential Transit Market
SR-18	31,350	0.25	7,838
SR-38	7,640	0.85	6,494
SR-330	15,696	1.00	15,696
Total	54,686		30,027

Table 5.6 – 2035 Peak Weekend Potential Transit Market, Winter

Facility	2035 Peak Weekend Person Demand	Potential Transit Market	2035 Peak Weekend Potential Transit Market
SR-18	54,475	0.25	13,619
SR-38	23,034	0.85	19,579
SR-330	45,516	1.00	45,516
Total	123,026		78,715

Table 5.7 – 2035 Average Weekday Potential Transit Market, Summer

Facility	2035 Weekday Person Demand	Potential Transit Market	2035 Average Weekday Potential Transit Market
SR-18	26,297	0.25	6,574
SR-38	5,501	0.85	4,676
SR-330	17,291	1.00	17,291
Total	49,090		28,542

Table 5.8 – 2035 Peak Weekend Potential Transit Market, Summer

Facility	2035 Peak Weekend Person Demand	Potential Transit Market	2035 Peak Weekend Potential Transit Market
SR-18	41,854	0.25	10,464
SR-38	15,373	0.85	13,067
SR-330	33,658	1.00	33,658
Total	90,885		57,188

5.1.3 Mode Choice Methodology

5.1.3.1 Background

A logit choice model compares the utility of the available modes and estimates the likelihood of a traveler choosing a particular mode given the utilities of the other choices. The economic concept of utility is used here to describe the travel characteristics associated with a mode such as:

- attributes of the mode (e.g., travel time)
- attributes of the traveler (e.g., auto ownership, income)
- attributes of the environment (e.g., population density)

For example, a trip made via automobile or transit can be broken down into many component parts. Time spent outside of a vehicle such as waiting for a bus or walking from a parking lot to one's final destination can be categorized as out-of-vehicle travel time (OVTT). Time spent in an auto or on the bus is referred to as in-vehicle travel time (IVTT). Costs associated with travel such as fares or parking costs are often included in a mode's utility expression. Each of these components of a trip have coefficients associated with them. These coefficients represent the impact of the variable on the utility of the alternative. The magnitude and sign indicate the relative importance of the variable.

5.1.3.2 Methodology

The study team developed ridership forecasts by applying several logit mode choice models. For work trips, "typical" coefficient values one might find in a model developed for an urban area were applied. For non-work trips, the study team performed a literature search to identify appropriate models for the Big Bear travel market. With the focus on outdoor recreation during the summer and winter, the study team was interested in models developed for recreational travel with similar temporal characteristics. There were two recent models that showed promise. One model was developed for the I-70 Interstate corridor for resident/tourist market between Denver and the major resorts in the area. The second model was developed for the Lake Tahoe resort area.

5.1.3.3 Work Trips

Based on aggregate summary of trips between San Bernardino and Big Bear Valley from the SANBAG travel demand model, about 40% of the total daily trips are home-based work (HBW) or work trips that have one leg of trip at home and the other at work. The balance of the trips were assumed to be non-work. Therefore, the study team used the work mode choice model for 40% of the potential transit market totals on weekdays. On weekends, 20% of all trips was assumed to be for work. This is based on research conducted for weekend travel models suggesting that weekend trip rates for work are about half the average weekday rates (*citation needed*).

5.1.3.4 Non-Work Trips

I-70 PEIS Mode Choice Model: The first mode choice model that was considered for the non-work trips for Big Bear was the I-70 PEIS Mode Choice Model. In early 2000, the Colorado Department of Transportation (CDOT) selected a consultant to study transportation alternatives between Denver and the mountain resorts along I-70 west. This corridor is infamous for persistent, severe congestion on the weekends in both the winter and summer seasons. As part of the PE/EIS effort, a significant model development effort was conducted including the collection of stated preference (SP) survey data for mode choice model calibration.

In some ways, the I-70 corridor may seem like a different market when compared to Big Bear corridor. Many of destinations along the I-70 corridor are much larger in scale and regularly attract tourists from across the US. There are, however, numerous similarities. The purpose of the I-70 SP survey was to examine the likelihood of a traveler using a proposed fixed guideway given different assumptions about travel times, costs, reliability, etc. So, while the *scale* of Big Bear Mountain is different compared to these larger resorts in Colorado, the factors that people weigh when making travel choices are the same. Also, the primary trip purposes are similar, i.e. travel between the urbanized area and the resort area. Issues such as cost, travel time among competing modes, and convenience are considerations for travelers in any market.

For the I-70 PEIS, 10 mode choice models were estimated from the SP survey. A binary logit formulation was used for a 10 trip purposes. Of those 10, the most appropriate for the Big Bear market is the “corridor day recreation” trip purpose. The mode constants for rail and monorail/maglev suggest that using these models will probably result in higher ridership forecasts. While it was not the study team’s intent to inflate the ridership forecasts, the study team believed using a typical urban mode choice models would not show the unknown benefits which supporters generally speak of.

Lake Tahoe Visitor Mode Choice Model: In the past few years, new activity-based models (ABM) were developed for the Tahoe Regional Planning Agency. This project included the development of a visitor mode choice model. While there is no gaming in the Big Bear Valley, there is strong travel demand on the weekends during the summer and winter seasons for outdoor recreation. One issue which may limit the model’s utility is that the visitor choice model was estimated for visitor travel around the Lake Tahoe area and not the long haul market from San Francisco/Sacramento to Lake Tahoe. On the other hand, this model may provide the study team an example of how travelers respond to transit service for intra-mountain travel.

The alternative specific constants (ASC) which are used to account for unobserved or unmeasured factors show that the values for Drive and Non-Motorized for Seasonal visitors are positive. This may suggest that Seasonal visitors visit on a regularly and are familiar enough with the area to favor Driving or Walking/Biking. The ASC values for Winter and Summer, Non-seasonal visitors shows the Drive to Transit mode with the largest value (least negative). This would suggest non-regular visitors in both winter and summer find transit (via park-n-ride) attractive when compared to other modes. Intuitively, this sounds reasonable given that non-regular visitors would be less familiar with the roads and travel options. Hence, this market might be more inclined to use transit in/around Lake Tahoe.

Both models use a logit mathematical function to estimate the probability of a traveler using the available modes. Detailed information, such as transit fares, travel time by auto and transit, fuel costs per mile, were input into the models to estimate the potential shares. Once the models computed the shares, the study team reviewed them against shares observed in other markets and projects. While the hope was that the models would provide reasonable results, this expectation was tempered by the fact that both models were developed for their own unique markets.

5.1.4 Vetting the Results

An essential part of the study involved the careful review of the mode shares estimated from the models. Mode choice models developed for urban areas provided some benchmarks targets. Mode shares for work trips from the SCAG 2003 Regional Travel Demand Model range from 2% in San Bernardino County to as high as 6% for Los Angeles (LA) County. The higher shares in LA County are attributable to a number of factors such as transit alternatives that are competitive in terms of travel time to auto, multiple route options, and an expansive fixed-guideway network that includes commuter rail transit, light rail transit, and bus rapid transit, and bus.

While regional transit shares in San Bernardino are lower than LA County, this fact is probably attributable to fewer transit alternatives that may not be competitive with respect to travel times. The existing bus service up/down the mountain, for example, carries few people. But it must be emphasized, it takes almost twice as long as a trip made by auto.

Transit service, like the one proposed in this Study, would likely attract new transit riders so using shares observed on existing services would be extremely conservative. The market between San Bernardino and the Big Bear corridor is also different when compared to urban markets. It is a longer distance corridor with winding, mountainous roads that often experiences closure due to adverse weather related conditions. Bundled with heavy travel demand, a transit service with competitive or faster travel time is likely to attract more riders than observed on existing services.

Finally, there are features unique to rail that even the Federal Transit Administration (FTA) recognizes this mode as something different from conventional buses. In the Section 5309 New Starts program which provides capital funds for new rail projects, the FTA permits rail constants in mode choice models to provide up to 15 minutes of travel time benefit when compared to the bus mode. Whether it is the amenities, the smoothness of the ride, the known location of stations, or the consistent travel times, fixed-guideway does seem to have some ineffable quality that is able to attract new transit riders.

5.1.4.1 Ridership Forecasts

Ridership for the alternative systems (Aerial and Cog Rail) was estimated by applying the transit mode shares to the potential transit demand market. The study team applied the various mode choice models in order to see the range of possible shares that transit might be expected to attract. When the models

were applied with the necessary inputs such as travel time, travel cost, fares, and etc., the share fell within the range of -2 to 6% for work trips and 6 to 9% for non-work. When the congested travel times were tested, the transit shares jumped up to 10 -17% for work trips and 15 - 23% for non-work trips. While this is a considerable increase, it must be emphasized that the Aerial's 78 minute travel time is approximately 100 minutes less than the congested auto time. While road conditions like this do not happen on a weekly basis, they do happen with enough regularity during the winter. Most travelers will gladly consider transportation alternatives that can save 100 minutes on a one-way trip.
Two markets not included in these estimates are intra-city and intra-mountain travel demand. Certainly, there are and will be trips made between the proposed fixed guideway stations located at the San Bernardino Metrolink station, San Bernardino Airport, and Highland. Similarly, intra-mountain travel demand could potentially be a significant market.

5.1.4.2 Aerial Option

For an average weekday, the mode choice models suggest that the Aerial mode can capture 3 to 6% of the work trips and 7 to 9% transit share of the non-work trips. This would represent roughly 1,600 to 2,300 riders during an average weekday in the winter. If the intra-San Bernardino and intra-mountain demand are accounted for, average weekday ridership could rise up between 2,050 – 2,750 riders. Although intra-market demand is a difficult value to estimate, a coarse effort was made in this analysis. Using values from the SCAG regional model, total intra-mountain demand for 2035 is forecast to be 15,000 person trips between the Big Bear and Running Springs/Snow Valley zones. Applying a 3% share, intra-mountain transit demand would be roughly 450 riders.

Average weekday ridership during the summer would be less due to the smaller potential transit market figure. Ridership was estimated between 1,500 and 2,200. When intra-mountain demand is included, this figure would increase to 1,950 to 2,650.

During a peak weekend day, ridership on the Aerial option could be in the range of 4,900 to 6,600 riders. This estimate assumes the same mode share assumptions, but it is applied to the peak weekend demand estimate. When the intra-mountain demand is included, the ridership estimate would increase between 5,350 to 7,000 riders.

Ridership would be highest during a roadway closure, adverse weather conditions, or severe congestion. This scenario would most likely occur on a weekend during the winter. When congested travel times were used in the model, transit mode shares jumped in the range of 14 -17% for work trips and 19 to 23% for non-work. When applied to the average weekday, ridership would increase to a range of 4,800 to 6,200 riders. During the peak weekend, it increases to 14,200 to 17,200 riders.
To determine if this was a reasonable, the study team compared the travel times for the various scenarios. An auto trip under normal traffic or free-flow conditions from the San Bernardino Metrolink Station to the Big Bear China Garden Station would take 76 minutes. Under extremely congested or weather affected conditions, auto travel time could increase as high as 174 minutes. The same trip made via the Aerial would take 77 minutes. Assuming a 100 minutes could be saved by taking Aerial, the doubling or tripling of the mode share would not be out of the realm of possibility.

5.1.4.3 Cog Rail Option

The COG Rail option with its slower travel time shows a similar mode share when compared to the Aerial. Based on the results from the choice model, mode shares were in the range of 2 to 5% for work trips and 6 to 8% for non-work. When applied to summer potential transit demand ridership would be in the ranges of 1,250 to 1,950 riders. Adding the potential intra-mountain demand would bump up ridership to 1,700 to 2,400 riders.

In winter, the average weekday ridership would increase to 1,300 to 2,000 riders. When intra-mountain demand is included, ridership would increase to 1,750 to 2,450 riders.

During a peak weekend day in summer, ridership on the COG Rail would be in the range of 3,000 to 4,200 riders. This estimate assumes the same 6 to 8% mode share, but applied to the peak weekend demand estimate. When intra-mountain demand is included, ridership would increase to 3,450 to 4,650.

Like the Aerial, Cog Rail would capture a much higher share during those severe weather days in the winter. The mode share would increase to 10 to 13% of work trips and 15 to 19% of non-work trips. Ridership could potentially be in the range of 11,000 to 14,000 riders during winter. At 97 minutes between the two station termini, the Cog Rail is almost 19 minutes slower than the Aerial, but significantly quicker than the congested auto travel time of 174 minutes between the two termini. Table 5.9 below provides a summary of the assumptions and results of the ridership estimates.

Table 5.9 – Summary of 2035 Assumptions and Forecast

	Aerial	COG Rail
Transit fare (maximum)	$15 one-way	$15 one-way
Service frequency	30 minutes peak	60 minutes peak
Auto operating costs	$0.15 per mile	$0.15 per mile
In-vehicle transit travel time (San Bernardino Metrolink Station to China Gardens Big Bear Station	77 minutes	97 minutes
Free-flow in-vehicle auto travel time between the San Bernardino Metrolink Station and China Gardens Big Bear Station	78 minutes	76 minutes
Congested in-vehicle auto travel time between the San Bernardino Metrolink Station and China Gardens Big Bear Station	174 minutes	174 minutes
Mode share (free-flow conditions)	3 - 6% work 6 – 9% non-work	2 – 5% work 6 – 8% non-work
Average weekday ridership, winter	1,600 – 2,300	1,300 – 2,000
Peak weekend ridership, winter	4,900 – 6,600	4,000 – 5,700
Average weekday ridership, summer	1,500 – 2,200	1,100 – 1,600
Peak weekend ridership, summer	3,500 – 4,800	2,500 – 3,600
Annualized ridership, winter	483,200 – 694,600	392,600 – 604,000
Annualized ridership, summer	453,000 – 664,500	377,500 – 588,900
Mode share (severe congestion)	14 - 17% work 19 – 23% non-work	10 - 13% work 15 - 19% non-work
Average weekday ridership, winter (congested)	4,800 – 6,200	3,900 – 5,000
Peak weekend ridership, winter (congested)	14,200 – 17,200	11,000 – 14,000
Average weekday ridership, summer (congested)	4,800 – 5,900	3,700 – 4,700
Peak weekend ridership, summer (congested)	10,300 – 12,500	8,000 – 10,200

5.1.4.4 Comparison to 1996 Study

The 1996 Study used the manual mode choice methodology from the National Cooperative Highway Research Program Report (NCHRP) 187 – *Quick Response Urban Travel Estimation Techniques and Transferable Parameters.* The model uses the airplane travel distance for auto and transit, auto parking costs, transit fare, and average auto operating speed to estimate impedances for the two modes. With both impedances, the transit share is estimated by looking up the values on a diversion curve or nomograph (two-dimensional diagram).

Using the method from the NCRHP 187 Report, the 1996 Study estimated the transit share at 20%. Based on the logit choice models used in this study, the potential transit share would be in the range of 2 to 10% of the potential transit market. Only with extremely congested auto travel times do the mode choice models show shares increasing to over 20%. Although an effort was made to review the detailed assumptions used in the 1996 Report, much of the data inputs were not well documented and therefore, a critical comparison of the forecasts cannot be made.

While the NCHRP 187 Report was a good tool for planners back in the mid-1970s, there has been considerable progress made in the field of choice modeling. The subject area of discrete choice has been borrowed from market research analysis and the incorporated into mode choice models. Transportation planning professionals now use logit models as the standard tools to estimate ridership on proposed transit investments.

5.2 Freight Forecasts

This section addresses the potential markets for goods movement using an alternative mode of transportation between the San Bernardino Valley and the mountain communities of Big Bear and Running Springs. A methodology for estimating freight volumes on the new system was developed, considering the special nature of the proposed fixed guideway technologies and potential markets in the mountain community.

