The Keystone Pipeline Debate: An Alternative Job Creation Strategy

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This report was funded with the generous support of the Chorus Foundation.

Executive Summary

The Keystone XL pipeline has been touted as a means to address America's jobs crisis. But how does its job creation compare to other possible projects? This study compares the jobs that would be created by the KXL pipeline to the jobs that could be created by water, sewer, and gas infrastructure projects in the five states the pipeline crosses. It finds that meeting unmet water and gas infrastructure needs in the five relevant states along the KXL pipeline route will create:

- More than 300,000 total jobs across all sectors;
- Five times more jobs, and better jobs, than KXL;
- 156% of the number of direct jobs created by Keystone XL per unit of investment.

President Barack Obama and others have criticized the KXL pipeline for its meager promise of 50 to 100 longer- term jobs. In contrast, water infrastructure operation and maintenance in the five relevant states alone will create 137 times as many direct long-term jobs, and over 95 times more total long-term jobs, than Keystone XL.

Proponents of KXL maintain it will be built by private investment without public subsidy. But the oil refineries that will use KXL oil, along with the rest of the oil industry, receive large government subsidies. All of the infrastructure work described in this study can be financed just by closing three Federal tax loopholes for fossil fuel companies. Indeed, taking just one tax subsidy now received by the refineries that would use KXL oil and using it instead for water infrastructure would create as many jobs as the KXL pipeline.

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Introduction

In the coming months, President Obama will decide whether to approve the permit for the Keystone XL pipeline, designed to transport crude tar sands oil from Alberta to the Gulf of Mexico. While opponents of the pipeline argue it will greatly aggravate climate change, supporters tout its potential to create jobs in construction industries suffering from high unemployment.

In July, President Barack Obama weighed in on KXL job creation claims, explaining to the *New York Times* that

"Republicans have said this would be a big jobs generator. There is no evidence that is true. The most realistic estimates are this might create maybe 2,000 jobs during the construction of the pipeline, which might take a year or two, and then after that we're talking about somewhere between 50 and 100 jobs in an economy of 150 million working people."

While the President is correct in pointing out the negligible jobs impacts of KXL, the promise of several thousand temporary well-paying jobs for construction workers represents a glimmer of hope for those struggling in a dismal economy.

Replacement of aging wastewater, drinking water and gas distribution pipes creates 156% of the number of direct jobs created by Keystone XL per unit of investment.

Fortunately, the President does not have to choose between job creation and environmental protection. In fact, meeting our water and natural gas pipeline infrastructure needs in the present and near future will create many more jobs than Keystone XL, both in absolute terms and per unit of investment.[1] Rehabilitating, replacing, and upgrading our water and gas pipeline infrastructure along the proposed 5 state corridor of the KXL pipeline illustrates available alternatives to the KXL pipeline. All of this necessary water and gas infrastructure work can be financed just by closing three Federal tax loopholes for fossil fuel companies. And eliminating the tax loopholes that help subsidize the KXL pipeline could fund as many jobs as building the pipeline.

The purpose of this report is to help put the focus back where it belongs: how to put our skilled pipeline workers to work fixing our infrastructure crisis. To do so it focuses on the five states through which the KXL pipeline will go: Montana, South Dakota, Nebraska, Oklahoma, and Texas. Using available data on location of major water and gas line infrastructure in the five KXL states, it estimates the total amount of spending needed for their maintenance and repair. Then, using widely accepted employment multipliers, it estimates the number of direct, indirect, and induced jobs created per proposed dollar of expenditure—without requiring any expansion of our fossil fuel infrastructure.

[1] The methodology underlying the conclusions presented in this report are presented in the Appendix: Methodology.

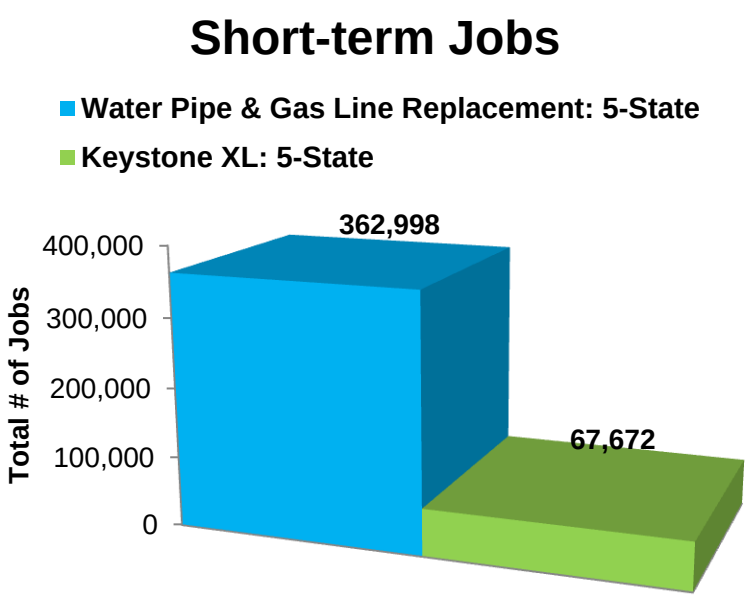
The results are straightforward and compelling: The data demonstrate the potential to create far more jobs for pipeline workers maintaining water lines that sustain homes and agricultural production and repairing gas lines that are leaking methane than will be created by the KXL pipeline. For example, meeting unmet water and gas infrastructure needs in the five relevant states will create:

- More than 300,000 total jobs across all sectors;
- Nearly five times more jobs, and better jobs, than KXL (see Figure 1 below);
- 156% of the number of direct jobs created by Keystone XL per unit of investment.

All of this necessary water and gas infrastructure work can be financed just by closing three Federal tax loopholes for fossil fuel companies.

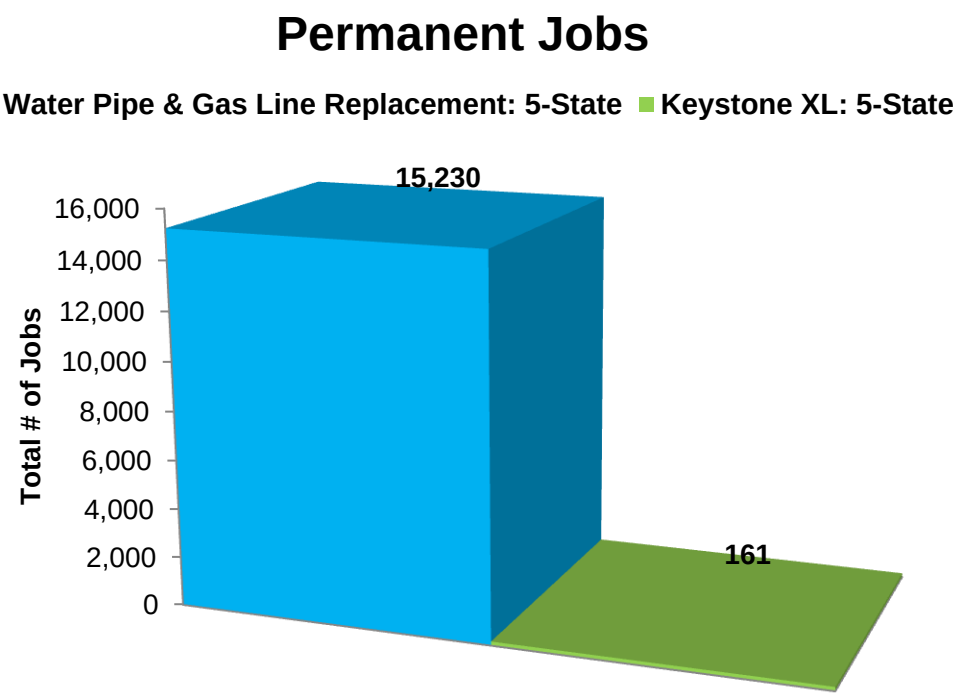
President Obama and others have criticized the KXL pipeline for its meager promise of 50 to 100 longer-term jobs. In contrast, water infrastructure operation and maintenance in the five relevant states alone will create 137 times as many direct long-term jobs, and 95 times more total long-term jobs, than Keystone XL, as shown in Figure 2 below. All of this necessary infrastructure work can be financed just by closing three Federal tax loopholes for fossil fuel companies.[2]

Figure 1. Total Short-term Job Creation: Keystone XL vs. Water and Gas Infrastructure



[2] Methodology for this section is presented in VI. How to Finance the Infrastructure Upgrade? Eliminate Fossil Fuel Tax Breaks A. National Fossil Fuel Tax Breaks in the Appendix.

Figure 2. Total Permanent Job Creation: Keystone XL vs. Water and Gas Infrastructure



America is facing an infrastructure crisis. Along the proposed five state KXL corridor alone, there exists over $16 billion in unmet water and gas infrastructure capital investment needs. Damage caused from leaking and unsafe gas pipelines poses a direct threat to local communities, costing these states more than $450 million between 1984-2013. And this crisis extends far beyond the pipeline route:

American Society of Civil Engineers (ASCE), in its latest Infrastructure Report Card, recently gave the country a D on drinking water and wastewater infrastructure, and a D+ on energy infrastructure.[3] Infrastructure failure is causing gas explosions and water main ruptures around the country.

Water infrastructure operation and maintenance will create 137 times as many direct long-term jobs as the KXL pipeline.

In other words, there is a lot of work that needs to be done. The movement for major investment in upgrading our national infrastructure holds the promise of significantly reducing the jobs deficit for American workers, particularly construction workers. A growing coalition is calling for major investment to return our infrastructure to a level of safety and efficiency. It includes powerful forces in American politics such as civil engineers, political leaders,

[3] American Society of Civil Engineers (2013), "2013 Report Card for America's Infrastructure." URL: http://www.infrastructurereportcard.org/

communities, businesses that produce and use water and gas, and unions.

But cutting across this gathering momentum has come a major distraction: the idea that the Keystone XL pipeline can provide a significant proportion of the jobs needed to address the issue of unemployment.[4] Many of the politicians who have touted the KXL pipeline as a source of jobs have opposed legislation to invest in job-creating infrastructure programs. Many organizations that have promoted the KXL pipeline, such as the US Chamber of Commerce, have also opposed infrastructure bills. The idea that KXL is somehow the way to solve our jobs problem, and that being pro-KXL should be a litmus test for being pro-job, has become a red herring, drawing attention away from effective job creation strategies such as needed infrastructure development to an illusory solution to our need for jobs.

If job creation is the primary goal then politicians should shift their focus from KXL to projects to repair existing pipeline infrastructure. It is time to move beyond political manipulation of the jobs issue to address the real needs of workers and communities.

A Note on Definitions:

The jobs numbers given throughout this report represent one worker employed for one year. So, for example, if we say a certain project will create 1,000 jobs, that may mean 1000 workers hired for one year each, or 100 workers hired for ten years each, or any other combination that adds up to 1,000 worker-years of employment.

Direct jobs refers to the number of jobs created to execute a project. *Indirect jobs* refers to the jobs created through supply purchases for the purpose of executing a project. *Induced jobs* refers to jobs created through consumption expenditures by the workers and managers at the firm executing the project and its suppliers. Together the three represent all the jobs created by a project.

[4] This idea is poorly founded and does not hold up to evidence. The State Department's initial study on the socioeconomic impact of Keystone XL concluded: "Unemployment rates in the proposed Project study area would probably not be affected in the long-term, although there could be a short-term lowering of unemployment during construction in the more rural areas" (Department of State 2011).

1 Pipeline infrastructure needs investment now.

In 2002, the EPA estimated that the country faced a 20-year capital needs gap of $122 billion for clean water, and $102 billion for drinking water. As a result, US water systems now suffer from stress—which only escalates as climate-drive droughts strain our nation's water infrastructure. For example, 1.2 trillions of gallons of water overflow our sewer systems every year, and many drinking water systems suffer 20% loss of water supply through leakage.

We estimate that in the five states affected by the proposed Keystone XL project, the capital needs gap is $7.7 billion for clean water and $9.1 billion for drinking water; the EPA operations and maintenance gap is $7.9 billion for clean water and $7.5 billion for drinking water. Adding these figures together, we find that there is *$32.2 billion* of unmet need for water infrastructure in the five relevant states. This estimate takes into account increased economic growth during the 2000s before the Great Recession.

The US system of natural gas pipelines is under threat due to aging pipes made of corrosion- and leak-prone materials such as iron (cast, wrought and ductile), and bare or unprotected steel. In 2011, US Secretary of Transportation Ray LaHood sounded a “Call to Action” to pipeline operators, regulators and industry stakeholders to develop plans to replace leak-prone pipeline infrastructure. Pipes made of cast, wrought and ductile iron, and bare steel, were all identified as needing replacement. In August 2011, the Pipeline and Hazardous Materials Safety Administration established new regulations requiring every local gas distributor to prepare a risk-based assessment and integrity maintenance plan for all gas distribution facilities.

2 Infrastructure upgrades needed in the KXL corridor will provide five times more jobs, and better jobs, than KXL.[5]

Essentially the same skills are required to build water, wastewater, and gas pipelines as the Keystone XL pipeline. But upgrading existing pipeline infrastructure will create a larger quantity of jobs, per dollar invested, than building and operating the KXL oil pipeline. And the amount of work needed for the upgrade dwarfs that needed for the KXL pipeline.

The total needed for pipeline infrastructure in the five KXL states is $18.123 billion.[6] These expenditures give rise to 151,806 total construction jobs, 185,185 direct jobs across all sectors and 362,998 total jobs across all sectors, Table 1. While the bulk of the construction jobs will be within-state, the indirect and induced jobs will be created all over the country.

[5] Methodology for this section is presented in IV. Total Project Estimate and Comparisons in the Appendix.
[6] For current and projected pipe replacement rates, see VII. Counterfactual: Aren’t These Pipes Being Replaced Already? in the Appendix.

