1.0
INTRODUCTION

The analysis which follows projects and examines, for alternate Sites 1 and 23, the socioeconomic impacts of the construction and operation of the Crow synfuels facility and incremental coal mining operations. As a primer to interpreting and evaluating these impact analyses, this introductory section provides a review and critique of the "state-of-practice" socioeconomic impact assessment methodology. The effectiveness of "state-of-practice" methods are evaluated using a recent comparison of the forecasts prepared by others in different impacted communities to the impacts that were found—retrospectively—to have actually occurred in those communities. The reasons for divergencies between actual and forecasted impacts have been identified and appropriate modifications made to the procedures used to project the socioeconomic impacts associated with the Crow synfuels facility. The final part of this introductory section describes briefly these changes and the general methodological approach used in this investigation.

1.1 SOCIOECONOMIC IMPACTS AND IMPACT FORECASTING

For purposes of this study, socioeconomic impacts are those alterations in the social, economic, and institutional conditions of a community, area, or region produced by externally imposed growth from major energy or industrial development projects. Such projects have the potential to alter normal growth and growth accommodation patterns by introducing new income and consequent economic activity into their host communities. While normally perceived as beneficial, such changes from externally imposed growth becomes disruptive when the rate and magnitude of this growth exceed the capacity of the public and private institutions and infrastructures to accommodate. Thus, adverse impacts from major energy or industrial projects are most likely to be experienced in small, rural areas lacking a diversified economic base.

Socioeconomic impact analysis is the name given to the process of forecasting the rate and magnitude of imposed growth and the effects of this growth on social, economic, and institutional conditions of the host area. This process can best be explained by examining the paradigm most frequently followed in impact analysis. Figure 1.1-1 presents in highly abstracted form the general analytical framework used to project the socioeconomic impacts (both positive and negative) resulting from industrial or energy projects on hosting communities. As the paradigm illustrates, the forecasting process begins with the direct employment requirements of the project. These are the jobs created directly by the construction and operation of the project's facility or facilities. Direct employment is the key independent variable in the forecasting process. From these exogenously provided data, all other growth and impact effects are estimated.

Most forecasting methods are grounded in economic base theory. Reduced to its essence, this theory asserts that the growth of an area depends upon the growth of its export sector. The implication is that the expansion of economic activities marketed outside the region is the driving force behind growth within the region. Thus, as Richardson points out, an increase in the economic base of the region (i.e., all exportable goods and services produced therein) sets off a multiplier process of

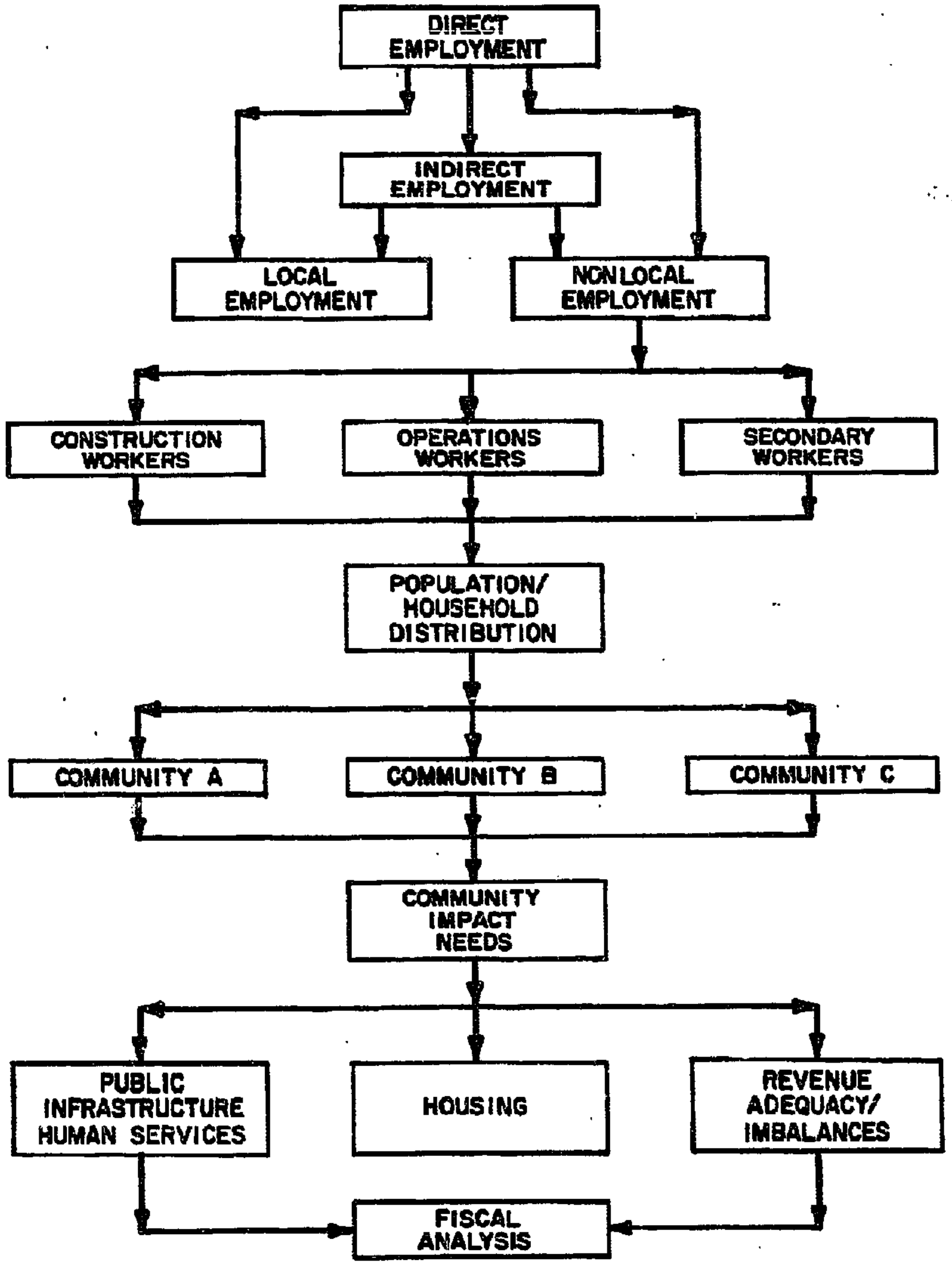

FIGURE 1.1-1

IMPACT PARADIGM

growth within the local or secondary sectors of the area's economy (Richardson 1969). (Reference 7) Following this theory, analysts of socioeconomic impacts typically attempt to quantify multipliers expressing the relationship between a measure of increased basic economic activity (e.g., direct employment) and increased local economy activity (e.g., secondary sector jobs). Using these multipliers and the number of direct (basic) jobs created by the project, the number of retail, commercial, and service sector jobs in the local area are estimated.

Given the number of basic and secondary jobs expected, the next step in the forecasting process is to determine the number of persons within commuting distance of the project who are available and willing to fill these jobs. Although the methods used to estimate the size of this local work force vary considerably, it is generally assumed that these local workers will be hired first. The number of direct and secondary positions generated by the project are reduced by the number of locally available workers. Those jobs not filled locally are assumed to attract in-migrating workers and their families. Thus, the impact of the project on the growth of the area's population is a result of the attraction provided by the unfilled direct and secondary jobs. Using a variety of assumptions, the demographic characteristics of this new population are estimated and these newcomers are "assigned" to the surrounding communities.

Given the estimated growth and change in the populations of these communities over time, the next step in the forecasting process is to evaluate the effects of this growth on the public infrastructures and institutions of their host communities. Most typically, this is done by forecasting the effects this growth will have on the demand for housing and publicly provided services and facilities. In the most rigorous analyses, the costs of providing the needed increased public services and facilities are projected and compared to expected increases in public revenues from the project and the project-related demographic and economic growth. Conveniently, the infrastructure and institutional effects of imposed growth are reduced, in these studies, to a single dollar value expressing the positive or negative difference between the incremental public revenues and expenditures attributable to the project.

1.2 A CRITIQUE OF SOCIOECONOMIC IMPACT FORECASTS

The general impact forecasting procedures described in Section 1.1 were developed in the early 1970s in response to the requirements of the National Environmental Policy Act (NEPA). NEPA required that the effects of major developments on their human and physical environments be assessed. Throughout much of the decade, considerable attention was given to the construction and improvement of large, computerized models designed to forecast these impact phenomena (Stenehjem and Metzger 1976; Stenehjem 1978). (Reference 9, 11) These models and their algorithms for projecting demographic and economic changes are still relied upon to forecast the socioeconomic effects of site-specific and programmatic Environmental Impact Statements. Unfortunately, while attention continued to be focused on building increased sophistication into these analytical tools, almost no effort was expended in looking retrospectively at how well these procedures had performed in the areas experiencing rapid, imposed growth.

One of the first attempts to examine whether the impacts actually experienced bore any resemblance to those forecasted to occur was the retrospective study conducted by the Denver Research Institute. In this study, 12 communities from Maine to California that had hosted the construction of power plants and for whom projections had been prepared of the likely socioeconomic effects were examined retrospectively. In this study the forecasted impacts were compared to those that actually occurred in an effort to discover whether the forecasting methods were adequate and to suggest changes in the methodologies where weaknesses were observed.*

*A second retrospective study was undertaken by Mountain West Research, Inc., at about the same time the DRI study began. Results from this study—sponsored by the Nuclear Regulatory Commission—are not yet available publicly. These two studies represent the only formal and comprehensive retrospective analyses that the authors of this assessment are aware of.

Among the general conclusions to emerge from this study are the following:

many forecasts of socioeconomic impacts define too narrowly the positive and negative impacts that accompany energy development; and

many socioeconomic impact forecasts measure too imprecisely those impacts that are addressed (a complete discussion of these points can be found in: Stenehjem 1981). (Reference 10)

Briefly summarized, many of the errors observed in the forecasts of socioeconomic impacts are directly traceable to errors in the estimates of direct manpower requirements. As mentioned in the preceding discussion, estimates of direct manpower are provided by the architectural and engineering firms; they represent the key independent variable used in socioeconomic impact forecasting. Table 1.2-1 illustrates the estimated and actual peak direct employment requirements for 15 power plants across the country. Although there is wide variation in the accuracy of these estimates, on average they understate the peak employment requirements at these sites by 60 to 70 percent.*

When the key independent variable is underestimated, estimating errors can be expected in all other variables as well. For example, an understatement of direct employment requirements leads to an underestimation of indirect employment, in-migration and population, and the impacts of growth on community infrastructure and institutions. Fortunately (or unfortunately), errors in direct employment are not the only problems with forecasting methods.

*These 15 power plants do not constitute a representative or probability sample of impact sites across the country. Thus, these data do not support the conclusion that manpower estimates are either always or even typically understated by these magnitudes. It must also be pointed out that the original forecasts of impacts at these sites were prepared by different firms and individuals using different methods, data, and assumptions.

Even though direct employment tends to be underestimated, estimates of indirect employment opportunities are often overstated. Employment multipliers expressing the relationship of local secondary jobs to basic (direct) jobs are often computed by simply dividing the number of secondary jobs in an area by the number of basic jobs in that area at a point in time. In many instances the quotient obtained is 2 or higher. Multipliers of this scale can be in error by an order of magnitude. There is evidence to suggest that the number of secondary jobs resulting from imposed basic employment will be far below that estimated using a simple ratio multiplier. In general, multipliers of 0.1 to 0.5 (indicating that for every 10 new basic jobs created, one to five secondary positions are created) are more realistic—especially during the period when the facility is being constructed.

Another problem has been observed in the estimation of in-migration. In general, forecasters have assumed that a much larger proportion of the jobs directly created by the project will be filled by local workers than actually are. Thus, forecasts of the number of in-migrants and consequent population growth tend to be overstated. Reasons for these errors are discussed in more detail below.

Finally, many of the socioeconomic impact forecasts examined tended to overstate the impacts that actually occurred because it was assumed that the in-migrating workers and their families would choose to live in the communities closest to the site of the project. In fact, many people were found to be willing to commute long distances to work in exchange for living in larger, outlying communities. It was also observed that a larger proportion of in-migrating construction workers than assumed would live in temporary quarters and return to their families and permanent residences on weekends.

Given the general nature of the problems found in the estimates of the independent and dependent variables in the forecasting process, it is conceivable that estimates of population change and infrastructure impacts may be generally correct but for all the wrong reasons. Given the findings from the retrospective study, greater care and attention must be given to estimates of direct employment, the size of employment

TABLE 1.2-1
ACTUAL VS. PROJECTED PEAK MANPOWER REQUIREMENTS AT 15 FACILITIES

Facility	Type	State Location	Actual Peak	Projected Peak	Difference	%
Coal Creek	Coal	ND	2,113	980	1,133	115
Clay Boswell	Coal	MN	1,560	900	660	73
Boardman	Coal	OR	1,482	760	722	95
Laramie River	Coal	WY	2,609	2,076	533	26
Fayette	Coal	TX	867	584	283	48
Bellefonte	NUC	AL	4,350	2,300	2,050	89
Wyman	Coal	ME	680	675	5	0.7
San Onofre	NUC	CA	4,000	3,120	880	28
Coronado	Coal	AZ	2,613	1,660	953	57
Cholla	Coal	AZ	1,423	500	973	195
Antelope	Coal	ND	1,370	840	530	63
Coyote	Coal	ND	1,060	1,020	40	4
Jim Bridger 1 & 2	Coal	WY	3,200	1,200	2,000	167
Jim Bridger 4	Coal	WY	954	1,700	(746)	(44)
White Bluff	Coal	AR	1,900	1,100	800	73

NOTES:

Error Range: 44% overestimation to 195% underestimation.

Mean Error: 70% underestimation.

Median: 60% underestimation.

Source: (Stenehjem, 1981) (Reference 10) multipliers used, the number of jobs not likely to be filled by local workers, and the likely settlement patterns and housing requirements of the new population.

In addition to finding errors in the data and methods of "state-of-practice" impact forecasts, it was also observed that the socioeconomic projection process fails to consider a number of important underlying phenomena associated with imposed growth. Figure 1.1-1 shows that the projection process focuses on demand-side problems; the emphasis is clearly on estimating:

how many new jobs,

how many new people,

how many new dwellings, and

how many new schools, police cars, firemen, etc.

What is being ignored are important supply-side issues relating to how these demands are likely to be met. Perhaps the most important supply-side issue associated with imposed growth concerns the functioning of the labor market. Two issues are of importance in understanding the functioning of this market. First, labor is a highly differentiated commodity that permits less substitutability than is generally recognized. Second, labor markets are not perfectly functioning mechanisms but require adjustment periods in meeting demands.

Many forecasts of socioeconomic impacts appear to regard labor as a homogeneous commodity with workers differentiated only with respect to whether they construct the facility, operate the facility, or work in secondary retail, commercial, or service-oriented jobs. Manpower, of course, is not homogeneous within these categories. The construction of a major energy facility requires a complex scheduling of bricklayers, pipefitters, boilermakers, carpenters, electricians, and workers with other skills. For example, bricklayers cannot be substituted for or replace electricians, and, on a union job, nonunion electricians cannot be used.

While this requirement may appear simple to many people, it is not well enough understood to have been incorporated in many forecasts of socioeconomic impacts. Too often, differences in skills and union affiliations are ignored in making projections of how many local persons will find employment in the construction or operation of these facilities. As indicated in the explanation of the socioeconomic forecasting process, it has been assumed that these jobs will be taken first by local people who are either unemployed or not currently in the labor force without consideration given to their skills or union affiliations. Such practices, arising from a failure to consider manpower supply-side issues, result in understatements of in-migration and the normal turnover (in- and out-migration of the different crafts or professions) of the work force. It also leads to unrealistic expectations on the part of local workers who are led to believe that they will be employed in these positions.

A second supply-side issue relating to the functioning of labor markets is the assumption that, as soon as a need for workers arises, it will be met automatically and instantaneously. What is overlooked is that the adjustment of supply to demand does not always occur immediately or smoothly. In general, the following conditions tend to prolong the adjustment process:

when development occurs in remote, sparsely settled areas;

when the pace of development is rapid;

when the scale of the development is large in relation to the surrounding area and its economic base;

when there is considerable uncertainty surrounding the project; and

when the adverse socioeconomic impacts accompany the project.

A failure to anticipate the occurrence of adjustment rigidities in the labor market can lead to understatements of both the length and severity of growth impacts in an area.

As this brief critique has attempted to demonstrate, state-of-practice socioeconomic impact forecasts suffer from data problems and inappropriate assumptions, many of which arise from a failure of the projection process to evaluate important supply-side issues. To the extent possible, the lessons learned from the retrospective studies of actual and forecasted impacts are incorporated in the assessment of the socioeconomic impacts accompanying the construction and operation of the proposed Crow synfuels facility.

1.3 AN OVERVIEW OF THE PROJECTION PROCESS FOR FORECASTING THE SOCIOECONOMIC IMPACTS OF THE CROW SYNFUELS PROJECT

The general framework described in Figure 1.1-1 is followed in the assessment of the impacts associated with the Crow project. However, in recognition of the special demand and supply-side problems associated with manpower projections, this assessment:

- uses alternate scenarios of labor requirements to indicate the effects on growth and growth-related impacts of different levels of direct employment;

- describes the labor requirements in terms of their skill or occupational categories;

- assesses the availability (and employability) of local workers with respect to their union affiliations and skills.

With respect to the estimation of the secondary jobs created as a result of the economic stimulus provided by the project, this analysis:

- avoids the use of simple ratio multipliers;

- uses a lag procedure to better replicate the dynamic nature of how such secondary jobs arise over time; and

- avoids assuming that the relatively low-paying jobs in the retail trade and service sectors will attract significant numbers of in-migrants.

Other modifications in the data and the methods described in the impact paradigm of Figure 1.1-1 include the use of carefully constructed assumptions concerning the likely settlement patterns of in-migrants and an analysis of the current capacities of the infrastructure in the areas likely to host the increased population. While the forecasting procedures used here have benefited from observations of errors in "state-of-practice" methods, they are still a projection of future events and as such are subject to alterations in the underlying assumptions. Thus, for example, if delays are experienced in the scheduled construction of this project (as a result of litigation, materials shortages, work stoppages, or other uncontrollable factors), these forecasts will have to be modified accordingly. The results of the analysis of the impacts from the Crow synfuels project are presented in the following sections. Each section corresponds to a major element of the impact forecasting process.

Section 3.0 describes the employment impacts of the project. In this section, the direct employment requirements by period and skill are described and alternative scenarios are presented. This section also includes an assessment of the availability of the local and commuting work forces with the appropriate skills. Finally, a description of multiplier estimation and lag procedure and the estimates of secondary jobs are presented. Section 4.0 presents the population impacts associated with the project. Included here are the estimates of the number and characteristics of the in-migrating population. This section also addresses the issues of the likely settlement patterns of this new population. Section 5.0 describes the levels of currently available infrastructure in the surrounding jurisdictions and an analysis of likely capacity expansion requirements given the project-related increases in the populations of these jurisdictions. Section 5.3 describes the estimated costs of increasing public facilities and services and estimates of the incremental project-related revenues available to meet these expenditure needs. The section concludes with an assessment of the incremental revenues less expenditures associated with project-related growth. Section 6.0 contains study conclusions and recommendations.

2.0
SUMMARY

The socioeconomic impacts of the Crow gasification plant were analyzed by modifying the "state-of-practice" framework presented in Figure 1.1-1 to reflect the most recent improvements in state-of-the-art forecasting methods. The analysis begins with an evaluation of the manpower requirements arising from the construction and operation of the facility. To obviate the problems associated with the use of point estimates of construction manpower demand, the scenarios were developed to provide a range of employment needs.*

Following the estimation of the annual "peak" and "average" scenario construction, plant operation, mine operation, and secondary employment requirements, the availability of local Crow and non-Crow workers with appropriate skills to fill these jobs was analyzed for Site 1 and Site 23. As a part of this analysis, estimates were made of the number of jobs that would be taken, by year, by the Crow work force; the numbers of jobs likely to be filled by non-Crow workers residing within commuting distance of Site 1 and Site 23; and the numbers of workers that would have to in-migrate to these sites to fill the remaining construction, operating, and secondary positions.

The estimates of the annual in-migrating work force provided the foundation for assessing the population impacts that the gasification plant would have on the communities within commuting distance of Site 1 and Site 23. The number of newcomers (in-migrating workers and their household members) to both sites were estimated for both the peak and average employment requirement scenarios. In addition to the number of dependents in each in-migrating household, estimates were

*The use of the scenarios to describe the range of manpower needs was proven to be well-founded. In late May 1982, after the socioeconomic analysis was virtually completed, a set of revised employment estimates were received which exceeded—in some periods—the levels of construction demand used in the "peak" scenario. These estimates are presented in Appendix C-4. They can be compared to the original estimates of manpower needs presented in Appendix C-5.

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made of the number of potential secondary workers likely to be provided by each of these households.

Given the impact on the populations of communities in the Site 1 and Site 23 areas, estimates were constructed of the impacts these newcomers would place on the demands for increased public and private facilities and services. From these figures, estimates were prepared of the likelihood that project-related growth would "pay its own way" in each of the areas. This involved comparing the estimates of the increased capital and operating costs of expanding public facilities and services to meet the needs of the new populations to the estimates of incremental public revenues contributed by the newcomers.

2.1 EMPLOYMENT EFFECTS

The direct and secondary work force requirements associated with the peak scenarios for constructing and operating the Crow synfuels facility and expanding nearby coal production facilities are summarized in Table 2.1-1. Omitted in this summary table are the differences in the skill requirements of these workers. These differences were explicitly considered in the supporting analyses of labor requirements and availability. As the table illustrates, the total employment requirements associated with the Crow synfuels facility rise rapidly to a peak near the end of the plant construction period. In succeeding years, the employment requirements quickly stabilize at a level roughly one-third of that expected in 1988.

The availability of local workers to fill these positions without having to change their residences was estimated by analyzing the number of Crow and non-Crow workers with the required skills at each site. Table 2.1-2 presents the estimates of the number of jobs filled by local workers under the peak employment scenario.

In constructing these estimates, it was assumed that the Crow workers possessing the necessary skills would be given preference in hiring. It was also assumed that the Crow workers with experience as construction laborers experience would be permitted to qualify for apprenticeship positions if too few "laborer" positions were available to accommodate them. Finally, it was assumed that as many as 174 Crow workers would qualify for plant operating jobs if an intensive 18-month training program were instituted prior to the completion of plant construction.*

*The first two assumptions are based on the strict application of the "Indian Preference" rule relating to employment. The expectation that 174 Crow workers would qualify for operating positions is based upon an analysis of the qualifications of actual Crow applicants to the Tribal Rights Employment Office.

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TABLE 2.1-1
SUMMARY OF EMPLOYMENT REQUIREMENTS

Year	Plant Construction	Plant Operations	Mine Production	Local Secondary	Annual Totals
1985	793			141	934
1986	2260			435	2695
1987	3350			706	4056
1988	3503			816	4319
1989		750	180	567	1497
1990		750	180	511	1441
1991		750	180	480	1410
1992		750	180	464	1394
1993		750	180	464	1394
1994		750	180	464	1394
1995[a]		750	180	464	1394

[a]The employment figures for following years should be the same as for 1995.

TABLE 2.1-2
NUMBER OF POSITIONS FILLED BY LOCAL EMPLOYEES AT EACH SITE

	Site 1					Site 23				
	Construction		Operation		Secondary	Construction		Operation		Secondary
	Crow	Non	Crow	Non	Total	Crow	Non	Crow	Non	Total
1985	324	321		90	141	324	32			108
1986	385	1193		90	435	385	33			208
1987	385	1192		90	706	385	103			534
1988	384	972		90	816	384	57			734
1989			264	90	567			264	90	567
1990			264	90	511			264	90	256
1991			264	90	480			264	90	320
1992			264	90	464			264	90	307
1993			264	90	464			264	90	307
1994			264	90	464			264	90	307

2.2 POPULATION EFFECTS

Given the estimates of the availability of local workers to fill the jobs created at Site 1 and Site 23, the number of in-migrating workers needed to fill the remaining positions was determined. Assuming that the average number of dependents per in-migrating construction worker household would be approximately 1.9 and that other in-migrating workers would have household sizes roughly equivalent to those of existing residents, the population effects of the Site 1 and Site 23 in-migrating work forces were estimated. The results—for the peak employment scenario—are summarized in Table 2.2-1.

Although Billings (Yellowstone County) is approximately 20 highway miles farther than Hardin from Site 1 (Big Horn County), it is assumed—based on recently acquired evidence from the Denver Research Institute's retrospective study of energy impacted communities--that the vast majority of in-migrating families will choose to live in and around Billings because of its size, amenities, and housing. The table reflects the effects of assuming that 90 percent of the newcomers to the Site 1 facility choose to live in or near Billings in Yellowstone County. As indicated, the relative population effects (the proportion of the total population of both counties made up of project-related newcomers) in the two counties are quite similar. Applying the generally accepted rule of thumb that additional growth of less than 7 to 10 percent/year usually can be accommodated without precipitating adverse impacts, neither Yellowstone nor Big Horn counties is likely to be significantly affected by the presence of the synfuels facility. If all the in-migrants were to settle within the limits of Billings and Hardin, the impact threshold would only be exceeded in Hardin and only during the period of greatest construction activity.

The same is not true for Sheridan County. With the city of Sheridan being the only major population center within reasonable commuting distance of Site 23, it is expected to host almost the entire in-migrating project-related population. The effect, as presented in Table 2.2-1, is exceeded in Sheridan County by a factor of two during the major construction period and almost reached in each of the succeeding years. If a majority of these project-related newcomers choose to settle

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TABLE 2.2-1
ESTIMATED POPULATION INCREASES AT SITES 1 AND 23

	Site 1 Counties				Site 23 Counties	
	Big Horn		Yellowstone		Sheridan	
Year	No.	%	No.	%	No.	%
1985	28	0.23	253	0.21	907	3.3
1986	130	1.07	1166	0.96	4103	14.6
1987	337	2.73	3032	2.44	5957	20.6
1988	407	3.25	3665	2.90	6093	20.6
1989	181	1.42	1628	1.26	2242	7.4
1990	181	1.40	1628	1.24	2375	7.7
1991	181	1.38	1628	1.22	2161	6.9
1992	181	1.36	1628	1.20	2162	6.8
1993	181	1.34	1628	1.19	2162	6.7
1994	181	1.32	1628	1.17	2175	6.6
1995	181	1.30	1628	1.16	2187	6.6

in the city of Sheridan, they possibly will represent 10 percent or more of the city's total population throughout the construction and plant operation periods.

2.3 INFRASTRUCTURE AND FISCAL EFFECTS

Given the number of newcomers expected in the communities and areas surrounding Sites 1 and 23, estimates were prepared of their demands for public and private sector facilities and services such as housing, health services, water and sewer facilities, police and fire service, educational facilities and services, and others. The additional costs of providing the public services and facilities projected to be required to accommodate this increased growth were estimated using cost factors prepared for the U.S. Department of Energy (see Appendix C-3, Summary of Community and Fiscal Impact Factors). In conducting the analyses of public costs, the capital costs were assumed to be met through the issuance of either revenue or general obligation bonds. The annual costs of servicing this debt were added to the estimated annual operating costs of increasing service levels.

In contrast, the increased revenues from property and—in the case of Sheridan and Sheridan County—sales taxes associated with the increased populations and economic activities in these areas were also estimated. The net public fiscal effects were estimated by subtracting the expected costs of accommodating the needs of the new populations from the incremental public revenues directly and indirectly contributed by the newcomers. The results for Billings and Hardin (Site 1) and Sheridan (Site 23) are presented in Table 2.3-1.

These figures are only rough estimates of the actual net fiscal balances likely to be experienced by the host communities. They do not reflect existing excess capacities in the people-serving infrastructures of these communities nor do they reflect all possible sets of expenditure requirements or revenue sources. However, even though they may not measure precisely the actual dollar effects of growth, they do illustrate, for similar revenue and expenditure items, the relative fiscal effects of growth in each community. Just as importantly, they indicate the relative degree to which each community is likely to be adversely impacted by the synfuels facility.

When rapid growth is imposed on a community, the demands for private and public services are correspondingly increased. If the demands for private-sector goods and

TABLE 2.3-1
NET PUBLIC FISCAL IMPACTS

Location	Annual Revenues	Operating Expenses	Debt Service	Net Fiscal Balance[a]
Site 1				
Billings	$1,952,287	$2,104,397	$2,114,538	-$2,266,648
Hardin	698,273	233,966	235,093	+229,214
Site 23				
Sheridan	2,010,530	2,826,976	2,840,600	-3,657,046

[a]These figures are for the operations period when the project-related populations have stabilized.

services are not met, the consequence is generally localized inflation with the distribution of scarce goods going to those with the greatest ability to pay. The people likely to suffer most under these conditions are those on fixed incomes and/or those who do not directly benefit from the growth-producing process. When the demands for publicly provided goods and services are not met (due to a shortage of public capital and revenues), the consequence is that there is less for everyone. As observed by Gilmore in his seminal study of boom towns, such shortages lead to frustrations on the part of local and in-migrating populations with the effect that the productive members of both groups leave (Gilmore and Duff 1974). (Reference 5) This results in high turnover and lower productivity in both the basic and secondary sectors. This reduced productivity leads to further declines in the provision of public goods and higher costs in constructing and operating the growth-producing facility. With an annual wage bill of $70 to 100 million in both the third and fourth years of plant construction (see Table 2.1-1), a reduction in worker productivity of 30 percent due to impact precipitated turnover carries a price tag of $21 to 30 million.

The likelihood that such conditions might arise at Site 23 is significantly greater than at Site 1. As illustrated in Table 2.3-1, nonconstruction growth is expected to "pay its own way" in Hardin. With Billings hosting 90 percent of the in-migrating population, a deficit of $2.3 million is expected in each year of plant operation. This represents just over 5 percent of the total 1980 revenues collected by Billings. In Sheridan, the net annual contributions to the community's deficit is expected to be just over $3.6 million during the operating period. This represents more than 30 percent of the city's 1982 budget of $11.5 million. Thus, when viewed as a proxy of impact severity, the figures in Table 2.3-1 suggest that, unless the Crow synfuels facility underwrites a sizable proportion of the infrastructure requirements, Sheridan may experience significant shortages in the provision of public facilities and services. As determined by generalizing from Gilmore's findings, the effects of these shortages may increase substantially the direct costs of construction and operating the facility at Site 23.

3.0
EMPLOYMENT EFFECTS

The employment effects of constructing and operating the Crow synfuels facility are dependent upon the following factors:

(1) the number of direct (project-related) jobs and their skill requirements over time;

(2) the number and timing of secondary jobs created in the retail, commercial, and secondary sectors of the area; and

(3) the availability of Crow and non-Crow employees within commuting distance of the project having the skills required to fill these jobs.*

*In the presentation of the estimates which follow the number of direct and secondary jobs created and the availability of Crow and non-Crow workers to fill them, the data imply considerable precision since the figures are not rounded. It should be recognized that these figures are only estimates and should not be interpreted as being precise to the individual unit (or person) level.

3.1 DIRECT EMPLOYMENT REQUIREMENTS

Estimates of the construction work force requirements by skill were prepared by Fluor Engineers and Contractors, Inc. Under their assumptions, construction would begin in January, 1986 with completion scheduled for March, 1989. The construction activity over this 39-month period is expected to require 15.8 to 16.6 million direct field man-hours and approximately 22 million total field man-hours of effort.

Table 3.1-1 presents the average quarterly employment requirements, by skill, for the construction of the synfuels facility. The last line of this table shows the average annual requirements in contrast to the average quarterly requirements. This comparison is more dramatically illustrated in Figure 3.1-1 which shows that construction employment fluctuates considerably on a quarterly basis—a phenomenon that would not be observed using annual data only. Thus, in year three (1987), the average number of employees required throughout the year is 2,619. However, the average number of workers required each quarter fluctuates between 3,350 and 1,940 workers.