For most freight systems, the primary market is substantial in nature, gauged by either by the distance moved or the volume transported. Typical markets for freight are ports, intermodal rail yards, warehouses, manufacturing facilities, big box retailers, etc. No large facilities of these types exist in the mountain area. The potential markets for a cargo transport service in the Big Bear Corridor are very diverse, both economically and geographically. The cargo transported up the mountain supports businesses, resorts and households.

Another consideration is that freight and passengers would have to share the new fixed guideway. Due to safety concerns freight lines don't serve passenger transport without substantial safety guidelines and temporal (time of day) separation.

The other factors that are used to assess the future demand for an alternative mode of transportation are the time and cost of that service in relation to other transportation options.

The typical assessment of the future demand for a new proposed service in a corridor would identify a similar service somewhere else in the country, borrow the model used to estimate demand in that corridor, and apply that model to the new proposed service in the corridor. However, no similar corridor could be identified. Due to the special nature of the fixed guideway technologies proposed for the Big

Bear Corridor, a unique approach was warranted to estimate the future freight demand. This approach comprises:

- estimating future cargo demand in the corridor;
- identifying classes of cargo that could be considered compatible with the proposed technology;
- estimating a portion of the compatible goods that would use the alternative mode, assuming cost-competitive rates.

The forecasting methodology and results reported in this document reflect an assessment of a reasonable range of estimates quantified for each variable analyzed. A reasonable, conservative estimate was chosen for each variable, to be carried forward through the calculations of the combined effects of all variables, to achieve a forecast of the future cargo demand on the alternative modes in the corridor. The analysis also includes an estimate of the level of certainty for each of the variables which are used to quantify the sensitivity of the forecasts to different variables analyzed in this document.

5.2.1 Future Baseline Demands

The future travel demand for the movement of goods, as well as of people, is estimated by taking the existing demand and using socioeconomic growth forecasts to extrapolate the demand to a future year. The following analysis will provide an estimate of the size of the future market for goods movement in the corridor.

<u>Existing Truck Traffic:</u> The existing conditions and baseline forecasts are based on traffic counts conducted in April, 2009. These traffic counts identified 2,200 weekly heavy truck (three or more axles) trips up and down the mountain to the Lake Arrowhead and Big Bear regions, and an additional 14,200 weekly light trucks (two axles). These traffic counts were compared to data published by Caltrans to confirm the quantity of heavy vehicle traffic in the mountain region to a relatively high degree of certainty (+/- 10%).

<u>Existing Cargo Demand:</u> The average cargo loads on trucks in the mountain region were not measured in this study. Existing nationwide data sources (2002 VIUS dataset) suggest that a typical 2-axle truck carries an average load of 1.34 tons, a typical 3-axle truck carries an average load of 13.18 tons, and a typical 4-axle truck carries an average load of 15.50 tons. The analysis of the Big Bear mountain area assumes that, because of the many curves and steep grades, trucks using the mountain roads would carry lighter loads than the national average (which is more applicable to travel on interstate highways). We assume typical cargo weights by different truck classes ranging from 1 ton for 2-axle trucks to 10 tons for 3- and 4-axle trucks. After accounting for empty trucks (19% of trucks observed) and trucks accessing the mountain area from the north (and therefore incompatible with the potential corridor), we estimate that the trucks serving the mountain areas carry approximately 32,000 tons of cargo into and out of the region per week.
Due to the lack of local data, we rate the uncertainty of the average truck load at a relatively low degree of certainty (+/- 25%).

<u>Geographic Distribution of Goods Movement:</u> Based on the distribution of truck traffic observed in the SCAG heavy duty truck model we estimate that 40% of the mountain cargo traffic travels between the San Bernardino Valley and planned station locations along the proposed fixed guideway alignment. Therefore, approximately 13,000 tons of cargo per week is hauled up and down the mountain weekly through the Big Bear Corridor. The majority of this cargo (10,800 tons) is associated with origins and

destinations in the Big Bear area and the remaining cargo (2,200 tons) is associated with stations in the Running Springs area.

The estimated truck distribution in the SCAG heavy duty truck model can be validated by a comparison of the observed truck volumes to the truck volumes assigned to the SCAG traffic network. This comparison suggests that the distribution of truck trips to the different areas of the Big Bear Corridor is estimated to a relatively high degree of certainty (+/- 10%).

Compatible Cargo: After accounting for incompatible cargo (36% of cargo identified), we estimate that approximately 8,400 tons of cargo per week could be compatible with one or both of the fixed guideway technologies. The categories of compatible cargo include parcels, food, beverage, various household products and waste material.

Due to the relatively small number of observations of trucks serving the mountain region, we rate the uncertainty of the percentage of compatible cargo loads at a moderate level of uncertainty (+/- 20%).

Socioeconomic Growth: Available sources of future growth forecasts in the mountain areas show a high level of uncertainty. Recent forecasts in the SCAG Regional Transportation Plan have assumed annual household and employment growth rates ranging between 1.6% and 3.7%, with an average of 2.45% for the extended Big Bear Lake region. When compounded from 2009 to the year 2035, a 2.45% growth rates suggest that the travel demand for goods could increase by over 80%. However, more recent forecasts by the City of Big Bear Lake assume that future growth in the corridor will be much more modest, approximately 1% per year. For the purposes of this analysis we assume that the growth of demand for goods movement in the corridor will grow at 1% per year. Compounding annually from 2009 to the year 2035 implies an overall growth of about 30%. The uncertainty of this variable's impact on the future demand is rated at a moderate level of uncertainty (+/- 15%).

Future Demand: Based on forecast population and employment growth, the potential market of compatible goods is expected to increase from 8,400 tons of cargo per week in 2009 to approximately 10,700 tons per week by the forecast year (2035) – 8,200 tons to and from the Big Bear area and 1,900 tons to and from the Running Springs area.

Potential Customers: Based on an informal survey of potential customers (e.g. supermarkets and parcel delivery) the consensus viewpoint is that if the alternative mode is priced at a competitive level, the business community will consider using it. Therefore it is clear that the cargo rate should be priced to be competitive with the cost of existing freight services in order to attract reasonable businesses to use the service.

Other significant considerations of potential clients include reliability of service, time sensitivity, compatibility and convenience of containers with alternative mode and loading and unloading procedures.

5.2.2 Mode Choice Methodology

Definition of Alternative Mode: It is clear that all potential customers for the goods movement market on the alternative guideway modes will make their decisions on a specific set of variables. Therefore, the exact definition of the goods moving system will require further analysis before a more precise estimate of the potential mode share can be estimated. Among the questions that need to be answered are:

- What classes of cargo will be accepted as compatible with the new mode?
- What will be the rate structure for cargo transportation?
- How will the cargo traffic be separated from passenger traffic - both physically and temporally?
- What types and volumes of containers will be available for transport, and will they be provided by the operator or by the customers?
- Which stations will be used for goods movement – all of the passenger carrying stations or a subset of these stations?
- What types of storage services will be available for cargo at stations?
- What type of delivery system will be available to move cargo from the station to the customers on the mountain and vice versa?

Mode Shares By Alternative Modes

Since answering these conditions is not possible given the scope of this feasibility study, we have made the following assumptions to bind our analysis:

- The baseline analysis has identified the approximate size and cost of the freight markets in the corridor;
- A cost structure can be defined to be competitive with the trucks serving the baseline freight market;
- That cost structure can be used to estimate the revenue potential of the freight market.

The mode choice methodology identifies a target range of shares given the data known about potential freight markets and the constraints inherent in each of the guideway alternatives.

Based on the adoption of a competitive pricing structure, as described above, we assume that at least half of the compatible cargo market will see some monetary value in the alternative mode. However, the wide variations of compatible cargo that could be served by the alternative modes will make it difficult to design a system that serves all potential markets equitably. Therefore, additional planning will be required to identify the cargo markets that are most compatible and most likely to generate cargo revenue for the alternative modes.

Also, we realize that the potential mode share for the cargo markets will vary by time of day, day of week, and season. We expect that that mode shares will peak during the periods of highest traffic congestion and during the winter months when the reliability of transportation on the alternative mode exceeds the reliability of the highway mode.

Since there is no comparable service in the US that can be used for comparison purposes, the most acceptable approach to identify the potential mode share for the proposed new mode of transportation is the *stated preference survey*. Such a survey would identify potential customers and interview them in order to determine their level of interest and what variables they would consider before changing their existing behavior.

For example, we would ask the following questions of potential customers who are observed carrying cargo in the study area:

- What are the origin and destination locations of your cargo trip?
- What are the type and amount (mass) of cargo that you are carrying on this trip?
- How often do you make this trip?
- Would you consider using a new mode of transportation that would allow you to drop that cargo at the bottom of the hill and retrieve the cargo at a distribution center in Big Bear (or Running Springs) for a rate of:

  $20 per ton;

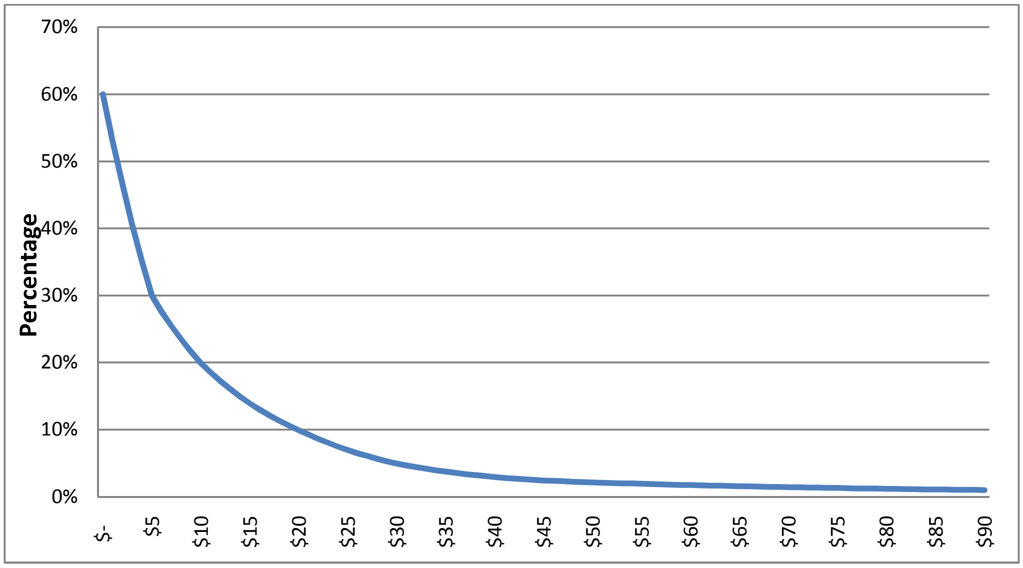
  $50 per ton;

  $100 per ton;
- Repeat the preceding question assuming the hypothetical range of travel times on the highway ranging from optimal (free-flow) to grid-lock conditions.

The stated preference survey could then be used to estimate an economic model, i.e. an equation that predicts the potential mode share as a function of the rate charged and the amount of travel time saved by the alternative mode.

Such a model will also be able to identify an optimal price range (rate) that can be used to maximize potential revenues. Stated simply, the potential revenue of the system is the product of the mode share (percent of cargo) times the cargo rate (dollars per ton). The left side of the model (as illustrated in the hypothetical example below) would quantify the mode share for nominal or free rates designed to maximize the mode share for the alternate mode. The maximum mode share at the zero rate (free) point would probably fall somewhere between 50 and 80%, due to the fact that some customers, for whatever reason, would never opt for the alternative mode. The right side of the model displays the effects of charging high rates designed to maximize unit profits. This model shows that, even with a high rate that is not competitive with the cost of transport by highway, some small share of the cargo traffic (less than 1%) will use the alternative mode due to the convenience or reliability considerations.

Figure 5.2 – Hypothetical Alternative Mode Freight Model



Without performing a stated preference survey it is impossible to estimate, with any level of certainty, the range of potential mode shares for the alternative mode. However, if we assume that the economic model for this project is similar to other economic models that estimate the willingness of potential consumers to pay for a potential product or service, we would assume that the mode share associated with the optimal price would fall somewhere in the range between 10 and 25%, depending on how steeply the demand curve drops on the left side of the model.

For the purposes of the following analysis of total market size and revenue potential, we will assume that the alternative mode will be designed to attract approximately 15% of the total compatible cargo volume to the alternative mode for hauling to and from the Big Bear area, and 10% of cargo to and from the Running Springs area. The higher mode share for the longer trips to Big Bear is based on the assumption that trips to Big Bear a subject to greater travel time savings than trips to Running Springs, and therefore subject to higher perception of user benefits for the system. Due to the lack of existing data sources, this variable has the highest level of uncertainty in our analysis, at approximately +/- 50%.

Freight Costs: Due to the wide variety of freight services in the mountain region, it is difficult to assess the typical cost of hauling freight to and from the service area. Preliminary data from port drayage companies in the region show typical freight costs in the vicinity of $0.25 per ton per mile for long-haul cargo traffic on heavy (40-foot) trucks operating on interstate highways (please note that this reflects the round-trip cost of hauling cargo in one direction). For shorter-haul trips such as the 40-mile distance between San Bernardino and Big Bear the average freight costs is in the range of $0.50 per ton per mile. Because of smaller truck loads and slower operating speeds that we would assume for goods movement in the mountain region, we estimate that heavy truck freight costs in the range of $0.80-1.00 per ton per mile, or a round-trip cost of $320-400 for a 10-ton shipment making the 40-mile trip between San Bernardino and Big Bear. This shipping cost is applicable to heavy trucks, which account for approximately 60% of the total cargo volume on the mountain.
The remaining 40% of cargo carried by light trucks is subject to higher unit shipping costs, because light trucks are generally more expensive than the more cost efficient heavy trucks (smaller trucks save some money on fuel and operating costs, but are subject to similar labor costs, which account for the greater share of the total operating cost). If we assume a round-trip cost of $240-320 for a 1-ton shipment

making the round trip between San Bernardino and Big Bear, that corresponds to a unit cost of $6.00-8.00 per ton per mile on smaller trucks. Based on these estimated shipping rates, and the observed mix of light and heavy trucks transporting cargo in the mountain region, we assume that the average freight shipping rate is approximately $3.40 per ton per mile, with a relatively low certainty rating (+/- 25%).

Rate Strategies: As described above, the range of effective trucking rates is very large, ranging from less than $1.00 per ton per mile for large trucks, to more than $6.00 per ton per mile for smaller trucks. For the purposes of the following analysis we will explore the potential impacts of two different rate strategies: a lower-rate strategy that is designed to be competitive with all cargo transport, including the large truck market; and a higher-rate strategy that is only designed to be competitive with markets that are currently served by small trucks.

For the lower-rate strategy we will assume that a competitive rate will be approximately $1.00 per ton per mile, or approximately $40 per ton for a shipment making the 40-mile haul from San Bernardino to stations in the Big Bear area, and approximately $16 per ton for the shorter haul to the Running Springs stations. For comparison purposes, this freight rate is approximately 20% of the unit rate anticipated for passengers on the alternative mode (assuming $20 one-way fare per passenger, and average weight of passenger plus baggage of 200 pounds).

For the higher-rate strategy we will assume that a competitive rate will be approximately $5.00 per ton per mile, or approximately $200 per ton for a shipment making the 40-mile haul from San Bernardino to stations in the Big Bear area, and approximately $80 per ton for the shorter haul to the Running Springs stations. For comparison purposes, this freight rate is approximately equal to the unit rate anticipated for passengers on the alternative mode.

5.2.2 Application and Results

Low-Rate Strategy Results: If we assume that a competitively priced system will compete with all trucks that currently serve the corridor, and will attain a 10-15% mode share of compatible cargo from all trucks to the new guideway mode, will carry approximately 1,500 tons of cargo per week in the future forecast year (2035).

High-Rate Strategy Results: If we assume that a competitively priced system will only compete with small trucks that currently serve the corridor, and will attain a 10-15% mode share of compatible cargo from small trucks (4-6% of all compatible cargo) to the new guideway mode, the proposed service will carry approximately 600 tons of cargo per week in the future forecast year (2035).