Table 1. Project Comparisons: Expenditures and Job Creation Estimates

Project Alternatives	Expenditures (billions $)	Construction Jobs	Direct Jobs	Total Jobs
5-State Pipe Replacement	$18.1	151,806	185,185	362,998
3-State Pipe Replacement	$2.05	17,210	21,043	41,154
Keystone XL 5-State	$5.0	10,937	32,529	67,672
Keystone XL 3-State	$3.1	6,800	20,224	42,073

Job Creation Per $1 billion Invested	Expenditures (billions $)	Construction Jobs	Direct Jobs	Total Jobs
5-State Pipe Replacement	$1.0	8,376	10,218	20,029
Keystone XL	$1.0	1,232	6,523	13,572
Ratio of Job Creation Impacts from Infrastructure Alternative vs. Keystone		**6.8**	**1.56**	**1.47**

Extraordinary claims have been made for the number of jobs that will be created by the KXL pipeline. For example, KXL advocate U.S. Chamber of Commerce President Tom Donohue has stated that the Keystone XL pipeline would create 250,000 jobs.[7]

There are obstacles to evaluating objectively the number of jobs that will be created by the KXL pipeline. Most of the available information comes from the pipeline's builder, the TransCanada Corporation. The best currently available information comes from the State Department's Draft Supplemental Environmental Impact Statement. However, there are several warning signs of potential for bias in this document. It was prepared by a contractor, Environmental Resource Management, Inc., that is a dues-paying member of the American Petroleum Institute, a principal advocate for the KXL pipeline.[8] Its job estimates are based on information supplied TransCanada. The US EPA has evaluated the statement and rated it "E0-2"—"Environmental Objections - Insufficient Information."[9] Hence, the job creation estimates we are using for Keystone represent the most favorable plausible estimates of job creation from that project.

An additional problem in comparing pipeline infrastructure jobs and KXL jobs is that the State Department draft only examines the jobs created by the KXL segment that goes through Montana, South Dakota, and Nebraska, since that is the only part that requires State Department approval. The draft finds that the total cost of building the KXL pipeline through those states will be $3.1 billion. It estimates on that basis that the project will create 3,820 year-round, full-time equivalent direct construction jobs, 6,800 total construction jobs, and a total of 42,073 direct, indirect, and induced jobs across all sectors. Applying a

[7] http://thehill.com/blogs/e2-wire/e2-wire/204239-in-fight-over-keystone-pipeline-jobs-are-the-key-battleground
[8] http://www.api.org/policy-and-issues/policy-items/keystone-xl/keystone-xl-pipeline
[9] http://www.epa.gov/compliance/nepa/keystone-xl-project-epa-comment-letter-20130056.pdf

conventional job multiplier for civil and heavy construction of 6.5 jobs per $1 million of investment to the $3.1 billion cost of the project indicates that KXL work in these three states will create 20,225 direct jobs across all sectors nationwide.

In the three KXL states covered by the State Department draft, the infrastructure replacement work will require a $2.05 billion investment, which will produce 21,043 direct jobs, and 41,154 total jobs, across all sectors. These numbers are comparable to those created by Keystone XL nationwide. But since most of Keystone XL jobs will be created outside those three states, they dwarf the job creation figures for Keystone XL within the three states. In-state, Keystone XL will create only 4,373 direct jobs and 11,600 total jobs across all sectors. The infrastructure replacement will create 3.55 times as many total jobs as Keystone XL within the three corridor states.

Using the numbers from the State Department, we can approximate the total number of jobs created by the KXL project in all five states, including Oklahoma and Texas. To do this, we have to make two crucial assumptions: that the cost per mile, and number of jobs created per mile, are identical across states and segments. The segments of the KXL pipeline that go through Oklahoma and Texas are called the Gulf Coast segment and the Houston Lateral. The Gulf Coast segment is approximately 484 miles long and extends from Cushing, OK to Port Arthur, TX on the Gulf of Mexico. The Houston Lateral, which is 48.6 miles long, extends from just west of Port Arthur to the refineries in the Houston area.

Given the assumption of identical jobs created and cost per mile, the five-state Keystone XL pipeline project will cost approximately $5.0 billion and create a total of 67,672 jobs. Of these, 32,529 will be direct jobs, and 10,937 will be construction jobs. These job numbers are summarized in Table 1 above; the infrastructure replacement would create 5.4 times as many total jobs, 5.7 times as many direct jobs, and 13.9 times as many construction jobs as the five-state Keystone XL pipeline project.

These differences in job creation result in part because the infrastructure replacement represents a larger scale of investment and work. But they also result from the larger number of jobs created by the infrastructure work per unit of investment. For every $1 billion of investment, the infrastructure work produces 10,218 direct jobs. KXL, in comparison, creates only 6,523. Per unit of investment, the infrastructure replacements create 1.56 times as many direct jobs and 1.47 as many total jobs as KXL. (Since we assume that the number of jobs created per mile are identical across the three- and five-state Keystone pipeline projects, these numbers do not differ between those two projects in our analysis.)

KXL may produce even fewer jobs than these figures indicate. A study by Cornell University Global Labor Institute[10] raises important questions regarding the number and character of the jobs estimated in the State Department draft. It calculates that total job creation from KXL in the three northern states, across all sectors, nationwide, may be as few as 33,000. It indicates that the figures for KXL are not all new jobs because they include existing TransCanada contract employees. It calculates that only 10-15% of the KXL

[10] http://www.ilr.cornell.edu/globallaborinstitute/research/upload/GLI_KeystoneXL_012312_FIN.pdf
For summary see http://priceofoil.org/content/uploads/2011/09/CU_KeystoneXL_090711_FIN2.pdf

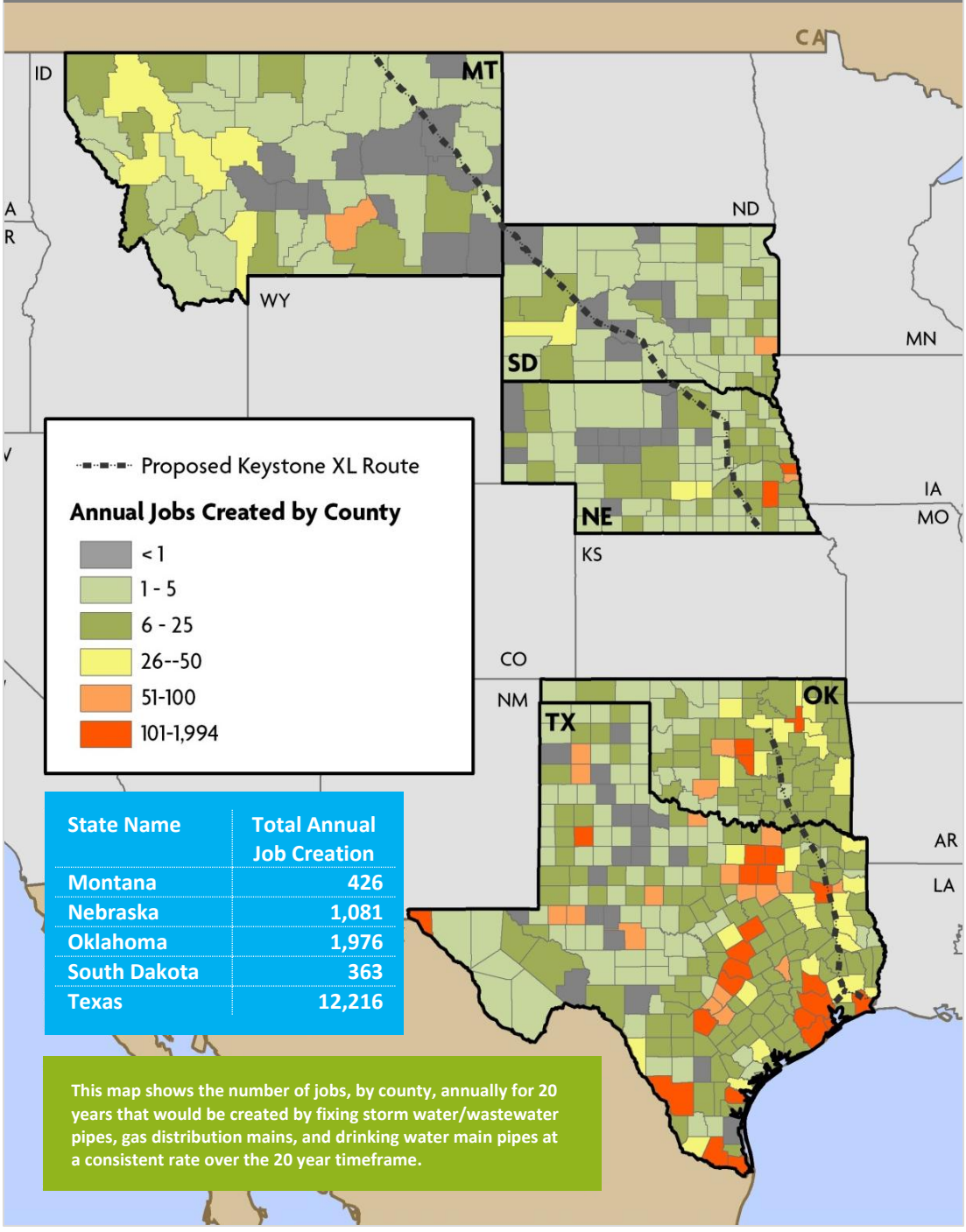
workforce will be hired locally. It argues that completion of the pipeline will lead to a rise in the price of gas in a 15-state Midwestern region, potentially leading to a loss of jobs. A similar pipeline owned by the same company produced 14 spills in the first year; similar spills from the KXL pipeline could contaminate rivers, drinking water, and the crucial Ogallala Aquifer, leading to severe health effects and job loss for farmers, ranchers, and tourist industry workers.[11] The production and burning of tar-sands oil will accelerate global warming, which is causing extreme weather and other forms of climate change that are already ravishing American communities, workplaces, and jobs. This provides further reason to believe that investing in necessary upgrades of existing water and gas pipelines could provide a far greater number of jobs than KXL.

Evidence also indicates that infrastructure work will produce a higher proportion of jobs in higher-paid industries like construction and manufacturing than KXL will.[12] For example, 43.43% of the jobs needed for water and wastewater infrastructure upgrading in the three KXL states covered by the State Department draft will be in construction and manufacturing.[13] In comparison, only 27.08% of total jobs created by KXL in the three states will be in construction and manufacturing. Conversely, only 15.32% of the jobs created by the water infrastructure projects are in the typically lower-paid service sector, whereas 32.3% of the KXL jobs – more than twice as high a proportion – are in the service sector.

[11] See also http://www.ilr.cornell.edu/globallaborinstitute/research/upload/GLI_Impact-of-Tar-Sands-Pipeline-Spills.pdf
[12] Methodology for this paragraph is presented in V. Job Composition in the Appendix.
[13] Comparable figures are not available for gas infrastructure updating.

Map 1

Total Annual Job Creation for Storm Water/Wastewater, Drinking Water and Gas Main Pipe Replacement



State Name	Total Annual Job Creation
Montana	426
Nebraska	1,081
Oklahoma	1,976
South Dakota	363
Texas	12,216

This map shows the number of jobs, by county, annually for 20 years that would be created by fixing storm water/wastewater pipes, gas distribution mains, and drinking water main pipes at a consistent rate over the 20 year timeframe.

3 Replacing failing wastewater pipe in five KXL states will create more than 100,000 jobs.[14]

According to the EPA, 7% of US wastewater pipes are beyond the end of their useful lives. So at the minimum an estimated 6,822 miles of sewer need replacement in the five states. The cost of doing so is $5.367 billion dollars. Each $1 million spent is estimated to produce nearly ten direct jobs and nearly ten additional indirect and induced jobs, (see Table 2).

Table 3 shows the results. Approximately 106,095 jobs would be created through wastewater pipe replacements in the five affected states alone. Of these total jobs, approximately 53,458 would be direct jobs, i.e. workers directly hired to replace the pipes. If the work was spread evenly over twenty years, it would create 2,673 direct jobs and 5,305 total jobs for the entire twenty-year period.

Table 2. Jobs Created per $1 Million Invested: Water Infrastructure Replacement

Direct Jobs	Indirect + induced Jobs	Total Jobs
9.96	9.81	19.77

Table 3. Estimated Expenditures and Jobs Created from Wastewater Pipe Replacement

State	Replacement Expenditures (millions $)	Direct Jobs	Direct + Induced Jobs	Total Jobs
Montana	$160.7	1,601	1,576	3,177
South Dakota	$133.2	1,327	1,307	2,634
Nebraska	$296.7	2,955	2,910	5,865
Oklahoma	$610.0	6,075	5,982	12,057
Texas	$4,166.7	41,500	40,862	82,362
Total	**$5,367.3**	**53,458**	**52,637**	**106,095**

[14] Methodology for this section is presented in I Wastewater Pipe Replacements in the Appendix.

4 Replacing failing drinking water mains in five KXL states will create 177,000 jobs.[15]

According to the American Society of Civil Engineers, "much of our drinking water infrastructure is nearing the end of its useful life." According to the EPA, annual replacement of the drinking water transmission and distribution lines in the US will need to rise from .5% of the total pipe mileage today to 2% in 2036.

In the five KXL states, that means 29,296 miles of drinking water mains will have to be replaced between now and 2033, at a cost of $8.987 billion, (see Table 4). That will create 89,511 direct jobs and 177,646 total jobs over the twenty year period (using the estimates from Table 2). If the work is spread evenly over those twenty years, it will create 4,476 direct jobs, and 8,882 total jobs, over the entire twenty years.

