The Economic Impact of the Yucca Mountain Nuclear Waste Repository on the Economy of Nevada

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EXECUTIVE SUMMARY

Current Yucca Mountain Project (YMP) operations provide relatively high-wage employment to the Nevada economy and constitute an economically stable proportion of the total gross state product (GSP). If the YMP were discontinued, economic losses, relative to the current economy, would be substantial. In 2000, the YMP contributed $195.7 million to the Nevada economy and an additional $188.6 million in 2001. The YMP was responsible for 3,650 jobs in 2000. This translates into a real disposable income of roughly $131 million earned each year in the state of Nevada.[1]

If the YMP is approved, future economic impacts will occur as a result of constructing the facility and transportation routes, transporting the waste, and operating the storage facility. At present, the methods and route for transporting the waste to YMP are not finalized. However, the 'mostly rail' scenario is the preferred alternative according to the Department of Energy Repository Final Environmental Impact Statement (DOE EIS)[2]. This scenario assumes that most – if not all - of the waste will enter Nevada via existing rail lines. We assume that once inside Nevada, waste will continue traveling by train over a new rail spur. There are five alternative new rail spur impacts considered in this report: the Caliente Rail Alternative, the Caliente-Chalk Mountain Alternative, the Carlin-Big Smokey Alternative, the Valley Modified Alternative, and the Jean Alternative.

Consistent with the DOE EIS, we assume that intensive construction of the facility and transportation routes begins in 2005 with transportation of nuclear waste to the site beginning in 2010. We compare the forecast with the YMP to that without the YMP. The difference between the "with" and "without" scenarios is the economic impact of the project. We report the total economic impact in terms of three familiar economic variables: employment, GSP, and RPI relative to the baseline forecast for the state of Nevada. The resulting output gives a reasonable portrait of the market-based economic impacts Nevada can expect if the YMP is approved.

The largest employment impacts are gained during the construction of the facility and transport routes. Construction-employment impacts vary over the alternatives from a job gain of 4,000 over the baseline forecast for the Caliente alternative to just over 3,200 for the Valley Modified Alternative. Employment impacts during the transportation and the operations phase (2010 - 2035) range between 2,000 and 2,500 jobs varying modestly

[1] In order to accommodate year-to-year comparison in terms meaningful to present day expenditures, these values - as are all other dollar values presented in this document - are in terms of real 2003 dollars.
[2] Section 2.6, p.2-98

with the transport alternative and the year. These are employment impacts over and above the current YMP employment.

YMP labor is expected to be well paid relative to the state average wage. RPI associated with the YMP grows steadily over the years analyzed for each of the five alternative transport routes and varies somewhat over the alternatives. Nevertheless, the economic assessment shows that substantial RPI impacts can be expected ranging from about $51 million during the initial construction phase, peaking at roughly $150 million in 2035.

The total economic activity generated by the YMP is represented by GSP. GSP impacts are largest during the construction phase. Wages and salaries to employees together with in-state procurement activity are expected to boost state GSP by as much as $228 million during the peak of the construction phase in 2006. Average annual GSP impacts over the transportation and operations phase exceed $102 million annually, topping $127 million in many years.

It is important to note the lack of cyclicality of the potential economic impacts of YMP. Unlike gaming and tourism, which are subject to national and international recession-expansion cycles, the YMP is expected to be a sustained source of economic activity that is independent of the vagaries of the financial markets and economic cycles. Relatively high-paid employment and in-state construction and operations procurement will provide a continuous stream of economic activity for Nevada.

The changes in expected economic activity are not limited to the standard economic impacts, however. There is also a market externality associated with nuclear waste. Namely, the toxicity of high-level radioactivity means that there are health and safety risks to anyone who may come in contact with the waste. In particular, the public has expressed concern about safe transport of nuclear waste. If households perceive the risk as too high, they may relocate in order to protect themselves from transportation accidents.

We estimate that perception-based risk impacts will initially partially offset some of the gains in employment, GSP and RPI. This effect should quickly diminish when residents who are susceptible to risk-based housing relocation are replaced by more risk-tolerant residents. Without any transport risk, Nevada is expected to add almost 21,000 jobs in 2010. The transport risk will cause that number to fall by about 3,300 to 17,700 new jobs expected in that year. Housing prices, predicted to rise by about 5 percent in 2010, will see a one-time decrease in the growth rate by 1.7 percentage points with expected growth in house prices falling to 3 percent that year. Home-price growth will resume at its predicted rate shortly thereafter. GSP impacts will also be observed in the early transport years (2010 – 2011) when GSP will fall short of the predicted value of $ 85.091 billion by just over $400 million. Again, the negative GSP impact will quickly diminish as the population shifts to a more risk-tolerant population base. GSP losses (relative to the baseline growth) will average about $17 million annually during the transportation and operations phase.

In theory, the total economic impact of the YMP is the sum of the direct, indirect, and induced effects together with the economic impact of the perceived transportation risk. However, the uncertain nature of the risk impacts makes us hesitant to make a direct comparison. For example, as we will show, one of the primary reasons that negative economic consequences are associated with transport risk is that people hold a very different perception of the risk of nuclear-waste transport than does the DOE. If people adopted the DOE's risk assessment, economic impacts associated with risk aversion would be small. Similarly, people have uncertainty about what risk will materialize. Reducing that uncertainty acts to substantially reduce the economic impact of the risk.

The fact that 1) the public and the DOE have widely divergent risk beliefs and 2) the public is very uncertain about what risk they will actually face means that the DOE and the federal government have latitude to offset the economic impacts associated with perceived risks of nuclear-waste transport using educational programs that give people information about risks. We will show that for the effort to be successful, it is critical that the information is perceived as accurate and reliable. It must be tailored to the local community and honestly depict the risk thereby familiarizing the community with the likelihood of different accident scenarios. The results show clearly that information and education programs can largely offset social-welfare losses if they are able to calm people's fears and reduce uncertainty.

We should also note that economic impacts in Nevada included in this report are largely wage and salary based. In other words, we assume that the bulk of the capital, machinery, and construction materials are purchased out of state. This is a reasonable assumption because Nevada currently does not have the manufacturing or production base to supply much of the needed material. Nevertheless, any additional YMP dollars spent in Nevada over and above those considered in the report will generate new spending activity and the economic impacts would undoubtedly be larger than estimated here. Therefore, the numbers we present are likely to be conservative estimates of the true economic impact.

A SUMMARY OF THE STANDARD MARKET-BASED ECONOMIC IMPACTS FOR THE FIVE SCENARIOS

Note: All values are presented in terms of real (2003) dollars, unless otherwise noted.

Caliente Rail Alternative

Rail construction is scheduled to take place over a 46-month period ending in December 2009. A total of 2,821,300 worker hours spread out evenly over the construction period is estimated, translating into 442 workers per year (with 25% labor contingency).

The GSP generated over and above the baseline forecast is largest during the construction phase, peaking at nearly $228.5 million in 2006. The GSP impacts are smaller in the operations and transportation phase, when GSP impacts average $117 million. RPI impacts are more constant over the construction and operations phase, averaging $123 million annually. Employment impacts mirror the pattern of GSP impacts with about 4,000 additional jobs relative to the baseline forecast in 2006-2007 and falling to approximately 2,000 jobs during the operations and transportation phase.

Caliente-Chalk Mountain Rail Alternative

GSP impacts average $124 million annually during the construction phase and $117 million during the operation and transportation stage. RPI impacts grow modestly over time, with construction RPI impacts ranging from $56 million to $131 million. The average operations and transportation RPI impact is $124.4 million. Employment impacts are very similar to those from the Caliente Rail Alternative, averaging 2,224 jobs annually over the baseline forecast.

Carlin-Big Smokey Rail Alternative

Construction GSP impacts exceed $203 million in 2006 and 2007 tapering off in the years thereafter. During the operations and transportation phase, GSP impacts range from $88.9 million in 2033 to just over $12.7 million in 2025. RPI impacts average $107.8 million during the construction phase and $122 million over the range of all operations. Employment impacts peak at just under 4,000 additional jobs in 2006 averaging 2,245 over the construction, transportation, and operations phases analyzed.

Jean Rail Alternative

GSP effects top $199 million in 2006 and reach $203 million by 2007. The aggregate GSP effect over the construction and transportation lifetime is $3.797 billion. RPI impacts are also substantial. As construction ramps up, RPI attributable to the YMP totals

$126.6 million annually. The cumulative, or aggregate, RPI effect is $3.712 billion. A year into construction, the state employment impact surges to 3,600 jobs. As construction winds down, so do employment impacts. By 2010, 2,250 jobs in excess of the baseline forecast are foreseen. During the transportation phase, the employment attributable to the program ranges between a low of 1,500 jobs in 2033 to a high of 2,345 in 2012.

Valley Modified Rail Alternative

Direct, indirect, and induced GSP impacts sum to $178.1 million and $179.1 million in 2006 and 2007, respectively. For the remaining years, GSP impacts range from $85.5 million to $144.7 million, varying with construction expenditures, transportation, and time. The total GSP impact over the 30 years of construction and transport is $3.355 billion. The initial income impact at the beginning of the construction phase in 2005 totals $55.5 million. By 2007, the income impact reaches $11.7 million. The impact hovers between $90.1 million and $123.1 million during the completion of the construction phase and the early years of waste transport (2008 – 2020). The aggregate RPI impact over the range of construction and transport totals $3.65 billion in 2003 dollars. Over the transportation phase, running from 2010 to 2035, the employment impact varies between a low of 1,485 jobs in 2032 and a high of 2,500 jobs in 2010, the first year of transportation. The average annual employment impact of this alternative is 2,148 above the baseline forecast.

The Economic Impact of the Yucca Mountain Nuclear Waste Repository on the Economy of Nevada: Final Report

I. INTRODUCTION

In July 2002, Congress passed and President Bush signed a bill recommending Yucca Mountain in Nye County, Nevada, as the country's central repository for spent nuclear fuel. This paves the way for a two-year licensing investigation of the site by the U.S. Nuclear Regulatory Commission. If licensed, the facility could begin accepting high-level radioactive waste as early as 2010.

Since 1987, when Yucca Mountain was named the sole site for study of its potential as a geologic repository, scientific investigation of the site has been ongoing. The project has employed scientists, engineers, and other workers who earn wages significantly higher than the average wage in Southern Nevada. Payments equivalent to taxes (PETTS) are paid to the state to offset costs to the state from federal employees. The project has also rented office and laboratory space. Taken together, this spending affects the Nevada economy directly by boosting employment, renting commercial space, and putting money in state and county coffers.

If approved, the repository construction, transporting nuclear waste to the site and construction of new transportation systems suited to the transport vehicles are likely to have economic consequences within Nevada. Construction of the facility will mean direct employment for Nevadans. And, whether trucking the waste to the site or shipping it by rail, money will be spent in Nevada for augmenting current transportation systems and building new ones, leading to more job creation in the state. Finally, when the repository opens, staff will be needed to manage handling of the waste and monitoring the facility. Thus, the YMP is likely to directly create new jobs in Nevada by hiring workers to work at the repository or constructing facilities to transport waste to the repository.

Of course, there are secondary economic benefits following the initial job creation. Workers will be spending time in rural Nevada and are likely to purchase lodging, services, and food. The resulting spending, termed indirect effects, may be a substantial. Other positive indirect economic benefits will accrue to Nevada firms supplying goods and services to those directly employed in road construction or transportation. For example, firms that supply concrete to road contractors will enjoy a surge in demand for their services as will those firms affiliated with concrete supply. Workers will purchase homes, retail goods, and services with their wages and much of that will be spent in Nevada. Their spending results in second- round economic impacts, or induced effects, of the initial economic impact of YMP. The total economic impact revealed by the market is the sum of the direct, indirect, and induced economic impacts. Table 1 gives definitions of direct, indirect, and induced effects and their potential impacts.

Table 1. Direct, Indirect, and Induced Effects: Definitions and Potential Impacts

	Definition	Potential Impacts
Direct Effects	The response (for example, change in employment) for a given industry per million dollars of final demand.	Direct employment, wage differential, capital expenditures, and tax offsets
Indirect effects	The response by all local industries caused by the iteration of firms purchasing from other firms.	Indirect employment impacts, wage differentials, capital expenditures
Induced Effects	The response by all local industries caused by new household expenditures generated by direct and indirect effects	Induced employment impacts, wage differentials, capital expenditures

The first goal of this study is to tally the direct, indirect, and induced economic impacts of the YMP on the state of Nevada if the site is approved. To do so, we employ a state-of-the art forecast model that we have specially calibrated for Nevada. We produce a baseline forecast of economic activity within the state beginning in 2005 through 2035. Following that, we develop a model of expected economic activity given that the YMP is approved. We assume that intensive construction of the facility and transportation routes begins in 2005, with transportation of nuclear waste to the site beginning in 2010. We compare the forecast with the YMP to that without the YMP. The difference between the "with" and "without" scenarios is the economic impact of the project. We report the impact in terms of three familiar economic variables: employment, gross state product (GSP), and real disposable personal income (RPI). The resulting output gives a reasonable portrait of the market-based economic impacts Nevada can expect if the YMP is approved.

The second goal of this study is to develop a picture of the current economic impacts of YMP activities on the state and primarily affected counties. We develop an "what if" scenario that describes what the local economy would lose if scientific investigation ceased at the site. By doing this, we are able to give a summary of what employment, PETTS, and other spending currently contribute to Nevada's economy. This information, together with the expected future economic impacts of proceeding with site development, gives a complete picture of market-based economic impacts, both present and future, of the YMP.

The changes in expected economic activity are not limited to the standard direct, indirect, and induced economic impacts, however. There is also a non-market externality associated with nuclear waste. Namely, the toxicity of high-level radioactivity means that there are health and safety risks to anyone who may come in contact with the waste. In particular, the public has expressed concern about safe transport of nuclear waste.

Market-based economic impacts are relatively easy to quantify. However, non-market based economic impacts, like those arising from the perception of increased health and safety risks associated with waste transport, may also affect the state and county economies but they are harder to quantify. In the Repository Final Environmental Impact Statement, DOE (DOE EIS) estimated that the annual frequency of the maximum reasonably foreseeable legal-weight truck accident would be 2.3 x 10-7. The potential consequences of such an accident would be 0.55 latent cancer fatalities, which would result from very low doses to a very large population. However, the public's perception of the health and safety risk will determine the final economic impact of the facility. If households perceive the risk as too high, they may relocate in order to protect themselves from transportation accidents.

The third component of this study examines the effects of the risk perceptions from transporting high-level radioactive waste on housing location decisions in southern Nevada using a variation of the contingent behavior method. We first develop a model-based subjective risk estimate for each household using data from a carefully-constructed survey of southern Nevada households. Conditioning on the household's subjective risk, we explore different factors that may influence the household's location decisions if the proposed transportation route is ultimately chosen for nuclear-waste transport. We extend the conventional model of expected utility to allow for uncertainty surrounding the actual risks borne by the household. This idea has been deemed an ambiguity effect (Viscusi and Magat 1992). Ambiguity may be particularly important when, in a project like Yucca Mountain, the risks are very difficult to assess. This third component includes the losses households experience because of perceived risk to their health and safety, and through depreciation in real-estate values. The predicted decline in real-estate values is then fed through the REMI model and the full economic impact of the transportation risk is then estimated. Again, this economic impact is reported in terms of the familiar concepts of employment, GSP, and RPI.

Finally, this study develops an estimate of the social costs of perceived losses in safety to Nevada households living near transportation routes. We identify two methods of estimating social costs. The first arises directly from the household-location model. We ask survey respondents about their relocation intentions given different values of federal government compensation for risks associated with nuclear-waste transport. This allows us to estimate an average value of willingness to accept (WTA) compensation for different levels of perceived risk. Following that, we estimate an average willingness to pay (WTP) to avoid risk using a conjoint model of housing choice.

In theory, the total economic impact of the YMP is the sum of the direct, indirect, and induced effects together with the economic impact of the perceived transportation risk. However, the uncertain nature of the risk impacts makes us hesitant to make a direct comparison. For example, as we will show, one of the primary reasons that negative economic consequences are associated with transport risk is that people hold a very different perception of the risk of nuclear-waste transport than does the DOE. If people adopted the DOE's risk assessment, economic impacts associated with risk aversion would be small. Similarly, people have uncertainty about what risk will materialize. Reducing that uncertainty acts to substantially reduce the economic impact ofthe risk.

The fact that 1) the public and the DOE have widely divergent risk beliefs and 2) the public is very uncertain about what risk they will actually face means that the DOE and the federal government have latitude to offset the economic impacts associated with perceived risks of nuclear-waste transport using educational programs that give people information about risks. We will show that for the effort to be successful, it is critical that the information is perceived as accurate and reliable. It must be tailored to the local community and honestly depict the risk thereby familiarizing the community with the likelihood of different accident scenarios. The results show clearly that information and education programs can largely offset social-welfare losses if they are able to address people's fears thereby reducing uncertainty.

The report is outlined as follows. Section II provides a general description of the YMP waste transportation alternatives. Section III describes the REMI model, the Nevada calibration, the baseline forecast, and the assumptions concerning expenditures and employment for the YMP. Section IV gives the standard economic impacts, in terms of employment, GSP, and RPI for future economic activity if the site is approved. It also includes an analysis of the economic impact of current YMP expenditures i.e. the current economic activity attributable to current activities related to the YMP. Section V presents the risk perception model, the housing-location model, and the economic consequences of the transportation risk. Following that, we provide an estimate of social costs based on the household-location model and a conjoint model. We conclude with a summary of the report's finding and some suggestions relating to future research.

II. GENERAL DESCRIPTION OF YUCCA MOUNTAIN PROJECT (YMP) WASTE TRANSPORTATION ALTERNATIVES

The DOE is currently considering two scenarios for transporting of nuclear waste to the proposed Yucca Mountain Nuclear Waste Repository.

Mostly Legal-Weight Truck Alternative. One scenario assumes legal-weight trucks[3] will transport most of the nuclear waste. Because transportation would occur along existing roadways, this scenario would require little or no new construction or road enhancement. And, because it is most likely that the truckers and trucking firms used to transport the waste will be based outside of Nevada (within proximity to the point of waste generation), this scenario would have very little direct economic impact on Nevada's state economy beyond construction, maintenance, and operation (CM&O) of the Yucca Mountain Nuclear Waste Repository.

Mostly Rail Scenario. The preferred alternative is the other group of options, called the 'mostly rail' scenario (DOE EIS Section 2.6, p.2-98). This scenario assumes that most – if not all – of the waste will enter Nevada via existing rail lines. Once inside Nevada, waste will either 1) continue traveling by train over a new rail spur, or 2) large-capacity rail shipping casks will be transferred to 'heavy haul' (HH) trucks[4] at an Intermodal Transfer Facility (IMT) before continuing on its final destination to the Yucca Mountain Site.

There are five railroad route alternatives and five heavy haul truck route alternatives. At this time, no more than one of these ten alternatives would ultimately be pursued. (DOE EIS, p. S-23.) Two of the five RR alternatives begin in the town of Caliente, about 150 miles northeast of Las Vegas. One originates east of Carlin in north central Nevada; one called the "Valley Modified Alternative" originates near Apex just northeast of Las Vegas, and one in the Jean/Sloan area just southwest of Las Vegas. One route each is associated with two of the potential IMT sites – Apex/Dry Lake and Jean/Sloan. Three alternative routes are associated with the Caliente IMT potential site.

Additional Notes on the Alternatives. Note that transport of Navy fuel cannot be done by means of legal-weight trucks. (DOE EIS, p. S-21, S-68). Thus, the legal-weight truck scenario assumes that over the 24-year transportation phase, approximately 300 shipments of naval spent nuclear fuel would be transported to the repository by way of heavy haul trucks after coming into Nevada over existing rail, and transferred at existing rail heads. (DOE EIS section 2.1.3.2.2.)

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[3] Definition of 'legal-weight trucks' DOE EIS, p. S-23.
[4] Definition of 'heavy haul trucks' DOE EIS, p. S-23.

If the mostly rail scenario is adopted, current plans anticipate about 260 trips of roughly 400 casks annually over the 24-year transportation phase. (REMI input doc no. 7, p. 1.) The DOE anticipates that an additional 1,100 legal-weight truck shipments from those locations that do not have the facilities to ship the large casks will be made over the same 24-year period. (DOE EIS, section 2.6, p 2-98.) In summary, if the mostly rail scenario is adopted only one of the ten alternatives (five railroad routes and five IMT/HH route combinations) will ultimately be built.

Both the Caliente-Chalk Mountain RR alternative and the Caliente-Chalk Mountain HH routes are officially "non-preferred" by the United States Air Force due to their proximity to sensitive areas within the Nevada Test Site. (Summary Doe EIS, p. S-21, "Nevada Transportation Implementation Alternatives.")

Recent events, including the threats of terrorism and the proximity of both the Jean RR/IMT alternatives to the future site of the cargo/freight airport in Ivanpah, present potentially new security concerns and safety hazards not considered in the original cost estimates. Study of this issue may result in additional construction and/or operation costs necessary to mitigate any such hazards. Such costs are not included in any of these estimates of economic impacts.

DOE analysis suggests that the environmental impacts of the mostly rail scenario are expected to be less than those for the legal-weight truck scenario. Thus, the mostly rail scenario is its preferred transportation alternative. (EIS Section 2.6, p.2-98.)

III. THE ECONOMIC IMPACT MODEL

To estimate the economic impact of Yucca Mountain on the state of Nevada, it is necessary to have 1) a forecast of economic activity in the state without the YMP and 2) a forecast of economic activity with the YMP. The former is termed the "baseline" forecast because it offers a baseline for assessing additional economic activity that can be solely attributed to the YMP. The forecast of economic activity with the YMP is based on spending assumptions related to the project. In the following subsections, we describe 1) the REMI forecast model 2) the model assumptions under the baseline forecast, and 3) YMP expenditure assumptions underlying the forecast with the YMP.

Given the assumptions concerning construction operations and new employment, we estimate the economic impact of the YMP. The final impact may be broken down into two main components: 1) the impact of the *direct* expenditures from the construction and operation of the YMP and 2) *indirect* and *induced* impacts, created by the multiplier effect, whereby direct spending re-circulates through the economy creating expenditures over and above those directly attributable to the project.

The economic impact of the YMP, the difference between the baseline and the YMP forecasts, will be presented using three key economic variables: employment, real GSP, and RPI. Employment impacts are reported in terms of the number of jobs created either directly or indirectly in the economy each year. Real GSP is defined as the inflation-adjusted final value of all goods and services produced in the regional economy (either at the county or the state level) over the life of the project. RPI impact is the income earned by the region's residents (either at the county or state level) over the life of the program that would not have been earned without the program. We report all numbers in constant 2003 dollars.

3.1. The REMI Model

To estimate the baseline forecast and forecast with the YMP, we employ a structural demographic and economic model developed by Regional Economic Models, Inc. (REMI), specifically for Nevada.

The REMI model is a state-of-the-art econometric forecast model that accounts for dynamic feedbacks between economic and demographic variables. Special features allow the user to update the model to include the most current economic information. The model employed divides Nevada into five regions--Clark County, Nye County, Lincoln County, Washoe County and Carson City, and the remaining counties are combined to form a fifth region. These regions are modeled using the U.S. economy as a backdrop. The model contains over 100 economic and demographic relationships that are carefully constructed to parsimoniously represent the state economy. The model includes equations to account for migration and trade between the regions and other counties in the U.S.

The data used to construct the model begin in 1969. Because Bureau of Labor Statistics (BLS) personal income data are reported with a two-year lag, the most recent historical data in the model are from 1999. In an effort to ensure that the most current data are used in the forecast, we update the model with employment figures from the Nevada Department of Employment, Training, and Rehabilitation.

3.2. The Baseline Model and Forecast

Each year, The Center for Business and Economic Research (CBER) at the University of Nevada, Las Vegas, together with the Southern Nevada Water Authority, Clark County Comprehensive Planning, and the Regional Transportation Commission (RTC) of Southern Nevada, develop a long-term consensus forecast of population growth and population for Clark County using the REMI model. The model is a forecasting tool developed specifically for Nevada and Clark County and calibrated by CBER to reflect the most current information available concerning county employment, hotel and infrastructure investment, and changing economic and demographic conditions.

The population forecast comes as a part of a total economic system forecast including GSP, employment by major industry, and other key economic variables such as capital formation and residential and commercial construction. This forecast is used as the baseline economic forecast for this analysis.

Each year, CBER updates the model provided by REMI to account for new information. Below we present the assumptions underlying the updates and other relevant information regarding the baseline population and economic forecast.

3.2.1. Recalibrating the Model

Because county-level income estimates are only available from the Bureau of Economic Analysis with a two-year lag, the historical series in the REMI model are lagged two years. Updating industry-level employment, then recalibrating the model to reflect the new employment figures, allow for recent economic changes to be included in the forecast. We also update data concerning public-infrastructure investment and hotel construction to improve the accuracy of the model. Finally, we include amenity and maturation adjustments to account for expected changes in the Clark County economy that elude the model. In the next subsections, we discuss each of these adjustments and updates in turn.

The Employment Update. Each year we update the REMI model to account for recent information about industry employment in Clark County. Using ES202 data from the Nevada Department of Employment, Training, and Rehabilitation (NDETR), we calculate industry growth rates for 2000 and 2001 and apply those growth rates to the 1999 employment levels, by sector, reported in the REMI model. For 2002, we average growth over January through June and use that growth rate for 2002. We then re-base the employment in the model to reflect the ES202 growth rates.

The rebased employment table is reported in Table 2. The most notable employment update takes place in the hotel industry. The REMI model out of the box predicts hotel

Table 2. REMI Employment, CES Employment Growth, and Rebased Employment

Industrial Classification	REMI Employment History 1999	Forecast 2000	Forecast 2001	Forecast 2002	CES Employment Growth Percent 1999-00	2000-01	2001-02	REMI Re-based Employment Employment: thousands of jobs 1999	2000	2001	2002
Lumber	1.866	1.861	1.876	1.878	2.53	4.94	0.78	1.866	1.913	2.008	2.023
Furniture	0.477	0.478	0.474	0.458	2.53	4.94	0.78	0.477	0.489	0.513	0.517
Stone,Clay,Etc.	2.592	2.616	2.625	2.601	2.53	4.94	0.78	2.592	2.658	2.789	2.811
Primary Metals	0.581	0.598	0.572	0.553	2.53	4.94	0.78	0.581	0.596	0.625	0.630
Fabricated Metals	1.542	1.58	1.581	1.564	2.53	4.94	0.78	1.542	1.581	1.659	1.672
Machin & Comput	0.845	0.856	0.766	0.713	2.53	4.94	0.78	0.845	0.866	0.909	0.916
Electric Equip	1.018	1.018	0.919	0.851	2.53	4.94	0.78	1.018	1.044	1.095	1.104
Motor Vehicles	0.045	0.045	0.045	0.043	2.53	4.94	0.78	0.045	0.046	0.048	0.049
Rest Trans Equip	0.158	0.157	0.157	0.16	2.53	4.94	0.78	0.158	0.162	0.170	0.171
Instruments	0.43	0.424	0.404	0.384	2.53	4.94	0.78	0.43	0.441	0.463	0.466
Misc. Manufact	2.754	2.7	2.743	2.676	2.53	4.94	0.78	2.754	2.824	2.963	2.986
Food	2.368	2.434	2.483	2.495	7.14	0.95	-1.89	2.368	2.537	2.561	2.513
Tobacco Manuf	0.031	0.024	0.021	0.018	7.14	0.95	-1.89	0.031	0.033	0.034	0.033
Textiles	0.032	0.031	0.033	0.033	7.14	0.95	-1.89	0.032	0.034	0.035	0.034
Apparel	0.798	0.741	0.812	0.847	7.14	0.95	-1.89	0.798	0.855	0.863	0.847
Paper	0.288	0.288	0.294	0.295	7.14	0.95	-1.89	0.288	0.309	0.312	0.306
Printing	3.448	3.482	3.552	3.536	7.14	0.95	-1.89	3.448	3.694	3.729	3.659
Chemicals	0.826	0.841	0.827	0.812	7.14	0.95	-1.89	0.826	0.885	0.893	0.877
Petro Products	0.007	0.007	0.007	0.007	7.14	0.95	-1.89	0.007	0.008	0.008	0.007
Rubber	1.473	1.483	1.494	1.491	7.14	0.95	-1.89	1.473	1.578	1.593	1.563
Leather	0.01	0.01	0.012	0.013	7.14	0.95	-1.89	0.01	0.011	0.011	0.011
Mining	1.467	1.426	1.418	1.384	0.00	0.00	-11.11	1.467	1.467	1.467	1.304
Construction	77.558	79.279	80.772	80.44	-1.00	-1.00	3.46	77.558	76.782	76.015	78.647
Railroad	0.527	0.501	0.482	0.462	12.08	12.80	6.16	0.527	0.591	0.666	0.707
Trucking	5.167	5.301	5.363	5.312	10.60	10.60	10.60	5.167	5.715	6.320	6.990
Local/Interurban	9.259	9.499	9.817	10.165	10.60	10.60	10.60	9.259	10.240	11.326	12.526
Air Transportation	6.853	7.283	7.241	7.288	19.12	13.58	-2.17	6.853	8.163	9.272	9.070
Other Transport	3.814	3.904	3.92	3.942	10.60	10.60	10.60	3.814	4.218	4.665	5.160
Communication	9.155	9.772	10	10.18	9.90	3.55	-1.60	9.155	10.061	10.419	10.252
Public Utilities	5.15	5.242	5.328	5.407	9.90	3.55	-1.60	5.15	5.660	5.861	5.767
Banking	12.24	12.072	12.432	12.404	5.62	6.44	3.42	12.24	12.928	13.761	14.232
Insurance	9.41	9.399	9.67	9.805	5.62	6.44	3.42	9.41	9.939	10.579	10.941
Credit & Finance	19.338	20.034	20.477	21.043	7.89	9.15	3.35	19.338	20.865	22.773	23.536
Real Estate	31.161	32.92	34.167	35.521	5.62	6.44	3.42	31.161	32.913	35.033	36.232
Eating & Drinking	46.72	47.135	49.184	50.255	10.42	2.64	3.86	46.72	51.587	52.949	54.993
Rest of Retail	84.928	85.17	89.158	89.244	11.33	8.41	1.22	84.928	94.550	102.499	103.754
Wholesale trade	24.311	24.942	25.193	24.708	3.10	0.00	0.86	24.311	25.064	25.064	25.279
Hotels	172.55	179.72	184.44	187.75	3.99	-0.62	-1.88	172.55	179.433	178.317	174.970
Pers Serv & Rep	20.819	21.13	21.287	21.46	6.98	6.52	3.06	20.819	22.271	23.724	24.450
Private Household	3.54	3.664	3.73	3.782	6.07	2.26	0.49	3.54	3.755	3.840	3.858
Auto Rep/Serv	8.172	8.192	8.286	8.49	6.07	2.26	0.49	8.172	8.668	8.864	8.907
Misc. Bus Serv	51.931	55.085	56.962	58.388	13.08	3.85	2.68	51.931	58.721	60.984	62.619
Amusem & Recr	23.504	25.451	26.631	27.638	6.07	2.26	0.49	23.504	24.930	25.493	25.617
Motion Pictures	2.836	2.975	3.072	3.093	6.07	2.26	0.49	2.836	3.008	3.076	3.091
Medical	33.689	33.488	37.04	38.828	3.68	6.56	3.85	33.689	34.930	37.220	38.652
Misc. Prof Serv	31.443	33.296	34.367	35.183	2.50	3.90	2.82	31.443	32.229	33.487	34.430
Education	3.647	3.547	3.744	3.796	6.07	2.26	0.49	3.647	3.868	3.956	3.975
Non-Profit Org	10.329	10.641	11.057	11.452	6.07	2.26	0.49	10.329	10.956	11.203	11.258

Table 2 cont.

Industrial Classification	History 1999	REMI Employment Forecas 2000	Forecas 2001	Forecast 2002	CES Employment Growth Percent 1999-00	2000-01	2001-02	REMI Re-based Employment Employment: thousands of jobs 1999	2000	2001	2002
Ag, Forestry, fishir	8.496	8.955	9.231	9.458	.0.10	0.00	0.00	8.572	8.581	8.581	8.581
State and Local	58.027	61.942	66.787	69.872	-6.57	6.25	0.00	58.027	54.215	57.603	57.603
Federal Civilian	8.607	8.718	8.868	8:922	4.04	-3.88	0.00	8.607	8.955	8.607	8.607
Federal Military	9.068	9.354	10.215	10.68	4.04	-3.88	0.00	9.068	9.434	9.068	9.068
Farm	0.338	8.48	8.52		0.00	0.00	4.11	0.338	0.338	0.338	0.352
Total	**815.65**	**850.19**	**880.55**	**887.78**	**5.64**	**3.77**	**0.98**	**815.72**	**857.60**	**886.31**	**898.63**

employment growth of 4.2, 2.6, and 1.8 percent in 1999-2000, 2000-2001, and 2001 – 2002, respectively. The latest employment figures from the NDETR reveal that growth rates of 3.99, -0.62, and –1.88, respectively, more closely match the growth rates over that time in the hotel and gaming sector. Thus, the updated model reflects the downturn occurring in 2001 as a result of the flagging national economy and the September 11 attacks.

Transportation and Infrastructure Improvements. Plans are in place by the RTC to construct a new fixed guide-way system and expand the share of public transport in the form of new buses and bus routes. Although some level of local spending on public infrastructure, like road building and additional services, is included in the model, future large projects such as the public-transport expansion, are not. Therefore, the model must be updated to account for the portion of these expenditures not currently included in the model. Some of the planned expenditures are "new money," whereas the remaining simply substitutes for money that would have been spent elsewhere. To avoid double-counting while maintaining a balanced budget, it is necessary to adjust the expenditures. The estimated unadjusted expenditures are $526.2 million between 2001 and 2005, $961.5 million between 2006 and 2010, and $961.5 million between 2011 and 2020. Assuming that 30 percent of the planned infrastructure investment is new money, we maintain the balanced budget by reducing local government transportation spending by 70 percent each year. Thus, local transportation spending is reduced by $73.6 million between 2001 and 2005, $134.6 million between 2006 and 2010, and $67.3 million between 2011 and 2020. This spending is re-allocated to infrastructure investment.

The Amenity Adjustment. Population and employment have grown at phenomenal rates in Clark County for over a decade. Hand in hand with rapid urban growth often come congestion, higher crime rates, deteriorating air quality, and a shortage of public services, such as education. These are types of social costs, or negative externalities, that affect residents of rapidly growing metropolitan areas. As social costs increase and wages remain the same, net in-migration may be discouraged as Clark County becomes less attractive relative to other areas. Table 3 gives the adjustments to the model.

Table 3. Real Wage Equivalent of Negative Externalities: 2002 - 2035

Year	Externalities Impact as % of Real Wage
2002	0.000
2003	0.033
2004	0.067
2005	0.100
2006	0.133
2007	0.167
2008	0.200
2009	0.233
2010	0.267
2011	0.300
2012	0.333
2013	0.367
2014	0.400
2015	0.433
2016	0.467
2017	0.500
2018	0.533
2019	0.567
2020	0.600
2021	0.633
2022	0.667
2023	0.700
2024	0.733
2025	0.767
2026	0.800
2027	0.833
2028	0.867
2029	0.900
2030	0.933
2031	0.967
2032	1.000
2033	1.033
2034	1.067
2035	1.100

Hotel Adjustment. The lag between initial permitting and constructing a large hotel/casino and the opening is typically between two and four years. As such, we are privy to information about hotel-opening dates well in advance of the actual opening. Because hotel/casino employment is such an important component of the Las Vegas economy, we use this information to adjust expected future hotel employment growth.

We base our forecast of hotel room growth and the associated employment on the numbers reported by the Las Vegas Visitors and Convention Authority. We combine these figures with local assessment of expected openings. Using a value of 1.6 hotel/casino employees for each new room, we add (or subtract) these hotel jobs from REMI's predicted hotel/casino employment growth. This provides the most accurate short-term prediction of room and employment growth. We give our updated forecast of room and hotel employment growth in Table 4. As we can see, the REMI model performs quite well in forecasting hotel rooms. However, using local projections is more precise and allows for year-to-year modeling consistency.

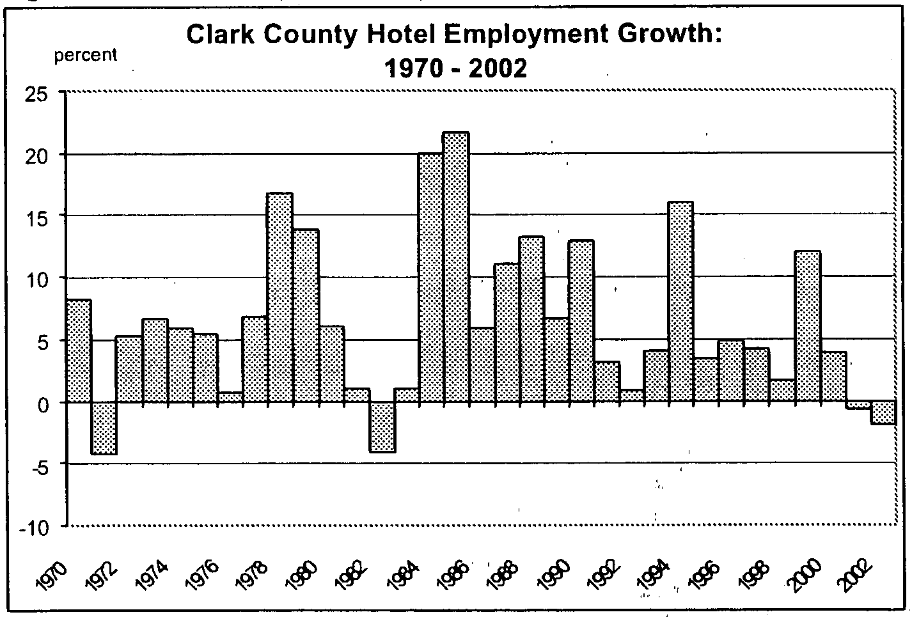
Table 4. Local Projections of Hotel Rooms 2003 – 2005.

Year	Local Projection of New Hotel Rooms (thous)	Number of New Hotel Rooms in the Remi Control Model (thous)	Forecast Additional Rooms in Excess of Control Forecast (thous)	Additional Jobs Assuming 1.6 Jobs per Room (thous)	Hotel Jobs from Remi Control Model (thous)	Total Hotel Employment for Adjusted Model (thous)
2001*	2.553	-0.697	3.250	5.200	178.3172	178.317
2002*	1.057	-2.092	3.149	5.038	174.9702	174.970
2003	2.415	2.123	0.292	0.467	178.3671	178.834
2004	2.513	2.106	0.407	0.652	181.736	182.388
2005	2.701	1.966	0.735	1.176	184.8813	186.058

* Actual hotel employment used for 2001 and 2002.

Maturation Adjustment. Clark County has held the title of being the fastest-growing county, in terms of population, for over ten years. The phenomenal growth may be attributed to continued strong economic migration and to equally vigorous growth in the retired age cohorts. In turn, economic migration has largely been driven by the continued growth in the hotel and gaming industry. Figure 1 shows growth in hotel employment over time.

Figure 1. Clark County Hotel Employment Growth from 1970 to 2002.



Hotel and gaming employment growth exhibits cyclical patterns. There are periods of vigorous growth during casino-construction booms, followed by slower growth as investors evaluate the success of new properties. New openings, such as MGM Grand, Luxor, and Treasure Island in 1993, and the Bellagio, Mandalay Bay, and Venetian in 1998 – 1999, are correlated with pronounced growth in hotel and gaming employment. Slower periods occur after construction booms and during times of international and national economic weakness.

Although Clark County has enjoyed robust gaming growth for decades, it is not likely that the future will be as prolific. Until the late 1970s, Nevada offered the only legal gaming in the U.S. When Atlantic City legalized gaming in 1978, many pundits forecasted difficulty for Las Vegas gaming. These claims became stronger when Indian gaming became a reality with the Indian Gaming Act of 1988. To date, Indian gaming and other casino development have not eaten into Las Vegas visitor volume. However, changes in California regulation of Indian gaming now allow for Las Vegas-style table games. These facilities, due to their proximity to the important Southern California market, may effectively compete with Las Vegas casinos for visitors from that region. Other markets are also experiencing increased competition. There are plans to build a Las Vegas-style casino in Macau (a self-governing entity on the coast of China) that could potentially lure customers from the lucrative Asian markets. Thus, Clark County is becoming increasingly vulnerable to national and international gaming-industry competition.

Another factor that helped to accelerate the Clark County casino industry was the high-tech bubble in California. The boom in the high-tech industry came with a surge in disposable income. Many employees of now bankrupt high-tech companies watched their stock options grow with each finishing bell of the New York Stock Exchange NYSE. Investors, quick to capture some of the seemingly endless runup in stock values, funded a parade of new information-technology companies. Hi-tech employees, investors, and company executives went on a spending spree. Las Vegas, through increased tourism and convention business, captured an inordinate share of the hi-tech-related spending. Comdex, a convention for the electronics industry, became the largest convention in the world, with an excess of 240,000 people attending in 1999.

The collapse of the high-tech bubble happened as rapidly as it arose. The Nasdaq fell from a lofty high of over 5,200 in January 2000 to 1,393 (as of November 18, 2002). High-tech wiz kids joined the ranks of the unemployed and tech-related convention and visitor spending screeched to a halt. Comdex attendance shrank to a mere 125,000 attendees in 2002.

Of course, the high-tech speculative bubble was not the sole basis for the casino expansions in Clark County in the 1990s. The fact that visitor volume and gaming revenue have stagnated, rather than fallen, attests to the marginal impact this sector had on gaming revenue. Similarly, increased competition in the gaming industry nationally and internationally is expected to dampen growth rather than lead to a contraction in local hotel/casino employment. Rather than affecting the level of convention and visitor volume, we expect the high-tech collapse and Indian gaming to translate into slower future growth of the Clark County economy.

The REMI model forecasts the local economy based on the history of the local economy and a long-run forecast of the national economy. It is unlikely that the model will capture increased international competition because the international component of the model is weak. Likewise, increased Indian gaming is an industry-specific phenomenon that is not captured by the historical data and is, therefore, omitted from the forecast. Finally, speculative bubbles are outside the realm of standard economic growth. As a result, the REMI model will tend to inflate the long-run trend above the trend fundamentals inducing upward speculative bias in the forecast. A forecast arising from a model that does not adequately incorporate industry-specific trends, while being buffeted by speculative-driven winds, is likely to overstate future-growth expectations. We do not feel that this is a weakness of the REMI model. Rather, it is a general limitation of all economic models as they try to balance data needs with forecast accuracy and computing time.

In an effort to see how recent economic events have been affecting county migration patterns, we examined monthly counts of out-of-state drivers' licenses turned into the Clark County Department of Motor Vehicles in recent months. The results are striking.

After posting a gain of 6.7 percent during 2001, the out-of-state drivers' license counts are falling at an annual rate of 2.1 percent this year. Other evidence, including rising residential vacancy rates for apartments in the county, supports the conclusion that the population growth rate has slowed substantially this year.

In response to this evidence, we modify the REMI population forecast to take account of the potential model bias induced by inadequate industry-level and international modeling. After the standard re-basing of the model is performed (employment, hotel, infrastructure, and amenity updates) we make a maturation adjustment by slowing the predicted employment growth for each sector by 0.7 percent from 2003 to 2010 and by 0.2 percent thereafter. We run the model and the resulting forecast gives us population growth, in terms of year-over-year differences. We think that this forecast, adjusted for the maturing of the Las Vegas economy, is a better representation of future economic growth than that arising directly from the model.

3.2.2. The Baseline Forecasts

After holding the title for the fastest-growing county, in terms of population, for over ten years, growth in Clark County is slowing. The state of Nevada's population and economic growth have slowed in turn. The phenomenal growth in Clark County and Nevada was attributed to strong economic migration and to equally vigorous growth in the retired age cohorts. In turn, economic migration was largely driven by the continued growth in the hotel and gaming industry. In recent years, hotel/casino investment has stalled in Nevada. The construction industry remains an important driver of the economy, but this engine of growth is expected to moderate in the coming months as demand for residential and commercial construction falters.

Population Forecast. Figures 3 through 6 and Table 5 give our population forecasts for Nye, Lincoln and Clark counties, rest of state, and the entire state from 2003 to 2035. Clark and Nye counties grow the fastest with initial growth rates of 3.9 and 3.5 percent, respectively. Growth tapers off slowly, falling to 1.6 percent by 2035 in Clark County and 1.1 percent in Nye County. The rest of state and Lincoln County have slow growth rates in the baseline forecast. The initial forecast for Lincoln County is a growth rate of 0.5 percent, rising to 1.4 percent by 2017. Growth in Lincoln County falls back to 0.6 percent by 2035. Similarly, growth in the rest of the state hovers between 0.8 and 1.1 percent for the range of the forecast.