Table 3.1-2 summarizes the sustained average and temporary peak number of construction workers required by year. In the analyses which follow, both sets of figures will be used. As indicated in the Introduction, the estimates of construction employment provided by contractors have been considerably understated, even for well-known technologies such as coal-fired power plants. While these estimates result generally from unanticipated events such as strikes, material shortages, litigation, and other delays, they are nonetheless troublesome. Thus, in the analyses which follow, two scenarios of construction employment requirements are used. The first assumes that the estimated annual average requirements will be met. The second assumes that the peak work force requirements—the level of employment reached for one short period during the year—will be sustained throughout the year. Scenario 1 in Table 3.1-2 uses a construction work force estimate of 456 while Scenario 2 assumes an annual construction work force of 793. The effects on secondary employment and population growth are forecasted using both sets of estimates.

TABLE 3.1-1
SIZE AND SKILL CHARACTERISTICS OF THE CONSTRUCTION WORK FORCE BY QUARTER FROM MAY 1985 THROUGH DECEMBER 1988

DESCRIPTION	1985			1986				1987				1988			
	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Boiler Makers	—	—	—	—	—	84	123	179	190	273	193	133	193	67	—
Bricklayers	—	—	—	—	1	5	7	—	6	10	—	—	—	—	—
Carpenters	7	66	206	216	224	267	245	216	142	133	90	92	177	150	13
Cement Finishers	1	4	6	8	18	42	35	30	26	21	7	—	30	10	—
Electricians	6	50	138	148	95	77	100	100	149	300	208	170	250	108	—
Insulators	—	—	—	—	—	—	—	14	93	105	87	52	267	367	—
Ironworkers	2	13	138	40	50	101	153	158	218	265	200	160	210	67	—
Laborers	18	72	169	180	296	389	288	227	231	230	213	217	225	220	24
Millwrights	—	—	—	—	—	78	125	163	170	235	195	143	210	50	—
Operators	59	75	22	28	63	119	87	97	117	163	80	73	100	70	—
Painters	—	—	2	2	—	—	—	—	52	83	37	13	180	350	12
Pipefitters	5	29	50	62	133	270	270	265	474	600	533	433	550	217	—
Pipefitters - Welders	—	—	—	—	—	95	95	96	177	227	200	175	200	59	—
Oilers	3	11	17	22	50	32	22	23	26	38	17	17	23	13	—
Teamsters	18	38	37	47	111	120	67	35	60	77	47	45	75	75	6
Nonmanual	8	37	49	53	70	105	150	137	262	347	327	277	343	278	47
Supervision	25	38	50	75	123	200	200	200	200	200	200	200	200	175	43
TOTALS	150	434	783	883	1250	1983	1907	1940	2593	3350	2634	2200	3233	2267	172
AVERAGE ANNUAL TOTALS		456			1521					2619			1968		

TABLE 3.1-2
PEAK AND AVERAGE CONSTRUCTION
REQUIREMENTS BY SKILL IN EACH YEAR

	1985 Year 1		1986 Year 2		1987 Year 3		1988 Year 4		Average Hourly Wages by Skill (1980)[a]	Personal Income Effects in Year 3[b] ($$10^3$)
	Peak	Average	Peak	Average	Peak	Average	Peak	Average		
Boiler Makers	—	—	123	52	273	209	193	98	$15.25	$ 7,803
Bricklayers	—	—	7	3	10	4	—	—	14.00	137
Carpenters	206	93	267	238	216	145	177	108	11.93	4,285
Cement Finishers	6	3	42	26	30	21	30	10	11.71	602
Electricians	138	65	148	105	300	189	250	132	14.40	6,663
Insulators	—	—	—	—	105	75	367	172	11.71	2,150
Ironworkers	38	18	153	86	215	210	210	109	14.11	7,254
Laborers	169	86	389	288	231	225	225	172	9.09	5,007
Millwrights	—	—	125	51	235	191	210	101	11.71	5,476
Operators	75	52	119	74	163	114	100	61	13.52	3,773
Painters	2	1	2	1	83	43	350	139	10.02	1,118
Pipefitters	50	28	270	184	600	468	550	300	15.60	17,874
Pipefitters-welders	—	—	95	48	227	175	200	106	15.73	6,739
Oilers	17	10	50	32	38	26	23	13	11.71	745
Teamsters	38	35	120	87	77	55	75	50	11.71	1,577
Nonmanual	49	31	150	95	347	268	343	249	11.71	7,683
Supervisors	50	38	200	150	200	200	200	155	—	—
TOTALS	793	456	2260	1521	3350	2619	3503	1988		$72,173

[a]These data were obtained from the U. S. Department of Labor, 1980.
[b]The hourly wage rates were assumed to increase by 10 percent between 1980 and 1981 and by 7 percent between 1981 and 1982. The personal income estimates are thus expressed in constant 1982 dollars.

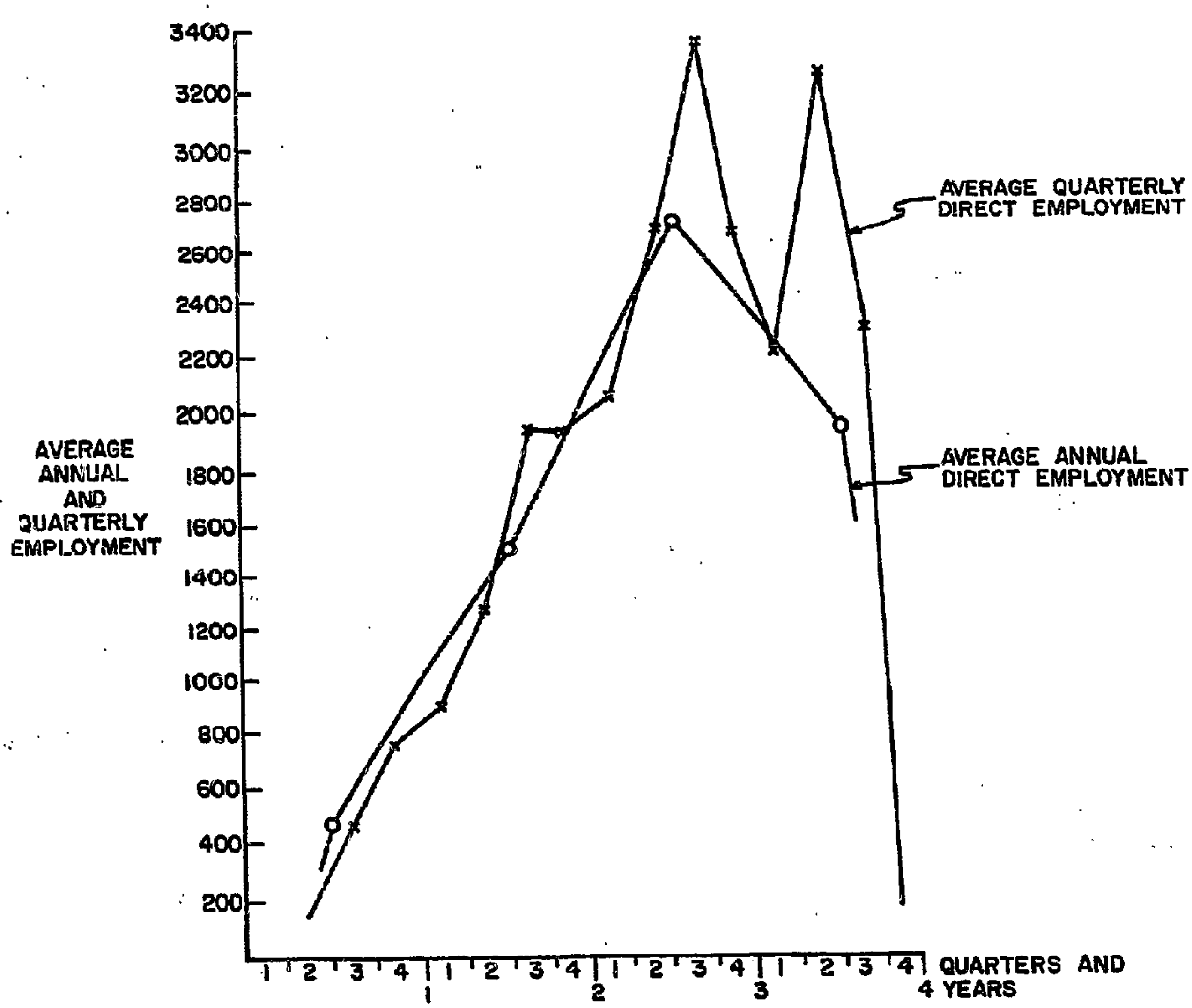

FIGURE 3.1-1

GRAPH OF AVERAGE ANNUAL AND QUARTERLY DIRECT EMPLOYMENT

Table 3.1-2 also presents the average union wages associated with each skill in the Billings, Montana, area in 1980 (see Appendix C-1). When these figures are inflated to 1982 dollars, the final column presents estimates of the wage bill for facility construction (less supervisory personnel) in 1982 dollars for the third year of construction assuming Scenario 1 levels of employment. The total wage bill is estimated to be more than $72,000,000 in 1982. These dollars, because they are imported into the region, can be expected to have a significant effect on the local economy of the area through the spending of these employees. It must be pointed out that the increase in personal income will be less than this figure, however. The reasons for this are that (1) a portion of the in-migrants will maintain residences elsewhere and continue their major spending in those areas and (2) some of the local workers will take construction jobs and vacate their previous positions. Thus, the net effect on personal income will be the difference between their previous earnings and their wages at the facility.

Still, some amount of the new (i.e., imported) wages will be available for spending and respending in the local area, increasing the demand for locally supplied retail, commercial, and service sector items. This increase in demand can be expected to increase the need for employment in these secondary sectors. Based on the reductions in the net personal incomes contributed by the facility and the observation from other studies that increased demand from fluctuating temporary basic employment has a relatively small effect on stimulating local secondary employment, a multiplier of 0.25 is used to express the expected relationship between each new basic sector construction job and the new secondary jobs. Thus, one new job in the secondary sector is expected to be created for each four new construction jobs. This relationship is consistent with the finding presented in the Introduction that construction period employment multipliers range generally between 0.1 and 0.5.

Another problem is raised in the manner in which these new secondary positions occur over time. The multiplier expresses the equilibrium relationship between new construction and new secondary jobs. The multiplier does not indicate when these new jobs (i.e., the new equilibrium) will arise. Relying on the findings of others, it is estimated that approximately four years will be required to reach equilibrium with 71 percent of the increased new secondary jobs occurring in the first year of the increase in basic jobs, 17 percent in the second year, 8 percent in the third, and 4 percent in the fourth (Stenehjem and Metzger 1976, p. 185). (Reference 9) Thus, a lag model using these factors has been incorporated into the procedure for estimating the number and timing of the changes in new secondary jobs with each increase or decrease in direct construction jobs. This procedure is illustrated in Table 3.1-3.

In addition to the direct construction jobs created by the facility, a constant number of operating jobs are required beginning in January, 1989. The number and types of the "operations" period jobs are presented in Table 3.1-4.

It is expected that these 750 jobs will remain constant over the life of the gasification facility. Because of their permanent nature, these jobs are expected to be filled by people who will regard them as long-term positions. The individuals having to in-migrate to fill these jobs, therefore, will regard themselves as permanent residents of the area. They can be expected to move their families into the area, purchase permanent dwellings, and add permanently to the economic base of the area. This being the case, this operating work force—as observed in other studies—can be expected to have a greater impact on the local secondary sector. Local merchants and businessmen, regarding the increased demands created by these families as both long-term and stable, are more likely to respond by adding more support jobs for each basic operating job than they did for basic construction jobs. In addition, supermarket, drug, motel, and fast-food chains have been observed to respond more readily to increased demands regarded as stable and permanent than to temporary and transitory changes in construction employment and population.

For these reasons, it is expected that the number of secondary jobs created by each permanent operating employee will be twice as high as the number generated by each construction worker. The multiplier for the operating period is assumed to be 0.50 which means that one job in the local secondary sector will be created by the economic stimulus provided by two operating workers.

.ABLE 3.1-3

THE EFFECTS OF CHANGES IN BASIC CONSTRUCTION EMPLOYMENT ON SECONDARY JOB CREATION

PEAK

Period	Annual Basic Jobs	In Basic Jobs	Secondary Jobs by Period 1	2	3	4	5	6	In Secondary Jobs	Total Secondary Jobs
1985	793	793	141						141	141
1986	2260	1467	34	260					294	435
1987	3350	1090	16	62	193				271	706
1988	3503	150	8	29	46	27	—	—	110	816
		-3503 @ .25								
1989	930	+930 @ .50		15	22	6	-622	330	-249	567
1990	930	0			11	3	-149	79	-56	511
1991	930	0				2	-70	37	-31	480
1992	930	0					-35	19	-16	464
1993	930	0							0	464
All Other Years	930	0							0	464

AVERAGE

Period	Annual Basic Jobs	In Basic Jobs	Secondary Jobs by Period 1	2	3	4	5	6	In Secondary Jobs	Total Secondary Jobs
1985	456	456	81						81	81
1986	1521	1065	19	189					208	289
1987	2619	1098	9	45	195				249	538
1988	1968	-651	5	21	47	-116			-43	495
		-1968 @ .25								
1989	930	+930 @ .50		10	22	-28	-349	330	-15	480
1990	930	0		11	13	-9	-84	79	-7	473
1991	930	0			7	-5	-39	37	-9	464
1992	930	0					-20	19	-1	463
1993	930	0							0	463
All Other Years	930	0							0	463

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TABLE 3.1-4
OPERATIONS PERIOD JOBS BY TYPE

Job Type	Number
Plant Staff	12
Operating Engineer	314
Maintenance	297
Engineering	30
Administration	97
Total	750

The effects of the basic construction and operating jobs (in addition to the 750 plant jobs, 180 mine operating positions are included in the operations period) on the creation of positions in the secondary sector are presented in Table 3.1-3. The upper portion of this table illustrates the lagged multiplier effect on secondary employment under the Scenario 2 assumption that the peak construction work force is reached and sustained for each of the four years of facility construction. Column 3 lists the annual increments (or decrements) in basic construction and operations employment. In period 1 (1985), 793 new construction jobs are created. The mutiplier of 0.25 results in the estimation that 198 new secondary jobs will be created in response. However, the lag procedure described earlier dictates that only 71 percent of these 198 jobs will be created in the first year. Thus, 141 is entered in the 1985 row under Period 1. Following the lag procedure, 17 percent (34) jobs are assumed to be created in the second year, 8 percent (16) in the third year, and 4 percent (8) in the fourth year. This same procedure is followed for the changes in construction jobs in 1986, 1987, and 1988. However, in 1989, all 3,503 construction jobs are assumed to have disappeared. Their multiplier of 0.25 suggests a lagged decline in secondary jobs of 876. Simultaneously, 930 new operating period jobs carrying a multiplier of 0.50 are created. They will, over a period of four years, result in an equilibrium level of 465 new jobs. This is reflected (with apologies for rounding errors) in the estimates for 1992, 1993, and subsequent periods.

Adding the total basic jobs and the total secondary jobs (Columns 2 and 11) provides the estimate of the total number of new jobs in each period. Thus, for 1985 it is estimated that the total number of new basic and secondary jobs will be 934. The totals for 1986, 1987, 1988, and 1989, are 2,695, 4,056, 4,319, and 1,497, respectively. Given these estimates for both construction employment scenarios, the next step is to determine the availability of local labor with the appropriate qualifications to fill these basic and secondary jobs.

3.2 MANPOWER AVAILABILITY

The availability of Indians and non-Indians with appropriate skills to fill both basic and secondary jobs is explored in this section. This is complicated by the fact that two separate sites are being considered for the synfuels facility. Estimates of the availability of workers with appropriate skills within commuting distance of the facility are different for the two sites. Site 1 is located on the northern boundary of the reservation where it is relatively easily accessible from both Hardin and Billings, Montana. Site 23 is located in the far southeast corner of the reservation adjacent to the Shell mine. Its nearest population center is Sheridan, Wyoming.

The availability of local labor (workers with appropriate qualifications located within commuting distance of the facility) is dependent on three factors. The first factor is the number of available Crows with applicable skills. The second factor is the availability of qualified non-Indians within commuting distance of the two sites. The major population centers of Billings and Hardin (Site 1) and Sheridan (Site 23) are expected to be the primary sources of these workers. The third factor influencing the availability of local workers is the competition for labor from other projects in the area. These factors are discussed below.

3.2.1 Availability of the Local Construction Work Force

According to records maintained by the Tribal Employment Rights Office (TERO), the following numbers of Crow workers having the following skills are estimated to be available currently:

Skill	Number
Bricklayers	1
Carpenters	10
Cement-Finishers	1
Electricians	2
Laborers	314
Operators	43
Painters	2
Pipefitters (or welders)	4
Teamsters	8
	385

While these figures may change before construction begins, it is assumed—conservatively—that there will be only 385 Crow workers available. It is also assumed that these workers will have priority in employment.

Table 3.2.1-1 presents the general distribution of Indians in and around the reservation according to the 1980 Census. As indicated by the estimates of driving distances to each site, over 95 percent of the 6,402 estimated Indians in the area live within 65 highway miles of Site 1. Based on this distribution of the population (and the work force), it is assumed that all of the Crow workers registered with the TERO office will be employed at the facility. With respect to Site 23, only 61 percent live within 65 miles. However, the 1,849 Indians in the Billings area live approximately 100 miles from the site and well over one-half of the commuting distance is a freeway. Given this information and the great need for employment among the Crow work force, it is assumed that, if Site 23 is selected, the Crow workers would commute on a daily or every-other-day basis.

TABLE 3.2.1-1
INDIAN POPULATION IN AND AROUND THE CROW RESERVATION
AND COMMUTING DISTANCES TO THE TWO SITES

	Population	Mileage Distance to Sites[a]	
		Site 1	Site 23
Hardin	463	0-19	60-65
S & SE of Hardin	789	20-24	55-59
Crow Agency	363	30-34	45-49
Big Horn Valley between Hardin and St. Xavier	168	35-39	50-54
Billings	1849	35-39	65-100
SE of Crow Agency	117	35-39	40-44
SW of Crow Agency	556	35-39	55-59
Big Horn Valley N of Hardin	25	40-44	65-100
S side of Yellowstone River	87	40-44	over 100
SE of Billings (includes Laurel)	52	50-54	over 100
Pryor	363	50-54	over 100
NW of Lodge Grass	132	50-54	30-34
Yellow Tail Dam Area	106	55-59	65-100
Lodge Grass	630	55-59	25-29
E of Lodge Grass	104	60-64	25-29
SE of Lodge Grass	303	60-64	25-29
Wyola	86	65 to 100	0-19
E of Wyola	209	over 100	0-19
Total	6402		
	Proportion less than 65 miles	95.4%	61.3%
	Proportion less than 100 miles	96.7%	92.2%
	Proportion more than 100 miles	3.3%	7.8%

[a]These are estimates of driving distances on existing roads and the proposed access roads to both Sites 1 and 23.

The effect of the Crow construction work force on the number of positions available during the four-year construction period is presented in Table 3.2.1-2. The figures in this table are based upon three assumptions:

all qualified Crow workers will seek jobs at the facility;

qualified Crow workers will have priority in employment; and

apprenticeship positions in the skilled crafts will be open to Crow laborers not employed directly as laborers.

The table illustrates, for both peak and average employment levels per year, both the number of jobs assumed to be filled by Crow workers and the number of jobs available for others.

3.2.1.1 Non-Indian Local Construction Work Force Estimates: Site 1

In addition to the Crow workers, there are non-Indian local construction workers available to work at the facility. However, estimates of their availability are dependent upon the site. The Billings area, being less than 40 highway miles from Site 1, is likely to be the major source of a commuting non-Crow construction work force. Table 3.2.1-3 presents the number of union workers by craft from the Billings area. It also lists the number of these workers currently employed in the construction of the Colstrip units 3 and 4 which are expected to be completed in 1985. Finally, the table presents estimates of the number of workers likely to be available for work on the construction of the Crow synfuels facility.

Likely to affect the availability of this work force are the number and types of competing projects. Based on a list of energy projects provided in the Montana Energy Almanac (Montana Dept. of Community Affairs 1980) (Reference 6), eight projects are proposed that would potentially compete for the available Montana construction work force. These projects, the companies sponsoring them, their

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TABLE 3.2.1-2

FACILITY CONSTRUCTION REQUIREMENTS AND THE NUMBER OF POSITIONS FILLED BY QUALIFIED CROW WORKERS EACH YEAR

	Apprentice To Journeyman Ratio[a]	Year 1								Year 2							
		Total Jobs	Peak Crows Jrymn	Peak Crows App.	Total Unfilled	Total Jobs	Average Crows Jrymn	Average Crows App.	Total Unfilled	Total Jobs	Peak Crows Jrymn	Peak Crows App.	Total Unfilled	Total Jobs	Average Crows Jrymn	Average Crows App.	Total Unfilled
Boilermakers	1:10	-	-	-	-	-	-	-	-	123	0	0	123	52	0	5	47
Bricklayers	None	-	-	-	-	-	-	-	-	7	1	0	6	3	1	0	2
Carpenters	1:5	206	10	34	162	93	10	16	67	267	10	0	257	238	10	21	207
Cement Finishers	1:2	6	1	2	3	3	1	1	1	42	1	0	41	26	1	0	25
Electricians	1:3	138	2	35	101	65	2	16	47	148	2	0	146	105	2	0	103
Insulators	1:4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ironworkers	1:5	38	0	6	32	18	0	3	15	153	0	0	153	86	0	0	86
Laborers[b]	None	169	(145) 169	0	0	86	(228) 86	0	0	389	(0) 314	0	75	288	(26) 288	0	0
Millwrights	1:5	-	-	-	-	-	-	-	-	125	0	0	125	51	0	0	51
Operators	1:10	75	43	7	25	52	43	5	4	119	43	0	76	74	43	0	31
Painters	1:3	2	2	0	0	1	1	0	0	2	2	0	0	1	1	0	0
Pipefitters	1:4	5	4	1	0	28	4	6	18	270	4	0	266	184	4	0	180
Pipe-Welders	1:4	-	-	-	-	-	-	-	-	95	0	0	95	48	0	0	48
Oilers	None	17	0	0	17	10	0	0	10	50	0	0	50	32	0	0	32
Teamsters	None	38	8	0	30	35	8	0	27	120	8	0	112	87	8	0	79
Nonmanual[c]	N/A	49	0	0	49	31	0	0	31	150	0	0	150	95	0	0	95
Supervisors[c]	N/A	50	0	0	50	38	0	0	38	200	0	0	200	150	0	0	150
TOTALS		793	239	85	469	456	155	47	258	2,260	385	0	1,875	1,521	358	26	1,137
CROW TOTALS			324				202				385				384		

TABLE 3.2.1-2
FACILITY CONSTRUCTION REQUIREMENTS AND THE NUMBER OF POSITIONS FILLED BY QUALIFIED CROW WORKERS EACH YEAR
(Continued)

	Apprentice To Journeyman Ratio[a]	Year 3								Year 4							
		Total Jobs	Peak Crows Jrymn	Peak Crows App.	Total Unfilled	Total Jobs	Average Crows Jrymn	Average Crows App.	Total Unfilled	Total Jobs	Peak Crows Jrymn	Peak Crows App.	Total Unfilled	Total Jobs	Average Crows Jrymn	Average Crows App.	Total Unfilled
Boilermakers	1:10	273	0	25	248	209	0	19	190	193	0	19	174	98	0	9	89
Bricklayers	None	10	1	0	9	4	1	0	3	-	-	-	-	-	-	-	-
Carpenters	1:5	216	10	36	170	145	10	24	111	177	10	24	143	108	10	18	80
Cement Finishers	1:2	30	1	10	19	21	1	7	13	30	1	7	22	10	1	3	6
Electricians	1:3	300	2	13	286	189	2	39	148	250	2	39	209	132	2	33	97
Insulators	1:4	105	0	0	105	75	0	0	75	367	0	0	367	172	0	34	138
Ironworkers	1:5	215	0	0	215	210	0	0	210	210	0	0	210	109	0	18	91
Laborers[b]	None	231	(89) 231	0	0	225	(89) 225	0	0	225	(89) 225	0	0	172	(142) 172	0	0
Millwrights	1:3	235	0	0	235	191	0	0	191	210	0	0	210	101	0	17	84
Operators	1:10	163	43	0	120	114	43	0	71	100	43	0	57	61	43	6	12
Painters	1:3	83	2	0	81	43	2	0	41	350	2	0	348	139	2	4	133
Pipefitters	1:4	600	4	0	596	468	4	0	464	550	4	0	546	300	4	0	296
Pipe-Welders	1:4	227	0	0	227	175	0	0	175	200	0	0	200	106	0	0	106
Oilers	None	38	0	0	38	26	0	0	26	23	0	0	23	13	0	0	13
Teamsters	None	77	8	0	69	55	8	0	47	75	8	0	67	50	8	0	42
Nonmanual[c]	N/A	347	0	0	347	268	0	0	268	343	0	0	343	242	0	0	242
Supervisors	N/A	200	0	0	200	200	0	0	200	200	0	0	200	155	0	0	155
TOTALS		3,350	301	84	2,965	2,619	296	89	2,233	3,503	285	89	3,119	1,968	242	142	1,584
CROW TOTALS			385				385				384				384		

[a]Data on the ratio of apprenticeship to journeyman positions obtained from a telephone surv... union Business Agents, 1 June 1981.
[b]The figure in parentheses in this row indicates the number of Crow laborers available for apprenticeship positions.
[c]It is assumed that this position will be filled by non-Crow in-migrants.

TABLE 3.2.1-3
NON-CROW CONSTRUCTION WORKERS AVAILABLE FOR SITE 1 GASIFICATION FACILITY

	Union[a]	No. of Qualified Members	No. from Billings Area	No. Working at Colstrip 6/1/81	Available Workers[b]	
					1985	Beyond
Boilermakers	Boilermakers District 11	300	150	300	0	120
Bricklayers	Bricklayers Local 10	84	70	3	54	56
Carpenters	Carpenters/ Joiners Local 1172	500	450	90	288	360
Cement Finishers	Cement Masons/ Plasterers Local 352	35	30	10	16	24
Electricians	IBEW 532	350	300	70	168	240
Insulators	Heat, Frost, and Asbestos Workers Local 32 (Spokane, WA)	127	50	60	0	40
Ironworkers	Ironworkers Local 708	220	150	200	0	120
Laborers	Laborers Local 98	700	350	125	220	280
Millwrights	Carpenters/ Joiners	12	12	12	0	9

TABLE 3.2.1-3
NON-CROW CONSTRUCTION WORKERS AVAILABLE FOR
SITE 1 GASIFICATION FACILITY
(Continued)

	Union[a]	No. of Qualified Members	No. from Billings Area	No. Working at Colstrip 6/1/81	Available Workers[b] 1985	Beyond
Operators	Operating Engineers Local 400 (Helena)	2000	1000	100	720	800
Painters	Painters Local 167	40	35	30	4	28
Pipefitters	Plumbers and Pipefitters Local 30	350	310	130	144	248
Teamsters	Teamsters Local 190	200	150	100	40	120

[a]Data from 1981 telephone survey of union business agents conducted by CERT.

[b]Assumes that 80% of the workers from the Billings area who are not working at Colstrip Units 3 and 4 will be available in 1985. Beyond 1985 (when the Colstrip projects are completed), it is assumed that 80% of all workers from the Billings area will be available to work on the construction of the Crow gasification plant.

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probable locations, and the distances from the Crow Reservation are presented below (based on the data in the 1980 Montana Energy Almanac))Reference):

Resource 89 Power Plant, 350-MW unit; Montana Power; Great Falls; 220 miles NW;

Basin Electric Power Plants, two 500-MW units; Basin Electric; Circle, Montana; 175 miles NE;

250 MMcf/d SNG plant; Tenneco; Wibaux County, Montana; 175 miles NE;

Redwater Synfuel Plant, 250 MMcf/d SNG; Wesco Resources; Circle, Montana; 175 NE;

Intake Synfuel Plant, 250 MMcf/d SNG plant; Utah International; Broadus, Montana; 130 miles ENE;

19 MMcf/d SNG plant, Northern Resources; Billings, Montana; 30 miles W;

Circle West Synfuel Plant, lignite to methanol; Northern Resource; Circle, Montana; 220 miles NE; and

Crow coal-fired power plant, 500 MW; same Site as Site 1 gasification facility.

The status of each of these projects was investigated to determine which might compete for the available skilled labor from the Billings area. This investigation led to the finding that several projects have been delayed or dropped altogether. Northern Resources has disbanded and one of its parent companies, Burlington Northern, is taking over its projects. Burlington Northern is awaiting a decision on federal coal leasing in the Circle, Montana, area before proceeding with detailed feasibility studies.

A conversation with officials at the Redwater Synfuel Plant indicated that they anticipate entering the permitting process in 1982. However, they were pessimistic about staying on schedule because of "political problems" which could refer to the increasingly poor prospects for federal loan guarantees from the Synthetic Fuels Corporation.* The Utah International project was reportedly delayed by disputes over water rights (Montana Dept. of Community Affairs 1980). (Reference 6)

The only projects likely to compete for the non-Crow construction work force from the Billings area are Resource 89 (construction scheduled for 1984–1989); Tenneco's synfuel plant (already in the EIS stage); and the Crow power plant. The Resource 89 project is relatively small and located 220 miles northwest of the reservation. Its labor force is expected to be drawn largely from the northern half of the state. The same applies to the Tenneco plant which is 150 miles from Billings. Given a choice, it is expected that the Billings work force would prefer to commute to the site of the Crow gasification facility (35–40 miles) rather than subject themselves to temporary relocation or weekly commuting between Billings and the projects that are farther away.

The final project competing for this work force is the Crow power plant. If the Crow power plant and the Crow synfuels facility were built simultaneously, a significant shortage in local labor would result. Also, the opportunity for employment of the Crow work force would be significantly diminished since these workers would be forced to choose between the two projects. Since neither of these outcomes is in the best interests of the Crow Tribe, it is more likely that the construction schedules of the two Crow facilities would be staggered so that as the construction of one is phasing out, the other would be phasing in.

Given the projected likelihood of other projects competing for the Billings area labor force and the assumption that construction of the Crow power plant will complement rather than conflict with the synfuels facility, it is assumed—conservatively—that 80

*Officials at Redwater Synfuel Plant 1981: personal communication to Kathleen Gramp-Smith at CERT.

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percent of the available work force in Billings would be available and willing to commute to Site 1. As illustrated in Table 3.2.1-3, a significant proportion of this work force is engaged currently in the construction of Colstrip units 3 and 4. Since this project is expected to be ongoing through 1985, Table 3.2.1-3 lists 80 percent of the construction workers by skill who are not currently employed at Colstrip as the estimate of the locally available non-Crow construction workers in 1985.

Table 3.2.1-4 presents the number of jobs by year and craft not expected to be filled locally. These estimates were prepared by subtracting, from the total average and peak requirements, those jobs filled by the Crows and those filled by the available local non-Crow construction work force in the Billings area. The remainder are assumed to attract an in-migrating construction work force. These figures indicate that the highest number of in-migrating workers needed to meet Site 1 peak annual demands is 2,143 in year four. With respect to the average annual requirements, it is estimated that the highest number of in-migrants required (1,275) will occur in the third year.

3.2.1.2 Non-Indian Local Construction Work Force Estimates: Site 23

The estimates presented in Table 3.2.1-2 of the numbers of Crow construction workers available apply equally to Sites 1 and 23. Estimating the number of locally available non-Crow construction workers is somewhat more difficult for Site 23 than for Site 1 because Site 23 is too far from Billings to permit assuming that these workers qualify as "locally available" (within a reasonable commuting distance). The non-Crow construction workers from Billings are more likely to have to establish either temporary residences (RV pads, mobile homes) or permanent residences closer to Site 23. Thus, these workers must be considered in-migrants.