Table 4. Estimated Expenditures and Jobs Created from Drinking Water Main Replacement

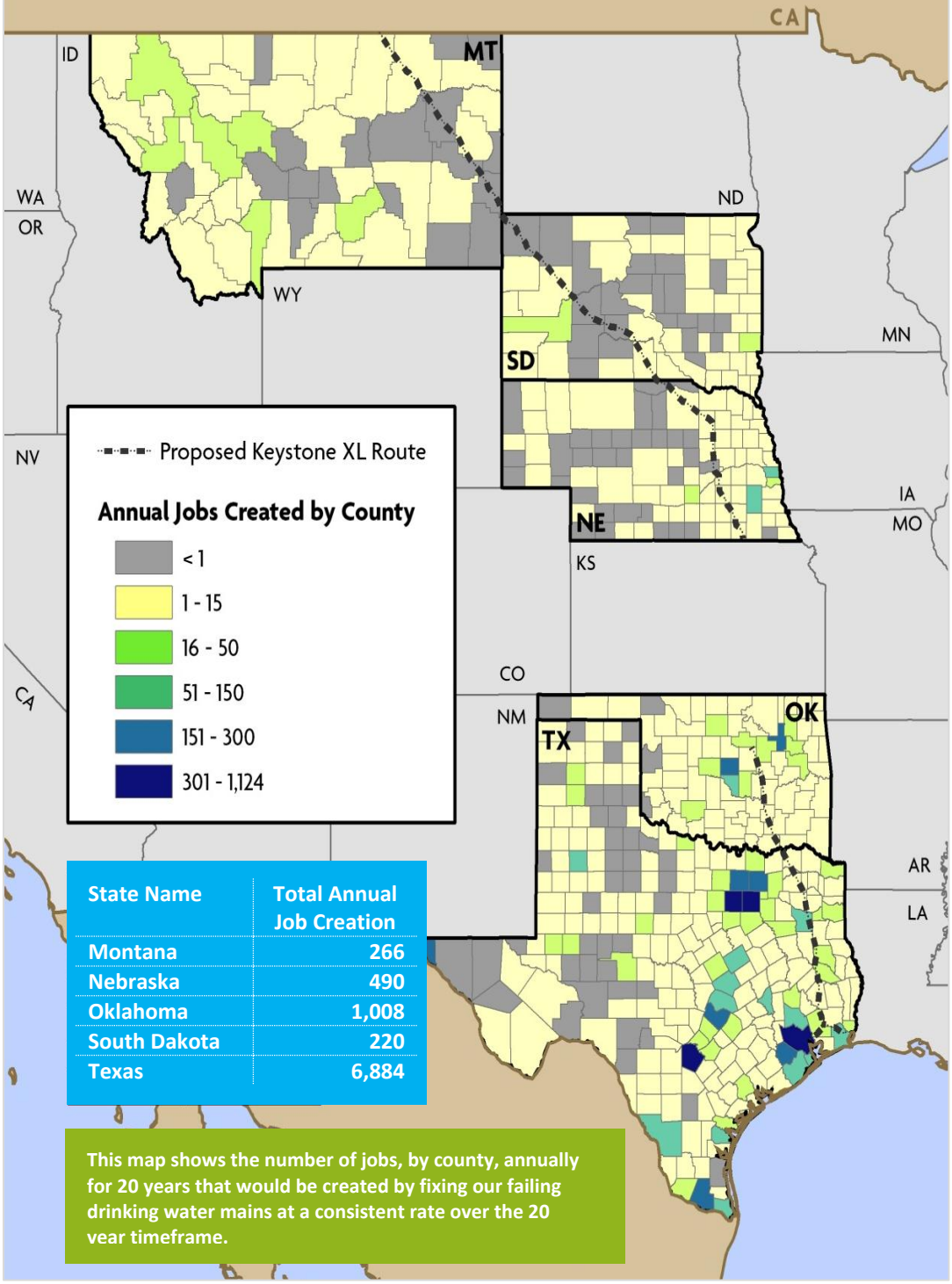
State	Replacement Expenditures 2013-2033* (millions $)	Direct Jobs	Direct + Induced Jobs	Total Jobs
Montana	$269.1	2,680	2,639	5,319
South Dakota	$223.1	2,222	2,188	4,410
Nebraska	$496.8	4,948	4,872	9,820
Oklahoma	$1,021.3	10,172	10,016	20,188
Texas	$6,976.7	69,488	68,420	137,908
Total	**$8,987.0**	**89,510**	**88,135**	**177,646**

** Based on an estimated cost $58 per foot of replacement and an estimated cost of $306,768 per mile.*

[15] Methodology for this section is presented in II Drinking Water in the Appendix.

Map 2

Annual Job Creation for Drinking Water Main Pipe Replacement



State Name	Total Annual Job Creation
Montana	266
Nebraska	490
Oklahoma	1,008
South Dakota	220
Texas	6,884

This map shows the number of jobs, by county, annually for 20 years that would be created by fixing our failing drinking water mains at a consistent rate over the 20 year timeframe.

5 Replacing failing gas distribution lines in five KXL states will create more than 37,000 jobs.[16]

The country's extensive system of natural gas pipelines is under threat due to aging pipes made of corrosion- and leak-prone materials such as iron (cast, wrought and ductile), and bare or unprotected steel. In 2011, US Secretary of Transportation Ray LaHood sounded a "Call to Action" to pipeline operators, regulators and industry stakeholders to develop plans to replace leak-prone pipeline infrastructure. Pipes made of cast, wrought and ductile iron, and bare steel, were all identified as needing replacement. In August 2011, the Pipeline and Hazardous Materials Safety Administration established new regulations requiring every local gas distributor to prepare a risk-based assessment and integrity maintenance plan for all gas distribution facilities.

In the five KXL states, 7.14% of gas mains are made of leak-prone iron and unprotected steel. Those 10,224 miles of pipe need to need to be replaced. The cost of replacing them will be $1,727,658,676.80. In addition, 3,008 miles of bare steel services must be replaced in these five states. These service line replacements will cost $508,297,786 in total. Gas line replacement is estimated to produce 12.05 direct jobs and 9.84 indirect and induced jobs for each million dollars invested, see Table 5. So the investment will produce 26,921 direct jobs and approximately 48,905 total jobs, see Table 6. If the work is spread evenly over twenty years, the result will be 1,346 direct jobs, and 1,099 indirect and induced jobs, for every year of the twenty-year period.

Table 5. Jobs Created per $1 Million Invested: Gas Main Replacement

Direct Jobs	Indirect + induced Jobs	Total Jobs
12.05	9.84	21.89

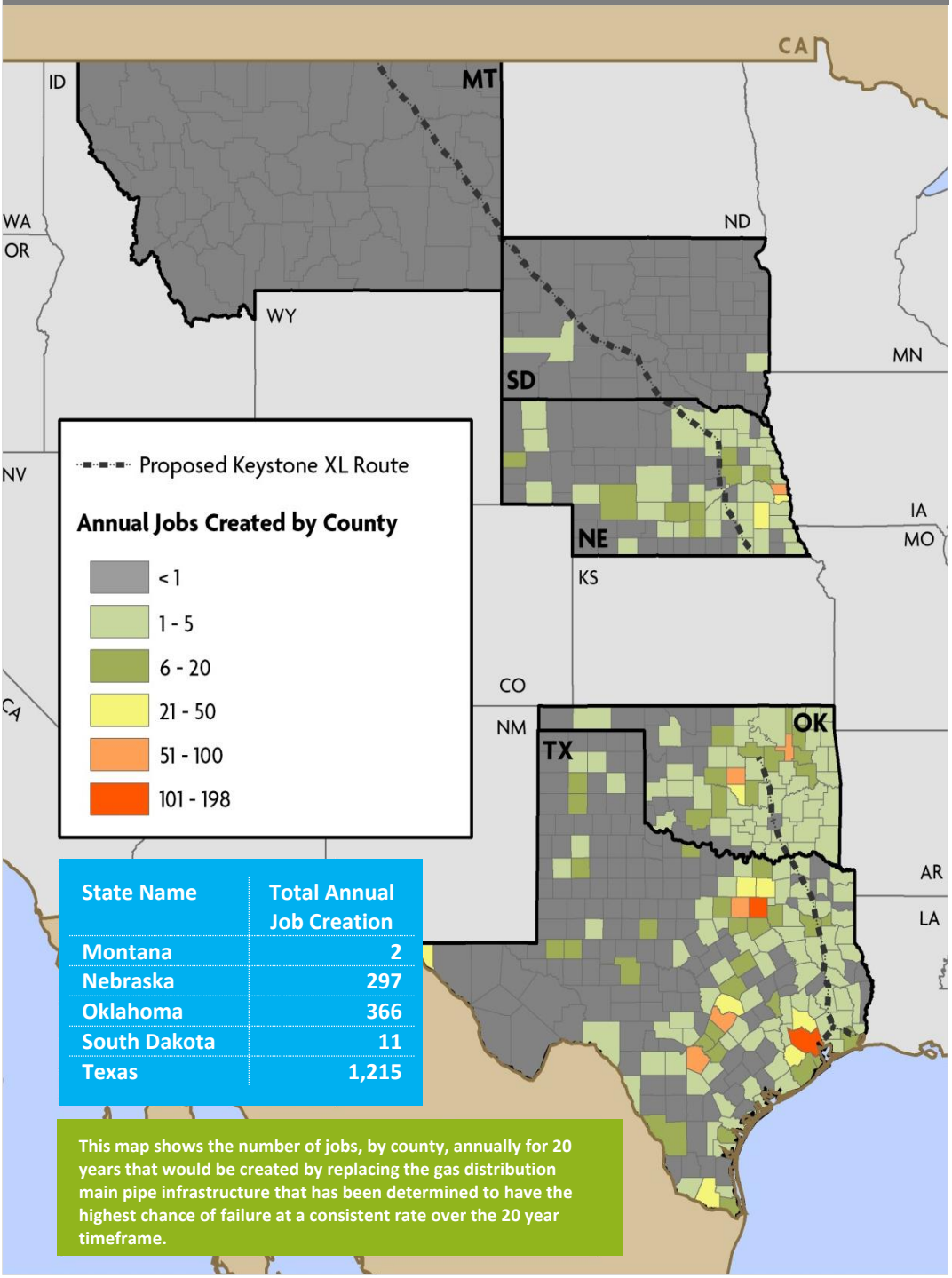
Table 6. Estimated Expenditures and Jobs Created From Gas Distribution Line Replacement

State	Total Cost of Replacement (millions $)	Direct Jobs Created	Total Jobs Created
Montana	$3.1	38	68
South Dakota	$14.8	178	323
Nebraska	$281.5	3,392	6,161
Oklahoma	$453.4	5,464	9,925
Texas	$1,481.3	17,850	32,426
Total	**$2,234.1**	**26,921**	**48,905**

[16] Methodology for this section is presented in III Gas Distribution Main Replacement in the Appendix.

Map 3

Annual Job Creation for Gas Distribution Main Pipe Replacement

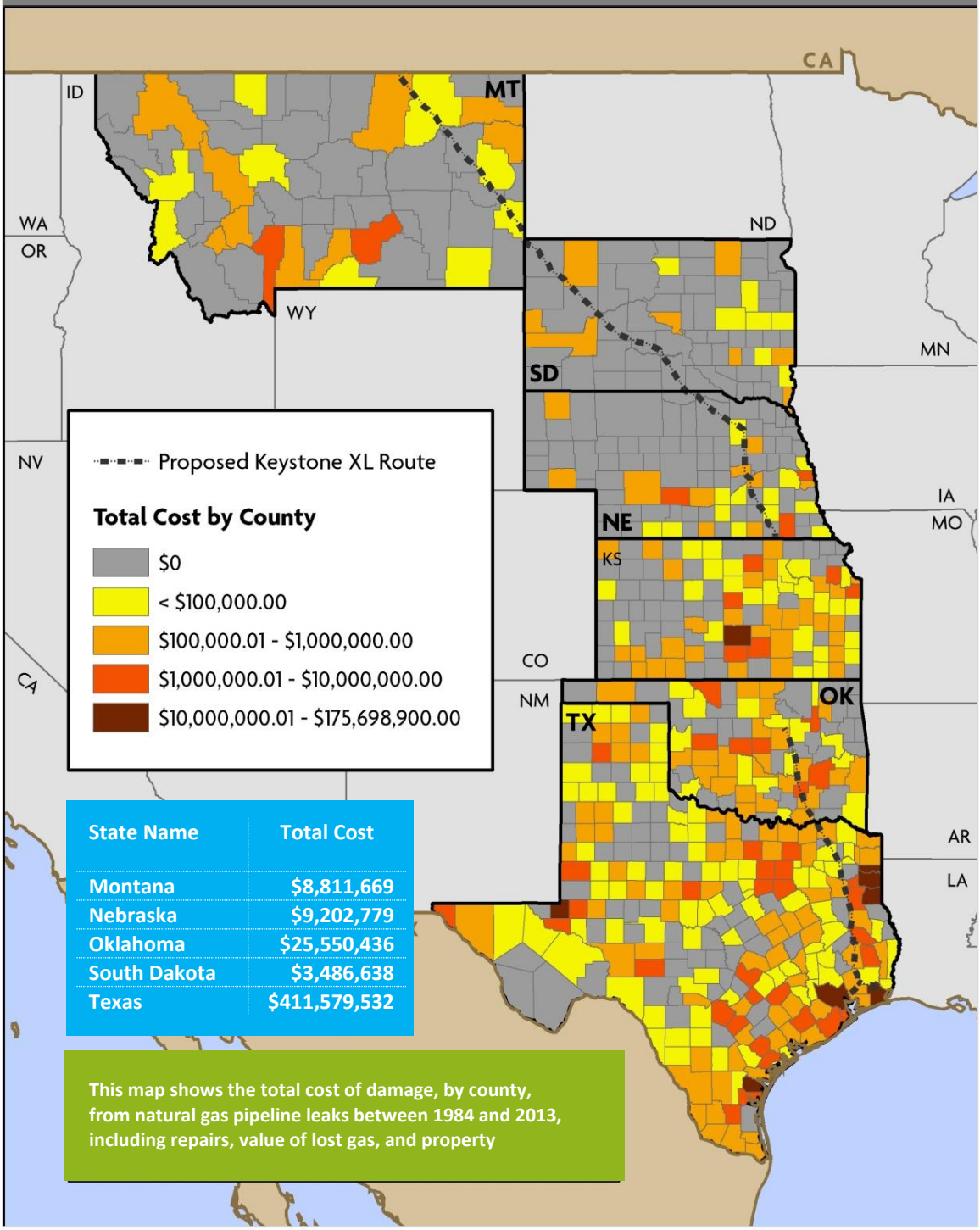


State Name	Total Annual Job Creation
Montana	2
Nebraska	297
Oklahoma	366
South Dakota	11
Texas	1,215

This map shows the number of jobs, by county, annually for 20 years that would be created by replacing the gas distribution main pipe infrastructure that has been determined to have the highest chance of failure at a consistent rate over the 20 year timeframe.

Map 4

Total Cost of Gas Incidents, 1984-2013



State Name	Total Cost
Montana	$8,811,669
Nebraska	$9,202,779
Oklahoma	$25,550,436
South Dakota	$3,486,638
Texas	$411,579,532

This map shows the total cost of damage, by county, from natural gas pipeline leaks between 1984 and 2013, including repairs, value of lost gas, and property

6 Maintaining water infrastructure will create 137 times as many direct long-term jobs as the KXL pipeline.

President Obama noted that the Keystone XL project would only create 50-100 permanent jobs. That's a good estimate; the State Department cites a permanent *direct* job creation figure of 35, which would lead to about 70-75 *total* jobs per year through multiplier effects. Could infrastructure investments create more permanent jobs than this? Absolutely – making needed water infrastructure investments could create many, many more permanent jobs.