Figure 2. Baseline Population Forecast Nye County

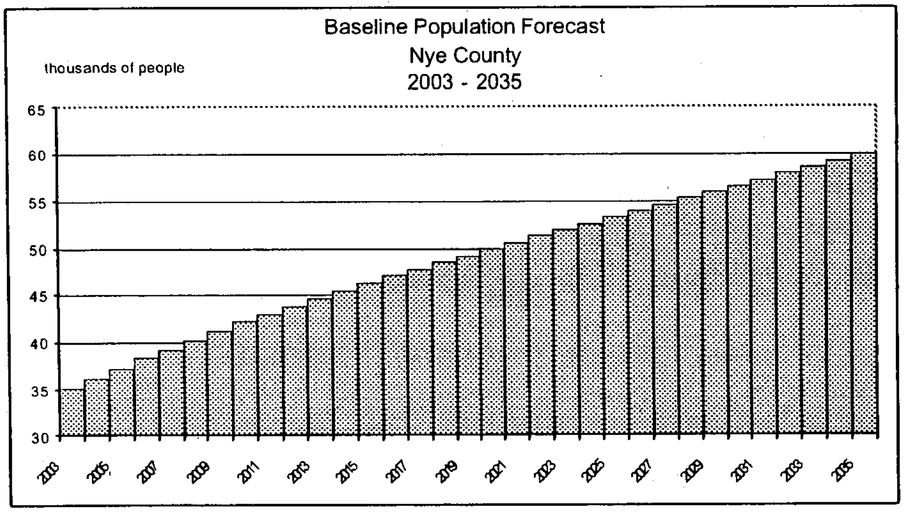
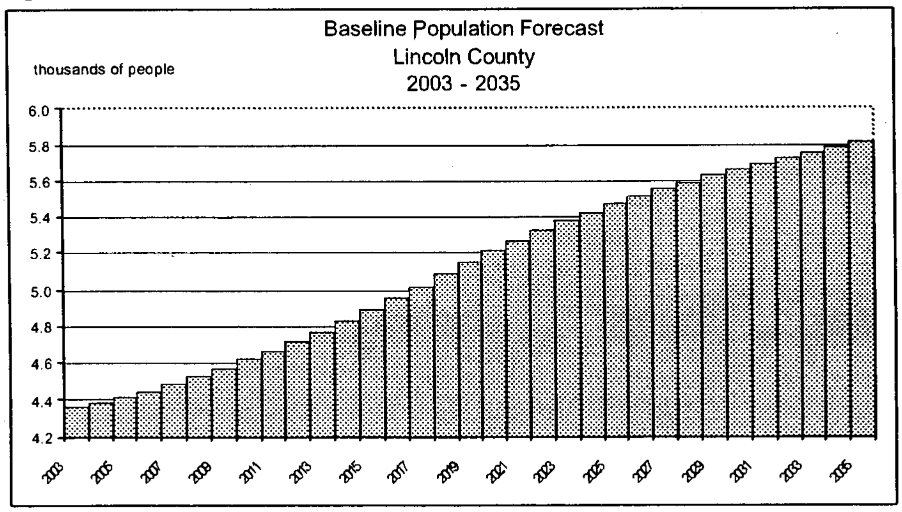


Figure 3. Baseline Population Forecast Lincoln County



The forecast for the state of Nevada reflects the strong growth rate in Clark and Nye counties in the near term. The state's population is expected to grow by 3.2 percent in 2003. The growth rate falls off slowly, resting at 1.5 percent in the out years of the forecast.

Figure 4. Baseline Population Forecast Clark County

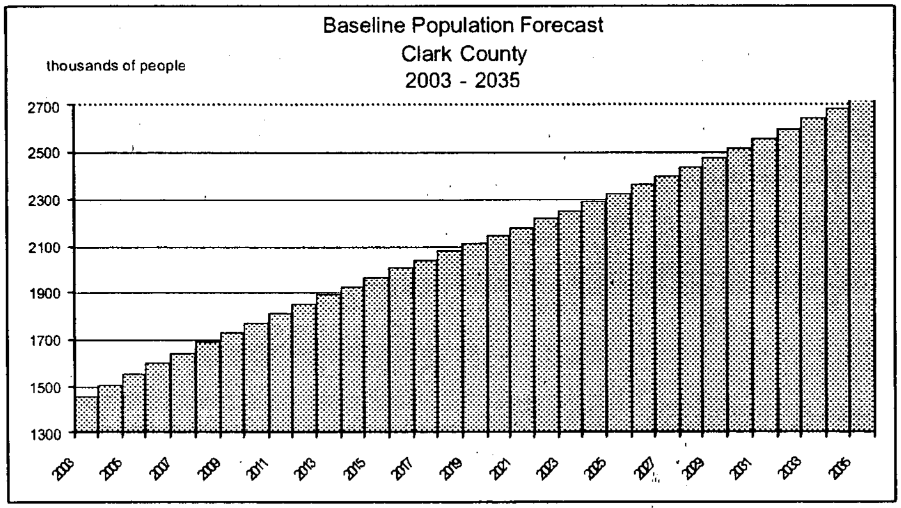


Figure 5. Baseline Population Forecast Rest of the State

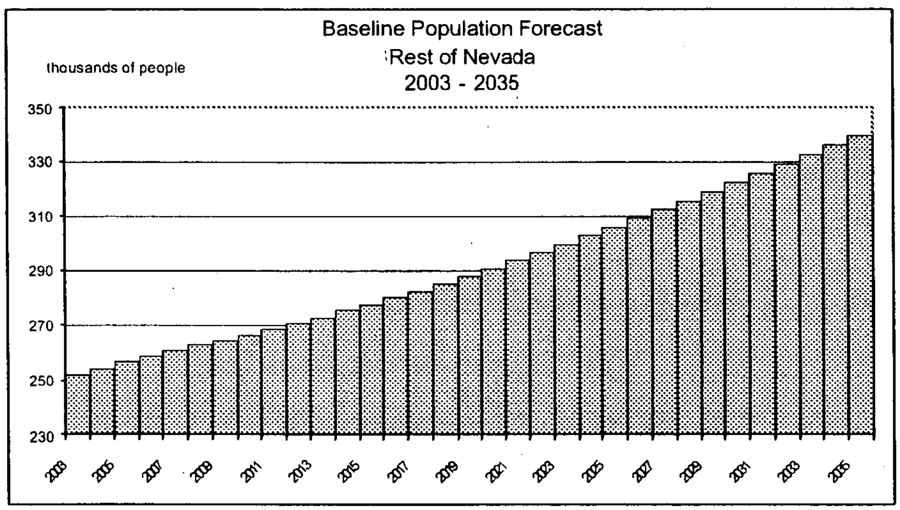


Figure 6. Baseline Population Forecast Nevada

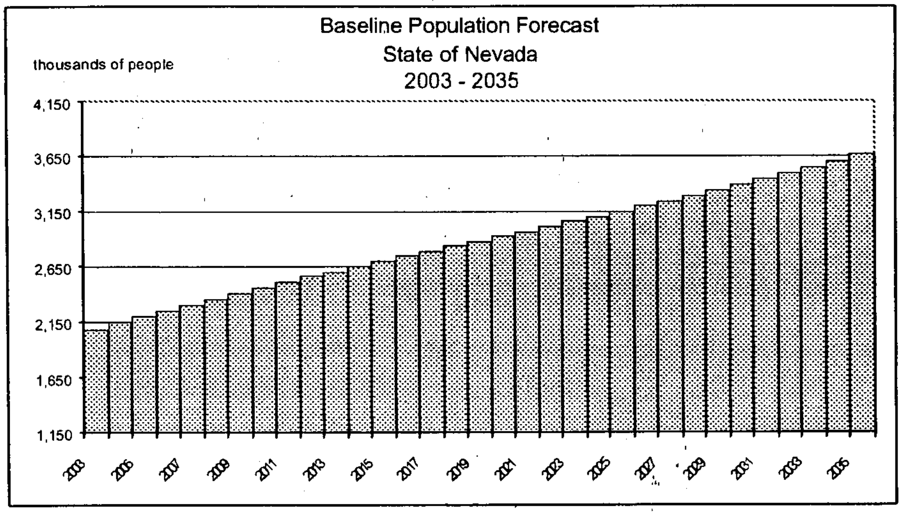


Table 5. County and State Population Growth Rates: 2003 – 2035

Year	Nye	Lincoln	Clark	Rest of the State	Nevada
2003	3.5%	0.5%	3.9%	1.1%	3.2%
2004	3.1%	0.6%	3.5%	1.0%	2.9%
2005	2.9%	0.7%	3.2%	0.9%	2.6%
2006	2.7%	0.8%	3.0%	0.9%	2.5%
2007	2.6%	0.8%	2.8%	0.8%	2.3%
2008	2.5%	0.9%	2.6%	0.7%	2.2%
2009	2.4%	1.0%	2.5%	0.8%	2.1%
2010	2.3%	1.1%	2.3%	0.8%	2.0%
2011	2.1%	1.0%	2.3%	0.8%	2.0%
2012	2.0%	1.1%	2.2%	0.8%	1.9%
2013	1.9%	1.1%	2.1%	0.8%	1.9%
2014	1.8%	1.2%	2.1%	0.8%	1.8%
2015	1.7%	1.3%	2.0%	0.8%	1.7%
2016	1.6%	1.3%	1.9%	0.9%	1.7%
2017	1.5%	1.4%	1.8%	0.9%	1.6%
2018	1.5%	1.3%	1.7%	0.9%	1.6%
2019	1.5%	1.3%	1.7%	1.0%	1.5%
2020	1.4%	1.2%	1.6%	1.0%	1.5%
2021	1.4%	1.1%	1.6%	1.0%	1.5%
2022	1.4%	1.0%	1.6%	1.0%	1.5%
2023	1.3%	1.0%	1.6%	1.0%	1.5%
2024	1.3%	0.9%	1.6%	1.0%	1.5%
2025	1.3%	0.8%	1.6%	1.0%	1.5%
2026	1.3%	0.8%	1.6%	1.0%	1.5%
2027	1.2%	0.7%	1.6%	1.1%	1.5%
2028	1.2%	0.7%	1.6%	1.1%	1.5%
2029	1.2%	0.6%	1.6%	1.1%	1.5%
2030	1.2%	0.6%	1.6%	1.1%	1.5%
2031	1.2%	0.6%	1.6%	1.0%	1.5%
2032	1.2%	0.5%	1.6%	1.0%	1.5%
2033	1.2%	0.5%	1.7%	1.0%	1.5%
2034	1.1%	0.6%	1.7%	1.0%	1.5%
2035	1.1%	0.6%	1.6%	1.0%	1.5%

Baseline Employment Forecasts. Figures 7 through 11 and Table 6 give the baseline employment forecasts for Nye, Lincoln and Clark counties, rest of state, and the entire state from 2003 to 2035. Nye County is expected to have the most rapid employment growth. Employment growth in Nye County is initially 2.2 percent in 2003 but falls to 0.7 percent by 2020. After that time, a modest renewal in growth is observed with employment growth reaching 1.0 percent annually. Clark County has the most consistent employment growth forecast, ranging from a 1.7 percent increase in the number of jobs in 2003. This figure falls to 1.0 percent in 2021, but returns to 1.3 to 1.4 percent in the final years of the forecast. Employment growth in Lincoln County and the rest of the state are relatively sluggish through the range of the forecast.

Figure 7. Baseline Employment Forecast for Nye County

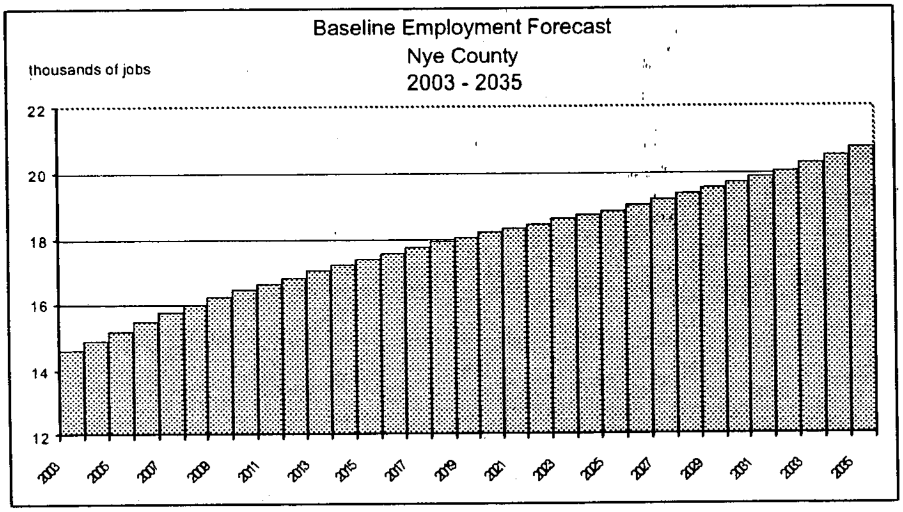


Figure 8. Baseline Employment Forecast for Lincoln County

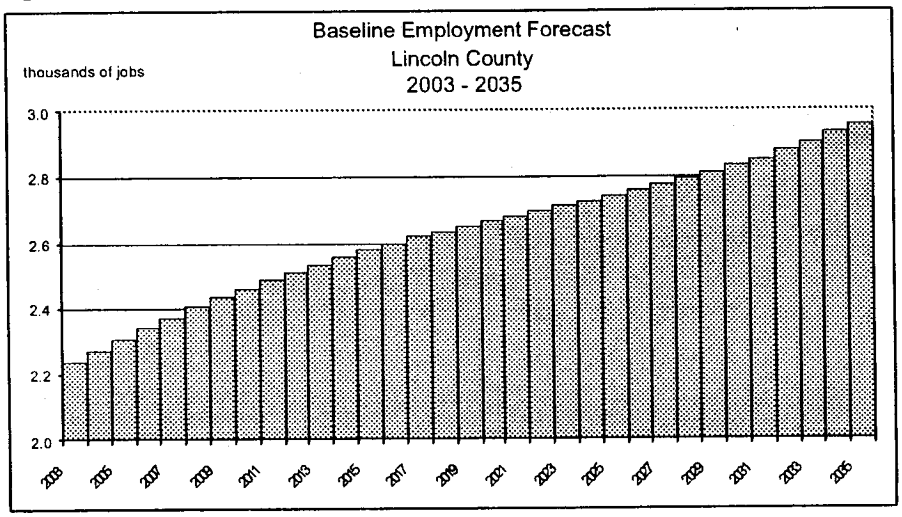


Figure 9. Baseline Employment Forecast for Clark County

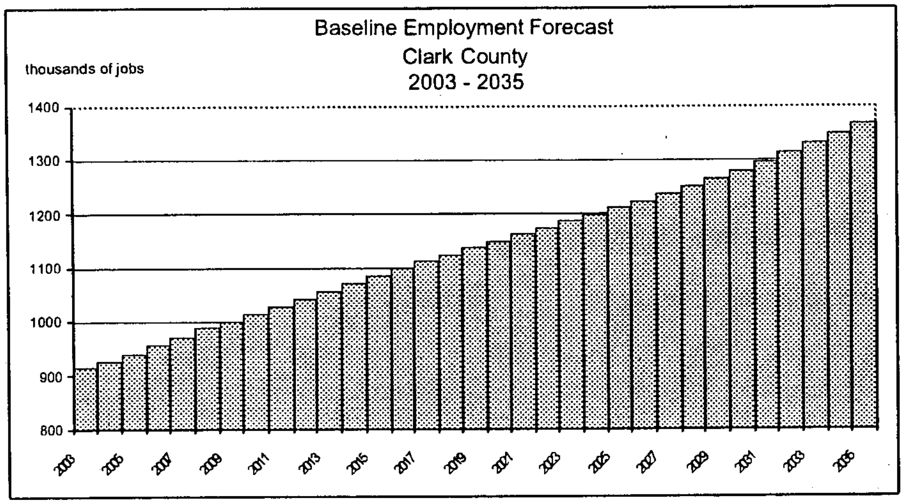


Figure 10. Baseline Employment Forecast for Rest Of State

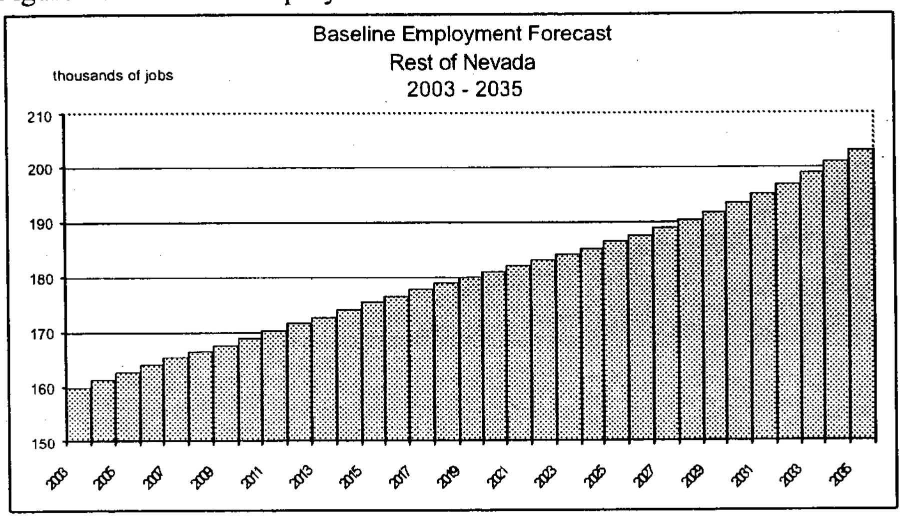
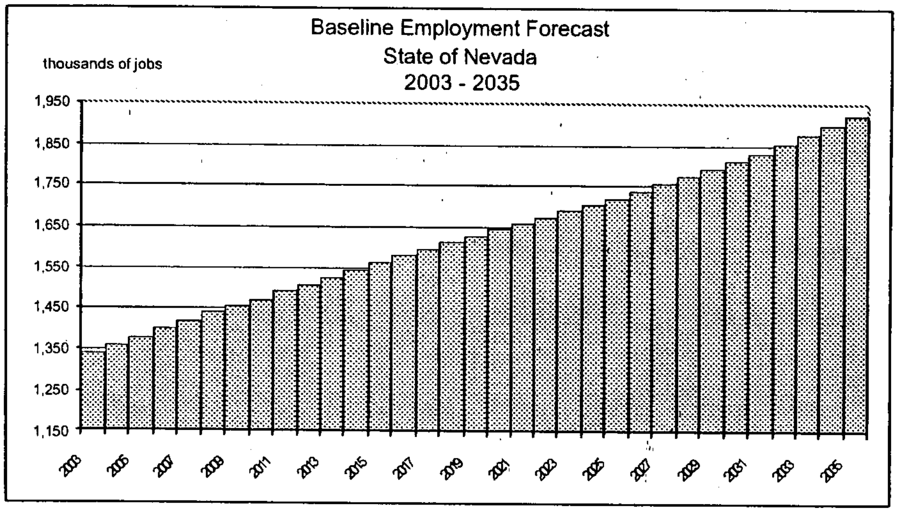


Figure 11. Baseline Employment Forecast for Nevada



The state of Nevada employment-growth forecast is slow relative to the boom years of the 1980s and 1990s. Only modest growth in the hotel/casino sector, slow national and world economies, and a slowdown in building activity are expected to keep employment growth well below recent history. Much of the growth that will occur will be in Nye, Clark, and Washoe counties. The forecasts call for employment growth closely tracking that of Clark County. State employment growth will fall from a high of 1.6 percent in 2003 to 0.9 percent by 2020. After 2026, a modest surge will occur, and employment growth will return to 1.2 percent by the end of the forecast.

Table 6. Baseline Employment Growth Forecasts: 2003 - 2035

	Nye	Lincoln	Clark	Rest of the State	Nevada
2003	2.2%	1.6%	1.7%	1.0%	1.6%
2004	2.0%	1.5%	1.4%	1.0%	1.3%
2005	1.9%	1.5%	1.5%	0.8%	1.4%
2006	1.9%	1.4%	1.7%	0.8%	1.5%
2007	1.8%	1.4%	1.7%	0.8%	1.5%
2008	1.6%	1.3%	1.6%	0.7%	1.4%
2009	1.4%	1.2%	1.2%	0.7%	1.1%
2010	1.2%	1.1%	1.3%	0.7%	1.2%
2011	1.3%	1.1%	1.5%	0.8%	1.3%
2012	1.1%	1.0%	1.4%	0.8%	1.2%
2013	1.1%	0.9%	1.3%	0.8%	1.2%
2014	1.1%	0.9%	1.3%	0.7%	1.2%
2015	1.1%	0.9%	1.3%	0.7%	1.1%
2016	1.0%	0.8%	1.2%	0.7%	1.1%
2017	1.0%	0.7%	1.2%	0.7%	1.1%
2018	0.9%	0.6%	1.2%	0.6%	1.0%
2019	0.8%	0.6%	1.1%	0.6%	1.0%
2020	0.7%	0.6%	1.1%	0.6%	0.9%
2021	0.7%	0.5%	1.0%	0.5%	0.9%
2022	0.8%	0.6%	1.1%	0.6%	0.9%
2023	0.8%	0.6%	1.0%	0.6%	0.9%
2024	0.8%	0.6%	1.0%	0.6%	0.9%
2025	0.8%	0.6%	1.0%	0.6%	0.9%
2026	0.7%	0.6%	1.0%	0.6%	0.9%
2027	0.9%	0.6%	1.1%	0.7%	1.0%
2028	0.9%	0.7%	1.2%	0.8%	1.0%
2029	0.9%	0.7%	1.2%	0.8%	1.1%
2030	0.9%	0.7%	1.2%	0.8%	1.1%
2031	0.9%	0.7%	1.2%	0.9%	1.1%
2032	1.1%	0.8%	1.3%	1.0%	1.2%
2033	1.1%	0.9%	1.4%	1.0%	1.3%
2034	1.1%	0.9%	1.3%	1.0%	1.3%
2035	1.0%	0.9%	1.3%	1.0%	1.2%

Baseline GRP and GSP Forecasts. Figures 12 through 16 and Table 7 give the baseline GRP forecasts for Nye, Lincoln and Clark counties, rest of state, and the GSP forecasts for Nevada from 2003 to 2035. The growth in GRP, not surprisingly, mirrors employment growth. Nye County is expected to grow the fastest of the four areas studied, with initial GRP growth of 2.1 percent. Economic growth will taper off gradually, falling to 1.2 percent by 2025. An unexceptional upturn follows, with the forecast concluding in 2035 and economic growth in Nye County pegged at 1.6 percent annually. In Clark County, steady economic growth will continue throughout the forecast. Nevertheless, the growth figures are lackluster, with expected GRP growth ranging from 1.7 percent in 2003, topping 2 percent in 2010, but falling off to 1.7 percent by 2035.

Figure 12. Baseline GRP Forecast Nye County

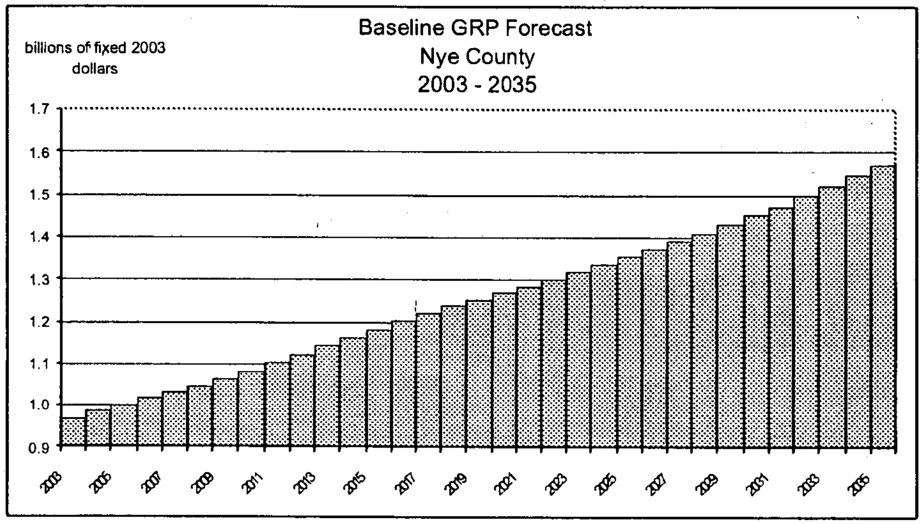


Figure 13. Baseline GRP Forecast Lincoln County

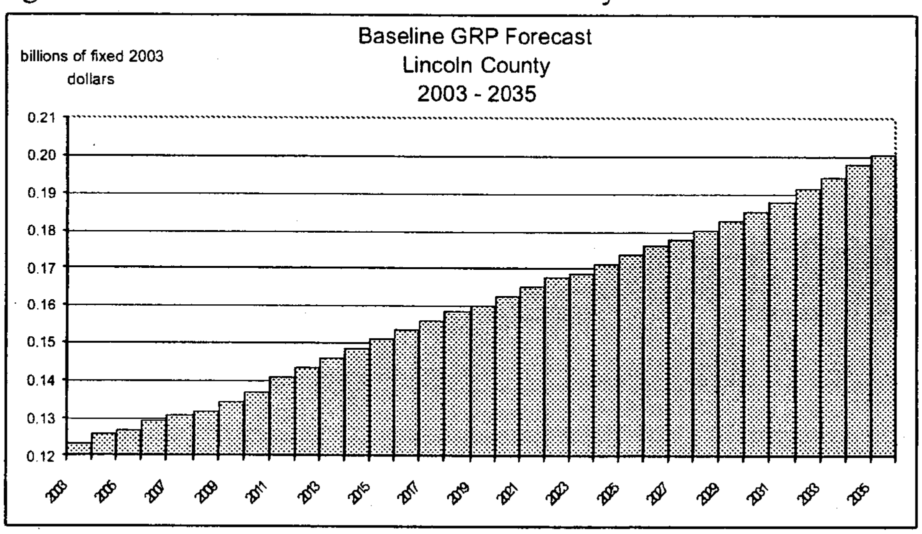


Figure 14. Baseline GRP Forecast Clark County

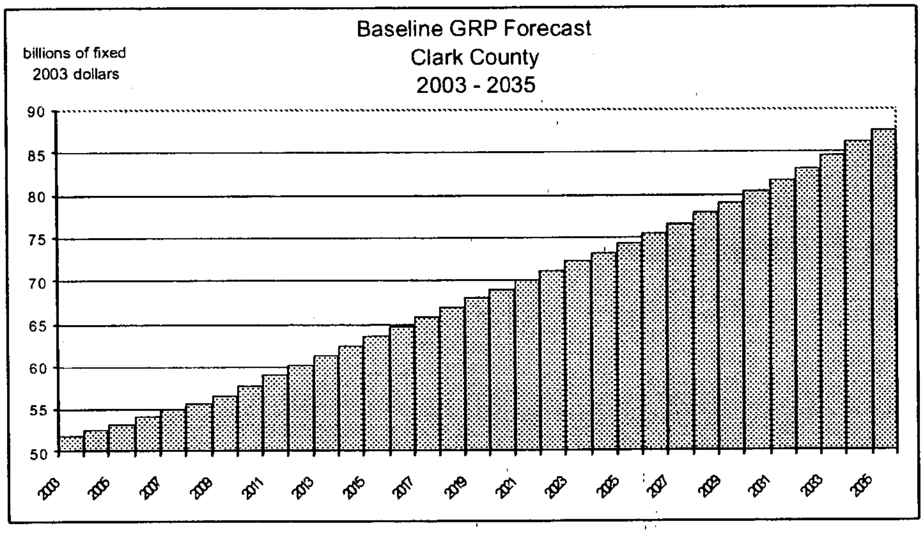


Figure 15. Baseline GRP Forecast Rest of the Nevada

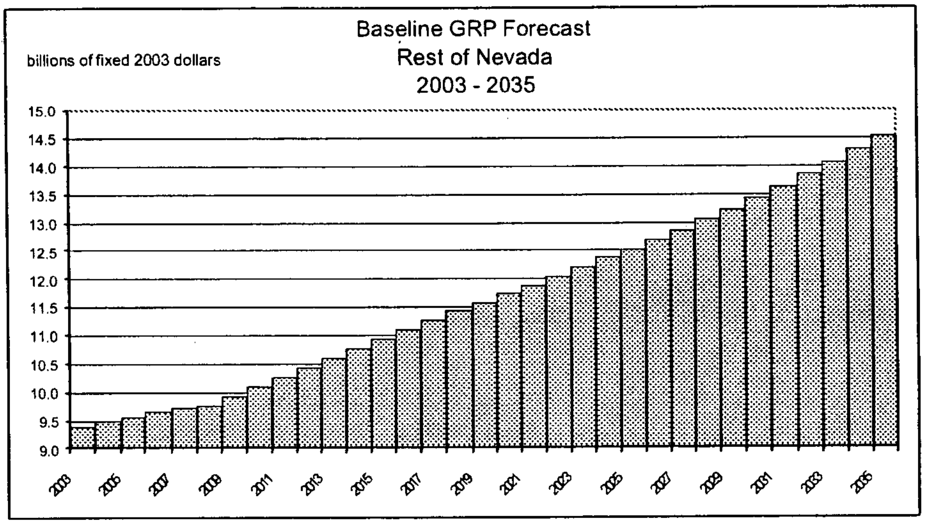
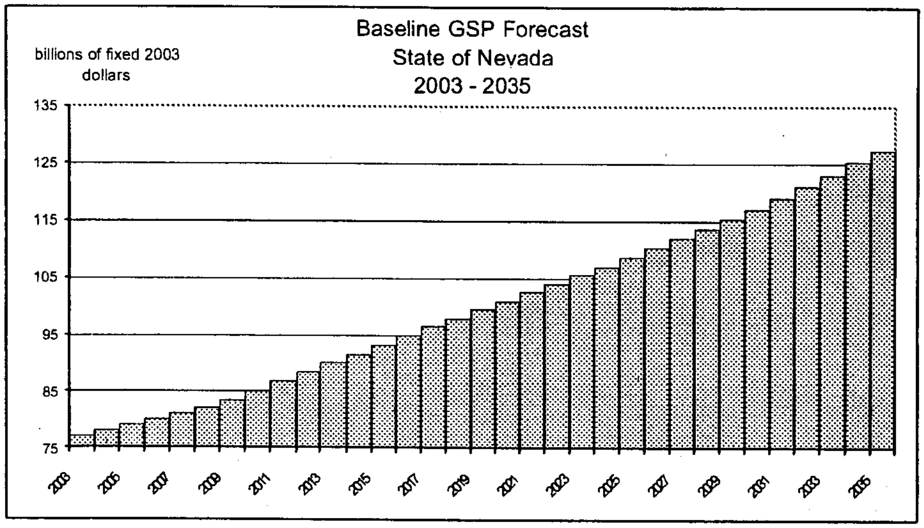


Figure 16. Baseline GSP Forecast Nevada



Lincoln County will have more sporadic growth than the other areas. In 2003, GRP growth will top 2.0 percent in Lincoln County, but quickly falls to 1.0 percent by 2005. Economic growth, in terms of county GRP, bounces between 1.0 and 2.8 percent over the remaining range of the forecast. The rest of the state will have modest growth, falling short of 2.0 percent over the entire forecast range.

Taken together, sluggish growth in the largest Nevada counties means a lackluster growth path for the state economy. Beginning at 1.6 percent in 2003, GSP growth peaks at 2.0 percent in 2010. In the remaining forecast years, GSP growth strolls along at an annual growth rate between 1.4 and 1.8 percent.

Table 7. Baseline Forecast GRP and GSP Forecasts: 2003 – 2035

Year	Nye	Lincoln	Clark	Rest of the State	Nevada
2003	2.1%	2.1%	1.7%	1.3%	1.6%
2004	1.7%	2.1%	1.4%	1.0%	1.4%
2005	1.7%	1.0%	1.4%	0.8%	1.3%
2006	1.6%	2.0%	1.6%	0.9%	1.5%
2007	1.4%	1.0%	1.5%	0.7%	1.3%
2008	1.2%	1.0%	1.4%	0.5%	1.2%
2009	1.8%	1.9%	1.5%	1.6%	1.4%
2010	1.9%	1.9%	2.1%	1.6%	2.0%
2011	1.9%	2.8%	2.1%	1.7%	2.0%
2012	1.7%	1.8%	2.0%	1.6%	1.9%
2013	1.7%	1.8%	1.9%	1.6%	1.8%
2014	1.8%	1.7%	1.9%	1.6%	1.8%
2015	1.6%	1.7%	1.8%	1.6%	1.8%
2016	1.6%	1.7%	1.8%	1.5%	1.7%
2017	1.5%	1.7%	1.8%	1.5%	1.7%
2018	1.5%	1.6%	1.7%	1.5%	1.6%
2019	1.3%	0.8%	1.6%	1.4%	1.5%
2020	1.3%	1.6%	1.5%	1.3%	1.5%
2021	1.3%	1.6%	1.5%	1.3%	1.4%
2022	1.4%	1.5%	1.6%	1.3%	1.5%
2023	1.3%	0.8%	1.5%	1.3%	1.4%
2024	1.3%	1.5%	1.5%	1.3%	1.4%
2025	1.2%	1.5%	1.4%	1.3%	1.4%
2026	1.3%	1.5%	1.5%	1.3%	1.4%
2027	1.5%	0.7%	1.6%	1.4%	1.6%
2028	1.4%	1.4%	1.6%	1.4%	1.5%
2029	1.4%	1.4%	1.6%	1.4%	1.6%
2030	1.4%	1.4%	1.6%	1.5%	1.5%
2031	1.5%	1.4%	1.6%	1.5%	1.6%
2032	1.6%	2.0%	1.8%	1.6%	1.7%
2033	1.6%	1.3%	1.8%	1.6%	1.7%
2034	1.6%	2.0%	1.8%	1.6%	1.7%
2035	1.6%	1.3%	1.7%	1.6%	1.7%

Some Considerations. As of September 2003, some of the recent uncertainty surrounding the short-term future of economic, hence population, growth in Nevada and in Clark County has waned. The U.S. occupation of Iraq has resolved much of the war-related uncertainty experienced in the spring of 2003. Meanwhile, the domestic economy appears to be reviving, but job losses are still rampant leading many to call this a "jobless recovery." Taken together, these forces have helped quell a storm of economic uncertainty that had clouded business-investment plans and consumer-spending intentions. Nevertheless, the "jobless recovery" does not bode well for the nation's long-term economic prospects.

Forecasting, always an uncertain business, becomes even more difficult during times of economic uncertainty. Moreover, the particular confluence of events---the threat of terrorism and slow economy---can have disproportionately large negative effects on tourism destinations such as Las Vegas. Shrinking consumer wealth can eat into vacation budgets and induce slow growth in tourist-based economies. The spike in fuel prices associated with the occupation of Iraq, has made business and pleasure travel more expensive. Until this resolves, firms and households are likely to keep lean budgets for these activities.

Much of the current economic uncertainty should dissipate in the coming months as stock markets stabilize and the tug-of-war with Iraq is resolved. Nevertheless, until that time, our population forecast, particularly in the short term, is surrounded by more uncertainty than in recent years. Users of the forecast would be wise to keep this in mind when applying the forecast. Updating, based on new information, will be increasingly important over the coming months if economic forces experience large or sustained shifts.

Concluding Remarks about the Baseline Forecast. It is important to note that the forecast this year has been developed during times of increased economic uncertainty. All reasonable attempts have been made to update the model to accommodate reliable new information about employment, hotel construction, public-infrastructure investment, and predicted amenity variations. Regardless, uncertainty is inherently difficult to include in a model with precision. Thus, uncertainty about future near-term economic conditions translates into increased forecast uncertainty. Policy makers may want to keep this in mind when using this forecast.

3.2. YMP Forecast Model Assumptions

If a railroad route is chosen, a new spur will be constructed from an existing line to the Yucca Mountain Site. There is currently no rail access to the Yucca Mountain Site. (DOE EIS, p. S-23.) Direct economic impacts come primarily from the employment for planning and construction of the railroad spur, and RR route operations (further information on the policy variables used can be found in REMI input document report no. 7. section 3.1 for construction, and section 3.2 for operations).

Each of the rail alternatives has alignment variations (ibid.). However, the variations are slight. Should any of these alignment variations be implemented, it should not significantly affect forecasts of economic impacts. Therefore for brevity and clarity, variations are not modeled.This analysis is based on an average of five rail trips per week, or 260 trips annually.

IV. ECONOMIC IMPACTS OF RAILROAD ALTERNATIVES, INCLUSIVE OF YMP CONSTRUCTION, MAINTENANCE, & OPERATIONS (CM&O), 2005-2035

The DOE is considering five railroad route alternatives. Only one of these alternatives – if any – will ultimately be chosen.
Railroad route alternatives:

1. Caliente railroad construction and operations
2. Caliente-Chalk Mountain railroad construction and operations
3. Carlin-Big Smokey railroad construction and operation
4. Jean railroad construction and operation
5. Valley Modified railroad construction and operation

We focus on economic impacts of these alternatives to the state of Nevada in three key areas: impact on real Gross State/Regional Product (GSP/GRP), impact on Real Disposable Income (RPI), and impact to employment.

Charts depicting regional impacts for Clark County, Nye County, Lincoln County, Washoe County, and the Rest of Nevada follow the analysis of overall State impacts. We include the county-level charts to give readers an idea of the distribution of the impacts. We provide a detailed discussion of the state-level effects only because the distribution of impacts is very similar for all of the routes and policy variables. In a nutshell, the bulk of all economic effects, independent of the route chosen, are enjoyed by Clark County. Historically, test-site workers live in Las Vegas and commute to the site. Thus, virtually all of wages related to test-site activity are spent in Clark County. Since wages represent the lion's share of project expenditures, Clark County is the primary beneficiary of the YMP in terms of economic growth.

The finding that Clark County reaps most of the economic benefit from the YMP hinges on DOE's current development plans for the site. In the current plan, research and development will take place in Clark County. If these plans change, distributional effects will also change. We base our assumption about worker location on past test-site worker's household location choices. Thus, distributional effects will also change if YMP workers choose to locate in Nye or other rural counties.

To aid in comparing results from one alternative to another, regional chart scales are kept consistent whenever possible. Thus, for example, employment chart scales go from 0 to 4,500 for "Nevada – All Regions" and "Clark County" over all five alternatives. Similarly, the scale for the five Nye County Employment Impact charts (one for each RR alternative) goes from 0 to 600.

The following descriptions of routes are taken from DOE EIS Fig. S-13, "Potential Nevada rail routes to Yucca Mountain, p. S-26 and from REMI input documentation reports nos. 7.(Bland 2001). Distances come from "Railroad Corridor Impacts" chart, p. S-72 of DOE EIS.

4.1. Caliente Railroad Route Alternative, Inclusive of Yucca Mountain Site Activity: Description and Model Results.

General Description. Under this alternative, all spent nuclear fuel and high-level radioactive waste transported along the existing rail line system would first make its way to Caliente, approximately 150 miles north-northeast of Las Vegas, before continuing on the final leg of its journey to the Yucca Mountain Site. From Caliente, this spur travels west staying north of the Nellis Air Force Range. The route turns southward just prior to reaching U.S. 95, and then runs along U.S. 95 past Beatty, turning eastward into the Nevada Test Site and the Yucca Mountain Site. This route is 319 miles long. Alignment variations are approximately the same length.

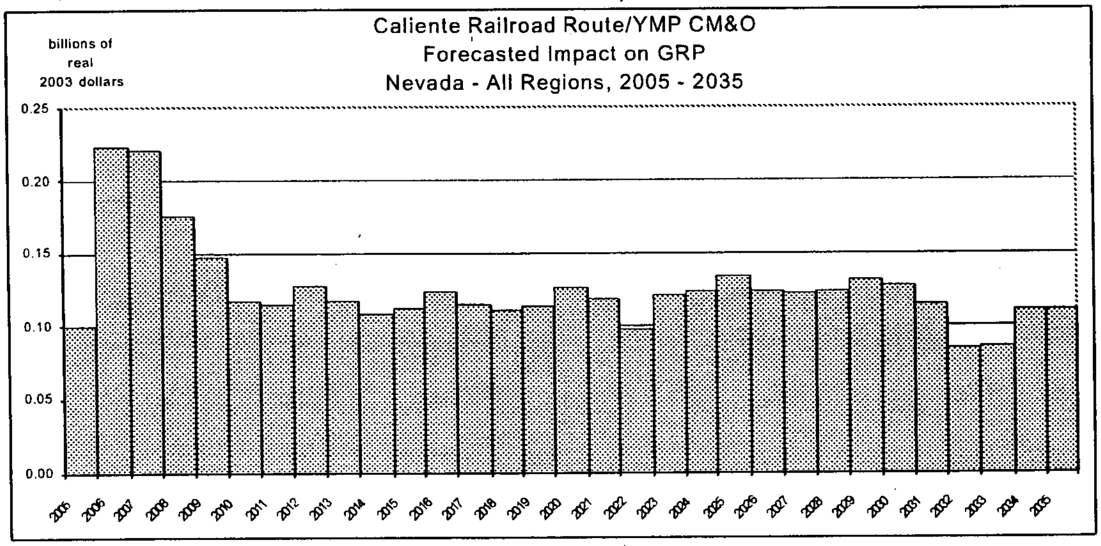
Description of Direct Impacts from Construction. Construction is scheduled to take place over a 46-month period ending in December 2009. A total of 2,821,300 worker hours spread out evenly over the construction period is estimated, translating into 442 workers per year (with 25% labor contingency). Workers are assumed to come from Clark County, work out of camps constructed along the route, and spend money locally for food and lodging during the workweek.

Planning, employment for RR construction, and expenses for constructing the trailer camps and well drilling (done by local contractors) constitute the direct economic infusions into the local economies.

Description of Direct Impacts from Operations. Transportation operations are scheduled to take place over the period 2010-2033. Based on DOE estimates, 47 workers (including a 25% contingency) are assumed. These workers are all assumed to reside in Lincoln County, and will earn higher-than-average wages. A subset of these workers who make the overnight round trip to the repository is assumed to purchase one day's worth of food and lodging in Nye County. Sales made by local and state merchants directly supporting RR route operations make up the final category of direct economic impacts due to operations of this route. Policy variables representing site CM&O are included in this simulation so that the total impacts of YMP under this transportation alternative may be estimated. The REMI model uses inputs for these direct impacts and their associated multipliers with other sectors of the economy to calculate the total (direct, indirect, and induced) economic impacts to the local and state economies.

Model Results; Gross State Product (GSP). Total GSP grows $101.56 million during year 2005, the first year of the construction phase at the site. Change in GSP over the baseline increases to approximately $215.8 million the following two years when RR construction begins, falling during the final two years of the construction phase to $176.5 million and then $147.8 million total new money into the economy.

Figure 17. GSP Impact of the Caliente Rail Alternative on the State of Nevada, 2005 – 2035, Constant 2003 Dollars



During the operation phase (2010-2033) total change to GSP hovers between $116 million and $127 million/year, peaking in 2025 at $133.3 million dollars. During the final two years of transportation operations (2032-33), changes in total GSP due to all YMP-related activities drop to $84.3 million and $86.6 million, respectively. This is a result of a large drop in total employment (from 1,465 in 2031 to 1,175 in 2032-2033) at the Yucca Mountain site. During the last two years of the forecast horizon (2034-35), the difference from the baseline increases to approximately $110 million/year. This is because although transportation of waste is assumed to have ceased, total employment at the Yucca Mountain site has increased back to almost historical (2005-2032) averages.