The locally available non-Crow construction work force is more likely to be found in the Sheridan, Wyoming, area which is less than 40 miles from Site 23. However, the union locals having jurisdiction in this area will not have priority in supplying labor to the Crow synfuels facility since Site 23 is located in Montana. Paradoxically, the construction workers located closest to the sites are not likely to have priority in

TABLE 3.2.1-4
TOTAL LOCAL AND IN-MIGRATING CONSTRUCTION WORK FORCE BY CRAFT AND YEAR: SITE 1

	YEAR 1						YEAR 2						YEAR 3						YEAR 4					
	Local						Local						Local						Local					
	Crow		Non-Crow		In-Migrants		Crow		Non-Crow		In-Migrants		Crow		Non-Crow		In-Migrants		Crow		Non-Crow		In-Migrants	
	PK	AV	PK	AV	PK	AV	PK	AV	PK	AV	PK	AV	PK	AV	PK	AV	PK	AV	PK	AV	PK	AV	PK	AV
Boilermakers	-	-	-	-	-	-	0	5	120	47	3	0	25	19	120	120	128	70	19	9	120	89	54	0
Bricklayers	-	-	-	-	-		1	1	6	2	0	0	1	1	9	3	0	0	-	-	-	-	-	-
Carpenters	44	26	132	62	0	0	10	31	257	207	0	0	46	34	170	111	0	0	34	28	56	55	87	24
Cement Finishers	3	2	3	1	0	0	1	1	24	24	17	1	11	6	19	13	0	0	8	4	22	6	0	0
Electricians	37	18	101	47	0	0	2	2	146	103	0	0	15	41	240	148	46	0	41	35	209	97	0	0
Insulators	-	-	-	-	-	-	-	-	-	-	-	-	0	0	40	40	65	35	0	34	40	40	327	98
Ironworkers	5	3	0	0	32	15	0	0	120	86	33	0	0	0	120	120	95	90	0	18	120	91	90	0
Laborers	169	86	0	0	0	0	314	288	75	0	0	0	231	225	0	0	0	0	225	172	0	0	0	0
Millwrights	-	-	-	-	-	-	0	0	9	9	118	42	0	0	9	9	226	182	0	17	9	8	201	75
Operators	50	48	25	4	0	0	43	43	76	31	0	0	43	43	120	71	0	0	43	49	57	12	0	0
Painters	2	1	0	0	0	0	2	2	0	0	0	0	2	2	28	28	53	13	3	6	28	28	320	105
Pipefitters	5	10	0	18	0	0	4	4	248	180	18	0	4	4	248	248	348	216	4	4	248	248	298	48
Pipe-Welders	-	-	-	-	-	-	0	0	0	0	95	48	0	0	0	0	327	175	0	0	0	0	200	106
Oilers	0	0	0	0	17	10	0	0	0	0	50	32	0	0	0	0	38	26	0	0	0	0	23	13
Teamsters	8	8	30	27	0	0	8	8	112	79	0	0	8	8	69	47	0	0	8	8	67	42	0	0
Nonmanual[a]	0	0	0	0	48	31	0	0	0	0	150	95	0	0	0	0	347	268	0	0	0	0	343	242
Supervisors[a]	0	0	0	0	50	38	0	0	0	0	200	150	0	0	0	0	200	200	0	0	0	0	200	150
TOTALS	324	202	321	184	148	94	385	384	1193	768	682	368	385	385	1182	958	1773	1275	384	384	978	718	2143	886

[a] The peak and average annual employment requirements for nonmanual and supervisory positions are assumed to be filled by permanent employees of the construction contractors.

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employment because of jurisdictional problems (this point was made by several of the business agents of Sheridan and Casper, Wyoming, union locals contacted by CERT in May 1982). The locally available construction workers will be hired only if there are jobs available after the in-migrating workers from the Billings area have been hired. For conservative computational purposes, it is assumed that 80 percent of all available non-Crow construction workers from the Billings area (see Table 3.2.1-3) would have first right to the jobs at Site 23. It is also assumed that they would be in-migrants if they elect to take jobs at this site. Thus, only those jobs listed in Table 3.2.1-4 which are assumed—for Site 1—to be filled by in-migrants would be open to the locally available construction work force from the Sheridan area if Site 23 is selected.

Estimates of the availability of the non-Crow construction work force from the Sheridan area were compiled in Table 3.2.1-5 from a series of interviews with the union locals having jurisdiction in the Sheridan area.* Influencing the availability of these workers are the labor demands of competing projects within commuting distance of the Sheridan area. Three construction projects that might compete with the synfuels facility were identified by the Wyoming Industrial Siting Commission:**

> Basin Electric Power Plant; Basin Electric; Sheridan, Cambell County Line; 50 miles ESE;
>
> Hampshire Synfuels Project; south of Gillette, Wyoming; 120 miles SE; and
>
> Wyodak Power Plant Unit 2, 330 MW; near Gillette, Wyoming; 110 miles SE.

*Union representatives 1982: personal communication.
**Carl Ellis of Wyoming Industrial Siting Commission May, 1982: personal communication.

Other projects include possible expansion of several coal mines in Campbell County, Wyoming. However, these would presumably not require a significant construction labor force.

The Basin Electric Plant was the subject of a feasibility study in the late 1970s. Since the identification of possible sites recommended by the feasibility study, no more requests for permitting action have been received by the Wyoming Industrial Siting Commission.* Subsequent conversations with the Information Office of Basin Electric in Bismarck, North Dakota, revealed that the earliest start date for construction of this facility would be 1988 or 1989. Therefore, this project is not expected to absorb the construction workers from the Sheridan area until near or after completion of the Crow project.**

The Hampshire Synfuels Project, located 120 miles ESE of Sheridan, could draw weekly commuters from the Sheridan area. However, this project is currently under consideration by the U.S. Synthetic Fuels Corporation. Its construction may depend on the outcome of the Corporation's decision. In addition, given its distance from Sheridan, it is not unrealistic to believe that, given a choice, the construction workers from the Sheridan area would elect to commute daily to Site 23 rather than move or commute weekly to the Hampshire project.

Wyodak Unit 2 is a 330-MW addition to the original plant. A permit has been received for this project but construction has been delayed—according to the Siting Commission—by bad economic conditions and reduced demand.** Given its location, it too is expected to draw weekly commuters or workers from the Sheridan area who are willing to temporarily relocate in the Gillette area. As in the case of the Hampshire project, it is realistic to assume that the construction workers in the Sheridan area would prefer to work on a project to which they could commute daily. Based upon the current status of these competing projects and the distance each is

*Basin Electric Information Office May, 1982: personal communication.
**Carl Ellis of Wyoming Industrial Siting Commission May, 1982: personal communication.

TABLE 3.2.1-5
NON-CROW LOCAL CONSTRUCTION WORKERS
AVAILABLE FOR SITE 23 GASIFICATION FACILITY

Craft	Union	No. of Qualified Members[a]	No. from Sheridan Area[b]	Available for Crow Project[c]
Bricklayers	Local 2 (Sheridan)[d]	137	137	110
Electricians	Local 322 (Casper)	450	68	55
Ironworkers	Local 454 (Casper)	473	71	57
Laborers	Local 1271 (Cheyenne)	900	90	72
Operating Engineers	Local 800 (Casper)	950	143	115
Teamsters	Local 307 (Casper)	850	128	128

[a]Based upon figures provided by the business agents of these unions during telephone interviews conducted May, 1982.

[b]Based on estimates provided by the interviewees, it is assumed that 10 percent of the workers in Cheyenne union locals are from the Sheridan area and that 15 percent of the members from Casper union locals reside near Sheridan.

[c]It is assumed, based upon competition from other construction projects, that 80 percent of the workers from the Sheridan area will be available for work on the Crow synfuels facility.

[d]These estimates were obtained from published data: U.S. Department of Labor, Construction Trade, Region 8, Wyoming, 1980.

from Sheridan, if the Crow synfuels facility were located at Site 23, approximately 80 percent of the construction work force from Sheridan would choose to work at this facility. However, as mentioned above, these workers would likely have to take jobs not filled by the construction workers from the Billings area. Table 3.2.1-6 presents the estimated distribution of construction jobs by craft filled by the locally available Crow workers, the in-migrant workers from the Billings area, the locally available workers from Sheridan, and other in-migrating construction workers.

3.2.2 Availability of the Operating Period Work Force

The synfuels facility is expected to be operational on 1 January 1989. The operation of this facility is expected to require 750 persons per year regardless of the site chosen. A broad breakdown of the positions available during plant operation is presented below:

Job Type	Employees Required
Plant Staff	12
Operating Engineers	314
Maintenance	297
Engineering	30
Administration	97
	750

In addition to the employees required by the synfuels facility, permanent positions will also be available at the coal mines supplying the facility during its operation. The Westmoreland mine is assumed to be the source of coal for the Site 1 synfuels facility while the Shell mine is expected to supply the mine-mouth synfuels facility at Site 23. The incremental requirements for the synfuels facility are approximately 6 million tons/year (6 MMtpy) from either facility. Since the production of this tonnage is directly attributable to the demands of the synfuels facility, these jobs and their impacts on the local and in-migrating work force must be considered in

TABLE 3.2.1-8
TOTAL LOCAL AND IN-MIGRATING CONSTRUCTION
WORK FORCE BY CRAFT AND YEAR: SITE 23

	YEAR 1						YEAR 2						YEAR 3						YEAR 4					
	Local						Local						Local						Local					
	Crow		Sheridan[b]		In-Migrants[a]		Crow		Sheridan		In-Migrants		Crow		Sheridan		In-Migrants		Crow		Sheridan		In-Migrants	
	PK	AV	PK	AV	PK	AV	PK	AV	PK	AV	PK	AV	PK	AV	PK	AV	PK	AV	PK	AV	PK	AV	PK	AV
Boilermakers	-	-	-	-	-	-	0	5	0	0	123	47	25	19	0	0	248	190	19	9	0	0	174	89
Bricklayers	-	-	-	-	-		1	1	0	0	6	2	1	1	0	0	9	3	-	-	-	-	-	-
Carpenters	44	26	0	0	162	67	10	31	0	0	257	207	46	34	0	0	170	111	34	28	0	0	143	80
Cement Finishers	3	2	0	0	3	1	1	1	0	0	41	25	11	8	0	0	19	13	8	4	0	0	22	6
Electricians	37	18	0	0	101	47	2	2	0	0	146	103	15	41	46	0	240	148	41	35	0	0	209	97
Insulators	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	105	75	0	34	0	0	367	138
Ironworkers	6	3	32	15	0	0	0	0	33	0	120	86	0	0	57	57	158	153	0	18	57	0	153	91
Laborers	169	86	0	0	0	0	314	288	0	0	75	0	231	225	0	0	0	0	225	172	0	0	0	0
Millwrights	-	-	-	-	-	-	0	0	0	0	125	51	0	0	0	0	235	191	0	17	0	0	210	84
Operators	50	48	0	0	25	4	43	43	0	0	76	31	43	43	0	0	120	71	43	49	0	0	57	12
Painters	2	1	0	0	0	0	2	2	0	0	0	0	2	2	0	0	81	41	2	6	0	0	348	133
Pipefitters	5	10	0	0	0	18	4	4	0	0	266	180	4	4	0	0	596	464	4	4	0	0	546	296
Pipe-Welders	-	-	-	-	-	-	0	0	0	0	95	48	0	0	0	0	227	175	0	0	0	0	200	106
Oilers	0	0	0	0	17	10	0	0	0	0	50	33	0	0	0	0	38	26	0	0	0	0	23	13
Teamsters	8	8	0	0	30	27	8	8	0	0	112	79	8	8	0	0	69	47	8	8	0	0	67	42
Nonmanual[c]	0	0	0	0	49	31	0	0	0	0	150	95	0	0	0	0	347	268	0	0	0	0	343	242
Supervisors[c]	0	0	0	0	50	38	0	0	0	0	200	150	0	0	0	0	200	200	0	0	0	0	200	155
TOTALS	324	202	32	15	437	243	385	384	33	0	1842	1136	385	385	103	57	2862	2176	384	384	57	0	3062	1584

[a]Includes the construction work force from the Billings area.
[b]The local construction workers from the Sheridan area are assumed to be eligible for positions only after all Billings area workers have obtained jobs.
[c]These positions are assumed to be filled by permanent employees of the construction contractor.

evaluating the total manpower requirements and availabilities associated with the operation of the facility. Estimates of the manpower needed to produce 5 MMtpy were obtained from several sources, as summarized in Table 3.2.2-1.

As indicated, there are wide variations in the estimated operating employment requirements that reflect differences in assumptions concerning productivity, seam thicknesses, and environmental considerations. Weighting these figures for the differences in the sizes of the mines and computing from them an average for a 6 MMtpy mine yields an estimate of the average manpower needed of 180 persons per year. Assuming that the occupational distribution of these workers approximates that noted in the Bureau of Mines Circulars, the number of workers by category is estimated to be 125 in production, 34 in maintenance, and 21 in supervisory positions (Bureau of Mines 1976). (Reference 3)

It is expected, based on previous work, that these mine-related positions will be filled locally (CERT 1981, pp. 5-85). (Reference 4) The Westmoreland mine has, in the past, filled more than 50 percent of its positions with Crow workers.* In Shell's draft Environmental Impact Statement, Shell reported that it will implement a training program to teach members of the Crow Tribe the necessary skills to work in the mine. Crow Indians would be given preference in all phases of employment with the objective of maximizing the ratio of Crow Indians in all employment classifications (BIA 1981, pp. 1-11). (Reference 2) Given the experience at Westmoreland and the indication of Indian preference and training at Shell, 50 percent of the positions at either mine are expected to be filled by Crow tribal members. The remaining positions are assumed to be filled locally by non-Crow workers.

With respect to the positions available during the operation of the synfuels facility, Table 3.2.2-2 presents estimates of the availability of Crow workers based upon different levels of training and preparation provided. These estimates were prepared by examining the educational and skill/experience background of the tribal members

*Bill Kelley, Director of TERO, Crow Agency, 1982: personal communication.

TABLE 3.2.2-1
OPERATING MANPOWER NEEDS FOR STRIP COAL MINES IN THE NORTHERN GREAT PLAINS

Personnel	BOM[a] (5 MMtpy)	Skelly & Loy[b] (5 MMtpy)	Bechtel[c] (6 MMtpy)	Estimate (5.5 MMtpy)
Production	66	NA	NA	125
Maintenance	18	NA	NA	34
Supervision	11	NA	NA	21
TOTALS	95	162	276	180

[a]Bureau of Mines 1976. (Reference 3)

[b]Skelly & Loy 1975. (Reference 8)

[c]Bechtel Corp. 1975. (Reference 1)

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TABLE 3.2.2-2
LABOR REQUIREMENTS FOR FACILITY OPERATION AND ESTIMATES OF AVAILABLE CROW WORKERS

Position Descriptions	Total Positions	No. Qualified Crows Registered with TERO Office[a]	No. Qualified with an Additional 18 Months Training[b]	No. Qualified after 4 Years of Additional Training[b]
ADMINISTRATION	97	6	8	12
(plant manager, assistants, secretaries, accountants, clerks)				
ENGINEERING	30	0	10	13
(plant engineer, associates, lab technicians)				
MAINTENANCE	297	18	83	108
(Maintenance sup't., mechanics, apprentices, electrical supervisors, helpers)				
OPERATING ENGINEERS	314	28	67	87
(Superintendent, shift supervisors, plant operators)				
PLANT STAFF	12	0	6	10
Totals	750	52	174	230

[a]Based upon an assessment conducted by CERT in 1981 of the individual qualifications of Crow registrants with the TERO office.

[b]Based upon an extensive review of individual records of TERO applicants conducted by CERT staff in 1981. The results reflect the judgments of CERT staff members.

registered with the Tribal Employment Rights Office. For the purposes of this analysis, it is assumed that 174 Crow workers will be employed as the result of an aggressive training and promotion program. The remaining 576 openings—because they are both permanent and relatively high-paying professional positions—are assumed to attract in-migrating workers.

3.2.3 Availability of the Secondary Work Force

Secondary positions are those jobs created in the retail, commercial, and service sectors of the area adjacent to the facility. As described in the preceding sections, the construction jobs are expected to have a multiplier effect of 0.25. That is, for each four new construction-related jobs, one additional position in the secondary sector is expected to be created. The multiplier for the plant and mine operation positions is 0.50 reflecting the fact that a greater economic stimulus is expected from these positions which merchants perceive as less subject to fluctuation. Estimates of the number of secondary positions expected to be created over time as a result of the number of basic construction and operations positions were provided in Table 3.1-3.

Estimates of the availability of local workers to fill these secondary sector positions are based on the assumption that, without the project, there would be no decline in the employment of the local people surrounding each site. Thus, if local workers are expected to fill these positions, they will have to be induced from the ranks of individuals not currently in the labor force. In preparing estimates of the available local labor force, the following procedure is used.

(1) The populations of Big Horn and Yellowstone counties (Site 1) and Big Horn and Sheridan (Wyoming) counties (Site 23) are forecasted by sex and age cohort for each year from 1982 to 2000 using the SEAM Model (Stenehjem 1978). (Reference 11)

(2) The male and female labor force for the Site 1 and Site 23 counties are estimated by applying the age and sex cohort Labor Force Participation

Rates (LFPRs) for each county to the numbers of men and women forecasted for each age and sex cohort by year to 2000.

(3) The potential sizes of the male and female labor forces in each of these counties are computed by assuming that the LFPRs in each of these counties approach the national average by age and sex cohort.

(4) The difference found by subtracting the results of item 3 from those of item 2 represents—if positive—the number of men and women who could be added to the labor forces of these counties in each year if sufficient jobs were available.

(5) It is assumed that this increase in the annual labor forces of these counties will occur in response to the increased need for secondary employees and that these increments in the labor force of each county constitute the supply of locally available workers who are willing to fill the new secondary jobs.

Using this procedure, it is explicitly assumed that the new secondary jobs will not be filled at the expense of vacating positions that exist currently or are expected to exist in the future to meet the needs of the baseline (nonproject-related) populations. Because employment opportunities in these energy resource counties are growing at a rate slightly greater than the rate of population increase (i.e., LFPRs are increasing over time), it is assumed that only 80 percent of these men and women may be available to fill local secondary jobs. However, even with this assumption, the demands for secondary employees are far exceeded by the number of persons in the incremental labor force. Therefore, no in-migration of secondary workers and households is expected to occur as a result of locating the facility at Site 1.

The situation at Site 23 is different. A comparison of the estimated demand for secondary workers in Table 3.1-3 and the availability of local persons listed in Table 3.2.2-3 reveals a shortage of several hundred people. Using the assumption that the

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only local people available to fill secondary jobs are those not currently in the labor force, these jobs—if they are to be filled—will have to attract an in-migrating work force.

However, the local residents in the area surrounding Site 23 are not the only source of local labor. Based on studies done by others, it is expected that in-migrating households will contribute to the available secondary work force. On the average, it has been found that the number of workers per in-migrating household is 1.2. Thus, one secondary worker is assumed to be provided by each five in-migrating households (Stenehjem and Metzger 1976). (Reference 9) The results of applying this assumption can be seen in Table 4.0-1.

TABLE 3.2.2-3

INCREMENTALLY AVAILABLE LOCAL WORKERS TO FILL SECONDARY POSITIONS

Year	Site 1 Big Horn and Yellowstone Counties			Site 23 Big Horn and Sheridan Counties		
	Male	Female	Total	Male	Female	Total
1982	730	3749	4479	15	73	108
1983	712	4031	4752	14	100	114
1984	692	4316	5008	14	106	120
1985	670	4598	5268	14	113	127
1986	650	4884	5534	14	120	134
1987	631	5165	5796	15	126	141
1988	616	5443	6059	16	131	147
1989	602	5718	6320	17	137	154
1990	595	6025	6620	18	143	161
1991	597	6071	6668	18	144	162
1992	603	6113	6716	17	145	162
1993	614	6151	6765	18	145	163
1994	629	6188	6817	20	146	166
1995	647	6222	6869	21	146	167

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4.0
POPULATION EFFECTS

As the introductory remarks indicate, the most important portion of an impact investigation is the specification of employment demand and supply. The demand for basic sector jobs (i.e., those in the construction and operation of the gasification facility and the mining of the required 5.5 MMtpy of coal) were described in Section 3.0. With the exception of the jobs related to coal mining, the number of basic jobs were provided by the project engineers. Recognizing that a host of factors can affect the demand for construction workers (e.g., strikes, material shortages, litigation), two scenarios of construction worker demand were constructed.

Given the estimates of the annual number of construction, plant operations, and mine workers required during the life of the facility, projections of the required secondary work force were prepared. Thus, for both Sites 1 and 23, the demand for workers of all types were estimated.

Given these estimates of demand, the numbers of locally available workers at both sites were evaluated. This evaluation was conducted by comparing projections of the local work force to the numbers and—where available—the skill requirements of the projections of labor requirements. Using conservative assumptions concerning the availability of local workers, estimates were constructed of the number (and types) of positions that would have to be filled by in-migrating workers. The results of this analysis are summarized in Table 4.0-1. As clarified by the table, the number of expected in-migrating workers varies considerably depending upon which scenario and which site is being evaluated. It is these in-migrating workers who give rise to the population impacts.

Given these projections of in-migrants, the Reservation Social and Economic Assessment Model (RSEAM) was used to project their effects on population growth in the areas around Site 1 and Site 23. The Reservation Social and Economic Assessment Model is based upon the SEAM model's data and algorithms. It is still being developed and modified by the technical staff of the CERT. The model is documented in Appendix C-2.

TABLE 4.0-1
SUMMARY OF LABOR DEMANDS AND SUPPLY

	Year 1			Year 2			Year 3			Year 4		
	Total Jobs	Local Jobs	In-Migrants	Total Jobs	Local Jobs	In-Migrants	Total Jobs	Local Jobs	In-Migrants	Total Jobs	Local Jobs	In-Migrants
SITE 1 PEAK												
Construction Workers	793	645	148	2260	1578	682	3350	1577	1773	3503	1360	2143
Plant Operations	-	-	-	-	-	-	-	-	-	-	-	-
Mine Workers	-	-	-	-	-	-	-	-	-	-	-	-
Secondary Workers	141	141	0	435	435	0	706	706	0	816	816	0
TOTALS	934	786	148	2695	2013	682	4056	2283	1773	4319	2176	2143
SITE 1 AVERAGE												
Construction Workers	456	362	94	1521	1153	368	2619	1344	1275	1968	1102	866
Plant Operations	-	-	-	-	-	-	-	-	-	-	-	-
Mine Workers	-	-	-	-	-	-	-	-	-	-	-	-
Secondary Workers	81	81	0	289	289	0	538	538	0	495	495	0
TOTALS	537	443	94	1810	1442	368	3157	1882	1275	2463	1597	866
SITE 23 PEAK												
Construction Workers	793	356	437	2260	418	1842	3350	488	2862	3503	441	3062
Plant Operations	-	-	-	-	-	-	-	-	-	-	-	-
Mine Workers	-	-	-	-	-	-	-	-	-	-	-	-
Secondary Workers	141	108	33	435	208	227	706	534	172	816	734	82
TOTALS	934	464	470	2695	626	2069	4056	1022	3034	4319	1175	3144
SITE 23 AVERAGE												
Construction Workers	456	213	243	1521	385	1136	2619	443	2176	1968	384	1584
Plant Operations	-	-	-	-	-	-	-	-	-	-	-	-
Mine Workers	-	-	-	-	-	-	-	-	-	-	-	-
Secondary Workers	81	81	0	289	163	126	538	372	166	495	495	0
TOTALS	537	294	243	1810	548	1262	3157	815	2342	2463	879	1584

TABLE 4.0-1
SUMMARY OF LABOR DEMANDS AND SUPPLY
(Continued)

	Year 5			Year 6			Year 7			All Remaining		
	Total Jobs	Local Jobs	In-Migrants	Total Jobs	Local Jobs	In-Migrants	Total Jobs	Local Jobs	In-Migrants	Total Jobs	Local Jobs	In-Migrants
SITE 1 PEAK												
Construction Workers	—	—	—	—	—	—	—	—	—	—	—	—
Plant Operations	750	174	576	750	174	576	750	174	576	750	174	576
Mine Workers	180	180	0	180	180	0	180	180	0	180	180	0
Secondary Workers	567	567	0	511	511	0	480	480	[illegible]	464	464	0
TOTALS	1497	921	576	1441	865	576	1410	334	576	1394	818	576
SITE 1 AVERAGE												
Construction Workers	—	—	—	—	—	—	—	—	—	—	—	—
Plant Operations	750	174	576	750	174	576	750	174	576	750	174	576
Mine Workers	180	180	0	180	180	0	180	180	0	180	180	0
Secondary Workers	480	480	0	473	473	0	464	464	0	463	463	0
TOTALS	1410	834	576	1403	827	576	1394	818	576	1393	817	576
SITE 23 PEAK												
Construction Workers	—	—	—	—	—	—	—	—	—	—	—	—
Plant Operations	750	174	576	750	174	576	750	174	576	750	174	576
Mine Workers	180	180	0	180	180	0	180	180	0	180	180	0
Secondary Workers	567	567	0	511	256	255	480	320	160	464	308	156
TOTALS	1497	921	576	1441	610	831	1410	671	736	1394	662	732
SITE 23 AVERAGE												
Construction Workers	—	—	—	—	—	—	—	—	—	—	—	—
Plant Operations	750	174	576	750	174	576	750	174	576	750	174	576
Mine Workers	180	180	0	180	180	0	180	180	0	180	180	0
Secondary Workers	480	451	29	473	262	211	464	311	153	463	307	156
TOTALS	1410	805	605	1403	616	787	1394	665	729	1393	661	732

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4.1 SITE 1 POPULATION EFFECTS

Site 1 is situated on the northern border of the reservation approximately 15 miles from Hardin and 35 miles from Billings. With Billings and, to a lesser extent, Hardin to draw upon, a significant number of the basic and secondary jobs generated by the gasification facility are expected to be filled by workers from these areas. Given the proximity of these communities, the workers from Billings and Hardin are expected to commute to and from the site.

The jobs not filled by Crow workers and others from the surrounding area are expected to attract workers and their households from outside the area. Based upon the evidence being gathered by the retrospective study of impacts referred to in the Introduction, it is assumed that the in-migrating workers will choose to relocate in the largest community within reasonable commuting distance of the site. For purposes of this analysis, it is being assumed that 90 percent of the in-migrating households will choose to live in or near Billings in Yellowstone County. It is assumed that the remaining 10 percent are assumed to settle in Big Horn County near Hardin.

Many of the in-migrating workers will bring their families; however, others will not. These workers may choose to live alone or with other single members of the labor force. Based upon the findings of the others regarding the household characteristics of in-migrating workers, the average household size of all workers (married and single) is assumed to be 2.3. It is further assumed that—on the average—each in-migrating household has 1.2 qualified workers. Stated alternatively, from every five new households, one more secondary worker is provided. Thus, the household factor (the number of dependents per in-migrating household) is 1.9.*

*These assumptions are based upon the findings by Stenehjem and others in studies of worker characteristics. For an expanded description of the data and reasons behind these figures, see Stenehjem, 1976.

Based upon these assumptions, the estimates of annual population impacts associated with the peak and average work force scenarios are presented in Table 4.1-1.* As this table demonstrates, the population impacts on both Big Horn and Yellowstone counties are expected to be relatively small. Using the peak employment scenario, the effect on Big Horn County—in the year of highest employment—is to add 407 persons which represents only slightly more than 3 percent of that county's nonproject-related population in 1988. In this same year, the effect on the population of Yellowstone County is projected to be 3,665 persons which, because of its large population base, represents just under 3 percent of the total population.

*In the tables relating to population estimates, precise figures implying accuracy to the first digit are used. It must be recognized that these data are only reasonable estimates based on computer models and population statistics around which a reasonable error bound should be inferred.

TABLE 4.1-1
ANNUAL POPULATION IMPACTS IN BIG HORN AND YELLOWSTONE COUNTIES UNDER PEAK AND AVERAGE EMPLOYMENT REQUIREMENTS

PEAK SCENARIO

Variables	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Basic Jobs	793	2260	3350	3503	930	930	930	930	930	930	930
In-migrating Basic Labor	148	682	1773	2143	576	576	576	576	576	576	576
In-migrating Secondary Labor	0	0	0	0	0	0	0	0	0	0	0
New Basic Population	281	1296	3369	4072	1809	1809	1809	1809	1809	1809	1809
New Secondary Population	0	0	0	0	0	0	0	0	0	0	0
New Total Population	281	1296	3369	4072	1809	1809	1809	1809	1809	1809	1809
New Big Horn Population	28	130	337	407	181	181	181	181	181	181	181
As a % of Baseline	0.23	1.07	2.73	3.25	1.42	1.4	1.38	1.36	1.34	1.32	1.3
New Yellowstone Population	253	1166	3032	3665	1628	1628	1628	1628	1628	1628	1628
As a % of Baseline	0.21	0.96	2.44	2.9	1.26	1.24	1.22	1.2	1.19	1.17	1.16

AVERAGE SCENARIO

Variables	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Basic jobs	456	1520	2619	1968	930	930	930	930	930	930	930
In-migrating Basic Labor	90	368	1276	866	576	576	576	576	576	576	576
In-migrating Secondary Labor	0	0	0	0	0	0	0	0	0	0	0
New Basic Population	171	699	2424	1645	1809	1809	1809	1809	1809	1809	1809
New Secondary Population	0	0	0	0	0	0	0	0	0	0	0
New Total Population	171	699	2424	1645	1809	1809	1809	1809	1809	1809	1809
New Big Horn Population	17	70	242	165	181	181	181	181	181	181	181
As a % of Baseline	0.14	0.58	1.96	1.32	1.42	1.4	1.38	1.36	1.34	1.32	1.3
New Yellowstone Population	154	629	2182	1481	1628	1628	1628	1628	1628	1628	1628
As a % of Baseline	0.13	0.52	1.76	1.17	1.26	1.24	1.22	1.2	1.19	1.17	1.16

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4.2 SITE 23 POPULATION IMPACTS

Site 23 is located in the southeast corner of the Crow Reservation approximately 30-35 miles north of Sheridan, Wyoming. With the synfuels facility located at Site 23, a major portion of the work force is expected to come from the Billings area. Given the distances involved, these workers are expected to establish either temporary or permanent residences in the Sheridan area. Concomitantly, the positions not filled by in-migrants from Billings, Hardin, and other Montana cities are expected to be taken by residents of Sheridan who will commute daily to the facility. Thus, the city and county of Sheridan is expected to be the focal point for the in-migrating and local work forces and secondary economic activities.

Table 4.2-1 presents the projected population impacts on Sheridan County of constructing the Crow synfuels plant at Site 23. These figures portray the potential for severe socioeconomic impacts to result from locating the synfuels facility at Site 23—especially if the actually experienced levels of employment approach those projected under the peak scenario. It is commonly accepted that adverse impacts accompany increases (or decreases) in the population of a community or impact area that exceed 10 percent annually. The impacts on Sheridan County are forecasted to be twice this threshold in 1987. Worse, this population change is not likely to be distributed evenly throughout the county. Instead, much of this impact is expected to occur in and around the city of Sheridan. The table also indicates a moderate impact on Big Horn County as a result of the commuting Crow work force who will likely spend a fraction of their incomes on the reservation and in Hardin. This spending will result in the creation of additional secondary jobs.