Permanent jobs in the area of water infrastructure will be created in the areas of operations and maintenance (O&M). Estimating the amount of money needed to fill the gap between projected needs and spending on O&M will give us an estimate of the number of jobs that can be created in these areas. Based on EPA estimates of the O&M investment gap, and adjusting for recent economic growth, we estimate that the total annual O&M investment gap is $22.95/person/year.[17] That works out to $770 million per year in the five relevant states – which would create 7,673 direct jobs per year and 15,230 total jobs per year. That's 152 times the *maximum* number of total permanent jobs created by Keystone XL (15,230 / 100). It's also 219 times the number of direct permanent jobs estimated by the State Department (7,673 / 35). Yes, you read that right – *219 times*.

Extending our estimates of permanent job creation from Keystone XL to include the already in-progress Gulf Coast and Houston Lateral sections of the pipeline would not change this result very much. Assuming the same number of permanent jobs per mile in the Gulf Coast section as in the northern section, a total of 56 direct jobs and 161 permanent jobs would be created. Filling the O&M investment gap, then, would create "only" 95 times (15,230 / 161) the number of total jobs as the full five-state Keystone XL pipeline would, and 137 times the number of direct jobs (7,673 / 56).

7 The necessary work can be financed just by closing three Federal tax loopholes for fossil fuel companies.[18]

While replacing the natural gas pipelines is a responsibility of the private sector, wastewater and drinking water piping is primarily the responsibility of government. Storm water and waste water pipe replacement will cost $5.367 billion for the 5 states. In an era of constrained public budgets, where can the money come from?

[17] For details, please consult Section VI.A of Appendix: Methodology.
[18] Methodology for this section is presented in VI. How to Finance the Infrastructure Upgrade? Eliminate Fossil Fuel Tax Breaks A. National Fossil Fuel Tax Breaks in the Appendix.

One obvious source of funding is to eliminate the subsidies that the public provides to fossil fuels in the form of tax loopholes. These subsidies are enormous – the International Monetary Fund estimates them at nearly two trillion dollars worldwide and more than half-a-trillion dollars for the US alone, when accounting for indirect costs incurred due to carbon pollution and other emissions from fossil fuel burning. Leaving all such pollution costs aside, a report for the Brookings Institution estimates the *direct annual fiscal cost* of fossil fuel tax loopholes at $4.14 billion. Just three of them cost US taxpayers $3.7 billion per year - year after year, see Table 7.

Table 7. Top Three Fossil Fuel Tax Loopholes*

	Tax Provision	Annual Revenue Foregone (billions $)
1.	Expensing intangible drilling costs	$1.4
2.	Domestic manufacturing tax deduction for oil and gas	$1.2
3.	Percentage depletion for oil and gas wells	$1.2
	TOTAL	**$3.7**

** Sourced from Aldy (2013).*

Thus, the entire $5.367 billion cost of meeting the 20-year wastewater infrastructure needs in the KXL corridor states could be paid for by less than two years of the revenue stream that would result from closing these three loopholes. As we have seen, that investment will create more jobs than the Keystone XL pipeline.

8 Eliminating the tax loopholes that help subsidize the KXL pipeline could fund as many jobs as building the pipeline.[19]

It is often maintained that the KXL pipeline is will be paid for by private companies, and that therefore, unlike public investment, it will not increase taxes or government borrowing. According to Senator Minority Leader Mitch McConnell, for example, the KXL pipeline "doesn't require a penny of our tax money."[20]

[19] Methodology for this section is presented in VI. How to Finance the Infrastructure Upgrade? Eliminate Fossil Fuel Tax Breaks B. Closing the Keystone XL Loopholes in the Appendix.

[20] http://www.humanevents.com/2012/02/06/mcconnell-keystone-pipeline-unlikely-to-pass-until-obama-is-voted-out/

However, buried in the depths of the US tax code is a provision that provides a significant subsidy to three oil refineries that will process tar sands imported through the KXL pipeline. The three refineries are investing $10 billion in the process, but their investment is subject to special depreciation provisions that allow 55% of the investment to be counted as a business expense for tax purposes in the first year of operation. This contrasts with normal accounting rules, which, assuming a typical 20-year life of the asset, allow only 2.5% of the investment to be treated as a business expense each year. These tax breaks are worth between $1 billion and $1.8 billion to the companies that receive them.

If $1.0-$1.8 billion were invested in water infrastructure projects, it would create between 9,960 and 17,928 direct jobs, and between 19,767 and 35,581 total jobs, (see Table 8). It would also create between 4,283 and 7,709 direct jobs in the construction and manufacturing industries alone.

Table 8. Annual Job Creation from Investing Value of KXL-Related Subsidy Into Water Infrastructure

Subsidy Value (billions $)	Construction & Manufacturing	Direct Jobs	Total Jobs
$1.0	8,585	9,960	19,767
$1.4	12,019	13,944	27,674
$1.8	15,453	17,928	35,581
Keystone XL5-State (Annual)	9,163	16,265	33,836
Keystone XL-3 State (Annual)	5,697	10,112	21,037

In short, investing the value of KXL-related tax subsidies in water infrastructure could create as many or more jobs over a one-year timeframe than the KXL project itself.

Conclusion:

Given a still-weak economy and high unemployment rate, resources for campaigning for job creation projects are scarce. These resources should be spent advocating projects, programs and policies that create real long-term and short-term benefits to the American economy in the form of family-supporting jobs, increased incomes and a clean environment. KXL is not one of those projects; a comprehensive national infrastructure upgrade is.

There is a growing chorus of voices throughout the United States academic, government, and professional communities that is advocating for such an upgrade. Examples include professional associations such as the American Society of Civil Engineers and American Water Works Association, academic institutes such as the Political Economy Research Institute at the University of Massachusetts, think tanks such as the Center for American Progress, and government departments and agencies such as the EPA, the Department of Transportation, and the Treasury.

The Department of the Treasury for example, recently wrote an analysis supporting the President's proposal for a national Infrastructure Bank on economic grounds.[21] This analysis proposed the renewal of Great Recession financing instruments, such as Build America Bonds, to facilitate private sector investment into public infrastructure projects. Build America Bonds have been endorsed by a wide array of political and industry groups including the U.S. Conference of Mayors, the Council of State Governments, and the Securities Industry and Financial Markets Association (SIFMA) as "improving efficiency, liquidity and transparency for borrowers and investors alike."[22] This kind of financial instrument can and should also be endorsed by labor unions and sustainability advocates as an important means of creating family-supporting jobs in clean industries.

21 http://www.treasury.gov/resource-center/economic-policy/Documents/20120323InfrastructureReport.pdf
22 Ibid, p.27.

KXL: Why the fuss?

Under the forest in northern Alberta, Canada lie the world's largest deposits of so-called "tar sands," sand mixed with thick, tar-like oil. To produce one barrel of heavy crude oil from tar sands requires strip mining the forest, extracting four tons of earth, contaminating two to four barrels of fresh water, burning large amounts of natural gas, and creating vast holding ponds of toxic sludge. Production of this oil is increasing and a growing amount of it is already being shipped to the US.

The proposed Keystone XL pipeline will be a 36-inch crude oil pipeline stretching nearly 2,000 miles from Hardisty, Alberta through Saskatchewan, Montana, South Dakota, Nebraska, Kansas, and Oklahoma to terminals at Nederland, Texas on the Gulf of Mexico. Tar sands oil will be heated to more than 150 degrees and pumped through it at high pressure. It is designed to carry more than eight hundred thousand barrels per day of crude oil extracted from oil sands to refineries in the US.

The Keystone XL pipeline is a key link in an energy path that will greatly aggravate climate change caused by the emission of carbon and other "greenhouse gasses" into the atmosphere. Despite claims that it is a myth, there is a near-total consensus among climate scientists that global warming is real and that it will cause increasingly devastating climate change. That means rising sea levels, an ever-increasing number of extreme weather events like droughts, floods, and heat waves, and consequences like forest fires and species extinction.

Scientists calculate that the safe level for carbon in the atmosphere is 350 parts per million or less. But we are already significantly over that level — which is why we are already facing devastating climate change. Only by drastically limiting our carbon emissions can we limit still greater devastation.

Why is a single pipeline — the Keystone XL — so important to this story? Because it is the key link in an energy strategy that will radically escalate carbon emissions still further. The energy strategy is to introduce large quantities of oil from Canadian tar sands. According to the US Department of Environmental Protection, the greenhouse gas emissions from Canadian oil sands crude oil will be more than 80% greater than oil refined in the US. Independent estimates run up to three times more global warming pollution than conventional oil.

Once the Keystone XL is in place, a wide area of the US will become dependent on oil from Canadian tar sands. With no available alternative, pressure will grow to import more and more of it. Even more dangerous, the pipeline will lock in dependence on fossil fuels for decades to come and remove the pressure to convert to renewable alternatives.

The Alberta tar sands are estimated to contain enough carbon to raise carbon emissions in the atmosphere by 200 parts per million. That would increase the current level of greenhouse gasses in the atmosphere by more than half. It would be more than enough to create more climate change than in the entire history of humanity on earth. It would also render pointless all other efforts to reduce greenhouse gas emissions. As leading climate scientist James Hanson put it, "If the tar sands are thrown into the mix, it is essentially game over. There is no practical way to capture the CO2 while burning oil." We "cannot get back to a safe CO2 level" if "unconventional fossil fuels, like tar sands are exploited."

There are other problems with the project. Tar sands extraction is already devastating native lands in Alberta. Other recently built pipelines are already leaking and spilling large quantities of oil into the US environment. The pipeline threatens the aquifer that is critical for Midwestern agriculture and drinking water. The tar sand oil carry some of the deadliest chemicals, including nickel, vanadium, lead, chromium, mercury, arsenic, selenium, and benzene.

Appendix: Methodology

Water and Gas Pipeline Infrastructure: An Economically Viable Job Creation Alternative to Keystone XL--Explanation of Methodology

Summary of Results

The Keystone XL pipeline has been justified in terms of its potential to create jobs in construction industries suffering from high unemployment, such as construction (13.9% in 2012).[23] However, there are many other ways to create such jobs. Rehabilitating, replacing and upgrading our water and gas pipeline infrastructure, areas in which the United States has lagged in recent years, is one of the best alternatives to the Keystone XL pipeline. President Obama, in his recent interview with the New York Times, stated, "When we know that rebuilding our infrastructure right now would put people back to work and it's never been cheaper for us to do so, and this is all deferred maintenance that we're going to have to do at some point anyway, I worry that we're not moving faster to seize the moment."[24] In fact, he's right. Meeting our water and natural gas pipeline infrastructure needs in the present and near future will create many more jobs than Keystone XL, both in absolute terms and per unit of investment, in similar industrial sectors.

We estimated the total replacement needs for wastewater pipe, drinking water main pipe, and natural gas distribution pipe for the three northern states and five total states directly and significantly affected by Keystone XL, as well as the nation as a whole. The three northern states are Montana, South Dakota and Nebraska. The five total states are Montana, South Dakota, Nebraska, Oklahoma and Texas. Kansas is also affected by Keystone XL, but the additional investment is limited to two pump stations (SEIS 2013) with no additional pipeline constructed.

Our central conclusion: while Keystone XL will create a non-negligible number of jobs in the short run, in the long run it will have virtually no effect. By contrast, an upgrade of water and gas infrastructure in the five states of Montana, South Dakota, Nebraska, Oklahoma and Texas will create benefits in both the short and the long run. An upgrade in the three northern states of Montana, South Dakota and Nebraska will create a smaller, but still significant, benefit. Further, while Keystone XL will endanger the natural environment significantly, upgrading water and gas infrastructure will improve it. We summarize our main findings below.

[23] Data on unemployment by industry are available from BLS: http://data.bls.gov/timeseries/LNU04032231
[24] "Interview with President Obama," *New York Times,* July 27, 2013. URL: http://www.nytimes.com/2013/07/28/us/politics/interview-with-president-obama.html?ref=politics&pagewanted=all

Using publicly available data and making a few heuristic assumptions, we found that making all necessary replacements to the wastewater / sewer, drinking water main, and natural gas distribution pipes in the three northern states alone would create a comparable number of direct and total jobs, but **2.5 times the number of total construction industry jobs** (17,210 vs. 6,800), than the Keystone XL pipeline, for a lower total cost ($2.05 billion vs. $3.1 billion). Replacing the corresponding pipes in the five total states would create many more direct, total and construction industry jobs than Keystone XL, for a larger project cost. Specifically, the 5-state infrastructure replacement project would cost $18.1 billion, 5.85 times larger than Keystone XL; it would create 9.2 times as many direct jobs (185,185 vs. 20,224), 8.63 times as many total jobs (362,998 vs. 42,073), and **22 times as many total construction industry jobs** as Keystone XL (151,806 vs 6,800). If we scale up the Keystone XL 3-state estimates to reflect the mileage of the full 5-state pipeline, these comparisons become 5.7, 5.4, and 13.9 respectively.

Pursuing the replacement of wastewater, drinking water and gas distribution pipelines on the national level would create a much larger volume of expenditure and jobs, almost two orders of magnitude larger than the 5-state project. Specifically, a comprehensive national water and gas distribution pipe replacement project would create **3,925,233 total jobs, a figure 93 times greater** than the Keystone XL project. It would create **2,001,041 direct jobs, a figure 99 times greater** than the Keystone XL project. And it would create **1,641,532 construction jobs, 241 times more** than the Keystone XL project. (When the mileage of Keystone XL is scaled up from three to five states, the relevant comparisons become 61.5, 58 and 150 respectively.) Were this project to unfold over 20 years, it would create 100,052 direct and 196,262 total jobs per year, 6.2 times and 5.8 times the annual job creation figures of the 2-year Keystone XL 5-state project. It would also create 75,433 construction jobs per year, 13.8 times the corresponding Keystone XL figure.

These outsized comparisons stem from the fact that not only is the water and gas infrastructure replacement need nationally and in the five Keystone XL corridor states considerably larger than the Keystone XL pipeline construction project, but its major component – water infrastructure – creates construction jobs at a rate over two and one-half times that of the Keystone pipeline for a given size project: 41.82% of water infrastructure project jobs (Clean Water Council 2009), versus 16.15% of the projected Keystone XL jobs (Department of State 2013b), are created in the construction industry.

As shown above, if we consider the annual and total job creation figures for the comprehensive national pipe replacement project, both the short and long run are much more favorable than Keystone XL. However, whether the 5-state and three-state projects create more jobs per year than Keystone XL depends on the timeframe and the type of job created.