Figure 18. GRP Impact of the Caliente Rail Alternative on the Clark County, 2005 – 2035, Constant 2003 Dollars

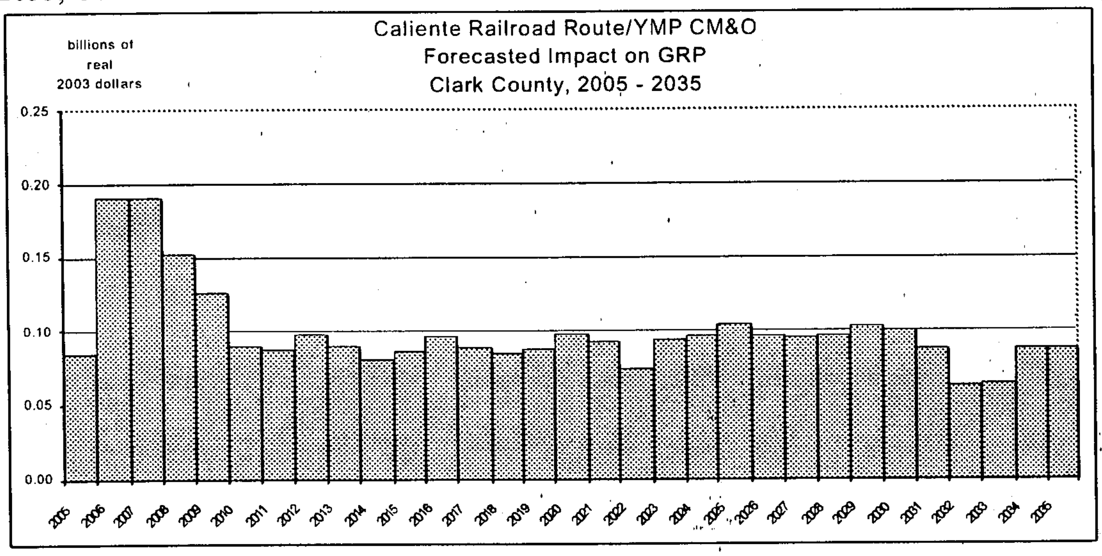


Figure 19. GRP Impact of the Caliente Rail Alternative on the Nye County, 2005 – 2035, Constant 2003 Dollars

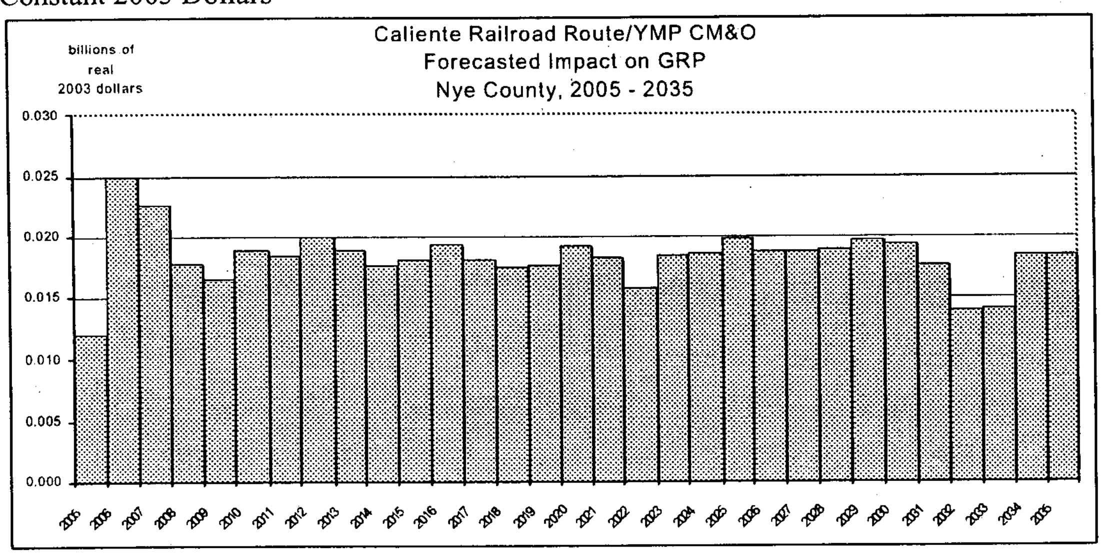


Figure 20. GRP Impact of the Caliente Rail Alternative on the Lincoln County, 2005 – 2035, Constant 2003 Dollars

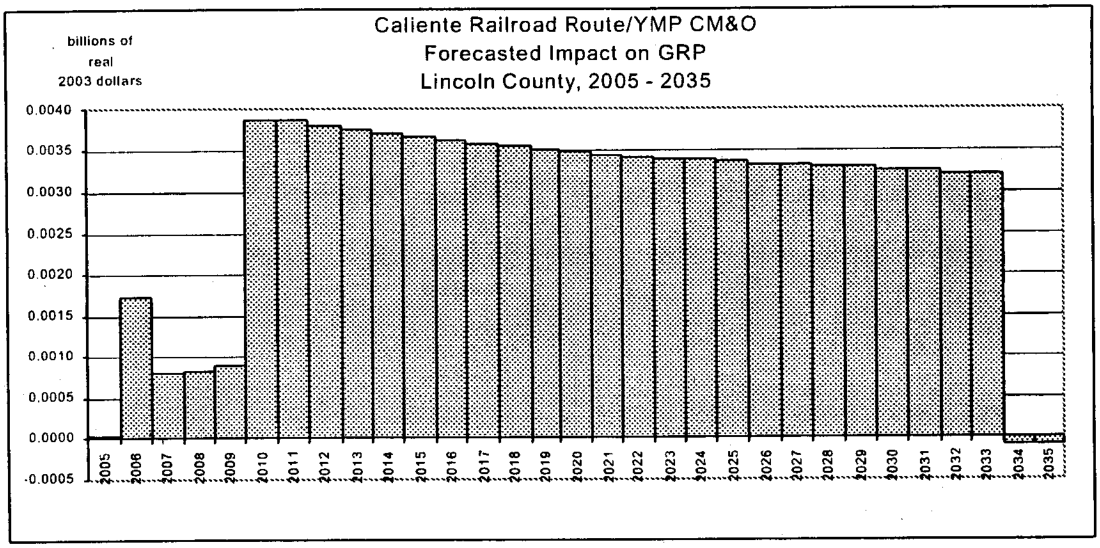
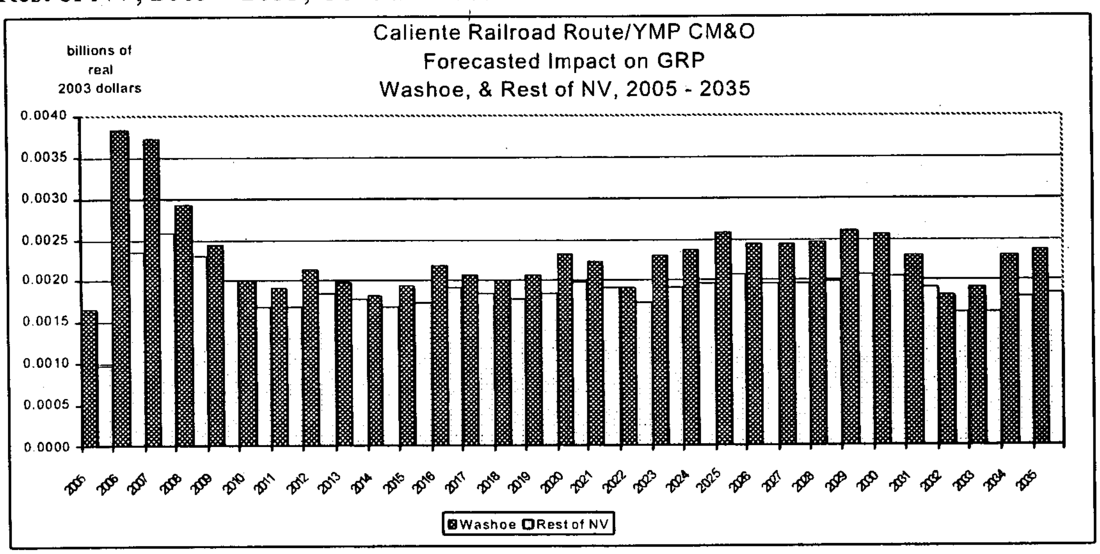


Figure 21. GRP Impact of the Caliente Rail Alternative on the County of Washoe & the Rest of NV, 2005 – 2035, Constant 2003 Dollars



Model Results; Real Personal Disposable Income (RPI). Similar to the growth in GSP, growth in RPI is forecast to be smallest (about $56 million) during 2005, the first year of construction.

The next few years of the construction phase see a dramatic increase in RPI to $132, $138, $119, and $114 million for each of the following four years. From 2010, where the change in RPI over the baseline is forecast at $102.8 million, the difference increases more or less steadily through 2030, to $150 million. A drop in forecast RPI to $138.4 million over the baseline the following year corresponds to an 8 percent drop in expected employment at the Yucca Mountain site in 2031. Like changes to GSP, changes in RPI during the last four years of the forecast horizon first dip (to about $120.6 million) because of further decreases in employment at the Yucca Mountain site, but increase (to about $147.25 million) when Yucca Mountain site employment returns to normal.

Figure 22. Real Disposable Personal Income Impact of the Caliente Rail Alternative on the State of Nevada, 2005 – 2035, Constant 2003 Dollars

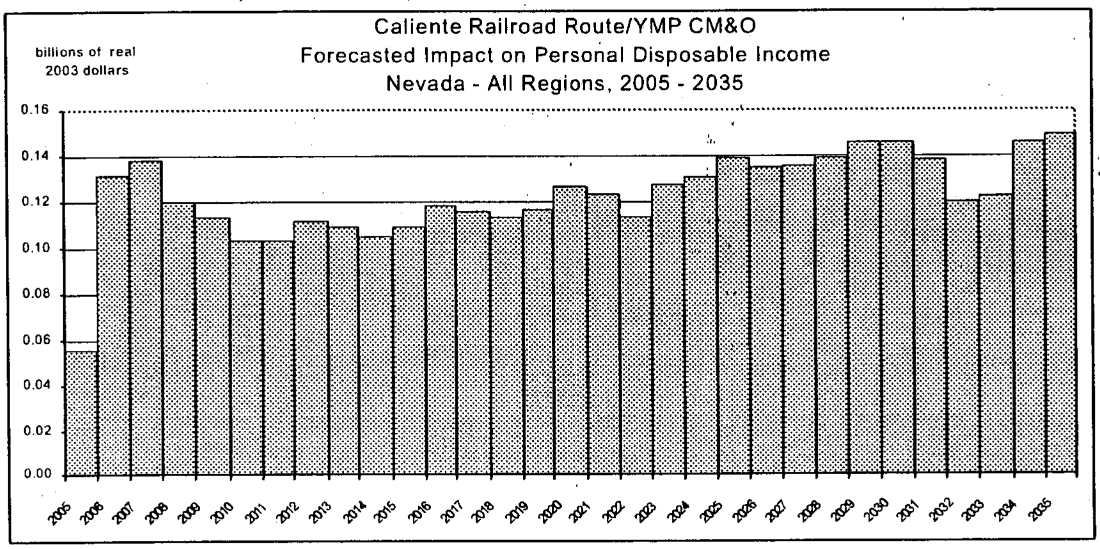


Figure 23. Real Disposable Personal Income Impact of the Caliente Rail Alternative on the Clark County, 2005 – 2035, Constant 2003 Dollars

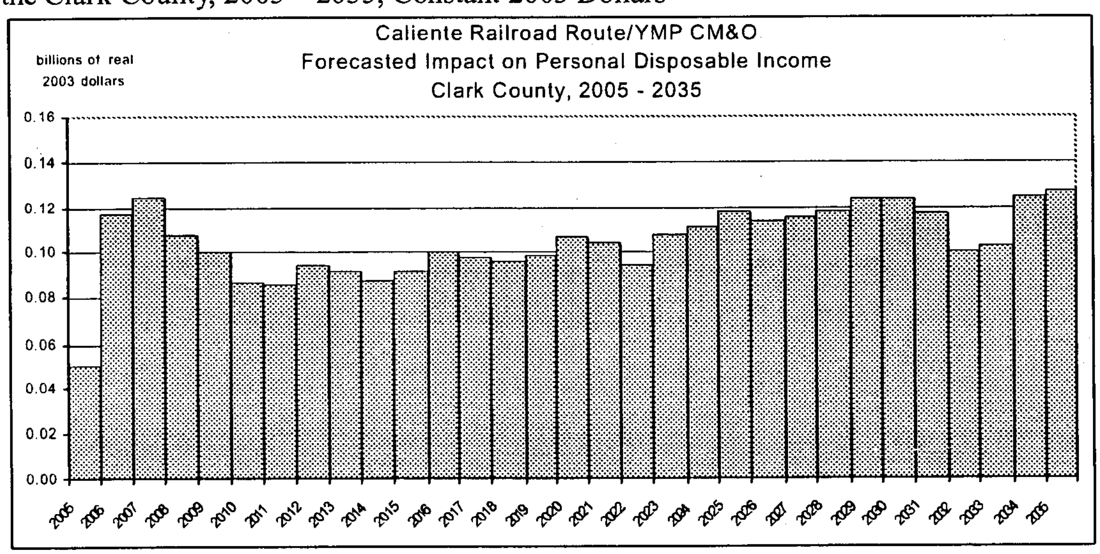


Figure 24. Real Disposable Personal Income Impact of the Caliente Rail Alternative on the Nye County, 2005 – 2035, Constant 2003 Dollars

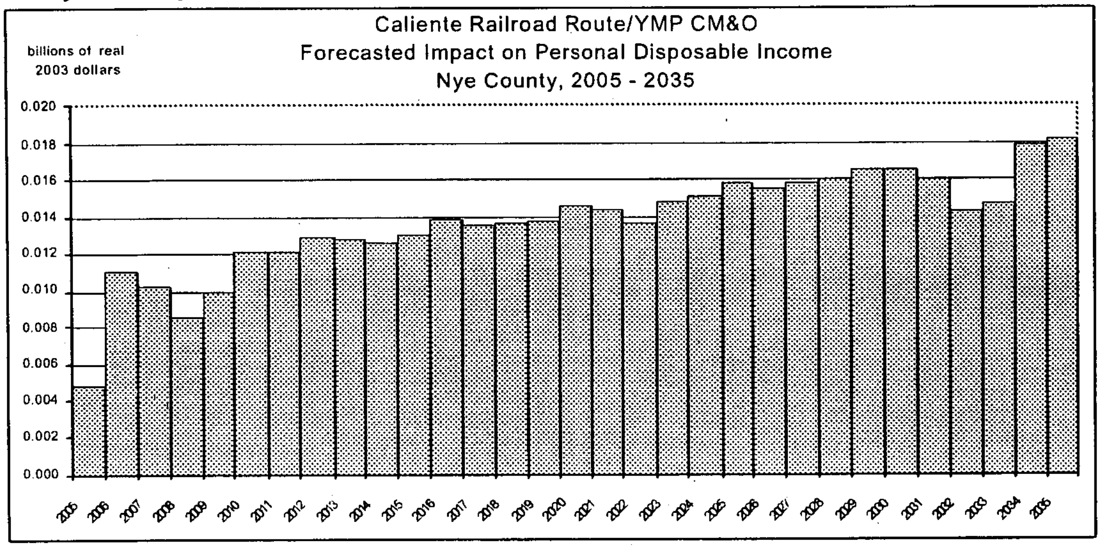


Figure 25. Real Disposable Personal Income Impact of the Caliente Rail Alternative on the Lincoln County, 2005 – 2035, Constant 2003 Dollars

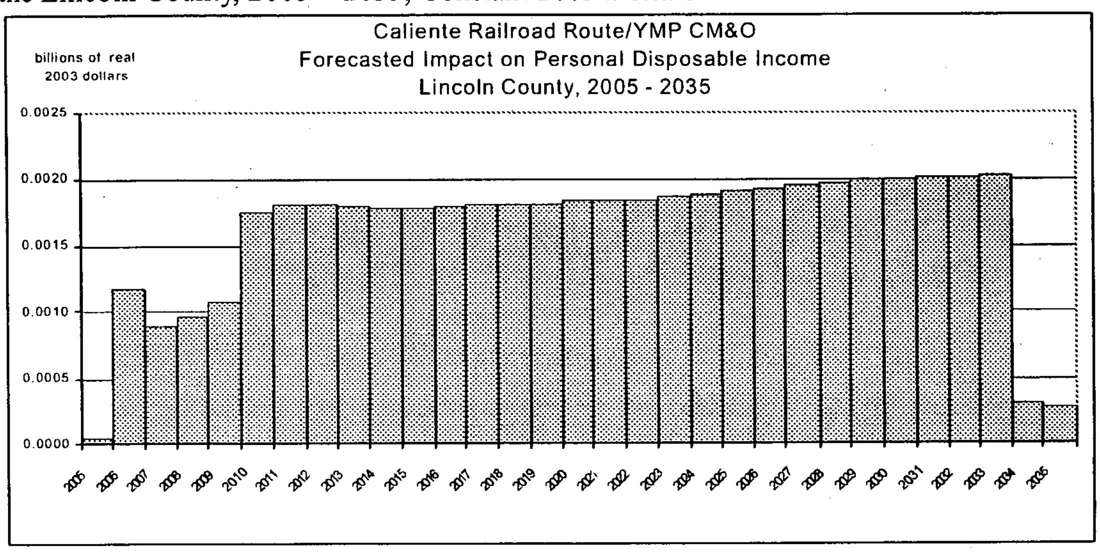
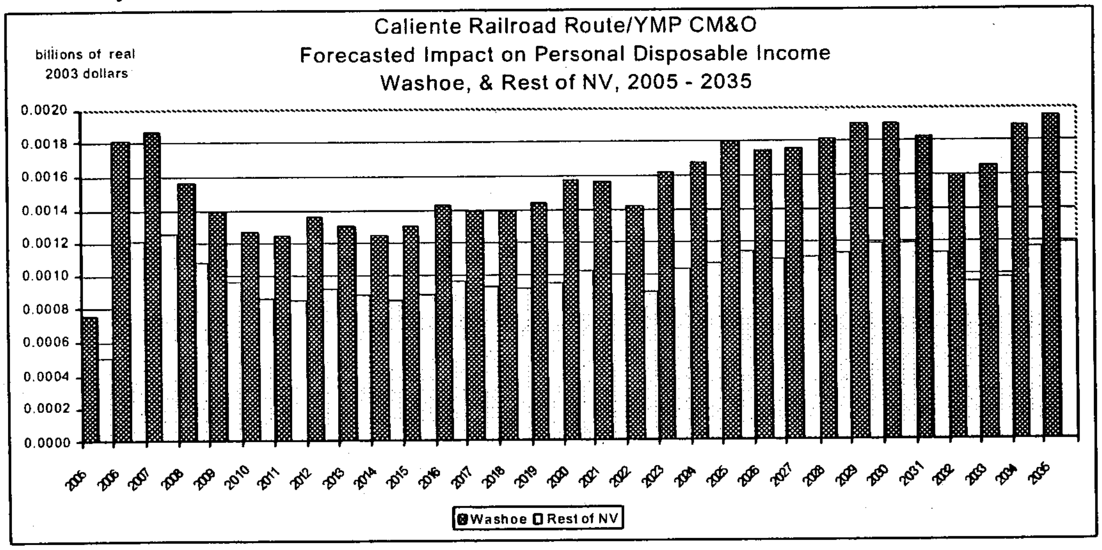


Figure 26. Real Disposable Personal Income Impact of the Caliente Rail Alternative on the County of Washoe & the Rest of NV, 2005 – 2035, Constant 2003 Dollars



Model Results; Total (Direct, Indirect, and Induced) Employment. The year-to-year rate of change in total employment under this transportation alternative because all YMP activity is almost identical to that of GSP.

Employment grows by almost 1,800 people during the first year of construction (2005), jumping to about 4,000 jobs above the baseline during 2006 and 2007. For the rest of the forecast horizon, up to the last four years, employment gains hold mostly steady between about 2,000 and 2,300 over the baseline.

Total employment impacts resulting from YM activities are expected to drop to about 1,500 new employees during years 2032-33, and return to about 2,000 new employees during years 2034-35. These changes over the baseline are consistent with those estimated for changes in GSP and RPI.

Figure 27. Employment Impact of the Caliente Alternative on the State of Nevada, 2005 – 2035, Thousands of Jobs

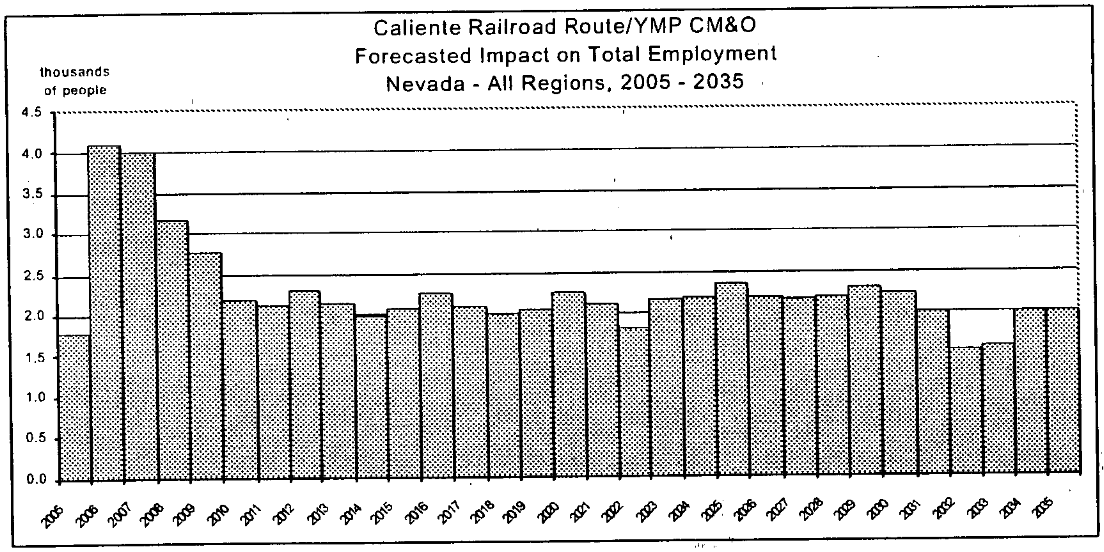


Figure 28. Employment Impact of the Caliente Alternative on the Clark County, 2005 – 2035, Thousands of Jobs

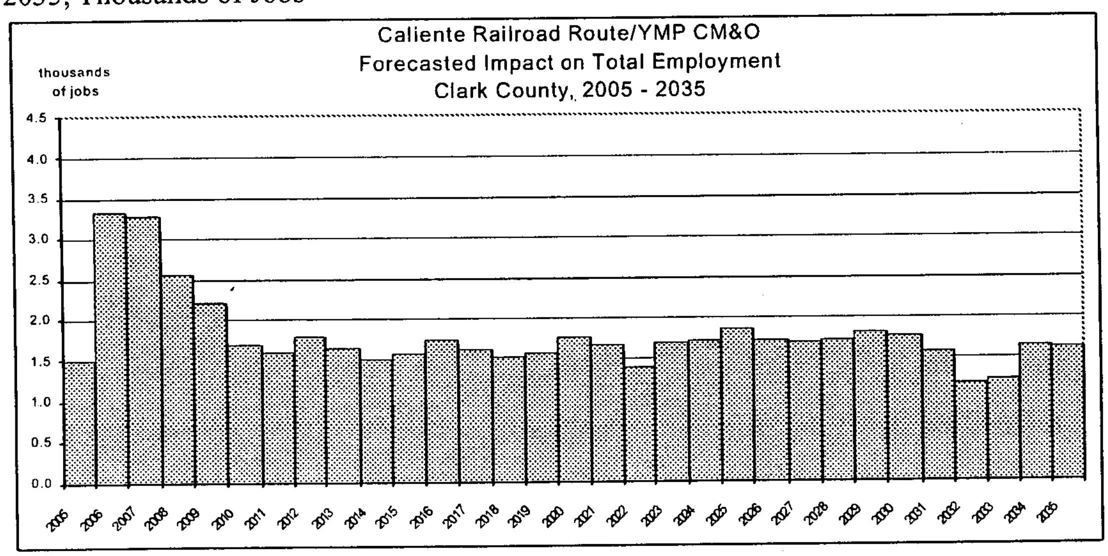


Figure 29. Employment Impact of the Caliente Alternative on the Nye County, 2005 – 2035, Thousands of Jobs

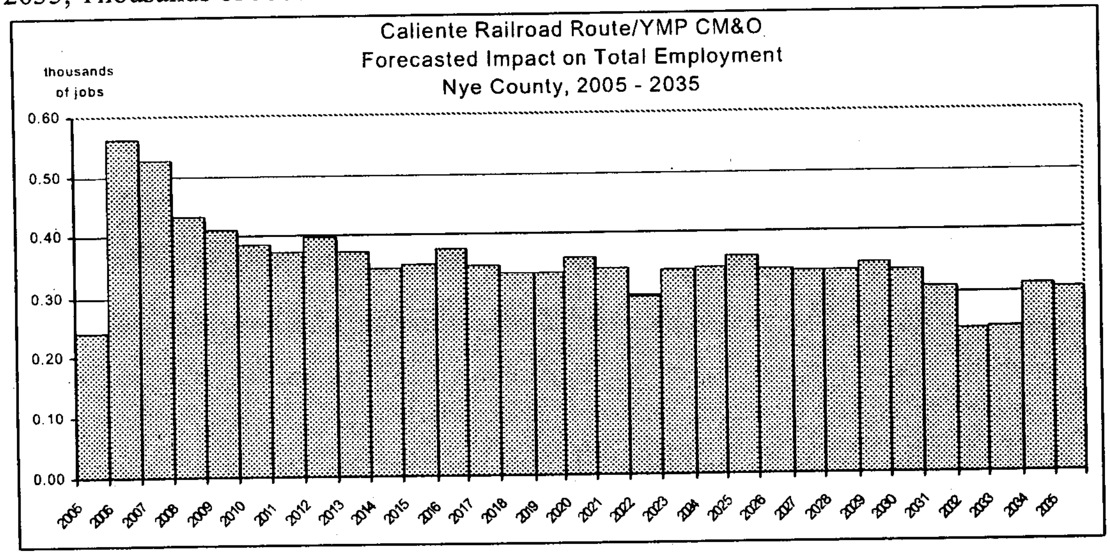


Figure 30. Employment Impact of the Caliente Alternative on the Lincoln County, 2005 – 2035, Thousands of Jobs

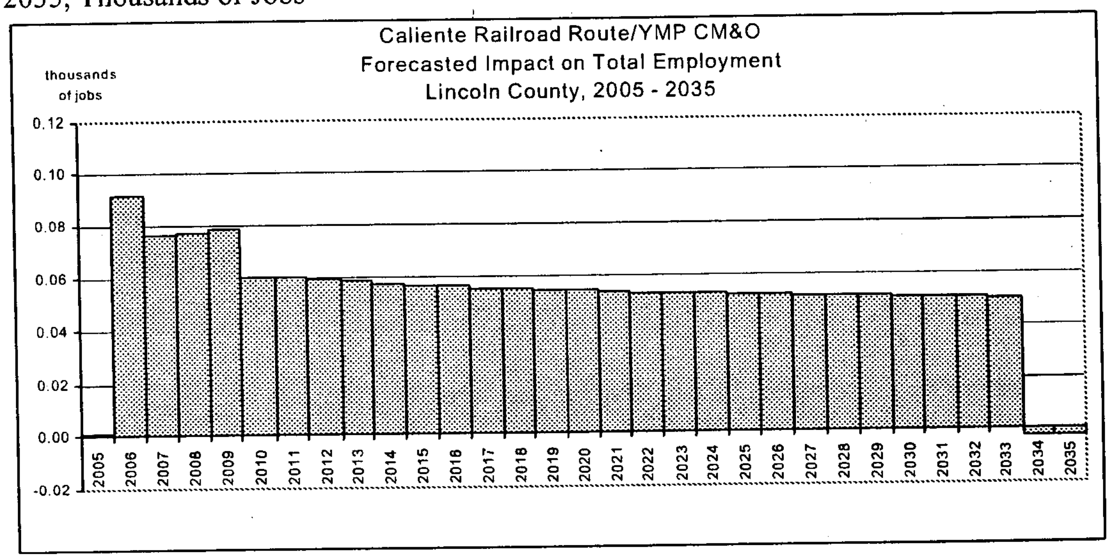
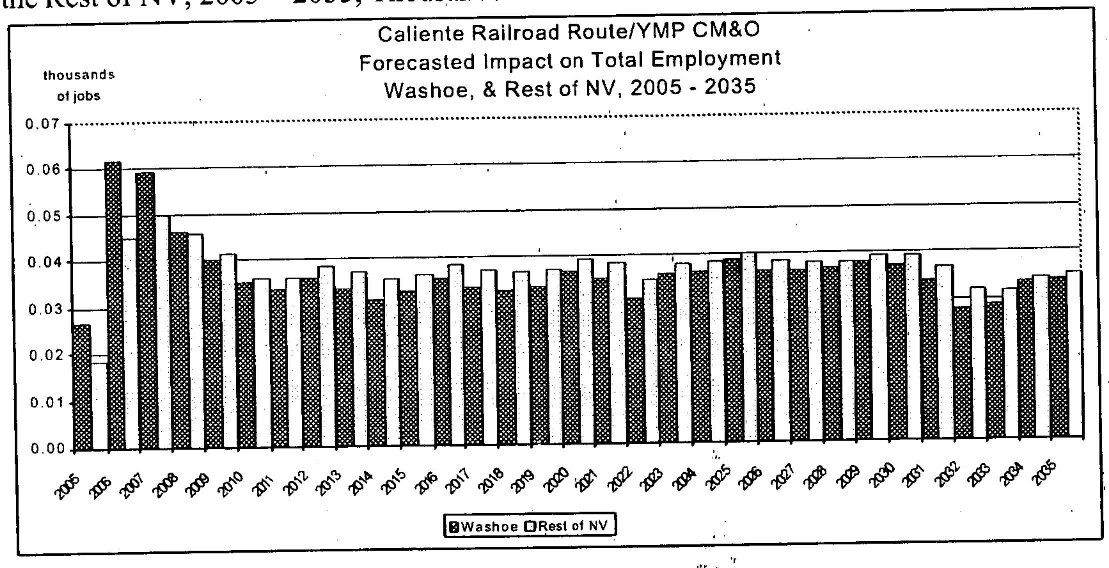


Figure 31. Employment Impact of the Caliente Alternative on the County of Washoe & the Rest of NV, 2005 – 2035, Thousands of Jobs



4.2. Caliente-Chalk Mountain Railroad Alternative, Inclusive of YMP Activity: Description and Model Results.

General Description. As with the Caliente RR route alternative, all waste first funnels along existing mainline railroads to the Caliente railhead, approximately 150 miles north-northeast of Las Vegas. From Caliente, waste is to be transported west on a newly constructed branch line following the same route as the Caliente RR alternative until it passes north of Rachel. From this point the route diverges, heading due south through the Nevada Test Site until it is west of the Yucca Mountain site. It then turns west, heading directly into the Yucca Mountain site. Because it makes its way through the Nevada Test Site (NTS), this 214 mile route is much shorter than the other alternatives.

This route is "nonpreferred" by the United States Air Force due to its proximity to sensitive areas within the NTS. It is, therefore, not likely to be chosen from among the candidate routes.

Description of Direct Impacts from Construction. Construction is scheduled to take place over a 43-month period ending in December 2009 requiring an estimated 2,002,200 worker hours to complete, or (with a 25% labor contingency) 337 workers per year. We assume that construction firms based in Clark County will get the construction and maintenance contracts. Therefore, we also assume that labor will commute weekly from Clark County, work out of camps constructed along the route, and spend money locally for food and lodging during the workweek. (REMI input document report 1, assumptions 3.1.11-3.1.18. Bland 2001)

Initial planning, employment for RR construction, and expenses for constructing the trailer camps and well drilling (done by local contractors) constitute the direct economic infusions into the local and state economies.

Description of Direct Impacts from Operations. Transportation operations are scheduled to take place over the 24-year period, from 2010 through 2033. Based on DOE estimates, 47 workers (with a 25% contingency) are assumed. These workers are all assumed to reside in Lincoln County, and will earn higher-than-average wages. A subset of 25 of these workers who make the overnight round trip to the repository is assumed to purchase one day's worth of food and lodging in Nye County. Sales in support of railroad operations made by local/state merchants, such as fuel and office equipment, make up the final category of direct economic impacts from operations of this route.

Direct economic impacts associated with Yucca Mountain Site CM&O are described above. Policy variables representing Site CM&O are included in this simulation so that total impacts of YMP with this transportation alternative can be estimated.

Impacts in General. The difference between economic impacts between this alternative and the previous (Caliente RR) is simply a matter of scale of the route. Both routes begin at the same point and go through the same counties. The interactions between the regional policy variables are, therefore, very similar. It is not surprising, then, that overlays of the year-to-year economic impacts over the three key areas (GSP, RPI, and employment) are almost identical except that the shorter route (Chalk Mountain) has a slightly smaller impact at every point along the forecast time horizon.

Model Results; Gross State Product. Total GSP grows $100.3 million in year 2005 during the first year of the Yucca Mountain site construction, increasing to approximately $203 million and $209.5 million, respectively, during the following two years when RR route construction begins. Total change in GSP from the baseline then falls to $165 million in year 2008, and $137 million total infusion into the economy during the final year of construction.

During the operation phase (2010-2033) total change to GSP averages about $116.2 million/year, dipping somewhat in 2022. When, as noted before, Yucca Mountain site employment drops.

During the final two years of transportation operations (2032-33), changes in total GSP due to all YMP-related activities drop to $83.8 million and $86.2 million, respectively. This is a result of a large drop in total employment (from 1,465 in 2031 to 1,175 in 2032-2033) at the Yucca Mountain site.

During the last two years of the forecast horizon (2034-35), the difference from the baseline increases to just under $110.4 million/year. The reason is that while transportation of waste is assumed to have ceased, total employment at the Yucca Mountain site has increased back to almost historical (2005-2032) averages.

Figure 32. GSP Impact of the Caliente-Chalk Mountain Rail Alternative on the State of Nevada, 2005 – 2035, Constant 2003 Dollars

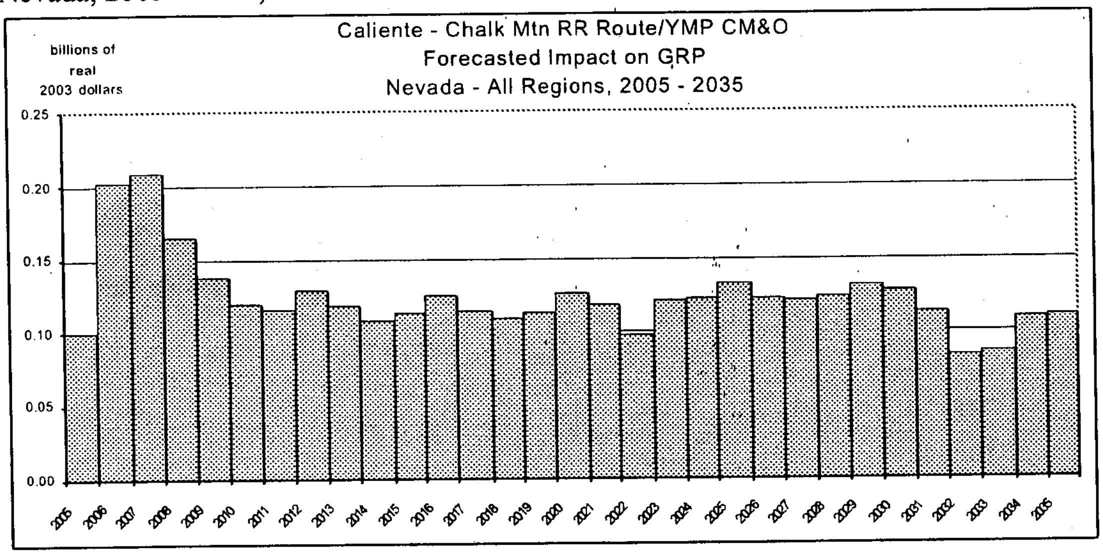


Figure 33. GRP Impact of the Caliente-Chalk Mountain Rail Alternative on the Clark County, 2005 – 2035, Constant 2003 Dollars

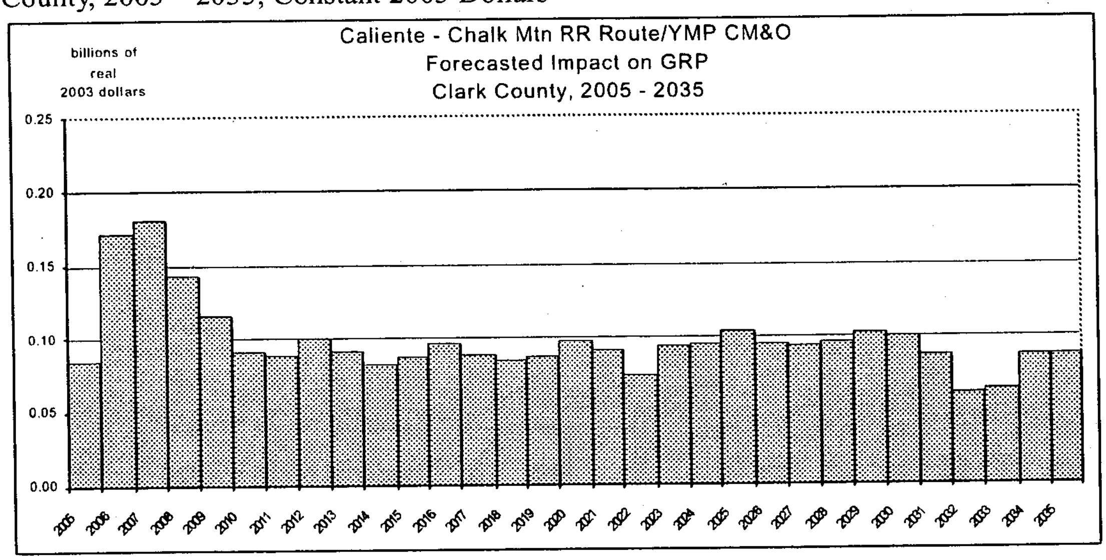


Figure 34. GRP Impact of the Caliente-Chalk Mountain Rail Alternative on the Nye County, 2005 – 2035, Constant 2003 Dollars

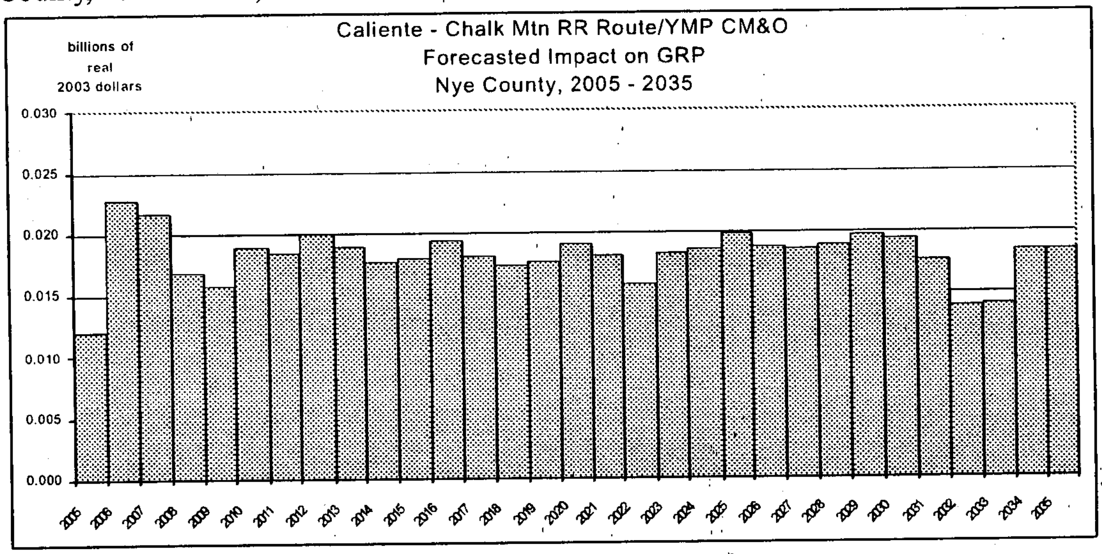


Figure 35. GRP Impact of the Caliente-Chalk Mountain Rail Alternative on the Lincoln County, 2005 – 2035, Constant 2003 Dollars

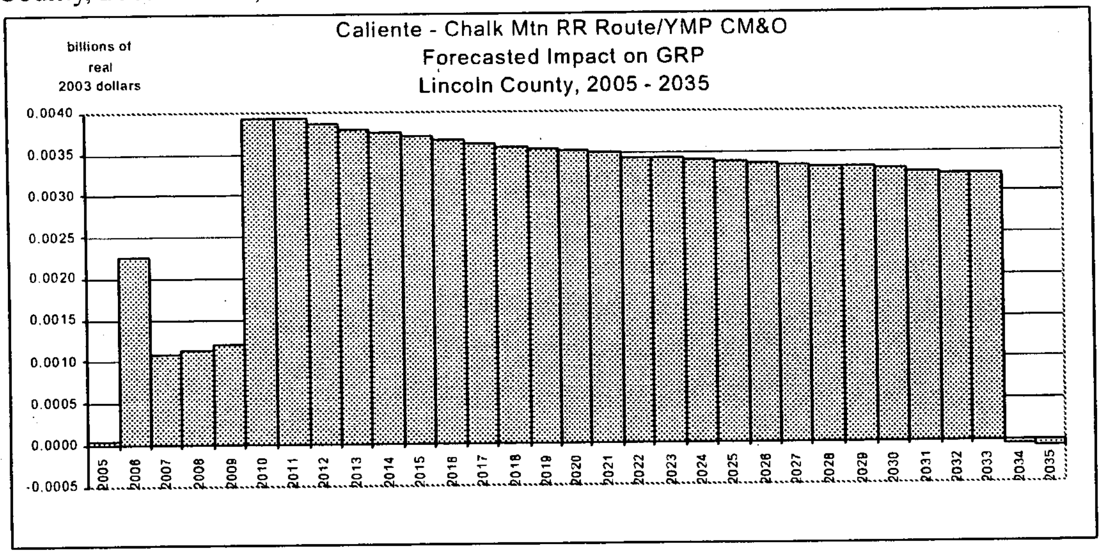
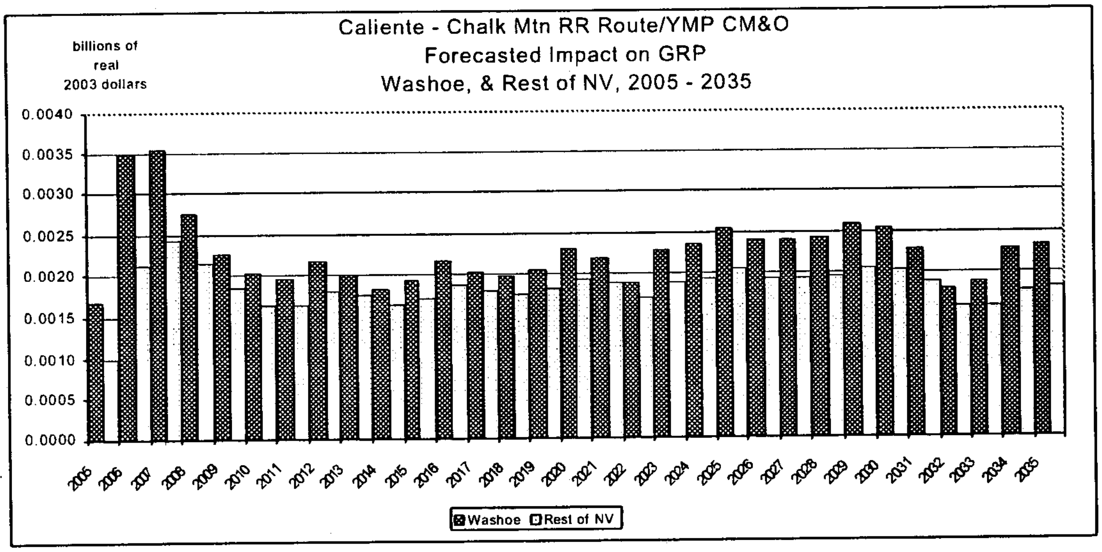


Figure 36. GRP Impact of the Caliente-Chalk Mountain Rail Alternative on the County of Washoe & the Rest of NV, 2005 – 2035, Constant 2003 Dollars



Model Results; Real Personal Disposable Income (RPI). Similar to the growth in GSP, growth in RPI is forecast to be smallest (about $55.86 million) during 2005, the first year of construction.

During the rest of the construction phase a dramatic increase is forecast in RPI to $116.3, $130.8, $108.9, and $106.6 million in each of the four following years, respectively. From 2010, where the change in RPI over the baseline is forecast at $102.8 million, the difference increases more or less steadily through 2031, peaking in years 2029 and 2030 at about $144.7 million.

Changes in RPI during the last four years of the forecast horizon follow the same pattern as GSP, first dipping to about $119 million/year during years 2032, 2033 (due to decreases in employment at the Yucca Mountain site), and increasing to about $145.2 million and $148.1 million during years 2034 and 2035, respectively, when Yucca Mountain Site employment returns to normal.

