Agribusiness and Applied Economics Report 695

Modeling Employment, Housing, and Population in Western North Dakota:

The Case of Dickinson

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NDSU AGRIBUSINESS AND APPLIED ECONOMICS

DICKINSON

THE WESTERN EDGE

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Executive Summary

Communities in western North Dakota are struggling to manage the unprecedented growth in employment associated with the current oil boom. The city of Dickinson is undergoing a comprehensive plan to develop policies, strategies, and solutions for providing infrastructure, transportation, housing, and public services as a result of the new conditions brought on by oil field development. This study was designed to provide input into the city's comprehensive planning effort.

Employment projections for the Dickinson trade area included future changes to employment in existing industries, future direct employment in the petroleum sector, and potential secondary employment associated with changes in direct employment in the petroleum industry. To frame the context and scope of future oil field development, perceptions and opinions on current and expected development in the Williston Basin were solicited from industry leaders and government representatives with knowledge of the industry. Those opinions and perceptions provided the basis for creating two development scenarios based on 32,000 wells in the Bakken/Three Forks formations in North Dakota by 2036.

Near-term growth in employment in the Dickinson trade area was substantial in the slow and rapid development scenarios. However, long-term employment dynamics differed. Those differences were reflected in the level of temporary employment and changes in permanent employment over the 25-year period. The slow development scenario produced a set of employment dynamics much more conducive to an orderly and sustained expansion. By contrast, the rapid development scenario indicated continued rapid growth in employment over the next decade. Further into the rapid scenario timeline, assumptions on oil field development produced a strong contraction in employment upon completion of well drilling which results in an employment change reminiscent of boom-bust resource development. Neither scenario was modeled as a prediction, but rather a potential possibility.

Two separate approaches were used to estimate future population for the city of Dickinson. One approach used current and planned build-out rates for future housing developments within the current city limits, occupancy rates in motels and other non-traditional housing arrangements, crew camps, lodging at work sites, and existing traditional Census population figures to produce an estimate of service population. Based on that approach, the city will reach a physical maximum service population of approximately 35,000 upon completion of all current and proposed projects (i.e., proposed projects as of early 2012). When all of the planned developments are build-out additional growth beyond that level will be dependent on how the city reacts to the demand for additional housing. Additional growth will require additional annexations.

A second approach to estimating future population used projections of regional employment in all industries to generate estimates of regional housing demand. Future housing demand in the region was estimated separately for permanent and total (permanent and temporary jobs) workforce. Permanent workforce produced housing needs associated with long-

term employment and would produce population estimates consistent with the Census. Total workforce (permanent and temporary workers) was used to produce estimates of future housing demand that were used to estimate service populations.

Future housing demand was allocated among the region's counties based on historic distributions of housing within the region. The allocation process was largely driven by the need to address mobility of the petroleum sector workforce. Petroleum sector workers may not necessarily reside where they work or be employed where they reside. Therefore, a direct correlation between place of employment and place of residence could not be used to allocate regional housing demand.

Future housing demand in each county was divided into homes, twin homes, and apartments (i.e., R1, R2, and R3 housing) and assigned occupancy rates by housing type by county based on historical data. Information on the expected mix of housing in future housing developments was used to adjust the future distribution of single family houses, twin homes, and apartments within the trade area counties. The process produced county-level estimates of permanent population and service population over the 25-year period.

Assuming all permanent housing needs are met within the region, an average of the slow and rapid development scenarios revealed that the Dickinson trade area permanent population could approach 57,000 in 25 years. If temporary employment is included, trade area service population could peak near 64,000 people around 2020.

Two levels of future housing demand within the city in Dickinson were considered. First, housing demand was modeled at a rate consistent with Dickinson's historic share of regional housing, approximately 50 percent. A second scenario assumed the city would supply 70 percent of the regional housing supply. The second scenario was based on the premise that other cities and communities in the region would not be able to meet future housing demand proportionate to their historical levels.

Housing demand for a permanent workforce was projected to be 72 percent to 140 percent above the 2010 Census estimate of housing units in the city of Dickinson, depending upon the share of regional housing units supplied by Dickinson. When housing demand included housing for the temporary workforce, housing demand peaked at 95 to 173 percent of the 2010 Census estimate of housing units in Dickinson 10 to 12 years into the planning period.

Future permanent population in the city of Dickinson could approach 30,000 in 15 years assuming 50 percent of regional housing demand. If that ratio were to change based on the assumption that smaller communities in the trade area were either unwilling or unable to maintain their historic housing supply and Dickinson now supplied 70 percent of the regional housing demand, future permanent population was estimated to approach 40,000 in 15 years. When temporary employment is included in the population estimates, the city of Dickinson could see a service population between 34,000 to 47,000 in 10 years depending upon the share of regional temporary housing demand supplied by the city.

Aside from detailed estimates of future employment, housing, and population, a number of insights were gained regarding current and expected future activity in the Dickinson trade area.

● Employment
- • Employment in the petroleum sector will remain high, and there are strong indications that increases in direct employment could occur in the near term.
- • Near-term employment drivers are associated with drilling and fracing activity in the Bakken/Three Forks formations.
- • Longer-term employment drivers are associated with oil field service and will be a direct function of the number of wells operating in the state.
- •Wildcards in the long-term employment may include development of other shale formations (e.g., Tyler formation).
- •Long-term predictions of employment are difficult.
  - ◦ The industry has substantial incentives to reduce current labor requirements.
  - ◦ Future use of new technologies and techniques are likely to be a factor in employment requirements.
  - ◦ Macro-economic factors affecting oil field development rates and the future desirability of the industry to pursue opportunities in shale oil formations in ND are difficult to predict.
  - ◦ Therefore, a host of factors make concise long-range estimates impossible. The best antidote for long-term uncertainty is to shorten the time between assessments and make the process of forecasting more iterative.

● Housing
- • There is substantial demand for housing in the Dickinson trade area.
- • Current build-out rates for water, sewer, and housing are not likely to result in overbuilding of infrastructure within the city of Dickinson.
- • Despite enormous demand for housing, it is not unlimited. The city must carefully plan how it will respond to the demand as overbuilding can result in equally serious ramifications.
  - ◦ Too much housing is likely to result in high vacancy rates, and a depressed housing market.
  - ◦ Too little housing drives up values and rents and creates additional problems for elderly and other fixed income residents.

- • Communities' response to the housing issue must include continual monitoring and periodic re-assessment to avoid building to peak demand.

● Workforce Characteristics
- • Workers in the petroleum sector are far more mobile than previously thought.
- • A good understanding of workforce characteristics is lacking.

- Planning efforts at both the local and state level would benefit from a better understanding of demographic profiles, anticipated work schedules, and likelihood/willingness of existing workforce to become North Dakota residents.
- Antidotal evidence (airline boardings, real estate purchases) suggests that workers are seeking housing outside of the oil fields, and using work schedules that allow them to work in ND but maintain their home residence elsewhere in the state or outside of ND.
- A mobile workforce responsive to housing availability has substantial implications for level of secondary employment–implications for support businesses, services, and commercial activity.

● Population
- Local communities must include estimates of service population when planning for delivery of public services.
- The duration and intensity of service population will largely be reflective of the city's policy regarding housing supply and the future rates of development within the oil field.

Modeling Employment, Housing, and Population in Western North Dakota: The Case of Dickinson

Dean A. Bangsund, Nancy M. Hodur, Rich Rathge, and Karen Olson[*]

Introduction

Rapid expansion of the petroleum sector in the Williston Basin has spurred unprecedented economic growth and led to substantial strains on infrastructure and public services. Infrastructure development, housing, transportation systems, and public services have in many cases not kept pace with the demands in the region. The speed and magnitude of change have left some state and local governments racing to try to catch up. In some cases, recollections of and the ramifications of previous boom-bust cycles have at least initially slowed the response for services related to growth in the petroleum industry. That lag in response has left some communities in the position where they are now operating on a reactionary basis and are playing catch up as the demand for services, housing and infrastructure improvements have far outpaced supply.

Other communities, however, have taken on planning initiatives to identify strategies to cope with the economic growth in the region. In an effort to avoid finding their community in a reactionary position, the city of Dickinson has contracted with Kadrmas, Lee and Jackson to develop a comprehensive strategic plan to prepare the city of Dickinson and the surrounding area for anticipated effects of the current expansion of the petroleum sector. The goal of the strategic plan is to identify and implement strategies to prepare for and appropriately manage the demand for public services from the current and future expansion and development of the petroleum industry.

Public policy makers, developers, community leaders and other stakeholders need to understand how the petroleum sector might influence critical systems. A better understanding of the current development of the Bakken/Three Forks formation in the Williston Basin and how current activity compares to previous boom-bust cycles is essential to the decision making process. An understanding of how the petroleum industry might influence employment, housing and population is a critical part of the planning process. Accordingly, this study was undertaken to examine how the petroleum industry might influence employment, housing and population in the city of Dickinson. Findings were used as inputs to the comprehensive planning process.

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Objectives

The goal of this study was to examine future employment, housing and population as part of a comprehensive plan to address future delivery of public services, transportation systems, and infrastructure needs in the city of Dickinson.
Specific objectives include:

1) Develop forecasts of petroleum sector employment,
2) Develop forecasts of regional employment,
3) Develop estimates of future housing demand for permanent and temporary workforce,
4) Develop estimates of the service population based on infrastructure change and non-traditional lodging, and
5) Develop estimates of permanent and temporary workforce population potential based on future housing demand.

Methodology and Findings

The rapid expansion of the petroleum sector has left planners, policymakers, and community leaders struggling to develop strategies to address the challenges associated with unprecedented growth in the petroleum sector. Models, methodologies and strategies used in the past to assess changes in economy are not well suited to model the effects of the rapid growth in the petroleum sector. Because of the unique nature of the circumstances in western North Dakota, namely the extremely rapid and significant expansion of the sector combined with severe housing shortages, many of the tools traditionally used to model economic, demographic, and fiscal impacts are not properly calibrated to the current economic environment. Traditional models do not accurately reflect the effects of the rapid and wide-spread expansion of the petroleum sector. Further, models are not easily updated in their entirety given the paucity of current economic data and the lag at which data can be collected.

Because of these unique circumstances new approaches and methodologies must be developed. Because the petroleum sector is the driving economic influence in western North Dakota, models and methods should focus on the effects of petroleum sector. Models and processes must be dynamic and flexible to allow for new data to be incorporated into modeling efforts as it becomes available.

Bangsund and Hodur (2012) developed a process to model direct and secondary employment associated with future development scenarios for the petroleum sector. This study uses the petroleum sector employment model and expands the analysis to include changes in regional employment in western North Dakota. The combined effects of future changes in the petroleum sector and future employment changes in other regional industries are used to produce estimates of regional employment. This study's methodology converts regional employment forecasts into demand for housing and ultimately future population (Figure 1). The process was used to provide estimates of regional employment, housing, and population potential for the Dickinson trade area.

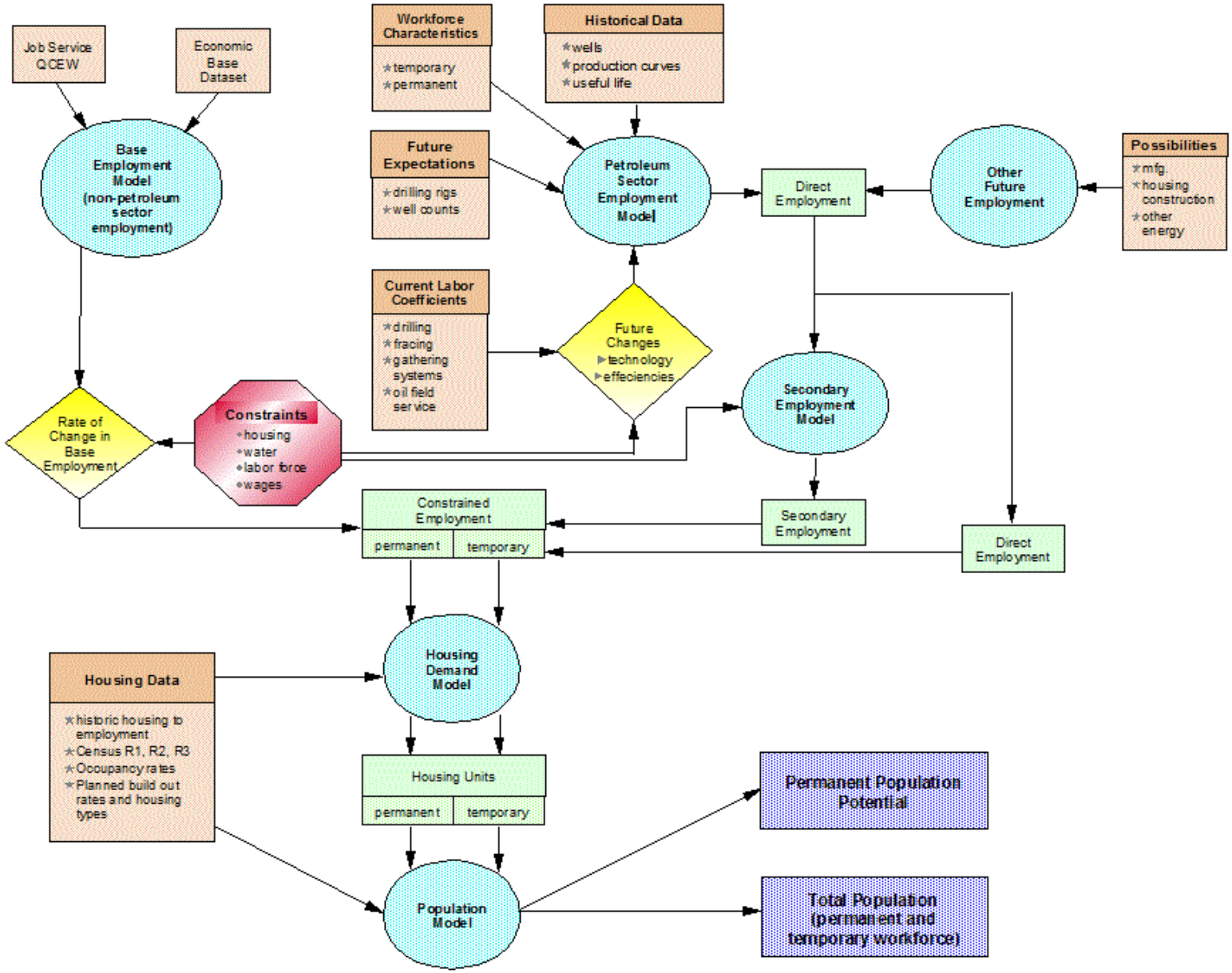

Figure 1. Employment, Housing, and Population Modeling Overview, Western North Dakota, 2012 (JPG)

Employment in western North Dakota is separated into two categories; 1) employment in the petroleum sector and 2) employment in all other industries and sectors (Figure 1). Petroleum sector employment estimates were based on a model developed by Bangsund and Hodur (2012). Constraints are used to adjust employment coefficients in the petroleum sector and to limit future employment change in non-petroleum base industries. Secondary employment is also subject to constraints within the model. The model produces a regional employment forecast that is used to estimate future housing demand (Figure 1). Because of workforce mobility, housing demand is estimated on a regional basis. Historic data on occupancy rates, current information on build-out rates and future mix of housing types were used to estimate regional population potential (Figure 1). The model estimates employment, housing, and population by modeling potential changes in the petroleum industry and existing industries in western North Dakota.