The Keystone XL pipeline building project only lasts two years, after which the number of permanent jobs created becomes negligible, about 35 full-time operations workers (Department of State 2013a, p.10). The timeframe for infrastructure replacement is dependent on a variety of factors, including project scheduling and financing. Adopting the 20-year timeframe that the EPA uses to compute infrastructure needs, we find that the 5-state infrastructure replacement project creates **twice as many construction jobs per year, for 20 years,** than the 2-year Keystone XL project (6,962 vs. 3,400). However, the direct annual jobs figures for

the 5-state project are somewhat lower (9,259 vs. 10,112), as are the total annual jobs figures (18,150 vs. 21,037). There appears to be a mild tradeoff, in this case, between the short run and the long run. A much greater number of jobs can be created in the long run by investing in infrastructure replacement than could be created in the short run by building Keystone XL; however, these jobs will be created somewhat more slowly (by approximately 8.5% on an annual basis).

The 20-year pipe replacement project in the three northern states alone creates 1.6 times as many construction jobs per year as does the portion of Keystone XL's construction labor hired within those states only (776 vs. 477). It does not, however, compare favorably on an annual basis to Keystone XL in terms of direct jobs in all sectors, even when we limit ourselves to counting only those direct jobs associated with Keystone XL that were hired within those three states (1,052 vs. 2,187). Nor do the corresponding figures for total jobs in all sectors (2,058 vs. 5,800) make a favorable comparison. In the case of jobs across all sectors, we are once again dealing with a trade-off of short run versus long run.

However, the picture becomes more favorable if we move beyond the question of pipe replacement exclusively, and address the broader issue of the large and growing gap between water infrastructure needs and current investment spending (EPA 2002). In Section VII of this Appendix, we estimate the job creation impact of filling the capital investment and operations and maintenance (O&M) gaps for all drinking water and wastewater infrastructure, including treatment plants, sewers, stormwater management facilities, and regular inspection and maintenance in addition to pipes. We combine these figures with our estimate of the replacement gap for natural gas distribution infrastructure, in the five Keystone XL-related states creates **over 1.5 times the number of direct and total jobs per year** than does Keystone XL itself. Filling the water infrastructure gap and estimated natural gas distribution infrastructure gap in the five states creates a total of **16,559 direct and 32,775 total *additional* jobs per year** – jobs that are not already being created by the current pattern of investment. This job creation total across the five states amounts to 1.6 times the number of direct and total jobs as Keystone XL in the three northern states, and approximately the same number of jobs as created by Keystone XL in the five states.

I. Introduction and Context

This report is written to underscore an important decision soon to be made on the part of the U.S. government: whether or not to approve the Keystone XL oil pipeline. Building this pipeline entails major environmental risks. If approved, the pipeline will run through rural areas of the northern U.S. plains, including Montana, South Dakota and Nebraska. If spills occur along this route, they will directly damage agriculture, ranching and outdoor recreation, and endanger the health of important species habitats and vital underground aquifers. Beyond those local environmental risks are the global risks of continuing to emit carbon dioxide into the atmosphere, worsening global climate change. The environmental risks of the Keystone XL pipeline are well-known and will not be analyzed in depth here. Rather, the economic alternatives will be presented and compared to the projected economic impact of the pipeline. We believe

(LNS and Ecotrust) that water and gas infrastructure upgrading and replacement represents a more sensible economic option, both in the short and the long run, than building Keystone XL.

The United States is due for a major upgrade of its existing gas and water pipeline infrastructure. The American Society of Civil Engineers (ASCE), in its latest Infrastructure Report Card, recently gave the country a D on drinking water and wastewater infrastructure, and a D+ on energy infrastructure; the country's GPA as a whole was a dismal D+.[25] These alarming evaluations are not unfounded. The EPA estimated in 2002 that the country faced a 20-year capital needs gap of $122 billion for clean water, and $102 billion for drinking water. This gap means that there is $122 billion in unmet need for capital investment in clean water: an additional $122 billion that should be invested in clean water, but isn't.

With regard to energy infrastructure, the country's extensive system of natural gas pipelines is under threat due to aging pipes made of corrosion- and leak-prone materials such as iron (cast, wrought and ductile), and bare or unprotected steel. In 2011, US Secretary of Transportation Ray LaHood sounded a "Call to Action" to pipeline operators, regulators and industry stakeholders to develop plans to replace leak-prone pipeline infrastructure (PHMSA 2013, Yardley and Associates 2012). Pipes made of cast, wrought and ductile iron, and bare steel, were all identified as needing replacement. In August 2011, the Pipeline and Hazardous Materials Safety Administration (PHMSA) established new regulations requiring every local gas distributor to prepare a risk-based assessment and integrity maintenance plan for all gas distribution facilities (Yardley and Associates 2012).

Proponents of the Keystone XL oil pipeline defend the project on the grounds of increased job creation and economic activity. But would much-needed upgrades to water and gas infrastructure provide a larger quantity of jobs and total economic activity than Keystone XL? The data presented in this report demonstrates that, in fact, they would.

The benefits of infrastructure investment are well-documented. Short-run analyses, such as those undertaken by the Clean Water Council (2009), indicate that $1 billion invested in drinking water, wastewater or stormwater infrastructure will create between $2.87 - $3.46 billion in output nationally, and a somewhat smaller but still significant effect on the state level: $1.8 - $2.5 billion in California, for example. An investment of this size will create a total of 20,003 – 26,669 jobs nationally, and a smaller but still significant number of in-state jobs (12,390 – 19,574 in California); it will also create $1.011 - $1.062 billion in personal income, at an average wage rate of $50,396, and $82.4 million in state and local taxes. The job multiplier is large as well: Bureau of Economic Analysis (2008) estimates that one job created in the water and sewer industry gives rise to 3.68 total jobs in all sectors of the economy.

Long-run analyses provide even more favorable results: one recent study (Krop *et al* 2008) estimates that $1 in water and sewer infrastructure will increase private output (GDP) by $6.35 in the long run; in other words, an investment of $1 billion would thereby induce a total of $6.35 billion in output nationally in the long run.

[25] American Society of Civil Engineers (2013), "2013 Report Card for America's Infrastructure." URL: http://www.infrastructurereportcard.org/

This Appendix outlines the methodology by which we can compare the job creation potential of Keystone XL with that of necessary upgrades to existing water and natural gas pipeline infrastructure in the states directly and significantly affected by Keystone XL as well as the nation as a whole. Upgrading existing pipelines will create a larger quantity of jobs, per dollar invested, than building and operating the Keystone XL oil pipeline. And the magnitude of expenditures needed for the upgrade dwarfs the size of the Keystone XL project. After reading this report, it will be clear that investing in necessary upgrades of existing water and gas pipelines could provide us with a far greater number of jobs than Keystone XL.

I will explain the methodology for estimating job creation in three pieces. First, I will explain how I derived the estimates of job creation for wastewater pipe replacements. Second and third, I will provide the same explanation for drinking water and gas distribution main pipe replacements, respectively. I explain each of these infrastructure types separately since each relies on different sources to generate the estimates.

II. Wastewater Pipe Replacements

In this section, I focus on publicly owned wastewater facilities only, since data on private water systems is difficult to find and aggregate. EPA (2002) reports that the best estimate of the national average for wastewater pipe needs are 21 feet per capita, 73% of the U.S. population is served by public wastewater systems, and 7% of wastewater pipes are beyond the end of their useful lives as of 2000.[26] The percentage of life-elapsed pipe is expected to rise to 9% by 2020. I report the results of the two estimates of necessary pipe replacements alongside each other in Table 1. Combining those estimates with population figures from the 2010 Census, I derive a rough estimate of the number of miles of wastewater pipe needing replacement in the states affected by Keystone XL.[27]

In the analysis that follows, I will report estimates of pipe replacement needs for the three states that comprise the northern portion of the Keystone XL project, which runs through Montana, South Dakota, and Nebraska. Alongside these estimates, I will also report those for the five states that include, in addition, Oklahoma and Texas, which comprise the Gulf Coast Segment of the project. The reason for reporting both figures is that the project has currently been divided into two parts. Only the northern portion requires presidential approval, since it crosses the USA-Canada border. TransCanada has already begun constructing the Gulf Coast Segment. Further, the northern portion of the pipeline is likely to run through or near some of the most ecologically sensitive areas on the route, including the Sand Hills Region of Nebraska, the Badlands of South Dakota and numerous rural counties in Montana.

[26] The EPA's estimate 21 feet of wastewater pipe per capita is based on a study by the American Society of Civil Engineers (ASCE).
[27] The calculation is: State population * (21 / 5280) = Number of total miles of wastewater pipe. 7% of this number will give an estimate of the number of miles of wastewater pipe that are beyond the end of their useful life.

Table 1. Wastewater Pipe Replacement Needs By State

State	Population (2012)	Estimated Total Wastewater Pipe (miles) Existing	In Need of Replacement, 2000	In Need of Replacement, 2020
Montana	1,005,141	2,918	204	263
South Dakota	833,354	2,420	169	218
Nebraska	1,855,525	5,387	377	485
Oklahoma	3,814,820	11,076	775	997
Texas	26,059,203	75,661	5,296	6,809
TOTAL: 3-State	**3,694,020**	**10,725**	**751**	**965**
TOTAL: 5-State	**33,568,043**	**97,462**	**6,822**	**8,772**
TOTAL: NATIONAL	**313,914,040**	**1,248,522**	**87,397**	**112,367**

The next step is to calculate the unit cost of replacing the pipe. Heaney *et al* (2000) provide a detailed empirical study of the cost of wastewater and stormwater infrastructure for U.S. cities. These costs vary systematically based on the diameter of the pipe installed.[28] Since we do not have comprehensive data on the distribution of pipe diameters across all municipalities in the Keystone XL affected states, I estimate the unit cost of pipe replacement assuming an average pipe diameter of 8".[29] Given an average diameter of 8", the cost per foot of pipe construction will be $101 in 1998 dollars, or approximately $149 in 2013 dollars, which translates to $786,720 per mile.[30]

We can now derive an estimate of the total expenditures required to replace wastewater pipes in the Keystone XL-affected states that are beyond the end of their useful life. We multiply the cost per mile by our estimate of life-elapsed pipe miles to calculate the total replacement expenditures for all life-elapsed sewer pipes. According to the estimates in Table 2 below, a total of $5.367 billion dollars must be spent on wastewater pipe replacement in the five states affected by the two segments of Keystone XL, assuming the 7% life-elapsed figure; if we assume the 9% life-elapsed figure, the replacement bill rises to $6.9 billion. For the three northern states, the figures are $590.6 million and $759.4 million respectively.

[28] The equation is C = 14.99D, where C is unit cost of replacement per foot, and D is pipe diameter.
[29] This assumption reflects the mode of the distribution of pipe diameters across cities of all size ranges as reported by Heaney *et al* (2000).
[30] I use the Consumer Price Index (CPI) to convert from 1998 to 2013 dollars. In 1998 the CPI was 162.3, based on a 1982 base of 100. The mean (statistical average) of the 2013 CPI, computed through May, is 239.23; $101 * (239.23 / 162.3) ≈ $149. Data source: BLS (2013): http://data.bls.gov.

Table 2 . Wastewater Pipe Replacement Expenditure Needs by State, 2000 and 2020

	Estimated Totals			
State	Sewer in Need of Replacement, 2000 (miles)	Replacement Expenditures, 2000 (millions $)	Sewer in Need of Replacement, 2020 (miles)	Replacement Expenditures, 2020 (millions)
Montana	204	$160.7	263	$206.6
South Dakota	169	$133.2	218	$171.3
Nebraska	377	$296.7	485	$381.5
Oklahoma	775	$610.0	997	$784.2
Texas	5,296	$4,166.7	6,809	$5,357.1
TOTAL: 3-State	**751**	**$590.6**	**965**	**$759.4**
TOTAL: 5-State	**6,822**	**$5,367.3**	**8,772**	**$6,900.8**
TOTAL: NATIONAL	**87,397**	**$68,756.6**	**112,367**	**$88,401.3**

Now we can estimate the number of jobs that would be created in a hypothetical comprehensive wastewater pipe replacement project. It is important to recognize that the following estimate represents total person-years of employment on the project, not number of workers hired at any one time. The number of workers hired will depend on the duration of the project. For example, if all pipes were to be replaced within the same year (unlikely), the job creation estimates given below would represent the number of workers hired for a single year.

The EPA's standard timeframe for evaluating infrastructure needs is 20 years. If we assume that the hypothetical replacement project lasts twenty years, the annual jobs created will be one-twentieth of the person-years of employment created by the entire project. However, as discussed, EPA (2002) also estimates an increase in the percentage of life-elapsed pipes over the period 2000-2020, from 7% to 9%, with an additional 23% of all wastewater pipes in "very poor" condition as the average age of pipe increases.[31] This percentage is expected to increase after 2020, but we have no projections of corresponding percentages of life-elapsed pipe beyond the year 2020. For our 20-year estimates, then, we use the 9% figure.

To estimate the number of jobs created through a comprehensive wastewater pipe replacement project, we use the job creation multipliers for water infrastructure reported by Heintz *et al* (2009), which are based on the multipliers given by IMPLAN, the industry standard economic impact analysis software. Job multipliers are given in terms of the number of jobs created per $1 million invested in a given project.

Jobs created by a given project can be divided into three categories: direct, indirect, and induced. Direct jobs refer to the number of workers hired, measured in full-time person-years, to execute the project. Indirect jobs refer to the jobs created through supply purchases for the purpose of executing the project; induced

[31] EPA (2002) estimates that as of 2000, only 2% of wastewater pipes were in "very poor" condition. The rapid uptick in the percentage of pipes reaching "very poor" condition has prompted the American Water Works Association (2001) to declare the year 2000 as the "Dawn of the Replacement Era." In this analysis, I assume that no pipes in "very poor" condition are replaced.

jobs refer to those created in the economy at large through consumption expenditures by those employed directly and indirectly by the project. Heintz *et al* (2009) estimate that 9.96 direct jobs, and a total of 9.807 indirect and induced jobs, are created, on average, through investments in water infrastructure in the United States. Hence, a total of 19.767 total jobs are created through such investments.[32] Using these multipliers, we can derive estimates of the direct, indirect + induced, and total jobs that would be created by undertaking the needed wastewater pipe replacements in the states affected by Keystone XL.