Summary of Assumptions and Uncertainty: The independent variables documented in this analysis are summarized below.

Table 5.10 –Assumptions and Uncertainty

Independent Variable	Assumed Value	Level of Certainty
Existing weekly heavy truck traffic to mountain region	2,200	+/- 10%
Existing weekly light truck traffic to mountain region	14,200	+/- 10%
Average truck load - heavy truck	10 tons	+/- 25%
Average truck load - light truck	1 ton	+/- 25%
Percentage of cargo on mountain destined to Big Bear	34%	+/- 10%
Percentage of cargo on mountain destined to Running Springs	7%	+/- 10%
Percent of cargo compatible with alternative modes	64%	+/- 20%
Population and employment growth through 2035	28%	+/- 15%
Mode share to Big Bear at optimal point	15%	+/- 50%
Mode share to Running Springs at optimal point	10%	+/- 50%
Average freight rate in study area	$3.40 per ton/mile	+/- 25%

In order to calculate the cumulative level of uncertainty for a combination of variables we would need to calculate the product of the range of uncertainty for the individual variables. For example, the range of certainty for the existing weekly heavy truck volume is from 0.90 to 1.10 (1.00 +/- 10%) and the range of certainty for the average heavy truck load is from 0.75 to 1.250 (1.00 +/- 25%), so the range of certainty for the amount of cargo carried by heavy trucks is 0.667 to 1.375 times the calculated value. By extension, the range of certainty for the total amount of cargo likely to be carried by the alternative mode in the year 2035 under the low rate strategy, which is estimated above at 1,500 tons of cargo per week, has a composite level of uncertainty of 0.21 to 3.13 times the calculated value, or between 310 and 4,700 tons of cargo per week.

5.2.3 Potential Revenue

Low-Rate Strategy Results: Based on the observed and estimated demand for compatible cargo being trucked up and down the mountain, distances to likely destinations, and the proposed shipping rates described above ($40 per ton between San Bernardino and Big Bear), the freight revenue potential of the alternative modes is estimated at $56,000 per week, or $2.9 million per year in the future forecast year (2035).

High-Rate Strategy Results: Based on the observed and estimated demand for compatible cargo being trucked up and down the mountain, distances to likely destinations, and the proposed shipping rates described above ($200 per ton between San Bernardino and Big Bear), the freight revenue potential of the alternative modes is estimated at $110,000 per week, or $5.75 million per year in the future forecast year (2035)

6. EVALUATION OF SYSTEM ALTERNATIVES

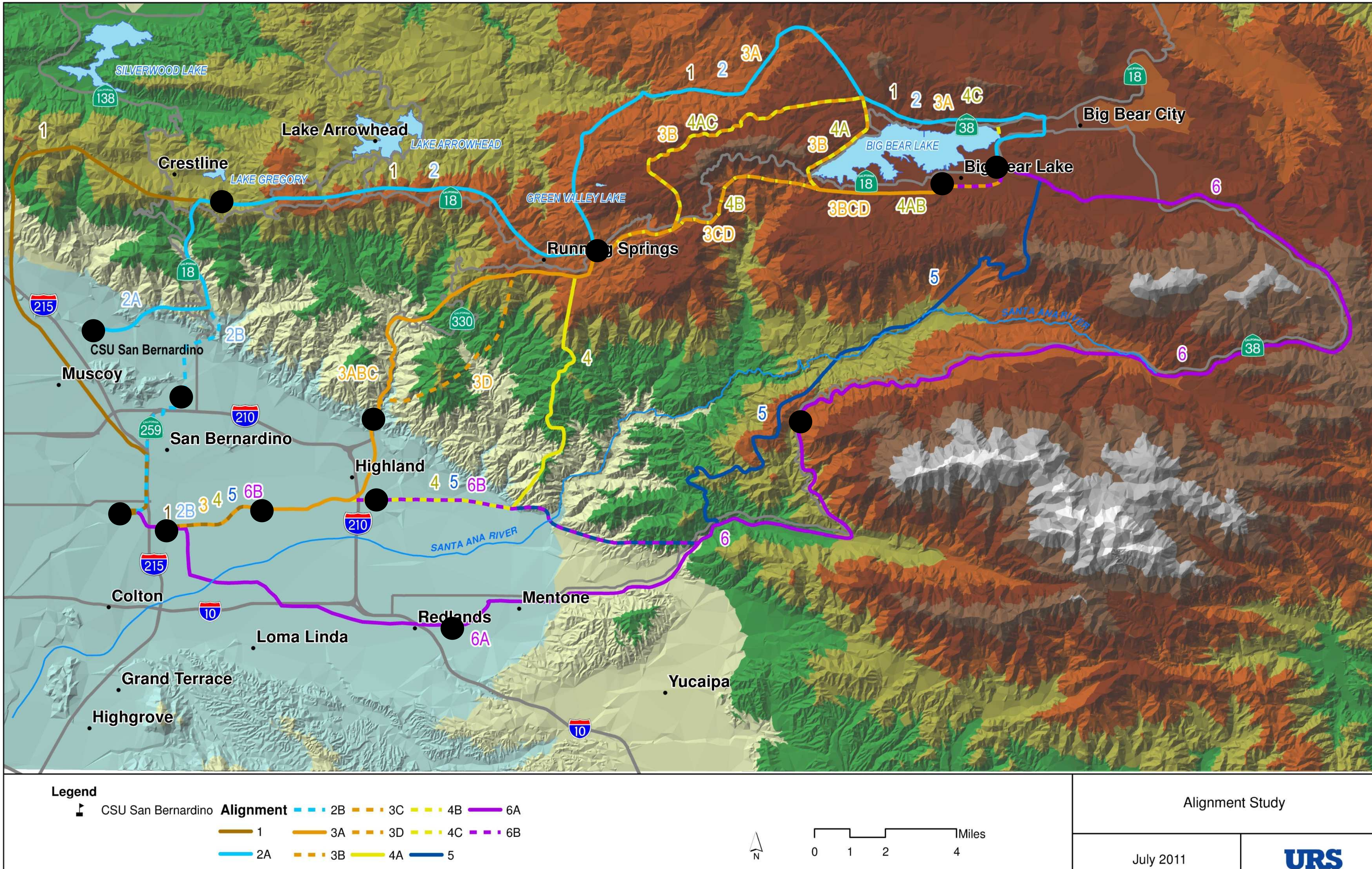
6.1 Description of System Alternatives

Previous chapters have evaluated alternative technologies and alignment options, and presented forecasts of potential usage (passengers and goods). This chapter builds on the preceding chapters and evaluates alternatives from a system perspective. For the purpose of this analysis, a system is a combination of technology, alignment, station locations, and operating characteristics. The following paragraphs describe the various components of the system alternatives to be studied.

Technology: As discussed in Chapter 3, the only existing (or reasonably foreseeable) technology that can traverse the corridor's terrain and length at competitive speeds is rail technology that is able to engage cog wheels to travel up and down slopes greater than 8%. This technology is therefore assumed for all system alternatives. A typical train is assumed to be comparable to the Stadler three-car train consist that accommodates 160 seated passengers.

Alignments: Chapter 4 identified six basic corridor alignment alternatives, with some optional routings for portions of several alternatives. Including the optional routings, a total of 13 alignment options were identified. All 13 alignment options are being carried forward into the evaluation of system alternatives, so there are a total of 13 system alternatives. The alignments are shown in Figure 6.1.

Figure 6.1 – Alignment Options Evaluated



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Station Locations: Each alternative has its western terminus in San Bernardino at either the Downtown Transportation Center (at "E" Street/Rialto Avenue) or at San Bernardino International Airport, depending on the alignment followed. (Alternative 2A, which terminates at Cal State San Bernardino, is the only exception to this rule.) Each alternative also has two stations in Big Bear Lake – China Gardens and the Village – and the eastern terminus of each alternative is at one of these two stations, depending on the alignment followed. Intermediate stations vary according to the alignment followed, and can include Crestline/Lake Arrowhead, Running Springs, Snow Valley, Highland, East Highland, Redlands, and Angelus Oaks. Alternative 6A would operate as part of the planned Redlands Rail extension, and would stop at each of the five planned stations between downtown San Bernardino and Redlands. Table 6.1 summarizes the key elements of each system alternative. General station locations are shown above in Figure 6.1. (Specific potential station locations have not been identified as part of this analysis.)

Table 6.1 – System Alternatives

Alternative	Corridor	Route	Alignment Length (mi)	Stations
1	Devore		57	• San Bernardino Intl Airport • SB Metrolink Depot • Crestline • Running Springs • Big Bear China Garden • Big Bear Village
2A	Waterman	to CSUSB	42	• CSU San Bernardino • Crestline • Running Springs • Big Bear China Garden • Big Bear Village
2B	Waterman	to SR-210	51	• San Bernardino Intl Airport • SB Metrolink Depot • E St./Marshall Bl. (SR-210) • Crestline • Running Springs • Big Bear China Garden • Big Bear Village
3A	Highland/ SR-330	Via City Creek, 2W03, Division	41	• Downtown SB (E St./ Rialto) • San Bernardino Intl Airport • Highland (330) • Running Springs • Big Bear China Garden • Big Bear Village
3B	Highland/ SR-330	Via City Creek, 2N13, BB Dam	39	• Downtown SB (E St./Rialto) • San Bernardino Intl Airport • Highland (330) • Running Springs • Snow Valley • Big Bear Village • Big Bear China Garden
3C	Highland/ SR-330	Via City Creek, Arctic Circle	31	• Downtown SB (E St./Rialto) • San Bernardino Intl Airport • Highland (330) • Running Springs • Snow Valley • Big Bear Village • Big Bear China Garden
3D	Highland/ SR-330	Via Plunge Creek, Arctic Circle	30	• Downtown SB (E St./Rialto) • San Bernardino Intl Airport • Highland (330) • Running Springs • Snow Valley • Big Bear Village • Big Bear China Garden
4A	East Highland	Via 2N13, BB Dam	40	• Downtown SB (E St./Rialto) • San Bernardino Intl Airport • Highland (Greenspot) • Running Springs • Snow Valley • Big Bear Village • Big Bear China Garden
4B	East Highland	Via Arctic Circle	32	• Downtown SB (E St./Rialto) • San Bernardino Intl Airport • Highland (Greenspot) • Running Springs • Snow Valley • Big Bear Village • Big Bear China Garden

4C	East Highland	Via 2N13, Division	39	• Downtown SB (E St./Rialto) • San Bernardino Intl Airport • Highland (Greenspot) • Running Springs	• Snow Valley • Big Bear China Garden • Big Bear Village
5	Radford Camp Rd.		37	• Downtown SB (E St./Rialto) • San Bernardino Intl Airport • Highland (Greenspot)	• Big Bear China Garden • Big Bear Village
6A	SR-38	Via Redlands	58	• Downtown SB (E St./Rialto) • Intermediate stops on Redlands rail • Redlands	• Angelus Oaks • Big Bear China Garden • Big Bear Village
6B	SR-38	Via East Highland	54	• Downtown SB (E St./Rialto) • San Bernardino Intl Airport • Highland (Greenspot)	• Angelus Oaks • Big Bear China Garden • Big Bear Village

Operations: For the sake of consistency and comparability, the system operating characteristics were assumed to be the same for all 13 alternatives. Assumed hours of operation were 5 a.m. to 11 p.m. seven days per week. Headways were selected to accommodate peak loadings at various times, assuming a seated capacity of 160 people per train. The following headways were applied:

Table 6.2 – Headway Assumptions

	Weekday headways	Weekend/Holiday headways
Base	60 min.	60 min.
Midday	60 min.	30 min.
Peak	30 min.	20 min.

Goods movement was assumed to be handled in a separate freight car that would be included in the passenger-carrying trains (i.e., operating cost estimates do not assume additional train trips for carrying only freight.) Freight operations would likely occur during off-peak hours so that passenger service operates at peak efficiency during peak periods.

A system of shuttle buses is assumed for collection and distribution of passengers in the mountain areas. Schedules of these buses would be timed to meet each train, and the shuttles would be operated in route deviation mode to provide more convenient service than fixed-route service while maintaining an efficient schedule tied to train arrivals and departures.

6.2 Criteria and Methods for Evaluating Alternative Systems

The screening of initial corridor alignment alternatives in Chapter 4 applied 21 different evaluation criteria. Several of the criteria yielded very similar results for all the alignments, so for the systems evaluation the criteria were selected to focus the analysis on key factors that differentiate the alternatives from one another in ways that could affect the feasibility of the system.

The following table presents the evaluation criteria, measures, and methods applied in the analysis of alternative systems.

Table 6.3 – Evaluation Criteria and Methods

Criteria	Measures	Methods
Capital Costs	Initial capital costs for construction, vehicles, maintenance facilities, right-of-way, and environmental mitigation (2011 dollars)	• Develop typical unit cost factor(s) for capital costs based on similar existing systems. Apply the unit costs to the system parameters (corridor length, vehicle fleets)
Operating Costs	Annual operating costs for rail operations and access/distribution system (2011 dollars)	• Develop typical unit costs for operations (rail and shuttle bus) based on similar existing systems. Apply the unit costs to the system parameters (annual hours of operations for rail and bus distribution)
Steep Slopes	Portion of corridor over which cog rail operation would be required (miles)	• Each corridor will be divided into 2,500-foot (or roughly ½-mile) segments, and the slope of each segment will be calculated by overlaying the corridor alignment on a topographic map. From these segment data, the total length of segments that will require cog rail operations (slopes > 8%) will be estimated
Communities Served	Number of stations, and communities served	• Number of stations along corridor (for the corridor that follows the Redlands Rail line, intermediate stations between Redlands and downtown San Bernardino will not be included) • List of communities with a station
Travel Time	Terminus-to-terminus travel time, including dwell time at intermediate stations.	• Calculate the end-to-end travel time for each corridor based on typical operating speeds along segments with adhesion (non-cog) operation, along segments with cog operation, and including intermediate station dwell times

Criteria	Measure	Method
Ridership	Estimate of annual ridership in 2035	• Use the Cambridge Systematics "Middle" annual passenger forecast as the estimate for original alignments 3, 4, and 5 (System Alternatives 3C, 3D, and 4B). For other system alternatives, apply the InfraConsult quick-response forecasting model with comparable assumptions to determine the relative difference in annual ridership.
Ridership Revenue	Estimated annual revenue from passengers in 2035 (2011 dollars)	• Calculate annual revenue using the annual passenger ridership estimate and the passenger fare levels assumed in the Cambridge Systematics passenger forecasts
Amount of Goods Movement	Estimate of annual tonnage and value of goods movement carried by the system in 2035	• Use the Cambridge Systematics estimate of annual good movement tonnage for system alternatives that include the same stops as system Alternatives 3C, 3D, and 4B. For other alternatives, estimate the difference in tonnage based on the communities served and the estimated portion of goods destined for those communities.
Goods Movement Revenue	• Estimated annual revenue from goods movement in 2035 (2011 dollars)	• Calculate a range of potential annual revenue using the estimates of annual tonnage of goods movement and the Cambridge Systematics estimates of revenue per ton under the High-Rate Strategy and the Low-Rate Strategy.
Roadless and Non-Motorized Areas	• Portion of corridor that directly crosses roadless or non-motorized areas (miles) • Portion of corridor which generally follows a road but may deviate into an adjacent roadless or non-motorized area (miles)	• Measure the length of the corridor that passes through Inventoried Roadless Areas • Measure the length of the corridor that passes through Back Country Non-Motorized areas • Measure the length of the corridor that follows road alignments that lie between Back Country Non-Motorized Areas
Critical Habitat	• Portion of corridor that passes through or adjacent to critical habitat areas (miles)	• Identify the number and types of critical habitat areas that a corridor passes through or immediately adjacent to using the US Fish & Wildlife Service Critical Habitat database • Measure the length of the corridor that passes through these areas
Geological Stability	• Portion of corridor that passes through highly unstable areas (miles)	• Measure the length of the corridor that passes through areas designated as "Very High" Landslide level in the State of California Department of Conservation map

6.3 Evaluation of Alternative Systems

This section presents the results of the alternative systems evaluation, based on analyzing each of the 13 alternative systems in relation to the criteria identified above. The following discussion covers each of the criteria individually, and a summary table is presented at the end of this section.