Employment

Estimates of future employment in the Dickinson trade area were separated into the petroleum sector and all other (non-petroleum sector) industries. Petroleum sector employment estimates were based on a model developed by Bangsund and Hodur (2012). Future base employment[1] in the Dickinson trade area was based on observed trends in historical data. Total future employment in the Dickinson trade area was a function of the change in base employment and the change in direct and secondary employment associated with the petroleum sector.

Employment Scenarios

The future development of oil fields in North Dakota is unknown. To frame the context and scope of future oil field development, perceptions and opinions on current and expected development of the oil sector in North Dakota were solicited from industry leaders and government representatives with knowledge of the industry. Those opinions and perceptions provided the basis for the development of a high estimate, consensus estimate, and low estimate of the number of future wells in North Dakota. While several scenarios were initially developed to illustrate a reasonable range of employment possibilities associated with petroleum sector development over the next 25 years, the study sponsors chose to use the consensus scenario for the city's comprehensive plan. The consensus scenario was based on achieving 32,000 Bakken/Three Forks wells in North Dakota and did not include activity in the Tyler or other shale formations in western North Dakota.

[1]Base employment refers to existing employment in all economic sectors of the economy after direct employment in the petroleum industry has been removed.

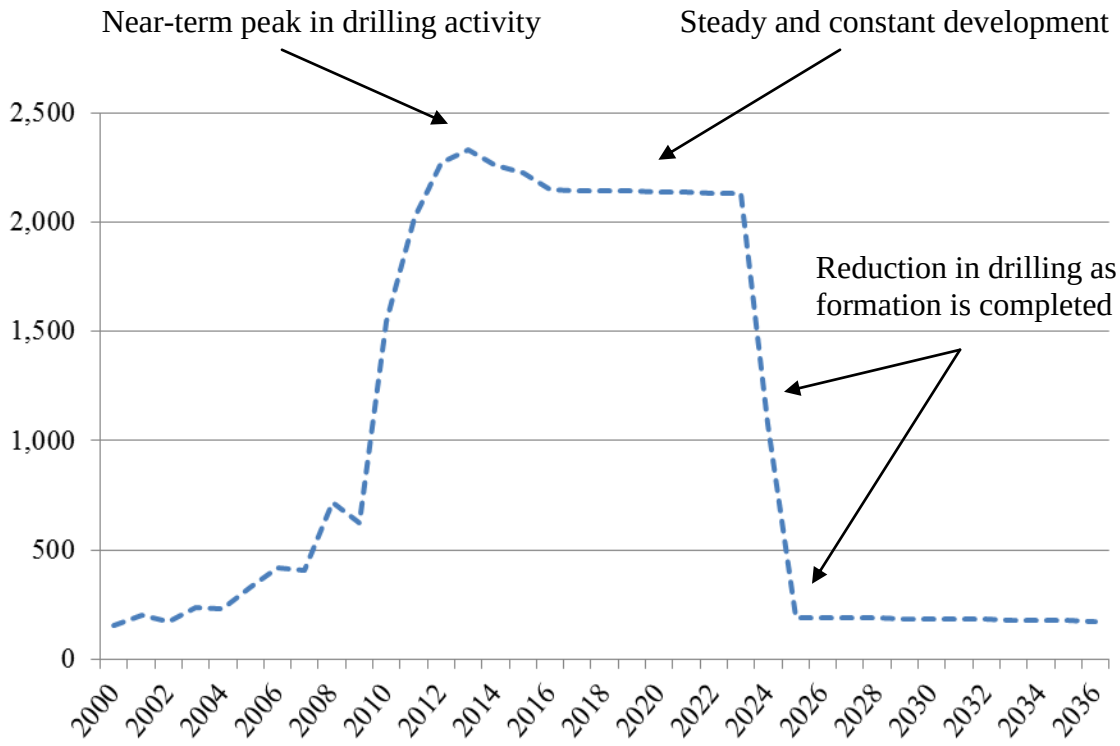

Figure 2. Well Creation, Rapid Development Scenario, North Dakota, 2000 through 2036.

Two rates of development were modeled for the consensus scenario: (1) a rapid build-out of the Bakken/Three Forks formations and (2) a more controlled pace of development (Figures 2 and 3). The rapid build-out scenario more closely approaches a classic boom-bust cycle where a formation/field is developed in a rapid fashion, only to have the development phase of oil production sharply curtailed when that formation approaches full development (Figure 2).

Opposite the rapid build-out, is a scenario with slow, deliberate, and decreasing pace of well development. This scenario required 25 years to achieve the target number of wells (Figure 3). Part of the justification for this scenario is that some areas of the Bakken/Three Forks will not get developed in the near term, which could be a function of well economics and oil prices, strategic decisions upon the part of oil operators to pursue other development opportunities, or that technologies change creating new opportunities in the future.

The slow and rapid rates of development represent 'bookends' on the potential of range of employment based on how many wells the state will have in the future.

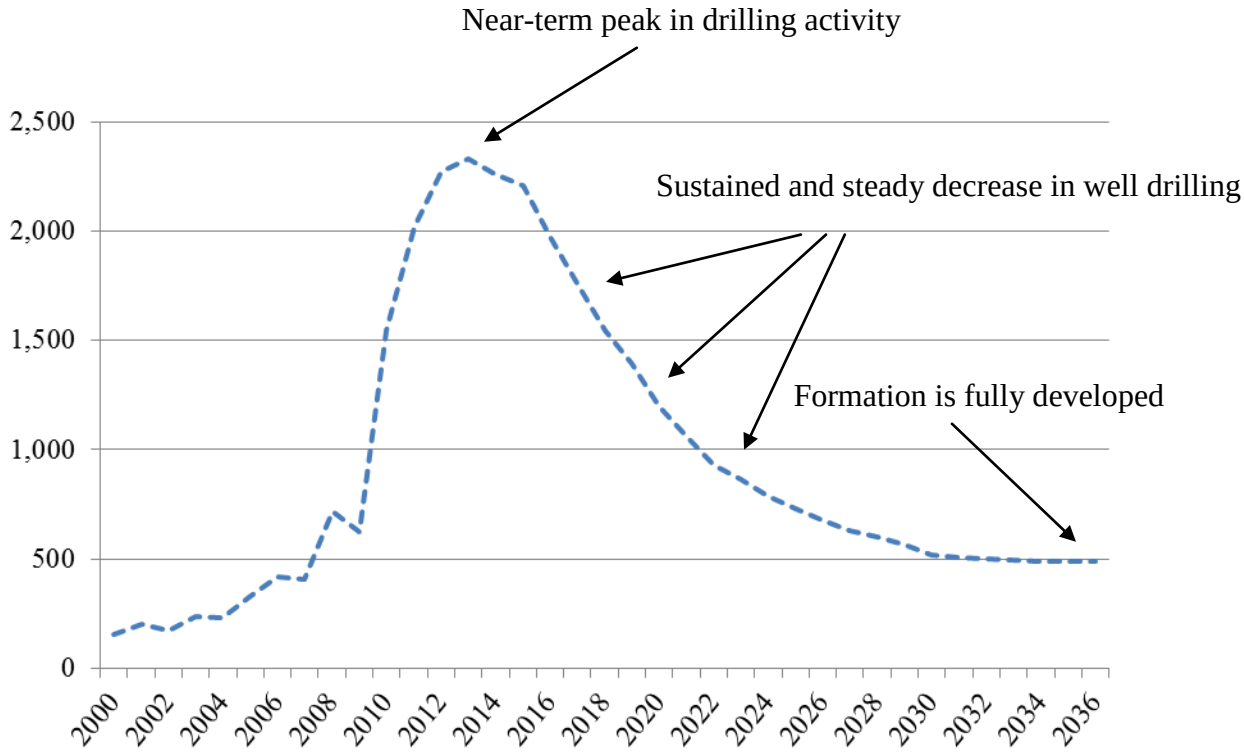

Figure 3. Well Creation, Slow Development Scenario, North Dakota, 2000 through 2036.

Employment Constraints

Bangsund and Hodur (2012) highlighted problems with developing employment projections without applying appropriate constraints. To assume constant and unconstrained growth in base employment and no change in future employment coefficients in petroleum sector employment would produce a false expectation for future employment. To account for existing constraints on employment (i.e., housing, wages, labor force availability) and to address potential regional responses to the economic environment associated with different scenarios for development of the oil field, constraints to employment growth were included in base employment, petroleum sector direct employment, and secondary employment estimates (see Figure 1). Constraints are discussed below for each of the employment scenarios.

Slow Rate of Development Scenario

The economic environment in western North Dakota in the slow development scenario over the next five years will remain heavily constrained in its ability to add employment outside of the petroleum sector. A slowing in the rate of development in the petroleum sector from current levels would offer communities an opportunity to catch up to what has been over the last several years, a constantly growing housing demand. Further, a downturn in oil field development would release some petroleum sector workers to seek employment in other sectors and relax some of the wage rate competition associated with labor force scarcity without creating the problems associated with a major economic downturn. This scenario would also be

favorable for creating greater levels of secondary employment. Looking beyond the pull back in drilling activity, the economy in western North Dakota would be expected to see some growth in base employment as result of a reduced housing, wage, and labor force constraints. The local economy is expected to be relatively healthy after a slow pull back in drilling activity, providing that pullback occurs in the near term. While a slow rate of development would give communities a chance to catch up and reduce some of the pressure from housing, wage and labor constraints, in the near term, most growth in employment will occur in the petroleum sector with little growth in other sectors of the economy.

The constraints used in the employment modeling focused on adjustments in three areas. Constraints are discussed below.

1) The growth in base employment (all non-petroleum-related employment currently in the trade area) was modeled to be substantially less than the historic rate of growth in the region. Base employment was modeled to be constant through 2016 (i.e., no growth in base employment). After 2016, growth in base employment resumed at a relatively low rate initially, but allowed to increase, in percentage terms, over the 2017 to 2036 period. However, the rate of growth in base employment remained lower than historical observations.

2) Secondary employment coefficients were held at constrained levels through 2016 (Bangsund and Hodur 2012). Beyond 2016, secondary employment coefficients were allowed to increase and constraints on secondary employment creation were relaxed over the remainder of the 25-year period.

3) Efficiency factors to account for improvements in technology were used to constrain future employment requirements for various activities in the oil fields (e.g. re-cycling of frac water) (see Figure 1). Oil service employment coefficients were reduced by 25 percent over the 25-year period. Drilling employment requirements were reduced by around 17 percent over the 25-year period.

Rapid Rate of Development Scenario

The economic environment in western North Dakota in the rapid development scenario will remain heavily constrained much like in the slow development scenario, except for a longer time frame. Unlike the slow development scenario, the industry's constant rate of development rapidly grows total employment in the petroleum sector, preventing communities from being able to mitigate the industry expansion. The rapid build-out maintains and keeps in place much of the problems currently experienced in western North Dakota associated with housing, wage, and labor force constraints. This prolonged problem associated with adding permanent housing creates problems for secondary job growth and presents problems for the ability of base industries to remain economically healthy.

The two big problems for the economy in western North Dakota with the rapid build-out scenario is that substantial infrastructure pressures remain for extended periods and the

likelihood of a substantial and dramatic pull back in employment within the petroleum sector increases. These factors represent the classic characteristics of a traditional boom/bust cycle in resource development. Not only does western North Dakota struggle with providing infrastructure, but a contraction in petroleum sector employment creates another sequence of problems associated with a loss of employment. The end result is a stagnate local economy struggling to adapt to the bust cycle of resource development. It is important to remember that the rapid build-out scenario was modeled as a possibility, not a prediction.

The constraints in the rapid scenario were more stringent than the adjustments performed in the slow scenario. The rationale is that a prolonged housing problem, coupled with wage constraints and labor shortages associated with continual growth in the petroleum sector, will place much greater strain on the local economy. Further, the local economy will feel more 'pain' associated with a boom-bust cycle. These factors will combine to produce a set of circumstances that keep the local economy under stress even after the bust has occurred in petroleum sector employment.

1) Base employment was not allowed to grow in this scenario until the last 10 years of the projection period and then growth rates remained lower than those modeled in the slow scenario. This scenario suggests it will take several years for the local economy to rebound from a severe employment contraction, and then initial growth in non-petroleum sectors after that contraction will be slow.

2) Secondary employment coefficients remained low in the 25-year period. The secondary coefficients were lower than modeled in the slow development scenario.

3) Efficiency factors for employment coefficients in the petroleum sector were the same as those used in the slow development scenario.

Base Employment

Historical employment, by county, for the Dickinson trade area was obtained from Job Service North Dakota (2012). Employment data was based on the Quarterly Census of Employment and Wages (QCEW) and represented a measure of jobs in a specified location using the North American Industrial Classification System (NAICS).

Because petroleum sector employment was modeled separately from other economic sectors, petroleum employment was removed from QCEW data for the Dickinson trade area from 1990 through 2010. However, non-disclosure of employment in several individual NAICS codes in most of the counties in the Dickinson trade area prior to 2003 prevented petroleum sector employment from being effectively removed from total employment on a county-level basis. Employment for State Planning Region 8 comprised a more thorough listing of employment by individual NAICS codes over the 1990 to 2010 period. State Planning Region 8 comprised all six of the counties in the Dickinson trade area and also included Adams and Bowman counties, which were not considered part of the Dickinson trade area.

Evaluation of overall employment, less petroleum industry employment, revealed consistent and sustained growth over the 1990 to 2010 period (Figures 4 and 5) for State Planning Region 8. Time-series regression of the data revealed an average annual increase of 204 jobs in State Planning Region 8 over the 1990 to 2010 period after removing petroleum sector employment. Non-disclosure and grouping of employment into multiple NAICS codes prevented removing petroleum sector employment in Adams and Bowman counties from State Planning Region 8 when examining historic changes in regional employment.