Table 3. Job Creation from Wastewater Pipe Replacement

State	Replacement Expenditures, 2000 (millions $)	Direct Jobs, 2000	Total Jobs, 2000	Replacement Expenditures, 2020 (millions)	Direct Jobs, 2020	Total Jobs, 2000
Montana	$160.7	1,601	3,177	$206.6	2,058	4,085
South Dakota	$133.2	1,327	2,634	$171.3	1,706	3,386
Nebraska	$296.7	2,955	5,865	$381.5	3,799	7,540
Oklahoma	$610.0	6,075	12,057	$784.2	7,811	15,502
Texas	$4,166.7	41,500	82,362	$5,357.1	53,357	105,894
TOTAL: 3-State	**$590.6**	**5,883**	**11,675**	**$759.4**	**7,564**	**15,011**
TOTAL: 5-State	**$5,367.3**	**53,458**	**106,095**	**$6,900.8**	**68,732**	**136,407**
TOTAL: NATIONAL	**$68,756.6**	**684,816**	**1,360,487**	**$88,401.3**	**880,477**	**1,749,197**

Table 3 indicates that approximately 53,458 direct jobs and 106,095 total jobs could be created by making the necessary wastewater pipe replacements in the five Keystone XL states as of 2000. (Indirect + induced jobs are simply total jobs minus direct jobs, or 52,637.) For the replacements that will be necessary by 2020, the corresponding figures are 68,732 and 136,407 respectively. For the three northern states, the figures are considerably lower due to their smaller populations; the direct jobs figures are 5,883 and 7,564 for the 2000 and 2020 estimates. These job creation estimates represent person-years, not employments that last indefinitely.

Decision-makers and the public will want to know how many individual jobs will be created per year. The answer depends on the duration of the project. If we assume that the replacement project will last 20 years, will meet the replacement needs for 2020, and will replace an equal number of pipe miles per year, the annual job creation estimates can be derived by dividing the 2020 estimates by 20 (see Table 3b below). Making the needed replacements in the three northern states will create an estimated 378 direct jobs, and 751 total jobs per year. Making the needed replacements in all five states will create an estimated 3,437 direct jobs and 6,820 total jobs per year.

[32] These multipliers represent the national average for IMPLAN Sector 33: Water and sewer systems.

Table 3b. Average Annual Job Creation Estimates for Hypothetical 20-Year Wastewater Pipe Replacement Project

	Miles Replaced	Expenditures (millions $)	Direct Jobs Created	Total Jobs Created
TOTAL: 3-State	48	$38.0	378	751
TOTAL: 5-State	439	$345.0	3,437	6,820
TOTAL: NATIONAL	5,618	$4,420.1	44,024	87,460

III. Drinking Water

ACSE (2013) writes, "At the dawn of the twentieth century, much of our drinking water infrastructure is nearing the end of its useful life." For drinking water distribution mains, we perform a similar analysis to that of wastewater pipe, but calculate both per-year and total 20-year necessary expenditures based on the information given by EPA's (2002) projections of needed capital stock replacements, which are set to rise over time as national infrastructure ages.

We begin by estimating the number of miles of drinking water distribution main in each Keystone XL-affected state. Folkman (2012), in his comprehensive study of water main break rates in the United States and Canada, reports an average of 1 mile of water main per 264 people. We take this average to derive an estimate of the number of miles of water mains per state. EPA (2002) provides us with an estimate of the percent annual capital stock replacement need over the years 2000-2070, based on a statistical model developed to predict the timing of replacement needs.[33] Based on this model, EPA (2002) calculates that approximately 0.5% of the transmission and distribution lines in the United States require replacement in 2013.[34] Following the model but simplifying its results, we assume a linear increase in the percent capital stock replacement from 0.5% in 2013 to 2.0% in 2036, when the replacement rate flattens out (EPA 2002). We use this simplifying assumption to derive an estimate of the total capital stock replacement of 23.04% over the 20-year period from 2013 to 2033 (see footnote 12 for details). Table 4 summarizes the estimates of necessary replacements in miles.

[33] The model assumes that pipes installed before 1910 last an average of 120 years, pipes installed from 1911-1945 last an average of 100 years, and pipes installed after 1945 last an average of 75 years. The model assumes that the actual life span of the pipe will be distributed normally around these averages. (EPA 2002)

[34] This annual replacement need figure is set to increase until the year 2036, when approximately 2% of the total stock of transmission and distribution mains must be replaced. The annual replacement need then falls gradually to approximately 0.75% by 2070.

Table 4. Drinking Water Distribution Main Replacement Needs By State

State	Population (2012)	Estimated Total Water Main (miles) Existing	In Need of Replacement, 2000	In Need of Replacement, 2020
Montana	1,005,141	3,807	19	877
South Dakota	833,354	3,157	16	727
Nebraska	1,855,525	7,029	35	1,619
Oklahoma	3,814,820	14,450	72	3,329
Texas	26,059,203	98,709	494	22,743
TOTAL: 3-State	**3,694,020**	**13,992**	**70**	**3,224**
TOTAL: 5-State	**33,568,043**	**127,152**	**636**	**29,296**
TOTAL: NATIONAL	**313,914,040**	**1,189,068**	**5,945**	**273,961**

EPA (2002) quotes an estimated cost per foot for drinking water main replacement of $58. Using that figure and the PERI job multipliers, we can derive all the job creation estimates from needed water main replacements in the relevant states (see Table 5 below). In the five states in the year 2013 only, 1,942.5 direct and 3,855 total jobs can be created; the corresponding 3-state totals are 214 and 424 jobs respectively. These estimates assume that water main replacement proceeds according to the EPA's replacement schedule. Further, this annual estimate will rise year on year until 2036. Holding constant the size of the capital stock, the annual replacement needs in 2036 will be four times those of 2013. Meeting the 2036 replacement needs will create 7,770 direct jobs and 15,420 total jobs over the five states in that year alone.[35]

[35] If we assume that the capital stock replacement needs increase linearly as a percentage of the total capital stock between 2013 and 2036, then we can estimate the total capital stock replacement needs over the entire 23-year period. Envision a right triangle with a base length of 23, the duration of the period in years, and a height of 1.5, the percentage-point increase over the period. To this area add a box with height 0.5 and length 23. The sum of the areas of the box and the triangle represents the total percentage of the capital stock needing replacement over the relevant period. By the formula for the area of right triangles, this percentage is: (0.5) * (1.5) * 23 + (0.5) * 23 = 28.75%. Assuming that the total size of the capital stock remains constant, the total 23-year replacement need across the five states is 127,152 * 0.2875 = 36,556.2 miles of main, which will cost approximately $11.214 billion to replace. This hypothetical project will create **111,694** direct jobs and **221,672.5** total jobs over 23 years.

Table 5. 1-Year and 20-Year Drinking Water Main Replacement Expenditures and Jobs Created (2013 and 2013-2033)

State	Replacement Expenditures, 2013 (millions $)	Direct Jobs, 2013	Total Jobs, 2013	Replacement Expenditures, 2013-2033 (millions $)	Direct Jobs, 2013-2033	Total Jobs, 2013-2033
Montana	$5.8	58	115	$269.1	2,680	5,319
South Dakota	$4.8	48	96	$223.1	2,222	4,410
Nebraska	$10.8	107	213	$496.8	4,948	9,820
Oklahoma	$22.2	221	438	$1,021.3	10,172	20,188
Texas	$151.4	1,508	2,993	$6,976.7	69,488	137,908
TOTAL: 3-State	**$21.5**	**214**	**424**	**$989.0**	**9,850**	**19,549**
TOTAL: 5-State	**$195.0**	**1,942**	**3,855**	**$8,987.0**	**89,510**	**177,646**
TOTAL: NATIONAL	**$1,820.7**	**18,134**	**35,990**	**$83,897.9**	**835,623**	**1,658,410**

The two rightmost columns of Table 5 take a 20-year timeframe on the necessary infrastructure replacement, simplifying the EPA's projected capital stock increases by assuming a linear increase in the capital stock replacement need from 0.5% in 2013 to 2.0% in 2036 (see above). Under these assumptions, the 20-year replacement need from 2013 to 2033 will be 23.04% of the total capital stock, or 29,296 miles of drinking water main. These miles will cost $8.987 billion to replace, which will create 89,510 direct jobs and 177,646 total jobs.

Table 5b reports the average number of jobs created per year over the period 2013-2033, across three states and five states. Replacing drinking water mains according to the EPA's schedule will create an average of 4,476 direct jobs, and 8,882 total jobs, per year in the five relevant states; the 3-state averages are 493 and 977 respectively. The projected number of jobs created in 2013 alone is less than the annual average from 2013-2033 because the replacement rate increases over time.

Table 5b. Average Annual Job Creation From 20-Year Drinking Water Main Replacement

	Miles Replaced	Expenditures (millions $)	Direct Jobs Created	Total Jobs Created
TOTAL: 3-State	44	$13.5	493	977
TOTAL: 5-State	36	$11.2	4,476	8,882
TOTAL: NATIONAL	81	$24.8	41,781	82,921

IV. Gas Distribution Main and Service Replacement

The final piece of our analysis concerns the replacement of gas distribution lines. We begin by adding up the miles of bare steel, coated unprotected steel, and cast, wrought, and ductile iron pipe in the gas distribution system for the relevant states (see Table 6 below).

Table 6. Gas Distribution Pipeline Replacement Needs By State

	Miles				Bare Steel Services	
State	Bare Steel	Coated Unprotected Steel	Iron (Cast, Wrought, Ductile)	Total Length of Distribution Mains	# of lines	Total Length (miles)
Montana	11	0	0	**11**	634	7
South Dakota	36	1	23	**60**	2,310	27
Nebraska	1,057	2	538	**1,597**	5,814	69
Oklahoma	1,889	89	0	**1,978**	59,675	705
Texas	5,376	224	967	**6,567**	186,092	2,199
TOTAL: 3-State	**1,104**	**3**	**561**	**1,679**	**8,758**	**104**
TOTAL: 5-State	**8,369**	**316**	**1,528**	**10,224**	**254,525**	**3,008**
TOTAL: NATIONAL	**61,309**	**16,036**	**32,394**	**109,739**	**2,555,214**	**30,198**

Our replacement cost figure comes from Thompson (2012), who estimates that the average cost of replacing gas distribution lines is $105 per meter. Converting from meters to miles, we arrive at the total expenditures necessary to replace all of the leak-prone gas distribution lines in the relevant states.

Table 7. Replacement Expenditures on Gas Distribution Mains and Services By State

State	Total Main Replacement Needs (miles)	Total Service Replacement Needs (miles)	Total Cost of Replacement (millions $)
Montana	11	7	$3.1
South Dakota	60	27	$14.8
Nebraska	1,597	69	$281.5
Oklahoma	1,978	705	$453.4
Texas	6,567	2,199	$1,481.3
TOTAL: 3-State	**1,668**	**104**	**$299.4**
TOTAL: 5-State	**10,213**	**3,008**	**$2,234.1**
TOTAL: NATIONAL	**109,739**	**30,198**	**$23,646.6**

From these expenditure estimates we can derive job creation figures using the multipliers provided by Heintz *et al* (2009) for gas pipeline replacement, 12.05 direct jobs per $1 million invested and 9.84 indirect + induced jobs per $1MM.[36] Making all of the needed gas distribution line replacements in the five relevant states will yield approximately 26,921 direct jobs and 48,905 total jobs. Making such replacements in the three northern states will yield 3,607 direct and 6,553 total jobs.

Table 8. Job Creation From Gas Main and Service Replacements

State	Total Cost of Replacement (millions $)	Direct Jobs Created	Total Jobs Created
Montana	$3.1	38	68
South Dakota	$14.8	178	323
Nebraska	$281.5	3,392	6,161
Oklahoma	$453.4	5,464	9,925
Texas	$1,481.3	17,850	32,426
TOTAL: 3-State	**$299.4**	**3,607**	**6,553**
TOTAL: 5-State	**$2,234.1**	**26,921**	**48,905**
TOTAL: NATIONAL	**$23,646.6**	**284,942**	**517,625**

There is no set timeframe for replacing gas distribution mains; I choose a 20-year timeframe to make the job creation estimates comparable across the three infrastructure categories analyzed in this report. Table 8b below reports direct, indirect + induced, and total jobs created annually alongside the corresponding total (20-year) estimates. We assume an equal number of pipe miles are replaced per year. Replacing gas distribution lines and service lines in the three northern states will create 18 direct and 328 total jobs per year. In the five total states, the replacement project will create 1,346 direct and 2,445 total jobs per year.

Table 8b. Annual Job Creation Estimates for 20-Year Gas Main and Service Replacement Project

	Miles Replaced	Expenditures (millions $)	Direct	Total
TOTAL: 3-State	1,772	$299.4	180	328
TOTAL: 5-State	13,221	$2,234.1	1,346	2,445
TOTAL: NATIONAL	139,937	$23,646.6	14,247	25,881

[36] These multipliers make use of two IMPLAN categories in equal proportions: 36 – Construction of other new non-residential structures, and 39 – Maintenance and repair construction of nonresidential structures.

V. Total Project Estimate and Comparisons

We can now put together the expenditure and job creation estimates for the necessary expenditures in wastewater pipe replacement, drinking water distribution lines, and gas distribution lines. Table 9 summarizes total and average annual expenditure, direct and total job creation from the combined replacement of wastewater, drinking water, and gas distribution pipe, across 3-state and 5-state scenarios. We assume the wastewater replacement needs are those of 2020 as described in Section I, and that drinking water replacement needs follow the pattern of increasing capital stock replacement rates described in Section II.

Table 9. Annual Average, 20-Year Total Expenditure and Job Creation from Infrastructure Replacement

	Average Annual				20-Year Total			
	Expenditure (millions $)	Direct Jobs	Total Jobs	Total Construction Jobs	Expenditures (millions $)	Direct Jobs	Total Jobs	Total Construction Jobs
TOTAL: 3-State	$102.5	1,052	2,058	776	$2,049.6	21,043	41,154	15,518
TOTAL: 5-State	$906.2	9,259	18,150	6,962	$18,123.7	185,185	362,998	139,242
TOTAL: NATIONAL	$9,797.3	100,052	196,262	75,433	$195,945.9	2,001,043	3,925,233	1,508,658

Following these assumptions (see Table 9 above) we arrive at the conclusion that over the next 20 years, $18.1 billion will need to be spent in the five states on water and gas infrastructure pipe replacement alone. This investment spending will create 185,185 direct jobs (measured in person-years) and 362,998 total jobs (in person-years). Spread out over the 20 years, the annual average expenditure will be approximately $906.2 million; 9,259 direct jobs and 18,150 total jobs will be created per year. For the three-state subset, the total spending over 20 years will be $2.049 billion, or $102.5 million per year. A total of 21,043 direct jobs will be created, and 41,154 total jobs will be created. Annually, an average of 1,052 direct jobs will be created, and 2,058 total jobs will be created.

For a national comprehensive project, the figures are much, much higher: almost $196 billion in total expenditure, or $9.8 billion per year, creating 100,052 direct and 196,262 jobs per year; over the 20-year project period, 2,001,043 direct and 3,925,233 total jobs will be created.