TABLE 4.2-1
ANNUAL POPULATION IMPACTS ON SHERIDAN COUNTY
FOR PEAK AND AVERAGE EMPLOYMENT REQUIREMENTS

PEAK SCENARIO

Variables	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Basic Jobs	793	2260	3350	3503	930	930	930	930	930	930	930
In-migrating Basic Labor	437	1842	2862	3062	576	576	576	576	576	576	576
Secondary Jobs	141	435	706	816	567	511	480	464	464	464	464
In-migrating Secondary Labor	33	227	172	82	0	255	160	156	156	156	156
New Basic Population[a]	830	3500	5438	5818	1094	1094	1094	1094	1094	1094	1094
New Secondary Population[b]	103	734	594	310	550	763	486	493	493	493	493
New Sheridan County Population	907	4103	5957	6093	2242	2375	2161	2162	2162	2175	2187
As a % of Baseline	3.3	14.6	20.6	20.6	7.4	7.7	6.9	6.8	6.7	6.6	6.6
New Big Horn County Pop.[c]	26	131	75	35	117	197	134	140	140	127	115

AVERAGE SCENARIO

Variables	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Basic jobs	456	1521	2619	1968	930	930	930	930	930	930	930
In-migrating Basic Labor	243	1136	2176	1584	576	576	576	576	576	576	576
Secondary Jobs	181	289	538	495	480	473	464	463	464	464	464
In-migrating Secondary Labor	0	126	166	0	29	211	153	157	157	157	157
New Basic Population[a]	462	2158	4134	3010	1094	1094	1094	1094	1094	1094	1094
New Secondary Population[b]	0	396	521	0	91	663	480	493	493	493	493
New Sheridan County Population	460	2483	4562	3010	1169	1639	1489	1499	1499	1499	1499
As a % of Baseline	1.7	8.8	15.8	10.2	3.9	5.3	4.7	4.7	4.6	4.6	4.5
New Big Horn County Pop.[c]	0	71	93	0	16	118	85	88	88	88	88

[a]The population factor of 1.9 is used for construction workers.
[b]Population factor for secondary workers is 3.14.
[c]Big Horn County is estimated to increase as a result of the increased incomes received by the Crow work force which is likely to be spent—and thereby create jobs—in Hardin.

5.0
PUBLIC SECTOR EFFECTS

One of the most obvious, if not most serious, manifestations of impact from imposed growth is found in the stress these increases in populations place on the provision of private and public services. Not only does rapid population change reduce the per capita availability of and access to publicly provided services and facilities, it also very seldom "pays its own way" in terms of providing sufficient public revenues to enable host communities to expand such services and facilities in a timely fashion.

The effects of rapid, imposed growth on Hardin in Big Horn County (Site 1) and Sheridan in Sheridan County (Site 23) are estimated in the following subsections. The analysis begins with a description of the current capacities of these entities to accommodate increased populations. Following the assessment of the availability of public and private services and facilities in these areas, the incremental needs associated with the new populations are described. The final section presents the results of a prospective analysis of the public expenditures needed to accommodate the needs of the new population. It also forecasts the contributions to local revenues made by the new population. A comparison of incremental expenditures and revenues (referred to as a net fiscal balance analysis) concludes this chapter and the assessment of socioeconomic impacts.

5.1 GROWTH CAPACITIES

Table 5.1-1 presents, in summary form, the infrastructure profiles of Hardin, Big Horn County, Sheridan, and Sheridan County. It is in these communities and counties that the impacts of increased population on publicly provided services and facilities are expected to be most severely felt. The table indicates the availability of public services and the applicable planning standards (per capita service requirements) in each area. It also provides a description of their revenue sources and bonding capacities.

As the figures indicate, service delivery systems appear to be relatively close to the planning standards. For example, Hardin exceeds the required number of physicians per capita while Sheridan and Sheridan County have a slightly lower than recommended number of physicians. With respect to education, both cities and counties have more teachers per student than recommended by the planning standards. Thus, there is some excess capacity that could be utilized to accommodate additional population growth. In the area of public safety, only Hardin has more police officers per capita than is recommended while both Big Horn and Sheridan counties have more volunteer firemen than suggested by the planning standards. Finally, using the planning standards, it is clear that both Hardin and Sheridan have considerable excess capacity in their water treatment and sewer facilities.

The last section of Table 5.1-1 presents an overview of the financial conditions of the jurisdictions. Of importance to the analysis of impact accommodation is the capacity of each entity to finance needed service and facility expansion. The figures reveal that Big Horn and Sheridan counties can incur $9.6 million and $2.5 million in debt, respectively, while the cities of Hardin and Sheridan have available $1.6 million and $1.0 million, respectively, in unused bonding capacity.

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TABLE 5.1-1
INFRASTRUCTURE PROFILES OF IMPACT AREAS

Item	Big Horn County[a] (11,096)	Hardin[a] (3,177)	Sheridan County[b] (25,025)	Sheridan[b] (15,146)	Applicable Planning Standards[c]
HEALTH SERVICES					
Physicians	N/A	5.0	35.0	21.0	
Per 1000		1.574	1.399	1.387	1.5
Dentists	N/A	2	18.0	N/A	
Per 1000		0.630	0.719		
Registered Nurses	N/A	4.0	76.0	47.0	
Per 1000		1.259	3.037	3.103	
Hospital Beds	N/A	16.0	97.0	97.0	
Per 1000		5.036	3.876	6.404	4.0
Nursing Home Beds	N/A	36.0	120.0	N/A	
EDUCATION					
Students	N/A	1350.0	4936.0	3844.0	
Classrooms	N/A	83.0	291.0	N/A	
Per student		0.061	0.059		0.045
Teachers	N/A	85.0	303.0	285.0	
Per student		0.063	0.061	0.074	0.045
PUBLIC SAFETY					
Police Officers	13.0	10.0	39.0	29.0	
Per 1000	1.172	3.148	1.560	1.915	2.0
Police Vehicles	7.0	4.0	16.0	11.0	
Per 1000	0.631	1.259	0.064	0.728	
Crimes	417.0	N/A	1352.0	735.0	
Per 1000	37.581		54.100	49.400	
Firemen (full-time)	N/A	None	22.0	18.0	
Per 1000			0.880	1.188	1.667
Firemen (volunteer)	20.0	Shared with	60.0	10.0	
Per 1000	1.802	county	2.400	0.660	0.667
Fire Vehicles	4.0	2.0	29	4.0	
Per 1000	0.360	0.630	1.160	0.267	
WATER AND SEWER					
Delivery Capacity	N/A	2.0 mgd	N/A	10.0 mgd	
Per 1000		0.630	Well and Septic	0.660	
Treated Water Storage	N/A	1.0 mgd		10.0 mgd	
Per 1000		0.315		0.660	
Water Treat. Cap.	N/A	1.9 mgd		10.0 mgd	0.040-0.230
Per 1000		0.598		0.660	

TABLE 5.1-1
INFRASTRUCTURE PROFILES OF IMPACT AREAS
(Continued)

Item	Big Horn County[a] (11,096)	Hardin[a] (3,177)	Sheridan County[b] (25,025)	Sheridan[b] (15,146)	Applicable Planning Standards[c]
WATER AND SEWER – Continued					
Sewer Plant Capacity	N/A	1.0 mgd		15 mgd	0.026-0.150
		0.315		0.990	
PUBLIC FINANCE					
1980 Expenditures	$4.9MM	$2.0MM	$15.9MM	$11.5MM	
Per Capita	$442	$630	$635	$759	
1980 Assessed Valuation	$106.1MM	$3.0MM	$142.6MM	$124.7MM	
Per Capita	$9636	$944	$5698	$8233	
1980 Mill Rate	75.98¢/000	115.17¢/000	10.83¢/000	12¢/000	
1980 Tax Revenues	$0.8MM	$3,749MM	N/A	$1.2MM	
Per Capita	$72.10	$1		$79.23	
1980 Indebtedness	None	None	$460,000	$325,000	
Per Capita			$18.38	$21.45	
1980 Bonding	$9.6MM	$1.6MM	$2.9MM	$1.3MM	
Per Capita	$865	$504	$116	$86	

[a]Data obtained from a telephone survey and literature search conducted by the Council of Energy Resource Tribes, 1981.

[b]Data obtained by Jim Richards under contract to CERT, 1982.

[c]DOE 1978. (Reference 12)

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5.2 INCREMENTAL INFRASTRUCTURE NEEDS

The Reservation Social and Economic Assessment Model (RSEAM) was used to compute the estimated additions to selected facilities and services of the population increases associated with the peak employment scenarios at Sites 1 and 23. The model used the peak numbers of in-migrants expected during plant construction and plant operations at both sites and translated these population figures into service and facility requirements using the conversion factors prepared by Murphy and Williams for the U.S. Department of Energy (DOE 1978; see Appendix C-3). (Reference 12) The resulting estimates reflect the needs of the in-migrating populations, they do not attempt to adjust for capacity excesses or deficiencies. In what follows, the estimated service and facility requirements for Site 1 and Site 23 are presented in sequence.

5.2.1 SITE 1 INCREMENTAL INFRASTRUCTURE NEEDS

Under the peak employment scenario, it is estimated that the population impact on Hardin and Big Horn County will be 337 people in the third year of plant construction and 181 during all years of plant operation. The estimated population impacts on Billings and Yellowstone County during these periods are 3,032 and 1,628 people, respectively. While the number of persons expected to choose Billings as their new residence is considerably higher than those assumed to locate near Hardin, the newcomers in Billings are a smaller proportion of the total population in Billings.

Table 5.2.1-1 presents the incremental service and facility requirements associated with the newcomers to Billings and Hardin. The first portion of the table presents the household and demographic characteristics assumed for these newcomers. These data are used in conjunction with the DOE requirement data to construct estimates of social service and private sector needs. As the results indicate, the impact requirements are expected to be fairly substantial in the Billings area. For example, as many as 29 new teachers are needed to meet the short-term demands of the construction work force. At the end of the fourth year, ten of these teachers will no longer be required to meet the sustained needs of the operating work force. In

TABLE 5.2.1-1
SITE 1 FACILITY AND SERVICE NEEDS

Impacts	Billings Construction	Billings Operation	Hardin Construction	Hardin Operation
POPULATION SUMMARY	3032	1628	337	181
Age distribution (years)				
5	437	168	49	19
5-17	725	467	81	52
18-29	961	456	107	51
30-44	576	317	64	35
45-64	315	164	35	18
65	18	55	2	6
Households	1189	498	132	55
School enrollment	652	421	72	47
REQUIREMENTS				
Teachers	29	19	3	2
Classrooms	29	19	3	2
Physicians	3	2	0	0
Registered nurses	18	13	2	1
Health support personnel	6	4	1	0
Police and firemen	9	6	1	1
Single family homes	588	314	65	35
land (acres)	105		12	
Mobile home units	458	131	51	15
land (acres)	26		3	
Multifamily units	262	78	29	9
land (acres)	8		1	
Parks and open space (acres)	2		14	
Residential/community streets (linear feet)				
arterials	8268		919	
collectors	11579		1287	
minor streets	38679		4301	
Retail building space (sq ft)	222843		120036	
Service building space (sq ft)	92498		49825	
Office building space (sq ft)	118723		68023	

addition to publicly provided services, it is expected that a substantial number of new homes and business properties will be required as a result of the impacts from the synfuels facility.

These data also reveal an impact phenomenon common to most major, imposed growth situations. That is, the initial need for public and private facilities and services is higher than that projected to meet the needs of the operations period population. This creates a dilemma for local businessmen and planners. If they build and expand to meet the expected demands of the peak population, they will be confronted with considerable excess capacity during the operations period. On the other hand, if they ignore the needs of the peak construction population, the risk is run that increased turnover and localized inflation will result in a general deterioration of the community's quality of life. The general solution to this dilemma is a compromise in which permanent facilities are built to accommodate the operating period population, and temporary facilities (and personnel) are added to meet the short-term needs of the construction-period population, in excess of the operating population. Thus, mobile classrooms are purchased or rented to satisfy the needs of educating the additional construction period students. Similarly, the excess housing demand of the construction-period population may be met by overbuilding mobile home pads that might be converted to camping facilities or single family home slabs once the housing demand stabilizes.

The percentage increase in population associated with the selection of Site 1 is just over 3 percent in Hardin and just under 3 percent in Billings at the height of plant construction. During the operation period, the increase is less than 1.5 percent of the baseline population in both communities. With normal population growth exceeding these levels in each community during the preceding decade, it is unlikely that expansion of the infrastructure will present the communities with significant excess capacity.

5.2.2 Site 23 Incremental Infrastructure Needs

The situation is much more extreme in Sheridan, Wyoming. If Site 23 is selected as the location of the Crow synfuels facility, the problems of in-migration and concomitant infrastructure impacts are likely to be severe. This is so because a significantly larger in-migrating work force is expected and these newcomers are expected to settle in and around the city of Sheridan in Sheridan County since it is the only major population center within reasonable commuting distance.

Estimates of the increased needs for public and private facilities and services associated with the peak employment scenario are presented in Table 5.2.2-1. As the figures reveal, a substantial number of newcomers are expected in both the construction and operation period. They represent an increase in the baseline population of Sheridan County of 20.6 percent and 6.7 percent respectively. This is a significant impact by any standard. However, if, as expected, this in-migrating population settles in and around the city of Sheridan, the relative impacts will be substantially larger. For example, if all these newcomers settle within the city limits, Sheridan's population will increase by an estimated 34 percent in the construction period and by 11 percent in the operation period.

The impacts on the personnel and capital infrastructure are substantial. For example, it is expected that 58 new classrooms and teachers will be required to accommodate the school-aged dependents of the in-migrating construction workers. During the operation period, the demand for teachers and classrooms is reduced by more than one-half.

The housing situation is likely to result in even more dramatic problems. As the figures indicate, the demand for housing is expected to reach 2,536 units during construction and to drop by more than 70 percent to 703 units during the operation period. Given the disparity between the housing needs of the construction work force and the stable and sustained demands of the operating work force, it is difficult to imagine how overbuilding will be avoided even if temporary quarters are resorted to during construction. One possible solution to this potential problem would be to provide a construction work camp for in-migrating workers. While this approach has been used in the oil shale regions of Colorado, it is both expensive and unlikely to contribute directly to the tax base of the community to which these workers will undoubtedly turn for other public and private services.

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TABLE 5.2.2-1
SITE 23 FACILITY AND SERVICE NEEDS: SHERIDAN

Impacts	Construction	Operation
POPULATION SUMMARY	5957	2187
Age distribution		
5	858	225
5-17	1424	628
18-29	1888	612
30-44	1132	426
45-64	620	221
65	36	74
Households	2306	669
School enrollment	1281	565
REQUIREMENTS		
Teachers	58	25
Classrooms	58	25
Physicians	6	3
Registered nurses	36	17
Health support personnel	12	5
Police and firemen	18	8
Single family homes	1141	422
land (acres	141	
Mobile homes	888	176
land (acres)	35	
Multifamily homes	507	105
land (acres)	11	
Parks and open space (acres)		19
Residential and community streets (linear feet)		
arterials		11107
collectors		15555
minor streets		51960
Retail building space		249946
Service building space		103748
Office building space		144073

5.3 INCREMENTAL PUBLIC EXPENDITURES AND REVENUES

The public and private sector expansion requirements were estimated for Site 1 and Site 23 communities in Section 5.2. With respect to Site 1, the infrastructure impacts on both Hardin (Big Horn County) and Billings (Yellowstone County) were estimated for two separate levels of in-migrating population growth: the peak construction period population and the peak operating period population. The impacts in terms of absolute requirements were estimated to be considerably larger for Billings because 90 percent of the in-migrating population are assumed to choose to live there. In relative terms, both the population and infrastructure impacts were found to be modestly higher in Hardin owing to its considerably smaller pre-impact size. In neither community, however, was the in-migrating population ever expected to exceed 3.25 percent of the existing or baseline population.

With respect to Site 23, the situation is markedly different. Due to its size and proximity, the Sheridan, Wyoming, area was projected to receive almost the entire population impact of the in-migrating work force (Sheridan is not expected to be the only recipient of the economic effects associated with the selection of Site 23; it is likely that the Crow construction and operating workers would spend a considerable proportion of their incomes in Hardin and the communities of the Crow reservation). And due to the exigencies of institutionalized work rules, it was estimated that the number of in-migrating workers would be substantial. The result of these conditions was the projection that, during the peak construction period, the population of Sheridan County could expand by more than 20 percent over projected baseline levels. Even during the operating period, the peak employment scenario resulted in contributing an additional 6-7 percent to the population of Sheridan County. The estimated effects of these newcomers on the requirements for public and private sector infrastructure in Sheridan were presented in the previous section.

The costs of providing the additional public sector facilities and services are estimated. In addition, rough estimates are provided of the incremental revenues these newcomers and their induced secondary economic activities will contribute to these communities. Subtracting anticipated expenditures from revenues yields an estimate of the net fiscal effects the Crow synfuels facility is likely to have on Hardin, Billings, and Sheridan.*

5.3.1 Site 1 Public Sector Fiscal Effects

Tables 5.3.1-1 and 5.3.1-2 present the public capital facility costs and the operating period revenues and expenditures for Billings and Hardin, respectively. It must be pointed out that the fiscal analysis suffers from two deficiencies. First, the unused capacities of these communities have not been factored into the fiscal analysis. Second, the analysis does not consider all the potential expenditures or revenues likely to confront these communities as a result of growth impacts. With these caveats in mind, the analysis provides a summary of the most important cost and revenue impacts on these communities under the assumption that no excess capacity exists in any of the major infrastructure categories. Thus, the fiscal analysis reflects, in general terms, whether imposed growth will or will not pay its own way with respect to the demands it places on these entities.

Table 5.3.1-1 summarizes the capital costs of providing many of the important facilities required by the in-migrants. The figures of primary importance here are those for the operation period. As expressed above, it is expected that both the Billings and Hardin areas will adjust to their growth impacts by expanding their permanent infrastructure sufficiently to accommodate the level of growth expected during plant operations. The additional needs of the short-term construction work force are most likely to be met with the addition of temporary services and facilities.

The capital costs of providing the permanent infrastructure are estimated to be $15.7 million in the Billings area and $1.7 million in the Hardin area. It is assumed that the construction of these capital facilities will be financed through the sale of revenue bonds (for the utilities) and general obligation bonds for other publicly

*For computational purposes, costs, and revenues are rounded to the nearest dollar. Rounding to the nearest thousand dollars may better represent their accuracy.

TABLE 5.3.1-1
SITE 1 CAPITAL COSTS FOR PUBLIC FACILITY NEEDS

Item	Billings Construction ($000)	Billings Operation ($000)	Hardin Construction ($000)	Hardin Operation ($000)
Parks and Open Space Total[a]	$ 389,912	$389,912	$43,350	$43,350
Development costs		181,484		20,177
Land costs		208,428		23,173
School Buildings Total	5,876,634	3,789,115	628,052	421,271
Construction	5,045,187	3253,018	560,761	361,668
Other	605,422	390,362	67,291	43,400
Community Street System Total[a]	3,257,931	3,257,931	362,215	362,215
Construction		3,044,796		338,518
Land		213,136		23,696
Public Facilities Total	1,982,528	1,064,497	220,354	118,350
Police Facilities	214,908	115,393	23,887	12,829
Fire Facilities	171,927	92,314	19,109	10,263
General Government	107,454	57,696	11,943	6,415
Health Care Facilities	1,267,958	680,817	140,931	75,693
Library Facilities	220,281	118,277	24,484	13,150
Utilities Total	16,678,202	7,292,972	1,853,655	810,828
Sewer System	4,041,324	1,749,216	449,162	194,477
Storm Drainage	3,701,027	1,678,998	411,341	186,670
Water Facilities	7,054,428	3,052,272	784,046	339,350
Gas and Electric	1,881,423	812,486	209,106	90,332
Total Capital Costs	$ 28,185,207	$15,794,427	$3,107,626	$1,756,014
Annual Debt Service Costs[b]	$ 3,773,401	$ 2,114,538	$ 416,045	$ 235,093

[a]It is assumed that even with a commitment to meet the needs of the construction work force, the parks and the community street system, because of their "public goods" nature, would not be expanded beyond the levels needed to accommodate the operation-period population.

[b]The annual costs of servicing 20-year, 12 percent tax-free bonds.

TABLE 5.3.1-2
ANNUAL INCREMENTAL REVENUES AND EXPENDITURES

Operating Revenue and Expenditure Items	Operations Period Costs Billings	Operations Period Costs Hardin
REVENUES		
TAXABLE VALUATIONS		
Residential Property	$16,071,033	$ 1,786,767
Nonresidential Property	17,177,493	10,105,207
TOTAL TAXABLE VALUATIONS	33,248,527	11,891,974
Total Incremental City/County TAXES	731,468	261,623
Local Nontax Revenues	416,937	149,125
State and Federal Transfers	803,883	287,524
TOTAL INCREMENTAL REVENUES	1,952,287	698,273
EXPENDITURES		
PUBLIC SCHOOLS TOTAL	820,127	91,181
General Operations	812,211	90,301
Busing	7,916	880
COMMUNITY STREETS TOTAL	42,357	4,709
PUBLIC SERVICES TOTAL	574,078	63,826
Police	75,005	8,339
Fire	75,005	8,339
Health Care	349,063	38,809
Libraries	11,539	1,283
Recreation	28,848	3,207
UTILITIES	448,589	49,874
Water and Sewer	60,581	6,735
Gas and Electric	360,602	40,092
Solid Waste	27,406	3,047
Other Operating and Maintenance Costs	219,246	24,367
Debt Services	2,114,538	235,093
Total Incremental Expenditures	4,218,935	469,059
Annual Fiscal Balance	$-2,266,648	$ + 229,214

provided facilities. If both debt instruments have a 20-year life and tax-free yields of 12 percent the annual costs of servicing the debt will be $2,114,000 in Billings and $235,000 in Hardin.

Table 5.3.1-2 summarizes the estimates of incremental revenues and expenditures associated with the permanent operation-period population. They indicate an annual short-fall of revenues of $2 million in Billings. However, in Hardin it is expected that growth will pay its own way and contribute modestly to an annual surplus in revenues.

5.3.2 Site 23 Public Sector Fiscal Effects

Table 5.3.2-1 summarizes the estimated increases in capital costs needed to accommodate the in-migrating population during plant construction and plant operations. The capital costs exceed the debt limitations of both the city and county. Thus, unless the debt ceilings can be lifted or other mechanisms found to provide these funds, it is doubtful that the required infrastructure will be available for the in-migrating populations. The consequences of shortages in community facilities and services have been reported in numerous studies. Gilmore, in his seminal work on boom towns, indicates that such shortages precipitate the "Problem Triangle." According to this paradigm, the lack of public and private facilities leads to frustration and disaffection among new (and old) residents causing increased out-migration and high labor turnover which, in turn, contributes to declining productivity in both the basic and secondary sectors of the economy. This decline in productivity results in a further reduction of goods and services, higher prices, more dissatisfaction, increased turnover, and absolute deterioration in the standards of living and quality of life (Gilmore and Duff 1974). (Reference 5)

Assuming that the funds needed to expand the public facilities in and around Sheridan can be borrowed, the annual debt service requirements, as shown at the bottom of Table 5.3.2-1, would be substantial. Table 5.3.2-2 presents an assessment of the annual incremental revenues and expenditures—including debt service costs—during the construction and operation periods. As shown, the annual deficits are expected

TABLE 5.3.2-1
SITE 23 CAPITAL COSTS FOR PUBLIC FACILITY NEEDS: SHERIDAN

Item	Construction ($000)	Operations ($000)
Parks and Open Space Total	$ 523,794	$ 523,794
Development Costs		243,799
Land Costs		279,995
School Buildings Total	11,545,880	5,090,169
Construction	9,912,328	4,369,994
Other	1,189,479	5224,399
Community Street System Total[a]	4,376,595	4,376,595
Construction		4,090,275
Land		286,319
Public Facilities Total	3,895,092	1,430,009
Police Facilities	422,232	155,015
Fire Facilities	337,786	124,012
General Government	211,116	77,507
Health Care Facilities	2,491,170	914,586
Library Facilities	432,788	158,890
Utilities Total	32,349,027	9,797,131
Sewer System	7,838,549	2,349,837
Storm Drainage	7,178,509	2,255,509
Water Facilities	13,682,762	4,100,319
Gas and Electric	3,649,207	1,091,467
Total Capital Costs	$52,690,388	$21,217,698
Annual Debt Service Costs[b]	$ 7,054,125	$ 2,840,600

[a] It is assumed that, even with a commitment to meet the needs of the construction work force, the parks and the communities street system, because of their "public goods" nature, would not be expanded beyond levels needed to accommodate the operation-period population.

[b] The costs of servicing 20-year bonds paying a tax-free 12 percent.

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TABLE 5.3.2-2
ANNUAL INCREMENTAL REVENUES AND EXPENDITURES: SHERIDAN

Operating Revenue and Expenditure Item	Construction	Operations Period
REVENUES		
Taxable Ad Valorem Valuations	$70,705,243	21,589,281
Residential Property	19,931,182	19,931,182
Nonresidential Property	90,636,425	41,520,463
Total Incremental City/County Ad Valorem Taxes[a]	498,500	228,363
Total Incremental Sales Revenue	45,593,559	12,880,962
Total City/County Sales Tax Revenues[b]	911,871	257,619
Local Nontax Revenues	886,643	520,666
State and Federal Transfers	1,709,511	1,003,882
Total Incremental Revenues	4,006,525	2,010,530
EXPENDITURES		
Public Schools Total	2,499,025	1,101,731
General Operations	2,474,903	1,091,097
Busing	24,121	10,634
Community Streets Total	56,901	56,901
Public Services Total	2,100,605	771,197
Police	274,451	100,759
Fire	274,451	100,759
Health Care	1,277,252	468,919
Library	42,223	15,501
Recreation	105,558	36,754
Utilities	1,641,428	602,619
Water and Sewer	221,672	81,383
Gas and Electric	1,319,476	484,421
Solid Waste	100,280	36,816
Other Operating and Maintenance Costs	802,241	294,528
Debt Service[c]	7,054,125	2,840,600
Total Incremental Expenditures	$ 14,154,325	$ 5,667,576
ANNUAL FISCAL BALANCE	$-10,147,800	$-3,657,046

[a]The combined city and county ad valorem tax is 22 mills on 25 percent of full value.

[b]The city and county each levy a 1 percent tax on sales within their jurisdictions. Although the entire in-migrant population may not live within the boundaries of the city, it is assumed that all will shop in Sheridan.

[c]The annual costs of servicing the debt from Table 5.3.2-1.

to be substantial even if the infrastructure is expanded only to the level required by the permanent operating and secondary work forces. To place these figures in perspective, the entire budget for Sheridan County was $15,987,000 in 1980; the budget for the city of Sheridan was $11,515,000 in the same year. The deficits of $10.1 million and $3.6 million forecasted for the in-migrating construction and operating period workers represent an extremely high proportion of these total budgets.

6.0
CONCLUSIONS

This analysis supports the conclusion that Site 1 is preferred over Site 23, from a socioeconomic standpoint. The projections presented in this analysis rest on a host of data and assumptions concerning manpower needs, the availability of local Indian and non-Indian labor, manpower competition from other projects, household sizes, the spatial distribution of households, and the service requirements and costs of new populations. Based upon the data available at the time this analysis was prepared and the assumptions constructed from the most recently available evidence of socioeconomic impact phenomena, the study concludes that the population and public sector impacts will be markedly greater on Sheridan if Site 23 is selected than on Billings and Hardin if Site 1 is selected.

These impacts impose project-related costs of two types. The first type of project-related impact costs are the direct costs of mitigating local public sector impacts. Recent mitigation agreements in the Rocky Mountain Region have required the project developer to provide both the incremental capital and the annual operating costs for new or expanded public facilities and services attributable to project-related growth. An estimate of these costs associated with the selection of Site 1 is provided in Tables 5.3.1-1 and 5.3.1-2. Capital facilities costs during the postconstruction period in both Billings and Hardin are estimated to be $17,550,440. The annual incremental costs of providing services to the newcomers in these two areas are projected to be $2,037,430. Their present value of $13,377,750 is estimated by discounting these costs over a projected 30-year project life at an assumed opportunity cost of capital of 15 percent. Total mitigation costs associated with the selection of Site 1 are estimated to be $30,928,190 in current dollars.* Similar projections of project-related mitigation costs associated with the selection of Site 23 are prepared using the postconstruction period costs in Tables 5.3.2-1 and

*Obtained by adding the capital cost estimates for Billings and Hardin during the operations period ($17,550,440) and the present value of operating and maintenance expenditures in excess of revenues in both communities over the projected 30 year life of the facility ($13,377,750).

5.3.2-2. The total costs in current dollars are estimated to be $45,229,790.* Comparing the costs of mitigating growth in Sheridan to the costs in Billings and Hardin provides one measure of the relative project-related impacts associated with the selection of Site 1 over Site 23.**

The second type of project-related impact costs are those associated with the turnover of the project work force in these two site areas. Quantifying the extent of turnover and its effects on productivity and project costs is extremely difficult. Sufficient empirical evidence of these effects does not exist to permit estimates to be made with precision. However, during the construction of the gasification facility, annual growth rates in Sheridan County are expected to exceed—by a factor of 2—the rates generally considered to be tolerable and at nonimpact-producing levels. If, as a result of the pressures of rapid growth (e.g., housing shortages, local inflation, increased crime and domestic violence, and shortage of needed services), it is assumed that labor productivity is just 20 percent lower at Site 23 than Site 1, the effects on project construction costs can be estimated. Table 3.1-2 presents the estimated construction labor wage bill ($72,000,000) for the third year of plant construction. A decline in productivity of 20 percent at Site 23 would have the effect of increasing construction costs there by approximately $14.5 million in the third year alone. Again, accepting the relationships among rapid growth, adverse socioeconomic impacts, labor turnover, and reduced productivity, Site 23 is expected to impose greater project-related costs than Site 1.

The estimates of both mitigation and productivity project related impact costs rest on too many assumptions to be accepted uncritically as projections of the actual dollar costs associated with growth impacts at Sites 1 and 23. The figures are presented instead to illustrate the relative severity of the socioeconomic impacts

*Obtained from Tables 5.3.2-1 and 5.3.2-2 by adding the present value of excess operating and maintenance expenditures to the total estimated capital costs.

**These figures reflect relative impact severity in the two sites. Whether they accurately represent actual project-related costs depends on a number of factors including the willingness and legal standing of both parties to negotiate mitigation agreements.

likely to occur at both sites. That is, accepting the assumptions used, it is likely that the costs of mitigating the impacts at Site 23 will be approximately 30 to 35 percent higher than the impact mitigation costs at Site 1. Similarly, it is expected that, if the impacts are not mitigated, productivity will be lower at Site 23 than at Site 1 as a result of a higher incidence of labor turnover. The figures on public costs and productivity effects are not sufficiently reliable, however, to permit an evaluation of whether it might be more cost-effective to mitigate impacts and avoid productivity declines or to accept reductions in productivity and resist contributing to impact mitigation.