Figure 37. Real Disposable Personal Income Impact of the Caliente-Chalk Mountain Rail Alternative on the State of Nevada, 2005 – 2035, Constant 2003 Dollars

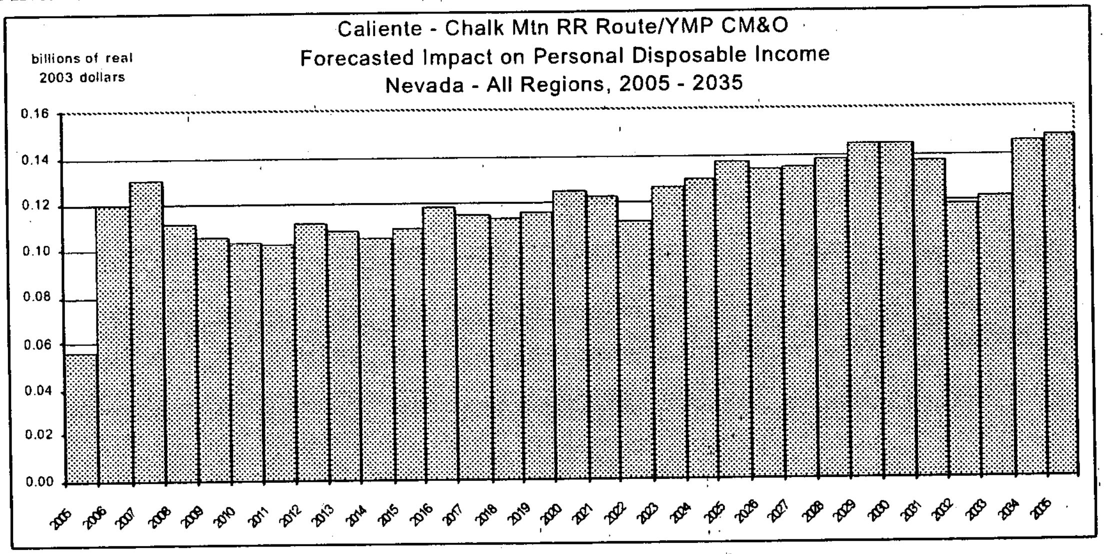


Figure 38. Real Disposable Personal Income Impact of the Caliente-Chalk Mountain Rail Alternative on the Clark County, 2005 – 2035, Constant 2003 Dollars

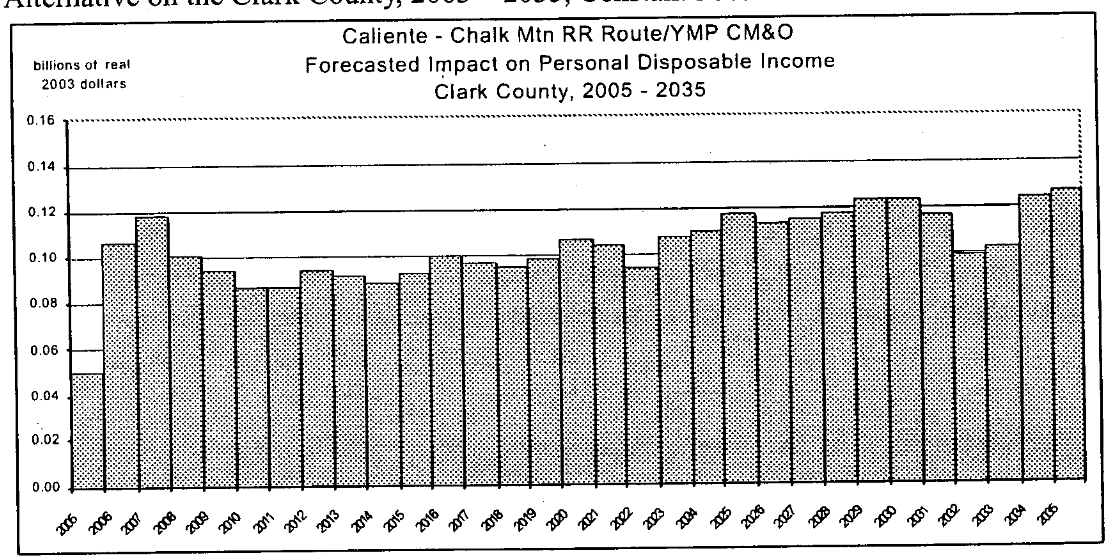


Figure 39. Real Disposable Personal Income Impact of the Caliente-Chalk Mountain Rail Alternative on the Nye County, 2005 – 2035, Constant 2003 Dollars

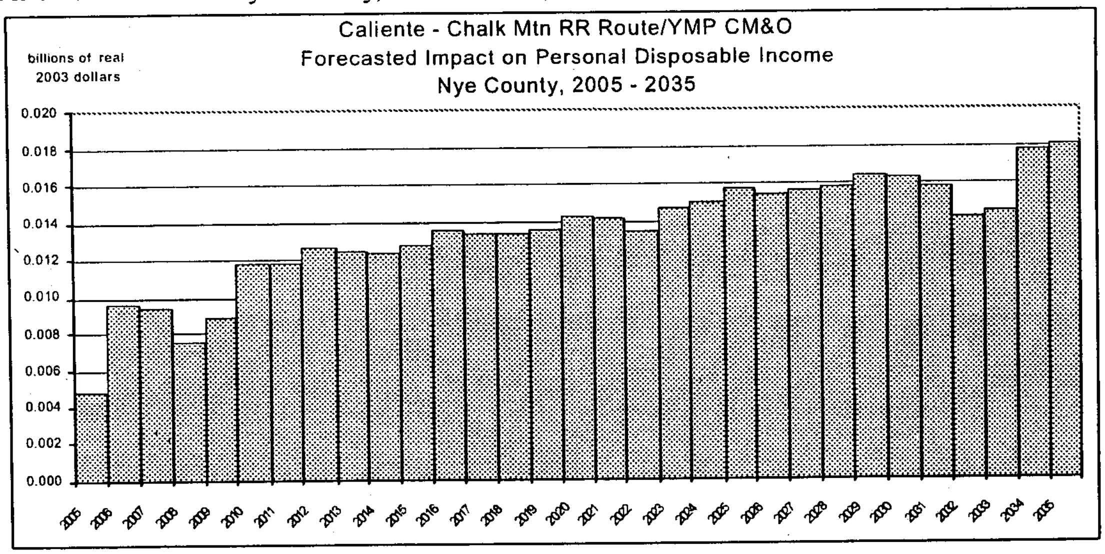


Figure 40. Real Disposable Personal Income Impact of the Caliente-Chalk Mountain Rail Alternative on the Lincoln County, 2005 – 2035, Constant 2003 Dollars

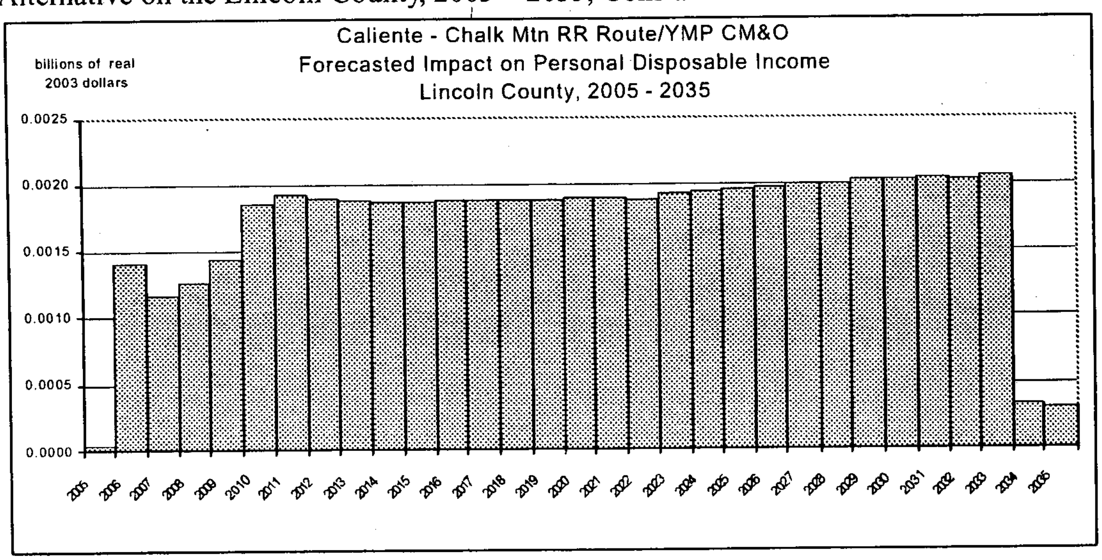
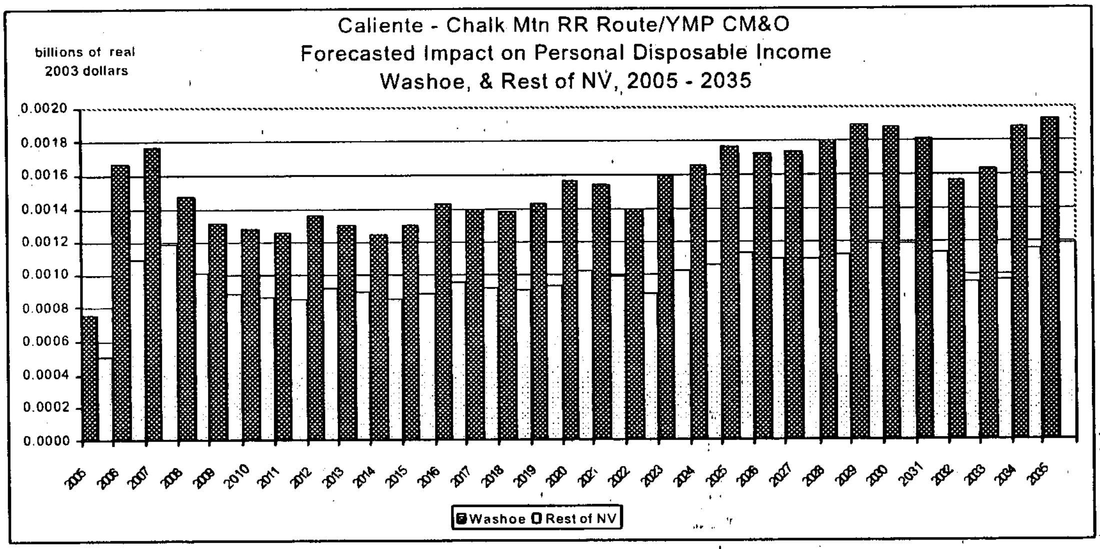


Figure 41. Real Disposable Personal Income Impact of the Caliente-Chalk Mountain Rail Alternative on the County of Washoe & the Rest of NV, 2005 – 2035, Constant 2003 Dollars



Model Results; Employment. The year-to-year rate of change in total employment under this transportation alternative because all YMP activity is almost identical to that of GSP.

Employment grows by almost 1,800 people during the first year of construction (2005), jumping to about 3,700 jobs above the baseline during each of 2006 and 2007. For the rest of the forecast horizon, up to the last four years, employment gains hold mostly steady between about 2,000 and 2,300 over the baseline.

Total employment impacts resulting from YMP activities are expected to drop to about 1,500 new employees during years 2032-33, and return to about 2,000 employees over the baseline during years 2034-35. This forecast is consistent with those estimated for changes in GSP and RPI.

Figure 42. Employment Impact of the Caliente-Chalk Mountain Alternative on the State of Nevada, 2005 – 2035, Thousands of Jobs

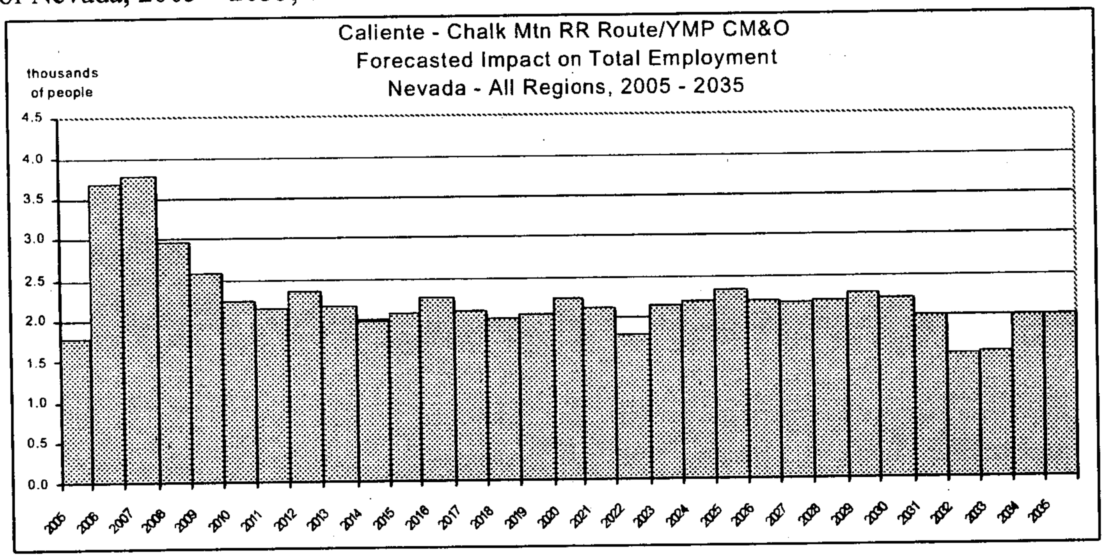


Figure 43. Employment Impact of the Caliente-Chalk Mountain Alternative on the Clark County, 2005 – 2035, Thousands of Jobs

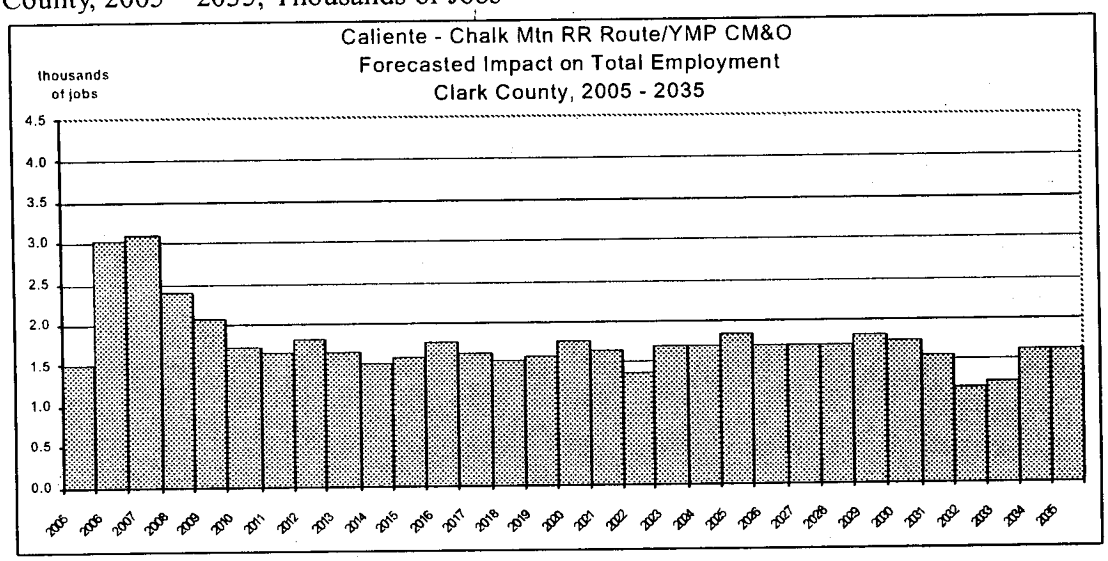


Figure 44. Employment Impact of the Caliente-Chalk Mountain Alternative on the Nye County, 2005 – 2035, Thousands of Jobs

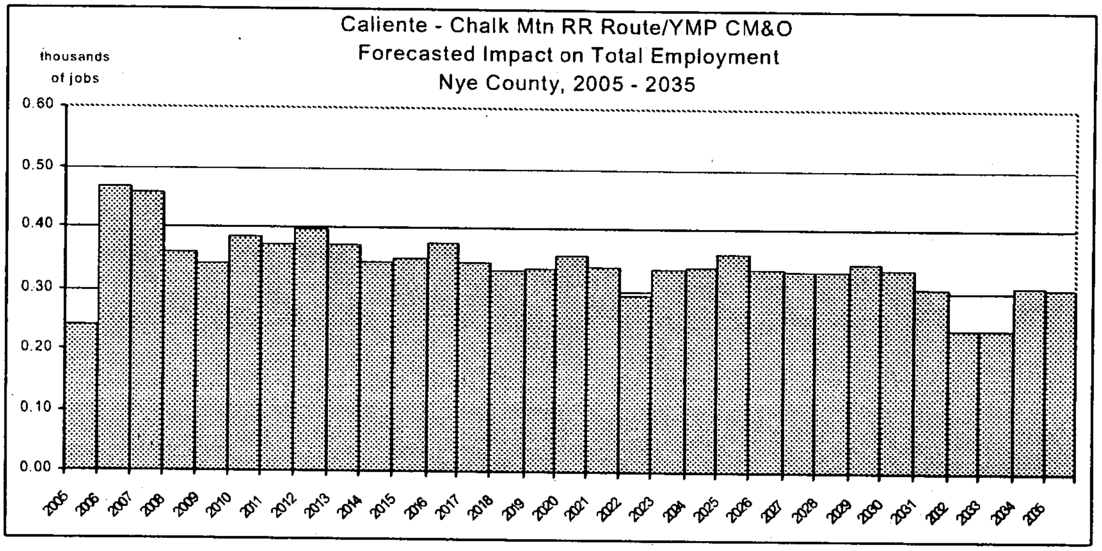


Figure 45. Employment Impact of the Caliente-Chalk Mountain Alternative on the Lincoln County, 2005 – 2035, Thousands of Jobs

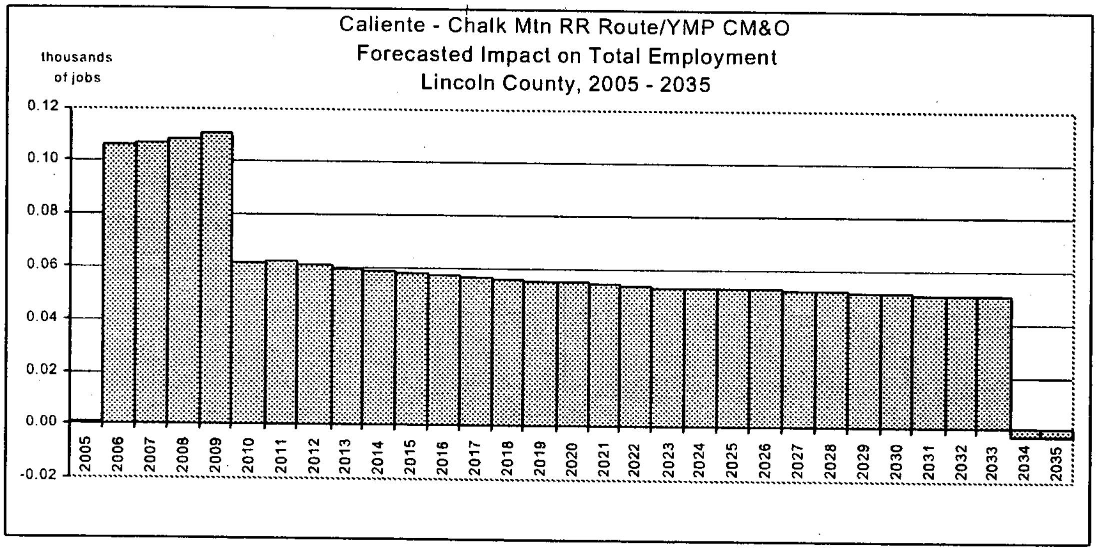
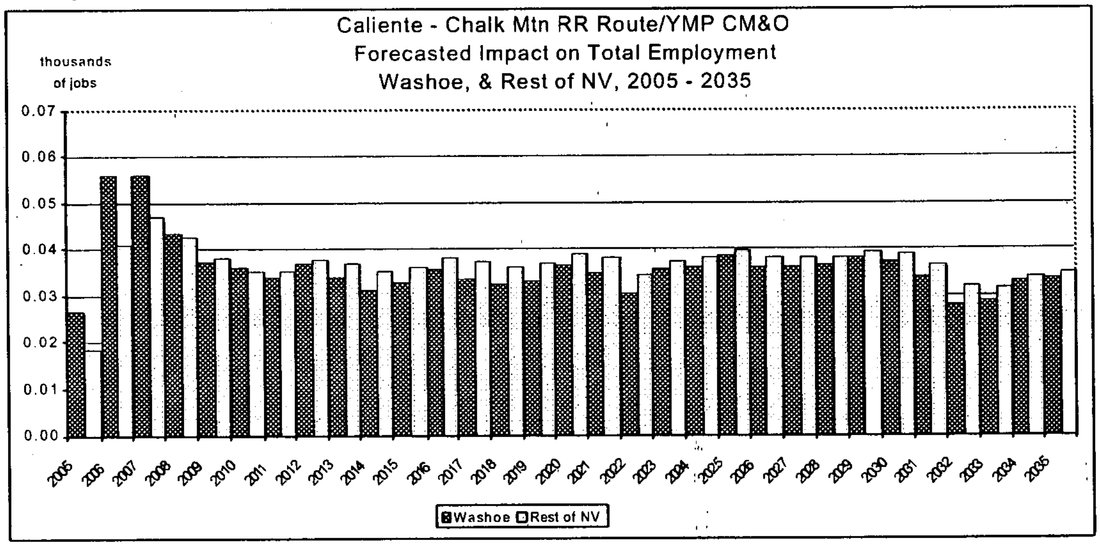


Figure 46. Employment Impact of the Caliente-Chalk Mountain Alternative on the County of Washoe & the Rest of NV, 2005 – 2035, Thousands of Jobs



4.3. Carlin-Big Smokey Railroad Alternative, Inclusive of YMP Activity: Description and Model Results.

General Description. The Carlin-Big Smokey route leaves the main line in north central Nevada from a point west of Carlin in Eureka County (whereas Carlin is in Elko County), and just southeast of Beowawe. (Map one of candidate rail corridors, p. S-92.) It heads southwest through the Big Smokey Valley past Tonopah, where from that point it continues due south using the same route as the Caliente alternative. One alignment variation goes through the Monitor Valley instead of Big Smokey Valley. The model for this alternative is based on the Big Smokey Valley route, approximately 323 miles long.

Description of Direct Impacts from Construction. Construction is scheduled to take place over a 46-month period ending in December 2009. A total of 2,463,700 worker hours is estimated, and is assumed spread out evenly over the construction period. Using a 25% labor contingency, this translates into 385 workers per year. It is assumed that construction firms based in Clark County will get the construction and maintenance contracts. It is, therefore, assumed that labor will come from Clark County, commute weekly to one of camps constructed along the route, and spend money locally for food and lodging during the work week. (REMI input document report 1, assumptions 3.1.11-3.1.18. Bland 2001)

Planning and employment for RR construction, along with expenses for constructing the trailer camps and well drilling (done by local contractors), constitute the direct economic infusions into the local and state economies.

Description of Direct Impacts from Operations. Transportation operations are scheduled to take place over the period 2010-2033. Based on DOE estimates, 47 workers (including a 25% contingency) are assumed. These workers are all assumed to reside in the REMI region known as the "Rest of Nevada," which includes both Eureka and Lander counties. These railroad employees will also earn higher-than-average wages for this employment sector. A subset of 25 of these workers who make the overnight round trip to the repository is assumed to purchase one day's worth of food and lodging in Nye County. Sales made by local/state merchants of such items as fuel and office equipment in support of RR route operations make up the final category of direct economic impacts from operations of this route.

Yucca Mountain site CM&O is described above. Policy variables representing Site CM&O are included in this simulation so that the total impacts of YMP under this transportation alternative may be estimated.

The REMI model uses inputs for these direct impacts and their associated multipliers with other sectors of the economy to calculate the total economic impacts to the local and state economies.

Model Results; Gross State Product (GSP). As with all other routes, route construction is not scheduled to begin until 2006. The $101.6 million change in GSP from the baseline during year 2005 comes solely from Yucca Mountain site activity. However, when construction begins on the RR route and employment associated with the Yucca Mountain site almost doubles, the change to the GSP baseline jumps to $218.6 million in 2006, and $214.3 million in 2007.

Forecast changes to base GSP falls over the next two years, 2008-2009, to $170.1 million and $142.2 million as employment at the Yucca Mountain site drops. Construction operations on the RR route are expected to be stable over this period.

During the transportation phase of the YMP, the total change to baseline annual GSP starts at about $118.1 million in year 2010, working up to about $126.9 million in year 2030. Repository employment drops during the final three years of scheduled transportation of nuclear waste to the Yucca Mountain site, bringing the forecast relative to the baseline GSP to increase by about $113.6 million in year 2030, and about $84.4 million/year for years 2032 and 2033.

Transportation is scheduled to complete by year 2034, but repository employment ramps up noticeably during years 2034 and 2035. Changes to baseline GSP expectedly increase during these last two year of the forecast time horizon to about $109.5 million/year.

Figure 47. GSP Impact of the Carlin-Big Smokey Rail Alternative on the State of Nevada, 2005 – 2035, Constant 2003 Dollars

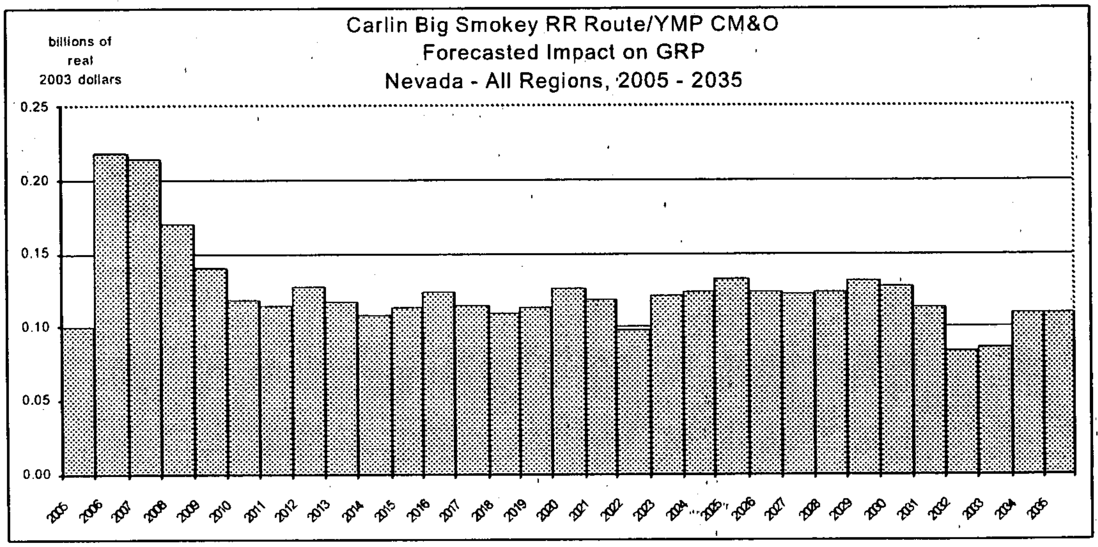


Figure 48. GRP Impact of the Carlin-Big Smokey Rail Alternative on the Clark County, 2005 – 2035, Constant 2003 Dollars

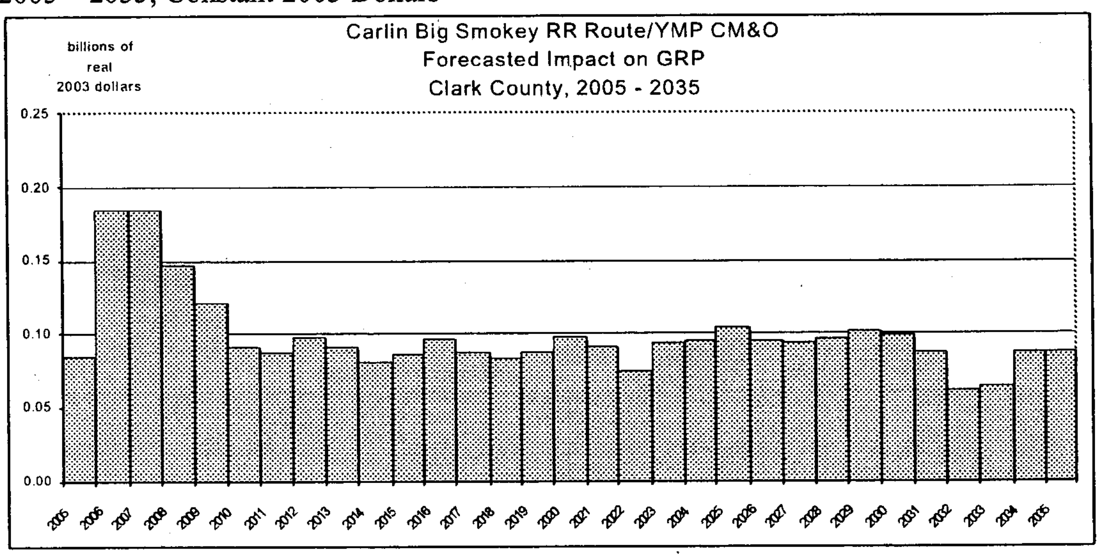


Figure 49. GRP Impact of the Carlin-Big Smokey Rail Alternative on the Nye County, 2005 – 2035, Constant 2003 Dollars

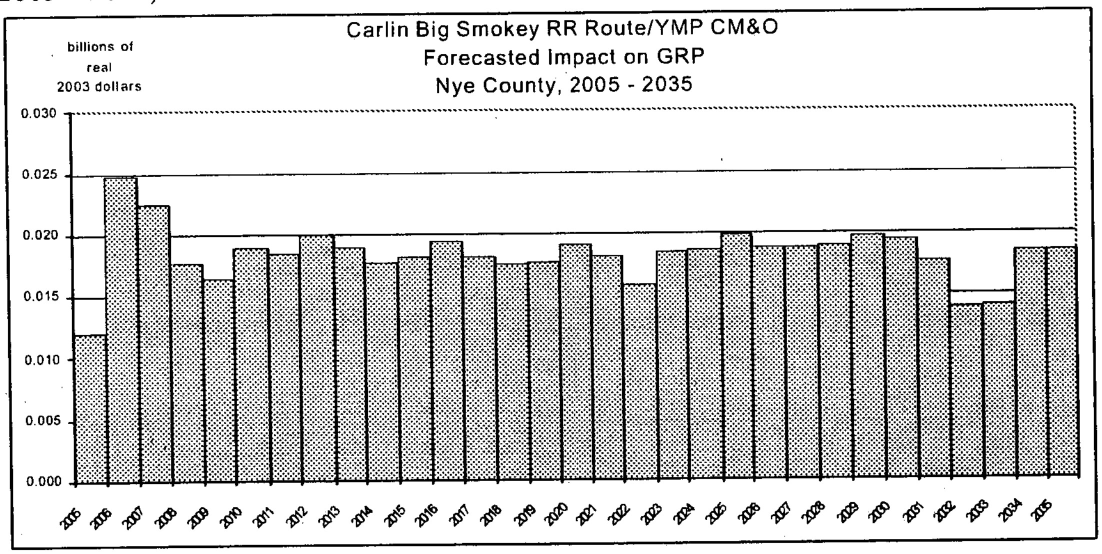


Figure 50. GRP Impact of the Carlin-Big Smokey Rail Alternative on the Lincoln County, 2005 – 2035, Constant 2003 Dollars

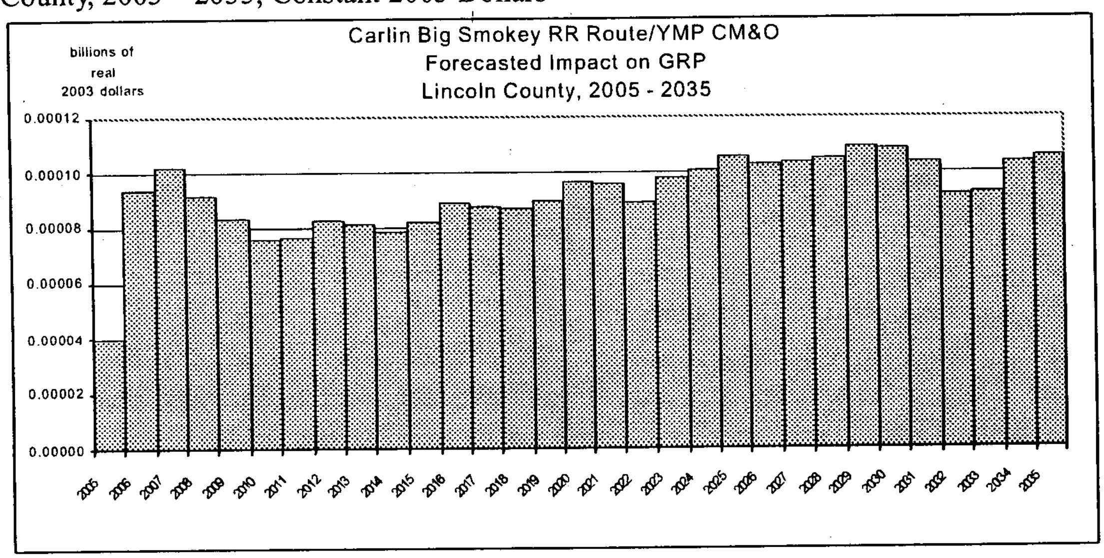
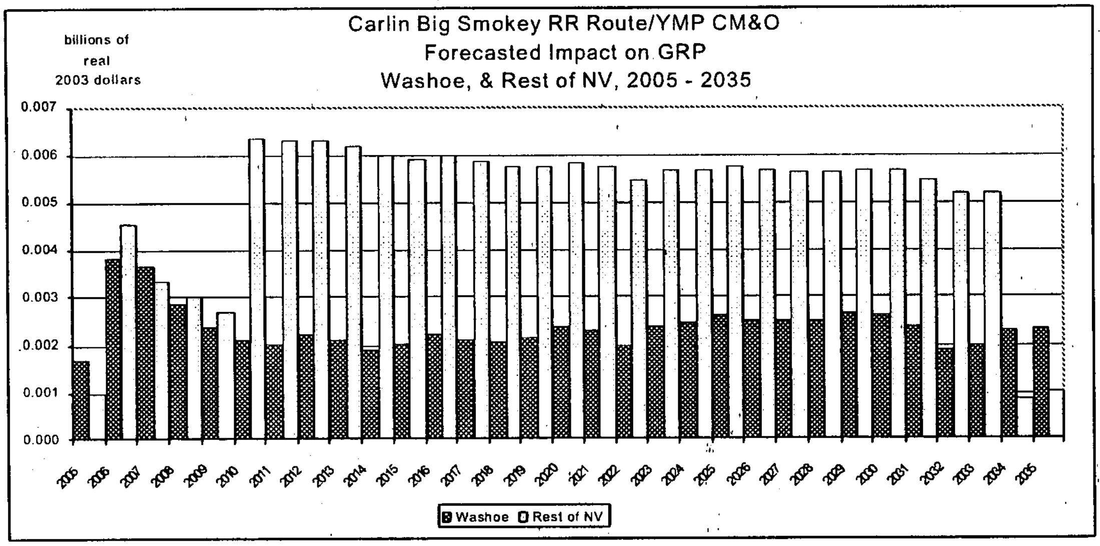


Figure 51. GRP Impact of the Carlin-Big Smokey Rail Alternative on the County of Washoe & the Rest of NV, 2005 – 2035, Constant 2003 Dollars



Model Results; Real Personal Disposable Income (RPI). As noted, changes to the baseline RPI during year 2005 are a result of Yucca Mountain site activities alone. They are, therefore, the same for each of the RR alternatives. When the beginning of construction on the RR route joins increased employment at the Yucca Mountain site in 2006, RPI over the baseline increases to $128.5 million. The following year RPI increases to $134.4 million. RR route construction moves along steadily over the next two years (2008, 2009), but employment at the Yucca Mountain site decreases, causing total (direct, indirect and induced) changes to baseline RPI to decrease to $114.3 million and $109.2 million, respectively.

RPI changes drop to $103.3 million after construction ends and transportation begins in year 2010, but climb steadily throughout most of the transportation phase. This steady increase peaks at about $145 million in each of the years 2029 and 2030, falling to about $138 million in 2031. Transportation of waste is scheduled to continue during years 2032 and 2033, but decreased employment and activity at the Yucca Mountain site reduce the overall impact on RPI during these years to about $118 million and $121.9 million, respectively.

The final two years of the forecast see changes to baseline RPI increase to their highest level due to increased activity at the Yucca Mountain site, even though transportation activity has by then ceased.

Figure 52. Real Disposable Personal Income Impact of the Carlin-Big Smokey Rail Alternative on the State of Nevada, 2005 – 2035, Constant 2003 Dollars

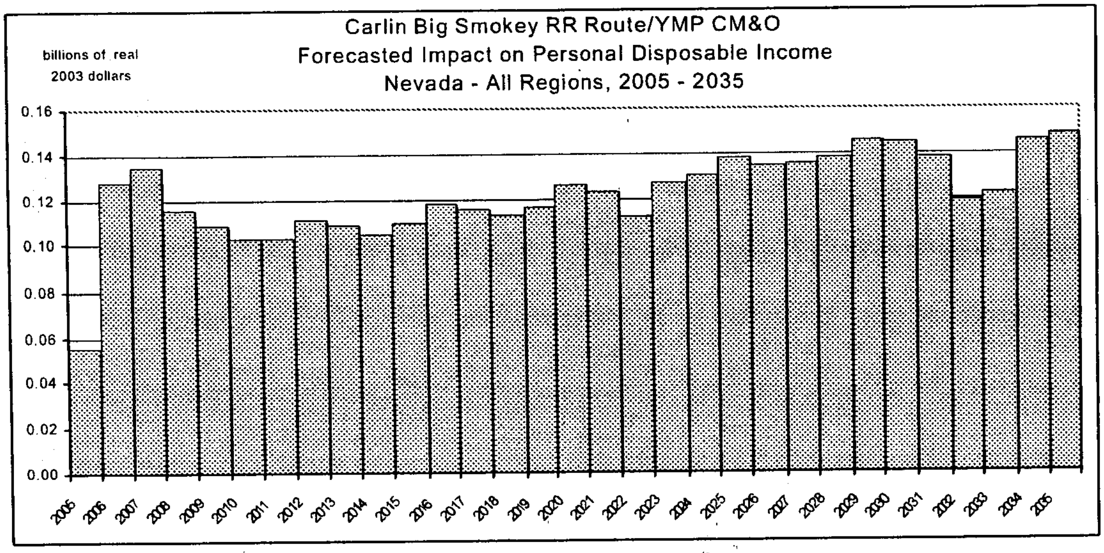


Figure 53. Real Disposable Personal Income Impact of the Carlin-Big Smokey Rail Alternative on the Clark County, 2005 – 2035, Constant 2003 Dollars

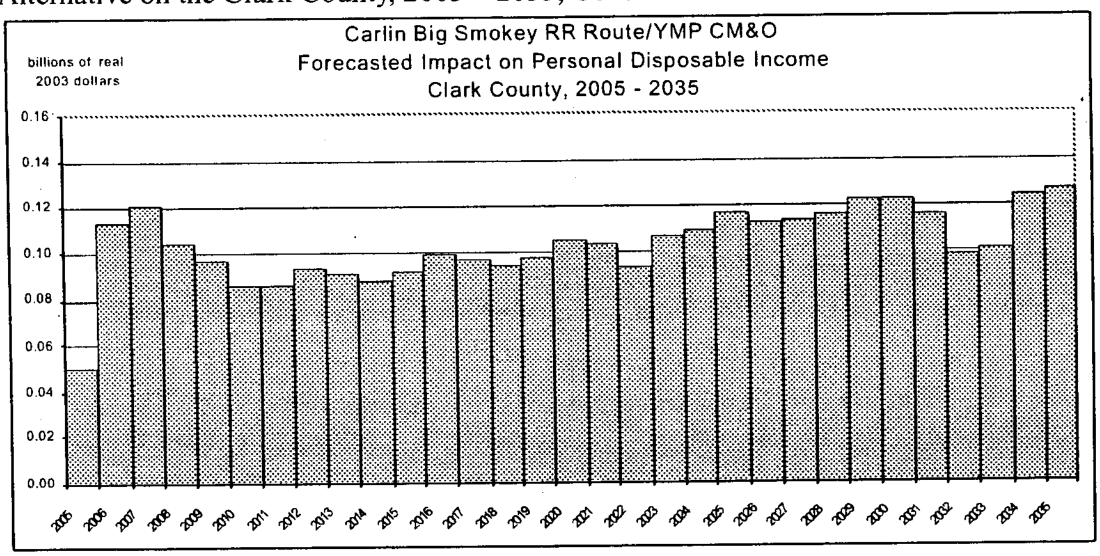


Figure 54. Real Disposable Personal Income Impact of the Carlin-Big Smokey Rail Alternative on the Nye County, 2005 – 2035, Constant 2003 Dollars

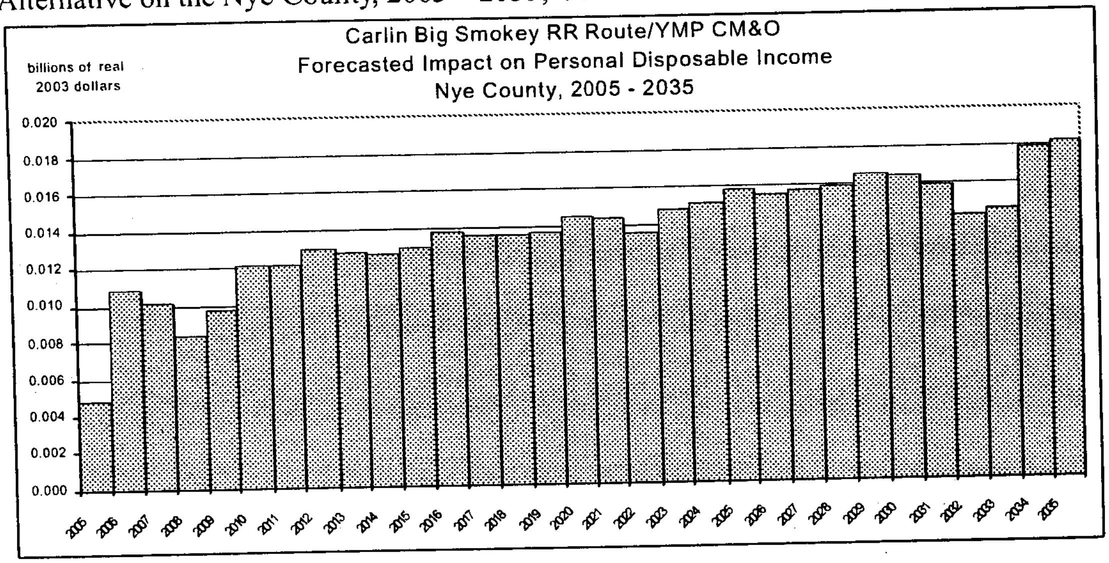


Figure 55. Real Disposable Personal Income Impact of the Carlin-Big Smokey Rail Alternative on the Lincoln County, 2005 – 2035, Constant 2003 Dollars

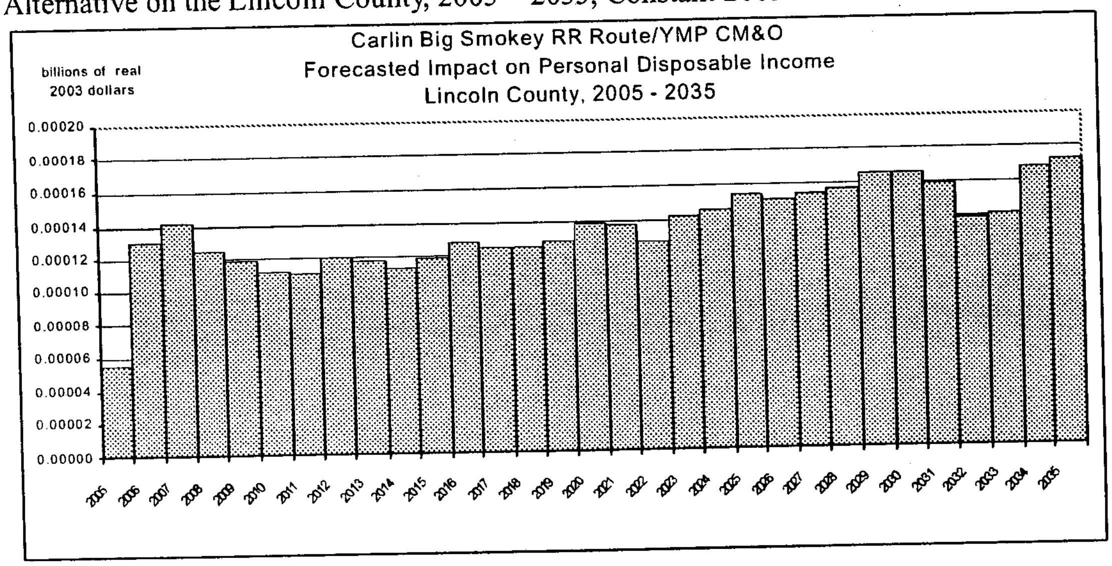
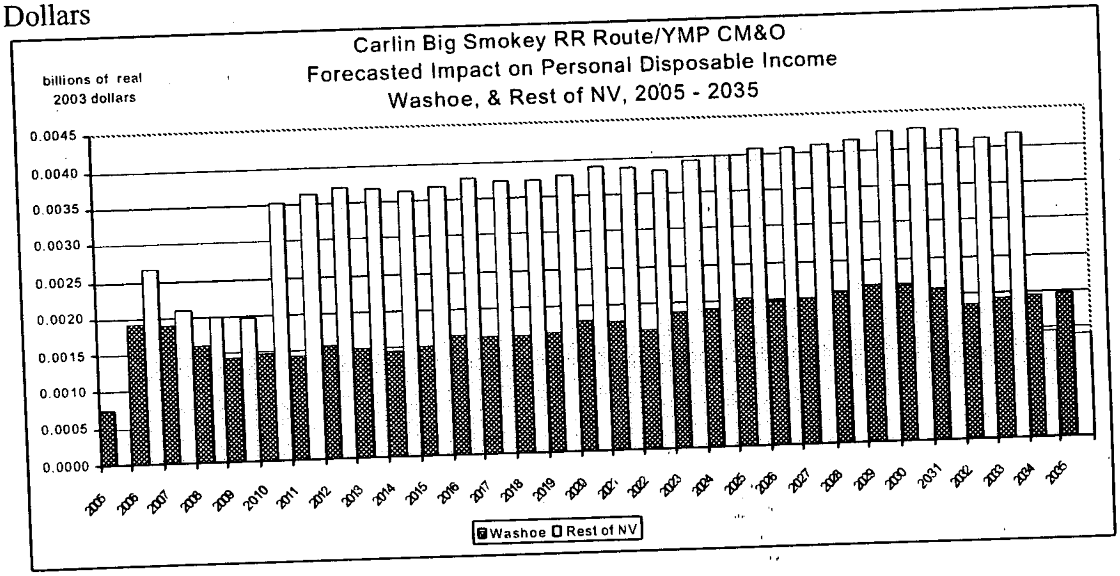


Figure 56. Real Disposable Personal Income Impact of the Carlin- Big Smokey Rail Alternative on the County of Washoe & the Rest of NV, 2005 – 2035, Constant 2003 Dollars



Model Results; Employment. Employment grows by almost 1,800 people during year 2005 when activity at the Yucca Mountain site begins. The following year construction on the RR route begins, accompanied by greatly increased activity at the Yucca Mountain site. This causes an estimated impact about 4,000 jobs above the baseline during each of 2006 and 2007.

For the rest of the forecast horizon, up to the last four years, employment gains hold mostly steady between about 2,100 and 2,300 over the baseline. The exception is during the year 2022 when total employment at the Yucca Mountain site takes a one-time dip of about 13%, or 200 employees.

Total employment impacts resulting from YMP activities are expected to drop to about 1,500 new employees during years 2032-33, and return to about 2,000 new employees over the baseline during years 2034-35.