6.3.1 Capital Costs

The capital cost of each system includes two components: the cost of the rail system and the cost to acquire shuttle buses for the collection and distribution of passengers at mountain stations. For the rail system, a unit cost of $70 million per mile was applied in the valley portions of each corridor, and a range of $100-200 million per mile in the mountain portions of each corridor. These unit costs represent an estimate of overall capital costs including construction, vehicles, stations, right-of-way, and environmental mitigation. For the collection/distribution system, a unit cost of $175,000 per bus was applied. Appendix I includes the technical memorandum that describes the research into capital costs of rail systems.

Table 6.4 summarizes the key inputs and capital cost estimates for the 13 alternatives. The shortest corridors (30-32 miles long) have estimated capital costs of approximately $5 billion, while the longest corridors (54-58 miles long) have estimated capital costs exceeding $9 billion.

Table 6.4 – Capital Costs

Alternative	Valley Miles	Mountain Miles	Rail Capital Cost ($M)	Shuttle Costs ($M)	Total Capital Cost ($M)
1	12.5	43.5	$5,225 - 9,575	$2.1	$5,227 - 9,577
2A	2.0	40.0	$4,140 - 8,140	$2.1	$4,142 - 8,142
2B	10.5	39.5	$4,685 - 8,635	$2.1	$4,687 - 8,637
3A	8.0	33.0	$3,860 - 7,160	$2.1	$3,862 - 7,162
3B	8.0	30.5	$3,610 - 6,660	$2.3	$3,612 - 6,662
3C	8.0	22.5	$2,810 - 5,060	$2.3	$2,812 - 5,062
3D	8.0	22.0	$2,760 - 4,960	$2.3	$2,762 - 4,962
4A	10.5	29.5	$3,685 - 6,635	$2.3	$3,687 - 6,637
4B	10.5	21.5	$2,885 - 5,035	$2.3	$2,887 - 5,037
4C	10.5	28.0	$3,535 - 6,335	$2.3	$3,537 - 6,337
5	16.0	20.5	$3,170 - 5,220	$1.2	$3,172 - 5,221
6A*	7.5	40.5	$4,575 - 8,625	$1.6	$4,577 - 8,627
6B	16.0	40.0	$5,120 - 9,120	$1.6	$5,122 - 9,122

* Valley miles and rail cost do not include a cost for the segment from San Bernardino to Redlands, which is currently being developed as a separate project.

6.3.2 Operations and Maintenance Costs

Operations and maintenance (O&M) costs consist of two components: rail operations and feeder bus operations. For rail operations, a unit cost of $375 per revenue service hour was applied to reflect a conservative estimate of rail operations costs compared to the average cost for light rail O&M in the United States (see Appendix J for background information on O&M costs of light rail systems). For the shuttle bus operations, a unit cost of $100 per revenue service hour was applied, a figure slightly higher than the current operating cost for MARTA of $90 per revenue service hour.

Table 6.5 summarizes the operating parameters and O&M costs for each of the 13 alternatives. Total annual O&M costs (in 2011 dollars) range from about $15-19 million, with the collection/distribution (shuttle bus) system comprising approximately 18-29% of the overall O&M cost.

Table 6.5 – Operations and Maintenance Costs

Alternative	Annual Rail Vehicle Revenue Service Hours	Annual Rail O&M Cost ($M)	Annual Shuttle Bus Revenue Service Hours	Annual Shuttle Bus O&M Cost ($M)	Total Annual O&M Cost ($M)
1	36,712	$13.8	47,086	$4.7	$18.5
2A	31,928	$12.0	47,086	$4.7	$16.7
2B	36,712	$13.8	47,086	$4.7	$18.5
3A	36,244	$13.6	42,380	$4.2	$17.8
3B	36,244	$13.6	48,932	$4.9	$18.5
3C	31,460	$11.8	48,932	$4.9	$16.7
3D	31,460	$11.8	48,932	$4.9	$16.7
4A	36,244	$13.6	48,932	$4.9	$18.5
4B	31,460	$11.8	48,932	$4.9	$16.7
4C	36,244	$13.6	48,932	$4.9	$18.5
5	31,928	$12.0	26,650	$2.7	$14.6
6A	36,712	$13.8	33,202	$3.3	$17.1
6B	36,712	$13.8	33,202	$3.3	$17.1

6.3.3 Steep Slopes

Each of the 13 conceptual corridor alignments was drawn into a geographic information system (GIS) to create a topographic profile. (Maps of the corridor alignments and profiles are provided in Appendix K.) Each resulting topographic profile was smoothed to reflect a profile that would be consistent with engineering design criteria (eliminating unlikely up-and-down portions of the alignment). The distance that each alignment would traverse slopes of at least 8% was measured (8% is the threshold above which cog operation would be required). These steep slope areas were then divided into two parts – segments with slopes of 8-14%, and segments with slopes greater than 14%. Table 6.6 summarizes the length of steep slopes along each alignment. The alignment of Alternative 6 has no segments that exceed 8%. Alternative 5 has the longest portion that would require cog operation – 7.5 miles.

Table 6.6 – Steep Slopes

Alternative	Length with slope of 8-15%	Length with slope of 14-25%	Total length with slope > 8%
1	0.0 mi.	3.5 mi.	3.5 mi.
2A	0.0 mi.	2.0 mi.	2.0 mi.
2B	0.0 mi.	2.0 mi.	2.0 mi.
3A	0.0 mi.	2.5 mi.	2.5 mi.
3B	2.5 mi.	2.5 mi.	5.0 mi.
3C	0.0 mi.	2.5 mi.	2.5 mi.
3D	6.0 mi.	0.0 mi.	6.0 mi.
4A	2.5 mi.	2.5 mi.	5.0 mi.
4B	0.0 mi.	2.5 mi.	2.5 mi.
4C	2.5 mi.	2.5 mi.	5.0 mi.
5	7.5 mi.	0.0 mi.	7.5 mi.
6A	0.0 mi.	0.0 mi.	0.0 mi.
6B	0.0 mi.	0.0 mi.	0.0 mi.

6.3.4 Communities Served

The communities (and stations) served were shown above in Table 6.1. The key differences between the alternatives can be summarized as follows:

- Only Alternatives 1 and 2 serve a station in the Crestline/Lake Arrowhead area.
- Only Alternatives 5 and 6 do not serve Running Springs.
- Only Alternatives 3B, 3C, 3D, and Alternative 4 (A-B-C) serve Snow Valley.
- Only Alternative 6 serves Angelus Oaks.

6.3.5 Travel Time

The total end-to-end travel time along each alignment was calculated based on vehicle travel speeds on different slopes, and assumed dwell times at intermediate stations. The assumed speeds are as follows:

- 0-3%: 40 mph
- 3-6%: 30 mph
- 6-8%: 22 mph
- 8-14% uphill: 18.6 mph
- 8-14% downhill: 12.4 mph
- 14-25% uphill: 11 mph
- 14-25% downhill: 9.3 mph

Assumed dwell times were 2 minutes for most intermediate stations, and 3 minutes for the primary park-and-ride station on each route and Snow Valley.

Table 6.7 summarizes the total travel time and overall average travel speed for each alternative.

Table 6.7 – Travel Times and Average Speeds

Alternative	Total Travel Time (min.)	Average Travel Speed (mph)
1	114	30
2A	90	28
2B	106	29
3A	92	27
3B	94	25
3C	73	25
3D	72	25
4A	93	26
4B	78	25
4C	91	26
5	85	26
6A	114	31
6B	114	28

Travel times are primarily determined by the length of the alignment, so Alternatives 3C, 3D, and 4B have the shortest overall travel times while Alternatives 1 and 6 have the longest travel times.

6.3.6 Ridership and Revenue

Chapter 4 presented the methodology and results of ridership forecasting for the original alignment alternatives. In that analysis, two different forecasting methodologies were applied to estimate the annual number of passengers carried on the system between the Valley and the mountain areas in Year 2035. The average annual ridership estimate of both methods was slightly under one million riders for the alignments serving San Bernardino, Highland, Running Springs, Snow Valley, and Big Bear. Since system Alternatives 3C, 3D, and 4B (the shortest alignments in the expanded set of alignments being considered in this evaluation) are essentially comparable to those alignments, the annual ridership forecast of 981,000 riders was used for those alternatives, and modified assumptions were applied to the quick response model to develop ridership estimates for the other alternatives, reflecting differences in travel times and stations served. The mode share assumptions used in the quick response model to develop these forecasts are included in Appendix L.

Annual passenger revenue estimates were calculated by applying the following assumed one-way fares (Year 2011 dollars) between the Valley stations and each of the mountain stations:

- Crestline: $10.00
- Angelus Oaks: $12.50
- Running Springs: $12.50
- Snow Valley: $15.00
- Big Bear: $20.00

Table 6.8 presents the comparison of estimated annual passenger ridership (the "middle" or average estimate) for each alternative, along with the estimated annual revenue.

Table 6.8 – Estimated Annual Ridership and Passenger Revenue

Alternative	Annual Ridership*	Annual Passenger Revenue ($M)
1	756,000	$11.5
2A	704,000	$10.7
2B	818,000	$12.5
3A	769,000	$12.9
3B	855,000	$14.3
3C	981,000	$16.5
3D	981,000	$16.5
4A	855,000	$14.3
4B	981,000	$16.5
4C	855,000	$14.3
5	641,000	$10.8
6A	575,000	$9.6
6B	575,000	$9.6

* between the Valley and mountain areas; middle estimate

6.3.7 Goods Movement and Revenue

The goods movement forecast presented in Chapter 4 included forecasts based on two alternative strategies. The low-rate strategy assumed that the system would carry a range of freight types with a range of values, whereas the high-rate strategy assumed that the system would carry only higher-value package goods. Those forecasts were expanded to apply to the wider range of corridor alternatives serving different stations. For goods movement, travel time differences were not assumed to affect the volume of goods carried, so volume differences between alternatives are essentially due to the different communities served. The annual revenue estimates from goods movement were derived by applying the assumed rate structure to the estimated volume of goods in each alternative. The estimates of volume and revenue by market area are included in Appendix M.

Table 6.9 presents the estimated weekly tonnage of goods in the Year 2035 for each rate strategy, and the estimated annual revenue from transporting these goods. Alternatives 1 and 2B handle the most freight and generate the most freight revenue because they serve the Crestline and Lake Arrowhead areas more directly than the other alternatives. For all alternatives, the High-Rate Strategy generates almost twice as much revenue as the Low-Rate Strategy.

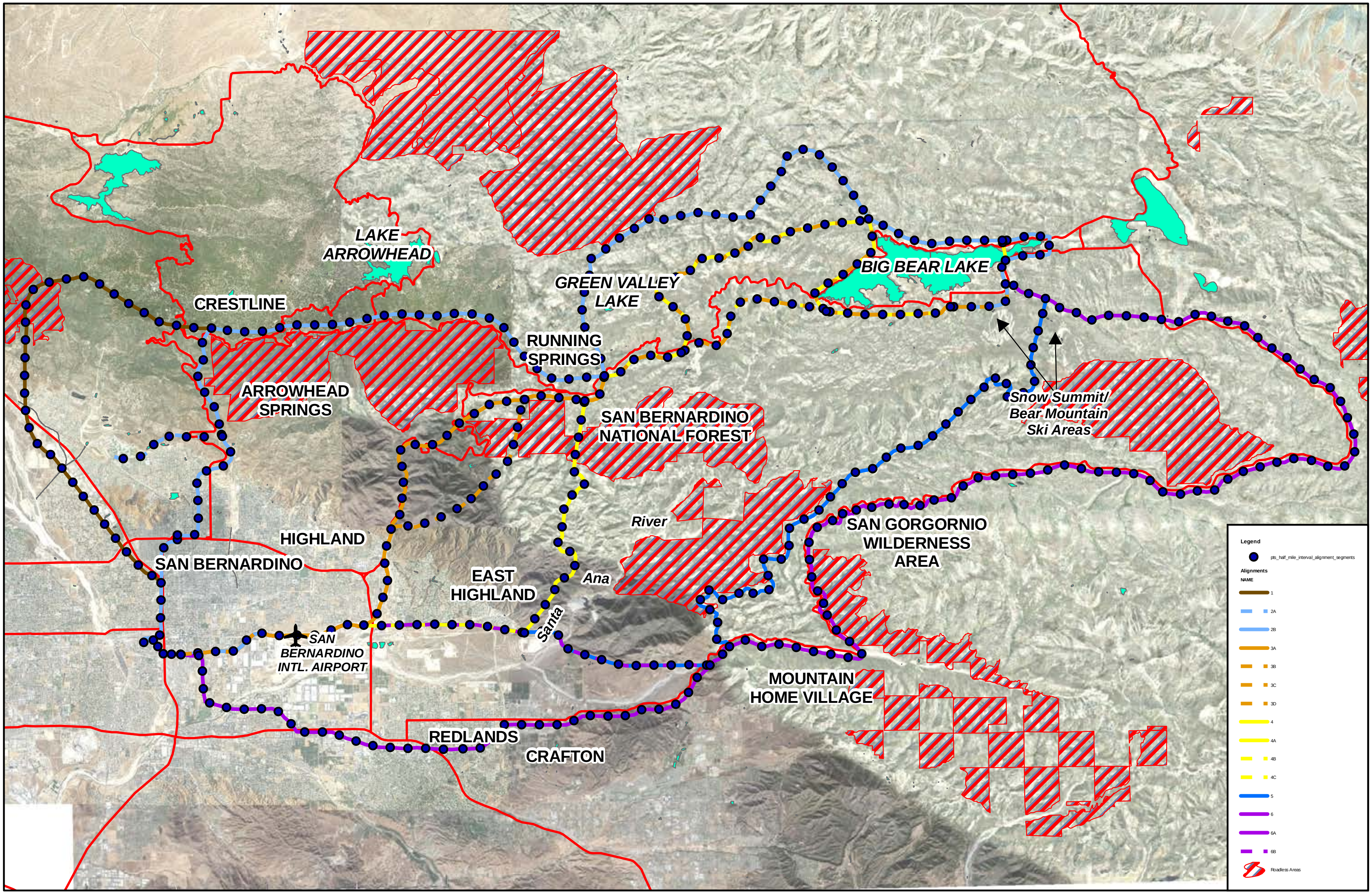
Table 6.9 – Estimated Goods Movement and Revenue

Alternative	Estimated Weekly Tonnage in 2035: Low-Rate Strategy	Estimated Weekly Tonnage in 2035: High-Rate Strategy	Estimated Annual Revenue ($M): Low-Rate Strategy	Estimated Annual Revenue ($M): High-Rate Strategy
1	2,230	870	$3.4	$6.7
2A	1,487	580	$2.3	$4.5
2B	2,230	870	$3.4	$6.7
3A	1,515	595	$2.9	$5.8
3B	1,515	595	$2.9	$5.8
3C	1,515	595	$2.9	$5.8
3D	1,515	595	$2.9	$5.8
4A	1,515	595	$2.9	$5.8
4B	1,515	595	$2.9	$5.8
4C	1,515	595	$2.9	$5.8
5	1,335	525	$2.8	$5.5
6A	1,415	555	$2.8	$5.6
6B	1,415	555	$2.8	$5.6

6.3.8 Roadless and Non-Motorized Areas

Land use compatibility could be a key determinant of system feasibility, as the alternative alignments pass through National Forest areas owned by the United States Forest Service (USFS) and designated as incompatible with transportation uses. The US Forest Service has designated certain areas as Inventoried Roadless Areas (IRAs) – lands without existing roads that are suitable for preservation as quasi-wilderness areas (shown in Figure 6.2). In addition, the San Bernardino National Forest (SBNF) land use plan has designated certain areas as non-motorized (shown in Figure 6.3). In either case, development of a new transportation system through these areas would not be compatible use with their current designation. USFS representatives have indicated that, while it would not be impossible to obtain approval for a change to accommodate a new transportation system through these areas, it would involve an extensive review and approval process within the Forest Service. The process would be somewhat simpler for traversing a non-motorized area, since it would be a local (SBNF) decision, whereas approval for incursion into an IRA would require approval at a higher (district) level within the USFS. (Appendix N includes the meeting notes from a workshop conducted with the key resource agencies to obtain their preliminary insights on key issues that could affect the feasibility of the project.)