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SECTION C

SOCIOECONOMIC DATA

APPENDICES

APPENDIX C-1

UNION WAGE LEVELS IN MONTANA

■ = COLA EXCLUDED • = ESTIMATED, SEE TECHNICAL NOTES

REGION OR STATE	CITY	CRAFT	LOCAL	EXP.DATE	NO.WRKRS	WAGE BENEFIT	WAGE RATE	H & W	PENSION	VACATION	* OTHER
COLORADO	DENVER	TAPERS	B0079	06/30/80	390	14.260	12.360	.750	1.150	.000	.000
		MASON OPCM	H0577	04/30/81	44	12.110	10.110	.550	1.150	.300	.000
			B0577	04/30/81	230	13.090	10.790	.550	1.150	.600	.000
		PLASTR OP	B0032	04/30/81	23	12.490	12.490	.000	.000	.000	.000
		PIPE FTTRS	B0208	04/30/81	1725	15.070	12.270	.850	1.150	.800	.000
		PLUMBERS	B0003	04/30/81	1000	15.070	12.270	.850	1.150	.800	.000
		ROOFERS	B0041	06/30/80	450	12.970 ■	11.770	.800	.000	.000	.000
		SHTMTL WKR	B0009	04/30/81	1250	15.160	12.990	.680	1.510	.000	.000
		TEAMSTERS	H0013	04/30/81	750	10.180	9.380 •	.400	.300	.100	.000
			B0013	04/30/81	600	10.180	9.380 •	.400	.300	.100	.000
	FORT COLLINS	BRIKLAYERS	B0010	04/30/81	110	13.390	11.490	.850	1.050	.000	.000
		CARPENTERS	R0000	04/30/81	50	9.380	6.680	.900	.950	.850	.000
		DRY WALL	R0000	04/30/81	50	9.380	6.680	.900	.950	.850	.000
		PLASTR OP	B0032	04/30/81	11	13.740	13.740	.000	.000	.000	.000
	GRAND JUNCTION	BRIKLAYERS	B0011	04/30/81	30	13.050	11.250	.850	.950	.000	.000
		MRBL STTRS	B0011	04/30/81	13	13.050	11.250	.850	.950	.000	.000
		TILE STTRS	B0011	04/30/81	9	13.050	11.250	.850	.950	.000	.000
		TRAZO WKRS	B0011	04/30/81	6	13.050	11.250	.850	.950	.000	.000
		ELCTCN INS	B0969	02/28/80	200	14.210	12.850	.720	.640	.000	.000
		MASON OPCM	B0694	04/30/81	90	13.090	10.790	.550	1.150	.600	.000
		PLASTR OP	B0032	04/30/81	22	15.240	15.240	.000	.000	.000	.000
		PIPE FTTRS	B0145	04/30/81	101	14.850	11.100	.850	1.150	1.750	.000
		PLUMBERS	B0145	04/30/81	79	14.850	11.100	.850	1.150	1.750	.000
	PUEBLO	BRIKLAYERS	B0002	04/30/81	78	13.270	11.470	.850	.950	.000	.000
		ELCTCN INS	B0012	05/31/81	500	14.590	12.690	.720	1.180	.000	.000
		LATHERS	B0069	09/19/78	20	10.290	10.290	.000	.000	.000	.000
		PAINTERS	B0178	06/30/82	189	11.690	10.440	.750	.500	.000	.000
		FLOOR PAT	B0419	05/31/78	32	9.920	8.470	.400	.750	.300	.000
		TAPERS	B0171	06/30/82	56	11.690	10.440	.750	.500	.000	.000
		MASON OPCM	B0050	04/30/81	90	13.090	10.790	.550	1.150	.600	.000
		PIPE FTTRS	B0020	06/30/79	226	14.120	12.230	.800	1.050	.000	.040
		PLUMBERS	B0020	06/30/79	99	14.120	12.230	.800	1.050	.000	.040
	STERLING	CARPENTERS	B0001	04/30/78	3724	12.065	10.335	.530	.700	.500	.000
		PILE DRVRS	B0001	04/30/78	420	12.065	10.335	.530	.700	.500	.000
		LABORERS	B0007	04/30/81	300	9.590	8.490	.500	.600	.000	.000
		MASON TEND	B0007	04/30/81	121	10.340	9.400 •	.440	.500	.000	.000
		PLSTR TEND	B0007	04/30/81	55	10.340	9.400 •	.440	.500	.000	.000
	** STATE TOTALS				34980	12.796	10.770	.720	.924	.368	.014
MONTANA	ANACONDA	CARPENTERS	B0088	04/30/83	160	12.270	10.720	.800	.750	.000	.000
		MLLWRIGHTS	B0088	04/30/83	25	12.520	10.970	.800	.750	.000	.000
		PILE DRVRS	B0088	04/30/83	16	12.520	10.970	.800	.750	.000	.000
		DRY WALL	B0088	04/30/83	16	12.270	10.720	.800	.750	.000	.000
		IRN STRCTL	B0001	06/30/80	90	14.260	12.310 •	.700	1.250	.000	.000
			H0001	06/30/80	15	14.260	12.310 •	.700	1.250	.000	.000
		IRN RODMAN	B0001	06/30/80	25	14.260	12.310 •	.700	1.250	.000	.000
			H0001	06/30/80	10	14.260	12.310 •	.700	1.250	.000	.000

* = COLA EXCLUDED # = ESTIMATED, SEE TECHNICAL NOTES

REGION 08

STATE	CITY	CRAFT	LOCAL	EXP.DATE	NO.WRKRS	WAGE BENEFIT	WAGE RATE	H & W	PENSION	VACATION	OTHER
MONTANA	BILLINGS	BRIKLAYERS	80010	05/31/80	92	14.000	13.550	.000	.450	.000	.000
		MRBL SETRS	80010	05/31/78	7	11.900	11.450	.000	.450	.000	.000
		TILE SETRS	80010	05/31/78	7	11.900	11.450	.000	.450	.000	.000
		TRAZO WKRS	80010	05/31/78	7	11.900	11.450	.000	.450	.000	.000
		CARPENTERS	81172	04/30/80	220	11.930	10.380	.800	.750	.000	.000
		MLLWRIGHTS	81172	04/30/80	10	12.930	11.380	.800	.750	.000	.000
		PILE DRVRS	81172	04/30/80	12	12.080	10.530	.800	.750	.000	.000
		DRY WALL	81172	04/30/80	12	11.930	10.380	.800	.750	.000	.000
		ELCTCN INS	C0532	05/31/80	200	12.490	11.200	.450	.840	.000	.000
			80532	05/31/80	160	14.400	12.820	.450	1.130	.000	.000
		IRN STRCTL	8A006	06/30/80	111	14.110	12.080	.750	1.350	.000	.000
		IRN RODMAN	8A006	06/30/80	99	14.110	12.010	.750	1.350	.000	.000
		LABORERS	80098	04/30/79	290	9.750	8.790 #	.480	.480	.000	.000
			110098	04/30/79	2000	9.090	8.090	.550	.450	.000	.000
		MASON TEND	80098	04/30/79	82	10.000	9.040 #	.480	.480	.000	.000
		PLSTR TEND	80098	04/30/79	48	10.000	9.040 #	.480	.480	.000	.000
		LATHERS	80298	04/30/78	10	8.930	8.930	.000	.000	.000	.000
		OP-ENG CRN	80400	04/30/82	70	13.520	11.670	.750	.650	.450	.000
		PAINTERS	80167	05/31/80	79	10.620	9.930	.490	.200	.000	.000
		GLAZIERS	80167	09/20/81	30	11.080	11.080	.000	.000	.000	.000
		FLOOR PAT	80167	05/31/80	19	10.620	9.930	.490	.200	.000	.000
		TAPERS	80167	05/31/80	22	10.720	10.030	.490	.200	.000	.000
		MASON OPCM	80392	05/18/80	42	11.000	9.900	.850	.250	.000	.000
		PLASTR OP	80392	05/18/80	14	11.050	9.950	.850	.250	.000	.000
		PIPE FTTRS	80030	08/31/78	121	13.350	11.450	1.000	.900	.000	.000
		PLUMBERS	80030	08/31/78	79	13.350	11.450	1.000	.900	.000	.000
		ROOFERS	80229	06/30/80	40	10.790	10.540	.000	.250	.000	.000
		SHTMTL WKR	80169	06/30/80	59	12.980 *	10.805 #	.680	.725	.000	.310
	BOZEMAN	BRIKLAYERS	80005	03/31/80	13	12.590	11.250	.750	.550	.000	.000
		MRBL SETRS	80005	03/31/80	5	12.550	11.250	.750	.550	.000	.000
		TILE SETRS	80005	03/31/80	5	12.550	11.250	.750	.550	.000	.000
		TRAZO WKRS	80005	03/31/80	5	12.550	11.250	.750	.550	.000	.000
		CARPENTERS	8D000	04/30/81	229	11.870	10.320	.800	.750	.000	.000
		MLLWRIGHTS	8D000	04/30/81	20	12.870	11.320	.800	.750	.000	.000
		PILE DRVRS	8D000	04/30/81	5	12.120	10.570	.800	.750	.000	.000
		DRY WALL	8D000	04/30/81	16	11.870	10.320	.800	.750	.000	.000
		ELCTCN INS	80416	03/31/81	40	13.060	11.950	.500	.610	.000	.000
		LABORERS	81334	05/14/79	60	9.250	8.410	.470	.370	.000	.000
		MASON TEND	81334	05/14/79	30	9.250	8.410	.470	.370	.000	.000
		PLSTR TEND	81334	05/14/79	30	9.500	8.660	.470	.370	.000	.000
		ROOFERS	80252	03/31/80	19	10.550	10.000	.550	.000	.000	.000
	BUTTE	BRIKLAYERS	80001	03/31/80	13	13.000	12.450	.000	.550	.000	.000
		MRBL SETRS	80001	03/31/80	6	13.000	12.450	.000	.550	.000	.000
		TILE SETRS	80001	03/31/80	6	13.000	12.450	.000	.550	.000	.000
		TRAZO WKRS	80001	03/31/80	2	13.000	12.450	.000	.550	.000	.000
		CARPENTERS	80112	04/29/82	360	12.880	10.330	.800	1.000	.750	.000
		MLLWRIGHTS	80112	05/07/82	15	13.630	11.080	.800	1.000	.750	.000
		PILE DRVRS	80112	05/07/82	4	13.630	11.080	.800	1.000	.750	.000
		DRY WALL	80112	05/07/82	18	12.880	10.330	.800	1.000	.750	.000
		ELCTCN INS	80623	05/31/81	150	14.280	12.750	.650	.880	.000	.000
		LABORERS	81334	04/30/79	100	9.770	8.120	.900	.400	.750	.000

= COLA EXCLUDED   * = ESTIMATED, SEE TECHNICAL NOTES

REGION 08

STATE	CITY	CRAFT	LOCAL	EXP.DATE	NO.WRKRS	WAGE BENEFIT	WAGE RATE	H & W	PENSION	VACATION	OTHER
MONTANA	BUTTE	MASON TEND	01334	04/30/79	50	11.010	9.360	.500	.400	.750	.000
		PLSTR TEND	01334	04/30/79	50	11.010	9.360	.500	.400	.750	.000
		OP-ENG CRN	00400	04/30/82	240	13.470	11.620	.750	.650	.450	.000
		MASON OPCM	00119	04/30/78	25	11.250	8.950	1.000	.250	1.000	.000
		PLASTR OP	00119	04/30/78	25	11.200	8.950	1.000	.250	1.000	.000
		PIPE FTTRS	00041	06/30/81	99	15.600	14.050	.700	.850	.000	.000
		PLUMBERS	00041	06/30/81	76	15.600	14.050	.700	.850	.000	.000
		ROOFERS	00250	04/30/79	20	10.600	8.850	.600	.600	.750	.000
		SHTMTL WKR	00103	07/31/78	11	11.920	10.150 *	.370	1.400	.000	.000
	GLASGOW	CARPENTERS	01211	04/30/81	138	11.790	10.240	.800	.750	.000	.000
		MLLWRIGHTS	01211	04/30/82	3	12.790	11.240	.800	.750	.000	.000
		PILE DRVRS	01211	04/30/81	4	12.040	10.490	.800	.750	.000	.000
		DRY WALL	01211	04/30/81	2	11.790	10.240	.800	.750	.000	.000
		ELCTCN INS	00122	02/29/80	10	13.390	11.600	.690	1.100	.000	.000
		LABORERS	01334	04/30/79	30	9.910	8.610	.500	.400	.000	.000
		MASON TEND	01334	04/30/79	10	10.070	9.170	.500	.400	.000	.000
		PLSTR TEND	01334	04/30/79	10	10.070	9.170	.500	.400	.000	.000
	GREAT FALLS	BRIKLAYERS	00003	03/31/80	30	13.300	11.850	.700	.750	.000	.000
		MRBL SETRS	00003	03/31/80	19	13.300	11.850	.700	.750	.000	.000
		TILE SETRS	00003	03/31/80	12	11.300	9.850	.700	.750	.000	.000
		TRAZO WKRS	00003	03/31/80	12	11.300	9.850	.700	.750	.000	.000
		CARPENTERS	00286	04/30/81	200	12.200	10.650	.800	.750	.000	.000
		MLLWRIGHTS	00286	04/30/81	12	13.200	11.650	.800	.750	.000	.000
		PILE DRVRS	00286	04/30/81	2	12.450	10.900	.800	.750	.000	.000
		DRY WALL	00286	04/30/81	18	12.200	10.650	.800	.750	.000	.000
		ELCTCN INS	00122	02/28/80	100	14.690	12.900	.650	1.140	.000	.000
		LABORERS	01334	04/30/79	250	9.720	8.820	.500	.400	.000	.000
		MASON TEND	01334	04/30/79	50	10.220	9.320	.500	.400	.000	.000
		PLSTR TEND	01334	04/30/79	50	10.220	9.320	.500	.400	.000	.000
		OP-ENG CRN	00400	04/30/82	60	13.690	11.840	.750	.650	.450	.000
		PAINTERS	00260	06/30/80	80	11.980 #	11.020	.560	.400	.000	.000
		TAPERS	00260	06/30/80	5	13.250 #	12.290 *	.560	.400	.000	.000
		MASON OPCM	00110	04/30/79	16	10.290	9.850	.440	.000	.000	.000
		PLASTR OP	00110	04/30/79	30	10.290	9.850	.440	.000	.000	.000
		PIPE FTTRS	00139	06/30/80	119	15.700	13.850	.750	1.100	.000	.000
		PLUMBERS	00139	06/30/80	99	15.700	13.850	.750	1.100	.000	.000
		ROOFERS	00052	06/30/81	10	10.750	10.750	.000	.000	.000	.000
		SHTMTL WKR	00246	01/31/79	55	12.280 #	11.410 *	.620	.250	.000	.000
	HAVRE	BRIKLAYERS	00012	03/31/80	14	13.450	11.950	.750	.750	.000	.000
		MRBL SETRS	00012	03/31/80	2	13.450	11.950	.750	.750	.000	.000
		TILE SETRS	00012	03/31/80	2	13.450	11.950	.750	.750	.000	.000
		TRAZO WKRS	00012	03/31/80	2	13.450	11.950	.750	.750	.000	.000
		ELCTCN INS	00122	02/29/80	5	14.690	13.000	.550	1.140	.000	.000
		PAINTERS	00692	05/31/80	40	9.780	9.780	.000	.000	.000	.000
		TAPERS	00692	05/31/80	10	9.780	9.780	.000	.000	.000	.000
	HELENA	BOILR MKRS	00011	07/18/82	200	15.245	12.870	1.275	1.100	.000	.000
		BRIKLAYERS	00006	03/31/80	14	12.550	11.650	.600	.300	.000	.000
		MRBL SETRS	00006	03/31/80	5	12.550	11.650	.600	.300	.000	.000
		TILE SETRS	00006	03/31/80	5	12.550	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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REGION 08

STATE	CITY	CRAFT	LOCAL	EXP.DATE	NO.WRKRS	WAGE BENEFIT	WAGE RATE	H & W	PENSION	VACATION	OTHER
MONTANA	HELENA	TRAZO WKRS	B0006	03/31/80	5	12.550	11.650	.600	.300	.000	.000
		CARPENTERS	H0557	04/30/81	600	12.080	10.530	.800	.750	.000	.000
			B0153	04/30/81	235	12.040	10.490	.800	.750	.000	.000
		MLLWRIGHTS	B0153	04/30/81	42	13.040	11.490	.800	.750	.000	.000
		PILE DRVRS	B0153	04/30/81	36	12.290	10.740	.800	.750	.000	.000
			H0557	04/30/81	300	12.330	10.780	.800	.750	.000	.000
		DRY WALL	B0153	04/30/81	6	12.040	10.490	.800	.750	.000	.000
		ELCTCN INS	B0189	02/28/81	45	13.660	12.150	.650	.860	.000	.000
		LABORERS	B0254	04/30/79	60	9.500	8.600	.500	.400	.000	.000
		MASON TEND	B0254	04/30/79	29	9.850	8.950	.500	.400	.000	.000
		PLSTR TEND	B0254	04/30/79	25	9.850	8.950	.500	.400	.000	.000
		OP-ENG CRN	B0400	04/30/82	60	13.470	11.620	.750	.650	.450	.000
			H0400	04/30/82	70	13.470	11.620	.750	.650	.450	.000
		MASON OPCM	H0000	09/04/81	151	11.380	10.130	.850	.400	.000	.000
		SHTMTL WKR	B0284	07/31/78	22	11.330 ■	10.310 ●	.770	.250	.000	.000
	KALISPELL	CARPENTERS	B0000	04/30/82	96	12.080	10.530	.800	.750	.000	.000
		MLLWRIGHTS	B0000	04/30/82	32	13.030	11.480	.800	.750	.000	.000
		PILE DRVRS	B0000	04/30/82	36	12.280	10.730	.800	.750	.000	.000
		DRY WALL	B0000	04/30/82	8	12.030	10.480	.800	.750	.000	.000
		ELCTCN INS	C0768	06/30/78	60	11.890	11.110	.450	.330	.000	.000
			B0768	02/28/80	200	13.720	12.200	.650	.870	.000	.000
		LABORERS	B1334	04/30/79	250	9.660	8.660	.550	.450	.000	.000
		MASON TEND	B1334	04/30/79	50	9.450	8.450	.550	.450	.000	.000
		PLSTR TEND	B1334	04/30/79	50	9.450	8.450	.550	.450	.000	.000
		OP-ENG CRN	B0371	04/30/82	60	13.470	11.620	.750	.650	.450	.000
			H0371	04/30/82	90	13.470	11.620	.750	.650	.450	.000
		MASON OPCM	B0436	04/30/80	31	12.650	11.300	.850	.500	.000	.000
		PLASTR OP	B0436	04/30/80	14	12.650	11.300	.850	.500	.000	.000
		ROOFERS	B0189	06/30/81	52	11.700	10.250	.750	.200	.500	.000
	LEWISTOWN	BRIKLAYERS	B0004	03/31/80	64	11.000	11.000	.000	.000	.000	.000
		MRBL STTRS	B0004	03/31/80	10	11.000	11.000	.000	.000	.000	.000
		TILE STTRS	B0004	03/31/80	14	11.000	11.000	.000	.000	.000	.000
		TRAZO WKRS	B0004	03/31/80	8	11.000	11.000	.000	.000	.000	.000
		PLASTR BMP	B0004	03/31/80	6	11.000	11.000	.000	.000	.000	.000
		MASON BMP	B0004	03/31/80	7	11.000	11.000	.000	.000	.000	.000
		ELCTCN INS	B0552	12/31/79	1	12.130	10.850	.450	.830	.000	.000
	LIVINGSTON	ELCTCN INS	B0532	05/31/81	160	12.640	11.300	.500	.840	.000	.000
	MILES CITY	BRIKLAYERS	B0010	03/31/80	52	16.000	15.550	.000	.450	.000	.000
		ELCTCN INS	B0653	03/31/79	10	9.680	9.400	.000	.280	.000	.000
		LABORERS	B0098	04/30/79	250	9.600	8.650 ●	.480	.480	.000	.000
		MASON OPCM	B0599	09/30/78	15	8.250	8.250	.000	.000	.000	.000
		PLASTR OP	B0599	09/30/78	15	8.250	8.250	.000	.000	.000	.000
	MISSOULA	BRIKLAYERS	B0007	03/31/80	28	12.750	11.550	.650	.550	.000	.000
		MRBL STTRS	B0007	03/31/80	10	12.750	11.550	.650	.550	.000	.000
		TILE STTRS	B0007	03/31/80	10	12.750	11.550	.650	.550	.000	.000
		TRAZO WKRS	B0007	03/31/80	10	12.750	11.550	.650	.550	.000	.000
		CARPENTERS	B0028	04/30/81	279	12.080	10.530	.800	.750	.000	.000
		MLLWRIGHTS	B0028	04/30/81	7	13.130	11.580	.800	.750	.000	.000

- COLA EXCLUDED * - ESTIMATED, SEE TECHNICAL NOTES

REGION 08

STATE	CITY	CRAFT	LOCAL	EXP.DATE	NO.WRKRS	WAGE BENEFIT	WAGE RATE	H & W	PENSION	VACATION	OTHER
MONTANA	MISSOULA	PILE DRVRS	00028	04/30/81	9	13.130	11.580	.800	.750	.000	.000
		DRY WALL	00028	04/30/81	275	12.080	10.530	.800	.750	.000	.000
		LABORERS	01334	04/30/79	100	9.365	8.465 *	.500	.400	.000	.000
		MASON TEND	01334	04/30/79	25	10.065	9.165 *	.500	.400	.000	.000
		PLSTR TEND	01334	04/30/79	25	10.065	9.165 *	.500	.400	.000	.000
		GLAZIERS	01692	05/31/78	16	10.100	9.090	.350	.000	.570	.090
		MASON OPCH	00415	08/14/79	29	11.600	10.500	.750	.350	.000	.000
		PLASTR OP	00415	08/14/79	7	11.600	10.500	.750	.350	.000	.000
		PIPE FTTRS	00459	06/30/81	520	15.730	14.280	.750	.700	.000	.000
		PLUMBERS	00459	06/30/81	91	15.730	14.280	.750	.700	.000	.000
		SHTMTL WKR	00166	06/30/80	40	13.510	12.440 *	.820	.250	.000	.000
	** STATE TOTALS				11976	11.710	10.352	.649	.641	.059	.008
NORTH DAKOTA	BISMARCK	BRIKLAYERS	00004	06/30/80	60	11.300	11.000	.000	.300	.000	.000
		MRBL SETRS	00004	06/30/80	19	11.300	11.000	.000	.300	.000	.000
		TILE SETRS	00004	06/30/80	10	11.300	11.000	.000	.300	.000	.000
		TRAZO WKRS	00004	06/30/80	9	11.300	11.000	.000	.300	.000	.000
		CARPENTERS	01091	06/30/80	150	10.850	10.200	.650	.000	.000	.000
		PILE DRVRS	01091	06/30/80	32	10.600	9.950	.650	.000	.000	.000
		DRY WALL	01091	06/30/80	19	10.850	10.200	.650	.000	.000	.000
		LABORERS	00580	06/30/79	101	7.250	7.250	.000	.000	.000	.000
		MASON TEND	00580	06/30/79	32	7.250	7.250	.000	.000	.000	.000
		PLSTR TEND	00580	06/30/79	10	7.250	7.250	.000	.000	.000	.000
		MASON OPCH	00697	05/31/78	28	9.590	9.590	.000	.000	.000	.000
		PLASTR OP	00697	05/31/79	18	11.610	11.610	.000	.000	.000	.000
		PIPE FTTRS	00795	06/30/80	46	14.550	13.150	.750	.650	.000	.000
		PLUMBERS	00795	06/30/80	39	14.550	13.150	.750	.650	.000	.000
	FARGO	ASBTS WKRS	00133	06/30/82	40	14.460	13.170	.600	.690	.000	.000
		BRIKLAYERS	00001	04/30/80	84	12.550	11.650	.600	.300	.000	.000
		MRBL SETRS	00001	04/30/80	24	12.550	11.650	.600	.300	.000	.000
		TRAZO WKRS	00001	04/30/80	12	12.550	11.650	.600	.300	.000	.000
		CARPENTERS	01176	05/31/80	338	11.120	10.590	.000	.530	.000	.000
		PILE DRVRS	01176	05/31/80	7	11.370	10.840	.000	.530	.000	.000
		DRY WALL	01176	05/31/80	9	11.120	10.590	.000	.530	.000	.000
		IRN STRCTL	00793	06/30/80	100	13.300	11.900	.600	.800	.000	.000
		IRN RODMAN	00793	06/30/80	150	13.300	11.900	.600	.800	.000	.000
		LABORERS	00580	04/30/79	101	7.390	7.390	.000	.000	.000	.000
		MASON TEND	00580	04/30/79	31	7.390	7.390	.000	.000	.000	.000
		PLSTR TEND	00850	06/30/79	18	7.140	7.140	.000	.000	.000	.000
		OP-ENG CRN	06049	01/14/80	400	10.750	9.500	.700	.550	.000	.000
			H0049	01/14/80	490	10.750	9.500	.700	.550	.000	.000
		PAINTERS	01908	04/30/79	150	9.300	9.300	.000	.000	.000	.000
		FLOOR PAT	01908	04/30/79	16	9.450	9.250	.200	.000	.000	.000
		TAPERS	01908	05/31/79	28	10.040	10.040	.000	.000	.000	.000
		MASON OPCH	00439	10/04/80	35	11.050	11.050	.000	.000	.000	.000
		PLASTR OP	00439	10/04/80	18	12.000	12.000	.000	.000	.000	.000
		PIPE FTTRS	00338	05/31/81	180	14.080	12.170	1.020	.890	.000	.000
		PLUMBERS	00338	05/31/81	140	14.080	12.170	1.020	.890	.000	.000
		ROOFERS	00214	07/31/81	50	9.050	9.050	.000	.000	.000	.000
		SHTMTL WKR	00117	05/31/80	92	13.200	12.150	.600	.450	.000	.000