Figure 57. Employment Impact of the Carlin-Big Smokey Rail Alternative on the State of Nevada, 2005 – 2035, Thousands of Jobs

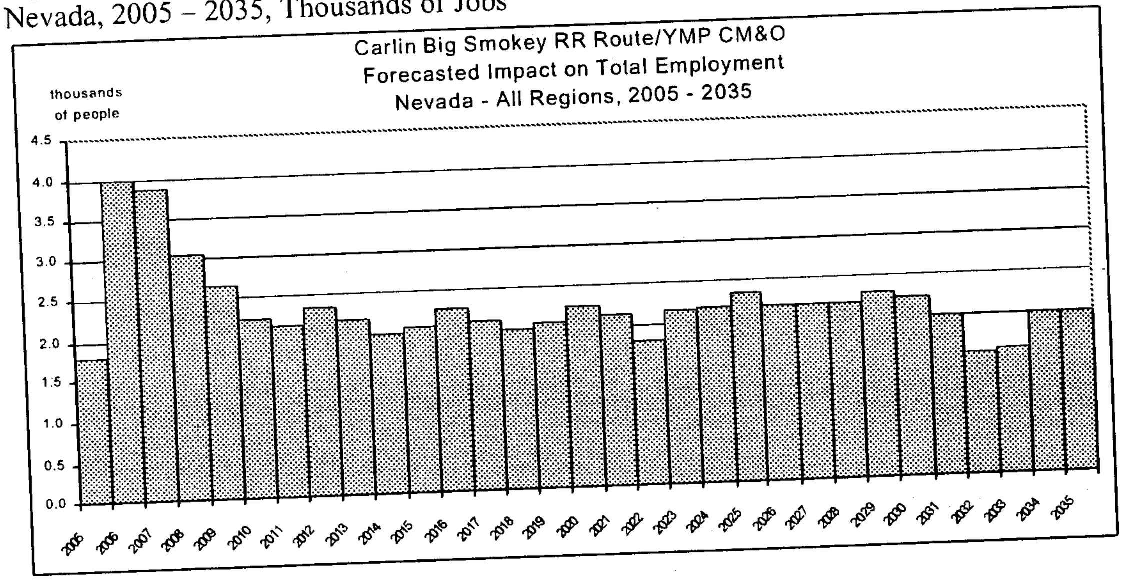


Figure 58. Employment Impact of the Carlin-Big Smokey Rail Alternative on the Clark County, 2005 – 2035, Thousands of Jobs

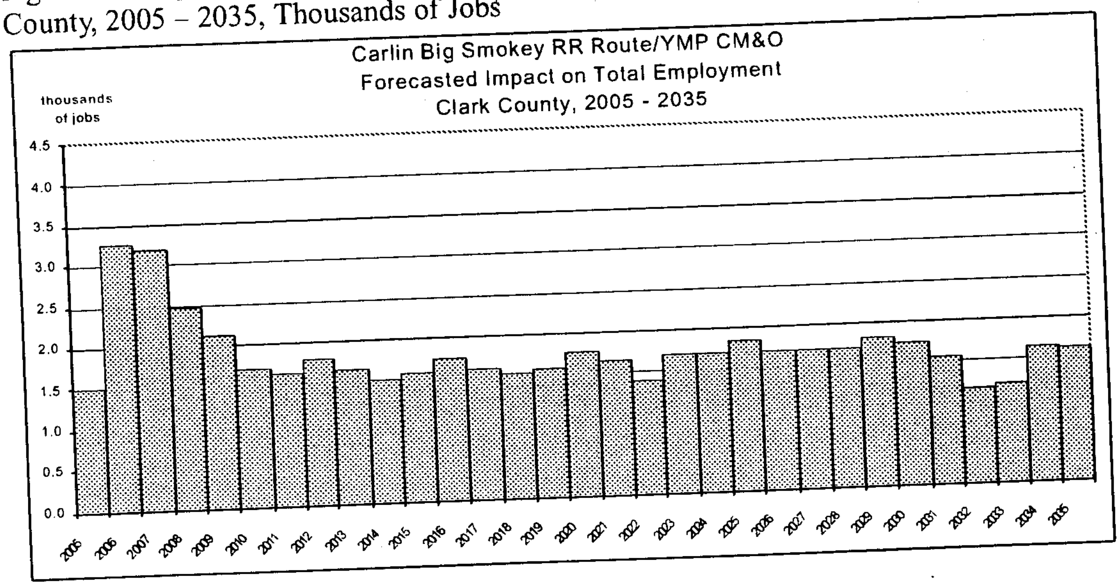


Figure 59. Employment Impact of the Carlin-Big Smokey Rail Alternative on the Nye County, 2005 – 2035, Thousands of Jobs

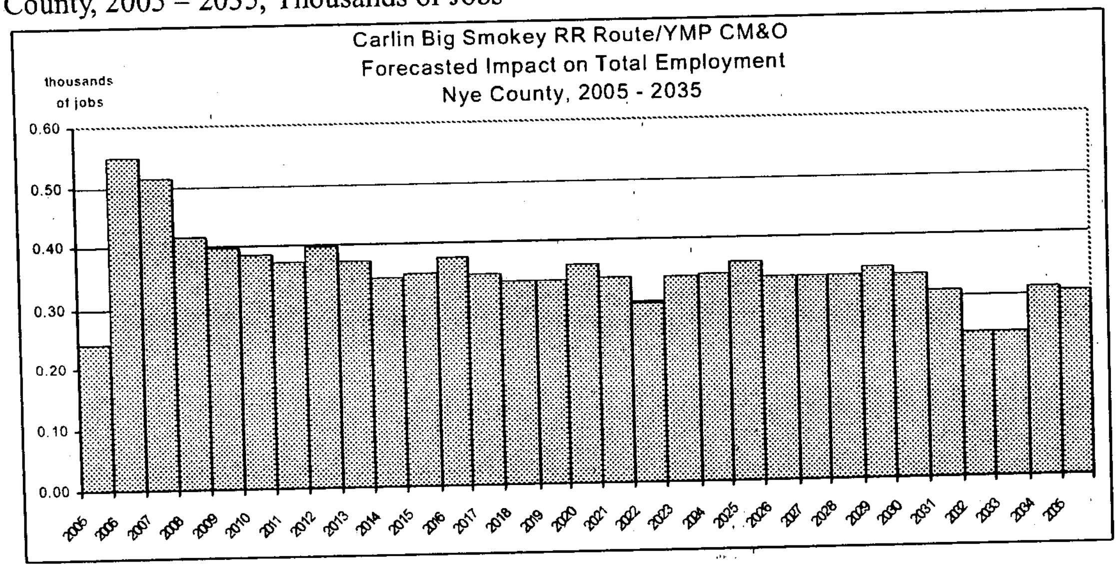


Figure 60. Employment Impact of the Carlin-Big Smokey Rail Alternative on the Lincoln County, 2005 – 2035, Thousands of Jobs

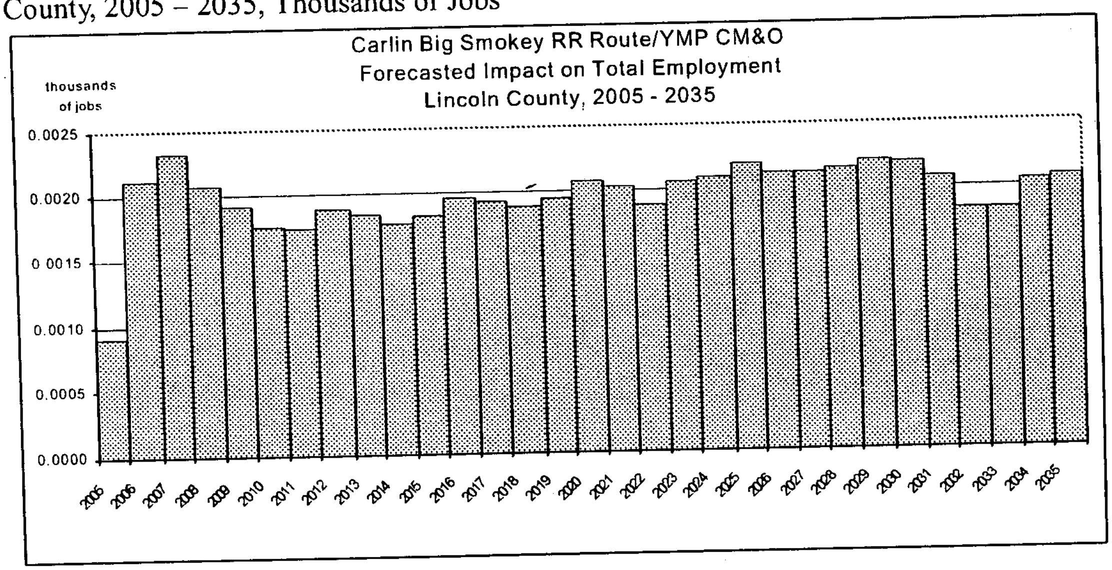
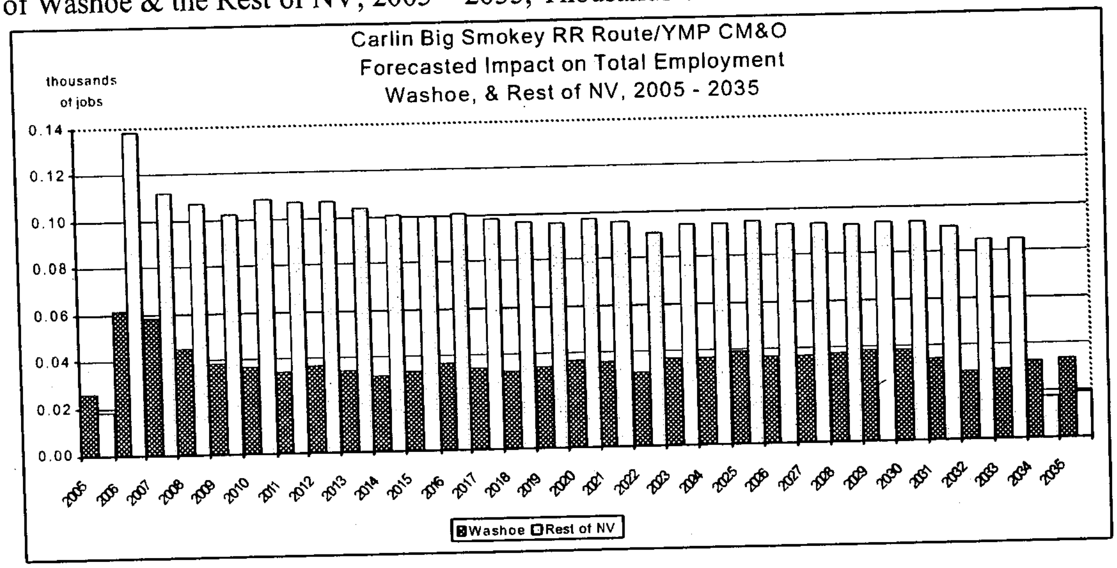


Figure 61. Employment Impact of the Carlin-Big Smokey Rail Alternative on the County of Washoe & the Rest of NV, 2005 – 2035, Thousands of Jobs



4.4. Economic Impact of the Jean Rail Transport Alternative Inclusive of YMP Activity: Description and Model Results.

General Description. Two major alignment options are associated with the Jean Corridor – Wilson Pass and Stateline Pass. The lengths of these major alignments and their variations range from 116 miles to 127 miles. (DOE EIS, Section 2.1.3.3.2, p 2-53.) These alignments originate about 35 miles (Wilson option) and 40 miles (Stateline option) south-southwest of Las Vegas off of Interstate 15 in the Sandy Valley near Jean, Nevada. Spent nuclear fuel and high-level radioactive waste transported into Nevada would be routed to the new Jean alternative branch over existing Union Pacific mainlines. Both major alignments head generally northwest, meeting up prior to reaching Pahrump. The route continues traveling northwest parallel to State Route 160, turning west-northwest just before reaching US Highway 95. Prior to reaching Amargosa, the route turns northward, crosses US Highway 95, and enters the NTS directly into the Yucca Mountain site.

Description of Direct Impacts from Construction. The labor hour estimate of 1,710,000 hours is based on the average construction costs of the two major alignments. Spread evenly over 43 months and assuming 2,000 hours per worker per year gives us 239 construction workers per year needed to complete construction of this alternative by December 2009. This model uses a standard 20% engineering contingency, resulting in 287 FTE construction employees as the input value into the simulation. Workers are assumed to commute daily from Clark County to one of the construction camps in Nye County, spending a per diem allowance for restaurant meals in Nye County.

Planning, employment for RR construction, and expenses for constructing the trailer camps and well drilling (done by local contractors) constitute the direct economic infusions into the local economies.

Description of Direct Impacts from Operations. Transportation operations are scheduled to take place over the period 2010-2033. Based on DOE estimates, 36 workers (including a 25% contingency) are assumed. These workers are all assumed to reside in Clark County, and will earn higher-than-average wages. Because each round trip to the repository is expected to be completed within a day, there are no overnight stays or per diem expenses to be accounted for. Local and state sales (e.g., fuel, office equipment) directly in support of RR route operations make up the final category of direct economic impacts due to operations of this route.

The Yucca Mountain site CM&O is described above. Policy variables representing site CM&O are included in this simulation so that the total impacts of YMP under this transportation alternative may be estimated.

The REMI model uses inputs for these direct impacts and their associated multipliers with other sectors of the economy to calculate the total (direct, indirect, and induced) economic impacts to the local and state economies.

Model Results; GSP Impact. The impact from the Jean Rail Transport Alternative offers the largest GSP benefits early in the construction phase (see Figure 62). GSP impacts top $199.3 million in 2006 and reach $203.1 million by 2007. After that time, GSP impacts taper off. By 2010, the beginning of the waste-transport phase, the GSP impact has fallen to $120.1 million. Over the transportation phase, the real GSP impacts range from a low of $83 million in 2032 to a high of $132 million in 2025. The aggregate impact over the construction and transportation lifetime is $3.797 billion in constant 2003 dollars.

Figure 62. GSP Impact of the Jean Rail Alternative on the State of Nevada, 2005 – 2035, Constant 2003 Dollars

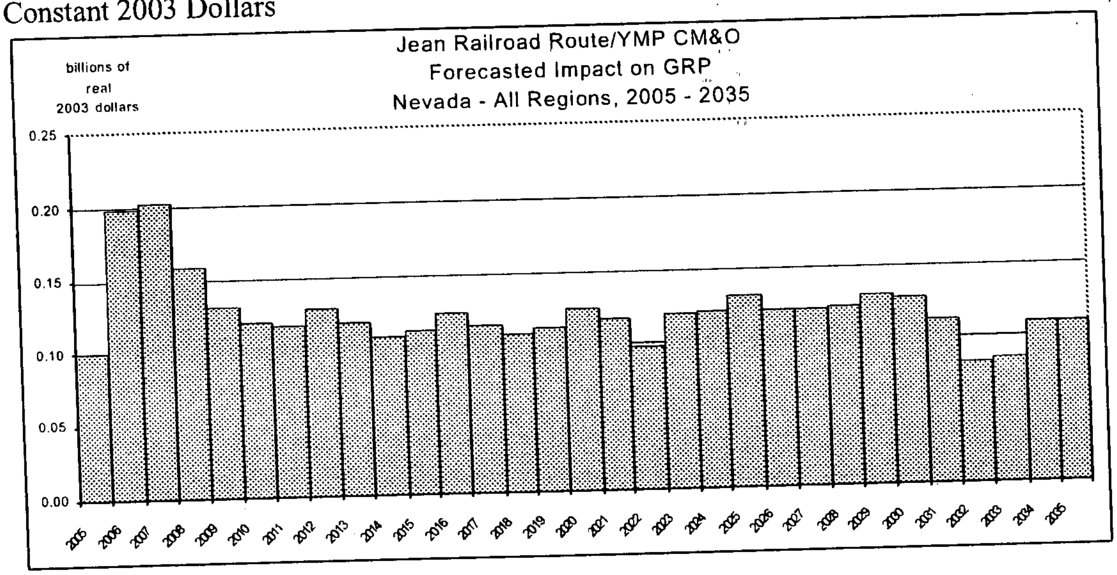


Figure 63. GRP Impact of the Jean Rail Alternative on the Clark County, 2005 – 2035, Constant 2003 Dollars

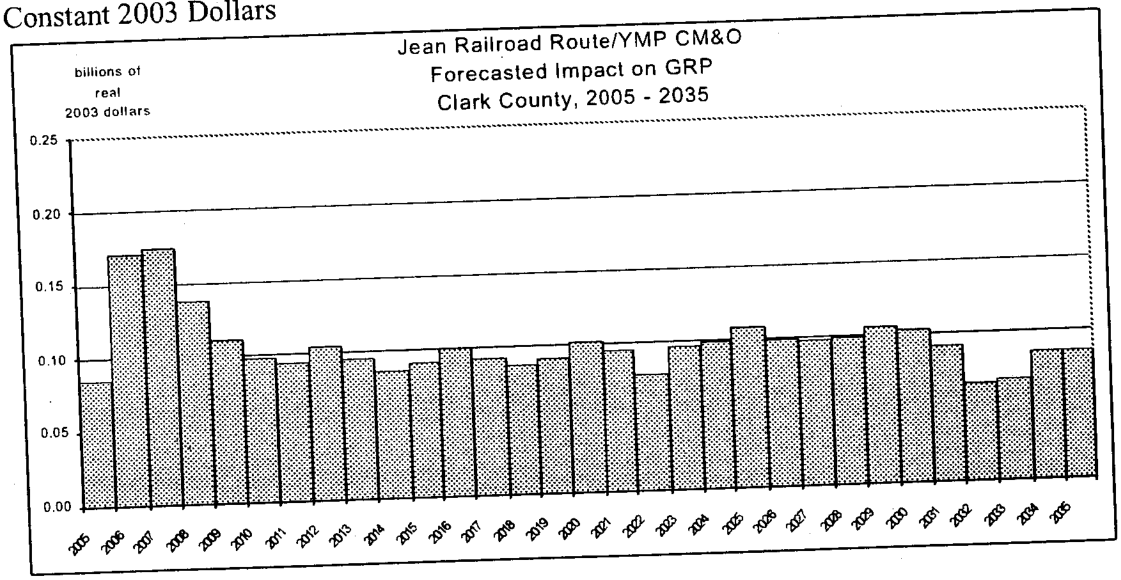


Figure 64. GRP Impact of the Jean Rail Alternative on the Nye County, 2005 – 2035, Constant 2003 Dollars

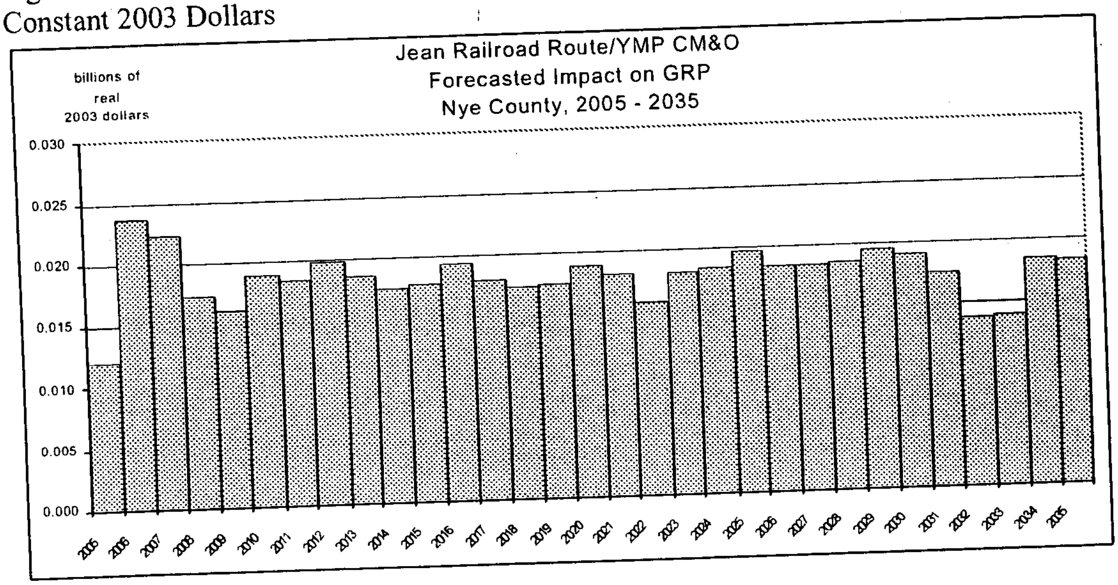


Figure 65. GRP Impact of the Jean Rail Alternative on the Lincoln County, 2005 – 2035, Constant 2003 Dollars

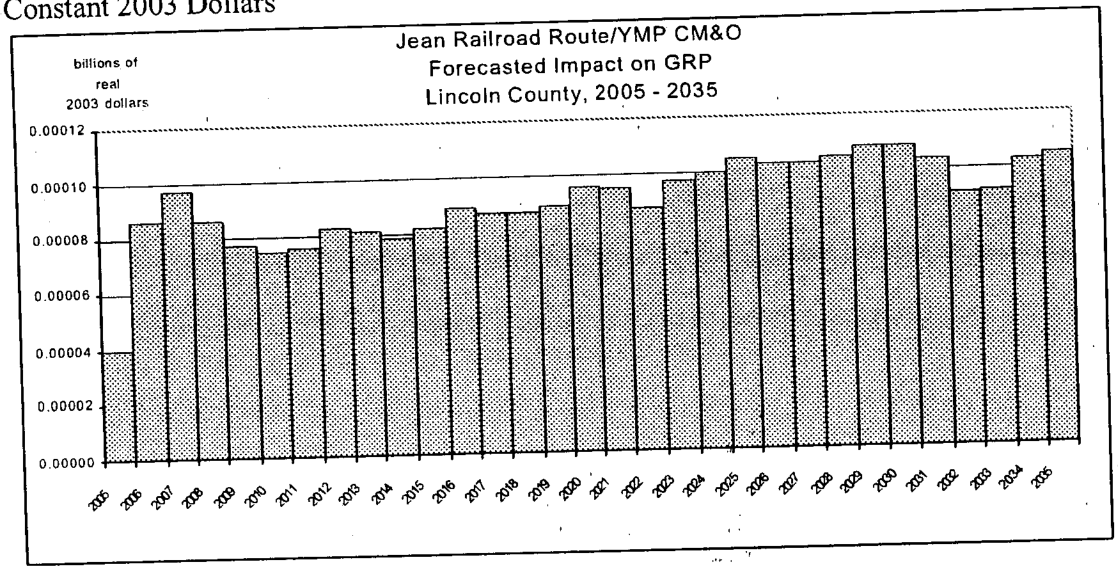
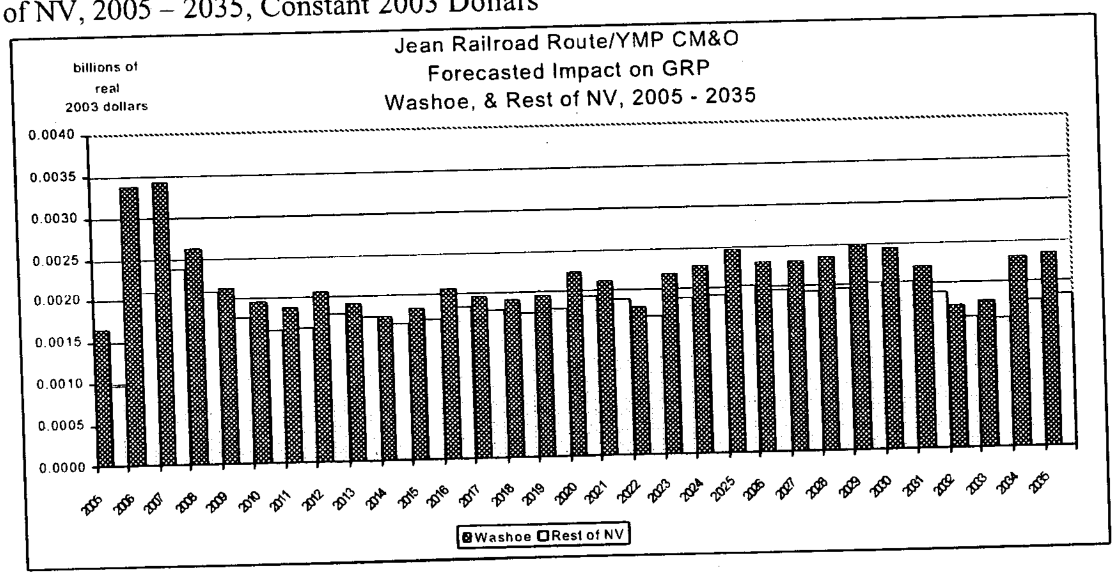


Figure 66. GRP Impact of the Jean Rail Alternative on the County of Washoe & the Rest of NV, 2005 – 2035, Constant 2003 Dollars



Real Disposable Personal Income Impacts. According to Figure 67, the initial real disposable income impact of the Jean Rail Transport Alternative is low at $55.8 million real 2003 dollars. As construction ramps up, the value rises to $112.4 million by 2007. The effect climbs somewhat sporadically through the beginning of the transportation phase when it peaks at $143.8 million by 2030. In the final two years, the change in baseline RPI exceeds $143.5 million dollars in each of the last two final years.

Figure 67. Real Disposable Personal Income Impact of the Jean Rail Alternative on the State of Nevada, 2005 – 2035, Constant 2003 Dollars

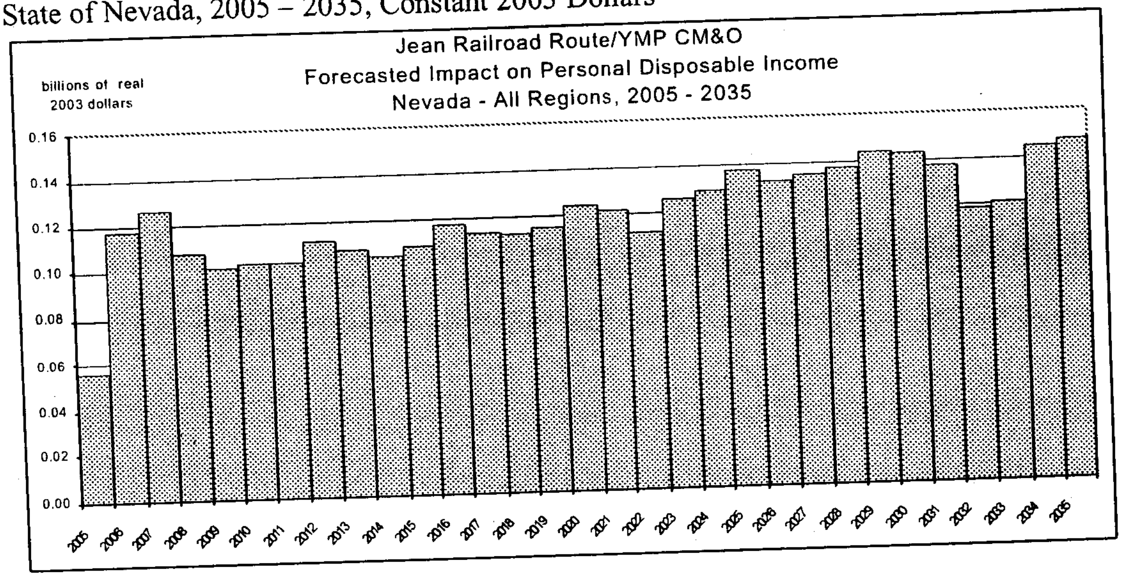


Figure 68. Real Disposable Personal Income Impact of the Jean Rail Alternative on the Clark County, 2005 – 2035, Constant 2003 Dollars

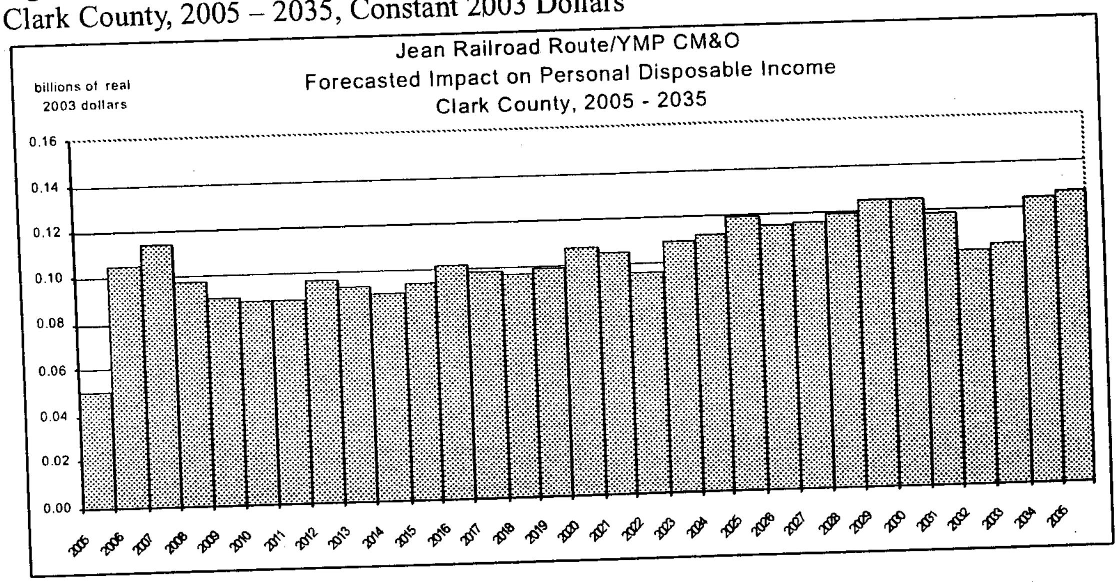


Figure 69. Real Disposable Personal Income Impact of the Jean Rail Alternative on the Nye County, 2005 – 2035, Constant 2003 Dollars

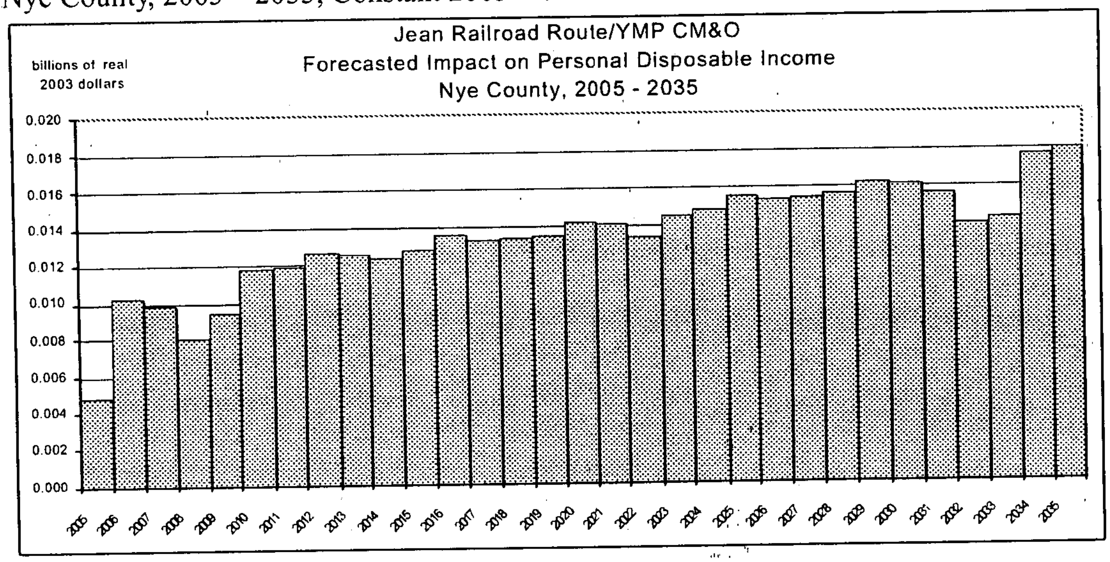


Figure 70. Real Disposable Personal Income Impact of the Jean Rail Alternative on the Lincoln County, 2005 – 2035, Constant 2003 Dollars

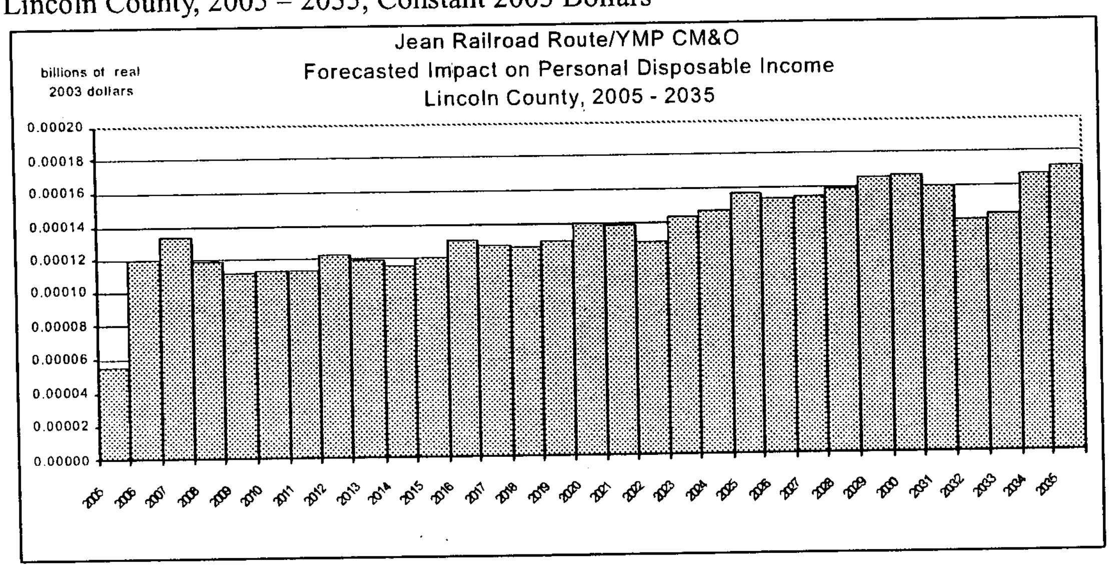
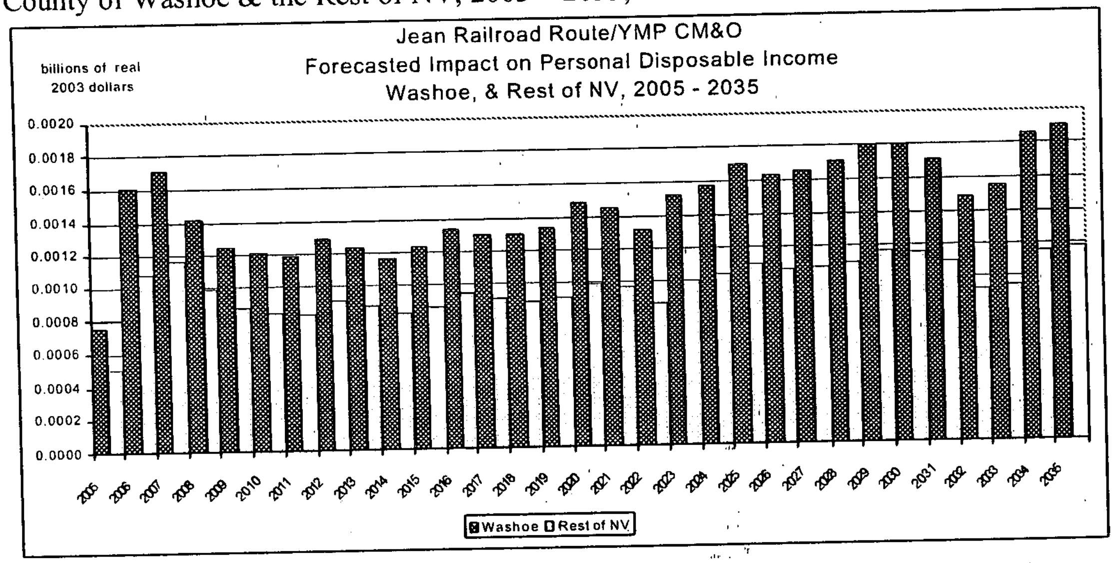


Figure 71. Real Disposable Personal Income Impact of the Jean Rail Alternative on the County of Washoe & the Rest of NV, 2005 – 2035, Constant 2003 Dollars



Model Results; Employment Impact. Figure 72 gives the employment impact of the Jean Rail Transport Alternative. Like the other alternatives, the Jean alternative has the largest employment impact during the project construction phase. A year into construction, the state employment impact surges to 3,600 jobs. As construction winds down, so do employment impacts. By 2010, the total jobs forecasted by the REMI model in excess of the baseline forecast is 2,250 jobs. During the transportation phase, the employment impact ranges between a low of 1,500 jobs in 2033 to a high of 2,345 in 2012.

Figure 72. Employment Impact of the Jean Rail Alternative on the State of Nevada, 2005 – 2035, Thousands of Jobs

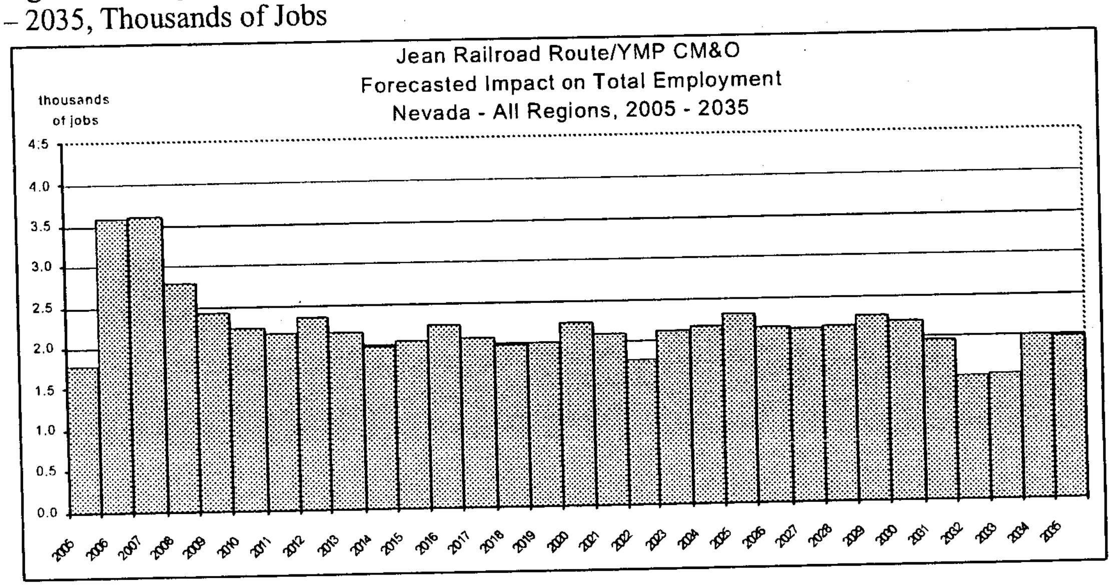


Figure 73. Employment Impact of the Jean Rail Alternative on the Clark County, 2005 – 2035, Thousands of Jobs

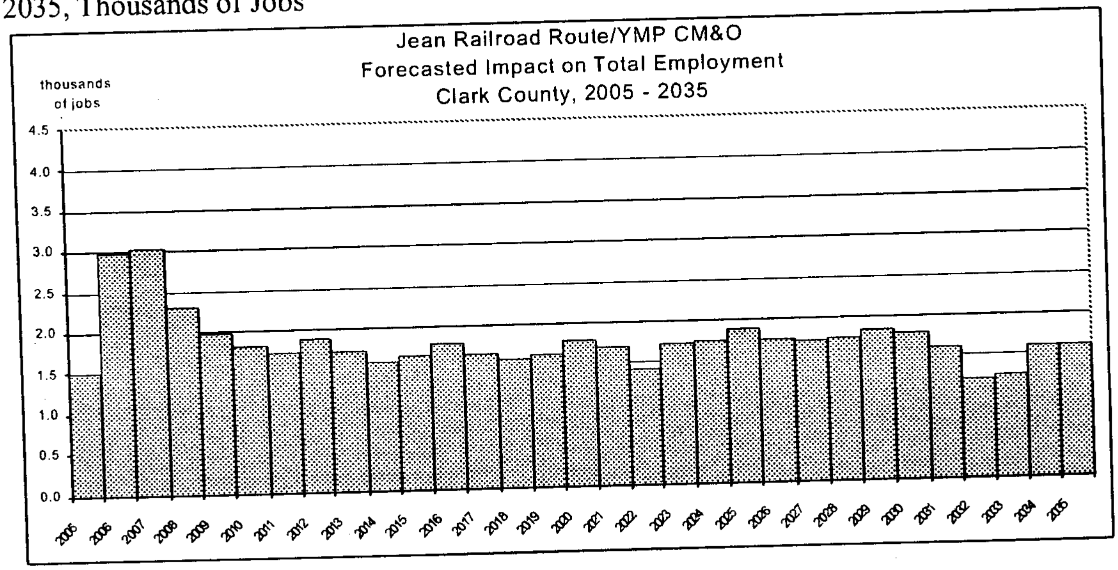


Figure 74. Employment Impact of the Jean Rail Alternative on the Nye County, 2005 – 2035, Thousands of Jobs

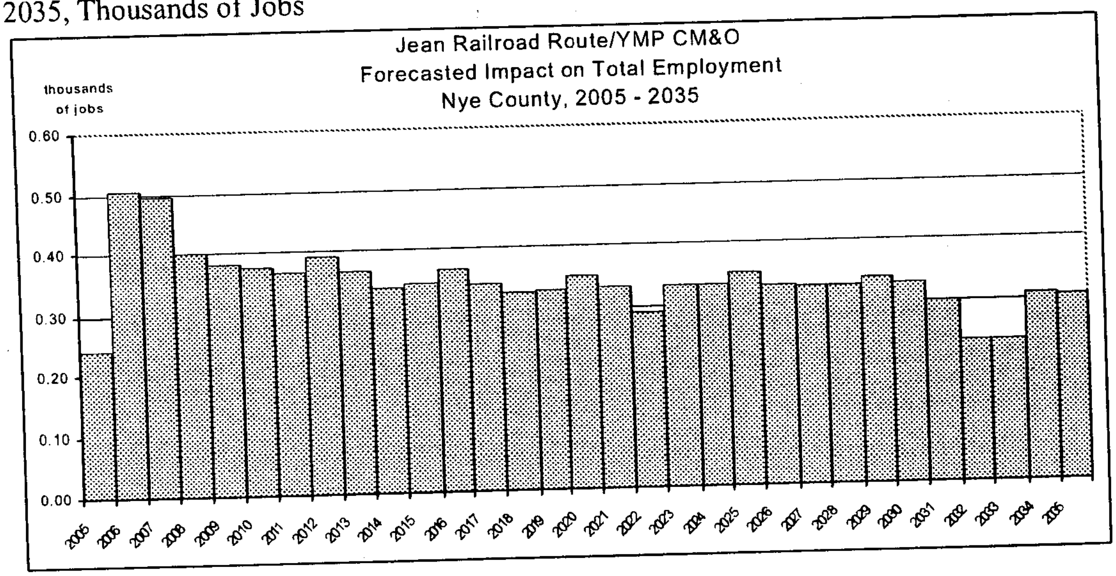


Figure 75. Employment Impact of the Jean Rail Alternative on the Lincoln County, 2005 – 2035, Thousands of Jobs

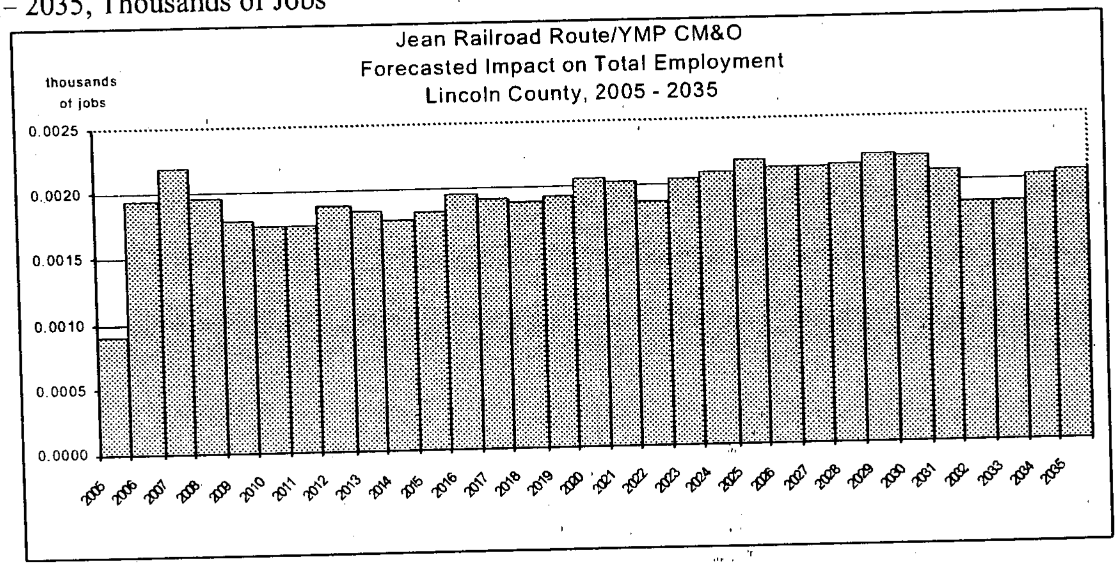
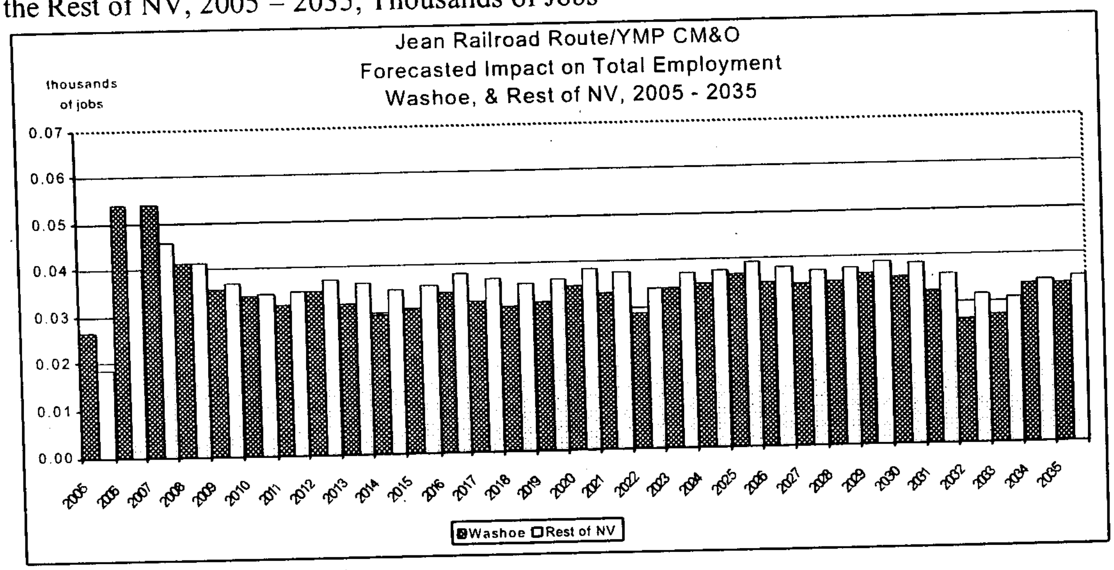


Figure 76. Employment Impact of the Jean Rail Alternative on the County of Washoe & the Rest of NV, 2005 – 2035, Thousands of Jobs



4.5. Economic Impact of the Valley Modified Rail Transport Alternative Inclusive of YMP Activity: Description and Model Results.

General Description.. As with all of the alternatives, the existing Union Pacific mainline is used to transport all spent nuclear fuel and high-level radioactive waste into Nevada. For the Valley Modified branch it then makes its way to Apex near the point where US Highway 93 and Interstate 15 diverge, about 15 miles northeast of Las Vegas. (DOE EIS, Section 6.3.2.2.5.1.)

From its origination near the existing Apex siding, the Valley Modified Corridor travels northeast, just south of the Las Vegas Mountain Range. This route then continues northeast parallel to US Highway 95, travels north of Indian Springs, and finally enters the Nevada Test Site at the southeast corner where it follows the southern border of the NTS before finally turning north into the Yucca Mountain site. This route and its variations range between 98 and 101 miles from railhead to railhead.