Figure 6.2 - Quasi-Wilderness Areas



Source: USGS National Hydrography Dataset

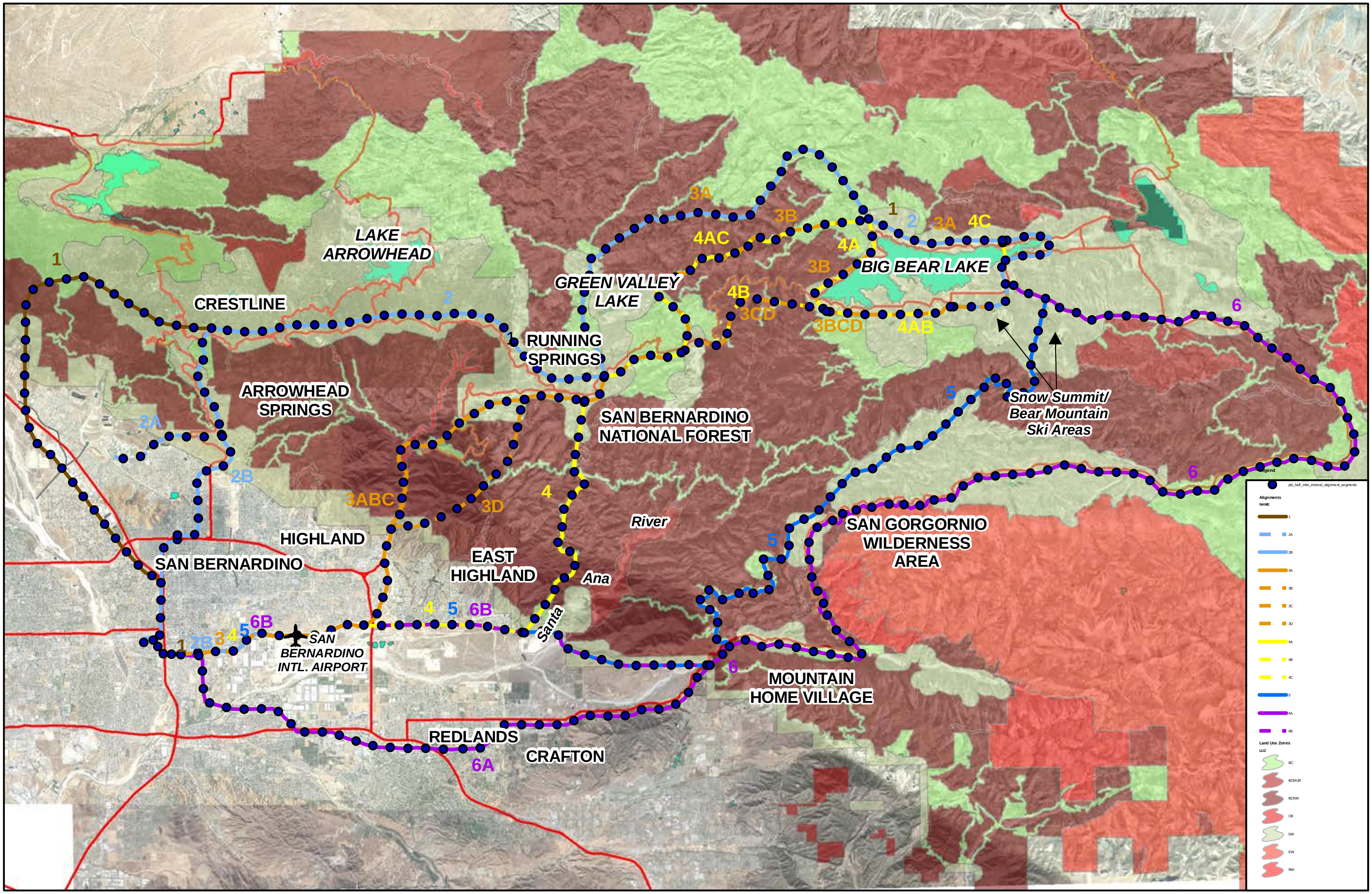
0 1.5 3 6 Miles

1 in = 4 miles

Big Bear Modal Alternatives 2011

Figure - Roadless Areas

Figure 6.3 - Designated Non-Motorized Areas



Source: USGS National Hydrography Dataset

0 1.5 3 6 Miles
1 in = 4 miles

Big Bear Modal Alternatives 2011

Figure -Land Use Zones

The evaluation documents the length of segments that cross IRAs and non-motorized areas. It also shows the length of segments that follow a motorized corridor (typically a fire road) within or adjacent to an IRA or non-motorized area. A new system following one of these motorized corridors would almost certainly intrude somewhat into the surrounding areas currently designated as inappropriate for transportation uses.

Table 6.10 presents the results of this analysis. Alternative 3D and Alternative 4 (A-B-C) are the only alternatives that directly cross an IRA (for a distance of 1 to 1½ miles). All other alternatives except 3B have segments that are adjacent to IRAs, with the longest such segments in Alternatives 5 and 6 (approximately 6 miles). Alternative 3D and Alternative 4 (A-B-C) have the longest segments that cross non-motorized areas, and Alternative 6 has the longest segment adjacent to non-motorized areas.

Overall, the alternatives with the shortest total distance crossing roadless or non-motorized areas are Alternatives 1, 2, 3A, 3B, 5, and 6. In terms of the least overall potential intrusion (either crossing or adjacent to roadless or non-motorized areas), Alternatives 1 and 2 are lowest (5 miles), Alternatives 3, 4, and 5 have approximately 8-11 miles with potential for intrusion, and Alternative 6 has over 18 miles of potential intrusion.

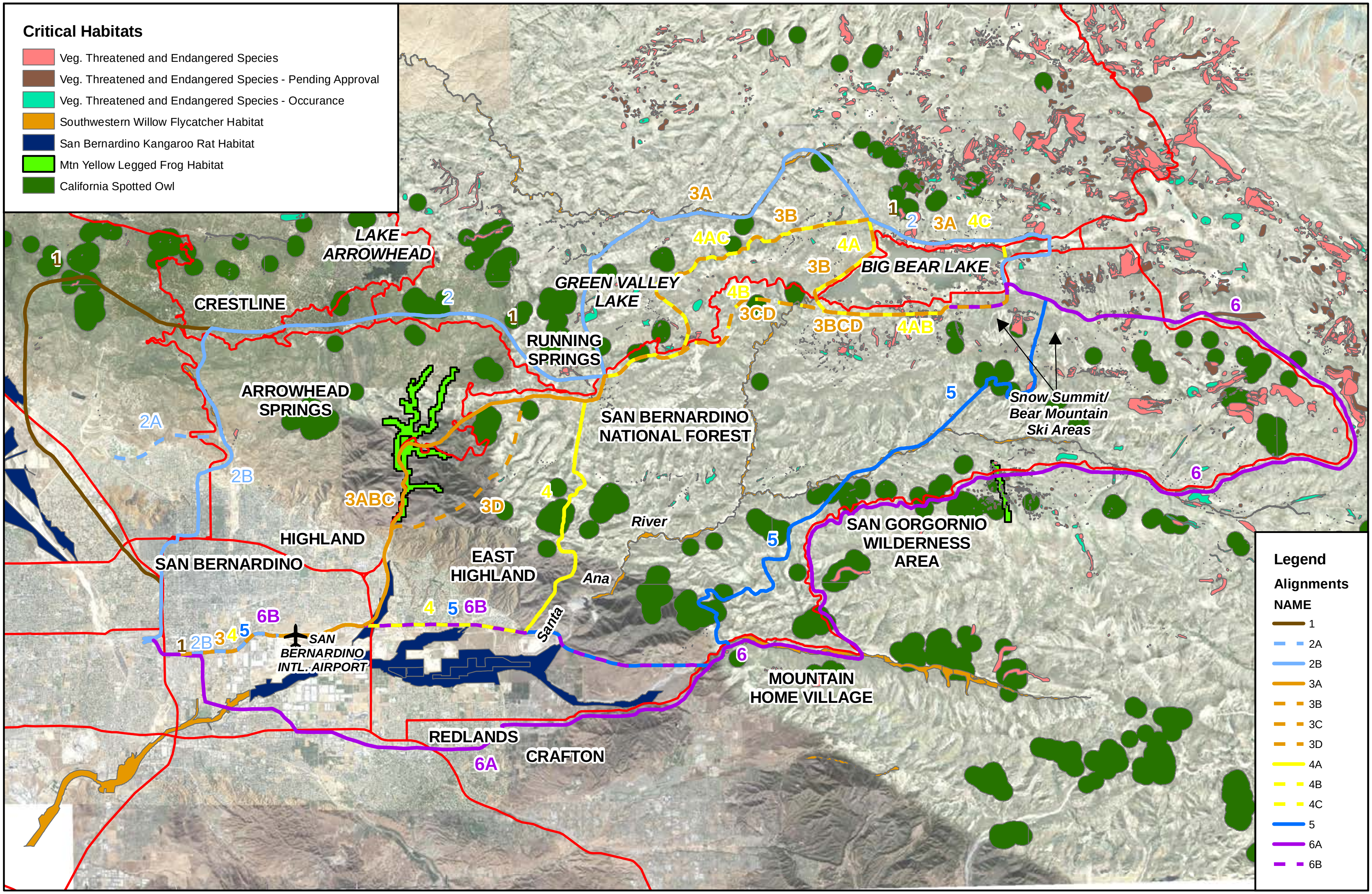
Table 6.10 – Roadless and Non-Motorized Areas

Alterna-tive	Total Length (miles)	Length Crossing IRA (miles)	Length Crossing Non-Motorized (miles)	Length Adjacent to IRA (miles)	Length Adjacent to Non-Motorized (miles)	Total Length Crossing IRA or N-M (miles)	Total Length Crossing or Adjacent to IRA or N-M (miles)	% of Corridor Crossing IRA or N-M	% of Corridor Crossing or adjacent to IRA or N-M
1	57	0.00	0.00	1.90	3.10	0.00	5.00	0%	9%
2A	42	0.00	0.00	1.90	3.10	0.00	5.00	0%	12%
2B	51	0.00	0.00	1.90	3.10	0.00	5.00	0%	10%
3A	41	0.00	0.60	1.90	6.10	0.60	8.60	1%	21%
3B	39	0.00	0.60	0.00	7.40	0.60	8.00	2%	21%
3C	31	0.00	3.85	0.00	3.60	3.85	7.45	12%	24%
3D	30	1.50	6.75	0.00	0.90	8.25	9.15	28%	31%
4A	40	0.90	5.00	0.00	4.40	5.90	10.30	15%	26%
4B	32	0.90	8.25	0.00	0.60	9.15	9.75	29%	30%
4C	39	0.90	5.00	0.00	4.40	5.90	10.30	15%	26%
5	37	0.00	1.10	6.00	3.75	1.10	10.85	3%	29%
6A	58	0.00	0.85	6.15	11.75	0.85	18.75	1%	32%
6B	54	0.00	0.85	6.15	11.75	0.85	18.75	2%	35%

6.3.9 Critical Habitat

Areas of critical habitat were identified in a GIS database provided by the US Forest Service, and the alternative alignments were overlaid on the habitat map to determine the length of each alignment that crosses areas of critical habitat. Figure 6.4 presents the map, and Table 6.11 summarizes the total mileage and percentage of each alignment that passes through critical habitat areas. Alternatives 4A and 4B have the shortest distance through critical habitat areas (4.6 miles and 4.5 miles, respectively), and Alternative 3A has the longest distance through critical habitat (10.1 miles). Alternatives 4A and 6A have the smallest percentage of their alignment through critical habitat areas (12%), and Alternatives 3A and 3C have the greatest percentage of their alignment through critical habitat areas (24% and 23%, respectively).

Figure 6.4 - Critical Habitat



Source: USFS Biological Critical Habitat

0 1.5 3 6 Miles
1 in = 4 miles

Big Bear Modal Alternatives 2011

Alignments and Critical Habitats

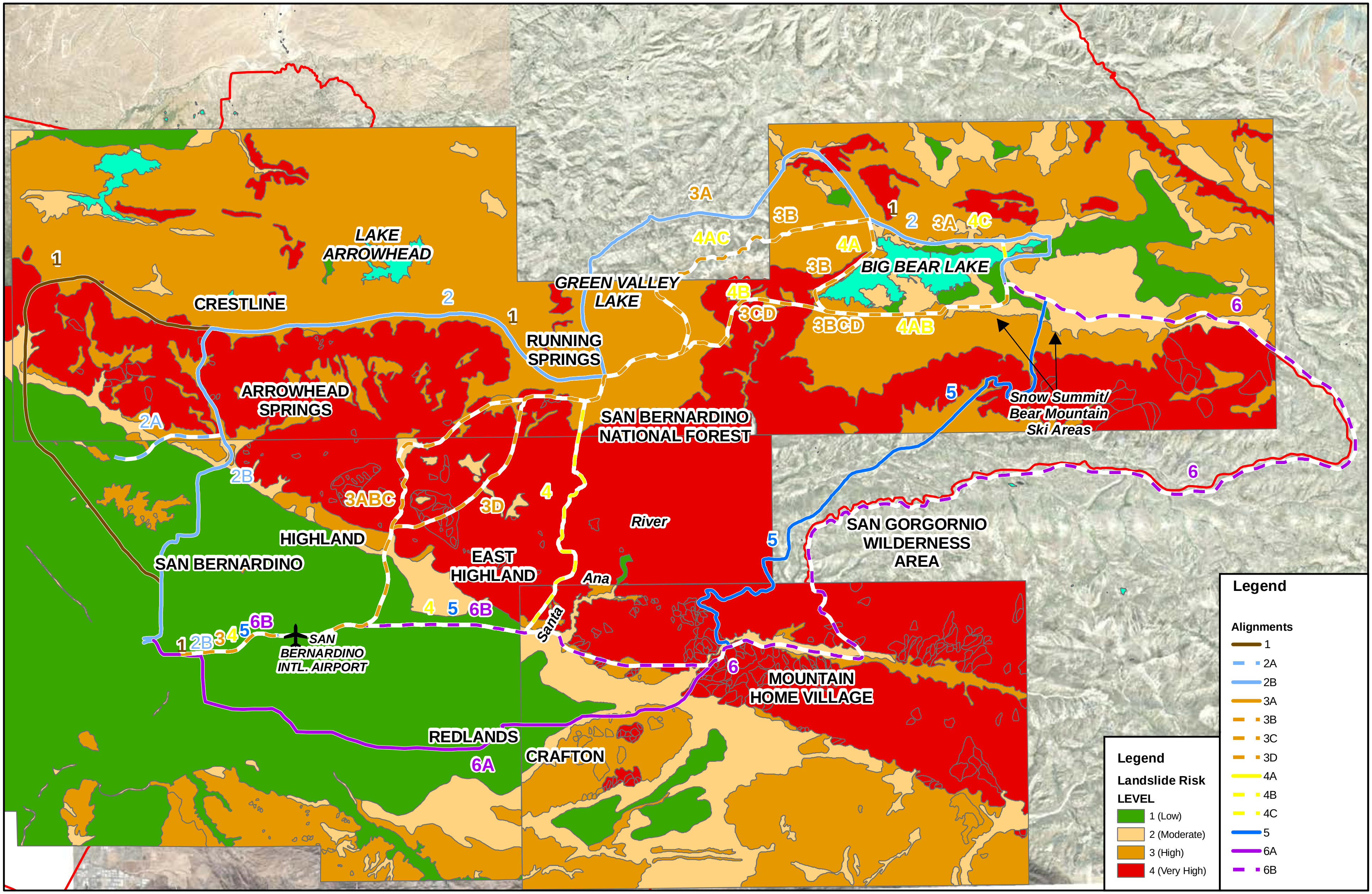
Table 6.11 – Critical Habitat Areas

Alternative	Length of Alignment in Critical Habitat Areas (mi)	% of Alignment in Critical Habitat Areas
1	8.3	15
2A	6.6	17
2B	7.4	15
3A	10.1	24
3B	7.4	19
3C	7.2	23
3D	4.9	16
4A	4.6	12
4B	4.5	14
4C	5.5	14
5	6.9	19
6A	6.6	12
6B	7.1	13

6.3.10 Geological Stability

Most of the study area is considered geologically unstable, as it is crossed by seismic faults and includes extensive areas of potential landslide activity. Detailed geological analysis will be needed in subsequent studies to identify areas of less risk for locating a new transportation system. For the purpose of comparing alignments, the alternative corridor alignments were overlaid on a California Department of Conservation GIS database of Landslide Risk map, and the length of each alignment passing through areas of High and Very High landslide risk was measured. Figure 6.5 shows the areas of landslide risk with the alternative alignments. For areas not covered by the database, the landslide risk was interpolated based on risk patterns in adjacent areas. Table 6.12 summarizes the results of the analysis. Alternative 6 has the greatest distance through Very High risk areas, and Alternatives 1, 2, and 6 have the greatest total length through High and Very High landslide risk areas. Alternative 2 has the shortest distance through Very High Risk areas, and Alternative 3D has the shortest distance through High and Very High risk areas.