APPENDIX C-2

MODEL DOCUMENTATION

```
$ssa[$1]$=
[0]     ssa
[1]     )digits 6
[2]     )width 132
[3]     'enter lag factor between 0.00 and 1.00 exclusive'
[4]     lag@$1
[5]     crowdat
[6]     'enter construction period secondary multiplier'
[7]     sempxc@$1
[8]     'enter operation period secondary multiplier'
[9]     sempxo@$1
[10]    'enter sec. labor fc. availability: 0.00-1.00'
[11]    selbf@$1
[12]    'enter household multiplier'
[13]    hsmlt@$1
[14]    c@tlabf#selbf
[15]    c@$dc+.5
[16]    d@hsmlt
[17]    a1@"76ua
[18]    h1@a1#d
[19]    a2@4#ua
[20]    h2@a2#3.14
[21]    h@h1,h2
[22]    j@$dh+.5
[23]   conv$ convert
[24]   format: ax@'inmigrating secondary labor'
[25]    xb@'new basic population          '
[26]    cx@'new secondary population      '
[27]    dx@'new total population          '
[28]    ex@'new big horn pop              '
[29]    fx@'  as a % of baseline          '
[30]    gx@'new yellowstone pop           '
[31]    hx@'  as a % of baseline          '
[32]    xx@'basic jobs                    '
[33]    xy@'inmigrating basic labor       '
[34]    zx@'secondary jobs created        '
[35]    variables@xx,xy,zx,ax,xb,cx,dx,ex,fx,gx,hx
[36]    variables@(11,27)$rvariables
[37]    data@totemp,a,b,e,j,g,k,kbh,m,kys,p
[38]    'pop'$lff 0,1
[39]    cr[3] $lff 4,1
[40]    a[3] $lff 4,1
[41]    sh $lff 4,1
[42]    hsmlt $lff 4,1
[43]    e[3] $lff 4,1
[44]    k[3] $lff 4,1
[45]    cr[11] $lff 4,1
[46]    a[11] $lff 4,1
[47]    e[11] $lff 4,1
[48]    k[11] $lff 4,1
[49]    totemp[3] $lff 4,1
[50]    b[3] $lff 4,1
[51]    totemp[11] $lff 3,1
[52]    b[11] $lff 4,1
[53]    kbh[3] $lff 4,1
[54]    kbh[11] $lff 4,1
[55]    kys[3] $lff 4,1
[56]    kys[11] $lff 4,1
[57]    bx[3] $lff 4,1
[58]    bx[11] $lff 4,1
[59]    yx[3] $lff 4,1
[60]    yx[11] $lff 4,1
```

```
[61]   $lff 3,1
[62]   data@(11,11)$rdata
[63]   ' '
[64]   ' '
[65]   'variables                    1985    1986    1937    1988
          1989    1990    1991    1992    1993    1994    1995'
[66]   ' '
[67]   variables;data
[68]   &ending
[69]   ' '
[70]   ' '
[71]   ' '
[72]   ' '
[73]   ' '
[74]   ' '
[75]   ' '
[76]   ' '
[77]  space: ' '
[78]   ' '
[79]   ' '
[80]   ' '
[81]   ' '
[82]   ' '
[83]   ' '
[84]   ' '
[85]   ' '
[86]   ' '
[87]   ' '
[88]   ' '
[89]   ' '
[90]   ' '
[91]   ' '
[92]   ' '
[93]   ' '
[94]   ' '
[95]  ending: 'end of ssa: to do another case enter ''ssa'''
[96]   ' '
[97]   &0
```

```
$ecrowdat[$]$a
[0]    crowdat
[1]    peak@793 2260 3350 3503 930 930 930 930 930 930 930
[2]    avg@456 1520 2619 1968 930 930 930 930 930 930 930
[3]    $1@'enter "peak" for annual peak values for primary empt"avg
       " for average values:'
[4]    totemp@$l
[5]    tlabf@135 260 668 918 500 320 400 385 385 385 385
[6]    l@11950 12137 12328 12522 12720 12920 13118 13311 13511 137
       21 13923
[7]    n@27432 28181 28892 29585 30237 30870 31455 32003 32495 324
       92 33345
[8]    cr@202 384 385 384 264 264 264 264 264 264 264
[9]    loc@154 34 103 57 90 90 90 90 90 90 90
[10]   a@(totemp-loc)-cr
```

```
]]sp
defn error
      $aconvert[*]]$s
[0]     convert
[1]     'enter portion of inmigrating basic labor living in smaller
         county: 0.000-1.000'
[2]     sh@*]
[3]     cr@((totemp-loc)-cr)$dcr
[4]     bh@(sh#a)+cr
[5]     bhc@"7$ubh
[6]     bhc@bhc#semrxc
[7]     bhc11@bhc[1]#.71
[8]     bhc12@bhc[1]#.206
[9]     bhc13@bhc[1]#.06
[10]    bhc14@bhc[1]#.024
[11]    bhc21@bhc[2]#.71
[12]    bhc22@bhc[2]#.206
[13]    bhc23@bhc[2]#.06
[14]    bhc24@bhc[2]#.024
[15]    bhc31@bhc[3]#.71
[16]    bhc32@bhc[3]#.206
[17]    bhc33@bhc[3]#.06
[18]    bhc34@bhc[3]#.024
[19]    bhc41@bhc[4]#.71
[20]    bhc42@bhc[4]#.206
[21]    bhc43@bhc[4]#.06
[22]    bhc44@bhc[4]#.024
[23]   bhc1@.bhc11,bhc12,bhc13,bhc14,0 0 0 0 0 0 0
[24]   bhc2@0,bhc21,bhc22,bhc23,bhc24,0 0 0 0 0 0
[25]   bhc3@0 0,bhc31,bhc32,bhc33,bhc34,0 0 0 0 0
[26]   bhc4@0 0 0,bhc41,bhc42,bhc43,bhc44,0 0 0 0
[27]   bho@4$ubh
[28]    bho@bho#semrxo
[29]    bho11@bho[1]#.71
[30]    bho12@bho[1]#.206
[31]    bho13@bho[1]#.06
[32]    bho14@bho[1]#.024
[33]    bho21@bho[2]#.71
[34]    bho22@bho[2]#.206
[35]    bho23@bho[2]#.06
[36]    bho24@bho[2]#.024
[37]    bho31@bho[3]#.71
[38]    bho32@bho[3]#.206
[39]    bho33@bho[3]#.06
[40]    bho34@bho[3]#.024
[41]    bho41@bho[4]#.71
[42]    bho42@bho[4]#.206
[43]    bho43@bho[4]#.06
[44]    bho44@bho[4]#.024
[45]    bho51@bho[5]#.710
[46]    bho52@bho[5]#.206
[47]    bho53@bho[5]#.06
[48]    bho61@bho[6]#.710
[49]    bho62@bho[6]#.206
[50]    bho71@bho[7]#.710
[51]   bho1@0 0 0 0,bho11,bho12,bho13,bho14,bho51,bho52,bho53
[52]   bho2@0 0 0 0 0,bho21,bho22,bho23,bho24,bho61,bho62
[53]   bho3@0 0 0 0 0 0,bho31,bho32,bho33,bho34,bho71
[54]   bho4@0 0 0 0 0 0 0,bho41,bho42,bho43,bho44
[55]    bx@bhc1+bhc2+bhc3+bhc4+bho1+bho2+bho3+bho4
[56]    bx@$dbx+.5
[57]    wr@]arcr>0
```

```
[58]  locnc@locnc#wc
[59]  ys@totemp-bh
[60]  ysc@"7$uys
[61]  ysc@ysc#sempxc
[62]  ysc11@ysc[1]#.71
[63]  ysc12@ysc[1]#.206
[64]  ysc13@ysc[1]#.06
[65]  ysc14@ysc[1]#.024
[66]  ysc21@ysc[2]#.71
[67]  ysc22@ysc[2]#.206
[68]  ysc23@ysc[2]#.06
[69]  ysc24@ysc[2]#.024
[70]  ysc31@ysc[3]#.71
[71]  ysc32@ysc[3]#.206
[72]  ysc33@ysc[3]#.06
[73]  ysc34@ysc[3]#.024
[74]  ysc41@ysc[4]#.71
[75]  ysc42@ysc[4]#.206
[76]  ysc43@ysc[4]#.06
[77]  ysc44@ysc[4]#.024
[78] ysc1@,ysc11,ysc12,ysc13,ysc14,0 0 0 0 0 0 0
[79] ysc2@0,ysc21,ysc22,ysc23,ysc24,0 0 0 0 0 0
[80] ysc3@0 0,ysc31,ysc32,ysc33,ysc34,0 0 0 0 0
[81] ysc4@0 0 0,ysc41,ysc42,ysc43,ysc44,0 0 0 0
[82]  yso@4$uys
[83]  yso@yso#sempxo
[84]  yso11@yso[1]#.71
[85]  yso12@yso[1]#.206
[86]  yso13@yso[1]#.06
[87]  yso14@yso[1]#.024
[88]  yso21@yso[2]#.71
[89]  yso22@yso[2]#.206
[90]  yso23@yso[2]#.06
[91]  yso24@yso[2]#.024
[92]  yso31@yso[3]#.71
[93]  yso32@yso[3]#.206
[94]  yso33@yso[3]#.06
[95]  yso34@yso[3]#.024
[96]  yso41@yso[4]#.71
[97]  yso42@yso[4]#.206
[98]  yso43@yso[4]#.06
[99]  yso44@yso[4]#.024
[100] yso51@yso[5]#.710
[101] yso52@yso[5]#.206
[102] yso53@yso[5]#.06
[103] yso61@yso[6]#.710
[104] yso62@yso[6]#.206
[105] yso71@yso[7]#.710
[106] yso1@0 0 0 0,yso11,yso12,yso13,yso14,yso51,yso52,yso53
[107] yso2@0 0 0 0 0,yso21,yso22,yso23,yso24,yso61,yso62
[108] yso3@0 0 0 0 0 0,yso31,yso32,yso33,yso34,yso71
[109] yso4@0 0 0 0 0 0 0,yso41,yso42,yso43,yso44
[110] yx@ysc1+ysc2+ysc3+ysc4+yso1+yso2+yso3+yso4
[111]  yx@$dyx+.5
[112]  b@yx+bx
[113]  e@b-c
[114]  w@e>0
[115]  e@w#e
[116]  f@e#3.14
[117]  sporbh@f#(bx%b)
[118]  sporys@f#(yx%b)
[119]  m@(kbh%l)#100
[120]  sporys@$dsporys+.5
[121]  sporbh@$dsporbh+.5
[122]  p@sporys+sporbh
[123]  bporbh@sbp,i
```

```
[124]  bpopbh@@dbpopbh+.5
[125]  bpopys@(1-sh)@J
[126]  bpopys@@dbpopys+.5
[127]  kbh@spopbh+bpopbh
[128]  kys@spopys+bpopys
[129]  p@(kys%n)#100
[130]  m@(kbh%l)#100
[131]  k@J+g
```

```
      #gservices[s]]sg
[0]    services
[1]    snomul@3.14
[2]    immulo@snomul
[3]    'enter indian household multiplier'
[4]    indmul@$]
[5]    inmulo@inmulc@indmul
[6]    'pop' $lff 1.1
[7]    indlfc@$lff 5.1
[8]    imblfc@$lff 5.1
[9]    sh@$lff 5.1
[10]   inmulc@$lff 5.1
[11]   spcemp@$lff 5.1
[12]   ntropc@$lff 5.1
[13]   indlfo@$lff 5.1
[14]   imblfo@$lff 5.1
[15]   spoemp@$lff 5.1
[16]   ntropo@$lff 5.1
[17]   pcyemp@$lff 5.1
[18]   pcysem@$lff 5.1
[19]   proemp@$lff 5.1
[20]   oprsem@$lff 5.1
[21]   npopbhc@$lff 5.1
[22]   npopbho@$lff 5.1
[23]   npopysc@$lff 5.1
[24]   npopyso@$lff 5.1
[25]   bx4@$lff 5.1
[26]   bx11@$lff 5.1
[27]   yx4@$lff 5.1
[28]   yx11@$lff 5.1
[29]   $lff 3.1
[30]   'which county is the analysis for? enter 1 for big horn and
        0 for yellowstone.'
[31]   co@$]
[32]   &(co=1)/ex
[33]   pctlfo@pctblf@1-sh
[34]   pcysem@yx4
[35]   oprsem@yx11
[36]   ntropc@npopysc
[37]   ntropo@npopyso
[38]   prempc1@pcyemp-(indlfc+imblfc)
[39]   prempc2@prempc1+(imblfc#pctblf)
[40]   prempo1@proemp-(indlfo+imblfo)
[41]   prempo2@prempo1+(imblfo#pctlfo)
[42]   indlfo@indlfc@0
[43]   ' '
[44]   prempc@prempc1#3.14
[45]   prempo@prempo1#3.14
[46]   'yellowstone county'
[47]   ' '
[48]   cntrpop
[49]   oprpop
[50]   hslds
[51]   income
[52]   housing
[53]   edusoc
[54]   bussec
[55]   &dnit
[56]  ex: pctlfo@pctblf#sh
[57]   pcysem@bx4
[58]   oprsem@bx11
```

```
[59]   nteorc@nporbhc
[60]   ntpopo@npopbho
[61]   premec@0
[62]   prempo@0
[63]   premec2@indlfc+(imblfc#pctblf)
[64]   prempo2@indlfo+(imblfo#pctlfo)
[65]   ' '
[66]   'bighorn county'
[67]   ' '
[68]   cntrpop
    ]  opppop
.70]   hslds
[71]   income
[72]   edusoc
[73]   housing
[74]   bussec
[75]   doit: 'opcstdat' $lff 0,2
[76]   retspc $lff 4,2
[77]   svcspc $lff 4,2
[78]   ofcspc $lff 4,2
[79]   indspc $lff 4,2
[80]   ps $lff 4,2
[81]   np $lff 4,2
[82]   os $lff 4,2
[83]   oschen $lff 4,2
[84]   npopo $lff 4,2
[85]   comart $lff 4,2
[86]   comcol $lff 4,2
[87]   comstr $lff 4,2
[88]   sfvopr $lff 4,2
[89]   mhvopr $lff 4,2
[90]   mfvopr $lff 4,2
[91]   $lff 3,2
[92]   'ccstdat' $lff 0,3
[93]   zero@0
[94]   zero $lff 4,3
[95]   zero $lff 4,3
[96] . zero $lff 4,3
[97]   zero $lff 4,3
[98]   zero $lff 4,3
[99]   zero $lff 4,3
[100]  zero $lff 4,3
[101]  cschen $lff 4,3
[102]  npopc $lff 4,3
[103]  zero $lff 4,3
[104]  zero $lff 4,3
[105]  zero $lff 4,3
[106]  sfvpcy $lff 4,3
[107]  mhvpcy $lff 4,3
[108]  mfvpcy $lff 4,3
[109]  $lff 3,3
[110]  dat1@prpopc,sepopc,pcypop,nppoc,nsepoc,npopc,prpopo,sepopo
       ,opppop,nppoo,nsepoo,npopo,0
[111]  dat2@0,hslpcy,hslopr,0,nhspcy,nhsopr,0,0,teepcy,teeopr,0,tl
       ypcy,tlyopr
[112]  dat3@0,cappcy,capopr,0,incpcy,incopc,0,0,0,c0to5,c5to17,c18
       to29,c30to44
[113]  dat4@c45to64,c65pls,0,0,o0to5,o5to17,o18to29,o30to44,o45to6
       4,o65pls,0,0,cschen
[114]  dat5@oschen,0,ctechr,otechr,schlnd,0,0,0,pcydoc,pcyrns,pcyh
       sp,pcypsp,0
[115]  dat6@0,oprdoc,oprrns,oprhsp,oprpsp,0,0,hospcy,hosopr,0,0,sf
       vpcy,mhvpcy
[116]  dat7@mfvpcy,0,0,sfvopr,mhvopr,mfvopr,0,0,sfvlnd,mhvlnd,mfvl
       nd,0,0
[117]  dat8@ps,np,os,pkos,0,0,resart,rescol,resstr,0,0,comart,comc
```

p

```
        o]
[118]   dat9@comstr,0,0,lrspcy,lrsopr,0,0,lsrpcy,lsropr,0,retspc,sv
        cspc,ofcspc
[119]   dat10@totspc,totind,0,mpfamp,indspc,totind
[120]   dats@dat1,dat2,dat3,dat4,dat5,dat6,dat7,dat8,dat9,dat10
[121]   dats@(123,1)$rdats
[122]   'datas' $lff 0,4
[123]   dats1@dat1,dat2,dat3
[124]   dats1@(39,1)$rdats1
[125]   dats2@dat4,dat5,dat6
[126]   dats2@(39,1)$rdats2
[127]   dats3@dat7,dat8,dat9,dat10
[128]   dats3@(45,1)$rdats3
[129]   dats1@$ddats1+.5
[130]   dats2@$ddats2+.5
[131]   dats3@$ddats3+.5
[132]   dats1 $lff 4,4
[133]   dats2 $lff 4,4
[134]   dats3 $lff 4,4
[135]   $lff 3,4

$ecntrpop[$1]$e
[0]     cntrpop
[1]     prpopc@(indlfc#indmul)+(imblfc#pctblf)#immulc
[2]     prpopc@(prempc)+prpopc
[3]     sepopc@(pcysem#snomul)
[4]     pcypop@prpopc+sepopc
[5]     nprpoc@(imblfc#pctblf)#immulc
[6]     nsepoc@ntpopc-nprpoc
[7]     npopc@nprpoc+nsepoc

$9opppop
[8]     [$1]$9
[0]      opppop
[1]      prpopo@(indlfo#inmulo)+(imblfo#pctlfo)#immulo
[2]      prpopo@prempo+prpopo
[3]      sepopo@(oprsem#snomul)
[4]      opppop@(prpopo+sepopo)
[5]      nprpoo@(imblfo#pctlfo)#immulo
[6]      nsepoo@ntpopo-nprpoo
[7]      npopo@nprpoo+nsepoo

$ehshlds[$1]$e
defn error
         hshlds[$1]
        $ehslds[$1]$e
[0]      hslds
[1]      prfamc@prpopc#.78
[2]      sefamc@sepopc#.89
[3]      ttfamc@prfamc+sefamc
[4]      otfamc@pcypop-(sefamc+prfamc)
[5]      oprfam@opppop#.92
[6]      otfamo@opppop#.08
[7]      ttfamo@oprfam
[8]      fampcy@ttfamc%3.61
[9]      othslc@otfamc%1.25
[10]     hslpcy@fampcy+othslc
[11]     famopr@ttfamo%3.8
[12]     othslo@otfamo%1.25
[13]     hslopr@famopr+othslo
[14]     nprfmc@nprpoc#.78
[15]     nsefmc@nsepoc#.89
[16]     nfampc@nprfmc+nsefmc
```

p

```
notfmc@npopc-(nsefmc+nprfmc)
noprfm@npopo#.92
notfmo@npopo#.08
nfmpcy@nfampc%3.61
nothsc@notfmc%1.25
nhspcy@nfmpcy+nothsc
nfmopr@noprfm%3.8
nothso@notfmo%1.25
nhsopr@nfmopr+nothso
chlpcy@nfampc#.71
chlopr@noprfm#.71
nochlc@nfampc-chlpcy
nochlo@noprfm-chlopr

*ghousing[*]]*g
housing
hospcy@nhspcy#1.10
hosopr@nhsopr#1.05
sfvpcy@hospcy#.45
mhvpcy@hospcy#.35
mfvpcy@hospcy#.20
sfvopr@hosopr#.60
mhvopr@hosopr#.25
mfvopr@hosopr#.15
sfvlnd@sfvopr%3
mhvlnd@mhvopr%5
mfvlnd@mfvopr%10
reslnd@sfvlnd+mhvlnd+mfvlnd
pg@1.8#(npopo%1000)
np@3.0#(npopo%1000)
os@3.7#(npopo%1000)
pkos@pg+np+os
resart@(sfvopr#6)+(mhvopr#5.5)+(mfvopr#5)
rescol@(sfvopr#7)+(mhvopr#17.25)+(mfvopr#13.5)
resstr@(sfvopr#47)+(mhvopr#22)+(mfvopr#10)
comart@resart#1.76
comcol@rescol#1.1
comstr@resstr#1.1

*gedusoc[*]]*g
edusoc
c0to5@(npopc%100)#14.4
c5to17@(npopc%100)#23.9
c18to29@(npopc%100)#31.7
c30to44@(npopc%100)#19.0
c45to64@(npopc%100)#10.4
c65pls@(npopc%100)#0.6
o0to5@(npopo%100)#10.3
o5to17@(npopo%100)#28.7
o18to29@(npopo%100)#28.0
o30to44@(npopo%100)#19.5
o45to64@(npopo%100)#10.1
o65pls@(npopo%100)#3.4
cschen@c5to17#.90
oschen@o5to17#.90
ctechr@cschen#.045
otechr@oschen#.045
schlnd@oschen#.013
pcydoc@1#(npopc%1000)
pcyrns@6#(npopc%1000)
pcyhsp@2#(npopc%1000)
pcypsp@3#(npopc%1000)
oprdoc@1.5#(npopo%1000)
oprrns@8#(npopo%1000)
```

p

```
[24]    oprhsp@2.5#(nprop%1000)
[25]    oprpsp@3.5#(nprop%1000)

$ubussec[#]$p
[0]     bussec
[1]     lrspcv@tlypcv#.48
[2]     lrsopr@tlyopr#.48
[3]     lsrpcv@tlypcv#.10
[4]     lsropr@tlyop.#.10
[5]     hdwr@(.082#lrsopr)%50
[6]     genmds@(.077#lrsopr)%50
[7]     fdst@(.277#lrsopr)%120
[8]     audl@(.195#lrsopr)%40
[9]     ssata@(.096#lrsopr)%40
[10]    arapl@(.058#lrsopr)%50
[11]    furn@(.022#lrsopr)%30
[12]    eadrk@(.060#lrsopr)%60
[13]    drust@(.036#lrsopr)%70
[14]    mscret@(.097#lrsopr)%30
[15]    retspc@hdwr+genmds+fdst+audl+ssata+arapl+furn+eadrk+drust+m
        scret
[16]    aurep@(.092#lsropr)%40
[17]    hotmot@(.242#lsropr)%45
[18]    mscrep@(.192#lsropr)%30
[19]    amsrec@(.121#lsropr)%15
[20]    lessvc@(.068#lsropr)%30
[21]    mscsvc@(.285#lsropr)%20
[22]    svcspc@hotmot+aurep+mscrep+amsrec+lessvc+mscsvc
[23]    const@150#.1#oprsem
[24]    tcpu@150#.1#oprsem
[25]    whsltr@150#.1#oprsem
[26]    enlret@175#.3#oprsem
[27]    busrep@150#.5#oprsem
[28]    prslsv@150#.5#oprsem
[29]    profsv@175#1.0#oprsem
[30]    ofcspc@const+tcpu+whsltr+enlret+busrep+prslsv+profsv
[31]    totspc@retspc+svcspc+ofcspc
[32]    pksspc@totspc#1.875
[33]    otrind@.25#(totspc+pksspc)
[34]    totind@totspc+pksspc+otrind
[35]    totind@totind%43560
[36]    msfemp@proemp#.11
[37]    indspc@msfemp#550
[38]    indpks@msfemp#260
[39]    otrind@.2#(indpks+indspc)
[40]    totind@indpks+indspc+otrind
[41]    totind@totind%43560
[42]    'running'
[43]    'services'
```

```
        )COPY runvar
saved   16.14.39 05/20/82
        ∇services[⎕]∇
[0]     services
[1]     'running services'
[2]     sa@'total primary construction period population  '
[3]     sb@'total secondary construction period population'
[4]     sc@'total peak construction period population     '
[5]     sd@'new primary construction period population    '
[6]     se@'new secondary construction period population  '
[7]     sf@'new peak construction period population       '
[8]     sg@'total primary operation period population     '
[9]     sh@'total secondary operation period population   '
[10]    si@'total operation period population             '
[11]    sj@'new primary operation period population       '
[12]    sk@'new secondary operation period population     '
[13]    sl@'new operation period population               '
[14]    sm@'                                               '
[15]    sn@'total households                              '
[16]    so@'       peak construction period               '
[17]    sp@'       operation period                       '
[18]    sq@'new households                                '
[19]    sr@'       peak construction period               '
[20]    ss@'       operation period                       '
[21]    st@'                                              '
[22]    su@'total employment earnings(dollars)            '
[23]    sv@'       peak construction period               '
[24]    sw@'       operation period                       '
[25]    sx@'total local income(dollars)                   '
[26]    sy@'       peak consruction period                '
[27]    sz@'       operation period                       '
[28]    saa@'percapita income(dollars)                     '
[29]    sba@'       peak construction period               '
[30]    sca@'.      operation period                       '
[31]    sda@'per household income(dollars)                 '
[32]    sea@'       peak construction period               '
[33]    sfa@'       operation period                       '
[34]    sga@'                                              '
[35]    sha@'population age distribution                   '
[36]    sia@'       peak construction period               '
[37]    sja@'              less than 5                     '
[38]    ska@'              5 to 17                         '
[39]    sla@'              18 to 29                        '
[40]    sma@'              30 to 44                        '
[41]    sna@'              45 to 64                        '
[42]    soa@'              65 plus                         '
[43]    spa@'                                              '
[44]    sqa@'       operation period                       '
[45]    sra@'              less than 5                     '
[46]    ssa@'              5 to 17                         '
[47]    sta@'              18 to 29                        '
[48]    sua@'              30 to 44                        '
[49]    sva@'              45 to 64                        '
[50]    swa@'              65 plus                         '
[51]    sxa@'                                              '
[52]    sya@'school enrollment                             '
[53]    sza@'       peak construction period               '
[54]    sab@'     operation period                         '
[55]    sbb@'school teachers                               '
[56]    scb@'     peak construction period                 '
[57]    sdb@'     operation period                         '
[58]    seb@'school land requirement (acres)               '
```

```
[59]  sfb@'                                                           '
[60]  sgb@'expected social service personnel                          '
[61]  shb@'       peak construction period                            '
[62]  sib@'            physicians                                     '
[63]  sjb@'            registered nurses                              '
[64]  skb@'            health support personnel                       '
[65]  slb@'            police and firemen                             '
[66]  smb@'                                                           '
[67]  snb@'       operation period                                    '
[68]  sob@'            physicians                                     '
[69]  spb@'            registered nurses                              '
[70]  sqb@'            health support personnel                       '
[71]  srb@'            police and firemen                             '
[72]  ssb@'                                                           '
[73]  stb@'total housing needs                                        '
[74]  sub@'       peak construction period                            '
[75]  svb@'       operation period                                    '
[76]  swb@'housing needs by type                                      '
[77]  sxb@'       peak construction period                            '
[78]  syb@'            single-family units                            '
[79]  szb@'            mobile home units                              '
[80]  sac@'            multi-family units                             '
[81]  sbc@'                                                           '
[82]  scc@'       operation period                                    '
[83]  sdc@'            single-family units                            '
[84]  sec@'            mobile home units                              '
[85]  sfc@'            multi-family units                             '
[86]  sgc@'                                                           '
[87]  shc@'residential land requirements (acres)                      '
[88]  sic@'       single-family                                       '
[89]  sjc@'       mobile homes                                        '
[90]  skc@'       multi-family                                        '
[91]  slc@'                                                           '
[92]  smc@'parks and open space land requirements (acres)'
[93]  snc@'       playgrounds                                         '
[94]  soc@'       neighborhood parks                                  '
[95]  spc@'       community open space                                '
[96]  sqc@'                          total parks and open space'
[97]  src@'                                                           '
[98]  ssc@'residential-related street system(linear ft.)             '
[99]  stc@'       arterials                                           '
[100] suc@'       collectors                                          '
[101] svc@'       minor streets                                       '
[102] swc@'                                                           '
[103] sxc@'community street systen(linear ft.)                        '
[104] syc@'       arterials                                           '
[105] szc@'       collectors                                          '
[106] sad@'       minor streets                                       '
[107] sbd@'                                                           '
[108] scd@'local retail sales(dollars)                                '
[109] sdd@'       peak construction period                            '
[110] sed@'       operation period                                    '
[111] sfd@'                                                           '
[112] sgd@'local services receipts(dollars)                           '
[113] shd@'       peak construction period                            '
[114] sid@'       operation period                                    '
[115] sjd@'                                                           '
[116] skd@'retail building space requirement(sq.ft.)                  '
[117] sld@'service building space requirement(sq.ft.)                 '
[118] smd@'office building space requirment(sq.ft.)                   '
[119] snd@'                  total building space requirement'
[120] sod@'                              total acres requirement'
[121] spd@'                                                           '
[122] sqd@'manufacturing employment                                   '
[123] srd@'industrial building space requirement(sq.ft.)              '
[124] ssd@'total industrial land requirement(acres)                   '
```

```
[125]  varia1@sa,sb,sc,sd,se,sf,sg,sh,si,sj,sk,sl,sm
[126]  varia2@sn,so,sp,sq,sr,ss,st,su,sv,sw,sx,sy,sz
[127]  varia3@saa,sba,sca,sda,sea,sfa,sga,sha,sia,sja,ska,sla,sma
[128]  varia4@sna,soa,spa,sqa,sra,sas,sta,sua,sva,swa,sxa,sya,sza
[129]  varia5@sab,sbb,scb,sdb,seb,sfb,sgb,shb,sib,sjb,skb,slb,smb
[130]  varia6@snb,sob,spb,sqb,srb,ssb,stb,sub,svb,swb,sxb,syb,szb
[131]  varia7@sac,sbc,scc,sdc,sec,sfc,sgc,shc,sic,sjc,skc,slc,smc
[132]  varia8@snc,soc,spc,sqc,src,ssc,stc,suc,svc,swc,sxc,syc,szc
[133]  varia9@sad,sbd,scd,sdd,sed,sfd,sgd,shd,sid,sjd,skd,sld,smd
[134]  varia10@snd,sod,spd,sqd,srd,ssd
[135]  'variabs' $lff 0,5
[136]  varias1@varia1,varia2,varia3
[137]  varias1@(39,46)$rvarias1
[138]  varias2@varia4,varia5,varia6
[139]  varias2@(39,46)$rvarias2
[140]  varias3@varia7,varia8,varia9,varia10
[141]  varias3@(45,46)$rvarias3
[142]  varias1 $lff 4,5
[143]  varias2 $lff 4,5
[144]  varias3 $lff 4,5
[145]  $lff 3,5
```

```
$gservices[$l]$g
[0]    services
[1]    'variabs' $lff 1,5
[2]    varias1@$lff 5,5
[3]    varias2@$lff 5,5
[4]    varias3@$lff 5,5
[5]    $lff 3,5
[6]    'datas' $lff 1,4
[7]    dats1@$lff 5,4
[8]    dats2@$lff 5,4
[9]    dats3@$lff 5,4
[10]   $lff 3,4
[11]   ' '
[12]   ' '
[13]   'community facility and service requirements'
[14]   ' '
[15]   varias1:dats1
[16]   ' '
[17]   varias2:dats2
[18]   ' '
[19]   varias3:dats3
[20]   ' '
```

```
)copy costrev
saved  09.20.35 01/11/82
       $pcosts[$1]@p
[0]    costs
[1]    c@1
[2]    o@0
[3]    'if this cost estimate is for the construction period enter
        ''c'', if for the operations period ,enter ''o'''
[4]    type@$1
[5]    &(type=0)/pute
[6]    'concstdat' $lff 1,3
[7]    retspc@$lff 5,3
[8]    svcspc@$lff 5,3
[9]    ofcspc@$lff 5,3
[10]   indspc@$lff 5,3
[11]   lrps@$lff 5,3
[12]   lrnp@$lff 5,3
[13]   lros@$lff 5,3
[14]   totse@$lff 5,3
[15]   totpop@$lff 5,3
[16]   asl@$lff 5,3
[17]   csl@$lff 5,3
[18]   msl@$lff 5,3
[19]   sfv@$lff 5,3
[20]   mhv@$lff 5,3
[21]   mfv@$lff 5,3
[22]   $lff 3,3
[23]   'enter total land costs for public facilities'
[24]   lcpf@$l
[25]   capcst
[26]   omcst
[27]   revs
[28]   &end
[29]  pute: 'opcstdat' $lff 1,2
[30]   retspc@$lff 5,2
[31]   svcspc@$lff 5,2
[32]   ofcspc@$lff 5,2
[33]   indspc@$lff 5,2
[34]   lrps@$lff 5,2
[35]   lrnp@$lff 5,2
[36]   lros@$lff 5,2
[37]   totse@$lff 5,2
[38]   totpop@$lff 5,2
[39]   asl@$lff 5,2
[40]   csl@$lff 5,2
[41]   msl@$lff 5,2
[42]   sfv@$lff 5,2
[43]   mhv@$lff 5,2
[44]   mfv@$lff 5,2
[45]   $lff 3,2
[46]   'enter total land costs for public facilities'
[47]   lcpf@$l
[48]   capcst
[49]   omcst
[50]   revs
[51]   ' '
[52]  end: 'end of costs'
[53]   'to re-run, enter "costs"'
```

```
#gcapcst[#]#p
[0]     capcst
[1]     'capital costs        '
[2]     ''
[3]     ''
[4]     ''
[5]     ax@'   parks and open space                 '
[6]     bx@'                                        '
[7]     cx@'      development costs                 '
[8]     dx@'        playgrounds                     '
[9]     ex@'        neighborhood parks              '
[10]    fx@'        open space                      '
[11]    gx@'                                        '
[12]    hx@'      land costs                        '
[13]    ix@'                                        '
[14]    jx@'   total                                '
[15]    kx@'                                        '
[16]    lx@'                                        '
[17]    mx@'   school buildings                     '
[18]    nx@'                                        '
[19]    ox@'      development costs                 '
[20]    px@'      other costs                       '
[21]    sx@'                                        '
[22]    tx@'   total                                '
[23]    ux@'                                        '
[24]    vx@'                                        '
[25]    wx@'   community street system              '
[26]    xx@'                                        '
[27]    yx@'      development costs                 '
[28]    zx@'        artorial streets                '
[29]    aax@'        collector streets               '
[30]    abx@'        minor streets                   '
[31]    acx@'      land costs                        '
[32]    adx@'                                        '
[33]    aex@'   total                                '
[34]    afx@'                                        '
[35]    agx@'                                        '
[36]    ahx@'   public facilities                    '
[37]    aix@'                                        '
[38]    ajx@'      development costs                 '
[39]    akx@'        police facilities               '
[40]    alx@'        fire facilities                 '
[41]    amx@'        general administrative          '
[42]    anx@'        health care facilities          '
[43]    annx@'        library facilities               '
[44]    aox@'      land costs                        '
[45]    apx@'                                        '
[46]    aqx@'   total                                '
[47]    arx@'                                        '
[48]    asx@'                                        '
[49]    atx@'   utilities                            '
[50]    aux@'                                        '
[51]    avx@'      sewer system                      '
[52]    awx@'        development costs               '
[53]    axx@'        system wide costs               '
[54]    ayx@'      storm drainage devel costs        '
[55]    azx@'      water facilities                  '
[56]    bax@'        development costs               '
[57]    bbx@'        system wide costs               '
[58]    bcx@'      gas & electric                    '
[59]    bdx@'        development costs               '
[60]    bex@'        system wide costs               '
[61]    bfx@'                                        '
[62]    bgx@'   total                                '
[63]    bhx@'                                        '
[64]    bix@'                                        '
```