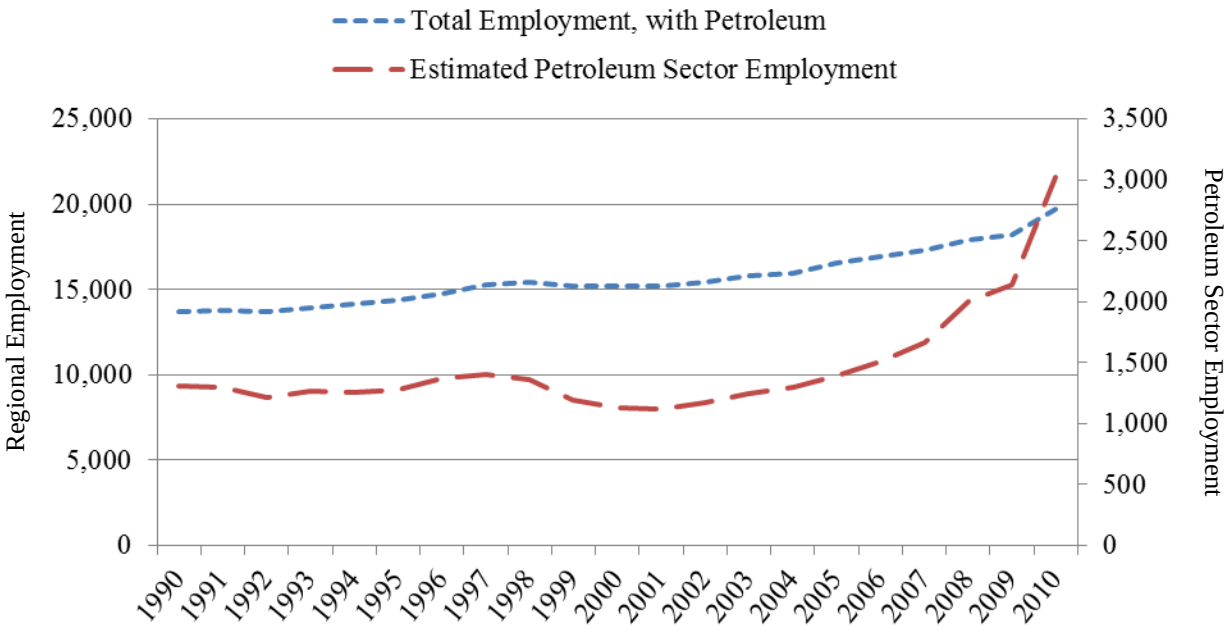

Figure 4. Total Employment and Employment in Petroleum Industry, State Planning Region 8, North Dakota, 1990-2010.

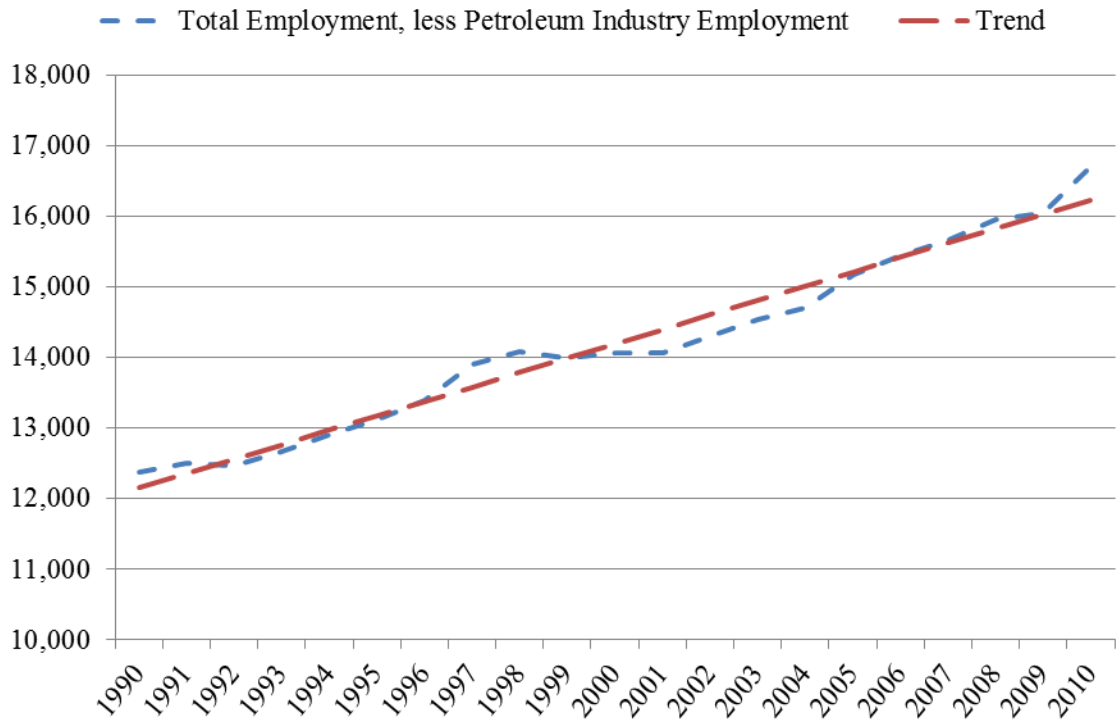

Figure 5. Trend in Base Employment, Excluding Employment in the Petroleum Industry, State Planning Region 8, North Dakota, 1990-2010.

Petroleum Industry Employment

Bangsund and Hodur (2012) developed a model to illustrate potential employment in the petroleum industry based on expectations for the future rate and level of development in the oil fields in North Dakota. A consensus scenario was developed for this study suggesting the state reaches 32,000 Bakken/Three Forks wells in North Dakota by 2036. Additional activity in the Tyler or other shale formations in western North Dakota were not included. The employment model was used to produce a rapid build-out of the Bakken/Three Forks formations (Rapid Development Scenario) and a gradually declining pace of development (Slow Development Scenario).

The rapid development scenario might more closely approach a classic boom-bust situation while the slow development scenario represents a more drawn out, deliberate, and decreasing pace of well development. Employment within the petroleum sector exhibited different dynamics based on the rate of development (Figures 6 and 7).

In the rapid development scenario, the industry has a reduction in the rate of development in the near term upon securing of a majority of leases in western North Dakota (see Figure 2 on well development). After securing leases, a downturn is modeled, but after that adjustment period the industry maintains a relatively high and constant rate of oil field development. This pattern of activity rapidly builds employment in the industry, and upon reaching completion of

the intended 32,000 wells, a sharp decline in employment occurs (Figure 7). At that point, employment in the industry is largely driven by oil field service and infrastructure maintenance as the vast majority of drilling and fracing employment is removed from the state. The rapid scenario was modeled as a possibility, not a prediction.

In the slow development scenario, the industry exhibits a much different approach to oil field development whereupon securing the leases, development activity begins to taper off and continues a steadily decreasing pace of well development for about 20 years. In this situation, total employment in the industry continues to decrease, but that decrease is more moderate and more consistent over the 25-year period than observed in the rapid development scenario. As modeled, the gradual increase in oil field service and infrastructure maintenance employment acts to offset some of the gradual decrease in drilling and fracing employment, producing an employment change where temporary workforce is mostly offset with increases in permanent workforce. As with the rapid scenario, the slow development scenario was modeled as a possibility, not a prediction.

In both scenarios, the state was modeled to have 32,000 wells associated with the Bakken/Three Forks Formations. Additional wells, all things equal, will lengthen the development period, and will likely result in higher levels of oil field service in the future. Bangsund and Hodur (2012) discuss how development size can influence future employment levels.

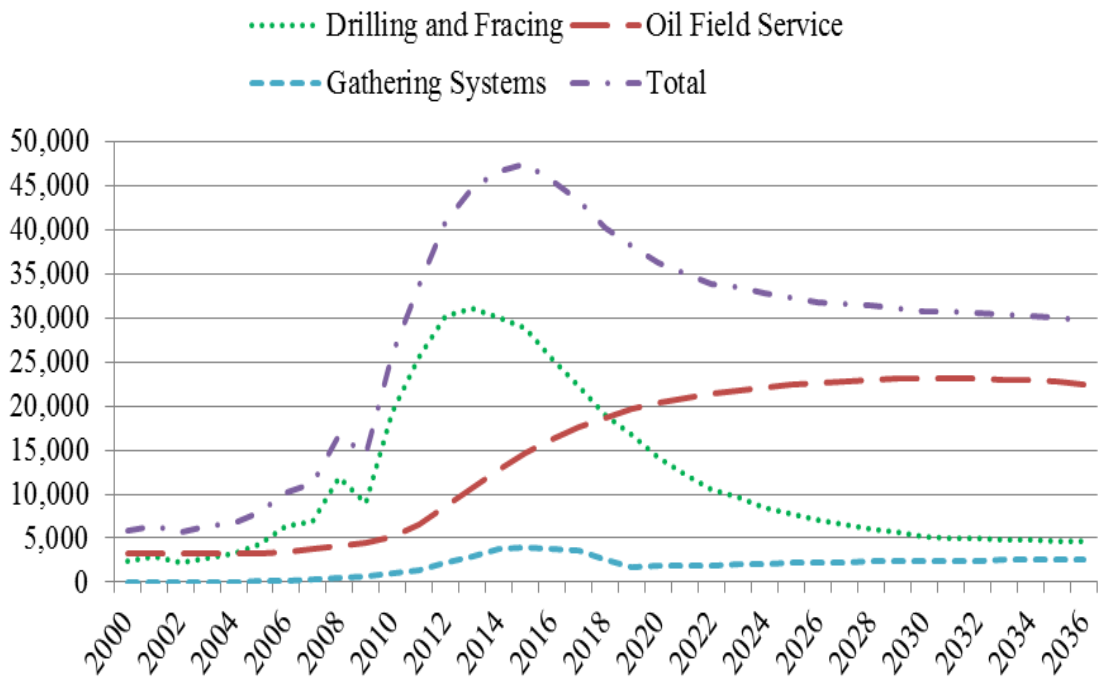

Figure 6. Petroleum Sector Direct Employment (Constrained), Slow Development Scenario, Western North Dakota, 2000 through 2036.

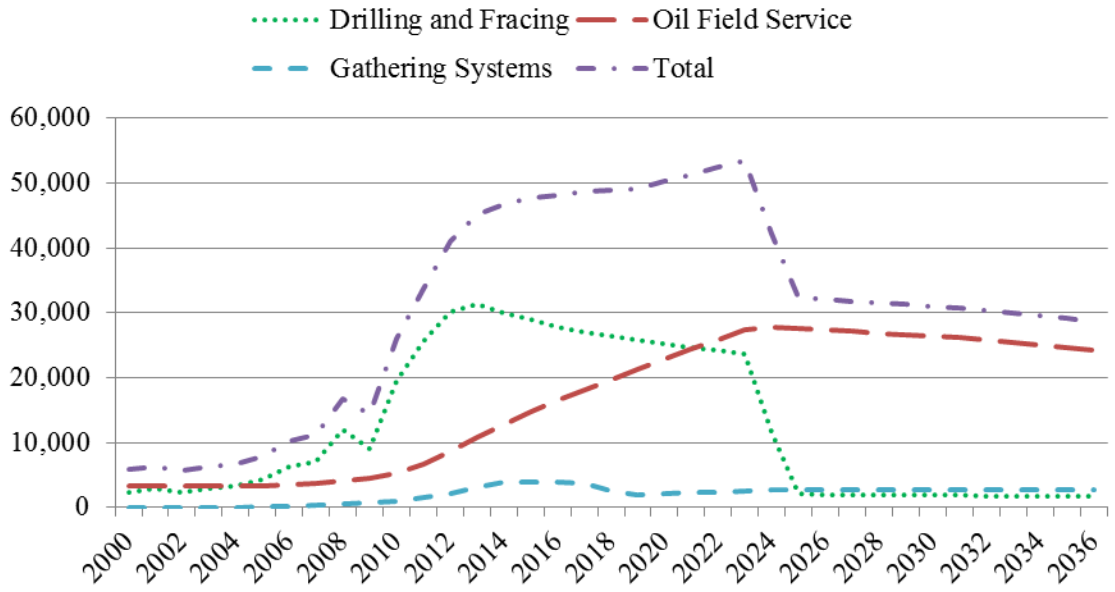

Figure 7. Petroleum Sector Direct Employment (Constrained), Rapid Development Scenario, Western North Dakota, 2000 through 2036.

The petroleum industry scenarios were adjusted to reflect expectations for employment within the Dickinson trade area. The current share of petroleum industry employment for the region's major trade centers was measured using QCEW employment in NAICS code 21 for western North Dakota (Table 1).[2] Based on that metric, Dickinson trade area had about 21 percent of the petroleum industry employment in 3rd quarter 2011. The relative share of petroleum sector employment in the Dickinson trade area has been increasing in recent years (Table 1).

Table 1. Share of Petroleum Sector Employment, by Major Trade Centers, North Dakota, 2002 through 2011[a]

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	---------- percent of petroleum industry employment ----------									
Bowman	2.4	3.9	4.2	3.2	2.8	2.5	1.9	1.7	1.2	1.2
Bismarck/Mandan	16.5	16.0	20.7	3.1	2.6	3.4	2.1	0.8	0.7	0.8
Dickinson	15.6	15.0	13.6	14.9	12.4	13.1	14.3	16.8	17.0	20.7
Williston	33.1	34.7	42.3	55.8	63.4	63.5	67.4	64.1	64.1	63.3
Minot	32.3	30.3	19.2	23.0	18.9	17.5	14.2	16.6	16.9	14.0

[a]Based on NAICS code 21 for county-level data obtained from Job Service North Dakota (2012). Some years may not total due to rounding.

[2]NAICS code 21 was used to gauge the relative share of petroleum sector employment among trade areas in western North Dakota. However, direct employment in the industry also exists in other NAICS codes.

Petroleum sector employment in the Dickinson trade area was expected to increase in the future based on conversations with industry officials expecting drilling activity and oil service activity to increase within the Dickinson trade area as more development activity targets the Three Forks formation. Petroleum sector employment in the Dickinson trade area was modeled to increase from 21 percent of the state industry total in 2011 to 25 percent of the state industry total in 2018 and remain at that level through 2036.

Bangsund and Hodur (2012) created a delineation for temporary and permanent workers within the petroleum industry. The breakout between permanent and temporary workforce was estimated separately for drilling, fracing, gathering systems (i.e., in-field pipeline and collection infrastructure) and oil field service. The result is an estimate of total direct permanent and temporary employment for the petroleum industry in the Dickinson trade area from 2011 through 2036 (Figures 8 and 9).

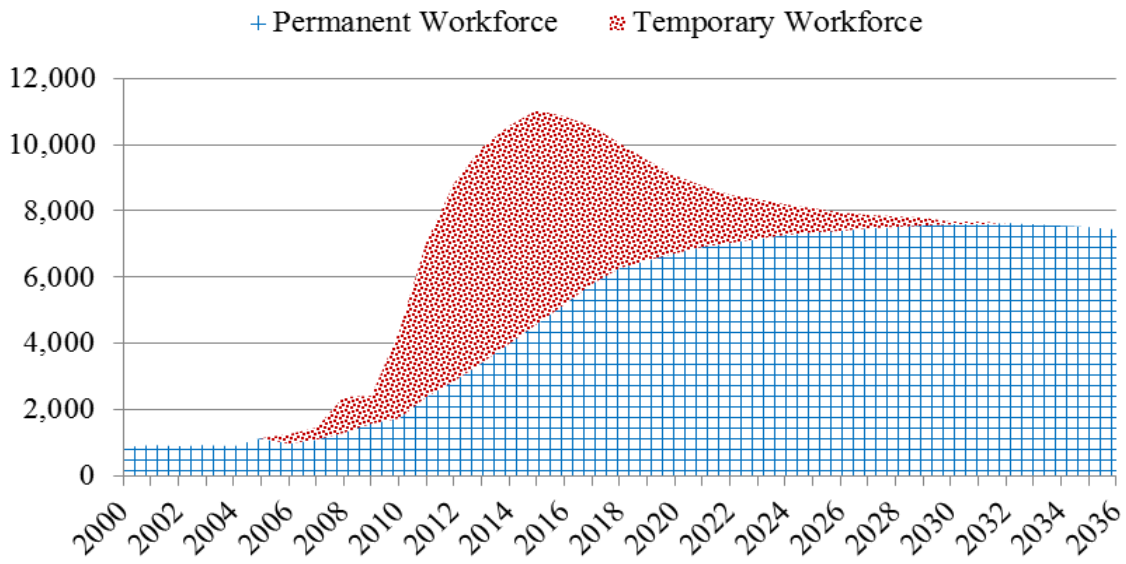

Figure 8. Total Direct Permanent and Temporary Employment in the Petroleum Industry, Slow Development Scenario, Dickinson Trade Area, 2000 through 2036.