Figure 6.5 - Landslide Risk



Source: State of California Department of Conservation

0 1.5 3 6 Miles
1 in = 4 miles

Big Bear Modal Alternatives 2011

Figure - Landslide Risk

Table 6.12 – Landslide Risk

Alternative	Distance in Very High Risk (mi)	Distance in High Risk (mi)	% of corridor in Very High Risk	% of corridor in High Risk
1	4.1	31.1	7%	55%
2A	2.1	31.1	5%	74%
2B	2.0	30.3	4%	60%
3A	5.5	19.1	13%	47%
3B	6.8	20.1	18%	52%
3C	7.4	11.7	24%	38%
3D	8.8	7.1	29%	24%
4A	8.0	19.2	20%	48%
4B	8.5	10.8	27%	34%
4C	6.3	18.0	16%	46%
5	14.2	8.8	38%	24%
6A	21.8	11.6	38%	20%
6B	22.6	11.1	42%	21%

6.4 Summary

Table 6.13 summarizes the results described above. To compare the relative effectiveness of the various alternatives in relation to these key criteria, Table 6.14 qualitatively rates the alternatives in relation to each criterion. Each alternative performs in the "best" category for at least one of the criteria. The shortest, most direct alternatives (3C, 3D, and 4B) perform best overall because they have shorter alignments with lower capital costs and shorter travel times, serve the most mountain communities in the San Bernardino-to-Big Bear corridor, attract the most passenger ridership, and generate above average goods movement revenue. The Alternative 6 systems (A-B) have the poorest overall performance because of their lengthy alignments with long travel times and lower ridership, the potential for intrusion into IRAs and non-motorized areas, and the length of their alignments through areas with high or very high landslide risk.

Table 6.13
Big Bear Modal Alternatives Analysis
Evaluation Results Summary Matrix

Alternative	1	2A	2B	3A	3B	3C (original Alt. 3)	3D (original Alt. 4)	4A	4B (original Alt. 5)	4C	5	6A	6B
Description													
Corridor	Devore	Waterman	Waterman	Highland/ SR-330	Highland/ SR-330	Highland/ SR-330	Highland/ SR-330	East Highland	East Highland	East Highland	Radford Camp Rd.	SR-38	SR-38
Route		To CSUSB	To SR-210	Via City Creek, 2W03, Division	Via City Creek, 2N13, BB Dam	Via City Creek, Arctic Circle	Via Plunge Creek, Arctic Circle	Via 2N13, BB Dam	Via Arctic Circle	Via 2N13, Division		Via Redlands	Via East Highland
Alignment Length (miles)	57	42	51	41	39	31	30	40	32	39	37	58	54
# of Stations	7	5	8	6	7	7	7	7	7	7	5	5	6
Stations/Communities Served	SB Intl. Airport Downtown SB SB Metrolink Crestline Running Springs Big Bear China Garden Big Bear Village	CSU San Bernardino Crestline Running Springs Big Bear China Garden Big Bear Village	SB Intl. Airport Downtown SB SB Metrolink SB E St./SR-210 Crestline Running Springs Big Bear China Garden Big Bear Village	Downtown SB SB Intl. Airport Highland SR-330 Running Springs Big Bear China Garden Big Bear Village	Downtown SB SB Intl. Airport Highland SR-330 Running Springs Snow Valley Big Bear Village Big Bear China Garden	Downtown SB SB Intl. Airport Highland SR-330 Running Springs Snow Valley Big Bear Village Big Bear China Garden	Downtown SB SB Intl. Airport Highland SR-330 Running Springs Snow Valley Big Bear Village Big Bear China Garden	Downtown SB SB Intl. Airport Highland Greenspot Running Springs Snow Valley Big Bear Village Big Bear China Garden	Downtown SB SB Intl. Airport Highland Greenspot Running Springs Snow Valley Big Bear Village Big Bear China Garden	Downtown SB SB Intl. Airport Highland Greenspot Running Springs Snow Valley Big Bear Village Big Bear China Garden	Downtown SB SB Intl. Airport Highland Greenspot Big Bear Village Big Bear China Garden	Downtown SB [intermediate stops] Redlands Angelus Oaks Big Bear China Garden Big Bear Village	Downtown SB SB Intl. Airport Highland Greenspot Angelus Oaks Big Bear China Garden Big Bear Village
Total One-Way Travel Time end to end (min)	114	90	106	92	94	73	72	93	78	91	85	114	114
Average speed (mph)	30	28	29	27	25	25	25	26	25	26	26	31	28
Steep Slopes Requiring Cog Rail (miles, slope > 8%)													
8-14%	0.0	0.0	0.0	0.0	2.5	0.0	6.0	2.5	0.0	2.5	7.5	0.0	0.0
14-25%	3.5	2.0	2.0	2.5	2.5	2.5	0.0	2.5	2.5	2.5	0.0	0.0	0.0
Capital Costs ($ millions)	$9,600	$8,100	$8,600	$7,200	$6,700	$5,100	$5,000	$6,600	$5,000	$6,300	$5,200	$9,400	$9,100
Annual Operating Costs ($ millions)													
Rail system	$13.8	$12.0	$13.8	$13.6	$13.6	$11.8	$11.8	$13.6	$11.8	$13.6	$12.0	$13.8	$13.8
Feeder bus system	$4.7	$4.7	$4.7	$4.2	$4.9	$4.9	$4.9	$4.9	$4.9	$4.9	$2.7	$3.3	$3.3
TOTAL ANNUAL O&M	$18.5	$16.7	$18.5	$17.8	$18.5	$16.7	$16.7	$18.5	$16.7	$18.5	$14.6	$17.1	$17.1
Estimated Annual Ridership, 2035 (valley-mountain riders)	756,000	704,000	818,000	769,000	855,000	981,000	981,000	855,000	981,000	855,000	641,000	575,000	575,000
Estimated Annual Revenue, 2035 (in millions of 2010 $)	$11.5	$10.7	$12.5	$12.9	$14.3	$16.5	$16.5	$14.3	$16.5	$14.3	$10.8	$9.6	$9.6
Estimated Weekly Tonnage of Goods Movement, 2035													
Low-Rate Strategy	2,230	1,487	2,230	1,515	1,515	1,515	1,515	1,515	1,515	1,515	1,335	1,415	1,415
High-Rate Strategy	870	580	870	595	595	595	595	595	595	595	525	555	555
Estimated Annual Value of Goods Movement, 2035 (in millions of 2010 $)													
Low-Rate Strategy	$3.4	$2.3	$3.4	$2.9	$2.9	$2.9	$2.9	$2.9	$2.9	$2.9	$2.8	$2.8	$2.8
High-Rate Strategy	$6.7	$4.5	$6.7	$5.8	$5.8	$5.8	$5.8	$5.8	$5.8	$5.8	$5.5	$5.6	$5.6
Portion of Alignment Crossing or Between Roadless or Non-Motorized Areas (miles)													
Crosses Roadless or Non-Motorized Areas	0.0	0.0	0.0	0.6	0.6	3.9	8.3	5.9	9.2	5.9	1.1	0.9	0.9
Alignment Between Roadless or Non-Motorized Areas	5.0	5.0	5.0	8.0	7.4	3.6	0.9	4.4	0.6	4.4	9.8	17.9	17.9
Portion of Alignment Crossing Critical Habitat Areas (miles)	1.4	1.6	1.7	5.2	3.9	4.0	1.7	0.5	0.6	0.5	1.3	1.7	2.1
Portion of Alignment Crossing Geologically Unstable Areas (miles)													
Very High Landslide Risk	4.1	2.1	2.0	5.5	6.8	7.4	8.8	8.0	8.5	6.3	14.2	21.8	22.6
High Landslide Risk	31.1	31.1	30.3	19.1	20.1	11.7	7.1	19.2	10.8	18.0	8.8	11.6	11.1

Table 6.14 – Qualitative Summary Evaluation of Alternatives

	ALTERNATIVE												
CRITERIA	1	2A	2B	3A	3B	3C	3D	4A	4B	4C	5A	6A	6B
Capital Costs	worst	poor	poor	average	good	best	best	good	best	good	best	worst	worst
O&M Costs	worst	average	worst	poor	worst	average	average	worst	average	worst	best	average	average
Steep Slopes	average	good	good	good	poor	good	poor	poor	good	poor	worst	best	best
Communities Served	good	poor	good	good	best	best	best	best	best	best	worst	average	average
Travel Time	worst	average	poor	average	average	best	best	average	best	average	good	worst	worst
Ridership & Revenue	average	poor	average	average	good	best	best	good	best	good	poor	worst	worst
Goods & Revenue	best	worst	best	good	good	good	good	good	good	good	average	average	average
Land Use Compatibility	best	best	best	average	good	good	poor	average	average	average	worst	worst	worst
Critical Habitat	good	good	good	worst	poor	poor	good	best	best	best	good	good	average
Landslide Risk	best	best	best	best	good	average	good	average	average	best	poor	worst	worst
Overall	average	average	good	average	average	best	best	good	best	good	poor	worst	worst

● = best ● = good ● = average ● = poor ● = worst

It is not the purpose of this analysis to recommend a preferred alternative, but rather to identify and evaluate the key factors that contribute to system feasibility. Clearly, the alignments that follow the more direct routes from San Bernardino to Big Bear are more attractive in terms of lower capital costs, shorter travel times, and the resulting ability to attract more riders. However, other factors such as land use compatibility (and acceptance by the US Forest Service), environmental impacts and mitigation requirements, and identifying a geologically stable alignment will be critical to determining the viability of any particular corridor, and these factors will only be sufficiently understood through more specific engineering analysis in subsequent studies.

7. FINANCIAL EVALUATION

7.1 Methodology

The purpose of the financial evaluation is to quantify the cost and revenue estimates associated with the system to evaluate its financial feasibility and identify the conditions under which it could be financially feasible. The evaluation first defines the capital and operations/maintenance cost scenario used as the base case for the financial evaluation. It then identifies potential sources of additional revenue, and evaluates how much funding could plausibly be generated from these sources. Finally, the analysis develops and evaluates several potential future financial scenarios to determine the circumstances under which the system would be financially feasible.

7.2 Base Case Cost Scenario

The capital cost of the alternative systems evaluated in Chapter 6 ranges from $5 billion for Alternative 3D to $9.6 billion for Alternative 1. As described in Chapter 6 and Appendix I, these estimates are based on a conservatively high all-inclusive unit cost factor that is accounts for construction, stations, vehicles, right-of-way, and environmental mitigation.

Table 7.1 compares the estimated annual operating revenue with annual estimated operations/ maintenance costs, and indicates that most systems are projected to operate with either a modest surplus or a modest deficit, so operating revenues alone will clearly be inadequate to finance the capital cost of any system alternatives.

Table 7.1– Annual Operating Surplus/Deficit

Alternative	Total Annual Revenue in 2035 ($M)	Total Annual O&M Cost in 2035 ($M)	Annual Surplus (Deficit) ($M)
1	$18.2	$18.5	($0.3)
2A	$15.2	$16.7	($1.5)
2B	$19.2	$18.5	$0.7
3A	$18.7	$17.8	$0.9
3B	$20.1	$18.5	$1.6
3C	$22.3	$16.7	$5.6
3D	$22.3	$16.7	$5.6
4A	$20.1	$18.5	$1.6
4B	$22.3	$16.7	$5.6
4C	$20.1	$18.5	$1.6
5	$16.3	$14.6	$1.7
6A	$15.2	$17.1	($1.9)
6B	$15.2	$17.1	($1.9)

Because of the magnitude of the shortfall, consultations with the TAC concluded that a cost and revenue calculation for each alternative would be relatively meaningless, and that the most useful financial analysis would be one that evaluates a range of plausible alternative future cost and revenue scenarios to determine the conditions under which a system could be financially feasible, as well as the amount of traditional government grant funding that would be needed to fill the revenue gap in each of those future scenarios.

To perform this analysis, a "base case" cost and revenue scenario was selected as a reference point for the alternative financial scenarios. The base case was selected to represent a system alternative that is better than average, but not best case, in terms of capital cost and excess operating revenue. A system generally comparable to Alternative 4C, totaling 37 miles in length, was selected as representative of the base case condition to be analyzed. The capital cost estimate for the base case system is $6 billion (2011 dollars), with annual operating costs of $13.6 million for the rail system and $4.9 million for the feeder bus system, and an annual operating surplus of $1.6 million.

7.3 Potential Revenue Sources

Recognizing that estimated operating revenue surpluses would not be sufficient to cover the debt payments to pay off the system's capital costs, the team evaluated potential additional sources of funding and estimated potential revenue generation under a range of funding scenarios. The analysis focuses on potential non-traditional funding sources – sources that don't involve government grants – since multi-billion dollar grants would be difficult to obtain in an era where project earmarks are being avoided by Congress. The analysis below identifies a list of potential revenue sources, estimates potential revenue from the more promising non-traditional sources, estimates potential passenger and freight revenue in alternative future scenarios, and discusses potential project financing mechanisms.

7.3.1 Potential Non-Traditional Revenue Sources

A "long list" of 26 potential non-traditional funding sources was identified and screened in consultation with the Technical Advisory Committee (TAC) at the February and March 2011 meetings. The comprehensive list of sources was identified based both on an analysis of project-specific characteristics (i.e., airport-based funding streams associated with a station stop at San Bernardino International Airport) and the types of local and private revenue sources typically used to fund comparable infrastructure projects. As part of an initial screening process, the Consultant team ranked the viability of each funding source according to a set of weighted criteria. The criteria and associated weightings shown in Table 7.2 were collaboratively developed with the TAC, and were used only to guide the group-based discussion and screening process, rather than to advance or eliminate particular sources from consideration:

Table 7.2 - Funding Source Screening Criteria and Weighting

Criterion	Relative Weight (out of 100)
Relevance to Purpose and Need	15
Historical Use of Source for Similar Projects	10
Political Support	20
Revenue Yield	30
Equitable Financial Impact	10
Legal Ease of Implementation	15

Tables 7.3 and 7.4 respectively summarize the screened sources advanced for further consideration and sources not advanced for consideration at this time based on subsequent feedback from the TAC.