p p

```
[65]   bjx@'                                   grand total'
[66]   variables1@ax,bx,cx,dx,ex,fx,gx,hx,ix,jx,kx,lx,mx,nx,ox
[67]   variables2@rx,sx,tx,ux,vx,wx,xx,yx,zx,aax,abx,acx,adx,aex,a
       fx,agx
[68]   variables3@ahx,aix,ajx,akx,alx,amx,anx,annx,aox,apx,aqx,arx
       ,asx
[69]   variables4@atx,aux,avx,awx,axx,ayx,azx,bax,bbx,bcx,bdx,bex
[70]   variables5@bfx,bgx,bhx,bix,bjx
[71]   variables@variables1,variables2,variables3,variables4,varia
       bles5
[72]   variables@(61,36)$rvariables
[73]  calculations:  pos
[74]   sbs
[75]   pf
[76]   css
[77]   util
[78]   tcc
[79]   posdata1@0,0,0,dcpg,dcnp,dcos,0,0,0,0,0,0
[80]   sbsdata1@0,0,0,0,0,0,0,0
[81]   cssdata1@0,0,0,dcas,dccs,dcms,0,0,0,0,0
[82]   pfdata1@0,0,0,cfdc,ffdc,gafdc,hcfdc,lfdc,0,0,0,0,0
[83]   utildata1@0,0,0,tdcss,swcss,0,0,tdcwf,swcwf,0,tdcse,swcse,0
       ,0,0,0,0
[84]   posdata2@0,0,dcpos,0,0,0,0,lcpos,0,0,0,0
[85]   sbsdata2@0,0,dcsbs,ocsbs,0,0,0,0
[86]   cssdata2@0,0,tdccss,0,0,0,lccss,0,0,0,0
[87]   pfdata2@0,0,tdcpf,0,0,0,0,0,lcpf,0,0,0,0
[88]   utildata2@0,0,tcss,0,0,tdcsd,tccwf,0,0,tccse,0,0,0,0,0,0,0
[89]   posdata3@0,0,0,0,0,0,0,0,0,tccpos,0,0
[90]   sbsdata3@0,0,0,0,0,tccsbs,0,0
[91]   cssdata3@0,0,0,0,0,0,0,0,tccoss,0,0
[92]   pfdata3@0,0,0,0,0,0,0,0,0,tccpf,0,0
[93]   utildata3@0,0,0,0,0,0,0,0,0,0,0,0,0,tccutil,0,0,cct
[94]   data1@posdata1,sbsdata1,cssdata1,pfdata1,utildata1
[95]   data1@(61,1)$rdata1
[96]   data2@posdata2,sbsdata2,cssdata2,pfdata2,utildata2
[97]   data2@(61,1)$rdata2
[98]   data3@posdata3,sbsdata3,cssdata3,pfdata3,utildata3
[99]   data3@(61,1)$rdata3
[100]  data1@data1#1.772
[101]  data2@data2#1.772
[102]  data3@data3#1.772
[103]  data1@$ddata1+.5
[104]  data2@$ddata2+.5
[105]  data3@$ddata3+.5
[106]  variables!data1!data2!data3
[107]  ''


$gomcst[$1]$g
[0]    omcst
[1]    oms@totse#1090
[2]    pse@totse#.72
[3]    hse@totse#.28
[4]    abcs@39#((pse#.25)+(hse#.33))
[5]    toms@oms+abcs
[6]    asom@asl#1.25
[7]    csom@csl#.75
[8]    msom@msl#.63
[9]    tomcss@asom+csom+msom
[10]   polom@totpop#26
[11]   firom@totpop#26
[12]   govadom@totpop#12
[13]   hcom@totpop#121
[14]   libom@totpop#4
[15]   recom@totpop#10
```

```
tomps@totpop#199
ssom@totpop#10
wfom@totpop#11
geom@totpop#125
swom@totpop#9.5
tomutil@totpop#155.5
othom@totpop#76
totom@toms+tomcss+tomps+tomutil+othom
' '
' '
' '
' '
'operating and maintenance costs'
' '
' '
' '
ca@'public schools         '
cb@'   general operations'
cc@'   bussing             '
cd@'total                  '
var1@ca,cb,cc,cd
var1@(4,21)$rvar1
data1@0,0,oms,0,abcs,0,0,toms
data1@(4,2)$rdata1
ce@'community streets     '
cf@'   arterials          '
cg@'   collectors         '
ch@'   minor sts.         '
ci@'total                 '
var2@ce,cf,cg,ch,ci
var2@(5,21)$rvar2
data2@0,0,asom,0,csom,0,msom,0,0,tomcss
data2@(5,2)$rdata2
cj@'public services       '
ck@'   police             '
cl@'   fire               '
cm@'   health care        '
cn@'   libraries          '
co@'   recreation         '
cp@'total                 '
var3@cj,ck,cl,cm,cn,co,cp
var3@(7,21)$rvar3
data3@0,0,polom,0,firom,0,hcom,0,libom,0,recom,0,0,tomps
data3@(7,2)$rdata3
cq@'utilities             '
cs@'   sewer              '
ct@'   water              '
cu@'   gas & electric     '
cv@'   solid waste        '
cw@'total                 '
var4@cq,cs,ct,cu,cv,cw
var4@(6,21)$rvar4
data4@0,0,ssom,0,wfom,0,geom,0,swom,0,0,tomutil
data4@(6,2)$rdata4
var5@'other o&m costs      '
var6@'          grand total'
data5@0,othom
data5@(1,2)$rdata5
data6@0,totom
data6@(1,2)$rdata6
data1@data1#1.772
data1@$ddata1+.5
data2@data2#1.772
data2@$ddata2+.5
data3@data3#1.772
data3@$ddata3+.5
```

```
[92]   data4@data4#1.772
[93]   data4@$ddata4+.5
[84]   data5@data5#1.772
[85]   data5@$ddata5+.5
[86]   data6@data6#1.772
[87]   data6@$ddata6+.5
[88]   var1!data1
[89]   ' '
[90]   var2!data2
[91]   ' '
[92]   var3!data3
[93]   ' '
[94]   var4!data4
[95]   ' '
[96]   var5!data5
[97]   ' '
[98]   ' '
[99]   var6!data6
[100]  ' '
      $s
```

```
revs[$]]$s
[0]    revs
[1]    sfval@sfv#1200#30
[2]    mhval@mhv#800#20
[3]    mfval@mfv#900#25
[4]    resval@sfval+mhval+mfval
[5]    lresval@resval#.06
[6]    tresval@resval+lresval
[7]    retval@retspc#27
[8]    svcval@svcspc#25
[9]    ofcval@ofcspc#35
[10]   indval@indspc#20
[11]   nresval@retval+svcval+ofcval+ofcval+indval
[12]   lnresval@nresval#.06
[13]   tnresval@nresval+lnresval
[14]   totval@tresval+tnresval
[15]   taxval@totval#.022
[16]   locrev@taxval#.57
[17]   tlocrev@taxval+locrev
[18]   nlocrev@tlocrev#.7
[19]   taxval@$dtaxval+.5
[20]   tlocrev@$dtlocrev+.5
[21]   nlocrev@$dnlocrev+.5
[22]   totrev@tlocrev+nlocrev
[23]   da@'   residential values           '
[24]   db@'      single family homes       '
[25]   dc@'      mobile homes              '
[26]   de@'      land required             '
[27]   dd@'      multifamily units         '
[28]   df@'   total                        '
[29]   var7@da,db,dc,dd,de,df
[30]   var7@(6,29)$rvar7
[31]   data7@0,0,0,0,sfval,0,0,0,mhval,0,0,0,mfval,0,0,0,lresval,0
       ,0,0,0,tresval,0,0
[32]   data7@(6,4)$rdata7
[33]   dg@'   nonresidential values        '
[34]   dh@'      retail                    '
[35]   di@'      service                   '
[36]   dj@'      office                    '
[37]   dk@'      industrial                '
[38]   dl@'      land required             '
[39]   dm@'   total                        '
[40]   var8@dg,dh,di,dj,dk,dl,dm
```

```
[41]  var8@(7,29)$rvar8
[42]  data8@0,0,0,0,retval,0,0,0,svcval,0,0,0,ofcval,0,0,0,indval
      ,0,0,0,lnresval,0,0,0,0,tnresval,0,0
[43]  data8@(7,4)$rdata8
[44]  dn@'   total taxable valuation   '
[45]  do@'   times tax rate            '
[46]  dp@'=estimated tax revenues      '
[47]  dq@'+local nontax revenues       '
[48]  dr@'+state & federal transfers   '
[49]  ds@'=grand total of all revenues '
[50]  var9@dn,do,dp,dq,dr,ds
[51]  var9@(6,29)$rvar9
[52]  data9@0,0,totval,0,0,0,.022,0,0,0,0,taxval,0,0,0,locrev,0,0
      ,0,nlocrev,0,0,0,totrev
[53]  data9@(6,4)$rdata9
[54]  ' '
[55]  'revenues'
[56]  ' '
[57]  ' '
[58]  var7;data7
[59]  ' '
[60]  var8;data8
[61]  ' '
[62]  var9;data9
[63]  ' '
[64]  ' '
[65]  ' '
[66]  ' '
[67]  'unmet financial requirements'
[68]  ancc@cct#.15
[69]  ' '
[70]  ' '
[71]  'annual capital debt service'
[72]  ancc@$dancc+.5
[73]  $1@ancc
[74]  ' '
[75]  'annual o&m costs'
[76]  totom@$dtotom+.5
[77]  $1@totom
[78]  ' '
[79]  'less annual revenues generated'
[80]  totrev@$dtotrev+.5
[81]  $1@totrev
[82]  ' '
[83]  'equals'
[84]  unm@ancc+totom+-totrev
[85]  $1@unm
[86]  'in 1981 dollars'
```

APPENDIX C-3

SUMMARY OF COMMUNITY AND FISCAL IMPACT FACTORS

p

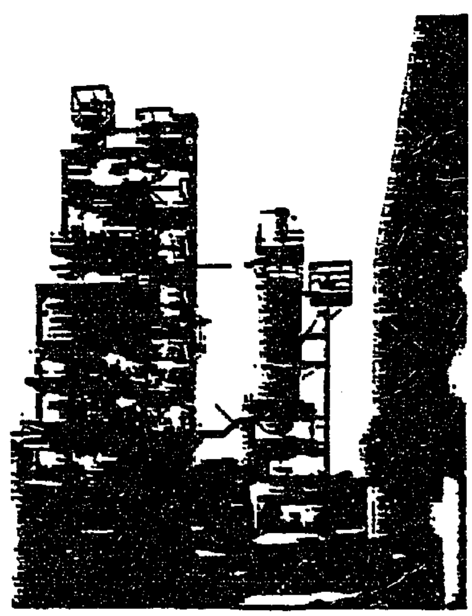
Socioeconomic Impact Assessment: A Methodology Applied to Synthetic Fuels

HCP/L2516-01
UC-13

April 1978

Prepared by
Murphy/Williams Urban Planning and Housing Consultants

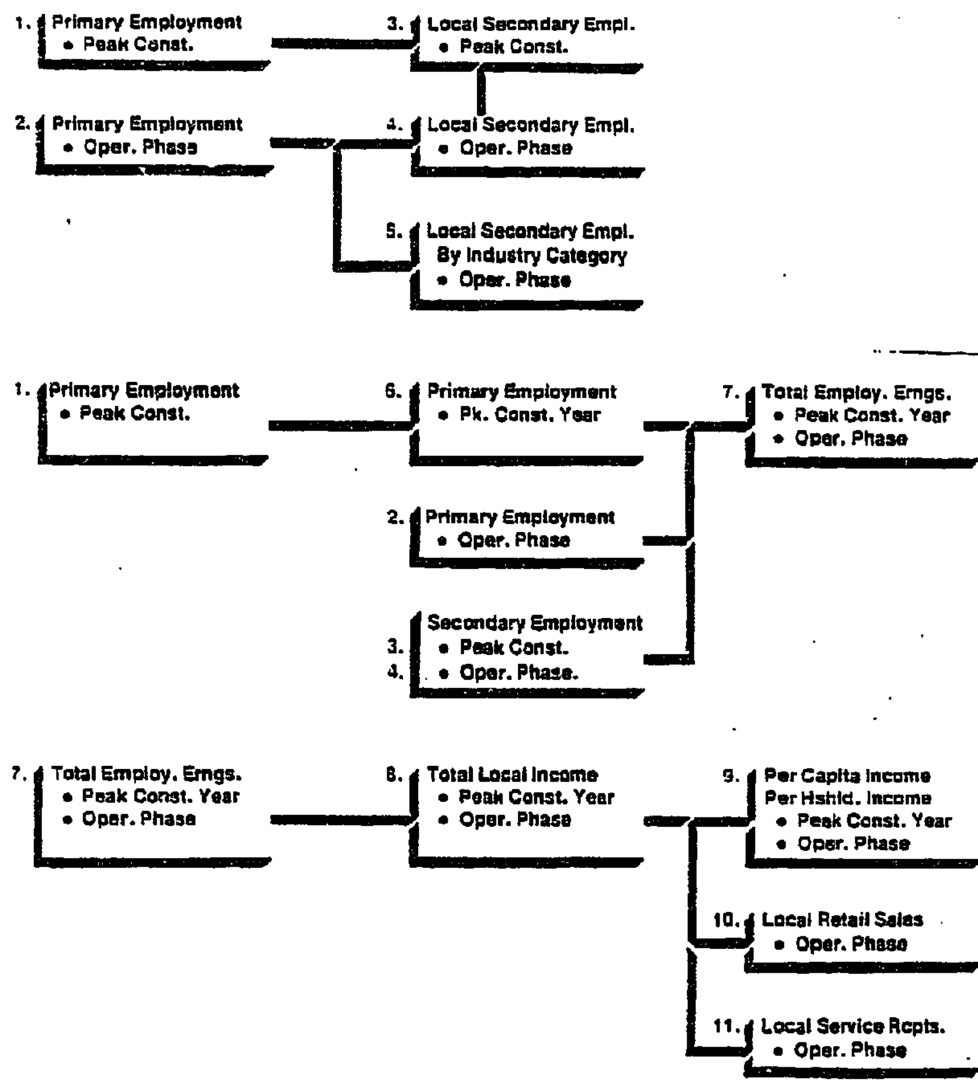
For the
U.S. DEPARTMENT OF ENERGY
ASSISTANT SECRETARY FOR RESOURCE APPLICATIONS
WASHINGTON, D.C. 20545



Under Contract No. EF-77-X-01-2516

A supporting document to the Final Environment Impact Statement, *Alternative Fuels Demonstration Program*, September, 1977.

FIGURE 4-a COMMUNITY DEVELOPMENT MODEL, ECONOMIC IMPACTS



1 __Primary Employment__, peak construction (PC) phase: based on industry sources

2 __Primary Employment__, operation (O) phase based on industry sources

3 __Local Secondary Employment__ (PC) = primary employment (PC) × .63

Based on income-sales-employment relationships in State of Wyoming. Assumes 65% local capture rate and only one local economic cycle (i.e. income of secondary workers generates no additional employment). A 60% local capture rate results in a ratio of .57, and a 70% local capture rate results in a ratio of .88.

4 __Local Secondary Employment__ (O) = primary employment (O) × 1.42

Based on income-sales-employment relationships in State of Wyoming. Assumes 70% local capture rate and four local economic cycles (i.e. income of secondary workers generates additional employment). A 65% local capture rate results in a ratio of 1.20, and a 75% local capture rate results in a ratio of 1.61

5. __Local Secondary Employment, by Industry Category__ (O) = local secondary employment (O) ×

.114	(.068)	construction
.182	(.046)	transportation
.069	(.033)	comm. and pub. util.
.044	(.236)	wholesale trade
.068	(.059)	F.I.R.E.
.038	(.099)	prsnl. bus., rep. svcs
.138	(.206)	prof. and rel. svcs
.111	(.065)	government

Expected proportions of total secondary employment based on income-sales-employment relationships in State of Wyoming, 70% local capture rate, four local economic cycles. Proportions for average U.S. county (in parentheses) indicate characteristics of expected local secondary economic mix.

6 __Primary Employment, peak construction year__ (PCY) = primary employment (PC) × .5

Earnings (see No. 7) is an annual figure, but the peak construction phase may not last a full year. Conversion factor based on estimates of PC and PCY workforce for several high-BTU development proposals.

7 __Total Employment Earnings:__

a) primary employ. (PCY) × $14,500 per employ.

b) primary employ. (O) × $14,300 per employ.

c) secondary employ. (PC) × $9,080 per employ.

d) secondary employ. (O) × 9,080 per employ.

total employment earnings (PCY) = a + c

total employment earnings (O) = b + d

Factors based on average hourly earnings in 1975 for a) contract construction workers, b) coal mining workers, and c) total private workers. Bureau of Labor Statistics, "Employment and Earnings," Vol. 23, No. 6

8 __Total Local Income__

total local income (PCY) = total employ earnings × 1.1

total local income (O) = total employ earnings × 1.2

Income includes income from social security, public assistance, interest, dividends, rent payments, etc. For the operation phase the factor is the mean income-earnings ratio in profile counties (SEP); assumes less income during the construction phase will come from sources other than earnings.

9 __Per Capita Income__ =

total local income ÷ total population (see no. 13, 14)

Per Household Income =

total local income ÷ total number of households (see no. 19)

10 __Local Retail Sales__ =

total local income × .48

Based on sales-income ratio in mining-dominant counties (SEP). The ratio is keyed to per capita income, with lower per capita income a larger share of total local income would be retail sales.

11 __Local Services Receipts__ =

total local income × .10

Based on receipts-income ratio in mining-dominant counties (SEP). The ratio is keyed to per capita income, with lower per capita income, a smaller share of total local income would be service receipts.

Notes

*All earnings, income, sales, costs, revenues estimates in 1975 $

(PC) = Peak Construction Period, (O) = Operating Period, (PCY) = Peak Construction Year

Major Sources

ERDA, "Socioeconomic Profile," unpublished (SEP)

Old West Regional Commission, Construction Worker Profile, 1975 (CWP)

Council on Environmental Quality, Costs of Sprawl, 1974 (COS)

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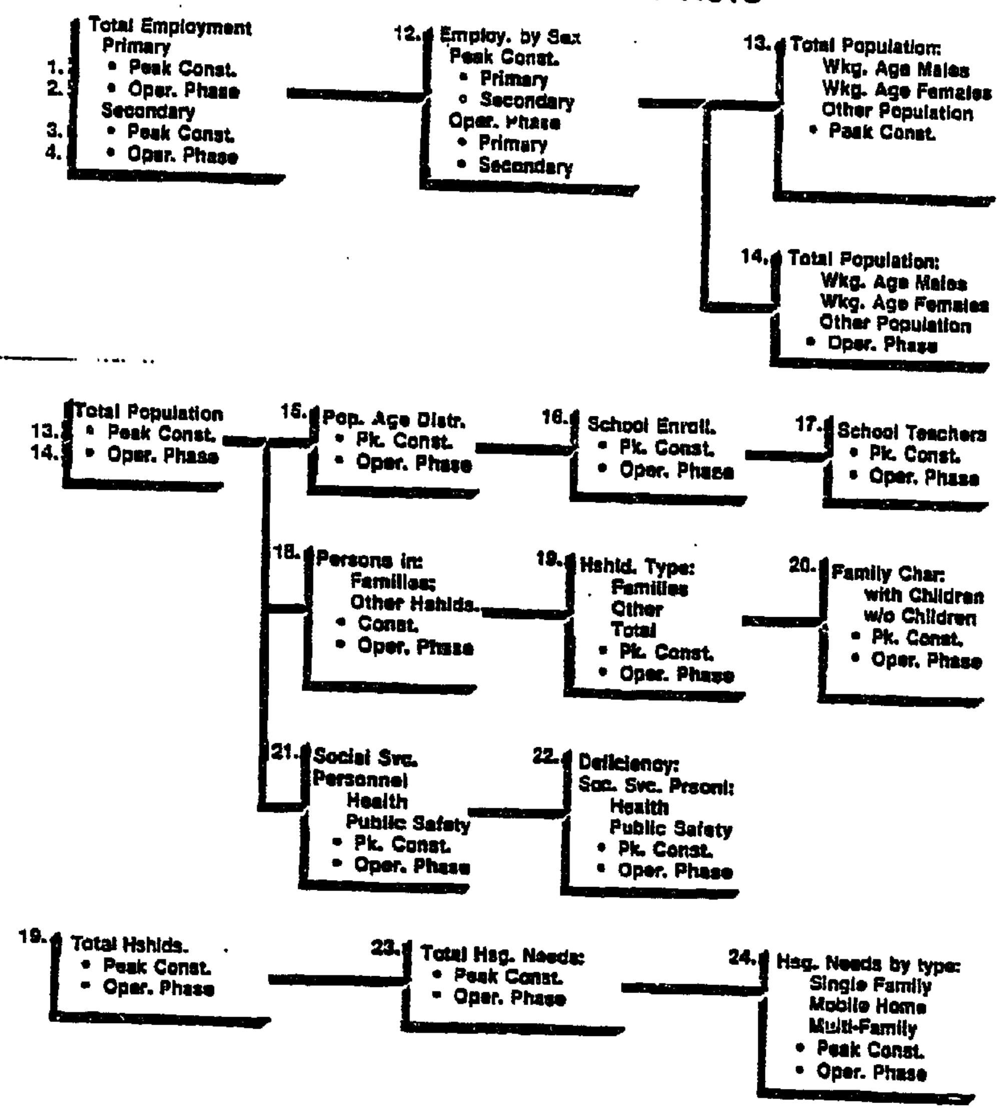
FIGURE 4-b COMMUNITY DEVELOPMENT MODEL, DEMOGRAPHIC AND SOCIAL IMPACTS



12. Female Employment (PC) =
primary employment (PC) × .02
+ secondary employment (PC) × .50

Female Employment (O) =
primary employment (O) × .04
+ secondary employment × .50

Nationwide, 5% of mining employees are female, but the synthetic fuels workforce may be more male-oriented than average. Construction employment is even more male-dominated (94% nationwide) than mining employment. Concentration of males in primary employment force results in a larger proportion of females in secondary employment jobs than in average U.S. county. (SEP)

13. Total Population (PC):
working age males = primary employment × 1.0
working age females = working age males × .45
other population = working age females × 1.61
Primary population = working age males, females, other population.
Construction workforce includes about 25% unmarried workers and about 25% married workers whose families are absent. [Other population is the children of working age females (CWP).]
working age males = male secondary employ. × 1.05
working age females = working age males × .89
other population = working age females × 1.61

Secondary Population = working age males, females, other population
Male population includes some not working. The proportion of married workers with families absent would be lower in the secondary than in the primary workforce, and the ratio of working age females to working age males would be correspondingly higher (CWP-SEP)
Total Population (PC) = primary population and secondary population

14. Total Population (O) Early Years:
working age males = primary employ × 1.1
working age females = working age males × .89
other population = working age females × 1.565
total population (O) = working age males, females, other population

An estimate for the early years of the operation phase: More working age males will not have jobs. The number of working age females almost equals the number of working age males. A larger proportion of total population will be in working age. (SEP: mean-profile counties)

Total Population (O) Latter Years:
working age males = male primary employ × 1.15
working age females = working age males × .95
other population = working age females × 1.54
total population (O) = working age males, females, other population

An estimate for the latter years of the operation phase. More working age males do not have jobs. The number of working age females almost equals the number of working age males. A larger proportion of total population will be in working age (SEP: mean-profile counties)

15. Population Age Distribution:

	<5	5-17	18-29	30-44	45-64	65+	Total
PC	14.4	23.5	31.7	19.0	10.4	0.5	100.0
O	10.3	28.7	28.0	19.5	10.1	3.4	100.0

During the construction phase, a larger proportion of the under 18 age group will be under 5 years, and a larger proportion of adults will be 18-29 years. (CWP). (SEP) in migrants, by age to selected state economic areas.

16. School Enrollment (elementary and high school) = population 5-17 years × .90

Factor based on average U.S. county and mean for mining dominant counties (SEP). Does not include nursery school, kindergarten, or college enrollment.

17. School Teachers (elementary and high school) = school enrollment × .045

Factor equals 4.5 teachers per 100 pupils (vs. 5.3 in average U.S. county), or 22 pupils per teacher (vs. 19 in average U.S. county) (SEP)

18. Living Situation (PC):
primary population in families = primary population × .78 (CWP)
secondary population in families = secondary population × .89 (CWP, SEP)
population in other households = total population (O) − population in families

Living Situation (O)
population in families = total population (O) × .92 (SEP)
population in other households = total population (PC) − population in families

Other households include persons living alone, with nonrelatives, or in rooming houses; includes workers whose families are absent.

19. Households (PC)
families = population in families ÷ 3.61 persons per family (CWP)
other households = population in other households ÷ 1.25 persons per household
households (PC) = families + other households

Households (O):
families = population in families ÷ 3.8 persons per family (SEP)
other households = population in other households ÷ 1.25 persons per household.
households (O) = families + other households.

Average family size is somewhat larger in operation phase. Average size of primary individual households, in nation and in urban areas was 1.25 in 1970.

20. Family Characteristics:
families with children = total families × .71 (SEP)
families without children = total families − families with children
Not all families would have children. Those with children would have about 2.4 per family (SEP)

21. Expected Social Service Personnel (PC)
health service personnel
physicians = 1.0 per 1,000 population
registered nurses = 5.0 per 1,000 population
health support personnel = 2.0 per 1,000 population
protective service personnel:
police and firemen = 3.0 per 1,000 population

Expected Social Service Personnel (O)
health service personnel:
physicians = 1.5 per 1,000 population
registered nurses = 6.0 per 1,000 population
health support personnel = 2.5 per 1,000 population
protective service personnel
police and firemen = 3.5 per 1,000 population

Oper. phase estimates keyed to experience in mining-dominant counties (SEP). Construction phase estimates assume somewhat lower rates.
Rates could be higher or lower depending on local conditions: e.g. established trade and service centers, climate, quality of life

22. Social Service Personnel Deficiency Measured Against:
21 health and hospital workers per 1,000 population
5 protective service workers per 1,000 population
5.3 teachers per 100 pupils
The above rates for average U.S. county are used as expected standard to which most communities are likely to aspire (SEP)

23. Total Housing Needs (PC) = total households (PC) × 1.10

Total Housing Needs (O) = total households (O) × 1.05

Because of high turnover and transiency during the construction phase, vacancy rates need to be higher than during the operation phase.

24. Housing Needs by Type:

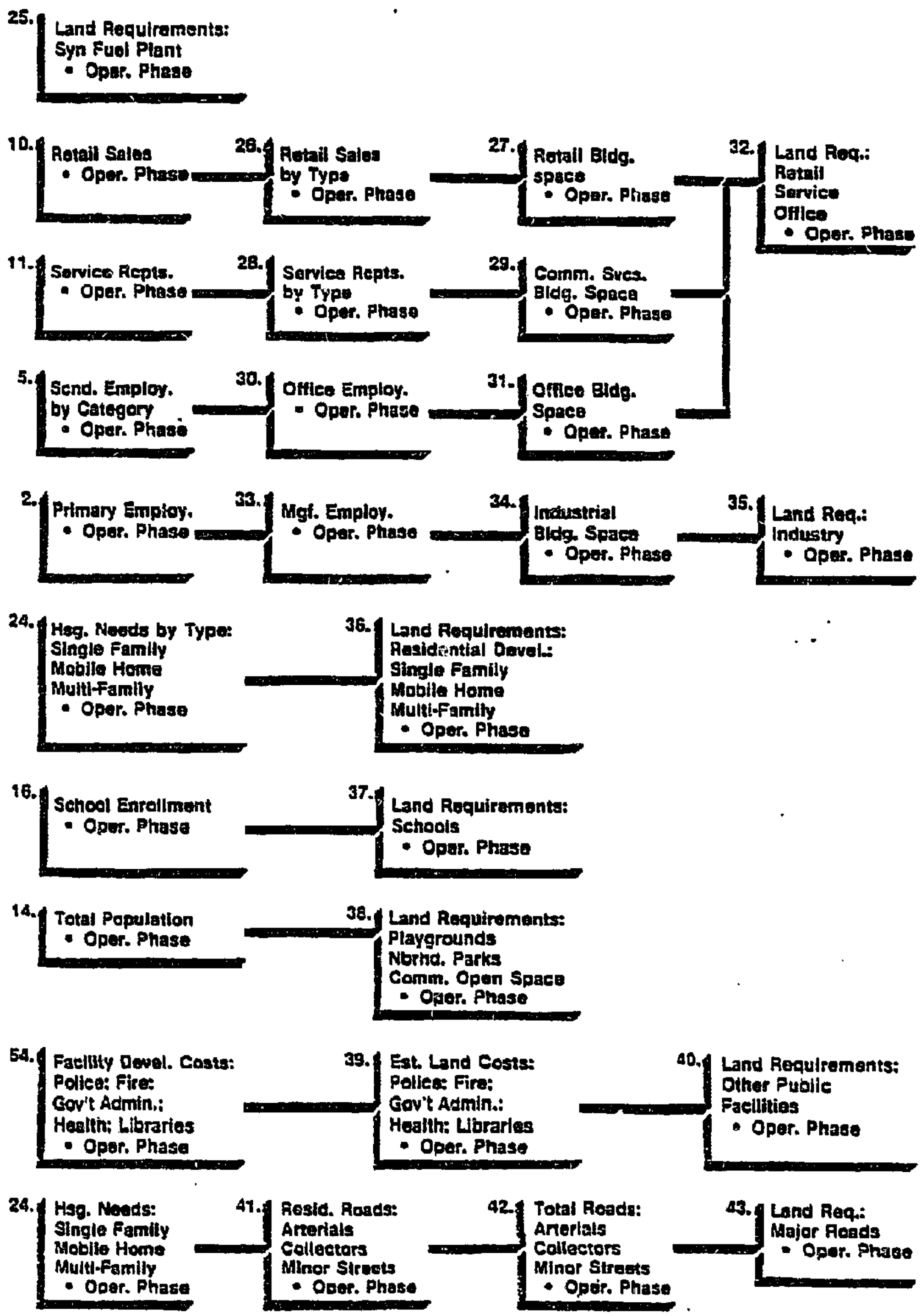
	Single-fam	Mobile Home	Multi-fam	Total Needs
PC	45	35	20	100
O	60	25	15	100

Distribution for construction phase based on actual housing of an appropriate category of newcomers (CWP). Distribution for operation phase based on housing demand (the type which would be purchased were it available) among newcomers (CWP). Assumed that the operation phase provides the necessary time to reduce the discrepancy between actual housing and housing demand.
Distribution of housing needs by type would vary for different segments of the impact population which would vary in their degree of commitment to the impact community.

Notes
All earnings, income, sales, costs, revenues estimates in 1975$. (PC) = Peak Construction Period. (PCY) = Peak Construction Year. (O) = Operating Period

Major Sources
Socioeconomic Profile (SEP)
Construction Worker Profile (CWP)
Costs of Sprawl (COS).

FIGURE 4-c COMMUNITY DEVELOPMENT MODEL. LAND USE IMPACTS



25. Plant Land Requirements (0):
Based on characteristics of the synthetic fuel plant and site; from industry sources.

26. Retail Sales by Type (0)
27. Retail Building Space (0) = total retail sales × proportion of sales by type ÷ sales per square foot

	Hdwr	Gen'l Merchan.	Food Stores	Auto Dealr	Gas Sta
Retail Sales	.082	.077	.277	.195	.096
Sales/sq. ft.	50	50	120	40	40

Appl & Appl	Furn	Eating & Drinking	Drug Stores	Misc Retail	Total
.058	.022	.060	.038	.097	$1.00
50	30	60	70	30	

Retail sales-distribution based on selected mining-dominant counties (SEP). Compared to nation as a whole, larger proportions of total retail sales are in eating and drinking, auto dealers, and gas stations; widely varying proportions are in building materials and hardware stores, general merchandise stores, appliance and apparel stores, and furniture stores. Ratio of sales per square foot gross leasable floor area derived from "Dollars and Cents of Shopping Centers," Urban Land Institute, 1975.

28. Service Receipts by Type (0)
29. Commercial Services Building Space (0) = total service receipts × proportion of receipts by type ÷ receipts per sq. foot.

	Hotels & Motels	Auto Repair	Misc Repair	Amuse. & Recr
total svc. rcpts.	.242	.082	.192	.121
rcpts. per sq. ft.	45	40	30	15

	Legal Svcs	Misc Svcs	Total
cont.	.068	.285	1.000
cont.	30	20	

Service receipts distribution based on selected mining-dominant counties (SEP). Compared to the nation as a whole, larger proportions are spent for hotels, motels, and trailer parks and for miscellaneous services (a category which includes personal and business services). Widely varying proportions are spent for miscellaneous repair and for amusement and recreation services.

30. Office Employment (0)
31. Office Building Space (0) = employment × employment by type activity × square footage per employee

SCND. EMPL. CATEG:	Const.	TCPU	Whsl. Trade
30. employ. by type ×	.1	.1	.1
31. office employ. ×	150	150	150

	Retail	[illegible]	[illegible]	[illegible]
cont.	.3	.5	.5	1.0
cont.	175	150	150	175

Office employment comprises varying proportions of total employment in various secondary economic categories. Office space per office employee varies by economic function.

32. Retail, Service and Office Land Requirement (0):
total building space = retail (27) + service (29) + office (31)
parking space = total bldg. space × 1.875
other land req. = (bldg. space + pkg. space) × .25
total land req. = bldg. space + pkg. space + other land

Assumes all building space at ground level. Parking factor assumes 5 spaces per 1000 square feet of building space, and 375 square feet per parking space. "Other land" includes service roads, utilities, landscaping.

33. Expected Manufacturing Employment (0) = primary employment (0) × .11 (SEP)

Ratio of manufacturing to mining employees is 1:9 in mining-dominant counties (SEP). Special programs and/or local conditions could increase the ratio; a ratio of 1:6 is an upper limit for mining-dominant counties (SEP).

34. Industrial Buildings Space (0) = manufacturing employment × 550 sq. ft. per employ.

Space per employee depends on characteristics of manufacturing firms.

35. Industrial Land Requirements (0):
parking space = mgt. employ. × 280 sq. ft. per employ.
other land req. = (bldg. space + pkg. space) × .2
total land req. = bldg. space + pkg. space + other land

Assumes all industrial space at ground level. Parking factor assumes .75 spaces per employee, 350 sq. ft. per space. "Other land" includes service roads, utilities, landscaping.

36. Residential Land Requirement (0):
single-family = single-fam. units ÷ 3 units per acre
mobile homes = mobile home units ÷ 5 units per acre
multi-family = multi-fam. units ÷ 10 units per acre
total land req. = single-fam. + mobile home + multi-fam.

Densities could be somewhat higher or lower, depending on local conditions. These are consistent with those for "single-family conventional," "single-family clustered," and "townhouse clustered" housing patterns in "Cost of Sprawl" neighborhood cost analysis.

37. School Land Requirement (0) = school enrollment × .013 acres per pupil

Assumes a 10 acre site for an elementary school with 750 pupils, a 20 acre site for a high school with 1500 pupils (COS).

38. Parks and Open Space (0):
playgrounds = total pop. × 1.8 acres per 1000 pop.
nbrhd. parks = total pop. × 3.0 acres per 1000 pop.
community open space = total pop. × 3.7 acres per 1000 pop.
parks and open space = plgrnds. + nbrhd. parks + open space.