Description of Direct Impacts from Construction. Construction is scheduled to take place over a 40-month period ending in December 2009. A labor hour estimate of 809,300 worker hours spread out evenly over the construction period translates into 121 workers per year. A standard engineering 20% contingency is used to bring this estimate up to the 145 construction workers per year used in this model. Workers are assumed to live in Clark County, commute to work daily, and bring their own lunch.

In addition to RR construction labor, planning and expenses for building one trailer camp and drilling wells along the route constitute the direct economic infusions into the local economies.

Description of Direct Impacts from Operations. Transportation operations are scheduled to take place over the period 2010-2033. Based on DOE estimates, we assume that 36 RR operation workers (including a 25% contingency) are employed on an annual basis. These workers are all assumed to reside in Clark County, and will earn higher than average wages. Because each round trip to the repository is expected to be completed within a day, there are no overnight stays or per diem expenses to be accounted for. Local and state sales (e.g., fuel, office equipment) directly in support of RR route operations make up the final category of direct economic impacts due to operations of this route.

Policy variables representing Site CM&O are included in this simulation so that the total impacts of YMP under this transportation alternative may be estimated.

The REMI model uses inputs for these direct impacts and their associated multipliers with other sectors of the economy to calculate the total (direct, indirect, and induced) economic impacts to the local and state economies.

Model Results; Gross State Product (GSP) Impact. According to Figure 77, the GSP impacts of the Valley Modified Rail Alternative are strongest during the construction phase corresponding to the highest levels of project spending in the state. Direct, indirect, and induced impacts sum to $178.1 and $179.1 million in 2006 and 2007, respectively. For the remaining years, GSP impacts range from $82.5 million to $144.7 million, varying with construction expenditures, transportation, and time. The total GSP impact over the 30 years of construction and transport is $3.736 billion constant (2003) dollars.

Figure 77. GSP Impact of the Valley Modified Rail Alternative on the State of Nevada, 2005 – 2035, Constant 2003 Dollars

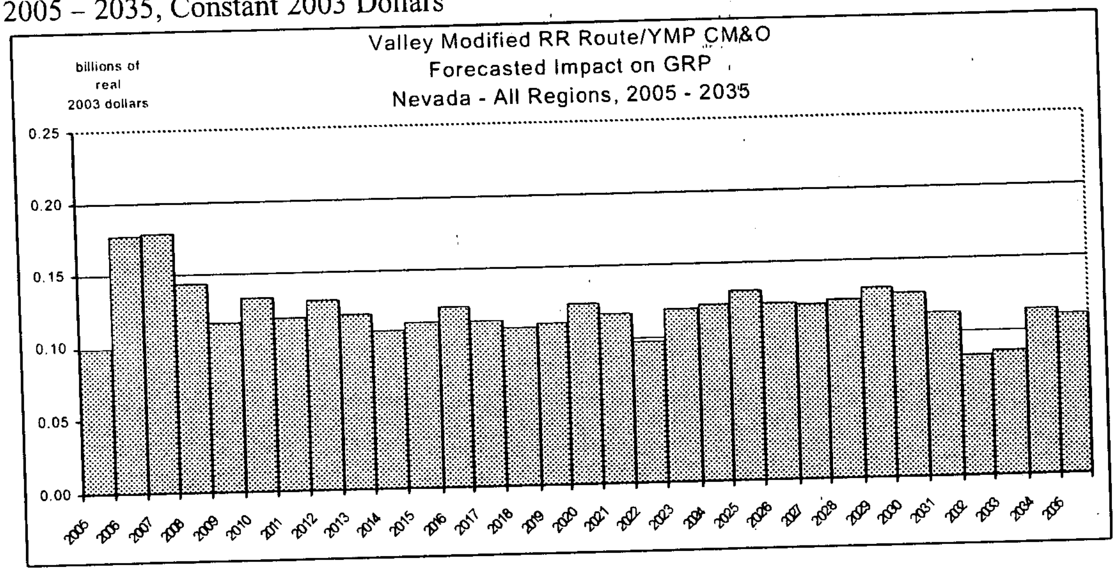


Figure 78. GRP Impact of the Valley Modified Rail Alternative on the Clark County, 2005 – 2035, Constant 2003 Dollars

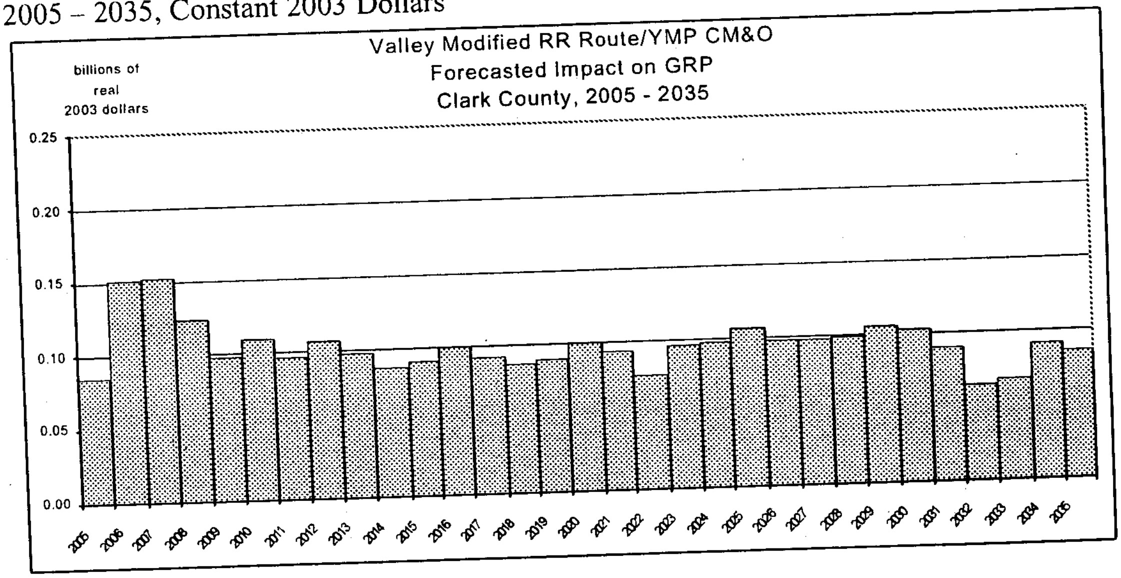


Figure 79. GRP Impact of the Valley Modified Rail Alternative on the Nye County, 2005 – 2035, Constant 2003 Dollars

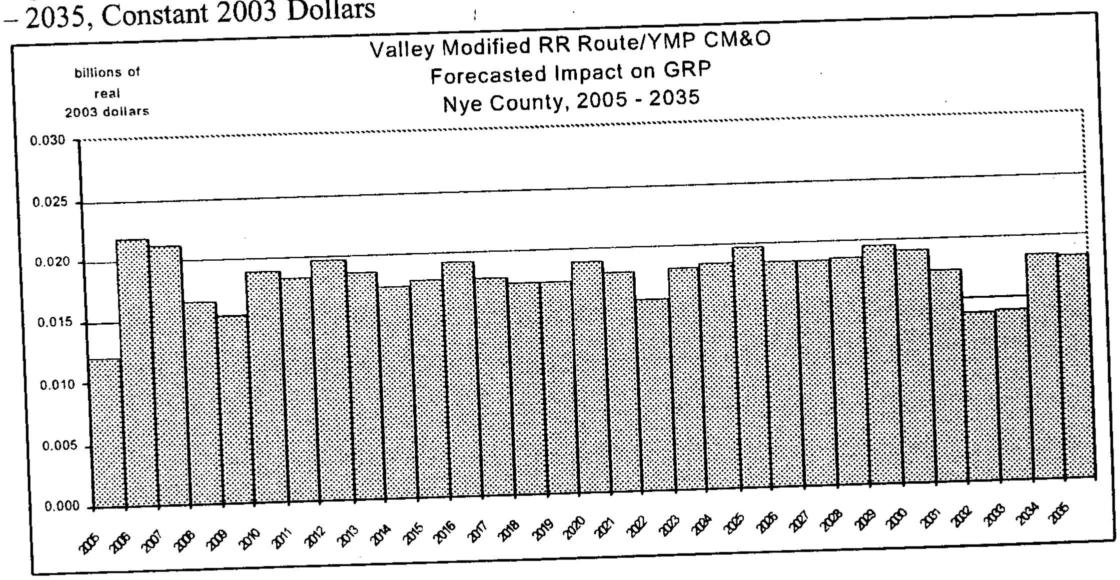


Figure 80. GRP Impact of the Valley Modified Rail Alternative on the Lincoln County, 2005 – 2035, Constant 2003 Dollars

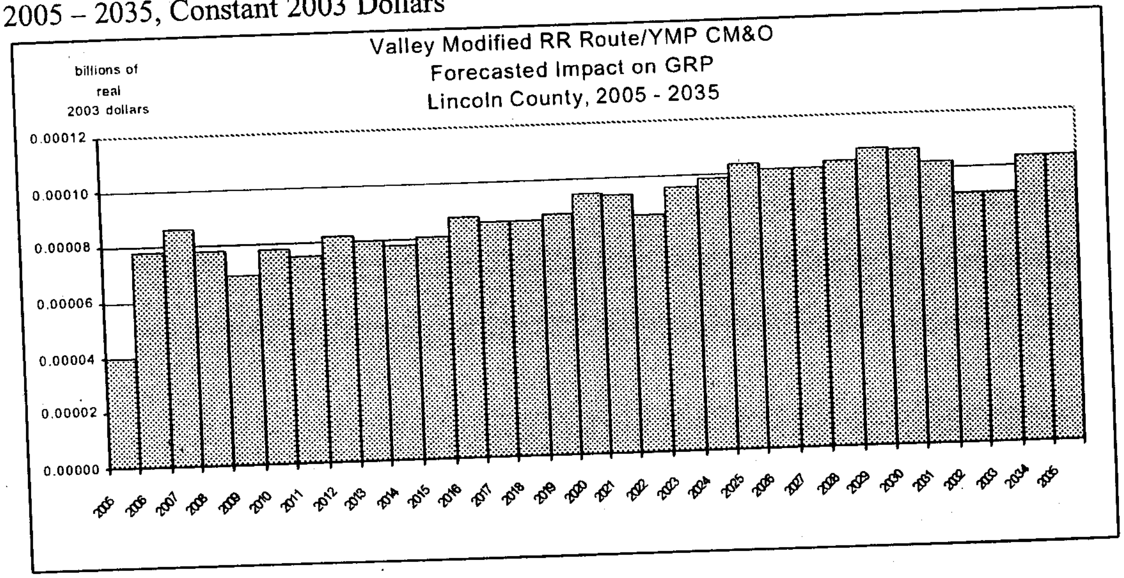
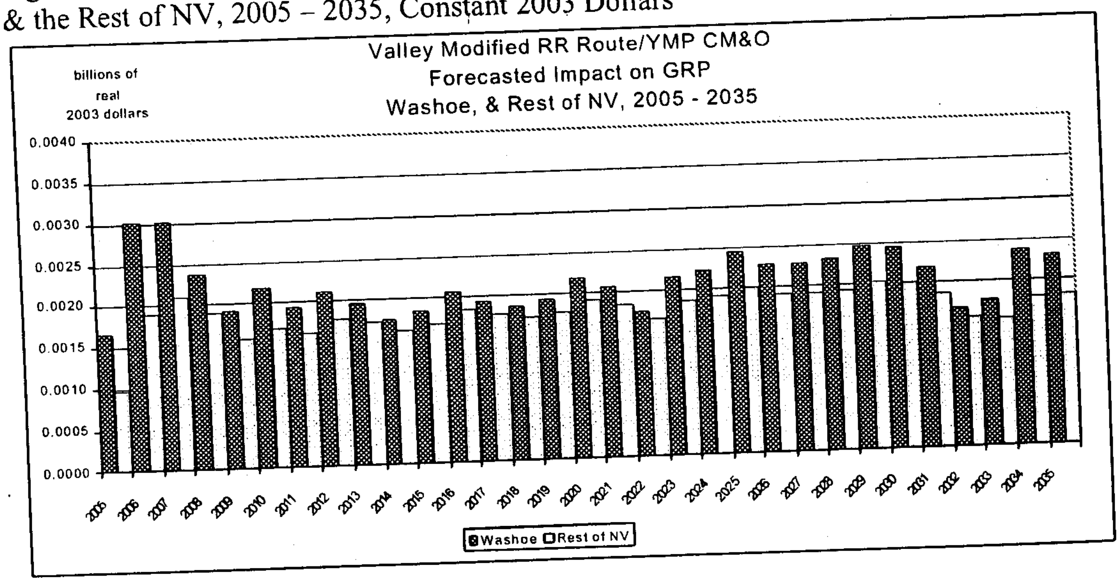


Figure 81. GRP Impact of the Valley Modified Rail Alternative on the County of Washoe & the Rest of NV, 2005 – 2035, Constant 2003 Dollars



Model Results; Real Disposable Personal Income Impact. RPI impacts increase over time for the Valley Modified Rail Alternative (see Figure 82). The initial impact at the beginning of the construction phase in 2005 total $55.2 million. By 2007, the income impact reaches $111.7 million. The impact hovers between $90.1 and $123.1 million during the completion of the construction phase and the early years of waste transport (2008 – 2020). By 2023, the real impact begins to grow, climbing to $146.6

Figure 82. Real Disposable Personal Income Impact of the Valley Modified Rail Alternative on the State of Nevada, 2005 – 2035, Constant 2003 Dollars

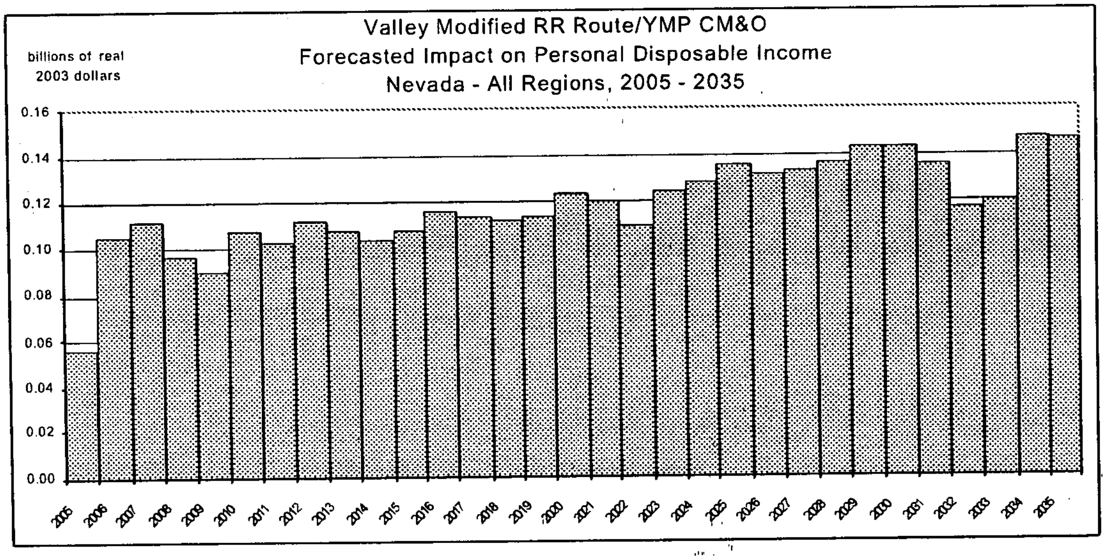


Figure 83. Real Disposable Personal Income Impact of the Valley Modified Rail Alternative on the Clark County, 2005 – 2035, Constant 2003 Dollars

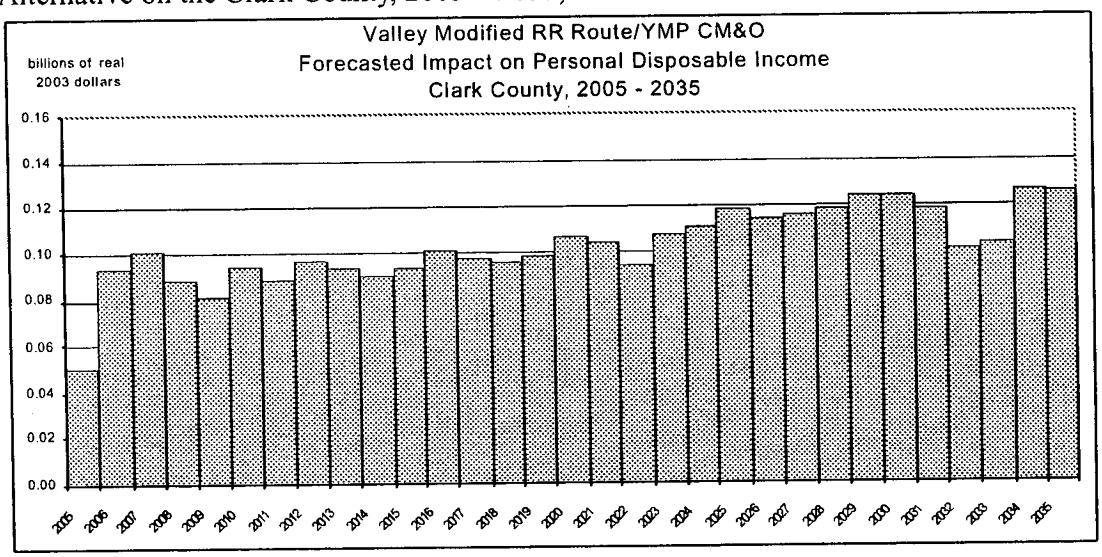


Figure 84. Real Disposable Personal Income Impact of the Valley Modified Rail Alternative on the Nye County, 2005 – 2035, Constant 2003 Dollars

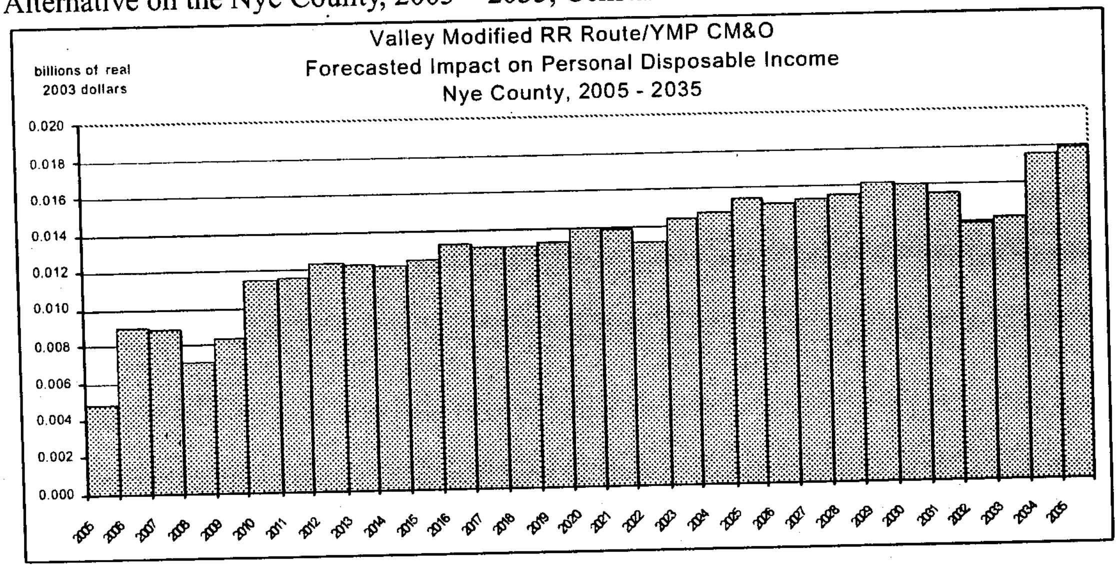


Figure 85. Real Disposable Personal Income Impact of the Valley Modified Rail Alternative on the Lincoln County, 2005 – 2035, Constant 2003 Dollars

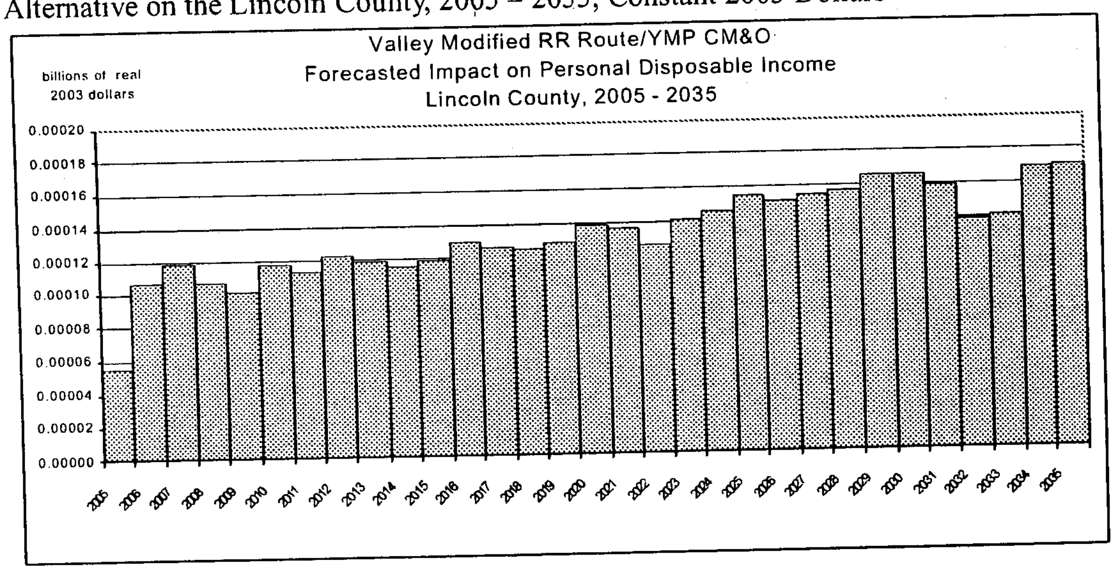
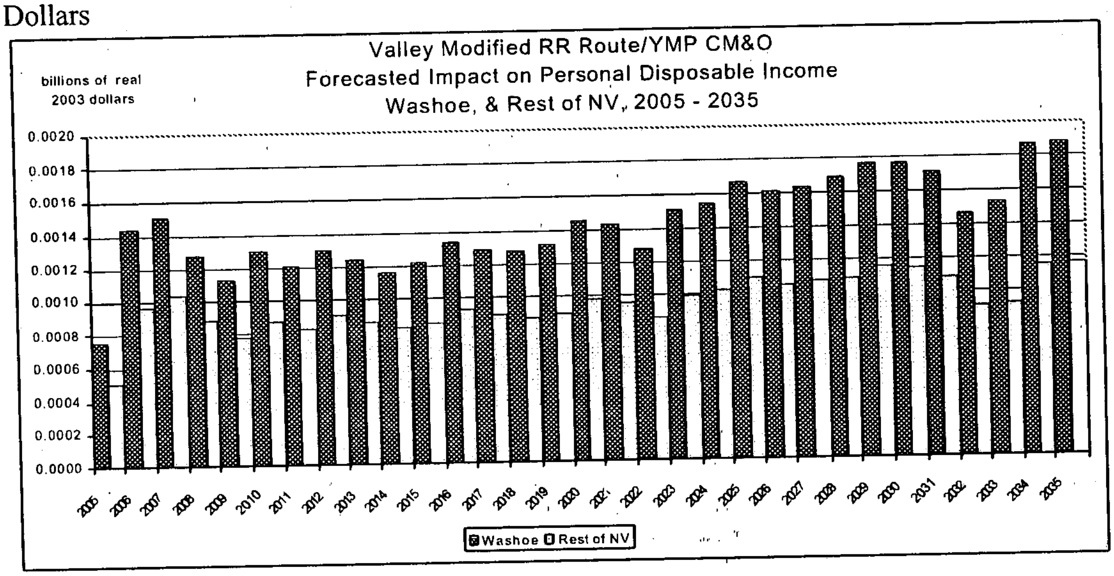


Figure 86. Real Disposable Personal Income Impact of the Valley Modified Rail Alternative on the County of Washoe & the Rest of NV, 2005 – 2035, Constant 2003 Dollars



million by the end of the transportation phase in 2035. The aggregate income impact over the range of construction and transport totals $3.650 billion in constant 2003 dollars.

Model Results; Employment Impact. The employment impact of the Valley Modified Rail Alternative is greatest during the construction phase (see Figure 87). In the first year of construction, 2005, 1,800 jobs are added over and above the baseline forecast for Nevada employment. The state enjoys the largest employment impact in the following two years, 2006 and 2007, when employment exceeds the baseline by over 3,100 jobs in each of the years. Over the transportation phase, running from 2010 to 2035, the employment impact varies between a low of 1,485 jobs in 2032 and a high of 2,500 jobs in 2010, the first year of transportation. The average annual employment impact of this alternative is 2,148 above the baseline forecast jobs annually.

Figure 87. Employment Impact of the Valley Modified Rail Alternative on the State of Nevada, 2005 – 2035, Thousands of Jobs

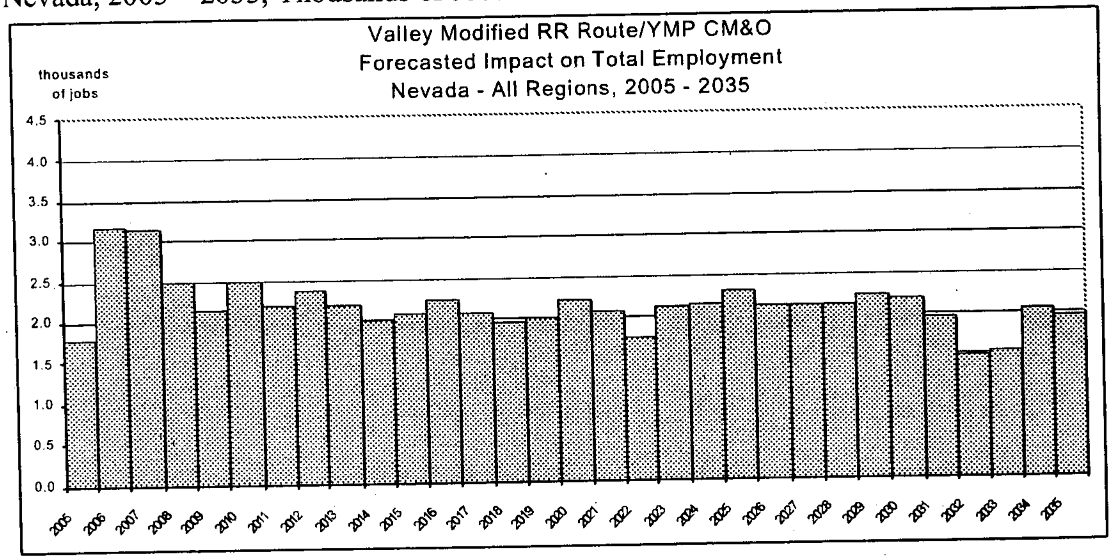


Figure 88. Employment Impact of the Valley Modified Rail Alternative on the Clark County, 2005 – 2035, Thousands of Jobs

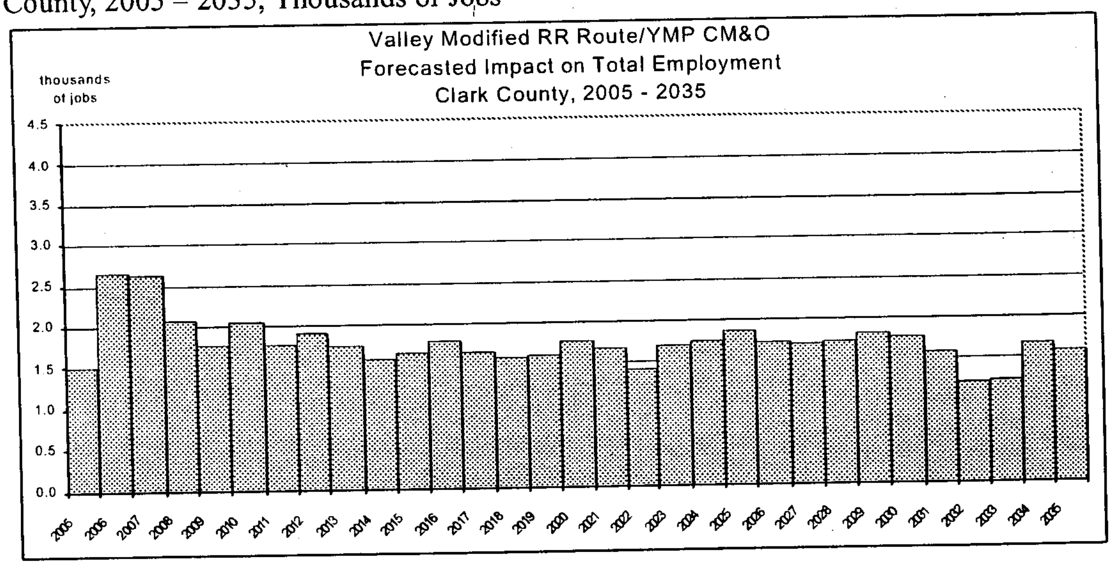


Figure 89. Employment Impact of the Valley Modified Rail Alternative on the Nye County, 2005 – 2035, Thousands of Jobs

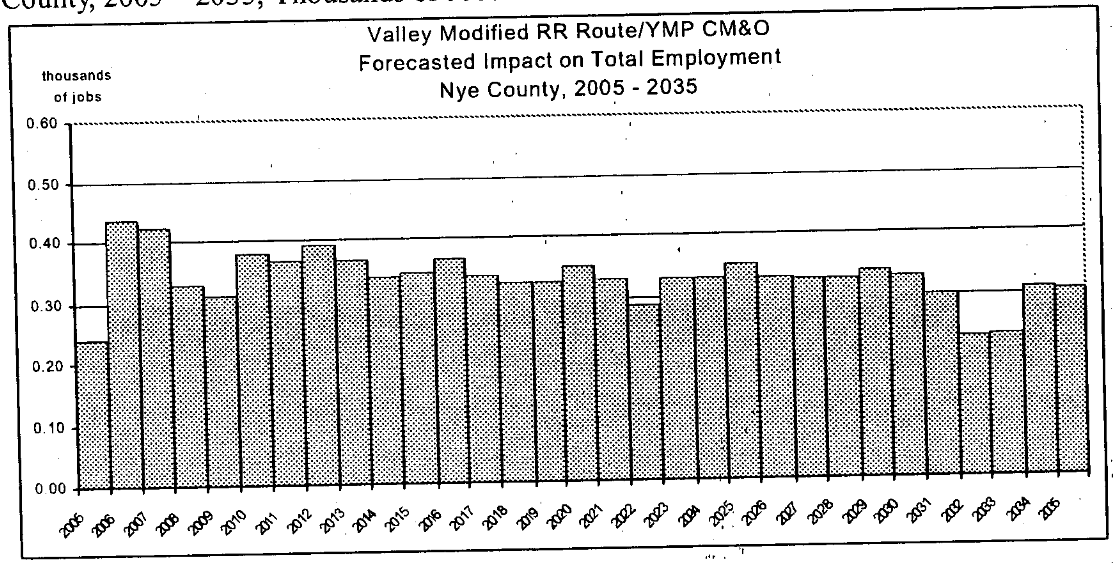


Figure 90. Employment Impact of the Valley Modified Rail Alternative on the Lincoln County, 2005 – 2035, Thousands of Jobs

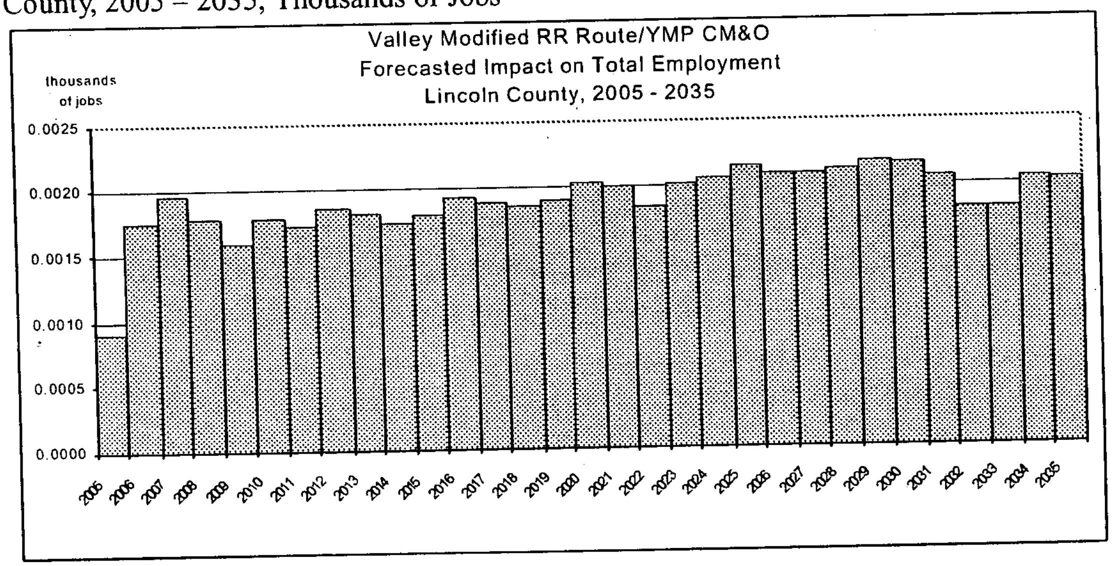
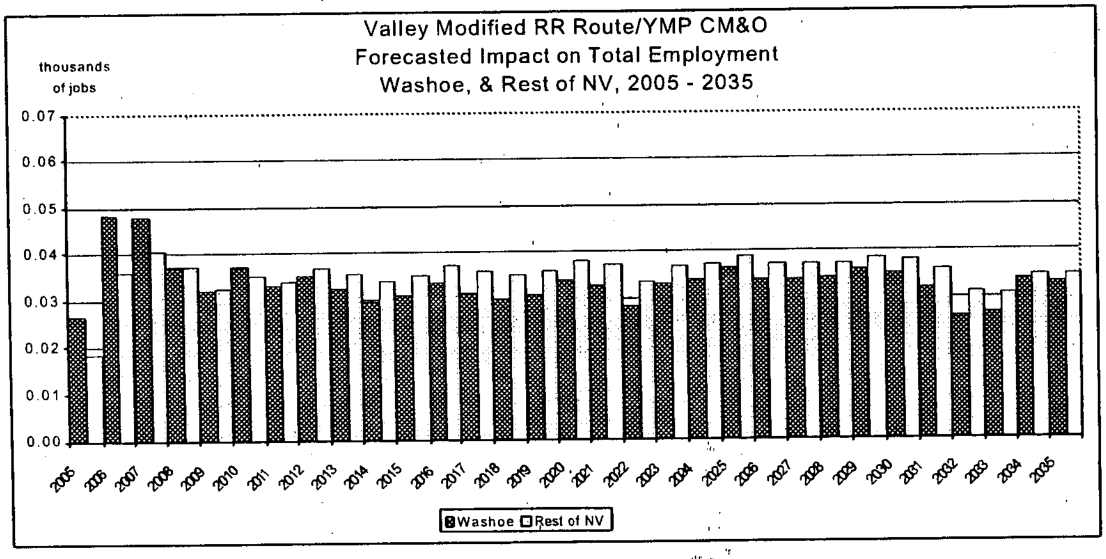


Figure 91. Employment Impact of the Valley Modified Rail Alternative on the County of Washoe & the Rest of NV, 2005 – 2035, Thousands of Jobs



4.6. Economic Impact of Current YMP Activities within Nevada

Current employment and expenditures in Nevada associated with the ongoing scientific study and planning at the proposed Yucca Mountain Nuclear Waste Repository also have an impact on the state economy. However, because those activities are already a part of the economy, their impacts are internal to the baseline. Therefore, in order to fully evaluate the economic impacts of the YMP on the State of Nevada, we ask ourselves how discontinuation of these activities would affect the economy. Taken together, this analysis of current YMP activity and expenditures along with the above simulations of the various construction and operation scenarios provides a much more robust description of potential YMP economic impacts on the Nevada economy.

Consistent with the indicators used in measuring the economic impact of YMP construction and operation under various potential transportation alternatives, we model the economic impact of current YMP activities in terms of changes to the baseline in total employment, real gross state product, and real personal disposable income.

Description of inputs. Until a more comprehensive evaluation can be completed, we have taken the interim approach of simulating immediate termination of all activities, beginning in the year 2000.[5]

[5] We limited this analysis to the calendar years 2000 and 2001, the years for which we have complete data.

The DOE provided the procurement expenditure, payments equivalent to taxes (PETTS) and taxes paid by contractors, set-aside payments, employment, and wage data necessary to perform this analysis. A complete description of the data and model assumptions is provided in Appendix A.

GSP Impact. The impact of ceasing all YMP related activity in Nevada on real GSP is presented in figure 92, below. In order to accommodate year-to-year comparison in terms meaningful to present day expenditures, these values, as are all others in this document, are presented in real constant 2003 dollars.

The greatest impact is felt in the first year when $195.7 million, is taken out of the economy. Overall real direct YMP expenditures increase 0.5% in 2001 over 2000. However, the yearly losses to the gross state product from removing this stimulus decrease to about $188.6 million in year 2001, or 3.6%. This drop in total economic impact is the result of the state economy "absorbing" the loss.

Figure 92. GSP Impact of Current YMP Associated Employment, Procurements, PETTS & Taxes, and Set asides on the State of Nevada, 2000-2001, Constant 2003 Dollars

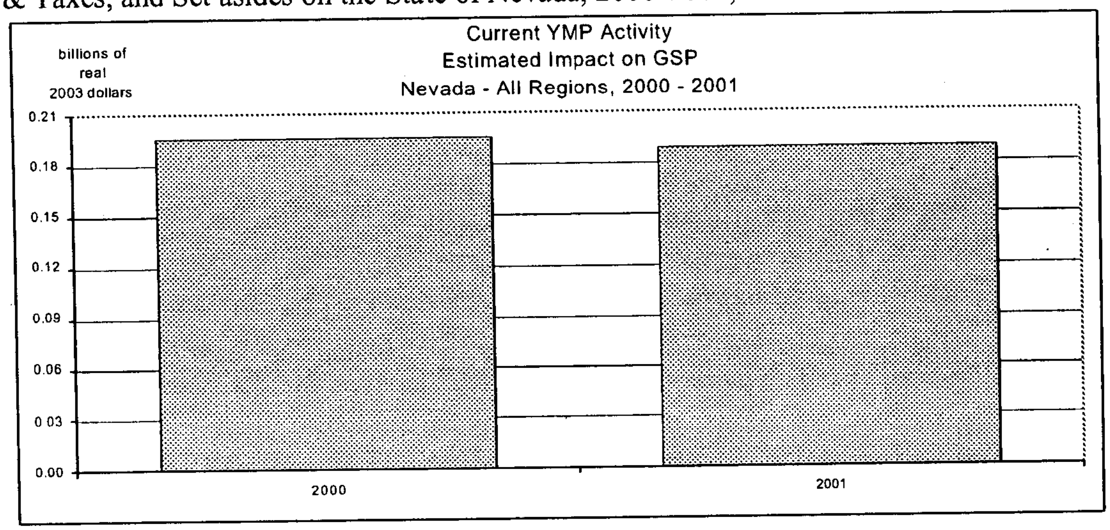


Figure 93. GRP Impact of Current YMP Associated Employment, Procurements, PETTS & Taxes, and Set asides on the Clark County, 2000-2001, Constant 2003 Dollars

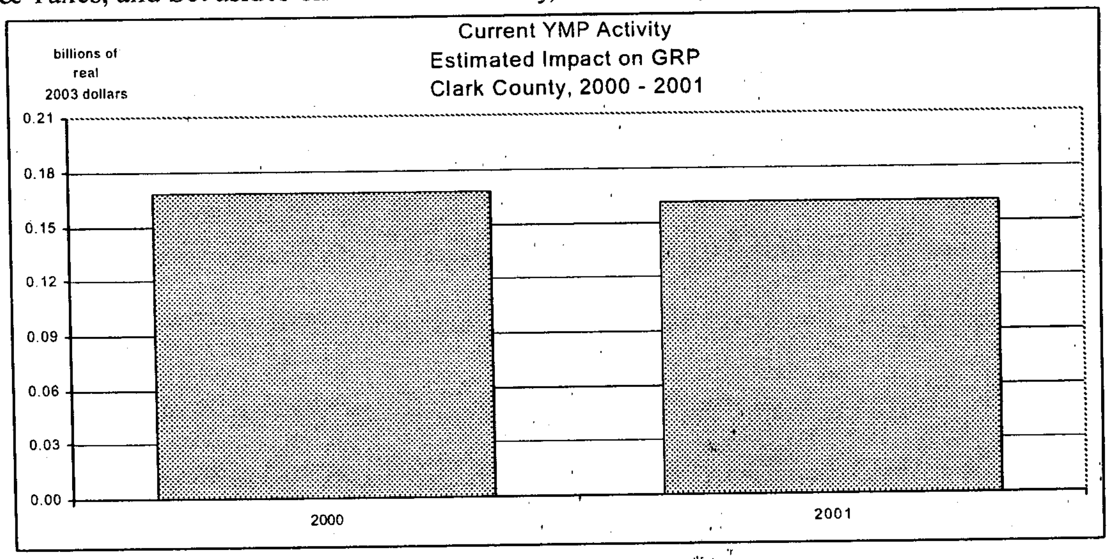
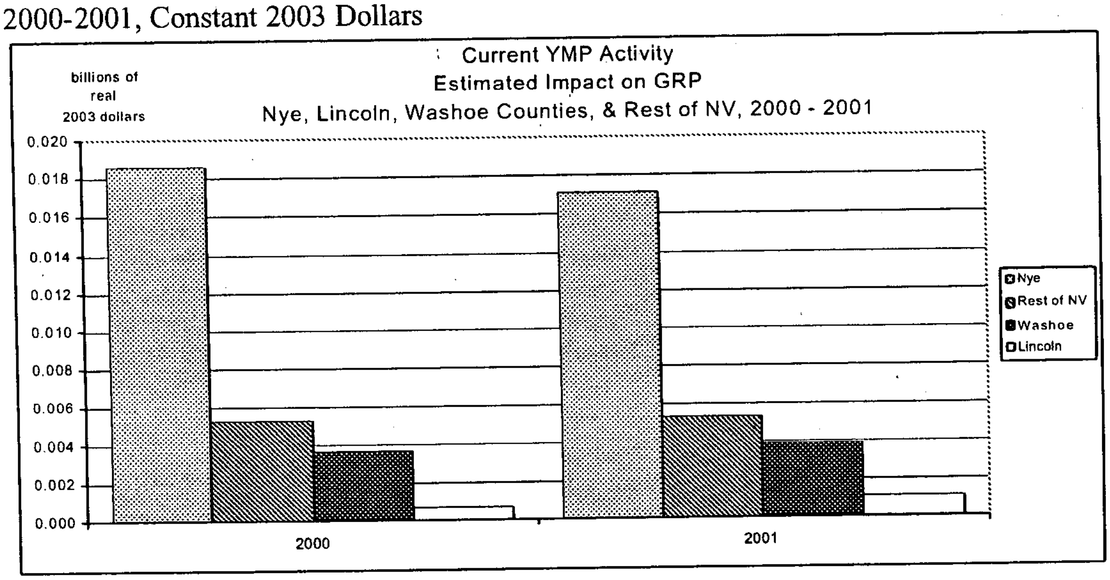


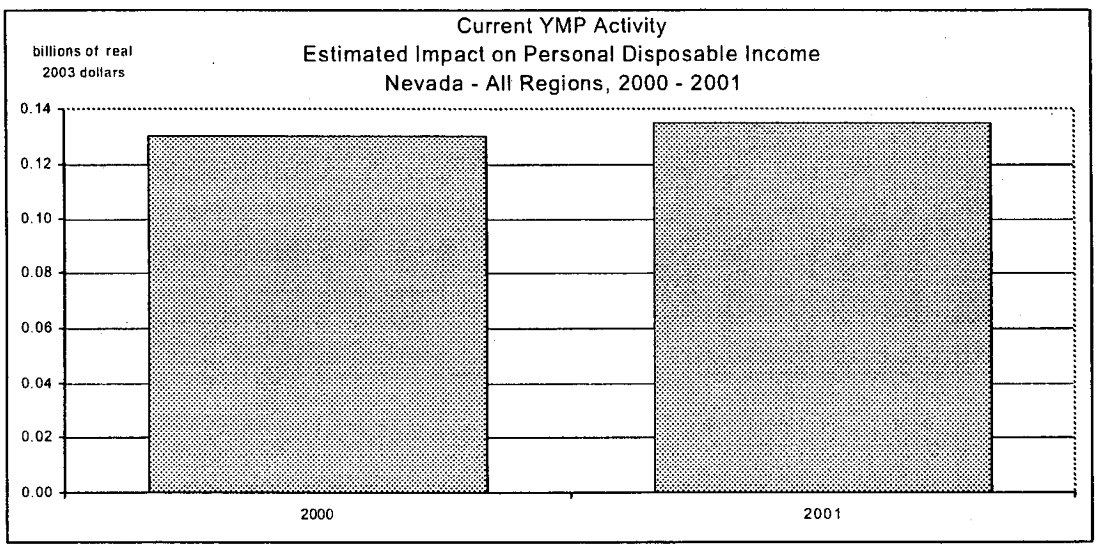
Figure 94. GRP Impact of Current YMP Associated Employment, Procurements, PETTS & Taxes, and Set asides on the Counties of Nye, Lincoln, Washoe, & the Rest of NV, 2000-2001, Constant 2003 Dollars



Disposable Personal Income Impacts. Changes to baseline RPI (fixed 2003 dollars) resulting from a YMP "shutdown" in year 2000 is presented in Figure 95. Counter to the model results for both (real) GSP and total (direct, indirect, and induced) employment changes, the impact to RPI increases from year to year. The difference in RPI from the baseline is about $130.7 million in the year 2000. This increases about 3.7% to a $135.3 million loss to the state's RPI in year 2001.