Table 7.3 - Sources Advanced for Further Consideration

Source	Description
Value Capture Strategies	
Infrastructure financing district	Property tax revenues generated beyond an established baseline are pledged specifically for infrastructure-related improvements within an area or district.
Joint Development Agreements	Public and private sectors work cooperatively in the planning, financing, and construction of development projects adjacent to and integrated with transportation facilities.
Highway Tolls on Routes 18, 38, 330	Revenues generated from the conversion of existing state highway facilities into toll roads.
Local option sales tax	Revenue generated from an additional 1/4 or 1/2 cent sales tax imposed on point-of-sale transactions within a city or county.
Benefit assessment districts - station areas/corridor	District formed to provide a specific service or benefit to property owners contained within its boundaries. Charges are based on the benefit to property rather than value of the property.
One-Time Revenue Event	
Land Contribution or Other Asset Sales	Revenues generated from the disposition of excess land owned by Omnitrans, cities or local agencies. Right-of-way contributions also possible.
General User-Based Fees	
Resort fees	Surcharge imposed on commercial recreation venues.
Rental car tax or surcharge	Tax or surcharge imposed on rental cars that are leased, typically within a city or cities served by the project.
Transient occupancy tax	Tax levied on the gross receipts of lodging.
Parking fees	Revenues generated from an increase in public parking meter rates.
Adventure Pass fee	An expanded amenity recreation fee attached to the existing U.S. Forest Service “Adventure Pass” sold at the entrance to the San Bernardino National Forest.
Private-Sector Revenues	
Business Improvement District (BID)	Business owners pay extra fees to form a BID or special district.
Developer Mitigation Fee	Revenues generated from one-time fee on new development.
Private equity (with PPP)	Public Private Partnership (PPP) arrangement whereby a private entity designs, finances, builds, operates and/or maintains a facility under a lease arrangement for a specified

Source	Description
	period of time.
Resort Association contribution	Existing mountain-area Resort Associations contribute a percentage of annual member dues toward the project.
Casino contribution	
Project-Based Revenues	
Freight revenues	Payments from freight carriers for the transport of cargo on passenger trains and/or shared use of corridor.
Advertising	Revenue from advertising placed at stations, on ticket stubs, agency-owned property, vehicles, etc.
Fare revenues	Revenue generated from the collection of passenger fares.
Station naming rights	Revenue generated from naming rights agreements for individual stations, most likely for 5 to 10 year contractual periods.
Airport revenues - (SBIA Station Only)	Airports typically generate revenue from a variety of sources, incl. landing fees, auto parking fees/concessions, passenger facility charges, and consolidated rental car facility charges.
Parking facilities charge	Charge imposed on parking at station facilities.

Table 7.4 - Sources Not Advanced for Further Consideration

Source	Description	Reason Not Advanced
Redevelopment agency funds	The Cities of San Bernardino, Highland, Big Bear Lake and Redlands all have existing redevelopment agencies whose annual property tax-increment financing revenues could be contributed to the project.	Uncertainty over future availability
Property transfer tax	Increase in tax levied on any real property that is sold or transferred.	Inadequate nexus to project
Taxi District Drop-off/Pick-up Surcharge	Revenues generated from surcharge imposed on taxi trips originating or terminating in a defined district.	Revenue contribution likely to be marginal
Utility users tax	Tax on consumption of utilities paid by the customer, applied to electricity, telephone, gas, water, sewer, garbage, and cable television services.	Inadequate nexus to project

To provide an order of magnitude of funding required, the five potential new funding sources estimated to generate the highest amount of ongoing revenue over the implementation period were then examined in greater detail. These sources are described in the following section.

7.3.2 Potential New Revenues

As previously mentioned, the Consultant team selected five potential funding sources based both on their weighted score in the screening process and their ability to generate the highest amount of ongoing revenue for the project over its implementation period. In addition to the level of revenue generated, the long-term consistency and stability of these funding sources were compelling factors in their selection from the "long list," as they could collectively be used to service annual debt payments on the capital costs of the system.

The five sources, along with the assumptions used to generate revenue ranges for each source, are summarized below:

Table 7.5 Potential Funding Sources and Revenue Range Assumptions

Funding Source	Revenue Range Assumptions
1. **Tolls on State Highways 18, 38, 330** (for vehicles traveling up and down the mountains):	**Low**: $3.00 one way-toll, with 25% of the revenues dedicated to the new system (the remainder assumed to be for mountain road maintenance and repairs). **High**: $5.00 one way-toll, with 50% of the revenues dedicated to the new system.
2. **Benefit Assessment District**	**Low**: Annual assessments (averaging $0.39 per square foot) on development within ¼ mile buffer of the new system. Residential exempt. **High**: Annual assessments (averaging $0.40 per square foot) on development within ½ mile buffer of the new system. All land uses assessed.
3. **Resort area fee**	**Low**: $2.50 per room-night with 50% average occupancy and 0% increase in hotel room inventory over existing levels **High**: $5.00 per room-night with 60% average occupancy and 10% increase in hotel room inventory over existing levels
4. **Vehicle license fee (VLF) surcharge** (implemented at a countywide level):	**Low**: $10 surcharge, 10% of the revenue to the new system. **High**: $10 surcharge, 25% of the revenue to the new system.
5. **Commercial Recreation Fee**	**Low**: $4 per use **High**: $8 per use

Estimates were developed of the range of annual revenue generated by each of the five sources using existing demographic information, SCAG growth projections for housing and employment, and other relevant data needed to quantify future revenue streams. The results are summarized below:

Table 7.6 - Range of Annual Revenue Generated by Potential New Funding Sources

	Funding Range (millions)		
	Low	Medium	High
1: Highway Tolls	$11.8	$20.5	$29.2
2: Benefit Assessment	$7.3	$14.7	$22.0
3: Resort Area Fee	$0.7	$1.2	$1.8
4: VLF Surcharge	$1.9	$3.4	$4.8
5: Lift Tickets	$2.8	$4.2	$5.6
Total	**$24.5**	**$44.0**	**$63.5**

Estimates for all funding sources reflect a compound annual rate of growth (CAGR) factor that has been applied to the underlying unit of calculation (ie. number of visitors, car registrations, traffic counts), escalated to the year 2020. For the benefit assessment district calculation, the midpoint average of SCAG housing and employment projections for 2006 to 2035 was used. The "Medium" estimate reflects the average of the low and high ranges.

7.3.3 Passenger and Freight Revenues

In the base case scenario, the system is estimated to generate an annual operating surplus of $1.6 million. To evaluate the project's financial viability under various potential future conditions, passenger and freight revenue estimates were generated for three alternative future scenarios based on assumptions of potential future conditions that could result in greater revenue surpluses. The ridership and mode share assumptions used as the basis for calculating net annual operating income in these alternative scenarios are summarized as follows.

The ridership forecast assumptions used in the "base case" evaluation assumed mode choice based on energy costs comparable to current conditions. The resulting forecast yielded a 5% mode split for the proposed system and provided the basis for revenue estimates from passenger fares.

The Consultant team also conducted alternate model runs using adjusted assumptions on future fuel costs. If the cost of energy were to double from today's levels, mode share is estimated to increase by 50% compared to the "base case" scenario. For the "Most Optimistic Case" (Scenario #3), an even more aggressive mode split of 17.5% was selected as the basis for calculating passenger fare revenues.

For the freight revenue assumptions, the "base case" scenario similarly assumes market conditions comparable to today's. TAC members pointed out that future air quality standards could require commercial vehicles to convert to zero-emission, battery-only propulsion technology. Such vehicles would likely lack sufficient power to traverse mountain grades, increasing the need for an alternative mode of freight transportation. The original freight forecasts estimated that 14% of freight could be carried on the new system. For the "Most Optimistic Case" (Scenario #3), the high end freight strategy (package freight) was assumed to maximize revenue with 100% of package freight carried on the new system.

Under each of the four scenarios evaluated, revenue from passenger fares and freight usage of the system were projected to exceed operating and maintenance costs, resulting in a net annual operating income that could be used to support a moderate level of debt service on the project, as shown in Table 7.7.

Table 7.7 - Ridership and Mode Share Assumptions

Scenario	Base	#1	#2	#3
Scenario Description	Base	Least Optimistic	Mid-Range	Most Optimistic
Passenger mode share	5%	7.5%	10%	17.5%
Freight mode share (package)	14%	28%	50%	100%
Net Annual Operating Income (millions)	$1.6	$14.0	$29.8	$62.6
Passenger fare revenue	$1.1	$7.8	$13.4	$25.5
Freight revenue	$0.5	$6.2	$13.1	$30.9

7.3.4 Potential Financing

Because the potential project-related revenue sources capable of generating upfront funding (such as land sales or naming rights) were insufficient to cover the capital costs of the project on a pay-as-you-go basis, the Consultant team explored using financing mechanisms to bond against future revenue streams and thereby implement the project. Annual debt service payments for the project were calculated based on the loan terms for traditional tax-exempt debt financing typically available to transit agencies. Lower-cost alternatives, such as interest rate-subsidized loans through the federal Transportation Infrastructure Financing and Innovation Act (TIFIA) program and the proposed Qualified Transit Improvement Bonds (QTIBs), were also analyzed to understand the effect of financing costs on project viability.

Traditional Tax-Exempt Debt
Traditionally, regional transit agencies have access to tax-exempt financing at lower borrowing rates than those available in the private capital markets. The financing terms used to calculate annual debt service payments on this project included a 5.00% fixed interest for a 30-year term, with a 2.0% loan origination fee and 1.2x required debt coverage ratio.

TIFIA Loans and Credit Guarantees
The TIFIA program provides Federal credit assistance in the form of direct loans, loan guarantees, and standby lines of credit to finance surface transportation projects of national and regional significance. The loan amount is limited to a maximum of 33% of the total eligible project costs and must be secured by a dedicated non-federal repayment source, with flexible repayment terms up to 35 years (including no repayments for the first 5 years after substantial completion of the TIFIA-financed project). Notably, the interest rate for the TIFIA program is set at a fixed, subsidized rate that may be lower than the rate for tax-exempt debt raised in the municipal market. TIFIA interest rates are equivalent to United States

Treasury rates on securities of comparable maturity counting from the date of execution of the loan agreement. As of May 2011, it was set at an annual rate of 4.28% based on a 35-year loan.

Qualified Transit Improvement Bonds (QTIBs)
As part of its America Fast Forward proposal, the Los Angeles Metropolitan Transportation Authority (Metro) has advanced legislation to create a new federal loan program for transit projects. QTIBs would be a form of tax credit bond issued by state, local or other eligible entities where the federal government subsidizes most or all of the interest cost through granting investors annual tax credits in lieu of interest.

At present, under the proposed program, the federal government would subsidize 100% of the financing costs (equivalent to a 0% interest rate) associated with the QTIBs, with the borrower responsible only for repayment of principal over a maximum 35-year loan period. For the purposes of the financial evaluation, the loan fee and debt coverage ratio requirements are assumed to be similar to traditional tax-exempt financing.

In a recent joint statement on the transportation reauthorization bill pending in Congress, a bipartisan group of Senators on the Environmental and Public Works Committee announced its intention to incorporate the principles of the America Fast Forward program into its forthcoming Moving Ahead for Progress in the 21st Century (MAP-21) legislation, the successor to SAFETEA-LU. This is the most promising signal to date that an enhanced, federally-sponsored financing program, whether in the form of QTIBs or more expansive TIFIA loans, may be available to advance large-scale transit projects in the future.

7.3.5 Alternative Project Cost Scenarios

Since the estimated project costs were based on conservatively high unit cost factors, alternative cost estimates were also identified for inclusion in the analysis of future financial scenarios. For capital costs, a best-case scenario was determined to be an average construction cost of $100 million per mile (roughly half the base case unit cost), because this value is consistent with some of the lower-cost light rail systems in the United States, and is a conservatively high estimate for the Aerobus technology if it became feasible for a project of this scale. For O&M costs, the average O&M cost for light rail systems in the United States (around $250 per hour) was determined to be an appropriate unit cost for analyzing alternative scenarios.

7.4 Potential Financial Scenarios

7.4.1 Project Financial Analysis – Base Case and Alternate Scenarios

The cost and revenue estimates were packaged into four scenarios: a Base Case (consistent with the evaluation of system alternatives) and three other scenarios that apply the various cost, revenue, and financing assumptions identified above. As shown in Table 7.8, the least optimistic estimates were assumed in the "Least Optimistic Case" (Scenario #1), the midpoint estimates were assumed for the "Mid-Range Case" (Scenario #2), and the most optimistic end of each range was included in the "Most Optimistic Case" (Scenario #3).

Table 7.8 - Cost and Revenue Range Estimates Applied to Each Scenario

Scenario	Base	#1	#2	#3
Scenario Description	Base Case	Least Optimistic Case	Mid-Range Case	Most Optimistic Case
Capital Cost	high	highest	medium	low
Operating Cost	high	high	average	average
Passenger and Freight Revenues	Lowest	low	medium	high
Potential New Revenue Sources	Medium	low	medium	high

For each scenario, the Consultant team assumed that the entire capital cost of the project would be financed. The total annual funding required for debt service was then calculated, based on the method of financing selected for that scenario. Any excess passenger/freight revenues and other funding sources available to support debt service were deducted from the total annual funding required to calculate the remaining annual funding gap. The corresponding amount of public funding (or reduction in capital cost) needed to make the project financially viable is also then shown.