Factors from C.O.S. assume community parks not justified for population of size normally generated by synthetic fuels developments.

39. Public Facility Land Costs (0):
40. Public Facility Land Requirements (0):
land costs (police and fire) = facil. devel. costs × .08
land costs (other public facil.) = facil. devel. costs × .06
total land req. = total land costs ÷ $8500 per acre

More severe locational constraints on police and fire facilities may result in higher land costs, as a proportion of facility development costs. Assumes that, within limits, the budget for public facility land determines the amount purchased. Land cost as proportion of facility development costs based on land cost impacts under sprawl mix development conditions (COS). Land cost per acre is a general expectation under low density sprawl development conditions (COS).

41. Residential-Related Street System (0):
arterials (100 ft. R.O.W.) = single-fam. units × 6 ft. per unit + mobile homes × 5.5 ft. per unit + multi-fam. units × 5 ft. per unit

collectors (60 ft. R.O.W.) = single-fam. units × 7 ft. per unit + mobile homes × 17.25 ft. per unit + multi-fam. units × 13.5 ft. per unit
minor streets (50 ft. R.O.W.) = single-fam. units × 47 ft. per unit + mobile homes × 22 ft. per unit + multi-fam. units × 10 ft. per unit

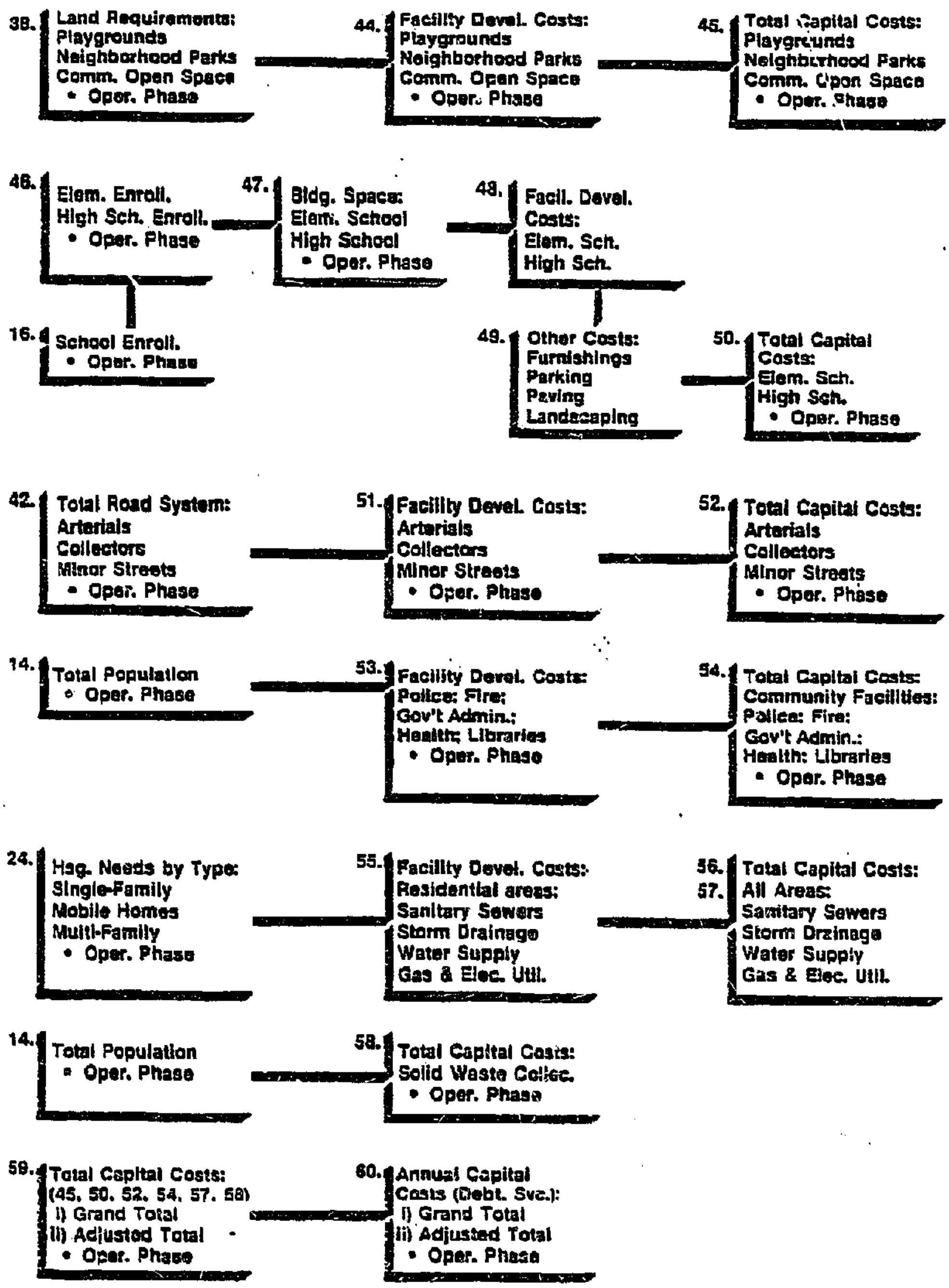
Factors based on neighborhood cost analysis for residential development of similar density (COS).

42. Community Street System (0):
arterials = arterials (resid.-related) × 1.75
collectors = collectors (resid.-related) × 1.1
minor streets = minor streets (resid.-related) × 1.1

Factors for non-residential portion of total community street system based on relationships in sprawl mix development pattern (COS).

43. Major Roads Land Requirements (0) = community street system (arterials + collectors)

FIGURE 4-d COMMUNITY DEVELOPMENT MODEL, LOCAL GOVERNMENT IMPACTS: CAPITAL COSTS



44. Parks & Open Space Development Costs (0):
playgrounds = land req. · $9,700 per acre (COS)
neighborhood parks = land req. · $13,300 per acre (COS)
community open space = land req. · $1500 per acre (COS)
total devel. costs = playgrounds - neighborhood parks - open space

45. Parks & Open Space, Total Capital Costs (0):
land costs = land requirement (see #38) · $8500 per acre
total capital costs = development costs - land costs

Land cost per acre is a general expectation under "low density sprawl development conditions" (COS).

46. School Enrollment, by Grade Level (0):
elementary = total school enroll. · .72 (SEP)
high school = total school enroll. · .28 (SEP)

47. School Building Space (0):
elementary = elem. enroll. · 120 sq. ft. per pupil (COS)
high school = high sch. enroll. · 153 sq. ft. per pupil (COS)
total bldg. space = elementary - high school

48. School Facility Development Costs (0) =
total school building space · $34 per square foot (COS)

49. Other School Development Costs (0) =
facility development costs · .12 (COS)

Other development costs include school furnishings, parking, paving, landscaping, etc.

50. Schools, Total Capital Costs (0):
total devel. costs = facility devel. costs - other devel. costs
land costs = total devel. costs · .04 (COS)
total capital costs = total devel. costs - land costs

Assumes that land costs, as a proportion of total development costs are lower for schools than for other public facilities (see #39).

51. Community Street System Development Costs (0):
arterials = arterial street length · $117 per foot (COS)
collectors = collector street length · $38 per foot (COS)
minor streets = minor street length · $37 per foot (COS)
total devel. costs = arterials - collectors - minor streets

52. Community Street System, Total Capital Costs (0):
land costs = total development costs · .07 (COS)
total capital costs = total development costs - land costs

Land costs, as proportion of street system development costs based on land cost impacts under "sprawl mix" development conditions.

53. Public Facility Development Costs (0):
police facilities (structure, equipment, vehicles) = total population · $40 per person (COS)
fire facilities (structure, equipment, vehicles) = total population · $32 per person (COS)
government administration (offices and meeting rooms) = total population · $20 per person (COS)
health care facilities (structure, equipment, furnishings) = total population · $236 per person (COS)
library facilities (structure, equipment, furnishings, books) = total population · $41 per person (COS)
total devel. costs = police - fire - gov't admin. - health - library

54. Public Facilities, Total Capital Costs (0) =
total development costs - land costs (see #39).

55. Residential-Related Utility Development Costs (0):

	Costs per unit: sanitary sewerage	storm drainage	water facilities	gas & elec. utilities
single-fam. units	1,185	1,933	2,959	643
mobile homes	735	1,293	1,982	432
multi-fam. units	466	861	1,263	279

Facility development costs based on neighborhood cost analysis for residential development of similar density (COS).

56. Non-residential Utility Development Costs (0):
sanitary sewerage = res.-related devel. costs · .43
storm drainage = res.-related devel. costs · .23
water facilities = res.-related devel. costs · .23
gas & elec. facilities = res.-related devel. costs · .23

Factors for non-residential portion of total utility systems based on relationships in "sprawl mix" development pattern (COS).

57. Utilities, Total Capital Costs (0):
facility development costs (sanitary sewer, storm drainage, etc.) = resid.-related devel. costs - non-res. devel. costs
system-wide devel. costs:
sanitary sewer (pumping stations, treatment plants) = facility devel. costs · .44
water facil. (storage facil., wells) = facil. devel. costs · .09
gas & elec. facil. (transf., transm. lines) = facil. devel. costs · .33
total capital costs = facility devel. costs - system devel. costs

Factors for special system-wide costs based on relationships in "sprawl mix" development pattern (COS).

58. Solid Waste Collection, Total Capital Costs (0):
development costs (structure, vehicles) = total population · $8.25 per person (COS)
landfill (disposal) costs = development costs · .08 (COS)
total capital costs = development costs - landfill costs

59. Total Capital Costs (0):
grand total = sum of 45, 50, 52, 54, 57, 58
adjusted total = grand total less minor streets (see #52) less gas & elec. util. (see #57)

Adjusted total assumes that the costs of minor streets and gas and electric facilities are reflected in the price of private development, and are therefore not reflected in local capital budgets; assumes that hospitals and health clinics are county facilities and are reflected in local capital budgets.

60. Annual Capital Costs, Debt Service (0) =
total capital costs · .0858

Annual capital costs are the partial payment on a 25 year loan at 7% interest. Annual costs would be 10% higher (.0944) on a 20 year loan at 7% interest, 9% lower (.0782) on a 25 year loan at 6% interest. Assumes that capital costs are all in a single bond issue, rather than in periodic bond issues during the development period.

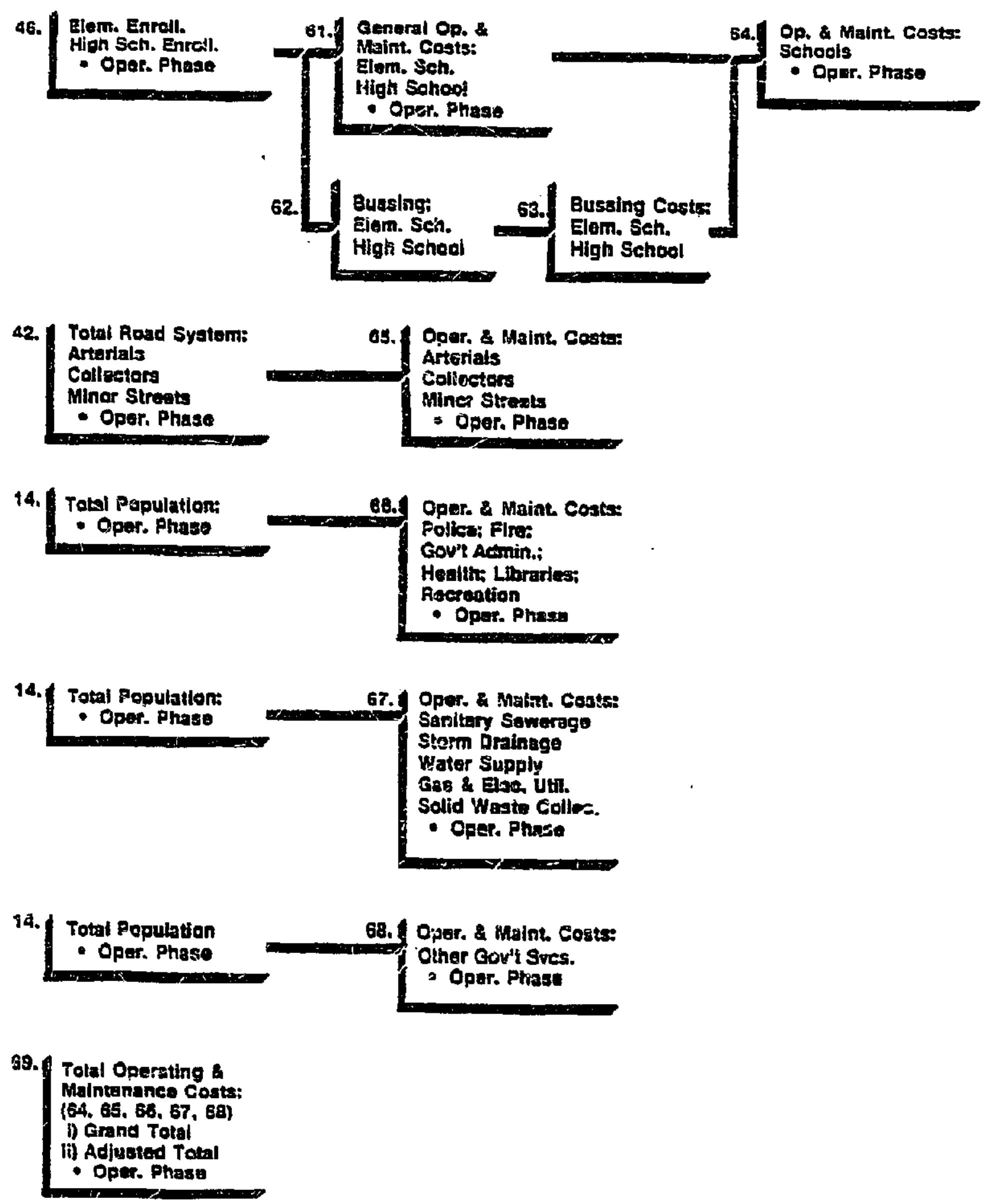
Total adjusted capital costs of $4700 per capita compares with $623 general debt outstanding per capita in the average county area, and $368 in county areas of 10-25,000 population. Annual capital costs of $405 per capita compares with $103 annual capital outlay per capita in the average county area, and $62 in county areas of 10-25,000 population.

In the average county, only a portion of the capital cost of the public facility and infrastructure system is reflected in current debt service; the model assumes new public facility and infrastructure development, with total costs reflected in current debt service.

Notes:
(pc) = peak construction period;
(pcy) = peak construction year;
0 = operating period
All earnings, income, sales, costs, revenues estimates in 1975 $

Major sources:
Socio-economic profile (SEP); Construction Worker Profile (CWP); Cost of Sprawl (COS); Urban Land Institute and Other sources

FIGURE 4-e COMMUNITY DEVELOPMENT MODEL, LOCAL GOVERNMENT IMPACTS: OPERATING AND MAINTENANCE COSTS



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61. Schools, General Oper. & Maint. Costs (0) =
school enrollment x $1,080 per pupil (COS)

62. Bussing (0):
elem. school = elem. enrollment · .25 (COS)
high school = high school enroll. · .33 (COS)

Percentage of school pupils bussed, by grade level, based on estimates for the "sprawl mix" development pattern (COS).

63. Annual Bussing Costs (0) =
pupils bussed · $39 per pupil (COS)

64. Schools, Total Oper. & Maint. Costs (0) =
general oper. & maint. costs + bussing costs

Total annual operating and maintenance costs are about $284 per capita, versus $308 in the average county area, and $267 in county areas of 10-25,000 population. Per capita rates do not reflect the school age portion of total population.

65. Community Street System, Oper. & Maint. Costs (0):
arterials = arterial street length · $1.25 per foot
collectors = collector street length · $.75 per foot
minor streets = minor street length · $.83 per foot
total oper. and maint. costs = arterials + collectors + minor streets

Factors derived from COS, adjusted to reflect the characteristics of road right-of-way maintained. Total annual operating and maintenance costs are about $15 per capita, versus $40 in average county area, and $52 in county areas of 10-25,000 population; differences are attributable to the costs of rural roads in most counties, not included in community street system. (CWP, COS AND U.S. Census)

66. Public Services, Oper. & Maint. Costs (0):
police = total pop. · $26 per person (90% salaries)
fire = total pop. · $25 per person (90% salaries)
gov't. admin. = total pop. · $12 per person
health care = total pop. · $121 per person (69% salaries)
library = total pop. · $4 per person (57% salaries)
recreation = total pop. · $10 per person (80% salaries)

The above factors, derived from COS, can be compared with per capita expenditures in the average U.S. county area, and with smaller county areas of 10-25,000 population:

police: $26 per person vs $32 (US), $12 (sm)
fire: $26 per person vs $16 (US), $3.4 (sm)
gov't admin. = : 12 per person vs $31 (US), $22 (sm)
(for financial admin., gnrl. control, gnrl. public bldgs.)
health care: $121 per person vs $44 (US), $38 (sm)
(ave. county area expend. reflect public costs exclusively)
library: $4 per person vs $5 (US), $2 (sm)
recreation: $10 per person vs $15 (US), $3 (sm)

Factors are derived from Costs of Sprawl service worker to population assumptions but can be compared to alternative assumptions.
3.6 police and fire employees per 1,000 pop. (COS) vs 3.5 protective service workers expected, (SEP) 5 in average US county (U.S. Cen.)
3.9 health service personnel per 1,000 pop. (COS), vs 9.5 physicians and registered nurses expected, (SEP), 15 in average county. (U.S. Cen.)
(disparity attributable to private medical practices)
0.8 recreation employees per 1,000 population.

67. Utilities, Oper. & Maint. Costs (0):
sanit. sewerage = total pop. · $10 per person
storm drainage: (included in street system maint.)
water supply = total pop. · $11 per person
gas & elec. util. = total pop. · $125 per person
solid waste collec. = total pop. · $9.6 per person

The above factors, based on "sprawl mix" development patterns (COS), can be compared with per capita expenditures in the average U.S. county area and with smaller county areas of 10-25,000 pop. (sm):
sanitary sewer.: $10 per capita vs $21 (U.S.), $6 (sm)
water supply: $11 per capita vs $10 (U.S.), $3.5 (sm)

For population in single family residential areas, per capita sewer service expenditures are about 6% higher; about 2% lower in multi-family residential areas. For population in single-family and mobile home areas, per capita gas and electric expenditures are about 15% higher; about 18% lower in multi-family residential areas.

68. Other Operation and Maintenance Costs (0) =
total population · $76 per person

"Other" category includes operation and maintenance expenditures for public welfare, interest on debt, housing and urban renewal, natural resources and correction. Factor based on expenditures in these areas in average county area, and in county areas of 10-25,000 population.

69. Total Operation and Maintenance Costs (0):
grand total = sum of 64, 65, 66, 67, 68
adjusted total = grand total — gas and elec. util. (see #67)
—70% health care (see #66).

Adjusted total assumes all gas and electric oper. and maint. expenditures, and 70% of health care oper. and maint. expenditures are private, not public costs.

Per capita oper. and maint. expenditures (adjusted total) of about $520 compares with $571 in average county area and $416 in counties of 10-25,000 population.

Notes:
All earnings, sales, costs, revenues estimates in 1975 $.
(pc) = peak construction period;
(pcy) = peak construction year;
(0) = operating period
(sm) = smaller counties—10,000-25,000 population

Major Sources:
Construction Worker Profile (CWP) is basis for applicable densities wherever possible, although most unit costs based on "sprawl mix" (COS)
Costs of Sprawl (COS)
Socioeconomic Profile (SEP)
U.S. Census of Governments, 1970 inflated to 1975 dollars for comparisons to average U.S. County and smaller U.S. Counties.

APPENDIX C-4

REVISED WORK FORCE ESTIMATES

CONTRACT 835704
TOTAL CROW SYNFUELS

REPORT # 8056020

HADAP 5 MANNING BY CRAFT-SUBTOTAL

DATE 05/24/82 RUN TIME 13.06.11 PAGE 1 OF 2

CRAFT DESCRIPTION		1QTR86	2QTR86	3QTR86	4QTR86	1QTR87	2QTR87	3QTR87	4QTR87	1QTR88	2QTR88	3QTR88	4QTR88
BOILERMAKERS	02	16.1	39.5	48.7	56.8	63.6	70.6	77.4	80.3	80.9	75.6	60.2	35.9
BRICKLAYERS	04	3.1	8.0	10.1	11.8	13.1	14.5	16.2	16.7	16.9	15.5	12.2	7.2
CARPENTERS	06	67.5	180.5	229.4	267.4	296.5	329.2	368.9	380.3	385.3	350.3	272.5	160.7
CEMENT MASONS	08	12.4	30.0	36.9	43.0	48.2	53.5	58.5	60.8	61.2	57.4	45.9	27.4
WAREHOUSE	15	0.0	22.1	37.1	43.4	44.1	49.0	65.2	64.1	67.5	49.2	29.4	14.8
ELECTRICIANS	18	70.0	176.7	220.2	256.7	286.5	318.1	351.5	363.9	367.4	339.9	268.6	159.6
INSULATORS	24	6.8	17.5	21.9	25.6	28.5	31.6	35.1	36.3	36.6	33.7	26.5	15.7
IRONWORKERS	26	35.9	90.1	112.0	130.6	145.9	161.9	170.6	185.0	186.7	173.1	137.1	81.5
LABORERS	28	104.0	315.1	413.2	481.8	527.9	586.1	673.3	689.1	702.3	618.9	467.2	271.4
MILLWRIGHTS	32	14.2	33.9	41.4	48.2	54.2	60.2	65.5	68.1	68.5	64.6	52.0	31.1
OILERS	34	5.0	16.7	22.7	26.4	28.7	31.8	37.3	38.0	38.9	33.4	24.6	14.1
OPERATING ENGINEERS	36	24.8	80.0	107.4	125.2	136.3	151.4	176.1	179.6	183.5	159.2	118.3	68.2
PAINTERS	38	13.0	32.3	40.0	46.6	52.2	57.9	63.7	66.0	66.6	61.9	49.2	29.3
PIPEFTRS/WLDRS/RIGRS	40	237.2	562.5	685.2	798.7	898.6	997.5	1084.2	1127.9	1134.1	1071.2	862.2	516.6
SHEET METAL WORKERS	48	0.6	3.1	4.5	5.3	5.6	6.2	7.7	7.7	8.0	6.4	4.4	2.4
TEAMSTERS	54	8.7	39.9	57.6	67.2	71.5	79.4	96.8	97.4	100.7	82.3	57.3	31.8
FLUOR STAFF	98	0.0	14.6	38.3	126.8	181.7	258.6	268.6	329.5	243.0	253.3	169.1	96.9
NON-FLUOR STAFF	99	0.0	12.0	31.3	103.7	140.7	211.6	219.8	269.6	198.8	207.2	138.3	79.2
TOTAL		619.3	1673.3	2157.9	2665.3	3031.7	3469.3	3844.3	4060.3	3947.0	3653.4	2795.0	1643.9

CONTRACT 835704
TOTAL CROW SYNFUELS

REPORT # 8056020

HADAP 5 MANNING BY CRAFT-SUBTOTAL

DATE 05/24/82 RUN TIME 13.06.11 PAGE 2 OF 2

CRAFT DESCRIPTION		1QTR83
BOILERMAKERS	02	15.7
BRICKLAYERS	04	3.1
CARPENTERS	06	68.2
CEMENT MASONS	08	12.0
WAREHOUSE	15	3.4
ELECTRICIANS	18	69.1
INSULATORS	24	6.8
IRONWORKERS	26	35.4
LABORERS	28	110.7
MILLWRIGHTS	32	13.8
OILERS	34	5.5
OPERATING ENGINEERS	36	27.2
PAINTERS	38	12.8
PIPEFTRS/WLDRS/RIGRS	40	228.7
SHEET METAL WORKERS	48	0.9
TEAMSTERS	54	11.4
FLUOR STAFF	98	16.6
NON-FLUOR STAFF	99	13.6
TOTAL		654.8

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OPERATIONS PERSONNEL - BASE CASE

Staff	-		20
Operating Personnel	-		416
Maintenance Personnel	-		413
		Total	849

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APPENDIX C-5

ORIGINAL WORK FORCE ESTIMATES

CONSTRUCTION
MANPOWER PROJECTION
(By Craft--In Man Months)

△ *FIELD MOVE IN*

Account	Description	01	02	03	04	05	06	07	08	09	10	11	12	Year 01 Subtotal	To Date Project Tot
Craft01	Boiler Makers					—	—	—	—	—	—	—	—	—	
Craft02	Bricklayers					—	—	—	—			—	—	—	
Craft03	Carpenters					4	9	26	41	130	198	210	210		
Craft04	Cement Finishers					—	1	3	4	4	6	6	6		
Craft05	Electricians					4	8	22	36	91	133	140	140		
Craft06	Insulators					—	—	—	—	—	—	—	—	—	
Craft07	Ironworkers					1	2	6	9	35	36	39	39		
Craft08	Laborers					12	26	43	54	120	162	172	172		
Craft09	Millwrights					—	—	—	—	—	—	—	—	—	
Craft10	Operators					36	81	92	81	52	21	23	23		
Craft11	Painters					·	—	—	—	—	1	2	2		
Craft12	Pipefitters					3	7	20	32	35	47	52	52		
Craft13	*P.F.- WELDERS* Other Crafts					—	·	—	—	—	—	—	—	—	
Craft14	*OILERS*					2	3	8	13	13	16	18	18		
Craft15	Teamsters					11	24	36	43	34	34	38	38		
Nomanl	Non-Manual					7	14	19	46	46	46	50	50		
Supervn	Supervision					25	25	25	40	50	50	50	50		
	*****GRAND TOTAL*****					100	200	300	400	600	750	800	800		

If any of the above include specialized personnel the contractor will supply, please footnote:

MANPOWER PR..ECTION
(By Craft--In Man Months)

Account	Description	13	14	15	16	17	18	19	20	21	22	23	24	Year 02 Subtotal	To Date Project T
Craft01	Boiler Makers	-	-	-	-	-	-	-	122	129	135	135	100		
Craft02	Bricklayers	-	-	-	-	-	3	3	4	7	22	-	-		
Craft03	Carpenters	220	220	208	194	238	240	250	250	300	300	235	200		
Craft04	Cement Finishers	6	6	11	14	19	20	20	33	72	65	40	-		
Craft05	Electricians	146	146	152	154	65	65	65	65	100	100	100	100		
Craft06	Insulators	-	-	-	-	-	-	-	-	-	-	-	-		
Craft07	Ironworkers	40	40	41	42	52	55	55	91	158	195	150	115		
Craft08	Laborers	180	180	184	262	280	345	360	385	402	268	300	395		
Craft09	Millwrights	-	-	-	-	-	-	-	114	120	125	125	125		
Craft10	Operators	23	23	38	52	67	69	103	124	130	100	80	80		
Craft11	Painters	2	2	2	-	-	-	-	-	-	-	-	-		
Craft12	Pipefitters	52	52	83	110	143	145	270	270	270	270	270	270		
Craft13	P.F.-WELDERS Other Crafts	-	-	-	-	-	-	94	95	95	95	95	95		
Craft14	OILERS	18	18	30	44	57	48	45	27	27	25	20	20		
[illegible]	Teamsters	38	38	66	93	119	120	120	120	120	100	50	50		
Nonmanl	Non-Manual	50	50	60	60	60	90	95	100	120	150	150	150		
Supervn	Supervision	75	75	75	75	150	150	200	200	200	200	200	200		
	*****GRAND TOTAL*****	1850	850	950	1100	1250	1400	1700	2000	2250	2150	1950	1800		

If any of the above include specialized personnel the contractor will supply, please footnote:

PAGE 2 OF 4

MANPOWER PROJECTION
(By Craft--In Man Months)

Account	Description	25	26	27	28	29	30	31	32	33	34	35	36	Year 03 Subtotal	To Date: Project To
		Months													
Craft01	Boiler Makers	64 154	168	215	190	190	190	265	275	280	230	200	150		
Craft02	Bricklayers	–	–	–	6	6	6	9	10	10	–	–	–		
Craft03	Carpenters	226	232	190	175	122	130	140	140	120	120	180	50		
Craft04	Cement Finishers	–	50	41	35	21	21	23	25	15	10	10	–		
Craft05	Electricians	100	100	100	112	144	190	300	300	300	250	200	175		
Craft06	Insulators	–	–	41	55	100	125	150	150	15	150	100	10		
Craft07	Ironworkers	140	160	170	190	220	245	265	280	250	230	200	170		
Craft08	Laborers	250	216	216	227	230	235	235	235	220	220	220	200		
Craft09	Millwrights	135	155	200	170	170	170	235	235	235	235	200	150		
Craft10	Operators	90	100	100	100	100	150	170	170	150	100	90	50		
Craft11	Painters	–	–	–	20	58	78	78	80	90	90	20	–		
Craft12	Pipefitters	260	250	285	346	480	595	595	600	600	550	550	500		
Craft13	~~Other Crafts~~ PipeF. – Welders	90	90	108	131	180	220	220	230	230	200	200	200		
Craft14	Oilers	20	24	24	24	24	80	40	40	85	20	20	10		
Craft15	Teamsters	35	35	35	44	60	75	80	80	70	55	55	30		
Nonmanl	Non-Manual	110	150	150	150	395	340	345	350	345	340	535	305		
Supervn	Supervision	200	200	200	200	200	200	200	200	200	200	200	200		
*****GRAND TOTAL*****		1900	2050	2200	2300	2600	3000	3350	3400	3300	3000	2700	2200		

If any of the above include specialized personnel the contractor will supply, please footnote

USE OR DISCLOSURE OF REPORT DATA IS SUBJECT TO THE RESTRICTION ON THE NOTICE PAGE AT THE FRONT OF THIS REPORT

✓ 44th CONSTR. MONTH

MANPOWER PRO TION
(By Craft--In Man Months)

Account	Description	37	38	39	40	41	42	43	44	45	46	47	48	Year 04 Subtotal	To Date Project Tot
						Months									
Craft01	Boiler Makers	100	150	150	180	200	200	150	50	–	–	–	–		
Craft02	Bricklayers	–	–	–	–	–	–	–	–	–	–	–	–		
Craft03	Carpenters	50	100	125	130	200	200	200	200	50	20	15	5		
Craft04	Cement Finishers	–	–	–	30	30	30	30	–	–	–	–	–		
Craft05	Electricians	150	160	200	250	250	250	200	100	25	–	–	–		
Craft06	Insulators	–	55	100	150	300	350	450	450	200	–	–	–		
Craft07	Ironworkers	145	160	175	230	200	200	100	100	–	–	–	–		
Craft08	Laborers	200	225	225	225	225	225	300	210	150	30	10	13		
Craft09	Millwrights	100	130	200	230	200	200	150	–	–	–	–	–		
Craft10	Operators	50	80	90	100	100	100	100	85	25	–	–	–		
Craft11	Painters	–	20	20	90	200	250	350	400	300	35	–	–		
Craft12	Pipefitters	350	400	550	550	550	550	400	200	50	–	–	–		
Craft13	PIPEFTRS- WELDERS Other Crafts	150	175	200	200	200	200	100	50	–	–	–	–		
Craft14	OILERS	10	20	20	20	25	25	25	15	–	–	–	–		
Craft15	Teamsters	30	50	55	75	75	75	100	75	50	10	5	2		
Nomanl	Non-Manual	265	275	290	340	345	345	345	290	200	105	25	10		
Supervn	Supervision	200	200	200	200	200	200	200	175	150	100	25	5		
	*****GRAND TOTAL*****	1800	2200	2600	3000	3300	3400	3200	2400	1200	300	180	35		

If any of the above include specialized personnel the contractor will supply, please footnote:

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September 29, 1981

STAFFING AND PAYROLL

ANNUAL OPERATING LABOR

125 MMSCFD PLANT

	No.
Plant Staff	12
Operations	314
Maintenance	297
Engineering	30
Administrative	97
Total	750