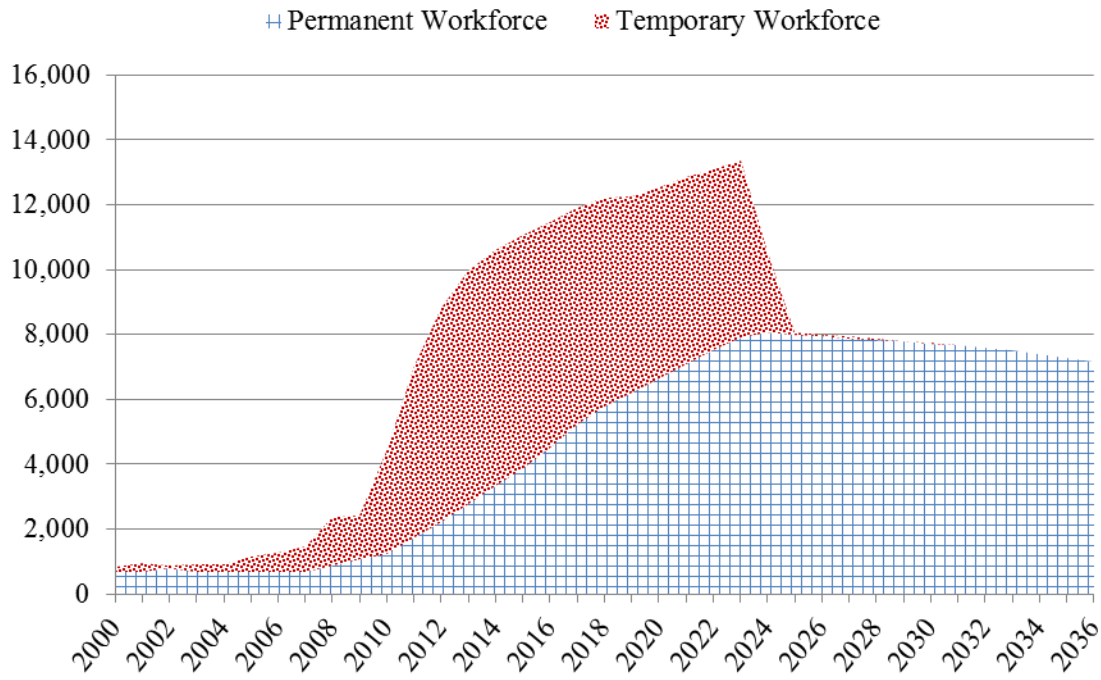

Figure 9. Total Direct Permanent and Temporary Employment in the Petroleum Industry, Rapid Development Scenario, Dickinson Trade Area, 2000 through 2036.

Bangsund and Hodur (2012) used information obtained from the Oil and Gas Division of the Department of Mineral Resources (Oil and Gas Division 2012) with the North American Industrial Classification System (2012) to allocate employment in drilling, fracing, gathering systems, and oil field service into various NAICS codes (data not presented). Placing industry employment into NAICS codes facilitated the use of QCEW data as a baseline for regional employment, and allowed future estimates of petroleum industry employment to be modeled by NAICS code. Further, projections of employment by 2-digit NAICS code facilitated incorporation of employment figures into other models (e.g., transportation modeling) for input into the comprehensive planning process being undertaken by the city of Dickinson.

Secondary Employment

Economists primarily use Input-Output analysis to estimate changes in employment associated with changes in revenues or expenditures within an industry. Those techniques have been refined over many decades (Leistritz 1998, 1994). However, current data would suggest a methodology relying on historic productivity ratios or employment multipliers, either linked to sales volume (sales to final demand) or industry spending (in-state expenditures) would currently overestimate total employment from the petroleum sector in North Dakota (Bangsund and Hodur 2012).

A more direct approach to estimating secondary employment was adopted that used the relationship between employment in basic-sectors (industries that bring money into a region) and non-basic sectors (industries that provide support and service to basic-sector industries).

Bangsund and Hodur (2012) used the ND Economic Base Data Set (Coon et al. 2012) in estimating secondary employment associated with current oil expansion in western North Dakota. The model developed by Bangsund and Hodur (2012) uses separate coefficients for creation of secondary employment for temporary and permanent workforce in the petroleum sector.

The rationale for differential treatment between temporary and permanent workforce was that characteristics of those types of workforce result in different demand for goods and services in the economy and that the petroleum sector workforce is expected to transition to a more permanent workforce over the next decade (Bangsund and Hodur 2012). Bangsund and Hodur (2012) suggest as the economy removes constraints (e.g., housing, workforce, wage rates) it would be expected that secondary employment dynamics in the region return to more historic observations.

Secondary job creation differed substantially between the two scenarios. In the slow development scenario, secondary job employment was modeled to remain steady as the majority of temporary workforce was removed, but secondary employment resumed growth in the future as the industry transitioned to a more permanent workforce (Figure 10). In the rapid development scenario, continued strong growth in overall petroleum sector employment followed by a substantial employment contraction was modeled to have substantial constraints on creation of secondary employment (Figure 11).

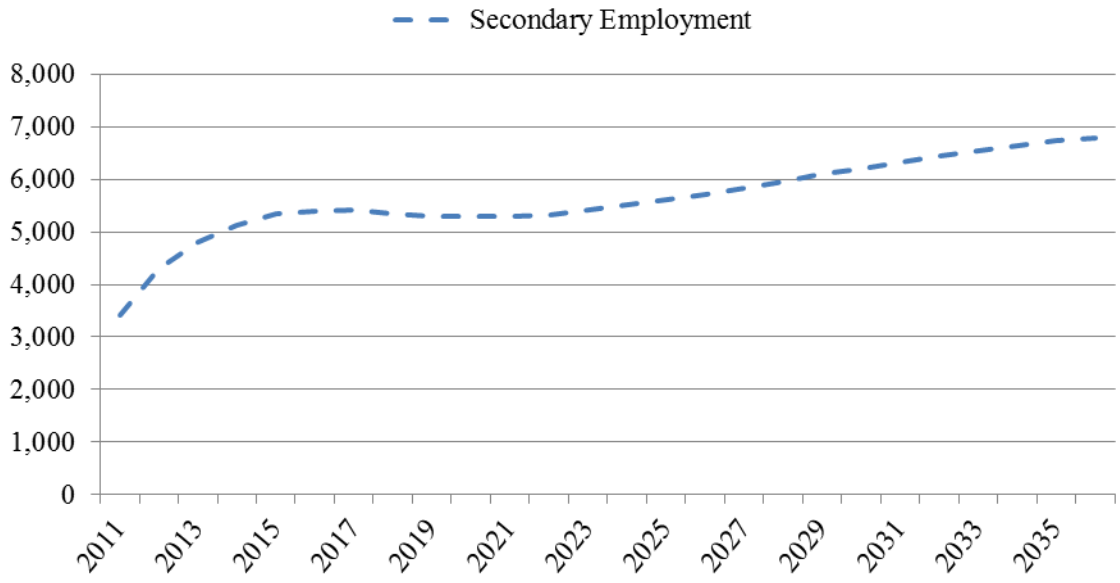

Figure 10. Secondary Employment, Petroleum Sector, Dickinson Trade Area, Slow Development Scenario, 2011 through 2036.

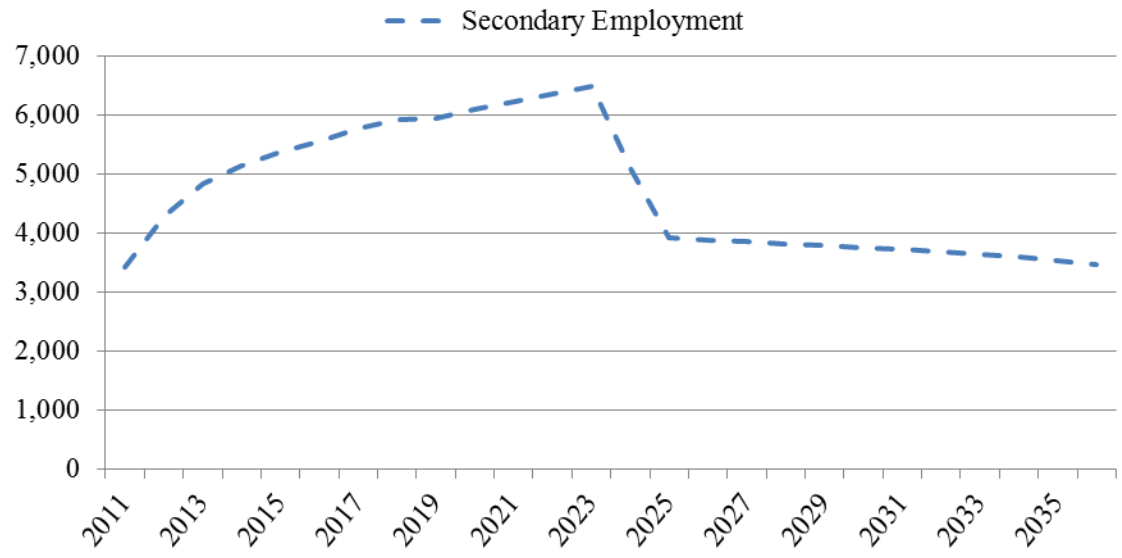

Figure 11. Secondary Employment, Petroleum Sector, Dickinson Trade Area, Rapid Development Scenario, 2011 through 2036.

Total Regional Employment

Total future employment in the Dickinson trade area was a function of the change in base employment and the change in direct and secondary employment associated with the petroleum sector. Employment from other developments, such as South Heart Mine and Plant, additional housing construction employment, or proppant manufacturing, were not included in the estimates. Considering the substantial growth in employment in recent years, and the expected growth in the region in the near term, subtle changes in regional employment would not likely change the current economic environment in western North Dakota.

Constraints on employment (i.e., housing, wages, labor force availability) were included in base employment, petroleum sector direct employment, and secondary employment estimates. Future employment in the trade area mirrored the pattern of employment change observed in the two petroleum sector scenarios (Figures 12 and 13).

Both scenarios show a decrease in future employment; however, the implications of the two futures presented by the scenarios is much different for the Dickinson trade area. If the petroleum industry proceeds as modeled in the slow scenario, the downturn in employment will be modest. The effects on total employment in the region will be mitigated by change in base employment and additional secondary employment associated with a permanent workforce. Given the rate at which oil development has occurred to date, the slow scenario would appear to present an optimistic future for the region.

If the petroleum industry proceeds with oil field development as outlined in the rapid scenario, the anticipated changes in employment are going to provide challenges for the Dickinson trade area. Continued rapid expansion of employment will act to keep housing problems in place for a longer period as communities struggle with a demand that keeps growing. Those expanding pressures to add housing put additional strain on the region as base employment could be expected to remain constrained over that period. Similarly, proportional changes in secondary employment will be difficult to capture if the housing shortage cannot be mitigated. These factors suggest a continued strong expansion of employment in the region will create difficult issues. Likewise, a sharp and pronounced contraction in employment as modeled in the rapid scenario creates another set of problems halfway through the 25-year planning period. At that point the region has gone the full set of experiences characteristic of boom/bust cycles in resource development.

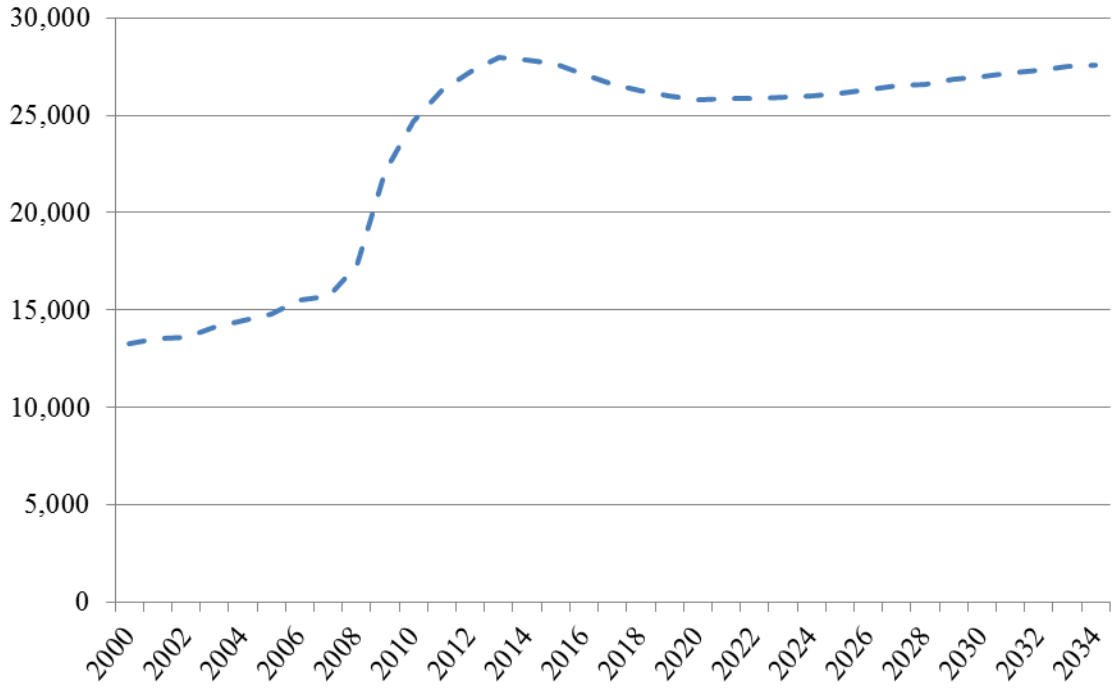

Figure 12. Employment Estimates in Dickinson Trade Area, Slow Development Scenario, 2000 through 2036.

Employment in Stark County and City of Dickinson

Employment in Stark County and the city of Dickinson were modeled as a percentage of the regional employment estimates for the Dickinson trade area. From 1990 to 2010, 77 percent to 82 percent of employment in the Dickinson trade area has been in Stark County (Figure 14). Stark County averaged 82 percent of the trade area employment from 2006 to 2010. Future employment for Stark County was modeled at 82 percent of employment in the Dickinson trade area for the 2012 to 2036 period. The city of Dickinson's share of overall employment in Stark County has decreased from 2002 through 2010 (Figure 15). In 2010, employment in Dickinson

remained over 90 percent of employment in Stark County and represented about 75 percent of employment in the trade area.