This trend is counter to the decreased impacts over time associated with GSP and total employment and some explanation is in order. There are several possible reasons for this at-first-glance disparity; one of the most plausible has to do with the nature of GSP and RPI in Nevada. Overall GSP spending essentially represents the backward linkages of the economic activity being analyzed. That is, the direct spending by the YMP is used by the suppliers of those goods and services in the purchase of their own production inputs. These purchases represent some other firm's revenue, which also adds to GSP *when the purchase is made within the state.* This re-circulation of revenues repeats itself on down the line to the beginning of the production process. To the extent that these indirect expenditures stay within the state, the direct impact of the initial spending is 'multiplied'.

Figure 95. Real Disposable Personal Income Impact of Current YMP Associated Employment, Procurements, PETTS & Taxes, and Setasides on the State of Nevada, 2000-2001, Constant 2003 Dollars



Real disposable income (RPI) is representative of consumption spending, or the forward linkages of the economic activity being analyzed. Employees of the YMP and the YMP organizations are also consumers. Consumption spending of these employee/consumers' disposable income in turn leads to job creation in support of their spending. This 'induced' employment leads to further consumption spending and another round of induced employment. In addition, to the extent that YMP spending necessitates increased (indirect) employment at its suppliers' level, their spending similarly induces new employment and consumption elsewhere in economy. The sum total of these induced employment/consumption impacts make up the rest of the multiplier effect.

Figure 96. Real Disposable Personal Income Impact of Current YMP Associated Employment, Procurements, PETTS & Taxes, and Setasides on the Clark County, 2000-2001, Constant 2003 Dollars

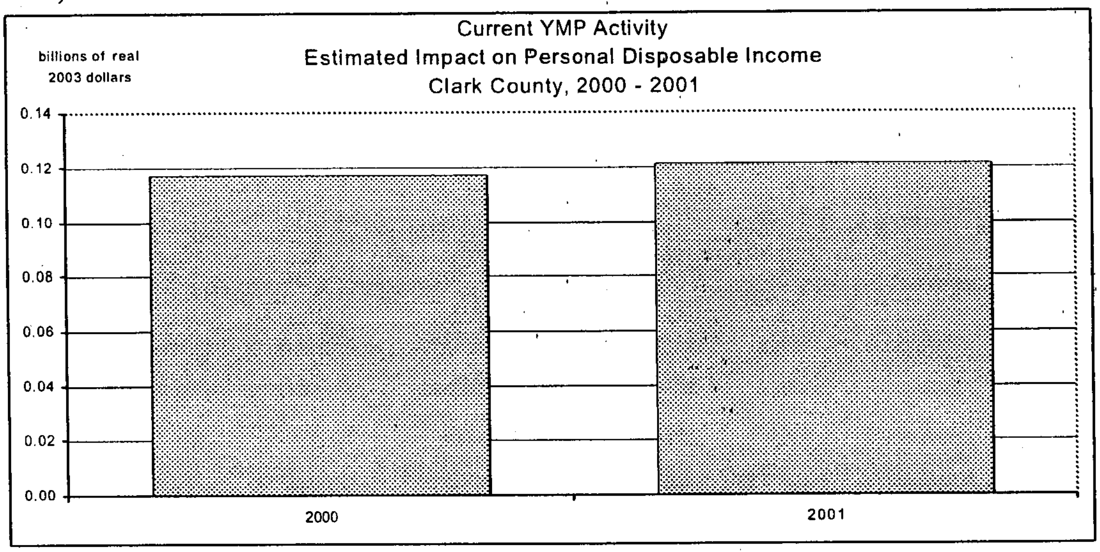
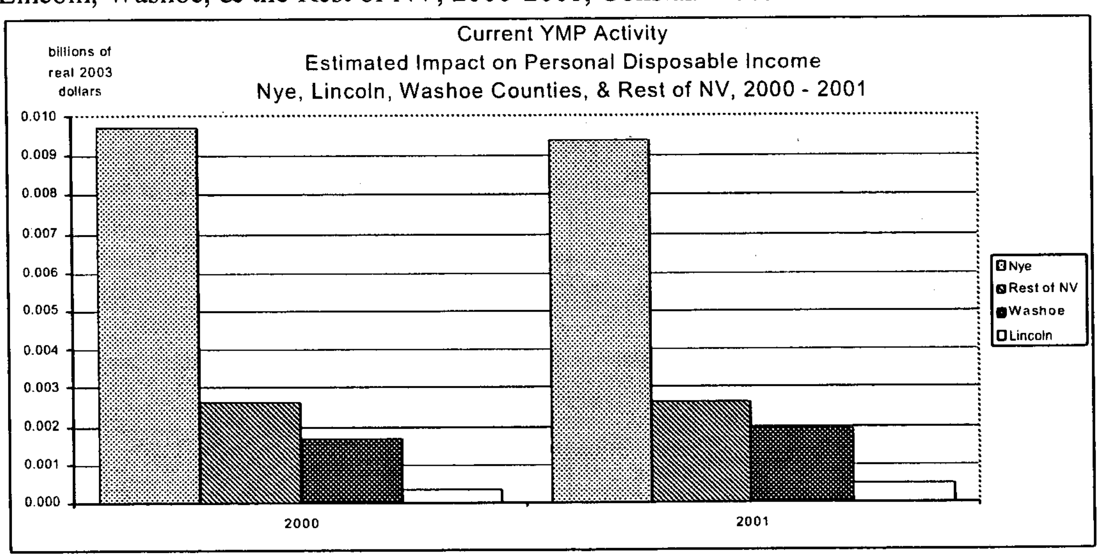


Figure 97. Real Disposable Personal Income Impact of Current YMP Associated Employment, Procurements, PETTS & Taxes, and Setasides on the Counties of Nye, Lincoln, Washoe, & the Rest of NV, 2000-2001, Constant 2003 Dollars



Because of the small size of the manufacturing sector in the Nevada State economy, it happens that there is a great deal of 'leakage'. That is, much of the indirect spending described above takes place outside the State, severely limiting the indirect impact of any initial expenditure on the local and state economies. However, consumers make the bulk of their purchases locally. Thus, there is less leakage of the induced impacts, and a greater multiplying effect associated with the forward linkage.

The disparity we observe between income and GSP likely arises from differences in the values of the multipliers associated with the backward (indirect/revenue) and forward (induced/consumption) linkages are manifesting themselves in a lesser impact to GSP over time relative to RPI impacts.

Employment Impact. Figure 98, below, presents all (direct, indirect, and induced) changes to baseline employment in Nevada resulting from "ceasing all YMP activity in Nevada in Y2K". Year 2000 sees the greatest total impact to the state's total employment, where about 3,660 fewer FTE employees are estimated as a result of "shutting down" the YMP that same year. The difference between the baseline and the simulated shutdown is about 2% smaller the following year, or about 3,590 fewer FTE than the baseline. According to DOE data, that year saw a slight decrease in total direct employment in all regions. More influential over this smaller impact in 2001 is that the local economies begin to rebound as they adjust to the loss.

Figure 98. Total (Direct, Indirect, and Induced) Employment Impact of Current YMP Associated Employment, Procurements, PETTS & Taxes, and Set asides on the State of Nevada, 2000-2001, Thousands of People

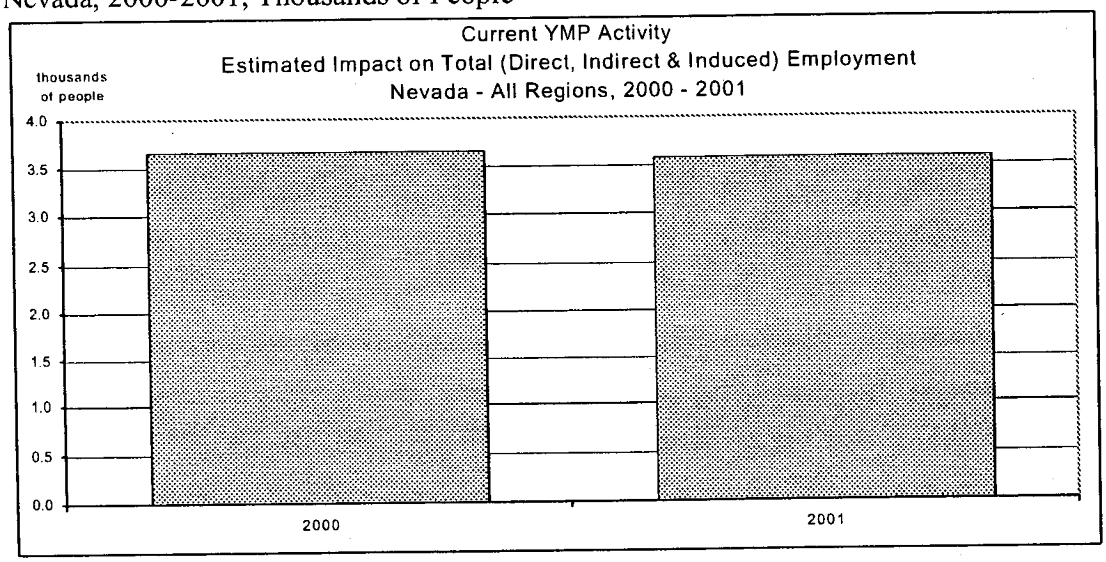


Figure 99. Total (Direct, Indirect, and Induced) Employment Impact of Current YMP Associated Employment, Procurements, PETTS & Taxes, and Set asides on the Clark County, 2000-2001, Thousands of People

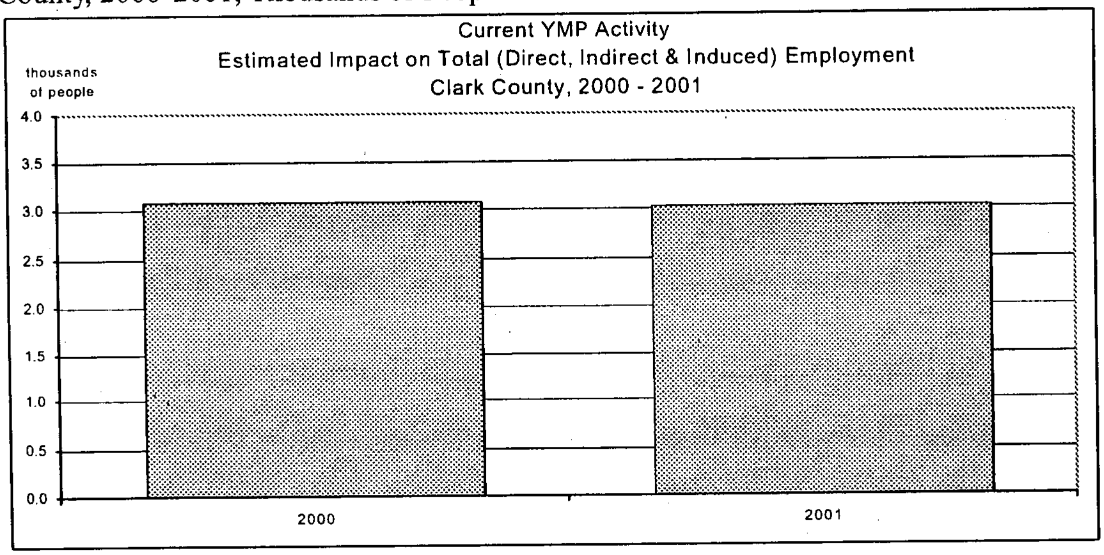
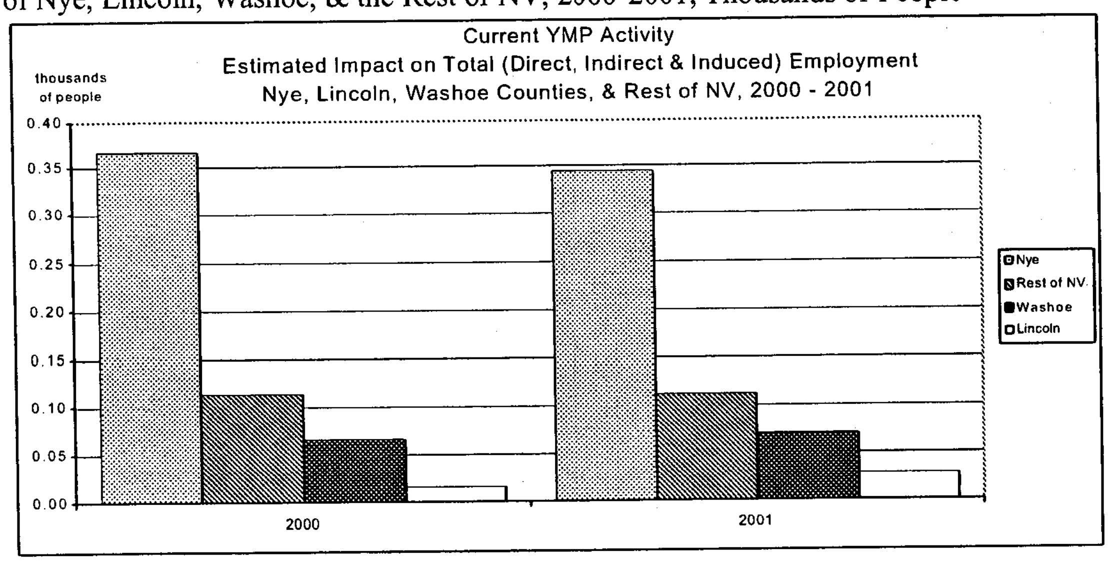


Figure 100. Total (Direct, Indirect, and Induced) Employment Impact of Current YMP Associated Employment, Procurements, PETTS & Taxes, and Set asides on the Counties of Nye, Lincoln, Washoe, & the Rest of NV, 2000-2001, Thousands of People



V. MODELING THE SOCIAL COSTS AND ECONOMIC IMPACT OF RAIL TRANSPORT TO YUCCA MOUNTAIN

At least two studies indicate health and safety risks from nuclear-waste transport are a primary source of opposition to the YMP (Riddel, Dwyer, and Shaw 2003 and Kunreuther and Easterling 1990). Kunreuther and Easterling (1990) found that southern Nevada residents had significant health and safety concerns related to the repository and nuclear-waste transport within the state. Using a telephone survey, respondents were asked if they would support a repository within their state under the condition that they would be given an annual tax credit for 20 years. The survey results revealed little support for the proposal. Even when the annual tax rebate offered was $5,000, over 50 percent of the respondents sampled stated they would not support the repository.

The survey results led Kunreuther and Easterling (1990) to conclude that the perceived risk is so high that the majority of respondents felt that the risk was incompensable. In other words, the transportation dangers were so great that the social costs would for all practical purposes be infinite. However, the survey results may have been skewed by the survey design. The phrasing of the question poses problems. Respondents may overstate their willingness-to-accept (WTA) compensation in an effort to increase the compensation that would be provided.

Another possible source of bias in the Kunreuther and Easterling (1990) study is uncertainty on the part of Nevadans about the risks that will eventually materialize. Then, as now, there was a large degree of uncertainty about the health and safety risks of the repository and waste transport to the repository. Primarily because of the complexity of the project, the actual health and safety risks are difficult to predict. A number of key safety issues have yet to be resolved including transportation container design, the precise location(s) of the rail transport routes, and the timing of transportation. People may be hesitant to support programs that pose uncertain risks. To account for this, an analysis of the social costs of the health risk should acknowledge the influence of uncertainty on individual risk preferences.

In an effort to gain an understanding of how people respond to risk and uncertainty, Riddel, Dwyer, and Shaw (2003) surveyed 343 southern Nevadans about their housing location decisions. They found that between 1 and 3 percent of households living near the proposed legal-weight truck routes planned to relocate in an effort to protect themselves from the risks of nuclear-waste transport. They also found that compensation could influence households to remain at their present location and bear the transport risk. They estimated the social cost of legal-weight truck transport to average roughly $10,000 annually per household.

A key finding of the Riddel, Dwyer, and Shaw (2003) study is that the social cost of transport increases with risk and uncertainty. Reducing the perceived risk acted to reduce the amount of compensation required to offset health and safety risks. Another significant finding was that uncertainty about what level of risk would eventually materialize also elevated the required compensation. Thus, merely providing people with reliable and concise risk estimates can help reduce social costs associated with transport risks.

The Riddel, Dwyer, and Shaw (2003) study evaluated the health risks associated with transport along the proposed legal-weight truck routes. In contrast, this portion of the economic impact study examines the effects of the risk from transporting high-level radioactive waste using the proposed rail-transport routes. Using data from a carefully constructed survey of southern Nevada households, we first develop a model-based subjective risk estimate for each household. Conditioning on the household subjective risk, we explore different factors that may influence the household's location decisions if the proposed rail transportation routes are ultimately chosen for nuclear-waste transport. Following Riddel, Dwyer, and Shaw (2003), we extend the conventional model of expected utility to allow for uncertainty surrounding the actual risks borne by the household.

We use two approaches to analyze the social costs associated with nuclear-waste transport by rail. The first is a contingent behavior model that focuses on household behavior under risk and uncertainty. We ask respondents whether they will stay at their current residence if given compensation A in the form of a federal tax rebate or move to protect themselves from the risk associated with the transportation of the waste. If the respondent reports he/she will stay, we conclude that the compensation offsets the costs of the additional risk. If the respondent reports that he/she may relocate in spite of the offered compensation, we conclude that the expected costs of the risk exceed the offered compensation. Using the responses, we are able to construct the relationship between the probability that a representative household remains at its current location, the subjective assessment of the risks of transport, and the offered compensation. This model provides an estimate of the social cost of the risk for each household. Since we ask people what compensation is necessary to keep their welfare the same as their pre-transport pre-risk state, the social cost is framed in terms of willingness to accept (WTA).

In addition, the results from the housing-market model can be linked to housing and labor-market models enabling us to estimate housing prices that could result from households avoiding the health risks of nuclear-waste transport by moving away from the perceived danger. These values are fed into the REMI model to assess the potential economic impacts of households relocating to protect themselves from the risk of transport. This provides an economic impact rather than a social cost of the perceived risks from nuclear-waste transport.

Our second approach to quantifying the social costs of the health and safety risk associated with nuclear-waste transport rests on a *hypothetical* market approach. The approach, popularized in the marketing literature, asks respondents to rank three alternative hypothetical houses that are identical save for 1) the distance from the house to the transportation route, 2) the price and corresponding monthly mortgage payment, and 3) whether or not the house has soundproofing to prevent noise from trains affecting the household. By varying the housing attributes; price, distance from the route, and soundproofing, we are able to assess how people value the health and safety risk of nuclear-waste transport holding train noise levels constant over all respondents. The resulting value is interpreted as the household's willingness-to-pay (WTP) for preventing health and safety risks.

Both WTA and WTP are measures of the "social cost" of a program or program component. Social costs arise when a program or program component causes the utility of an individual or household to fall relative to its current state.[6] In markets without externalities, the social cost is represented by the price of the good. For other situations some of the losses are external to any market, so we cannot rely directly on prices to reveal the cost to society of the activity as we would with a conventional economic good. For example, there is a market for electricity and the market cost is the price of a KWH. However, producing electricity with coal means SO_2 and other pollutants are emitted. Pollutants can cause health problems and lead to a fall in utility for those affected. These "external" costs are real but are not included in the market price. Here, the social cost and market price diverge because the total cost of the good to society is higher than the market price. The social cost of a KWH is the sum of the external cost imposed on individuals and households and the market price of a KWH.

In this study, transportation risk may impose social costs because people are exposed to health and safety risks from transport. WTP states social cost in terms of how much a household would be willing to pay to avoid the risk of transport. They pay to maintain their current level of utility. The WTA measures how much a household would have to be compensated to return them to their level of utility before the transport began.

The Survey. The data were collected in an in-person survey of Nevada households from March through May 2003. Participants were recruited at three counties where the DOE has proposed rail transport to Yucca Mountain: Clark County, the largest metropolitan statistical area in Nevada, Lincoln County, a largely rural area, and Nye County, the future site of the Yucca Mountain repository. Trained interviewers contacted people outside local supermarkets and hardware stores. Participants were first asked if they lived in the county. Only residents were surveyed.

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[6] The term "social cost" is a general term for a variety of welfare measures including equivalent variation, compensating variation, and other consumer surplus measures. A discussion of these types of cost can be found in Freeman (1993).

Approximately 384 surveys were completed; 38 percent from Lincoln and Nye counties and the remaining from Clark County. The survey questions can be grouped into four components. In the first component, respondents are asked to report their best guess of the risk of nuclear-waste transport by rail. They are shown a map of the proposed rail transport route taken directly from the Yucca Mountain EIS. They are also asked how far they are from one of the proposed routes. This section is completed by asking respondents to grade the reliability of information from different information sources such as the DOE, environmental groups, the media, or the university.

The second component aids in estimating the household-location model. Respondents are asked to state whether they would stay at their present location or move to protect themselves from nuclear-waste transport given compensation A. Compensation is varied across respondents. Compensation is framed in terms of a federal tax rebate and respondents are told that their moving costs and a relocation stipend will be paid.

The third component of the study questions respondents about hypothetical housing choices. Each participant is presented with two choice experiments ranking three houses that vary with the attributes, price, monthly mortgage payment, distance from the transport route, and a soundproofing variable. These responses are used to estimate the WTP measure described below.

The fourth and final component of the survey questioned respondents about household and demographic characteristics such as income, age, education, and gender. In the following section, we describe the theoretical and empirical housing-location models and the results. Following that, we present the conjoint model, estimation, and results.

5.1. Measuring Willingness to Accept Nuclear-waste transport: Household-Location Model

In this next section, we describe the risk model and WTA household-location model. The risk model allows us to explore how risk perception varies with personal and demographic characteristics of the respondent. Following the risk model, we describe the household-location model and provide the estimate of the social cost to Nevadans, in terms of WTA, of transporting waste through the state. In addition, we examine factors such as the level of perceived risk and uncertainty about that risk that may affect the social-cost estimate. Finally, we link the housing-location model to the housing-market model. This allows us to estimate the economic impact, in terms of employment, GSP, and personal income, of losses in real-estate value that may arise from risk aversion to nuclear-waste transport near residential communities.

5.1.1. The Risk Model

The DOE claims that an accident during transportation is unlikely. The DOE EIS estimates that the annual frequency of the maximum reasonably foreseeable legal-weight truck accident would be 2.3×10^{-7}. The potential consequences of such an accident would be 0.55 latent cancer fatalities, which would result from very low doses to a very large population. However, the public's perception of the health and safety risk will determine the final economic impact of the facility. If households perceive the risk as too high, they may relocate in order to protect themselves from transportation accidents. Thus, to adequately assess the economic impacts and social costs of health and safety risks, it is useful to understand how the perceived risk varies with information and demographic characteristics of the respondent.

Table 8 gives the results of a censored logit model of the respondents' "best guess" of what risk they will face from transporting nuclear waste along the proposed rail transport routes. The risk is measured in terms of the *number* of deaths arising from transport accidents per 100,000 deaths. This number is naturally bounded from below by 0 and from above by 100,000, leading us to choose a truncated logistic model that categorically precludes values outside the interval (0,100,000).

Respondents graded the reliability of different information sources from 1 (not reliable) to 5 (very reliable). Three reliability variables in the model- RELIABLE DOE (reliability of the DOE), RELIABLE ENVIRON (reliability of environmental groups), and RELIABLE UNIV (reliability of university reports)- are shown to significantly affect risk perceptions for three of the information sources. The results also confirm the effectiveness of these two organizations in disseminating their message. Respondents that report higher reliability indices for environmental groups are more likely to rate the risk higher. Conversely, those that rate DOE or university information as highly reliable are likely to report lower perceived death rates from nuclear-waste transport.

The results suggest that the DOE's goal to moderate public risk perception can succeed if the targeted audience finds the DOE information to be well researched and effectively presented. Sixteen percent of respondents feel that DOE information is unreliable, whereas 41 percent find DOE reports to be somewhat reliable. The remaining 43 percent that responded felt that the DOE reports are either a reliable or very reliable source of information. Thus, the DOE enjoys moderate support. Nevertheless, the importance of the public's perception of the dependability of information cannot be understated. If credibility is compromised, then the DOE information could act to increase the public's perception of risk, undermining the effectiveness of public-risk education programs.

Table 8. A Truncated Logistic Model of Factors Influencing the Respondents' Mean Risk Perception. Dependent Variable Is the Respondents' "Best Guess" of the Risk from Nuclear-Waste Transport by Rail Measured as Annual Lifetime Deaths per 100,000

Dependent Variable: BESTGUESS
Method: ML - Censored Normal (TOBIT) (Quadratic hill climbing)
Included observations: 180
Excluded observations: 149#
Left censoring (value) series: 0
Right censoring (value) series: 100,000
Convergence achieved after 4 iterations
QML (Huber/White) standard errors & covariance

	Coefficient	Std. Error	z-Statistic	P-Value*
C	586.1534	199.9221	2.931909	0.0034
FEMALE	109.2261	66.99895	1.630265	0.1030
RAILTOHOME	-4.369772	1.471594	-2.969413	0.0030
EDUCATION	-1.927941	31.59297	-0.061024	0.9513
RELIABLE DOE	-127.4119	38.02892	-3.350395	0.0008
RELIABLE ENVIRON	160.7541	35.78867	4.491759	0.0000
RELIABLE UNIV	-98.41208	43.10277	-2.283196	0.0224

R-squared	0.192439	Mean dependent var	369.08
Adjusted R-squared	0.159574	S.D. dependent var	480.1085
S.E. of regression	440.1384	Sum squared resid	33320147
Log likelihood	-1339.228	Hannan-Quinn criter.	15.02674
Avg. log likelihood	-7.440155		

*P-value is the probability that the null hypothesis of $H_0: \beta_k = 0 \text{ vs } H_A: \beta_k \neq 0$ is true.
Observation not included to missing values

Environmental groups are also generally perceived as a reliable source of information about the proposed repository. However, they enjoy a somewhat less favorable rating than the DOE. Twelve percent of respondents report they find the information from environmental groups to be reliable and another 43 percent think they offer very reliable information about the proposed repository. Thirty one percent and 15 percent of respondents think that information from environmental groups pertaining to the repository is somewhat reliable or unreliable, respectively.

Interestingly, only a weak negative correlation is observed between the DOE's and environmental groups' reliability ratings ($\rho = -0.05$). The coefficient of DOE reliability is -127.412, nearly offsetting the increase in risk perception induced by the environmental group information. Not surprisingly, the two groups appear to be in a tug-of-war for public support for the repository, but it is not clear, at least at this point, who is ahead.

Other factors than information influence risk perception. Women, on average, perceive more risk from the repository than do men. This finding has been broadly reported in other risk-perception studies (Jianakoplos and Bernasek 1998). Those living near the transportation route perceive higher risks than those living further away. Riddel, Dwyer, and Shaw (2003) also observed this in their study of legal-weight truck transport to the repository. According to the model, education does not significantly affect respondents' perceived risk.

5.1.2. Household-Location Model

Theoretical Model. In this section we present the theoretical model developed by Riddel, Dwyer, and Shaw (2003) to model the net benefit of staying at the present location. Assume $W = 1$ if an accident causing exposure occurs and 0 otherwise. Then $E[W]=P(\textit{accident with exposure})=\pi$ and $Var[W]=\pi(1-\pi)$. The survey gives individuals two choices: either they can accept payment A and stay at their current residence experiencing the subjective risk π, or they can relocate to make their risk of accident with exposure equal to zero. For those that choose to move, all moving costs and a supplement to cover intangibles would be available.

Accordingly, let s^* represent the net benefit of staying, less moving costs and intangibles, at their present location, an unobservable variable. If $s = 1$ the household chooses to stay at its present location and $s = 0$ when the household chooses to move. Then:

$$(1) \quad \begin{aligned} s &= 1 \text{ if } s^* \geq 0 \\ s &= 0 \text{ if } s^* < 0 \end{aligned}$$

Equation 1 suggests two indirect utility functions (see Hanemann 1984, Cameron 2001):

(2) $V_1(Y + A, W, \mathbf{X}) = g(Y + A) + h_1(W, \mathbf{X}) + e_1$ and

(3) $V_0(Y, \mathbf{X}) = g(Y) + h_0(\mathbf{X}) + e_0$

where V_1 is the utility the household experiences if they accept payment A and endures the risk, V_0 is the utility gained if they refuse payment and move to protect themselves from the risk, Y is income, and $\mathbf{X}$ is a vector of individual specific traits that affect utility. Note that the episodic event variable, W, is absent in (3) because the probability of exposure is zero if the household relocates.

We assume that W enters the indirect utility functions in two ways: directly as W and through the range of possible risks W_{high}- W_{low}. Define f(W)=)+$\gamma_1 W+\gamma_2(W_{high}-W_{low})$ so that:

(4) $V_1=\mathbf{a}_1'\mathbf{X}+\beta\ln(Y+A)+\gamma_1 W+\gamma_2(W_{high}-W_{low})+e_1$

(5) $V_0=\mathbf{a}_1'\mathbf{X}+\beta\ln Y+e_0$

Taking the expectation over W gives the expected utility difference between the two choices:

(6) $E_W[V_1-V_0]=E_W\{\mathbf{a}_1'\mathbf{X}+\beta[(\ln(Y+A)/Y)]+\gamma_1 W+\gamma_2(W_{high}-W_{low})+e_1-e_0$
$= \mathbf{a}'\mathbf{X}+\beta[(\ln(Y+A)/Y)]+\gamma_1\pi+\gamma_2(\textit{Ambiguity})+e$

where $\mathbf{a}'\mathbf{X} = \mathbf{a}_1'\mathbf{X} - \mathbf{a}_0'\mathbf{X}$, $e=e_1-e_0$, and $E[W_{high} - W_{low}] = \pi_{high} - \pi_{low} = ambiguity$. If the utility under state 1 exceeds that under state 0 so that $E[V^1 - V^0] \geq 0$, then the respondent will accept compensation and remain at his/her current residence. However, if $E[V^1 - V^0] < 0$, then the expected utility in state 0 is higher than state 1, and the respondent will refuse compensation and relocate to protect themselves from the risk.[7]

We recognize (6) as a linear-in-parameters utility difference model that relates location choice to environmental risk, ambiguity about that risk, income, and offered compensation. The parameters of the model, $\mathbf{a}$, β, and γ_i may be estimated using a statistical binary-choice model such as logit or probit. The coefficient γ_2 measures the impact of ambiguity on the housing location decision. If $\gamma_2 < 0$, then increasing ambiguity causes expected utility to fall and ambiguity aversion is inferred. The coefficient β determines the responsiveness of the household's location decision to compensation offered to offset utility losses from the increase in risk. Finally, the coefficient vector $\mathbf{a}$ accounts for changes in location decisions motivated by individual-specific state-dependent characteristics.

5.1.3 Results of the Housing-Location Model

Table 9 gives the results of the probit indirect-utility difference function with the dependent variable equal to 1 if the respondents choose to stay at their present location and accept compensation and 0 if they choose to relocate to protect themselves from the risk of rail transport. All of the model variables are significant at the $\alpha = 0.05$ level.

Risk and ambiguity both affect housing location decisions. As perceived risk increases, the probability the household will refuse compensation and relocate increases. This supports the hypothesis that health and safety risks are an economic "bad." The respondents exhibit ambiguity aversion: as ambiguity about what future costs will be born increases, people report they are less likely to accept compensation and remain at their current residence. This is consistent with past findings. In a series of experiments using lotteries, Ellsberg (1961) showed that people often prefer gambles with known expected payoffs to uncertain gambles. Similarly, Cameron (2001) revealed that people with more uncertainty about the likelihood of future climate change were less likely to

[7] It is important to note that the resulting utility difference model traditionally does not include a constant term. This result depends on the equivalence of the underlying intercept terms, φ_1 and φ_0. If $\varphi_1 = \varphi_0$, then the constants will cancel and the estimation model will not include a constant term. Alternatively, if $\varphi_1 \neq \varphi_0$, then the estimated constant term will be $\varphi = \varphi_1 - \varphi_0$, the difference between the two original constant terms.

support programs to mitigate global warming. Finally, Riddel, Dwyer, and Shaw (2003) found that uncertainty raised the expected WTA the risk from transporting nuclear waste by legal-weight truck. Our results provide further support for ambiguity aversion affecting preferences under risk.

Table 9. Probit Models for the Indirect-Utility Difference Function: Dependent Variable =1 if Respondent Reports They Will Stay at Current Residence

Dependent Variable: STAY

Method: ML - Binary Probit (Quadratic hill climbing)
Included observations: 162*
Convergence achieved after 4 iterations
QML (Huber/White) standard errors & covariance

Variable	Coefficient	Std. Error	z-Statistic	Prob.
LN((Y+A)/Y)	1.4061	0.6788	2.0715	0.0383
RISK	-0.0019	0.0009	-2.1190	0.0341
EDUCATION	0.2509	0.09189	2.7317	0.0063
OWN HOME	0.7514	0.24029	3.1277	0.0018
AMBIGUITY	-0.0006	0.00029	-2.5588	0.0105

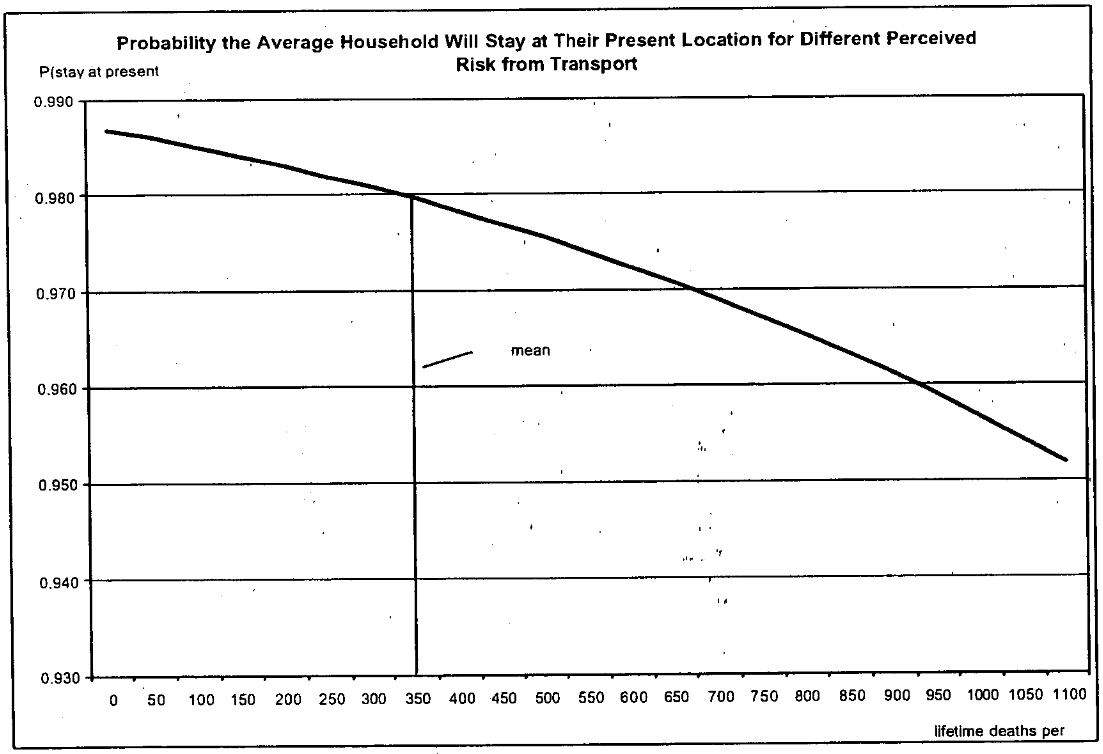
Mean dependent var	0.6914	S.D. dependent var	0.4634
S.E. of regression	0.4332	Sum squared resid	29.4664
Log likelihood	-86.8668	Avg. log likelihood	-0.5362

* some observations dropped due to incomplete responses.

Education and home ownership increase the likelihood that households will stay at their present location rather than relocating to protect themselves from the transport risk. Presumably households that own their own homes have stronger ties to the community. Likewise, more educated households may feel they are better adapted to protect themselves from the risk without relocating.

Figure 101 gives the relationship between perceived risk and the probability the household will stay at their present location. As expected, the larger the perceived risk, the larger the likelihood that the household will relocate to protect themselves. At the mean risk, roughly 370 deaths in 100,00 deaths, just under 2 percent of the households will relocate. Interestingly, these results closely parallel the findings of Riddel, Dwyer and Shaw (2003) that between 1 and 3 percent of households would relocate.

Figure 101. The Probability a household will Stay at Their Present Location for Different Levels of Perceived Risk.



Given (6), we can calculate the social cost, in terms of option value, of transporting waste through Nevada by rail. The formulas for generalized option price (GOP) and expected GOP are:

$$GOP = Y[\exp\{-(\mathbf{a}'\mathbf{X} + \gamma_1 \pi + \gamma_2 Ambiguity + \varepsilon)/\beta\} - 1]$$

$$E_\varepsilon[GOP] = Y * \exp\{-[\mathbf{a}'\mathbf{X} + \gamma_1 \pi + \gamma_2 Ambiguity]/\beta\}\exp\{1/(2\beta)^2\} - Y$$

The average annual household payment that offsets the rail transport risk is $2,828. Assuming a social discount rate of 6 percent, the present value per household over the 24 years of transport is $36,884. Assuming a household size of 2.6 this implies a VSL (value of a statistical life) of $3.4 million.

5.1.4 Impact on Housing Markets

The REMI model assumes all land is homogeneous: all acres have identical properties. Thus, one cannot induce spatial price differentiation. To offset this, we used the demand change associated with a house removed 13 miles from the transport route, the average distance of houses in the sample. For each of the counties along the rail-transport route, we estimate the drop in housing demand implied by the household contingent behavior survey for the mean reported risk of 370 lifetime annual deaths per 100,000 deaths. According to the model, approximately 2 percent of households may relocate.[8] The 2 percent reduction in demand enters the REMI model through a fall in the consumer demand for real estate.[9] The total assessed value for residential property including vacant land, single family residences, mobile and manufactured homes, and multifamily residential is $28.195 billion The 2 percent demand reduction translates into losses in assessed value of $563.894 million.

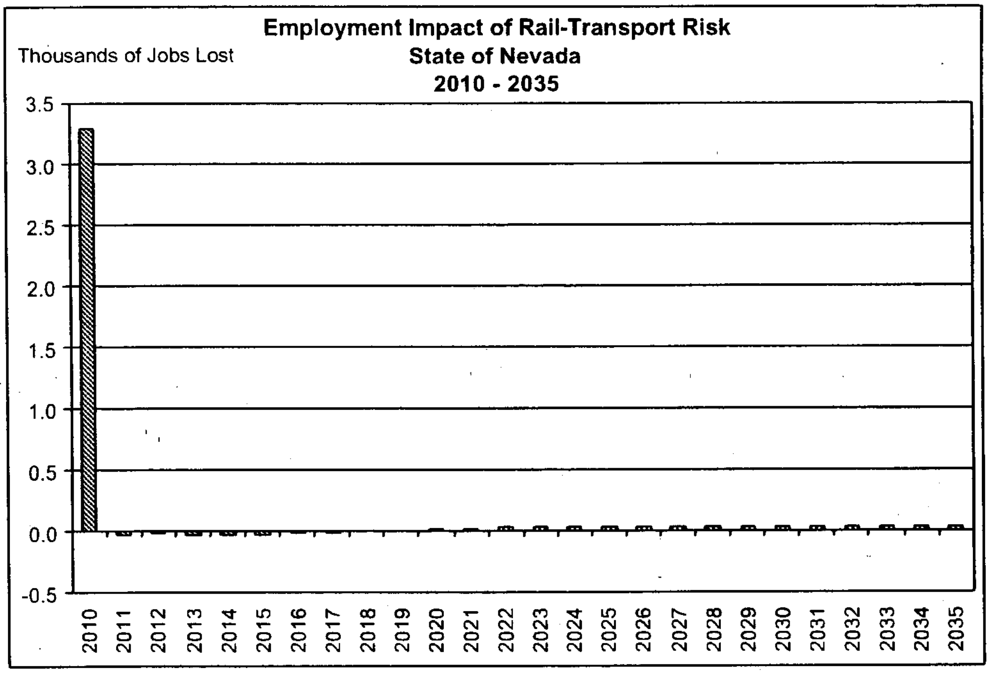
The results, reported in terms of total employment, GSP, and RPI impacts on the state of Nevada, are reported in Figures 102 to 104. We discuss each in turn.

Employment Impact of Rail-Transport Risk. Figure 102 shows the net job losses relative to the baseline forecast caused by the indirect effects of lost wealth from a fall in real-estate demand spurred by rail-transport risk aversion. In the first year of transport the primary employment losses are suffered as people relocate to protect themselves from transport risk. In 2010, the first year of transport, roughly 3,300 jobs in Nevada are lost relative to the baseline forecast. The initial impact is offset rapidly, however, as the economy absorbs the initial out-migration shock. In 2011, the second year of transport, actually becomes positive but statistically insignificant.

[8] Since we do not have any data on business location choice under rail-transport risk, we ignore this potential impact. This omission is unlikely to overly bias the real-estate price impacts since businesses typically exhibit less environmental risk aversion than households. Nevertheless, we do expect that we may slightly underestimate the overall real-estate price impact.

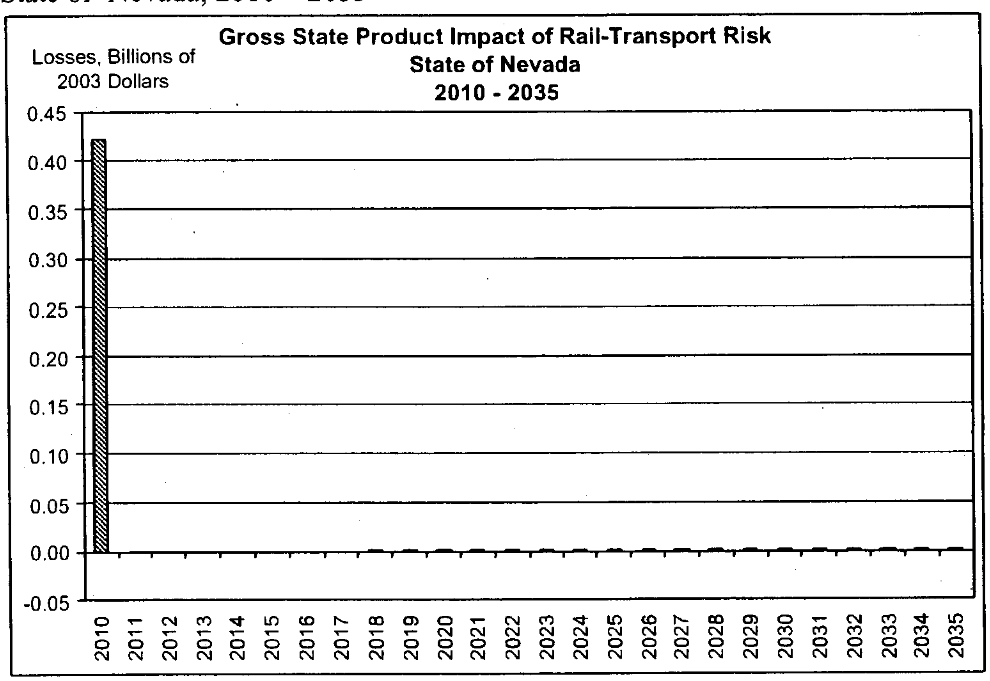
[9] The change enters the model through REMI policy variable T648.

Figure 102. Employment Losses Resulting from Rail-Transport Risk: State of Nevada, 2010 – 2035*



*Losses are relative to the baseline forecast for employment growth in Nevada.

Figure 103. GSP Losses Resulting from Rail-Transport Risk: State of Nevada, 2010 – 2035*

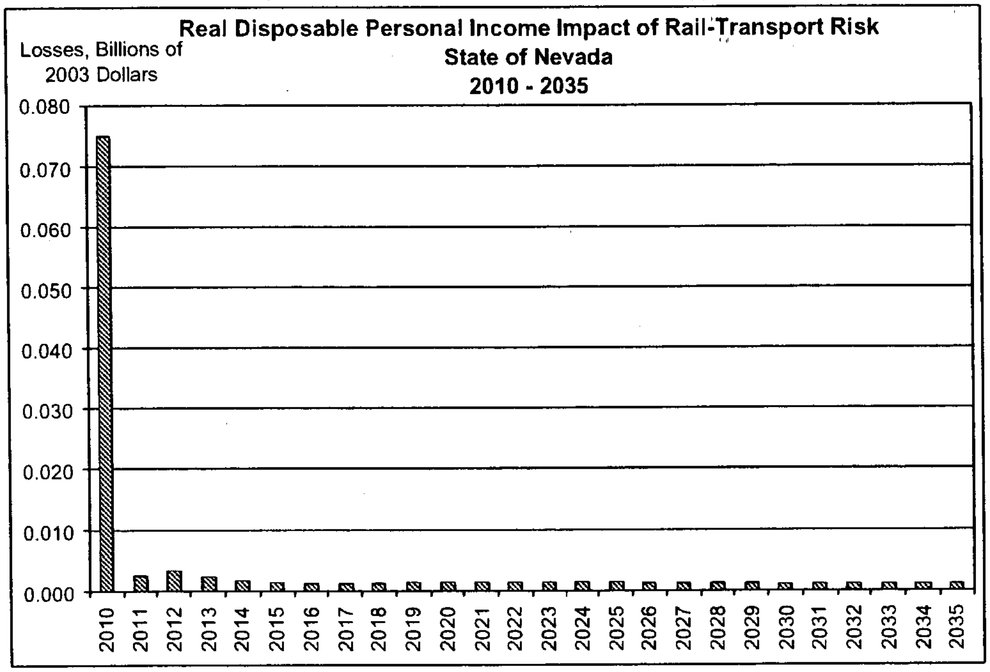


* Losses are relative to the baseline forecast for GSP growth in Nevada.

GSP Impact of Rail-Transport Risk. The one-time shock to housing demand translates into real GSP losses of approximately $423 million in the first year of rail transport (see Figure 103). Like employment, the transitory nature of the shock means that the effect dies out rather rapidly. By the second year, the GSP shortfall turns slightly positive but not statistically different from zero. The cumulative impact over the 25 years totals roughly $435 million or 0.01 percent of GSP expected to accumulate during that time in the baseline model

RPI Impact of Rail-Transport Risk. Figure 104 shows that the RPI impact associated with the one-time drop in residential real-estate demand arising from fears of transport accidents mirrors the losses seen in GSP. The initial impact peaks in the first year at just over $18 million. After that time, risk has no significant impact on the state's economy. During the transport phase, RPI impacts total $114.6 million accounting for a drop of 0.004 percent in the state's expected RPI under the baseline forecast.