We can compare these job creation figures to the ones reported by the State Department in its Draft Supplemental Environmental Impact Statement (SEIS).[37] These figures are reported in Table 9b below.

[37] Available at: http://www.Keystonepipeline-xl.state.gov/. The SEIS job figures should be considered high estimates. The entire SEIS process has been called into question due to the connection between the contractor hired by the State Department to perform the impact statement, Environmental Resources Management, Inc. (ERM), and the American Petroleum Institute (API), the oil and gas industry's principal lobbying group. ERM is a dues-paying member of API.

Table9b. Keystone XL: Expenditures and Job Creation Estimates

Expenditures	Scale	Construction Jobs	Direct Jobs	Total Jobs
$3,100,000,000	Nationally	6,800	20,224	42,073
	In-State Jobs (MT, SD, and NE)	955	4,373	11,600

The figures reported in Table 9b are subject to two important limitations. First, the SEIS only covers the three states of Montana, South Dakota and Nebraska; Oklahoma and Texas segments of the pipeline have been split into a second project which does not require State Department approval, and hence is not subject to the same degree of public disclosure. Second, the SEIS report does not fully split the total job creation estimates into direct, indirect, and induced components. While the report identifies the number of direct *construction sector* jobs created by Keystone XL, it does not count the direct jobs created in *other sectors* by the project. It does, however, break down total (direct + indirect + induced) jobs figures by sector, which we will examine in Section V.

The Socioeconomics section of the SEIS statement indicates that the total construction, materials and support costs of the Keystone XL pipeline through the three states is $3.1 billion, which we will take as the effective project size (Department of State 2013a). The $3.1 billion in expenditure on construction, materials and support across the three project states of Keystone XL will create 3,820 *direct* construction jobs[38], 6,800 *total* construction jobs, and a 42,073 total (direct, indirect and induced) jobs *across all sectors* nationally (Department of State 2013a, Department of State 2013b).[39]

As stated above, these 42,073 jobs are not divided into direct, indirect and induced components. However, we can derive a rough estimate of the total direct jobs created by the Keystone XL 3-state project using the IMPLAN data set, an economic modeling tool that breaks down total U.S. economic activity by industrial category. Among other functions, IMPLAN estimates multipliers for the number of jobs created per unit investment across industrial categories. It is the source of the multipliers used by Heintz *et al* (2009) to calculate the job creation potential of infrastructure investments. To estimate the direct jobs across all sectors created by Keystone XL, we use the IMPLAN multiplier for new civil and heavy construction of nonresidential structures (category 36), which covers construction of pipelines of all types. We use the national multiplier to capture all direct jobs created across all states. This multiplier is 6.5 jobs created per $1 million of investment. A total project investment of $3.1 billion in IMPLAN category 36 will yield 20,225 direct jobs across all sectors nationally.[40]

38 Other categories of direct jobs besides construction will also be created, but these jobs are not listed in the SEIS. The total jobs numbers are, however, split into sectoral categories.

39 The SEIS job creation estimate of 42,073 lies between the low and high estimates of 33,000 – 54,000 estimated by the 2012 Cornell study (Skinner and Sweeney 2012). It is far less than the estimate of 119,000 published by the Perryman Report (2010).

40 The figure is actually 20,224.5, but we have rounded up. Also, IMPLAN's data suggests that this jobs figure represents a generous estimate of direct job creation from Keystone XL. A project of $3.1 billion invested entirely in IMPLAN category 36 would yield a total of 53,651 direct, indirect and induced jobs (nationally). For each direct job created by such a project, 1.6527 indirect and induced jobs would be created; put another way, the ratio of total jobs to direct jobs is 2.6527. If we apply this ratio to the quoted SEIS total jobs figure of 42,073, then we arrive at an estimate of 42,073

Within the three states of Montana, South Dakota and Nebraska alone, the project is expected to create 11,600 direct, indirect and induced, one-year, full-time equivalent jobs (SEIS 2013).[41] However, in this case we cannot estimate the direct job proportion from the expenditures, since we do not have data on expenditures within the states. To calculate the number of direct jobs across all sectors created within the three project states, we use the indirect and induced job multiplier for category 36, new civil and heavy construction of nonresidential structures (see above). Each direct job created in this category gives rise to 1.6527 indirect and induced jobs; the ratio of total jobs to direct jobs is thus 2.6537. A total in-state job figure of 11,600 thus implies 4,373 direct jobs in all sectors over the two-year life of the project, or 2,187 jobs per year. Finally, the SEIS (2013) reports that 955 direct construction jobs will be created within those three states, or 477.5 construction jobs per year.

Table 9c below compares the job creation impact of the entire infrastructure project described in Sections I-III with that of the Keystone XL project. In addition to direct and total jobs figures, we derive rough estimates of the number of construction jobs created by the infrastructure replacement project and compare those with the number of construction jobs created by Keystone XL. The Clean Water Council (2009) studied water infrastructure projects in five states, and determined that construction jobs comprise approximately 41.82% of total jobs created through these projects. To compare this estimate with that of the SEIS (2013), we assume that this proportion holds for direct jobs as well as total jobs. We have no corresponding data on gas main replacement job breakdowns; we thus assume, conservatively, that the proportion of construction jobs created by gas main replacements is identical to that created by Keystone XL nationally (16.15%). Under those assumptions, the number of total construction jobs created by the 5-state, 20-year project is approximately 151,806. For the corresponding 3-state project, it is 17,210. The 3-state project, though smaller in size than Keystone XL ($2.083 billion vs. $3.1 billion), would thus create a larger total number of construction jobs than would Keystone XL by a factor of 2.5 (17,210 vs. 6,800).

Comparing the second and third lines of Table 9c, we find that replacing the wastewater, drinking water and natural gas pipes in the smaller, 3-state project will create a comparable number of direct and total jobs as Keystone XL will create nationally. Infrastructure replacement jobs tend to be hired largely in-state; for this reason, the default local purchase coefficient (LPC) on construction industries in the IMPLAN data set is 100% by assumption (Thorvaldson *et al* 2011).[42] Jobs building the Keystone XL pipeline, by contrast, will be primarily hired out of state (Skinner and Sweeney 2012). For the local hiring in the 3-state analysis to be equal to that of Keystone XL, the local purchase coefficient on infrastructure construction in the three states of Montana, South Dakota and Nebraska would have to be approximately 20% (4,373 / 21,043), which would be an unusually low coefficient on a state's construction industry. Comparing the second and fourth lines of Table 9b, we discover that the number of direct and total jobs created by the 3-state infrastructure replacement project will dwarf the number of in-state jobs created by Keystone XL.

/ 2.6527 = 15,860 direct jobs created from Keystone XL.

[41] Spending associated with in-state job creation is not reported, since SEIS (2013) does not include it. We do not have access to the data inputs to SEIS (2013), which would allow us to replicate the study in IMPLAN.

[42] Any departure from 100% local hiring in the construction industry must be specified by the analyst from data supplied by the project to be analyzed.

Finally, we add to Table 9c scaled-up estimates of the Keystone XL pipeline to reflect the pipe mileage running through Oklahoma and Texas. It could be argued that comparing the 5-state infrastructure replacements with the full 5-state Keystone XL pipeline is a more valid comparison than comparing it with the 3-state Keystone XL pipeline. However, data at this level of detail are not published in any of the State Department analyses. TransCanada split the original 5-state Keystone XL project into two pieces, for which only the northern portion requires State Department approval. Hence the job creation data for the northern portion, which covers the three states of Montana, Nebraska and South Dakota, is provided in detail in the State Department SEIS. The northern portion of the Keystone XL pipeline is about 876 miles in length, and the southern portion (Oklahoma and Texas) is about 532 miles long. Due to the lack of detailed cost and employment data on the southern portion, we assume that the expenditure per mile, number of workers employed per mile, and sectoral breakdown of workers is the same for Oklahoma and Texas as it is for Montana, Nebraska and South Dakota. Moving from the 3-state to the 5-state project thus involves scaling up all of the figures by a factor of about 1.6 (876/532).

Table 9c. Project Comparisons: Expenditures and Job Creation Estimates

Project Alternatives	Expenditures (millions $)	Construction Jobs	Direct Jobs	Total Jobs
National Pipe Replacement	$195,945.9	1,641,532	2,001,043	3,925,233
5-State Pipe Replacement	$18,123.7	151,806	185,185	362,998
3-State Pipe Replacement	$2,049.6	17,210	21,043	41,154
Keystone XL 5-State	$4,986.2	10,937	32,529	67,672
Keystone XL	$3,100.0	6,800	20,224	42,073
Keystone XL: In-State Jobs	-	955	4,373	11,600

Table 9d below reports the ratios of the infrastructure projects' expenditures and job creation to those of Keystone XL. The national pipe replacement will involve over 63 times the amount of total expenditure as Keystone XL 3-state, and 39 times the amount of expenditure as Keystone XL 5-state. It will create over 98 times the total direct jobs as the 3-state project, and 61.5 times as many jobs as the 5-state project. The rest of the table can be read accordingly. An important takeaway message that emerges from the bottom line of Table 9d:

Making necessary wastewater, drinking water and gas distribution pipe replacements in the three northern states of Montana, South Dakota and Nebraska will create ***nearly five times the number of direct jobs in all sectors****, and* ***eighteen times the number of construction jobs****, in those states as would the Keystone pipeline.*

Table 9d. Ratios of Project Expenditures and Job Creation Estimates to Keystone XL

Project Alternatives	Expenditures (millions $)	Construction Jobs	Direct Jobs	Total Jobs
National Pipe Replacement to Keystone XL, 3-State	63.2	241.4	98.9	93.3
National Pipe Replacement to Keystone XL, 5-State	39.3	150.1	61.5	58.0
5-State Pipe Replacement to Keystone XL, 3 State	5.8	22.3	9.2	8.6
5-State Pipe Replacement to Keystone XL, 5 State	3.6	13.9	5.7	5.4
3-State Pipe Replacement to Keystone XL, 3 State	0.7	2.5	1.0	1.0
3-State Pipe Replacement to Keystone XL, 3-State, in-State Jobs	0.7	18.0	4.8	3.5

Table 9e below compares the alternative infrastructure projects to Keystone XL by the number of jobs that each project will create per $1 billion invested. The table indicates that $1 billion invested into water and gas pipeline infrastructure in the three states will create 10,267 direct jobs and 20,079 total jobs[43]; $1 billion invested in Keystone XL will create 6,523 direct jobs and 13,572 total jobs.

Table 9e. Job Creation Per $1 Billion Invested

Project Alternatives	Construction Jobs	Direct Jobs	Total Jobs
National Pipe Replacement	8,377	10,212	20,032
5-State Pipe Replacement	8,376	10,218	20,029
3-State Pipe Replacement	8,397	10,267	20,079
Keystone XL, 3-State or 5-State	2,192	6,523	13,572

Comparison ratios of job creation per $1 billion are given in Table 9f below. $1 billion invested in water and gas pipeline infrastructure in the 3-state project will create **1.6 times** as many direct jobs, and **1.5 times** as many total jobs, than will Keystone XL. It will create 3.8 times as many construction jobs as Keystone XL.

[43] The estimates we derive for water infrastructure job creation are comparable to other estimates in the literature. Roessler and Smith (2010) estimate that $1 billion invested in water infrastructure will create between 14,342 and 23,784 total jobs – more than school buildings, transport or energy, and many more than a tax cut. Clean Water Council (2009) estimates that $1 billion invested in water infrastructure will create between 20,003 and 26,669 total jobs.

Table 9f. Ratios of Job Creation Per $1 Billion Invested

Project Alternatives	Construction Jobs	Direct Jobs	Total Jobs
National Pipe Replacement	3.8	1.6	1.5
5-State Pipe Replacement vs. Keystone XL	3.8	1.6	1.5
3-State Pipe Replacement vs. Keystone XL	3.8	1.6	1.5

Three important take-away messages emerge from Tables 9b-9f:

1) *Total water and gas pipe infrastructure replacement needs in the five states dwarf the size of the Keystone XL project.*
2) *Water and gas infrastructure replacement is a more efficient job creator than oil pipeline construction, creating 1.5 times more jobs for a given amount of money invested.*
3) *Water and gas infrastructure replacement will create approximately **3.8 times as many construction** industry jobs, per unit of investment, than will Keystone XL.*

Table 9g below summarizes the three infrastructure projects alongside Keystone XL in terms of annual job creation estimates, assuming that the Keystone XL project will last two years, and the hypothetical infrastructure replacement project will last 20 years. On this conservative 20-year timeframe, the 3-state Keystone XL project creates a slightly larger number of jobs annually in the short run (1-2 years) than the 5-state infrastructure project (10,112 vs. 9,259). The five-state Keystone XL project creates considerably more jobs over this timeframe (16,265 vs. 9,259). Also over this same timeframe, the Keystone XL project creates more jobs annually in the three northern states than does the 3-state infrastructure project (2,187 vs. 1,052). These results are artifacts of the 20-year timeframe; taking a 10-year timeframe on the 5-state infrastructure project would yield 18,518 direct jobs and 37,020 total jobs per year, which are greater than the per-year jobs created by the Keystone XL 5-state project over the much shorter 2-year time frame.[44] Further, even under these conservative assumptions, both infrastructure replacement projects create many more construction jobs than Keystone XL. Finally, when operations and maintenance needs are taken into account, the 5-state infrastructure project creates a larger number of jobs per year than Keystone XL, and the 3-state project creates a comparable number of direct jobs (see Section VII).

[44] For each hypothetical infrastructure investment project, we can calculate the time frame over which annual job creation would be identical to Keystone XL. For direct jobs over all sectors created by the 5-state infrastructure project, in comparison to the Keystone XL 5-state pipeline project, this equivalent time frame would be equal to 185,185/16,265 ≈ 11.38. This number means that if the necessary replacements were made in the five states over 11.38 years, the number of jobs created per year would be identical to Keystone XL.

Table 9g. Annual Job Creation Estimates

Project Alternatives	Expenditures (millions $)	Construction Jobs	Direct Jobs	Total Jobs
National Pipe Replacement	$9,797.3	75,433	100,052	196,262
5-State Pipe Replacement	$906.2	6,962	9,259	18,150
3-State Pipe Replacement	$102.5	776	1,052	2,058
Keystone XL 5-State	$2,493.1	5,469	16,265	33,836
Keystone XL 3-State	$1,550.0	3,400	10,112	21,037
Keystone XL: In-State	$1,550.0	477	2,187	5,800

Table 9h below reports the ratios of expenditures and job creation between the various pipe replacement projects and Keystone XL. Reading the second column of the table, we find that the national pipe replacement project creates 13.8 times as many construction jobs per year as Keystone XL; the 5-state pipe replacement project creates about 1.3 times as many. The three-state pipe replacement project creates 1.6 times as many construction jobs per year than Keystone XL does within the three states only. We can find similar ratios for direct jobs and total jobs in the fourth and fifth columns of the table, respectively.