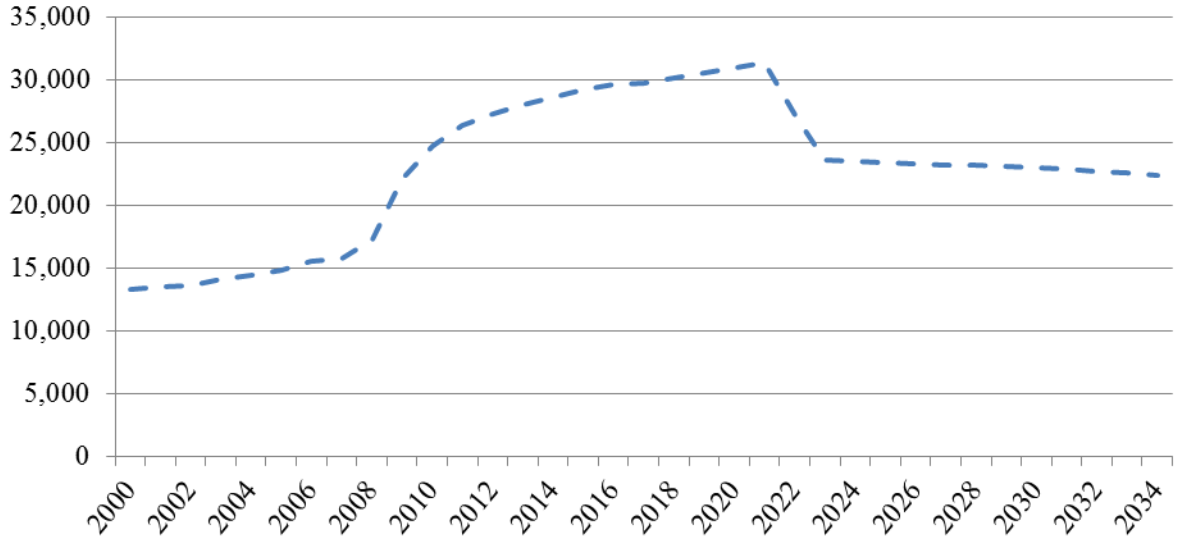

Figure 13. Employment Estimates in Dickinson Trade Area, Rapid Development Scenario, 2000 through 2036.

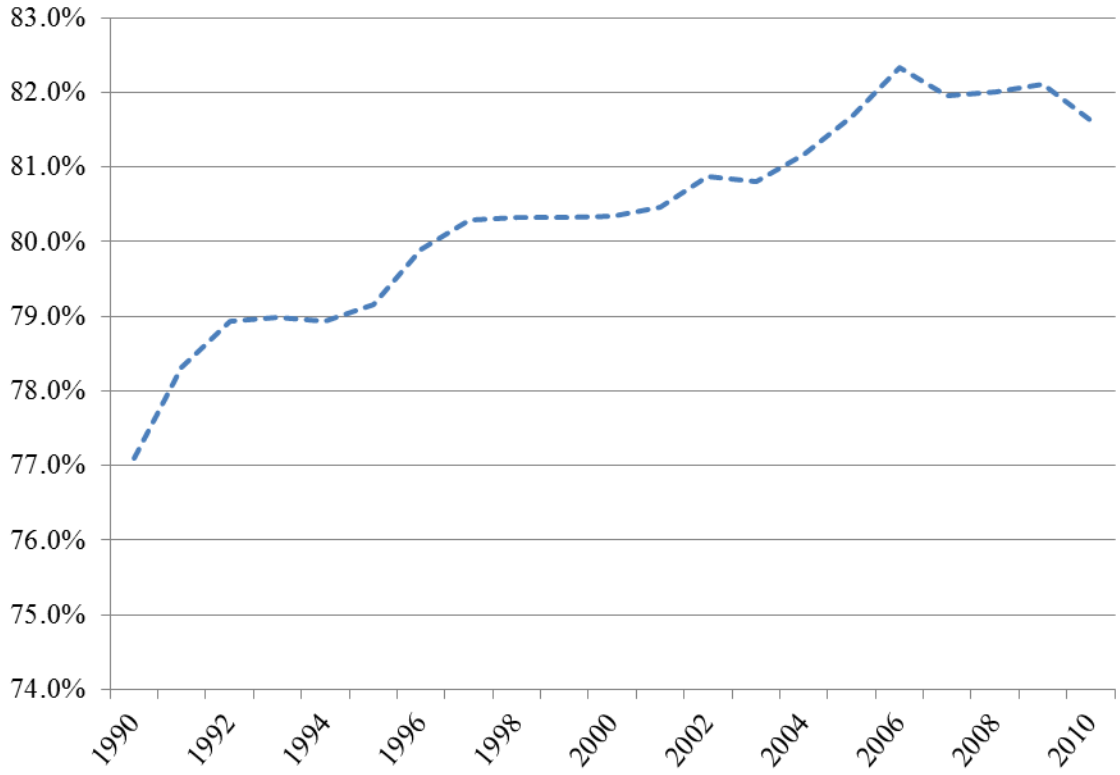

Figure 14. Stark County Share of Employment in Dickinson Trade Area, 1990 through 2010.

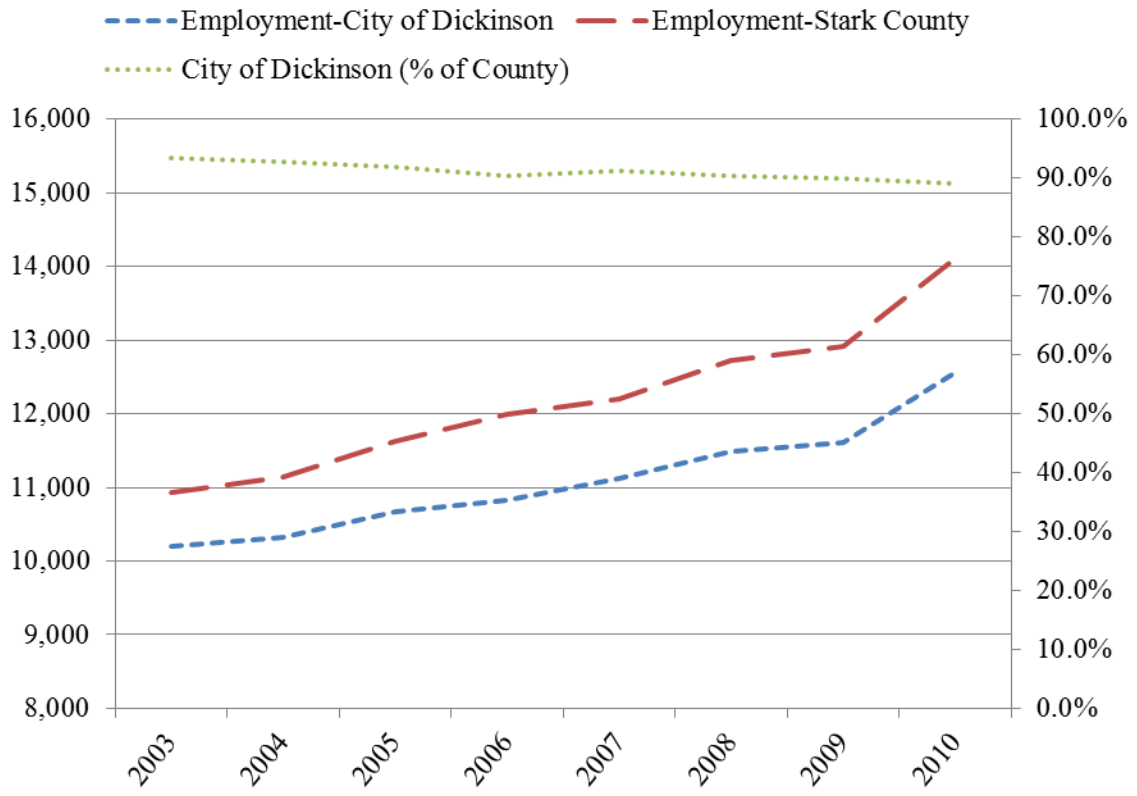

Figure 15. City of Dickinson Share of Employment in Stark County, 2002 through 2010.

Housing Demand

A housing demand model was developed based on historical relationships between regional employment and regional housing supply. The model produced estimates of housing demand for permanent employment and housing demand for total (permanent and temporary) employment. Housing demand was quantified as total housing units. A housing unit can be a house, twin home, or apartment. Housing demand was estimated for the Dickinson trade area and for the city of Dickinson.

Dickinson Trade Area

The historical relationship between the change in regional employment and the corresponding change in regional housing supply was first examined as a means to estimate future housing demand in the region (Table 2). The annual average change in housing supply in the region was divided by the average annual change in employment from 2000 through 2010. Averaged over the 2000 to 2010 period, the Dickinson trade area added about 1 housing unit for every 4 additional jobs (Table 2). However, estimating future demand for housing based on suggesting the region add one housing unit for an increase of 4 jobs would substantially underestimate of future housing demand.

The rate of growth in employment in the Dickinson trade area has quickly exhausted the current supply of housing thereby removing any elasticity in housing supply.[3] With elasticity in housing supply removed from the region, future demand for housing will be more closely linked to absolute (as opposed to percentage or relative) changes in employment.

The housing model adopted a process of linking ratios of employment to housing as a means to project future housing demand based on employment projections. Examination of the direct ratio of employment to housing (see Table 2) showed how the growth in employment and the lack of corresponding supply of housing has resulted in a situation where an increase in one job could be expected to result in an equivalent increase in housing units.

The employment to housing ratios within the model were adjusted over the 25-year planning period to reflect different dynamics with respect to absolute changes (as opposed to percentage changes) in employment. During a period of rapid employment growth, absolute change in employment resulted in nearly proportional changes in housing demand. During periods immediately following rapid employment growth, the proportionality between housing demand and employment was reduced. Alternatively, at that time it was modeled that a change of more than 1 job would be required to add one housing unit. During periods of relatively stable employment, which occurred in the latter years of the employment projections, housing demand was modeled to more closely approach historical employment-to-housing ratios. The process of relaxing future housing demand when employment became stable is consistent with historical observations within the region and is consistent with introducing more elasticity into the regional housing market (see Table 2).

The housing model produced estimates of future housing demand for permanent employment and total (permanent and temporary) employment in the Dickinson trade area (Figures 16 through 19). For community planning purposes, it was imperative that separate housing needs be developed for temporary and permanent employment. Also, the pattern of how housing demand may change in the future for both temporary and permanent workforce is useful as communities develop strategies to supply both types of housing.

[3]Elasticity in the context of a housing market can be described as the ability to absorb change in housing demand without creating divergence between housing demand and housing supply. Essentially, in a situation where housing supply is in equilibrium with housing demand small changes in employment can be absorbed by existing supply without creating housing shortages. Housing supply therefore is not as acutely influenced by year to year variations in employment. However, elasticity is said to be exhausted when housing supply fails to keep pace with housing demand. In those conditions, additional employment will more closely require corresponding changes in housing supply since the existing housing supply has been exhausted.

Table 2. Historical Ratios of Regional Employment and Housing, Dickinson Trade Area, 2000 through 2010

	Regional Employment		Housing Units		Employment to Housing Ratios	
Year	Number	Annual Change (%)	Number	Annual Change (%)	Direct Ratio[a]	Ratio of Change[b]
2000	12,904		15,059		1.17	
2001	13,012	0.8	15,116	0.4	1.16	2.21
2002	13,280	2.1	15,180	0.4	1.14	4.86
2003	13,523	1.8	15,244	0.4	1.13	4.34
2004	13,605	0.6	15,325	0.5	1.13	1.14
2005	14,111	3.7	15,408	0.5	1.09	6.87
2006	14,464	2.5	15,528	0.8	1.07	3.21
2007	14,784	2.2	15,618	0.5	1.06	4.04
2008	15,513	4.9	15,695	0.5	1.01	9.39
2009	15,739	1.5	15,783	0.6	1.00	4.28
2010	17,282	9.8	16,168	2.4	0.94	4.02

[a] Ratio of housing units to employment.

[b] Ratio created by dividing the annual change in employment (jobs) by the annual change in housing supply (units).
Sources: U.S. Census Bureau (2012a,d).

Future housing demand in the slow development scenario is characterized by growing demand for both temporary and permanent housing in the near term, followed by reduced temporary housing demand and stabilizing permanent housing demand over the remainder of the 25-year period (Figure 16). Demand for temporary housing peaks in about 5 to 7 years, then slowly declines over the next decade. Permanent housing demand does not peak till the end of the 25-year period. Since temporary housing demand is slowly reduced over a 20-year period until total housing demand equals permanent demand, it might be suggested that local communities could cover total housing demand by quickly producing a substantial supply of permanent housing, and then largely hold that supply constant as temporary housing demand decreases and permanent demand increases; however, that strategy would risk overbuilding as the near term peak in housing demand is greater than total housing demand for all but the last few years of the planning period (Figure 16).

Future housing demand in the rapid development scenario is characterized by demand for housing increasing in the next decade, followed by a housing bust and stagnated housing demand in the last half of the 25-year period (Figures 17 and 19). The overall demand for temporary housing does not change much over the next decade due to a steady presence of drilling and fracing workforce in North Dakota. Also occurring over next decade would be a steady increase in the demand for permanent housing (Figure 17). A constant demand for temporary housing combined with a growing demand for permanent housing creates a situation where total housing demand continues to escalate.

A substantial bust in total housing demand in the rapid scenario could result in the near disappearance of the demand for temporary housing and a potentially simultaneous peak in permanent housing demand (Figure 17). If the petroleum industry exhibits the characteristics of a rapid development of the Bakken/Three Forks formations, communities must plan for both a potential bust associated with a dramatic reduction in temporary housing demand and a potential peak in permanent housing demand that may coincide with the loss of temporary housing demand. Perhaps the only viable solution would be to rely heavily on temporary housing of a type that can be quickly removed from the market place to offset the sharp decline in employment. A slow response to the housing bust would quickly create problems associated with an oversupply of housing. Further complicating the challenges associated with the rapid development scenario is that permanent housing shows a peak about the time of the employment contraction (Figures 17 and 19). The supply of housing must be carefully monitored to avoid a serious issue of having too much permanent housing, and not be able to effectively remove enough temporary housing supply from the market.