The following table summarizes the results of the financial analysis:

Table 7.9 - Calculation of Annual Funding Gap/Surplus

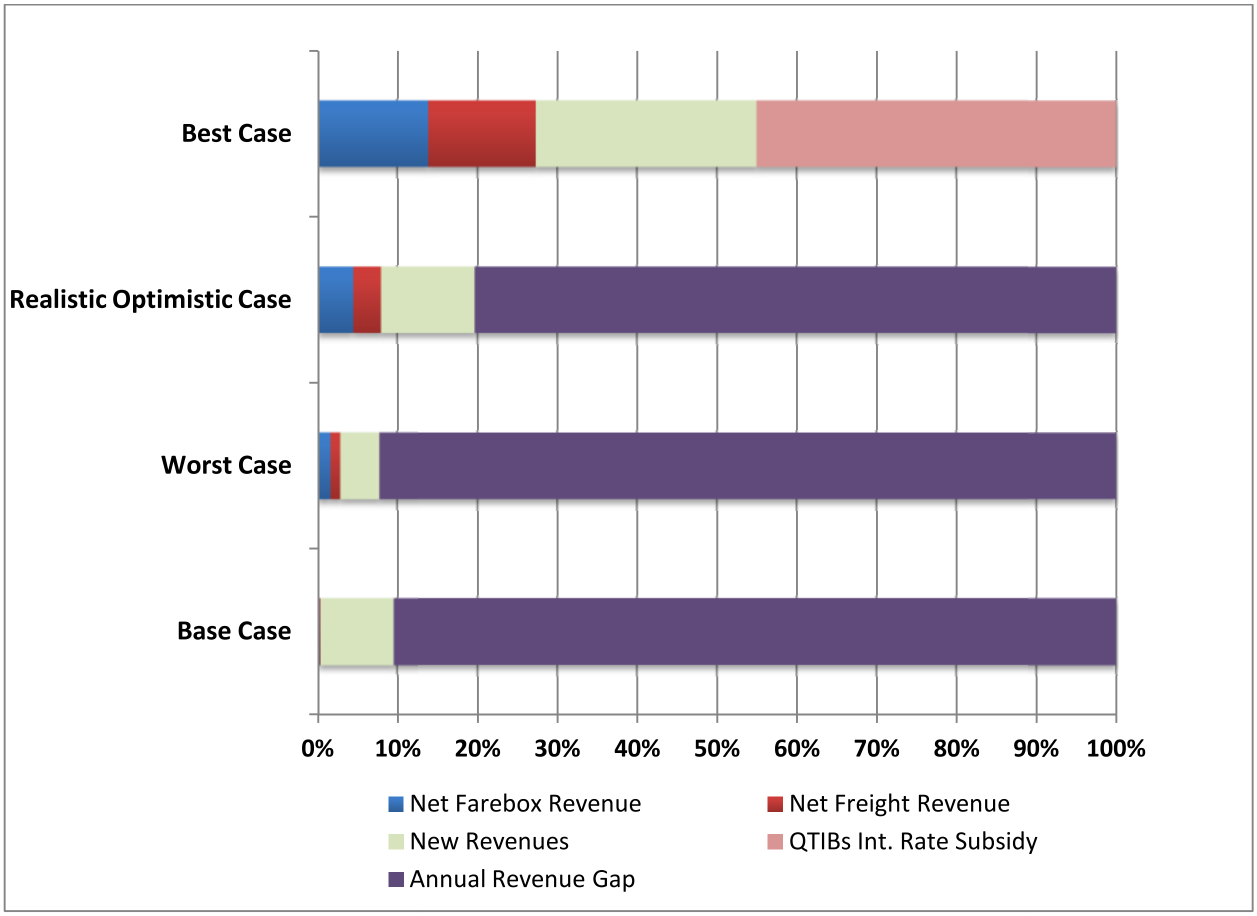
Scenario	Base	#1	#2	#3
Scenario Description	Base Case	Least Optimistic Case	Mid-Range Case	Most Optimistic Case
Assumed alignment length	37 miles	37 miles	37 miles	37 miles
Capital Cost ($2011, millions)	$6,000.0	$6,250.0	$4,710.0	$3,070.0
Financing Method	traditional tax-exempt	traditional tax-exempt	traditional tax-exempt	QTIBs 0% interest
Annual revenue stream needed to cover debt svc	($477.7)	($497.6)	($375.0)	($107.4)
Passenger and Freight Revenues	$1.6	$14.0	$29.8	$62.6
New revenue sources	$44.0	$24.5	$44.0	$63.5
Total available annual revenue sources available for debt svc	$45.6	$38.5	$73.8	$126.1
Annual revenue (gap)/surplus	**($432.1)**	**($459.1)**	**($301.2)**	**$18.8**
Bonding Capacity of Total Available Revenue Sources	$572.8	$483.9	$926.8	$3,606.7
Additional Public Funding/Capital Cost Reductions Needed or (Bonding Capacity Surplus)	$5,427.2	$5,766.1	$3,783.2	($536.7)

On this basis, only the Most Optimistic Case Scenario could be fully funded, assuming the highest passenger and freight revenue scenarios, the highest rates for supplementary revenue sources, and the lowest interest rates on bonding. For all other scenarios, the annual shortfall needed to finance additional bond proceeds is projected to range from $301 million per year to $459 million per year, as shown in Figure 7.1 below.

Figure 7.1 - Annual Projected Funding Streams and Additional Revenue Needed to Support Project Debt Service (funding gap shown in purple)

For both the “Base Case” and “Least Optimistic Case” (Scenario #1), the total available revenue stream provides less than 10% of the funding required to cover debt service on the project’s capital costs. For the “Mid-Range Case” (Scenario #2), these sources generate less than 20% of the funding required. For the “Most Optimistic Case” (Scenario #3), substantially higher passenger and freight revenues combined with a significant reduction in capital costs and near-zero interest rate financing are able to close the funding gap entirely. The interest rate subsidy offered through the QTIB program in the “Most Optimistic Case” scenario constitutes over $103 million in avoided annual project costs. Figure 7.2 shows the composition of funding sources and their relative contribution to the total required annual debt service payments in percentage terms.

Figure 7.2 - Annual Revenue Gap as a Percentage of Total Debt Service Requirement



7.3.2 Sensitivity Tests

In the "Most Optimistic Case" (Scenario #3), the total available revenue sources exceed the annual debt service payments by almost $19 million, thereby generating excess bonding capacity on the order of approximately $536 million. Given this surplus, the Consultant team ran a series of sensitivity tests to determine the parameters of financial sustainability for the project under this scenario, including 1) minimum level of interest subsidy required; 2) maximum debt coverage ratio; 3) minimum loan repayment period; 4) maximum increase in capital costs. These sensitivity tests acknowledge that some of the financing assumptions used in the "Most Optimistic Case" may ultimately change. The level of interest rate subsidy provided under the proposed federal QTIBs program is, for example, likely to be in the range of 70% to 100%; the risk premium on fare revenue bonds may translate into a higher required debt coverage ratio for any financing obtained on the project; other loan terms may also change. In addition, not all of the anticipated capital cost reductions may be successfully achieved.

Table 7.10 below shows the maximum adjustment that could be made to each of these individual financing and cost assumptions while maintaining project viability. Each sensitivity test assumes that all other project factors are kept constant (ie. adjustments are not cumulative):

Table 7.10 - "Most Optimistic Case" Sensitivity Tests

	Most Optimistic Case Scenario Assumption	Maximum Adjustment
Level of interest subsidy	100% (0.00% interest)	82% (0.923% interest)
Debt Coverage Ratio	1.20	1.41
Loan repayment period (yrs)	35.0	29.8
Capital cost (millions)	$3,070	+17.5% over existing cost

Alternatively, the estimated annual revenue surplus of approximately $19 million under the "Most Optimistic Case" scenario could also obviate the need for some of the new funding sources assumed for this scenario (see Section 7.1.2).

7.5 Findings and Conclusions of Financial Evaluation

The key findings of the financial analysis are as follows:

- The high capital cost and the project financing cost (assuming traditional tax-exempt debt) are the most significant financial impediments to financing a feasible project.
- The project could generate an operating surplus under the following conditions:
  - the corridor alignment follows one of the shorter or medium length routes;
  - the system includes stations that provide: a direct connection to Metrolink, convenient transloading for goods movement, a convenient park and ride lot at the base of the mountains, and intermediate stations in the mountain area (such as Running Springs and Snow Valley)
  - the system's hourly operating costs are toward the middle or lower end of the cost range for light rail systems in the United States; and
  - the system operation includes a package shipping operation that can successfully attract an adequate share of the market.
- Other additional sources of revenue (besides passenger fares and freight revenue) will be needed in order to have a sufficient revenue stream to pay for capital costs through bond financing. Various types of new revenue sources are possible, though relatively few could generate sufficient ongoing revenue to meaningfully contribute to debt payments for a project of this magnitude. For those sources that are capable of generating a significant revenue stream, support from the public and elected officials will be required to achieve their adoption.
- Even with very optimistic assumptions regarding operating revenues and additional revenue sources, the project's financial viability depends on getting either low interest bond financing or a multi-billion dollar government grant to help defray the capital costs.

For the project to be financially feasible:

- The estimated capital cost will need to be lower than the $5+ billion estimated in this study. More detailed study will be needed to identify an alignment that: follows a reasonably direct routing between San Bernardino and Big Bear Lake, has relatively limited need for elevated segments or structures, avoids environmentally sensitive areas, and minimizes right-of-way costs.

- Operating revenues will need to be maximized. A significantly higher-than-typical passenger mode share will need to be captured because of factors like substantial increases in fuel prices, or extended road closures in the mountains. A very high level of freight movement activity will need to be captured because of factors like extended road closures in the mountains or new vehicle technology requirements that limit trucks' ability to climb mountain grades.
- Substantial new sources of funds will be needed to help defray capital costs.
- Very low interest bond financing will need to be secured for most of the project's capital cost.

8. FINDINGS AND RECOMMENDATIONS

This chapter highlights the study's key findings that will significantly affect/determine the desirability and feasibility of implementing an alternative mode in this corridor and the conditions under which it would be feasible. The findings are followed by recommended actions for the agencies to take to: (1) better define specific system parameters (alignments, etc.) that would help enhance the system's feasibility; and (2) monitor the progress of technological, legislative, or other issues that could significantly contribute to system feasibility.

8.1 Key Findings

Transportation System Constraints

1. The mountain highway routes that provide access to the Big Bear Valley experience traffic congestion on weekends throughout the year, and experience high levels of congestion for extended periods of time on holiday weekends and winter weekends with good snow conditions.
2. The mountain access roads are increasingly vulnerable to closure or restriction because of adverse weather, traffic accidents, rockfall, landslides, or wildfire.
3. These impediments to mountain access act as constraints to growth and development in the Big Bear Valley, and to the Southern California Region's ability to take advantage of the mountain area's four-season recreational assets.
4. The feasibility of adding significant capacity to existing highways or constructing a new road facility is doubtful because of both environmental and financial constraints.
5. A non-roadway transportation alternative could increase transportation system capacity, reduce traffic congestion, operate in adverse weather or when roads are closed, and help accommodate long-term growth in mountain area population and visitation, and with environmentally sensitive and sustainable planning and construction, could likely have less environmental impact than road improvements that would provide comparable system capacity.

Technology Issues

6. Only one non-roadway transportation technology currently exists and has demonstrated in commercial operation its capability to safely transport large numbers of people across the kinds of distances and the steep terrain encountered in this corridor at speeds and costs that are competitive with automobile travel (and could therefore attract significant numbers of riders). For these reasons, the current preferred feasible technology for this corridor is light rail technology with a rack (cog) system that can engage on steep slopes.
7. Self-propelled aerial ropeway technology has shown the potential to have competitive operating characteristics with a lower initial capital cost, but has only been built and operated on a limited basis and is not currently in commercial operation.

Corridor Alignment Considerations

8. Certain alignment and station options are important to the success of the system and to best achieve the purpose and need:

f) a reasonably direct alignment between San Bernardino and Big Bear Lake, because a long alignment would substantially increase the project's capital cost and the overall travel time, which would make the system less attractive to potential riders and reduce operating revenues;
g) an alignment that serves intermediate mountain communities such as Running Springs and Snow Valley, because it would increase ridership and revenue and would substantially increase the number of travelers for whom an alternative system could be a viable travel option;
h) a station with direct connection to Metrolink, to provide convenient transit access to Big Bear Lake from much of the greater Los Angeles metropolitan area;
i) valley and mountain stations that provide convenient transloading for goods movement, so the system can compete effectively in the freight shipping market; and
j) a convenient station/park-and-ride lot at the base of the mountains, to attract auto users that prefer not to navigate the mountain roads.

9. More detailed engineering studies will need to be undertaken in order to confirm feasible alignments. In particular, detailed study will be needed to find alignments that avoid sensitive habitat areas, minimize needs for environmental mitigation, and are not unreasonably subject to landslide risk.
10. Much of the corridor will pass through the San Bernardino National Forest. Regardless of the specific alignment selected, it will traverse areas currently designated as incompatible with a new transportation system, since extensive areas of the National Forest have been designated to remain roadless or as appropriate only for non-motorized transportation. US Forest Service representatives have indicated that an extensive review and approval process within the Forest Service would be required to obtain approval for a change to accommodate a new transportation system through these areas.

Financial Considerations

11. For the project to be financially feasible:
    a) The estimated capital cost will need to be toward the lower end of the range estimated in this study. More detailed study will be needed to identify an alignment that: follows a reasonably direct routing between San Bernardino and Big Bear Lake, has relatively limited need for elevated segments or structures, avoids environmentally sensitive areas, and minimizes right-of-way costs.
    b) Operating revenues will need to be maximized. Changing conditions in the coming years are expected to lead to increasing interest in, and demand for, an alternative transportation mode to the mountains; these include increasing fuel prices, environmental regulations that affect vehicle technology (limiting the ability of trucks to ascend steep grades), and more frequent mountain road closures. These factors could enable a new transportation system to capture a significantly higher-than-typical passenger mode share and a high level of freight movement activity in the corridor, and generate a substantial positive stream of net operating revenue.
    c) Substantial new revenue sources will be needed at the local or regional level, to provide a reliable funding stream so the project sponsor can issue long-term bonds to satisfy the upfront capital need.
    d) Very low-interest bond financing will need to be secured for most of the project's capital cost.
    e) If all of the above factors do not materialize, substantial supplemental sources of traditional grant funding will likely be necessary to help defray capital costs in addition to any new revenue sources.

8.2 Recommendations

In short, the analysis has found that an alternative transportation system would be a good solution to help address future transportation needs between the San Bernardino Valley and Big Bear Lake; however, the system's technical and financial feasibility depends on the convergence of a number of political, financial, and operational conditions. Changing circumstances associated with energy costs, fuel sources, vehicle technology, air quality regulation, and transportation project funding and financing could create a situation in which an alternative transportation mode would be financially feasible. The following recommendations for further action are designed to increase understanding about the evolving status of circumstances that would be necessary for the project's success, while developing more specific information about system alignments, technologies, and operations that could help define a specific project proposal that is consistent with the requirements for success.

Next Steps

A. Outreach

1. Conduct a dialogue with the corridor's key elected officials and opinion leaders to determine the current level of interest in, and support for, the project.
2. Conduct an ongoing dialogue with the US Forest Service to develop a better mutual understanding of future transportation needs through the San Bernardino National Forest and how to serve them.
3. Work with USFS staff to develop a description of the requirements and process that would be involved in order for the Forest Service to be able to approve an alternative transportation system through the San Bernardino National Forest.
4. Monitor the progress of legislation in Congress that could present opportunities for grant funding.
5. Monitor the progress of the Fast Forward America legislation in Congress, and identify the potential and conditions for zero- or very-low interest financing for this project.
6. Monitor technological progress toward commercial operation of high-speed, high-capacity transportation technologies that can travel long distances and traverse steep grades through the mountains at overall speeds competitive with automobile travel.
7. Explore the potential to enter into a project development agreement with a light rail vehicle or other equipment manufacturer who may be interested in bringing its technology to market and may be willing to co-fund a Major Investment Study.
8. Conduct a dialogue with other resort access corridors that face similar transportation access challenges (Sacramento - Lake Tahoe, CA; Salt Lake City - Cottonwood Canyons UT; and Denver - Rocky Mountain Resorts, CO). Identify common issues and explore possibilities for benefits from cooperation.

B. Project Phasing/Early Action Opportunities

1. Evaluate potential project phasing to ascertain the viability of developing a first phase of the project before the entire system.
2. Identify potential early action projects that could serve as initial steps toward a new mountain access system.

C. Cost and Revenue Refinement

1. Undertake a conceptual engineering study or Major Investment Study to determine the location and cost of alignment alternatives that serve intermediate mountain communities, avoid sensitive habitat and minimize environmental mitigation, and avoid unnecessary risk of landslides.
2. Develop a better understanding of the geotechnical issues, constraints, and risks involved with developing a cog rail system through the corridors identified as alternatives for Alignments 3 and 4, for the purpose of helping to identify a lower-risk alignment that follows a relatively direct route from San Bernardino to Big Bear Lake.
3. Develop refined estimates of potential ridership and farebox revenues, as well as potential freight shipments and revenue.
4. Develop a more refined concept for passenger access to and from the mountain stations in the system. Identify an operational concept that is well suited to the access and distribution needs of potential passengers, as well as estimates of capital costs, operations and maintenance costs, and potential revenues.
5. Develop a more specific understanding of current goods movement activity through the corridor, including the types and volumes of commodities being carried and how the goods are distributed to mountain destinations.
6. Develop a more refined concept of how a cog rail system could serve the mountain corridor's goods movement needs effectively and efficiently. Include determination of types of goods to be carried, feasible and effective operational strategies, and a concept for distributing goods from mountain stations to their destinations.
7. Evaluate the potential ridership and farebox revenue within catchment areas of the corridor (i.e., trips between valley stations and between mountain stations), including potential increases if more stations are added to the alignment.
8. Investigate the reasons for differences in hourly operating costs for light rail systems in the United States, and develop a refined operating cost scenario for a light rail/cog rail system in the San Bernardino – Big Bear Lake corridor.