Figure 104. Real Disposable Personal Income Losses Resulting from Rail-Transport Risk: State of Nevada, 2010 – 2035*



* Losses are relative to the baseline forecast for RPI growth in Nevada.

5.2. Measuring Willingness to Pay to Avoid the Risks from Nuclear-waste transport: Conjoint Study

Whereas the household-location model gives estimates of WTA, the conjoint study presented in this section provides an estimate of social cost in terms of WTP. Hanemann (1991) showed that the divergence between WTP and WTA results from endowment and substitution effects. Since the public good "health and safety" does not have close substitutes, it is likely that WTP-based welfare estimates of nuclear-waste transport may be substantially less than the WTA values estimated in the past. Endowment effects may exaggerate the divergence. Thus, theory suggests that WTP estimates for nuclear-waste transport may be much smaller than WTA measures offered in this and other studies.

Our WTP estimate is based on a conjoint study ranking housing preferences as a function of mortgage payment and distance from the rail-transport route. In the following section, we briefly describe the choice model motivating the conjoint analysis and the hierarchical Bayesian (HB) method used to estimate the model parameters.

5.2.1 The Conjoint Experiment

In the choice experiment, the individual is presented with three houses (A, B, and C) that are identical save for varying levels of the four attributes price, mortgage payment (a function of price), distance from the nuclear-waste transport route, and soundproofing. Let the utility that household n derives from alternative j in choice experiment t be equal to:

(7) $U_{njt} = \beta_n ' X_{njt} + \varepsilon_{njt}$

For a given choice experiment, the respondent will rank the houses with A as the most preferred and C as the least preferred if $U_{At} > U_{Bt} > U_{Ct}$ or equivalently if $\beta ' X_A + \varepsilon_A > \beta ' X_A + \varepsilon_A > \beta ' X_A + \varepsilon_A$ where $\beta ' X_{jt}$ is the systematic component of utility derived from alternative j and ε_{jt} is the unobserved individual-specific component of utility derived from alternative j.

If the errors are distributed independently as Type I extreme value then the probability of the ranking given β is the joint logit probability (see Train 2002 pg. 177):

$$\text{Prob}(\beta ' X_A + \varepsilon_A > \beta ' X_B + \varepsilon_B > \beta ' X_C + \varepsilon_C) = \text{Prob(ranking A, B, C)=}$$

(8) $$\frac{\exp(\beta' \mathrm{X_A})}{\sum_{j=A,B,C} \exp(\beta' \mathrm{X_j})} \frac{\exp(\beta' \mathrm{X_B})}{\sum_{j=B,C} \exp(\beta' \mathrm{X_j})}.$$

More generally, the probability of household n's sequence choice $y_n ' = (y_{n1}, y_{n2}, \ldots, y_{nt})$ given β is:

$$(9) \qquad P(y_n \mid \beta) = \frac{\exp(\beta' x_{n_{y_{nt}} t})}{\sum_j \exp(\beta' x_{n_j t})}$$

Intuitively, the rankings in (8) are the result of two choices by the respondent. Respondents choose A, the most preferred, then B, the second most preferred. The choice of the second-most preferred determines the rank of the remaining house as the least preferred. Thus, for J alternatives in (9), there are J-1 sequential choices, each of which can be modeled using a logit model. The sequential modeling as in (9) gives the exploded logit model (Train 2002 pg. 178).

The elements of the coefficient vector, β, are the partworths. They reflect the utility individual i gains or losses from the corresponding attributes of the good. In (7), the partworths represent the value of a one-unit change in the attribute. As such, the coefficient of the income or cost term is interpreted as the marginal utility of money. The ratio of the attribute partworth to the income or cost partworth is the welfare measure of the attribute in question.

The probability in (9) assumes that β is a fixed parameter vector. However, past research has shown that in many instances parameters may vary randomly over respondents (Train 1998, Revelt and Train 1998, Train 2002). The variation in the coefficient vector may represent variation in household tastes or information sets. This may be particularly important in the conjoint experiment under investigation. If variation in individuals' perceived risks of nuclear-waste transport induces heterogeneity in the choice functions, then a random parameters model will more closely match the underlying preference function.

Assuming random-parameter vector $\beta \sim f(\beta \mid \theta)$, the resulting mixed-logit probability is (see Train 2002 pg. 178):

$$(10) \qquad \text{Prob}(y_n) = \int P(y_n \mid \beta) = \frac{\exp(\beta' x_{n_{y_{nt}} t})}{\sum_j \exp(\beta' x_{n_j t})} f(\beta \mid \theta)\, d\theta.$$

Mixed-logit models require the estimation of multiple integrals. As a result, researchers typically estimate the individual probabilities using simulation methods like those in Geweke (1989), Hajivassiliou (1990) and Keane (1994). The parameters of the distribution are estimated using simulated maximum likelihood (SML) based on the simulated probabilities (see Train 2002 or Greene 2000 for a detailed description of SML). Another option is estimating parameters using hierarchical Bayesian (HB) estimation methods (Train 2001, Sawtooth Software 1999). Both HB and classical estimators require simulating high-order integrals. However, when simulation is involved, HB estimators are preferred because they are asymptotically normal and they converge to the classical *unsimulated* maximum likelihood function. In contrast, the simulated maximum likelihood function is not asymptotically normal, thus desirable properties such as consistency and efficiency cannot be assumed.

Another advantage of HB procedures is that they can be readily adapted to handle coefficient distributions that are transformations of normal distributions (Train and Sonnier 2003). In the classical setting, lognormally distributed coefficients are often difficult to estimate because they have non-concave likelihood functions. The lognormal distribution is particularly important because its values are strictly positive. If the negative of the price variable enters the model, then the price coefficient is naturally bounded below at zero as economic theory would suggest. Thus, the ability of the Bayesian approach to readily estimate the parameters of lognormally distributed coefficients makes it empirically attractive. Finally, HB models easily accommodate correlated coefficients, allowing for deviations from the standard logit assumption of independence of irrelevant alternatives.

In summary, Bayesian procedures have superior asymptotic properties to classical methods when simulation is required and are more tractable for key distribution functions. In the next section, we briefly describe the HB model. Following that, we turn to a discussion of the choice experiments and their results.

5.2.2. Hierarchical Bayes Estimation Procedures

Train (2002 pg 326 - 32) provides an excellent discussion of hierarchical Bayesian estimation procedures for the mixed-logit model. We briefly describe his results in this section.

For person n, the probability of the sequence choice $y' = (y_1, y_2, ..., y_t)$ conditional on β is: $L(y_n \mid \beta) = \prod_t \frac{\exp(\beta' x_{n_{y_{nt}} t})}{\sum_j \exp(\beta' x_{njt})}$.

Assume a multivariate normal distribution for β with mean vector and covariance matrix b and Ω, respectively, so that $P(\beta) = \phi(\beta \mid b, \Omega)$. Following Train and Sonnier (2003), we assume a normal prior distribution for b with a variance large enough to make the distribution flat and numerically indistinguishable from a diffuse prior. For the covariance matrix, Ω, we specify an inverted Wishart distribution $IW(\Omega, K, KI)$ where K represents the degrees of freedom and I is the identity matrix. Multiplying the priors for b and Ω gives the joint prior distribution $k(b, \Omega)$. The unconditional probability of choice sequence y for respondent n is equivalent to the mixed-logit probability

$L(y_n \mid b,W) = \int L(y_n \mid \beta)\phi(\beta \mid b,\Omega)d\beta$. The joint posterior distribution of b and Ω is proportional to the product of the n unconditional probabilities and the prior, $k(b,\Omega)$. Therefore the joint posterior distribution of $b,\Omega,$and β_n given the choice sequences for all n is:

$$\Lambda(\beta_n, b, \Omega \forall n \mid Y) \propto \prod_n L(y_n \mid \beta_n)\phi(\beta \mid b,\Omega)k(b,\Omega).$$

The posterior distributions of the coefficients can be estimated as described in Train and Sonnier (2003). Briefly, the posterior distribution of b is simply $N(1/n\sum \beta_n, \Omega/n)$ whereas the conditional posterior distribution of Ω is $IW(\Omega \mid K+N, KI+\sum(\beta_n - b)(\beta_n - b)')$ given β and b. Draws from these distributions, denoted $\tilde{b}$ and $\tilde{\Omega}$ are readily available using Gibbs sampling. Draws for β_n for all n can be obtained using the Metropolis-Hastings algorithm (M-H) conditioning on Ω and b. Typically, some order of 10,000 draws are taken to gain convergence. Following that, 1,000 – 3,000 draws are retained to conduct inference. The average of the latter draws is the mean of the posterior distribution whereas the sample variance of the draws is the estimator of the posterior distribution's variance.

5.2.3. Including Bounded Distributions

Until recently, the bulk of mixed-logit models assume that the model coefficients are normally distributed due to the ease of estimation and asymptotic properties of the resulting estimators. This is problematic in valuation applications because the normal distribution is unbounded on the right, suggesting that some of the respondents have a preference for higher prices. According to Train and Sonnier (2003) the WTP distribution does not always exist when the price coefficient is allowed to take on positive values. Thus, it is necessary to restrict the price coefficient distribution to negative space. In practice, one enters the negative of the price variable in the model and the lognormally distributed price coefficient is strictly positive so that the law of demand is satisfied and people prefer lower prices, all else equal.

The HB model is based on normal posteriors and was therefore thought to be incompatible with bounded coefficients. As a result, many applications resorted to SML, despite its undesirable asymptotic properties so that the log-normal distribution may be used for the price coefficient. However, the likelihood functions associated with SML models based on log-normal distributions are often not globally concave and optimization proves difficult (Train and Sonnier 2003).

In a recent article, Train and Sonnier (2003) show that monotonic transformations of β_n so that $c_n = f(\beta_n)$ involving only β have the same properties since the variable ultimately used in the posterior is transformed to the normal distribution for estimation. This opens the door for using bounded distributions together with correlated coefficients in mixed-logit models. The lognormal is a transformation of the normal distribution making it a natural and useful application of the HB estimation strategy. The only difference in estimation from that described for normal-based HB models is one must transform c_n into a normal coefficient at each iteration. Thus, the asymptotic properties of the normal-based HB estimator are preserved and bounded distribution may be easily accommodated.

5.2.4. The Conjoint Data and Model Results

Each survey respondent was presented with two choice experiments ranking three hypothetical houses. Approximately 15 percent gave answers that offered inconsistent preferences by choosing a more expensive house over the identical house at a lower price. These observations were dropped from the sample. A log-likelihood test indicated that there was no significant difference between the first and second choice experiments and we therefore combined the two to form a total sample size of 405.

Participants were asked to rank three houses that were identical save for four attributes: proximity to the nuclear-waste transport route, mortgage cost, price, and different levels of soundproofing. The attribute levels are reported in Table 10. We used a fractional factoral design that allows estimation of two-way interaction effects (Louviere, Hensher, and Swait 2000.) Soundproofing was offered because some households may prefer to live further from the rail route simply because of noise. The mortgage interest variable represents the cost whereas the distance from the transport route incorporates the perceived danger of transport to respondents. Households living nearer to the transport route face greater risks from potential accidents or radiation leaks than those located further away from the route.

We are interested in the partworths of the price and the distance variable. The ratio of the distance partworth to the price partworth is the compensating variation for proximity to the route. Distance is measured in miles and the monthly mortgage payment in dollars so the ratio of their respective partworths reveals how much more the respondent would be willing to pay in their monthly mortgage to live one mile further from the rail-transport route.

The coefficient of the cost variable, represented by the mortgage payment, should lie everywhere above zero so we assume a lognormal distribution and enter the negative of the price variable in the model.[10] The distance partworth can take on positive or negative values. People who perceive risk from nuclear-waste transport are expected to have a distance partworths that exceed zero. For others, who perceive little or no risk from transport, may have no preferences with respect to their proximity to the route and therefore have zero or possibly negative values.

Table 10. Attribute Levels for the Choice Experiments for Clark, Lincoln, and Nye Counties

	Attribute Levels						
Clark County							
Price	$109,500	$119,500	$129,500	$139,500	$149,500	$159,500	$189,500
Mortgage (Monthly Payment, 30-yr Mortgage with 20% Down)	$548.71	$620.06	$671.95	$723.84	$775.72	$827.61	$983.27
Distance from Transport Route	0.5	1	5	10	25	50	
Soundproofing	yes	no					
Nye County							
Price	$66,300	$76,300	$86,300	$96,300	$106,300	$116,300	$126,300
Mortgage (Monthly Payment, 30-yr Mortgage with 20% Down)	$318.00	$365.97	$413.93	$461.89	$509.86	$557.82	$605.79
Distance from Transport Route	0.5	1	5	10	25	50	
Soundproofing	yes	no					
Lincoln County							
Price	$44,300	$54,300	$64,300	$74,300	$84,300	$94,300	$104,300
Mortgage (Monthly Payment, 30-yr Mortgage with 20% Down)	$212.48	$260.44	$308.41	$356.37	$404.34	$452.30	$500.26
Distance from Transport Route	0.5	1	5	10	25	50	
Soundproofing	yes	no					

A good model will also control for other factors that may affect the utility difference function. Gender, age and other individual-specific characteristics will enter the model if females or older people have different health and safety preferences. Because individual characteristics do not vary across alternatives, they fall out of the probability. The way around this is to interact these variables with house attributes. For example, distance from the rail transport route may be interacted with gender so that WTP will vary with distance and gender.

[10] We chose to model the cost of the house using mortgage payment, rather than price, because the mortage payment model had a superior statistical fit.

We assume that utility is loglinear in income so that it has the desirable property of diminishing marginal utility of income.[11] We allow for rural Nevadans to have different WTP values to urban Nevadans by interacting an indicator variable, *Rural,* for rural addresses (in Nye and Lincoln counties) and an indicator variable for urban Clark County, *CC*, with the monthly mortgage attribute.[12] Thus, the coefficients of *CC*Mort* and *Rural* Mort* are the price coefficients for Clark County and rural Nevada, respectively. A likelihood-ratio test indicates that the creating separate urban and rural price coefficients is superior to the constrained model where they are assumed to be equal.

Table 11 gives the estimated means and variances of the model coefficients, β_n, their standard errors, and their partworths for four variables: rural price, Clark County price, the distance variable $1/m$, and the interaction between female and distance $female*m$ where m = the number of miles from the transport route. Other variables, including soundproofing, age, and education did not significantly affect preferences and are excluded from the reported model results.

Recall that the model coefficient vector, β_n, is a normally distributed random vector. If coefficients were independent, the partworths for the lognormally distributed coefficients could be estimated recognizing that $E[\ln\beta] = \exp(b + .5\sigma^2)$ and $Var[\ln\beta] = \exp(2b + 2\sigma^2) - \exp(2b + \sigma^2)$ for $\beta \sim N(b, \sigma^2)$. For independent normally distributed coefficients, an estimate of the partworth is simply the corresponding coefficient in β_n. In our application, the covariates are allowed to have nonzero correlation allowing us to relax restrictive assumptions about the covariance matrix. In the correlated case, the partworths arise from the joint distribution so that simple variable-by-variable transformation is not appropriate. In response, the partworths are obtained by simulation. We keep the post-convergence respondent-specific draws from each iteration. The sample mean and variance of these draws are estimators of the mean and variance of the partworths (Train and Sonnier 2003).

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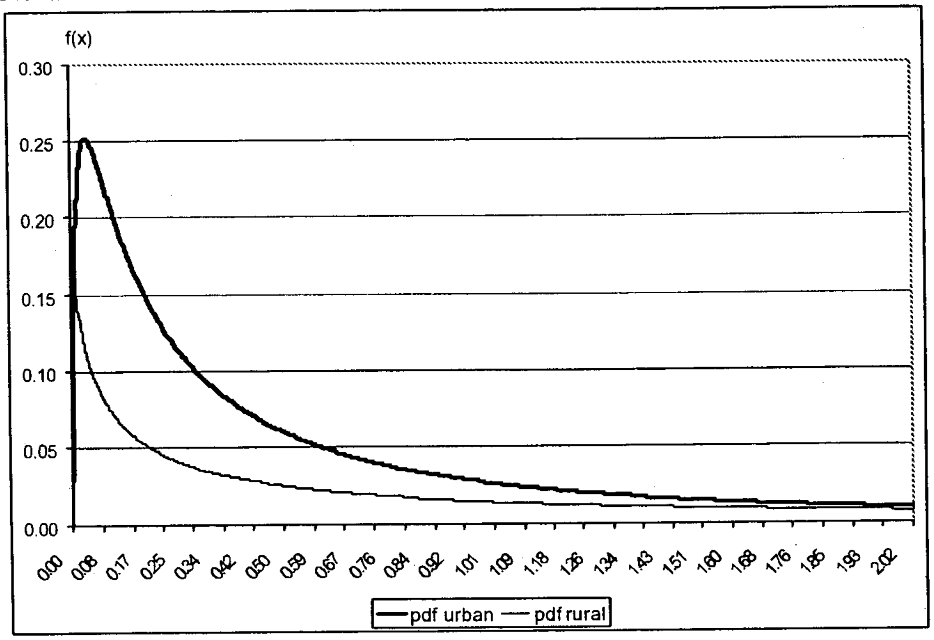
[11] The price variable $\ln[(Y - A)/Y]$ arises from the utility difference function $U_{diff} = U_1 - U_0$ where $U_1 = \ln(Y - A) + \gamma q + \varepsilon_1$ *and* $U_0 = \ln Y + \gamma q + \varepsilon_0$ for income Y, payment A to avoid the risk of environmental quality change from q_1 *to* q_0.

[12] Urban and rural Nevada are very dissimilar. Clark County is the urban center of Nevada. According to the U.S. Census, 98 percent of Clark County residents are classified as urban. Clark County's median household income is $44,616. In contrast, the median household income is $36,024 and $31,979 in Nye and Lincoln counties, respectively. All of Lincoln County and 55 percent of Nye County residents are classified as rural. Homes and land are significantly cheaper in Nye and Lincoln counties. The median house prices in Nye and Lincoln counties were $96,300 and $74,300, respectively, in 1999. The Clark County median house price was $132,200 that year.

Table 11. Hierarchical Bayes Conjoint Model of Housing Choice: Dependent Variable is Housing Rank

Variable	β_n		Partworths		
Lognormal	Mean	Variance			share below 0
*CC*Mort* (negative)	-3.3571	2.5061	0.1050	0.0687	0.0000
	(0.2849)	(1.2554)			
*Rural*Mort* (negative)	-5.4762	6.222	0.0420	0.0453	0.0000
	(0.4445)	(2.1047)			
Normal					
1/m	-2.2813	4.1844	-2.2512	4.6554	0.85
	(0.3404)	(1.3995)			
*Female*m*	0.5426	0.2519	0.5872	0.2234	0.1100
	(0.0665)	(0.0582)			
Log-likelihood	-500.4183				

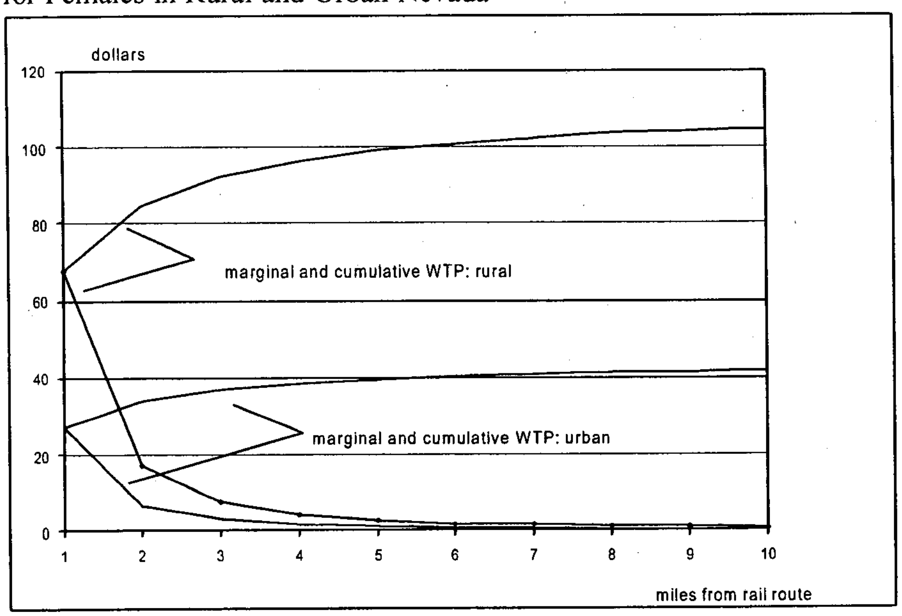
Figure 105. Lognormal Price Coefficient Distributions for Clark County and Rural Nevada



The population partworth distributions for rural Nevada and Clark County are graphed in Figure 105. The mean of the distribution of the Clark County price coefficient is shifted to the right relative to the rural price coefficient suggesting that the marginal utility of income is higher for urban residents. Rural residents have a larger variance of the price distribution so that the tail of the rural price coefficient is thicker than that for urban Clark County residents.

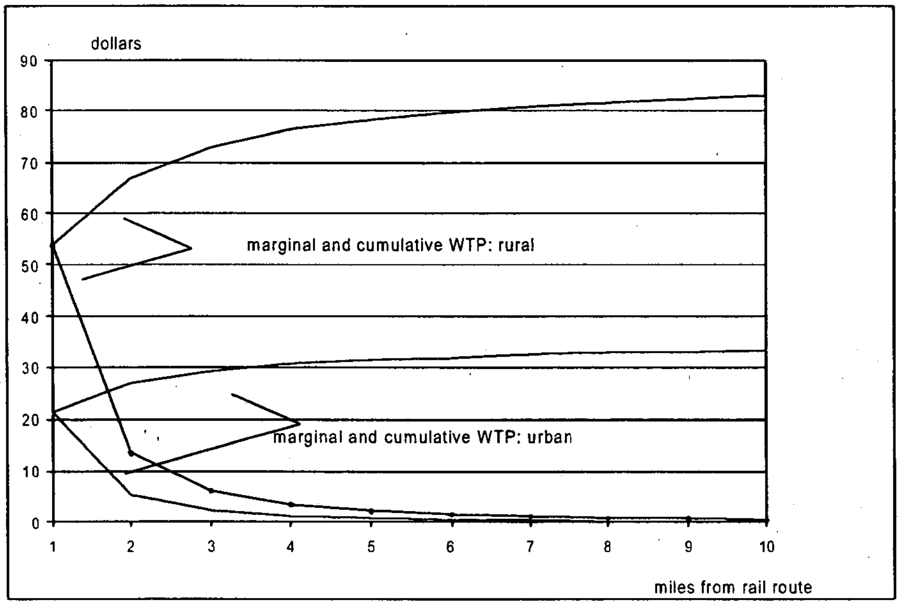
The distance variable enters the model in two ways: directly through the inverse functional form and through an interaction variable with the female indicator variable. More precisely, the distance enters through the function $g(m) = \alpha_m \, {}^{1}\!/_{m} + \alpha_{m'} female * m$ for m miles. This formulation allows women and men to value proximity to the transport route differently while allowing for the attractive property of diminishing marginal value for each additional mile removed from the site.[13] The distribution of the coefficient of the distance function suggests a positive and significant relationship between distance from the route and preference ranking for 85 percent of the population. For the remaining 15 percent of the population, distance does not affect preferences or respondents prefer to live near the transport route. For females, the coefficient distribution is shifted to the left suggesting that women prefer to live further from the route and the dangers associated with high-level waste transport.

Figure 106. Marginal and Cumulative WTP for Each Mile Distant from Transport Route for Females in Rural and Urban Nevada



[13] We allow the distance coefficient to vary with gender in response to a host of past studies suggesting that women report higher subjective risk measures than do men and tend to value risk mitigation more for a given level of risk (Riddel, Dwyer, and Shaw, 2003; Jianakoplos and Bernasek 1998.)

Figure 107. Marginal and Cumulative WTP for Each Mile Distant from Transport Route for Males in Rural and Urban Nevada



Given the partworths, the welfare measures can be estimated. The compensating variation for moving one mile distant from the transport route is equal to $\alpha_d \frac{dg(m)/dm}{\alpha_Y}$ where α_d is equal to the partworth for the distance function, $g(m) = 1/m$, α_Y is equal to the marginal utility of income. Figures 106 and 107 graph the marginal and cumulative compensating variation for households located m miles from the route for women in rural and urban Nevada. The inverse functional form allows the marginal WTP to decline for each additional mile removed from the site. The marginal WTP falls off sharply as distance increases. On average, males in Clark County are willing to pay \$21.44 a month more in their mortgage payment for the first mile removed from the transport route and an additional \$5.36 for the second mile. Thus, the cumulative WTP for Clark County males living two miles distant from the site is \$26.80. At 25 miles from the route, cumulative WTP is \$34.43 per month. Women in Clark County are willing to pay considerably more: \$43.41 a month in additional mortgage for 25 miles removed from the transport route. Compensating variations are higher in rural Nevada with men and women willing to pay \$54.60 and \$67.58 more, respectively, in their monthly mortgage payment for the first mile removed from the route. The marginal WTP falls off sharply: the compensating variation for house 25 miles from the site is \$86.07 and \$108.52 for men and women, respectively.

Nuclear-waste transport to Yucca Mountain is currently slated to take place over 24 years. For those living one mile from the transport route, total social losses during 24 years of transport are estimated to be $3,423 and $8,557 per household for urban and rural Nevada, respectively. Recall that the household-location model gave a social cost, in terms of WTA, of$36,884 per household over 24 years of transport. This is more than 10 times the urban WTP value and more than 4 times the rural value. The large disparity is not altogether surprising. WTP values are typically less than WTA because they are not subject to endowment effects. Additionally, when a good has few or very poor substitutes, like health and safety, substitution effects cause even greater divergence between WTP and WTA (Shogren et al. 1994). Both of these forces are certainly at work here. Nevertheless, the WTP values are still a large portion of household income and, when aggregated over many households, could represent significant welfare losses.

To give some insight into what the total social losses could be for an affected community in Nevada, we consider a representative "hypothetical" city. Assume the city is circular with radius 12 miles and a uniform population density of 500 people per square mile giving a total population of 226,195. The route bisects the city. The percent of the population that is female is equal to the percent that is male. Further assume that the household size is the national average of 2.59 persons per household. For this representative city, using the more conservative "urban" WTP estimates, the total social cost for all of the households within the city in the first year of transport is $34.536 million given current risk perceptions. The present value of the social costs for the city over 24 years at a social discount rate of 6 percent of transport is $459 million. If perceived risk increases (decreases) then social costs will rise (fall).

Of course, these values are based on current risk perceptions. If the DOE is successful in developing and implementing public risk-education programs that reduce the public's perception of the riskiness of nuclear-waste transport, the social costs will fall significantly. The risk model underscores the importance of the public's perception of the reliability of the source. Only sources that the public deem reliable are likely to shift risk perceptions so that the public will tolerate urban nuclear-waste transport.

5.3. The Validity of the Stated Preference Results

We note that both approaches – the contingent behavior approach aimed at estimating WTA and the conjoint approach used to estimate WTP – are based on stated, rather than revealed preferences of consumers. Some researchers are critical of stated preference studies because households' actual behavior may not match their intended behavior. Many researchers share their concern but we realize that some information is better than none. In the case of long-term high-level nuclear-waste transport, there is no opportunity to collect revealed preference data.

The few papers that have examined nuclear-waste transport are either not published in peer-reviewed journals and/or deal with short-term transport (Bentz et al. 1993, Gawande and Jenkins-Smith 2001). Bentz et al. (1993) excludes important variables in their analysis such as income, population changes, mortgage interest rates, and employment growth. These are critical determinants of housing prices but are not controlled for in the study. Without controlling for changes in these variables, the results are tenuous. Gawande and Jenkins-Smith find some evidence of changes in house prices resulting from *transient* nuclear-waste transport. The impact is small and is not uniform. Nevertheless, that study examines transient transport. Transient and long-term transport risks are almost certainly different simply because of differences in the time span of the transport and amount of waste shipped. Unfortunately, their unconventional risk measure is not comparable to the more standard risk-ladder based measure used here. (See Corso, Hammit, and Graham (2001) for a discussion of the accuracy of risk ladders for eliciting risk perception.)

Simply put, one cannot directly examine the relationship between transport, property values, and social costs because long-term high-level waste transport *has never occurred.* Thus, we turn to second-best methods to gain some understanding of the potential social costs. Nevertheless, there is reason to believe that stated preference studies have considerable values for policymakers. In 1993, the National Oceanic and Atmospheric Administration (NOAA) commissioned a study by a panel of experts in 1993 composed of Nobel Laureates Kenneth Arrow and Robert Solow and other well known economists (Arrow et al. 1993). A key finding of the study is that stated preference models for environmental valuation can provide useful and reliable information for policymakers. The NOAA study concluded that stated-preference surveys can be considered unreliable if:

1) they suffer from high nonresponse for the valuation question, or
2) inadequate responsiveness to the scope of the environmental insult, or
3) lack of understanding of the task by the respondents.

The survey results reported here suffer from none of these shortcomings. The valuation questions were answered by over 90 percent of respondents. Thus, item nonresponse is not an issue. Reassuringly, the estimated social costs increase as the distance from the hypothetical house location (for the conjoint component) and the actual distance the respondent's home is located from the transport route (for the contingent behavior component) decreases. Homes closer to the transport route clearly are more likely to be negatively affected by accidents than those further away. Thus, it is reassuring that for both the conjoint and contingent behavior valuation questions increasing the distance of the household from the route caused the estimated social costs to fall. Further, the perceived risk was strongly correlated with the social cost of nuclear-waste transport. Taken together, the findings that perceived risk and distance influence costs suggests strongly that respondents were aware of the scope of the externality thereby eliminating 2) as a source of bias.

Since respondents were overwhelmingly able to answer the valuation questions and recognized the fact that risks varied with location, we feel confident that the bulk of respondents understood the task presented to them. As a result, we consider the survey a reasonably reliable instrument for assessing the social costs of nuclear-waste transport. This is supported by the fact that it meets the NOAA panel's guidelines for reliability.

VI. CONCLUSION

This research summarizes the current and expected future economic impacts of the YMP on the state of Nevada. The findings show that YMP could provide a stable source of revenue, income, and employment for the state.

Currently, the scientific investigation of the suitability of the site continues as the DOE prepares to apply to the NRC for a license to operate the site as a waste storage facility. If the YMP were discontinued, economic losses, relative to the current economy, would be substantial. In 2000, the YMP contributed $195.7 million to the Nevada economy and an additional $188.6 million in 2001. The YMP was responsible for 3,650 jobs in 2000. This translates into a real disposable income of roughly $131 million earned each year in the state of Nevada.

If the Yucca Mountain facility is approved and licensed, the economic benefits would continue to flow into Nevada as a result of employment and procurement activity. New employment linked to the project is expected to peak during the construction phase at nearly 4,500 jobs. Employment gains will average 2,000 to 2,500 above and beyond the baseline job forecast during the transportation and operations phase. RPI associated with the YMP grows steadily over the years analyzed for each of the five alternative transport routes and varies somewhat over the alternatives. The economic assessment shows that substantial RPI impacts can be expected ranging from about $51 million during the initial construction phase, peaking at roughly $150 million in 2035. Like RPI, GSP impacts are largest during the construction phase. Wages, salaries, and in-state procurement activity are expected to boost state GSP by as much as $228 million during the peak of the construction phase in 2006. Average annual GSP impacts over the transportation and operations phase exceed $102 million annually, topping $127 million in many years.

It is noteworthy that YMP revenues entering the state do now and will in the future lack the cyclicality in associated with Nevada's current primary industry, gaming and tourism. YMP jobs will be concentrated in relatively high-wage industries such as construction, professional services, and engineering. As such, they can provide a steady stream of income to Nevada residents that are largely independent of national and international economic cycles.

We should also note at this point that economic impacts on the state of Nevada included in this report are largely wage and salary based. In other words, we assume that the bulk of the capital, machinery, and construction materials are purchased out of state. This is a reasonable assumption because Nevada currently does not have the manufacturing or production base to supply much of the needed material. Nevertheless, any additional YMP dollars spent in Nevada over and above those considered in the report will generate new spending activity and the economic impacts would undoubtedly be larger than estimated here. Therefore, the numbers we present are likely to be conservative estimates of the true economic impact.

This study also examined the potential economic impacts and social costs of risk arising from transporting waste to the site. Our survey of Nevadans living near the proposed rail-transport routes reveals that there may be an initial housing market impact that has short-lived but significant negative economic consequences. Job losses, relative to the baseline forecast growth of nearly 21,000, are expected to peak in the first year of transport at 3,300. In other words 17,700 new jobs, rather than 21,000, will be created in Nevada in 2010. Housing prices, predicted to rise by about 5 percent in 2010, will see a one-time *decrease* in the growth rate by 1.7 percent with house prices instead growing by 3.3 percent that year. Price growth will return to its previous pace shortly thereafter. GSP impacts will also be observed in the early transport years (2010 – 2011) when GSP will fall short of the expected value of $85.091 billion by just over $400 million. As the population shifts to a more risk-tolerant base, the impact is expected to moderate substantially. During the remaining years, GSP losses are insignificant.

The contingent behavior and conjoint studies are used to get estimates of the WTA and WTP, respectively, of nuclear-waste transport. The estimates reveal that social costs of nuclear-waste transport could be very high if transport routes transect densely populated areas. As a result, convincing the public to allow ongoing transport of high-level nuclear waste may be challenging. Perceived risk of transport is high for both the rail and trucking alternative. The relatively large estimated social costs suggest that public opposition to transport may be strong, particularly in metropolitan areas that do not currently have any on-site temporary storage and therefore have little to gain by moving the waste.

The results of the risk model provide an avenue for mitigating the social costs and reducing local resistance to nuclear-waste transport: reducing the risk that people perceive from transport. DOE education programs can moderate public risk perception if the targeted audience finds the DOE information to be well researched and effectively presented. The importance of the public's perception of the dependability of information cannot be understated. If credibility is compromised, then the DOE information could act to increase the public's perception of risk, undermining the effectiveness of public risk-education programs.

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Appendix A. Description of Data and Assumptions Used in Modeling the Economic Impact of Current YMP Activities.

This appendix identifies the sources of the raw data and the assumptions used to generate the input files for the REMI model of current YMP activities and expenditures on Nevada.

Data Sources

All data other than procurements of goods and services was provided to us directly, upon request, by staff of the Yucca Mountain Project Socioeconomic Monitoring Program (SMP). Data pertaining to YMP procurement of goods and services came from the biennial "Procurement Data Reports" produced by the SMP.

In all cases, this data was presented in terms of time periods that do not coincide with the calendar year.[14] However, REMI model inputs are assumed to be for a calendar year. Therefore, it was necessary to make assumptions about the timing of some of the expenditures. With no other information available, we made the assumption that all expenditures were made uniformly throughout the reporting periods. This allowed us to allocate expenditures spanning calendar years proportional to the number of months in one year, or the other. For example, procurement expenditures for semiannual reporting period October 1, 2000 to March 31, 2001 were allocated equally between those two calendar years. PETTS & taxes paid in Nevada Tax Year 2000 were allocated one half each to calendar years 2000 and 2001.

Procurement Data and Assumptions

The Procurement Data Reports document nominal biennial and annual procurement expenditures in the State of Nevada by 2-digit SIC (Standard Industrial Classification) code, and by region of expenditure. These SIC codes map directly to REMI-EDFS industry spending categories.

Spending was translated into more refined categories where more detailed information was available about the procurements. For example, spending for SIC category 82 (educational services) was allocated to policy variable T200 (colleges and universities). Because spending on university research is substantively different than spending in the more general category "education services", the dynamic feedbacks between the economic and demographic variables result in different economic impacts. This type of refinement, therefore, increases the accuracy of the estimated impacts of the

[14] All data other than PETTS & Taxes presented for federal fiscal years, October 1 - September 30 of said year. PETTS & Taxes presented for Nevada Tax Years (NTY), July 1- June 30 of following year.

procurements. See Table A1, below, for mapping of SIC codes to EDFS industry spending input variables.

Table A1. Map of SIC Categorized Nevada Procurement Spending to EDFS Industry Spending Input Variables.

Policy Variable	SIC	Description
623	15	Building construction-gen contractor
623	17	Construction, special trade contractors
602	25	Furniture and fixtures
617	27	Printing, publishing, and allied industries
620	30	Rubber and miscellaneous plastics prod
603	32	Stone, clay, glass, & concrete products
605	34	Fabricated metal products
606	35	Industral & commercial machinery & comp equip
607	36	Ecectronic equip & compnts, except comp equip
626	41	Local & suburban transit & interurban hwy
625	42	Motor freight transp & warehousing
T214	43	USPS
627	45	Transp by air
629	48	Communications
630	49	Electric, gas & sanitary services
637	50	Whosesale trade - durable goods
637	51	Whosesale trade - nondurable goods
636	52	Building materials, hardware, & mobile homes
636	53	General merchandise stores
636	54	Food stores
636	55	Automotive dealers & gasoline s ervice stations
636	56	Apparel & accessory stores
636	57	Home furniture, furnishing, & equip stores
635	58	Eating & drinking places
636	59	Miscellaneous retail
634	65	Real estate
638	70	Hotels, rooming houses, and other lodging places
639	72	Personal services
642	73	Business services
641	75	Automotive repair, services, & parking
639	76	Misc repair services
644	78	Motion pictures
T198	81	Legal Services
T200	82	Educational Services
648	83	Social Services
648	84	Museums
646	87	Engineering, accounting, research, management
182	91	Executive, legislative, and gen govt, except finance
182	92	Justice, public order, and safety
182	93	Public finance, taxation, and monetary policy
182	95	Admin of environ quality & housing programs

Similarly, an expenditure of the same type and amount in two different regions, whose economies differ by size and makeup, necessarily result in differing impacts. The Procurement Reports' breakdown of the expenditures by regions is identical to those used in the REMI model, allowing for input by region and greater accuracy of the estimated economic and demographic impacts.

A very small fraction of procurement spending in each region lacked enough information to assign it to an SIC code in the Procurement Reports.[15] We distributed these amounts amongst the other procurement categories in proportion to their relative expenditures within that region.

Employment & Wage Data and Assumptions

The employment and wage data provided by the SMP staff was already categorized by the EDFS policy variables used in the REMI model, eliminating the need to make assumptions about this facet of the model. However, we did need to make some assumptions about the wage bill.

YMP wages are generally greater than the average wages paid in the respective labor sectors. An accurate estimation of the Yucca Mountain Project's employment impact on local and state economies therefore requires taking into account this wage bill differential.

Average wages by business sector came from the recalibrated baseline forecast developed by the Center for Business and Economic Research, as described above in Section 3.2. With only one year's YMP wage data available to us, we used the relative difference between YMP wages and business sector average wages that existed in year 2002 as a proxy for wage differentials in the years 2000 and 2001. These values were used to make the appropriate adjustment to the baseline wage bills for the labor sectors directly impacted by YMP employment.

Payments-Equivalent-to-Taxes (PETTS) and Tax Data and Assumptions

The staff of the YMP SMP provided us with summaries of payments-equal-to-taxes (PETTS) and estimated taxes paid by YMP organizations to Clark and Nye counties, and to the State of Nevada.[16] PETTS and taxes were broken down by Nevada Tax Year (NTY), by type of PETT or tax, and by taxing jurisdiction.

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[15] About one percent was not assigned to an SIC for the entire state over the 2000-2001 period. This amount ranged from about .25% to 2.5% by region.

[16] This data came from the "letters and enclosures prepared by the Department of Energy and sent to the counties or Nevada department of Taxation to document the PETT."

The PETTS and taxes are exclusive of each other, and so are treated additively to derive their total direct economic impact to the State and local economies. For the remainder of this section, references to "taxes" means both the PETTS paid by the YMP, and the taxes paid by the YMP organizations.

Because these tax payments are an exogenous infusion of cash from outside the state economy, we modeled them as federal grants to the state and local governments. We did this by inputting them into the model as increases in appropriate state and local government spending categories. This methodology avoids the automatic decreases in private sector spending otherwise implied by increased tax revenues.

The YMP and affiliated contractors pay three general types of taxes; sales and use taxes, property taxes, and the Nevada Business tax. We used a combination of statutory regulations and simplifying assumptions (when regulations were not readily available) to identify the type of government spending and distribution of spending amongst the various state regions. While not perfect, this methodology allows for more accurate estimation than simply dropping all these payments into general government spending categories.

Development of REMI Model Inputs for PETTS & Taxes

Table A2 depicts the allocation of Nevada Business Tax, sales and use, and property taxes into state and/or local governmental spending increases for Clark County. This allocation is generally representative of how these taxes were allocated in the rest of the REMI model regions. Descriptions of the allocations follow.

Table A2. YMP PETTS and YMP Organization Taxes Policy Variable Inputs, and Descriptions: Clark County.

Tax	PV	Description	Detail
NV Business Tax	181	State Govt. Spending (amt)	General
Sales & Use-NRS 372	181	State Govt. Spending (amt)	General
Sales & Use-NRS 374	T332	Local Govt Spending (amt)	Elem. & Secon. Educ
Sales & Use-NRS 377	182	Local Govt.Spending (amt)	General
Sales & Use-NRS 377	182	State & Local Govt Spending (amt)	General
Sales & Use-NRS 377A	T345	State & Local Govt Spending (amt)	Other Commerce & Transp.
Sales&Use-NRS 543	182	Local Govt Spending (amt)	General
Sales&Use-NRS 377B	182	Local Govt Spending (amt)	General
Property Tax	181	State Govt. Spending (amt)	State-General
Property Tax	T336	State Govt. Spending (amt)	State-Indigent Trust
Property Tax	182	Local Govt Spending (amt)	Local-General
Property Tax	182	State Govt. Spending (amt)	Local-Family Court
Property Tax	182	Local Govt Spending (amt)	Local-Co-op. extension
Property Tax	182	Local Govt Spending (amt)	Local-Debt
Property Tax	T335	State Govt. Spending (amt)	Local-Med Asst. to Indigent pop
Property Tax	182	Local Govt Spending (amt)	Local-Capital
Property Tax	T332	Local Govt Spending (amt)	Local-School District
Property Tax	182	Local Govt Spending (amt)	Local-General

Nevada Business Tax: 100% of the Nevada Business Tax goes into the State general fund where it is then distributed throughout the State according to a complex set of statutes, regulations, and formulas.

Utilizing such formulations would be very costly, both in terms of accurate allocation of type and region of spending, and computing time. Furthermore the tax payments are relatively small, and we do not believe that using this information would have a material impact on overall model results.

Because of this and because regional tax distributions are closely related to regional populations, we assume that the regional distribution of these tax revenues is proportional to relative populations. Finally, because these dollars go into the state general fund, it is appropriate to use the state general spending input policy variable 181.

Sales & Use Taxes: The Nevada Department of Taxation web site identifies the sales and use tax rates for each of the counties in Nevada, as well as how those tax revenues are to be distributed and spent[17]. When at all possible, we used this matrix to identify regional tax spending. For example, this web page notes that revenue from the first two percentage points of this tax is earmarked for the state's general fund. We therefore distribute this portion of these taxes in the same manner as described for the Nevada Business Tax. In a similar fashion, we distribute the tax payments earmarked for the Supplemental City-County Relief Tax to the various regions in an amount proportional to their relative populations, and input them as increases in general local government spending (PV 182).

All other portions of this tax are distributed back to the county where the sale was made, and are earmarked for a specific purpose. We used matching detailed governmental spending category input variables when available. Otherwise, spending was allocated to general local government spending increases.

Property Taxes: The YMP and affiliated organizations pay property taxes in Clark and Nye counties. However, as with the other tax bases, much of these tax revenues are distributed throughout the state. While the Clark County Government Services web site[18] provides detailed information about property taxes paid in this county, no such information was readily available for Nye County.

All eighty-four tax districts in Clark County pay a minimum base rate of 2.0886% of assessed value. In addition, tax rates amongst the 84 districts vary depending on the type of additional services provided in each area. The average tax rate paid by all 84 districts is 2.7767% of assessed value. We took the simple average of the differential above the base, and allocated that amount to general local governmental spending.

Rather than allocate all property taxes paid in Nye County to general state and local government spending increases, we assume that the property tax structure in this county is identical to that in Clark County. We base this assumption on the fact that property taxes are the major funding source of county government services and local school districts, and so are likely to be similarly structured from county to county.

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[17] http://tax.state.nv.us

[18] http://www.co.clark.nv.us/finance/TaxBreakdown.htm

Set Asides Data and Assumptions: DOE personnel also provided us with data for fiscal year set-asides[19]. These expenditures include monies (1) spent at the U.S. Bureau of Reclamation (BOR) office in Boulder City, Clark County that are related to the YMP project, (2) spent on the Nye/Inyo County drilling program, (3) spent on Information Management Services at Clark County DOE facilities, and (4) granted to the State and counties for external oversight programs.

As with procurement expenditures, these fiscal year values were translated to calendar years using the assumption that the set-aside payments and consequent spending were uniform throughout the year.

U.S. BOR spending was modeled as an increase in federal civilian spending in Clark County. Consistent with earlier modeling of well drilling as part of the construction efforts for the railroad transportation alternatives, spending on the Nye/Inyo County drilling program was modeled as increased sales output in the miscellaneous professional services sector.[20] Information Management Services spending reflects contracting for video services at Clark County DOE facilities. We model this as an increase in the sale of motion picture services within Clark County.

General state government spending (PV 181) of the State AULG (external oversight) funds was distributed over all regions receiving direct AULG funds in proportion to their relative populations. Finally, spending of AULG set-aside payments to the various local governments is best reflected by increases in general local government spending (PV 182).

[19] This data came to us in the form of a spreadsheet. The cited source is "The Fiscal Year September DOE Management Analysis Reporting System (MARS) Status of Obligational Authority Reports".
[20] REMI Input Documentation Report Number 7, Section 3.1.