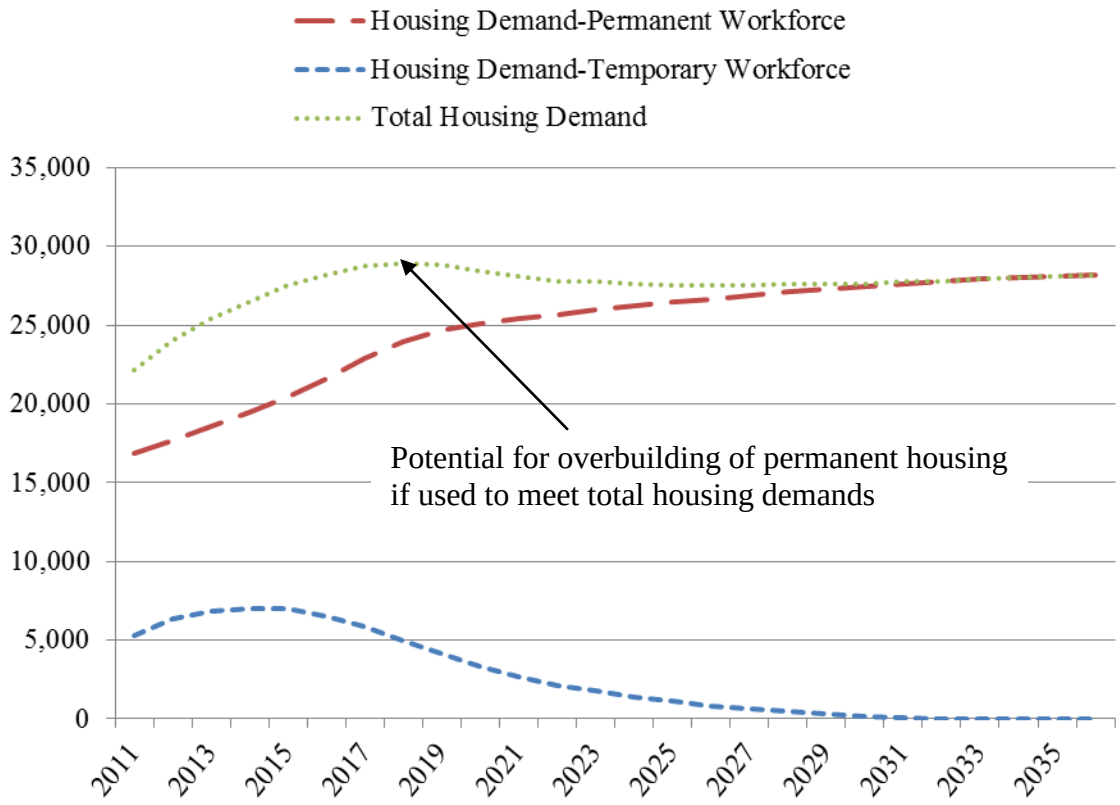

Figure 16. Housing Demand, Dickinson Trade Area, Slow Development Scenario, 2011 through 2036.

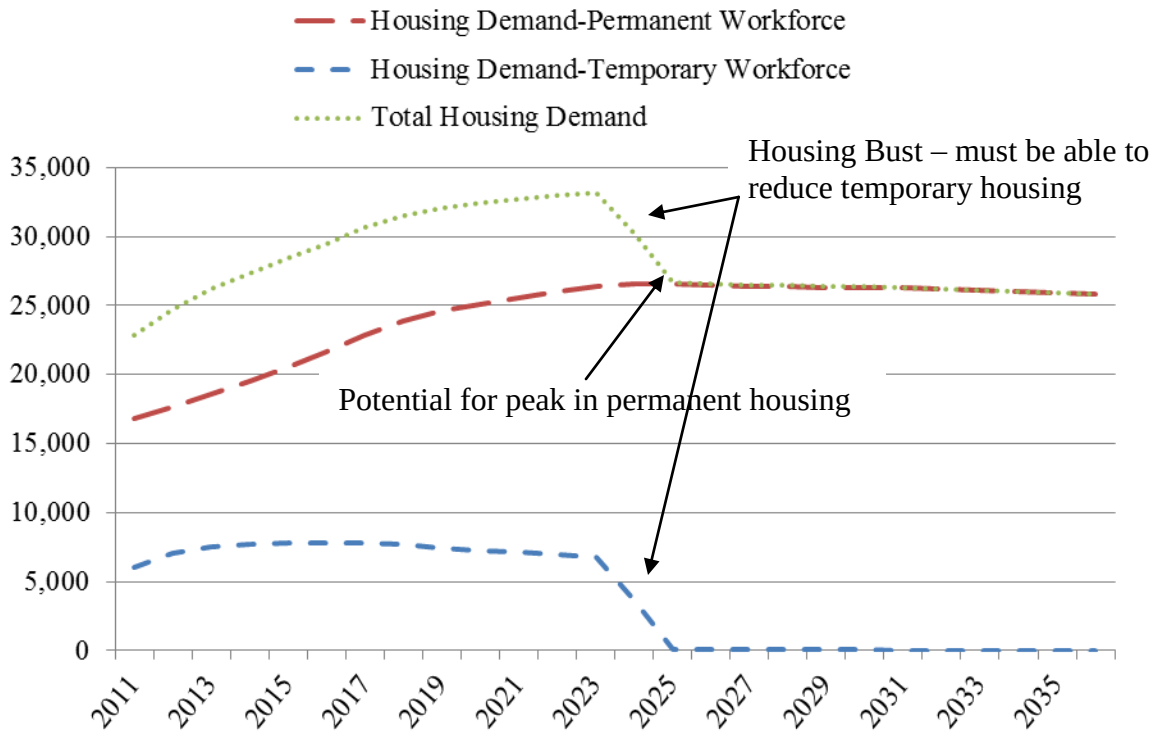

Figure 17. Housing Demand, Dickinson Trade Area, Rapid Development Scenario, 2011 through 2036.

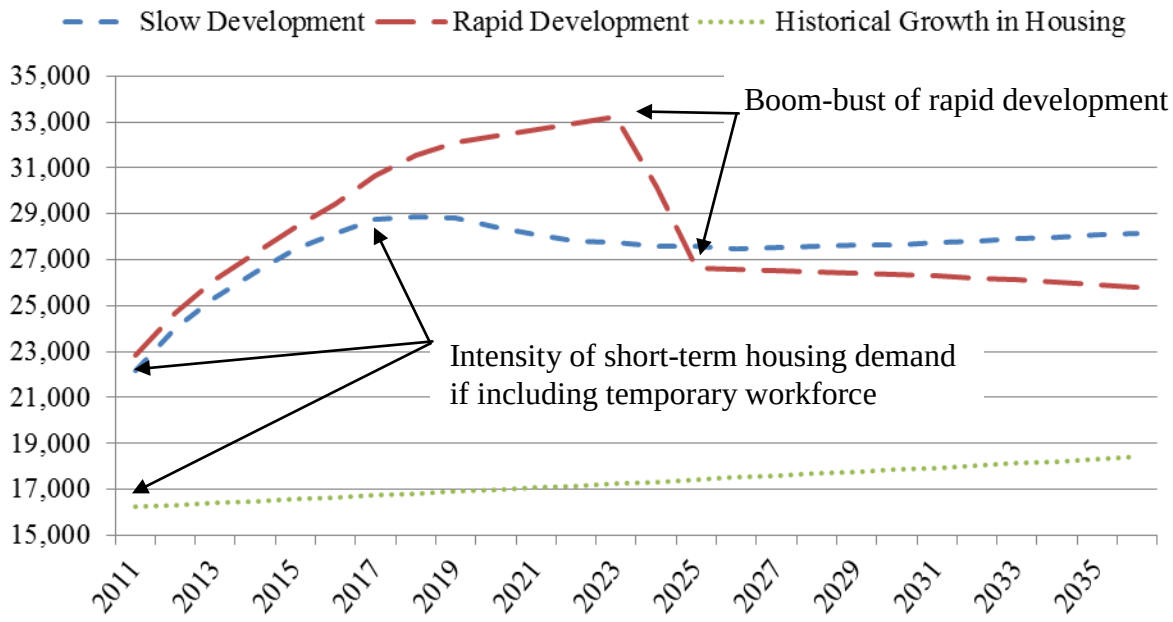

Figure 18. Housing Demand for Temporary and Permanent Workforce, Comparison Between Slow and Rapid Development Scenarios, Dickinson Trade Area, 2011 through 2036.

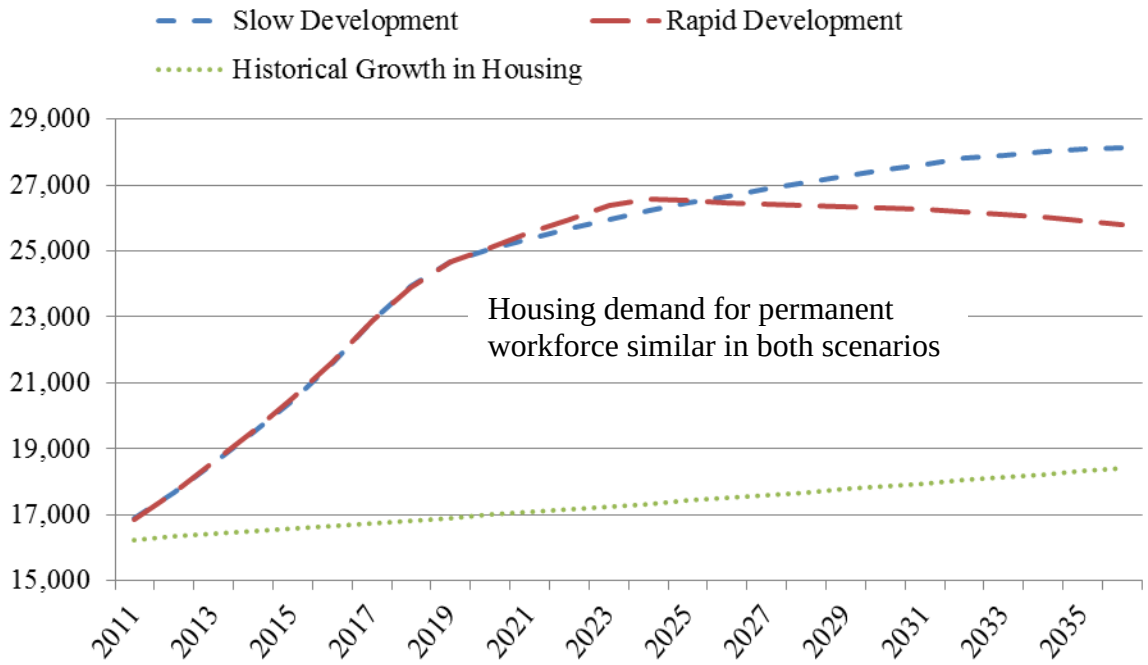

Figure 19. Housing Demand for Permanent Workforce, Comparison between Slow and Rapid Development Scenarios, Dickinson Trade Area, 2011 through 2036

Distribution of Housing Demand Among Trade Area Counties

Regional housing demand consisted of housing units for the entire six-county trade area. Distribution of expected future supply of housing units by county was based on the relative share of each county's share of regional supply and the rate of change in the number of housing units in each county from 2000 through 2010 (Table 3). Workforce projections were done on a regional basis. Future housing demand as a result of those workforce projections were allocated among the trade center counties based on the historic distribution of housing due to workforce mobility. Workers may not necessarily reside where they work or work where they reside. Therefore, a direct correlation between place of employment and place of residence could not be used to allocate regional housing demand.

Trends in the distribution of housing among counties in the Dickinson trade area revealed only Dunn and Stark county added housing from 2000 to 2010 (Table 3). The underlying trends among the trade area counties provided the basis for distributing future housing supply within the trade area counties over the 25-year period. Over the next 25 years Billings, Dunn, Golden Valley, Hettinger, and Slope counties were modeled to have a declining future share of regional housing demand. Stark County was modeled to have an increase in its relative share of housing demand over the period (Table 3).

The estimated future share of housing demand for each county was multiplied by the regional forecast for housing demand to estimate per-county future housing demand from 2011 through 2036. Housing changes have been highlighted in 5-year increments for the slow

development scenario (Table 4) and the rapid development scenario (Table 5). In most cases, due to the rapid increase in housing demand, future housing units in each county increased even as the near-term relative percentage of regional supply decreased. For example, Billings County's share of future housing demand (permanent and temporary workforce) was expected to decrease from 2.6 percent of the regional total in 2015 to 2 percent in 2020; however, actual housing units in the county were projected to increase from 484 units in 2010 to over 700 units in 2015 in the slow scenario (Table 4). Similar effects were observed in other counties in the Dickinson trade area.

Table 3. Distribution of Housing Units, by County, Dickinson Trade Area, 2000 through 2010

	Total Housing Units						
Year	Billings	Dunn	Golden Valley	Hettinger	Slope	Stark	Total
2000	529	1,965	973	1,419	451	9,722	15,059
Share of Regional Total (2000)	3.5%	13.0%	6.5%	9.4%	3.0%	64.6%	
2001	530	1,970	971	1,421	454	9,770	15,116
2002	531	1,971	972	1,425	456	9,825	15,180
2003	530	1,971	974	1,429	459	9,881	15,244
2004	531	1,970	972	1,432	462	9,958	15,325
2005	531	1,970	970	1,437	464	10,036	15,408
2006	531	1,968	970	1,435	464	10,160	15,528
2007	530	1,978	969	1,433	463	10,240	15,613
2008	531	1,984	967	1,432	463	10,318	15,695
2009	532	1,985	967	1,430	463	10,406	15,783
2010	484	2,132	967	1,414	436	10,735	16,168
Share of Regional Total (2010)	3.0%	13.2%	6.0%	8.7%	2.7%	66.4%	
Numeric Change 2000-2010	-45	167	-6	-5	-15	1,013	1,109
Percentage Change 2000-2010	-8.5	8.5	-0.6	-0.4	-3.3	10.4	7.4

Source: U.S. Census Bureau (2012c,d)

Table 4. Estimated Distribution of Future Housing Units by County, Dickinson Trade Area, Slow Development Scenario, 2015 through 2035

Year	Billings	Dunn	Golden Valley	Hettinger	Slope	Stark	Total
	---------- Percentage of Regional Supply ----------						
2015	2.6	13.0	5.5	8.0	2.4	68.5	100.0
2020	2.0	12.5	5.2	7.5	2.2	70.7	100.0
2025	1.8	12.3	5.0	7.2	2.0	71.6	100.0
2030	1.8	12.3	5.0	7.2	2.0	71.6	100.0
2035	1.8	12.3	5.0	7.2	2.0	71.6	100.0
	---------- Permanent and Temporary Workforce ----------						
2010	484	2,132	967	1,414	436	10,735	16,168
2015	701	3,588	1,522	2,189	668	18,834	27,502
2020	572	3,552	1,475	2,126	621	20,074	28,419
2025	508	3,390	1,388	1,981	563	19,732	27,561
2030	509	3,396	1,390	1,985	564	19,770	27,614
2035	518	3,455	1,414	2,019	574	20,110	28,089
	---------- Only Permanent Workforce ----------						
2010	484	2,132	967	1,414	436	10,735	16,168
2015	522	2,672	1,134	1,630	497	14,028	20,478
2020	504	3,134	1,302	1,876	548	17,713	25,076
2025	487	3,252	1,331	1,900	540	18,931	26,442
2030	506	3,377	1,382	1,974	561	19,659	27,459
2035	518	3,455	1,414	2,019	574	20,110	28,089

Table 5. Estimated Distribution of Future Housing Units, by County, Dickinson Trade Area, Rapid Development Scenario, 2015 through 2035

Year	Billings	Dunn	Golden Valley	Hettinger	Slope	Stark	Total
	---------- Percentage of Regional Supply ----------						
2015	2.6	13.0	5.5	8.0	2.4	68.5	100.0
2020	2.0	12.5	5.2	7.5	2.2	70.7	100.0
2025	1.8	12.3	5.0	7.2	2.0	71.6	100.0
2030	1.8	12.3	5.0	7.2	2.0	71.6	100.0
2035	1.8	12.3	5.0	7.2	2.0	71.6	100.0
	---------- Permanent and Temporary Workforce ----------						
2010	484	2,132	967	1,414	436	10,735	16,168
2015	725	3,707	1,573	2,261	690	19,460	28,416
2020	652	4,050	1,682	2,424	708	22,889	32,404
2025	491	3,277	1,341	1,915	544	19,076	26,645
2030	485	3,239	1,326	1,893	538	18,853	26,334
2035	478	3,188	1,305	1,863	529	18,557	25,920
	---------- Only Permanent Workforce ----------						
2010	484	2,132	967	1,414	436	10,735	16,168
2015	525	2,684	1,139	1,637	499	14,089	20,048
2020	505	3,140	1,304	1,879	549	17,746	24,618
2025	489	3,262	1,335	1,906	542	18,990	26,036
2030	484	3,233	1,323	1,889	537	18,818	25,800
2035	478	3,188	1,305	1,863	529	18,557	25,442

City of Dickinson

In the 2010 Census, Dickinson had roughly 50 percent of the total housing units in the six-county trade area (Table 6). The remaining incorporated cities in the trade area collectively accounted for about 21 percent of housing supply, while the remaining 30 percent of housing units were in rural, unincorporated areas.

Several scenarios to describe the response to the future housing demand in the Dickinson trade area are possible. Future supply of housing could be proportional to the 2010 Census distribution of housing units among cities and communities in the region. A proportional allocation of future housing units would result in Dickinson absorbing roughly 50 percent of the projected future regional housing demand.

Another possible scenario would be a disproportionate increase in the supply of housing by the smaller cities and communities in the region. This would result in Dickinson's share of future housing supply being less than the 50 percent reported in the 2010 Census.

Another possibility is that the smaller cities and communities in the region would either be unwilling or unable to provide a proportional response to future housing demand. Under those conditions, Dickinson's share of regional housing could increase above the 50 percent share reported in the 2010 Census.

Two scenarios of future housing demand for Dickinson were estimated: one based on the city supplying 50 percent (historic levels) and one where the city supplied 70 percent of the future regional housing demand. City officials requested modeling a scenario where Dickinson would supply a larger proportion of housing as it was their view that smaller cities and communities in the trade area would not be able to meet a proportional supply of future housing demand.

Future housing demand in the city of Dickinson was substantial (Table 7). Assuming Dickinson supplied the historic proportion of regional housing (50 percent) and averaging the housing demand for the slow and rapid development scenarios[4], peak demand for permanent housing for Dickinson would be over 13,530 total housing units in 2035, an almost 72 percent increase above the 2010 Census housing inventory. If Dickinson supplied 70 percent of the regional housing demand for permanent employment, the city would have to supply over 11,000 additional housing units for an increase of 140 percent above the 2010 Census to meet peak demand. The growth in permanent housing demand was estimated to peak near the end of the 25 year planning horizon. Permanent housing demand in year 25 of the projection period was only slightly less than the peak demand (Table 7).

[4]The city of Dickinson wanted to consider only one set of housing and population estimates. Accordingly, an average of slow and rapid rates of development was calculated for inclusion in the city's comprehensive planning efforts.

Table 6. Housing Units by City, 2010 Census, Dickinson Trade Area, 2010

City	Housing Units	Percentage of Regional Supply
Dickinson	7,865	48.6
Beach	601	3.7
Belfield	418	2.6
Mott	415	2.6
Killdeer	342	2.1
New England	319	2.0
Richardton	285	1.8
Halliday	135	0.8
South Heart	129	0.8
Regent	120	0.7
Gladstone	113	0.7
Medora	102	0.6
Taylor	96	0.6
Marmarth	93	0.6
Dunn Center	80	0.5
Dodge	67	0.4
Golva	52	0.3
Sentinel Butte	38	0.2
Amidon	17	0.1
Total for All Cities		11,287
Percent of Total Trade Area		69.8
Total for Cities with 200+ Housing Units		10,245
Percent of Total Trade Area		63.4
Total for Cities with 400+ Housing Units		9,299
Percent of Total Trade Area		57.5
Total Units in Trade Area		16,168

Source: U.S. Census Bureau (2012c).

Table 7. Housing Demand Compared to 2010 Census, City of Dickinson, Average of Slow and Rapid Scenario, 2011 through 2036

Measure	Dickinson Supplies 50 Percent of Regional Housing Demand		Dickinson Supplies 70 Percent of Regional Housing Demand	
	Demand for Permanent Housing	Demand for Permanent and Temporary Housing	Demand for Permanent Housing	Demand for Permanent and Temporary Housing
Peak Demand, Total Housing Units	13,531	15,340	18,943	21,476
Year for Peak Demand	2035	2023	2035	2023
Lowest Demand, Total Housing Units after Peak	13,509	13,509	18,913	18,913
Year for Lowest Demand after Peak	2036	2036	2036	2036
2010 Census Permanent Housing, Total Units	7,865	7,865	7,865	7,865
Additional Housing Units to Meet Peak Demand	5,666	7,475	11,078	13,611
Additional Housing Units to Meet Lowest Demand after Peak	5,644	5,644	11,048	11,048
Peak Demand, Change in Housing Units from 2010 Census	72.0%	95.0%	140.9%	173.1%
Lowest Demand after Peak, Change in Housing Units from 2010 Census	71.8%	71.8%	140.5%	140.5%

While demand for housing associated with permanent employment was stable at the end of the 25-year planning period (i.e., when averaging the slow development and rapid development scenarios), total housing demand, which included temporary employment, had different dynamics. When housing demand for the temporary workforce was included in the estimate, future housing demand peaked 10 to 12 years into the planning period in 2023 at about 15,340 total housing units. This represents a 95 percent increase from 2010 housing supply assuming the city maintains a 50 percent share of the regional housing demand.

The employment projections and housing model indicate that Dickinson has a demand that ranges from 2,260 up to 3,340 units associated with temporary employment between 2012 and 2023 (Table 8). Including temporary employment and assuming the city supplies 70 percent of the regional housing demand, future housing demand peaks in 2023 at 21,476 housing units– about a 173 percent increase over 2010 housing supply. Housing needs for temporary employment from 2012 through 2023 for Dickinson is about 2,600 units assuming the city supplies 70 percent of the regional housing demand (Table 8).

The city must plan accordingly to track the supply of temporary housing and supply of permanent housing over the next 10 to 12 years to avoid over supplying the housing market. How much temporary housing Dickinson supplies will vary depending upon what portion of the regional demand they choose to supply, how much temporary housing exists within the trade region, and the rate at which permanent housing is added in the city since temporary housing also serves as a bridge until permanent housing can be supplied. Annual housing demand for Dickinson and the surrounding trade area are detailed in Table 8.

Table 8. Housing Demand for Permanent Employment and Total Employment, Dickinson Trade Area and City of Dickinson, Average of Slow and Rapid Scenarios, 2011 through 2036

			City of Dickinson			
	Dickinson Trade Area		50 Percent of Trade Area Housing Demand		70 Percent of Trade Area Housing Demand	
Year	Permanent Housing Demand	Permanent and Temporary Housing Demand	Permanent Housing Demand	Permanent and Temporary Housing Demand	Permanent Housing Demand	Permanent and Temporary Housing Demand
	---------- total housing units ----------					
2011	16,870	22,527	8,435	11,263	8,435	11,263
2012	17,671	24,345	8,836	12,172	9,189	12,659
2013	18,593	25,765	9,296	12,883	10,040	13,913
2014	19,515	26,882	9,757	13,441	10,928	15,054
2015	20,522	27,950	10,261	13,975	11,903	16,211
2016	21,618	28,808	10,809	14,404	12,971	17,285
2017	22,879	29,736	11,439	14,868	14,185	18,436
2018	23,897	30,281	11,949	15,141	15,294	19,380
2019	24,657	30,534	12,328	15,267	16,274	20,152
2020	25,087	30,531	12,543	15,265	17,059	20,761
2021	25,463	30,544	12,732	15,272	17,824	21,381
2022	25,819	30,571	12,910	15,286	18,074	21,400
2023	26,161	30,680	13,081	15,340	18,313	21,476
2024	26,383	28,898	13,192	14,449	18,468	20,228
2025	26,492	27,137	13,246	13,568	18,544	18,996
2026	26,573	27,057	13,287	13,529	18,601	18,940
2027	26,660	27,038	13,330	13,519	18,662	18,927
2028	26,746	27,042	13,373	13,521	18,722	18,929
2029	26,827	27,041	13,413	13,520	18,779	18,928
2030	26,904	27,008	13,452	13,504	18,833	18,906
2031	26,973	27,048	13,486	13,524	18,881	18,933
2032	27,031	27,031	13,516	13,516	18,922	18,922
2033	27,047	27,047	13,524	13,524	18,933	18,933
2034	27,055	27,055	13,528	13,528	18,939	18,939
2035	27,061	27,061	13,531	13,531	18,943	18,943
2036	27,019	27,019	13,509	13,509	18,913	18,913

Population

Two approaches to modeling future population were examined. One approach used a combination of Census information, informal lodging arrangements, and infrastructure build-out rates to examine near-term potential population change within the city of Dickinson. This approach was developed to provide reasonable estimates of the city's service population in the next 5 years. Service population was defined as the sum of the normal resident population (Census population) and the population that works in Dickinson but maintains a residence elsewhere. The service population is not captured by US Census estimates. Estimates of the service population are necessary to provide guidance to city administrators on the provision of public services. While those individuals that make up the "service population" are not considered permanent residents of the city of Dickinson, they do use and demand city and public services.

This approach was developed to address the unique circumstances in western North Dakota. Standard population projection models use historic birth, death, and migration rates. Due to substantial data lag, standard population models are not appropriate for modeling the situation in western North Dakota. Rapid in-migration to fill jobs created by expansion in the petroleum sector has made traditional population projection models ineffective. Standard cohort models are not able to account for the ongoing rapid in-migration occurring in Dickinson from oil field activity in a timely manner. The housing population approach to population models the effects of rapid in-migration. The housing population component does not model birth and death rates.

In addition to the service population, a second approach to estimating population was developed. The model examines potential job growth in the petroleum sector and converts regional employment into housing demand for various types of housing. Anticipated future occupancy rates were applied to estimates of various housing types to project potential population. Workforce was classified as either permanent or temporary in order to differentiate between demand for permanent housing and demand for temporary housing. The temporary workforce represents the service population in this model. Some jobs such as those in construction, drilling and fracing are typically more transient than jobs in oil field services such as well maintenance and transportation. Workers in the development activities of the petroleum sector are less likely to become permanent residents, however they still need housing and demand services while working in North Dakota. Accordingly housing demand was described as either permanent (i.e. Census population) or temporary (i.e. service population).

Service Population Model

The 2010 Census for the city of Dickinson provided the baseline for service population projections. Census numbers were adjusted using a housing population model. The housing population model captures the rapid expansion in traditional housing developments and non-traditional temporary housing. As a result of the severe housing shortage, workers are seeking out alternate housing options such as hotels, informal construction camps, crew camps, and RV

parks and campgrounds. Because the demand for housing is so acute non-traditional housing was and should be included in a housing population model.

New Housing Developments. The 2010 population was adjusted to reflect new housing construction since 2010, developments under construction and planned annexations. A list of all developments underway and planned annexations with the number of each type of housing unit (R1, R2, R3) was made using data obtained from city administrators (Unpublished data, city of Dickinson). City administrators also provided estimated length of time for build-out and the percent competed to date. Persons per household occupancy rates of 2.48 for owner occupied and 1.89 for renter occupied were based on the 2010 Census. Occupancy rates were applied to the estimate of new housing, housing under construction, and planned annexations to estimate additional population.

Non-traditional Housing

Hotels. As of 2011, there were 1,026 rooms in Dickinson with another 481 under construction and slated for completion in 2012. Just under 60 percent of all rooms in Dickinson were under long term and contract leases. The model assumes that rooms under long term and contract leases were serving as temporary housing. This estimate does not include any additional hotel construction beyond that which is currently under construction. Occupancy rates per room assumed to be 1.2. Occupancy rates are based on observation of hotel managers in Dickinson.

Informal Construction Camps. Demand for construction has exceeded local builders capacity. Accordingly, informal on-site camps at construction sites are common. An estimate of the number of construction sites, the portion with on-site camps and average occupancy were provided by city administrators. Administrators estimate approximately half of the 66 construction sites in the city had informal construction camps with approximately 4 occupants per camp.

Campgrounds/RV Parks. Based on personal interviews with the owner/managers of Dickinson's two campground/RV parks with year-round availability, an estimate of the increase in occupancy since 2010 was made. Only the change in occupancy since 2010 was considered. It was assumed that the Census captured permanent residents at these locations in 2010. The estimate also incorporated near-term plans for expansion in 2012 and 2013. No expansions beyond 2013 were modeled. Occupancy rates for RVs (1.5) and manufactured homes (2.0) were based on campground and RV Park owners observations. Occupancy rates for manufactured homes were assumed to be the same as owner-occupied homes (2.48) as reported by the 2010 Census.

Crew Camps. City administrators provided an estimate of crew camps. This estimate includes only those camps that have made inquiries and have begun the permitting process in Dickinson. Build-out of crew camps was assumed to be for 1,250 individuals in 2012 and 1,000 each in 2013 and 2014. This estimate of crew camps does not include any additional crew camps that may be built beyond the two locations currently under consideration.

Roommates, Boarders, Double-ups. There is no available estimate of roommates, boarders and double-ups. It is likely that historic occupancy rates underestimate current rates, however an empirical estimate of roommates, boarders and double-ups was beyond the scope of this study. The Census tallies nonrelatives, roommates or boarders, housemate or roommate, unmarried partners and other nonrelatives by household type. The 2010 Census recorded 1,286 nonrelatives. While this is not a large number it is noteworthy that is roughly double the 2000 Census of 688 nonrelatives. Future efforts to quantify the effect of roommates, boarders and double-ups would help to refine service and total population estimates in Dickinson and western North Dakota.

Population projections for 2016 were developed using the 2010 Census as a baseline with adjustments for new and planned housing, non-traditional housing (service population), and assuming various completion rates. Assuming various completion rates (100, 80 and 60 percent) over the next 4 years for new housing developments and annexations and a minimal vacancy rate for new housing, 3 population projections for 2016 were developed. Assuming no additional annexations, no additional hotel capacity and no additional crew camps; population projections for 2016 ranged from 30,000 to 35,000. The city will reached a physical maximum population of approximately 35,000 upon a 100 percent build-out. Timing of physical maximum population is dependent on how quickly available real estate is built out. Additional growth will be dependent on how the city reacts to demand for additional housing as a result of activity in the energy sector. Additional growth will require additional annexations.

The housing population model reflects rapid growth in in-migration in Dickinson. It does not however adjust for any potential changes in birth rates as a result of in-migration. Changes in birth rates are a function of the characteristics of new residents, gender, age, marital status, birth rates, death rates, etc. No existing data on key indicators for new workers are available at time the study was conducted.

Table 9. Service Population, City of Dickinson, Service Population Model, 2016

	High Scenario[a]	Mid Scenario[b]	Low Scenario[c]
New Housing			
R1 (Single Family)	2,666	2,111	1,555
R2 (2- 4 units)	3,657	2,895	2,133
R3 (more than 4 units)	5,089	4,029	2,969
Total New Housing since 2010	11,413	9,035	6,657
Non-traditional Housing			
Hotels	1,026	1,026	1,026
Informal Construction Camps	264	264	264
Campgrounds/RV Parks	1,292	1,292	1,292
Crew Camps	3,250	3,250	3,250
Roommates and Borders	n/a	n/a	n/a
Total Non-traditional Housing since 2010	5,832	5,832	5,832
Calculation of Service Population			
Base Population, 2010 Census	17,787	17,787	17,787
Total New Housing since 2010	11,413	9,035	6,657
Total Non-traditional Housing since 2010	5,832	5,832	5,832
City of Dickinson Service Population	***35,301***	***32,654***	***30,276***
Percent Change from 2010	*97*	*84*	*70*

[a] Build-out of new housing is 100 percent complete by 2015, vacancy rate of 4 percent. 2.48 persons per household for owner-occupied units (R1), 1.48 for renter-occupied (R2 and R3). Source: U.S. Census Bureau (2012c)

[b] Build-out of new housing is 80 percent complete by 2015, vacancy rate of 4 percent. 2.48 persons per household for owner-occupied units (R1), 1.48 for renter-occupied (R2 and R3). Source: U.S. Census Bureau (2012c)

[c] Build-out of new housing is 60 percent complete by 2015, vacancy rate of 4 percent. 2.48 persons per household for owner-occupied units (R1), 1.48 for renter-occupied (R2 and R3). Source: U.S. Census Bureau (2012c)

Housing-to-Population Model

The housing-to-population projection model allocates total housing demand for a trade region into various categories of housing unit types by county. Expected future occupancy rates, by housing type, by county, were used to convert the number of future housing units into

population estimates. The model was used to provide estimates of population for the city of Dickinson.

After regional housing de**m**and was allocated to the trade area counties, total housing units were converted to housing types (i.e., R1, R2, R3). R1 housing units are single family homes. R2 housing are structures with two to four units. R3 housing structures have five or more units.

The distribution of housing types was based on data from the 2010 American Community Survey (U.S. Census Bureau 2012c) with modifications reflective of recent changes in the percentage of each type of housing unit constructed. Recent building patterns indicate an increase in the percentage of R2 and R3 units relative to the number of R1 units. Multi-unit structures make up a greater portion of the available housing mix than they have historically. Using the modified share of future housing for R1 units, the distribution of R2 and R3 housing units were estimated by subtracting R1 units from total housing units.

Occupancy rates for each housing type were estimated from the 2010 American Community Survey (U.S. Census Bureau 2012c). Occupancy rates were assigned to the distribution of R1 and residual housing (i.e., R2 and R3 housing types), by county, over the planning period (see Table 9). Occupancy rates for residual housing units (R2 and R3) were based on R3 occupancy rates in 2010 (American Community Survey 2012c) (Table 10).

Assuming all permanent housing needs are met within the region, an average of the slow and rapid development scenarios, the Dickinson trade area permanent population could approach 57,000 in 25 years. If temporary employment is included in the population estimates, trade area service population could peak near 64,000 people in 12 years (Table 11). Population estimates based on the slow and rapid scenario are detailed in Tables 12 and 13.

Table 10. Housing Type and Occupancy Rate, By County, Dickinson Trade Area, 2010

	Billings	Dunn	Golden Valley	Hettinger	Slope	Stark	Total
2010 Total Housing Units	488	2,117	956	1,460	470	10,528	16,019
American Community Survey							
R1 Housing Units	375	1527	782	1,253	416	7,561	11,914
R1 as Percentage of Total Housing	76.8	72.1	81.8	85.8	88.5	71.8	
R1 Modified - 15% of R1 distribution (30% for Stark County)	65.3	61.3	65.4	68.7	75.2	50.3	
	---------- persons per housing unit ----------						
R1 Housing	2.00	1.90	1.60	1.80	1.5	2.54	2.20
R2 Housing	1.00	1.00	1.20	2.00	1.0	2.00	1.30
R3 Housing	1.00	1.30	1.20	2.00	1.5	2.00	1.30

Notes: R1 housing is single family homes. R2 housing are structures with two to four units. R3 housing structures have five or more units.Sources: U.S. Census Bureau (2012c).

Table 11. Population Estimates, Dickinson Trade Area Average of Slow and Rapid Development Scenario, 2010 through 2035

Year	Dickinson Trade Area Counties						All Counties
	Billings	Dunn	Golden Valley	Hettinger	Slope	Stark[a]	
				Permanent Population[b]			
2010	783	3,536	1,680	2,477	727	24,199	33,402
2015	866	4,467	1,975	3,043	748	31,933	43,030
2020	835	5,232	2,265	3,497	823	40,272	52,922
2025	807	5,432	2,318	3,545	811	43,068	55,981
2030	819	5,512	2,352	3,598	823	43,700	56,803
2035	823	5,539	2,363	3,615	827	43,915	57,083
				Service (Permanent and Temporary) Population[c]			
2010[d]	783	3,536	1,680	2,477	727	24,199	33,402
2015	1,179	6,083	2,690	4,144	1,018	43,493	58,607
2020	1011	6,339	2,744	4,237	997	48,795	64,122
2025	826	5,560	2,372	3,628	830	44,076	57,292
2030	822	5,533	2,361	3,611	826	43,866	57,019
2035	823	5,539	2,363	3,615	827	43,915	57,083

[a] Assumes city of Dickinson's share of regional housing demand proportional to historic rates.

[b] Population associated with permanent workforce.

[c] Population associated with permanent and temporary workforce.

[d] Service population not estimated for 2010. Figures represent 2010 Census population only (U.S. Census Bureau 2012b).

Table 12. Population Estimates, Dickinson Trade Area, by County, Slow Development Scenario, 2010 through 2035

Year	Dickinson Trade Area Counties						All Counties
	Billings	Dunn	Golden Valley	Hettinger	Slope	Stark[a]	
				Permanent Population[b]			
2010	783	3,536	1,680	2,477	727	24,199	33,402
2015	864	4,457	2,646	4,077	746	31,863	57,649
2020	834	5,227	2,564	3,959	822	40,234	59,921
2025	806	5,424	2,412	3,690	810	43,001	58,259
2030	837	5,633	2,417	3,697	841	44,656	58,372
2035	856	5,762	2,458	3,760	860	45,679	59,375
				Service (Permanent and Temporary) Population[c]			
2010[d]	783	3,536	1,680	2,477	727	24,199	33,402
2015	1,160	5,984	1,971	3,036	1,001	42,782	42,937
2020	945	5,923	2,263	3,494	932	45,598	52,873
2025	840	5,653	2,314	3,540	844	44,820	55,894
2030	841	5,664	2,403	3,676	846	44,907	58,045
2035	856	5,762	2,458	3,760	860	45,679	59,375

[a] Assumes city of Dickinson's share of regional housing demand proportional to historic rates.

[b] Population associated with permanent workforce.

[c] Population associated with permanent and temporary workforce.

[d] Service population not estimated for 2010. Figures represent 2010 Census population only (U.S. Census Bureau 2012b).

Table 13. Population Estimates, Dickinson Trade Area, Rapid Development Scenario, 2010 through 2035

Year	Dickinson Trade Area Counties						All Counties
	Billings	Dunn	Golden Valley	Hettinger	Slope	Stark[a]	
				Permanent Population[b]			
2010	783	3,536	1,680	2,477	727	24,199	33,402
2015	867	4,476	1,979	3,050	749	32,003	42,257
2020	835	5,236	2,267	3,500	824	40,309	52,136
2025	808	5,441	2,321	3,551	812	43,135	55,261
2030	801	5,392	2,300	3,519	805	42,745	54,761
2035	790	5,317	2,268	3,470	794	42,152	54,001
				Service (Permanent and Temporary) Population[c]			
2010[d]	783	3,536	1,680	2,477	727	24,199	33,402
2015	1,198	6,183	2,734	4,212	1,035	44,204	59,565
2020	1,077	6,754	2,924	4,515	1,062	51,992	68,324
2025	812	5,466	2,332	3,567	816	43,332	56,324
2030	802	5,402	2,305	3,525	807	42,825	55,665
2035	790	5,317	2,268	3,470	794	42,152	54,790

[a] Assumes city of Dickinson's share of regional housing demand proportional to historic rates.

[b] Population associated with permanent workforce.

[c] Population associated with permanent and temporary workforce.

[d] Service population not estimated for 2010. Figures represent 2010 Census population only. (U.S. Census Bureau 2012b).

Population estimates for the city of Dickinson are dependent on what share of the regional housing demand is supplied by the city of Dickinson (Table 14). Historically the city has provided about 50 percent of regional housing. If that ratio is maintained, future permanent population could approach 30,000 in 15 years. If that ratio were to change based on the assumption that other smaller communities in the trade area were either unwilling or unable to maintain the historic distribution and the city now supplied 70 percent of the regional housing demand, future permanent population was estimated to approach 40,000 in 15 years.

When temporary employment is included in the population estimates, the city of Dickinson could see a service population of between 34,000 to 47,000 in 10 years depending upon the share of regional temporary housing demand supplied by the city. Population estimates for Dickinson

exceeded 40,000 people at the end of the 25-year period when the city supplies 70 percent of the region's housing needs (Table 14).

Table 14. Population Estimates, City of Dickinson, Average of Slow and Rapid Scenarios, 2010 through 2035

			City of Dickinson			
	Dickinson Trade Area		50 Percent of Trade Area Housing Demand		70 Percent of Trade Area Housing Demand	
Year	Permanent Workforce	Permanent and Temporary Workforce	Permanent Workforce	Permanent and Temporary Workforce	Permanent Workforce	Permanent and Temporary Workforce
2010	33,402	33,402	18,895	25,230	18,895	25,230
2015	36,947	50,322	23,779	31,688	28,535	38,026
2020	45,082	54,623	28,010	33,598	39,213	47,037
2025	47,555	48,668	29,231	29,763	40,923	41,668
2030	48,253	48,436	29,670	29,752	41,538	41,653
2035	48,490	48,490	29,721	29,721	41,609	41,609

Summary

Communities in western North Dakota are struggling to manage the unprecedented growth in employment associated with current oil boom. The city of Dickinson is undergoing a comprehensive plan to develop policies, strategies, and solutions for providing infrastructure, transportation, housing, and public services as a result of the new conditions brought on by oil field development. This project was designed to provide input into the city's comprehensive planning effort.

Employment projections for the Dickinson trade area were based on the sum of existing employment, future direct employment in the petroleum sector, and potential secondary employment associated with changes in direct employment in the petroleum sector. To frame the context and scope of future oil field development, perceptions and opinions on current and expected development of the oil sector in North Dakota were solicited from industry leaders and government representatives with knowledge of the industry. Those opinions and perceptions provided the basis for the development of slow and rapid development scenarios associated with 32,000 wells in the Bakken/Three Forks formations in North Dakota by 2036.

Two separate approaches were used to estimate future population for the city of Dickinson. One approach used current and planned build-out rates for future housing, occupancy rates in motels and other non-traditional housing arrangements, crew camps, and existing traditional Census estimates of residents to produce an estimate of service population. A second approach converted future housing demand into various housing types (e.g., homes, apartments) and assigned occupancy rates by housing type to arrive at a regional population potential.

The housing demand model used future employment projections for the Dickinson trade area to estimate future housing demand. Housing demand was estimated separately for permanent employment and temporary employment. Temporary employment was used to estimate the service (not permanent) population. Housing demand in Dickinson was modeled two ways. First, housing demand was modeled at a rate consistent with Dickinson's historic share of regional housing, approximately 50 percent. A second scenario assumed the city would supply 70 percent of the regional housing supply. The second scenario was based on the premise that other cities and communities in the region would not be able to meet future housing demand proportionate to historical levels.

Near-term growth in employment in the Dickinson trade area was substantial in both the slow and rapid development scenarios. However, long-term employment dynamics differed. Those differences were reflected in the level of temporary employment and changes in permanent employment over the period. The slow development scenario produced a set of employment dynamics much more conducive to an orderly and sustained expansion. By contrast, the rapid development scenario indicated continued rapid growth in employment over the next decade. Further, in the rapid scenario, upon completion or well drilling there is a strong contraction in employment which results in a classic boom-bust scenario.

Housing demand for a permanent workforce was projected to be 72 percent to 140 percent above the 2010 Census estimate of housing units in the city of Dickinson, depending upon the share of regional housing units supplied by Dickinson. When housing demand included housing for the temporary workforce, housing demand peaked at 95 to 173 percent of the 2010 Census estimate of housing units in Dickinson 10 to 12 years into the planning period. Temporary employment, and demand for temporary housing, were minor by the end of the 25-year period.

Conclusions

The process of examining changes in employment, both outside and within the petroleum sector provided insights on potential changes in western North Dakota. Given the rate of change, and that traditional methods of estimating population change do not fit the conditions associated with the current oil boom, new methods and models need to be developed. This study used an employment-based approach to estimating housing and population. While employment-based modeling as a tool for estimating population is not by itself new, many of the techniques used in this study were unique to the current conditions in western North Dakota.

Aside from detailed estimates of future employment, housing, and population, the study produced a number of insights regarding current and expected future activity in the Dickinson trade area.

- Employment
  - Employment in the petroleum sector will remain high, and there are strong indications that increases in direct employment could occur in the near term.
  - Near term employment drivers are associated with drilling and fracing activity in the Bakken/Three Forks formations.
  - Longer-term employment drivers are associated with oil field service and will be a direct function of the number of wells operating in the state.
  - Wildcards in the long-term employment may include development of other shale formations (e.g., Tyler formation).
  - Long-term predictions of employment are difficult.
    - The industry has substantial incentives to reduce current labor requirements.
    - Future use of new technologies is likely to be a factor in employment requirements.
    - Macro-economic factors affecting oil field development rates and desirability of the industry to pursue opportunities in shale oil formations in ND are difficult to predict.
    - Therefore, a host of factors make concise long-range estimates impossible. The best antidote for long-term uncertainty is to shorten the time between assessments and make the process of forecasting more iterative.

- Housing
  - There is substantial demand for housing in the Dickinson trade area.

• Current build-out rates for water, sewer, and housing are not likely to result in overbuilding of infrastructure within the city of Dickinson in the near term.
• Despite enormous demand for housing, it is not unlimited. The city must carefully plan how it will respond to the demand as overbuilding can result in equally serious ramifications.
    ◦ Too much housing is likely to result in high vacancy rates, and a depressed housing market.
    ◦ Too little housing drives up values and rents and create additional problems for elderly and other fixed income residents.

• Communities' response to the housing issue must include continual monitoring and periodic re-assessment to avoid building to peak demand.

● Workforce Characteristics

• Workers in the petroleum sector are far more mobile than previously thought.
• A good understanding of workforce characteristics is lacking.
• Planning efforts at both the local and state level would benefit from a better understanding of demographic profiles, anticipated work schedules, and likelihood/willingness of existing workforce to become North Dakota residents.
• Antidotal evidence (airline boardings, real estate purchases) suggests that workers are seeking housing outside of the oil fields, and using work schedules that allow them to work in ND but maintain their home residence elsewhere in the state or outside of ND.
• A mobile workforce responsive to housing availability has substantial implications for level of secondary employment–implications for support businesses, services, and commercial activity.

● Population

• Local communities must include estimates of service population when planning for delivery of public services.
• The duration and intensity of service population will largely be reflective of the city's policy regarding housing supply and the future rates of development within the oil field.

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