Table 9h. Ratio of Annual Expenditures and Job Creation

Project Alternatives	Expenditures	Construction Jobs	Direct Jobs	Total Jobs
National Pipe Replacement vs. Keystone XL 5-State	6.3	13.8	6.2	5.8
5-State Pipe Replacement vs. Keystone XL 5-State	0.4	1.3	0.6	0.5
5-State Pipe Replacement vs. Keystone XL 3-State	0.6	2.0	0.9	0.9
3-State Pipe Replacement vs. Keystone XL 3-State, In-State	0.1	1.6	0.5	0.4

VI. Job Composition

This section analyzes the composition of jobs created by the infrastructure project in comparison to Keystone XL. The first subsection looks at the composition of permanent jobs, finding that a plausible infrastructure replacement would create vastly more permanent jobs than Keystone XL. The second subsection looks at the sectoral breakdown of jobs created by infrastructure versus Keystone XL. It finds that a much larger proportion of jobs created by infrastructure replacement would be in construction and manufacturing sectors.

A. Permanent Jobs

President Obama noted in his recent New York Times interview that the Keystone XL project would only create 50-100 permanent jobs. That's a good estimate; the State Department cites a permanent *direct* job creation figure of 35, which would lead to about 70-75 *total* jobs per year through multiplier effects. Could infrastructure investments create more permanent jobs than this? Absolutely – making needed water infrastructure investments could create many, many more permanent jobs.

Jobs in water infrastructure consist not only of construction, but also of operations and management. To figure out how many jobs could be created by plausible and necessary investment in water infrastructure, we consult EPA's estimates of the clean water and drinking water infrastructure investment needs gap. EPA estimates the likely gap that will emerge between current needs and spending on water infrastructure, if current trends in spending continue 20 years into the future. They divide this gap into capital investment needs – basically replacement and upgrading of pipes and facilities – and operations and maintenance (O&M). O&M needs are consistent year after year; hence a job created in O&M is, for all intents and purposes, a permanent job. We use estimates of the O&M gap for the five Keystone-relevant states to derive an estimate for the number of permanent jobs that would be created from filling that gap.

A full discussion of the assumptions behind our estimates is available in Section VIII, Subsection B. We start from an estimated 20-year, national drinking water and clean water infrastructure O&M gap estimate of $144.6 billion, or $7.23 billion per year. This works out to an average of $22.95 per person, assuming a population of 315 million. Across the five Keystone-relevant states, the spending needed to fill this gap is $770.5 million per year. Applying the multipliers for water infrastructure from Heintz *et al* (2009), we find that filling the O&M gap will create 7,673 direct jobs and 15,230 total jobs per year. These annual jobs will last year after year. In comparison with Keystone XL, filling the water infrastructure operations and maintenance gaps will create 152 times the maximum number of total permanent jobs (100) created by the Keystone XL 3-state pipeline, and 95 times as many as the Keystone 5-state pipeline. It's also *219 times* the number of direct permanent jobs estimated by the State Department to be created by Keystone XL 3-state pipeline, and 137 times as many direct permanent jobs estimated for the 5-state pipeline.

B. Sectoral Breakdown

The previous section showed us that upgrading gas and water infrastructure will create a larger number of total jobs, as well as jobs per unit of investment, than will Keystone XL. But what kind of jobs would these be? The United Association of Plumbers, Pipefitters and Sprinklerfitters have declared their support for the Keystone XL pipeline, on the grounds that it creates jobs in the industrial sectors in which their members work (UA 2013). Would the infrastructure replacement proposed in this memo create a similar number of jobs in those sectors?

Our limited data does not allow us to measure the exact number of pipefitting jobs in the two alternative proposals. But we can look at the broad industrial categories in which jobs will be created, using existing data from the SEIS and water infrastructure project documents. The result is clear: **water infrastructure provides more jobs in the areas of construction and manufacturing, per unit of investment, than Keystone XL.**

Department of State (2013b) reports the breakdown of total (direct, indirect and induced) jobs by sector for each of the three states of the proposed Keystone XL project, as well as the national breakdown. The national breakdown differs substantially from any of the state breakdowns, since a large percentage of the workers hired to construct the oil pipeline come from out-of-state contractors.

Our data on water infrastructure jobs comes from the Clean Water Council (2009). In their report *Sudden Impact*, they estimate the economic impact of investing in water and wastewater infrastructure in five states: California, Georgia, Minnesota, New Mexico and Pennsylvania. Using IMPLAN, they estimated the impact of such investments on employment, output, and total economic activity. Their employment estimates include a detailed breakdown of total jobs created by sector.

Table 10 compares the sectoral job breakdown of Keystone XL vs. the water infrastructure projects described by the Clean Water Council (2009). For ease of presentation, I aggregated all of the job categories into higher-level categories: construction and manufacturing; finance, insurance, real estate and management of companies and enterprises; trade, transport and warehousing; the service sector, and all other sectors.

The most important result is displayed in the top line, construction and manufacturing. This job category comprises only 27.08% of the total U.S. jobs created by the Keystone XL pipeline project, and a far smaller proportion in each pipeline state (approximately 10% to 13%) due to the predominance of out-of-state contracting. For water infrastructure, the corresponding figure is 43.43% of the jobs in construction and manufacturing, the majority of which would come from inside the states needing the replacement. If we restrict ourselves to construction sector only, the difference becomes even more dramatic. Jobs in the construction sector comprise only 16.15% of total jobs in the Keystone XL project, while such jobs comprise 41.82% of total jobs in the water infrastructure projects described in *Sudden Impact* (Clean Water Council 2009).

Moreover, the service sector comprises over twice the proportion of jobs created nationwide by Keystone XL than water infrastructure (32.3% vs. 15.32%). Service sector jobs tend to pay less than construction and manufacturing jobs. The SEIS acknowledges this reality in its report, acknowledging the discrepancy between the jobs breakdown and the earnings breakdown by state:

> About 22 percent of all earnings, or $408 million, would occur in the proposed Project area states of Montana, South Dakota, Nebraska, and Kansas. This compares with 29 percent of all jobs… A smaller share of earnings (compared to the share of jobs) for these states **suggests that**

> **the largest impacts would occur in industries paying lower wages**, such as trade and personal services, that are commonly associated with household spending. (Department of State 2013a, emphasis added)

Further, finance, insurance, real estate and management – the main "white-collar" job category – comprises almost twice the proportion of Keystone XL jobs as water infrastructure jobs (21.14% vs. 11.86%). These jobs, which are primarily in supervisory, technical, project management and financial services, do not reflect the constituency of labor unions such as UA. These data indicate that infrastructure projects serve the labor constituency better than do oil pipelines. Finally, the total number of jobs created per unit investment is greater for the water infrastructure projects studied by the Clean Water Council (2009) than for Keystone XL. This comparison provides further evidence that an infrastructure upgrade is a more efficient creator of construction and manufacturing jobs than Keystone XL. The take-away message:

- *Water infrastructure projects serve the construction and manufacturing constituency more effectively than oil pipelines.*

Table 10. Job Breakdown: Keystone XL vs. Water Infrastructure

	Keystone XL								Water Infrastructure		
	Montana		South Dakota		Nebraska		USA				
Sectors	#	%	#	%	#	%	#	%	Jobs Created / $ 1 BB	Percent of Total	Jobs Created for KXL Project Size
Construction and Manufacturing	466	12.8%	433	12.6%	444	10.0%	11,400	27.1%	8,687	43.4%	26,930
Finance, Insurance, Real Estate and Management	973	26.6%	870	25.2%	1,016	22.8%	8,900	21.1%	2,372	11.9%	7,353
Trade, Transport and Warehousing	657	18.0%	644	18.7%	773	17.4%	6,400	15.2%	722	3.6%	2,238
Service Sector	1,455	39.8%	1,414	41.0%	2,097	47.1%	13,600	32.3%	3,065	15.3%	9,502
All Other Sectors	103	2.8%	86	2.5%	119	2.7%	1,800	4.3%	5,157	25.8%	15,987
TOTAL JOBS	3,654		3,447		4,449		42,100		20,003		62,009

Table 10b indicates the number of total construction and manufacturing jobs created per year for the Keystone XL project versus the water infrastructure replacement projects proposed in this report. The results are striking. Though the average annual water infrastructure replacement in the five states will give rise to approximately one-half the dollar value of expenditures on the Keystone XL project, the total number of construction and manufacturing jobs created per year by that expenditure will be greater than for Keystone XL by over a thousand jobs - compare the first and fourth lines of Table 10b.

Table 10b. Annual Total Construction and Manufacturing Job Creation: Comparison of KXL and Water Infrastructure

Project Alternatives	Expenditures (millions $)	Construction and Manufacturing Jobs
Keystone XL 5-State, National Jobs	$2,493.1	9,168
Keystone XL 3-State, National Jobs	$1,550.0	5,700
Keystone XL 3-State, In-State Hiring	-	672
3-State Water Infrastructure Only	$87.4	743
5-State Water Infrastructure Only	$794.4	6,752

VII. How to Finance the Infrastructure Upgrade? Eliminate Fossil Fuel Tax Breaks

A closer look at the alternative jobs proposal presented in this paper will raise another important question: can the U.S. government presently afford to finance its portion of the bill? Of the $7.289 billion in proposed infrastructure investments, only $1.727 billion of it – the natural gas pipeline replacement – comes from the private sector. The remaining $5.562 billion are public sector investments in upgrading wastewater and drinking water infrastructure. Where would this $5.562 billion come from?

We propose that eliminating fossil fuel subsidies – simply by closing fossil fuel tax loopholes - is the best way to raise the necessary funds. Support for energy subsidy reform has gained considerable traction in recent years, as a way to address the long-term climate crisis along with fiscal crises that have plagued numerous national governments since the Great Recession. The Los Angeles Times (McKibben 2012), the Washington Post (Plumer 2013), and the Guardian (Clark 2012) have all run prominent Op-Eds calling for the elimination of fossil fuel subsidies. The International Monetary Fund (IMF), an institution known for its fiscal conservatism, has joined the chorus: it recently released a report estimating the total magnitude of annual global energy subsidies at *$1.9 trillion* (International Monetary Fund 2013). This total includes the foregone tax revenue from setting an appropriate carbon price, as well as consumption subsidies that artificially lower the price of oil, and foregone tax revenues from suppressing the taxation of fossil fuel products.

This piece of the analysis considers two scenarios. First, we consider the impact of closing the three biggest tax loopholes for fossil fuel companies nationally, and estimate the number of jobs that would be created if we invested the resulting tax revenues in water infrastructure upgrades. Second, we look at the tax breaks associated with the Keystone XL project alone, and estimate the number of jobs that would be created if we invested that money in water infrastructure. The results:

1. Closing the three biggest national tax loopholes, and investing the resulting revenues in water infrastructure, would yield a considerably larger annual number of jobs than the Keystone XL project.

2. Eliminating the tax breaks given to the refineries that would profit from Keystone XL, and investing the resulting revenues in water infrastructure, would yield approximately the same annual number of jobs as the Keystone XL project.

The take-away message: *Eliminating the tax loopholes associated with the Keystone XL pipeline could create as many jobs in one year as building the pipeline.*

A. National Fossil Fuel Tax Breaks

Financing the infrastructure upgrades proposed in Sections I-IV of this report does not require us to tax carbon emissions. Rather, *we can finance the entire public sector portion of the 5-state infrastructure project by closing just three of the biggest tax loopholes enjoyed by U.S. oil companies for just two years*. Aldy (2013), in his report for the Brookings Institution's Hamilton Project, estimates the ten-year impact of closing all such loopholes at $41.4 billion, or $4.14 billion per year. The annual tax revenue foregone due to the three largest loopholes is listed below in Table 11. **These three tax loopholes cost U.S. taxpayers $3.7 billion dollars per year**. Spread out over two years, that's $7.2 billion dollars, more than enough to finance the upgrades of publicly owned wastewater and drinking water infrastructure proposed in the first four sections of this report. The federal government could simply close these loopholes and place the revenue into a fund that could be accessed by municipalities for water infrastructure projects. And keep in mind – these loopholes represent only a very small percentage of the direct and indirect fossil fuel subsidies granted by the U.S. today. IMF (2013), in fact, estimates total *annual* U.S. fossil fuel subsidies at ***$502 billion***, taking into account the implicit subsidy from carbon pollution.

The take-away message: *Eliminating the three biggest national fossil fuel tax breaks will allow us to finance infrastructure upgrades that will create more jobs than Keystone XL.*

Table 11a. Top Three Fossil Fuel Tax Loopholes[45]

	Tax Provision	Annual Revenue Foregone (billions $)
1.	Expensing intangible drilling costs	$1.4
2.	Domestic manufacturing tax deduction for oil and gas	$1.16
3.	Percentage depletion for oil and gas wells	$1.2
	TOTAL	**$3.7**

** Sourced from Aldy (2013).*

[45] Sourced from Aldy (2013).

B. Closing the Keystone XL Loopholes

A recent analysis by EarthTrack and Oil Change International (2012) took a look at the burden of Keystone XL on the U.S. taxpayer. Despite the assertions of Senate Minority Leader Mitch McConnell that our tax dollars are not supporting Keystone XL, the research indicates otherwise: we are giving the refineries that benefit from Keystone XL a large tax break. The total bill: between $1 billion and $1.8 billion in tax breaks to refineries building capacity in order to process tar sands oil from Canada.

The subsidy to the Keystone-related refineries is essentially created through the accounting process. Three refineries are currently embarking on $10 billion in capital investment projects to build capacity for processing Canadian tar sands oil. The capital investment is subject to special depreciation provisions that allow over half (55%) of the investment to be expensed in the first year the facility opens. Under normal tax accounting rules, assuming a 20-year life of asset, only 2.5% of the value of the investment would be expensed.

This accelerated expensing means that over half of the value of the facility can be written off in that year, as a deduction from taxable income. Earth Track and Oil Change International (2012) write, “Because firms can invest this savings and earn a return on it, higher deductions soon after an investment is made are valuable… in effect, the higher deductions act as an interest-free loan from the government to the refinery owner.” The loan, in this case, is “paid back” by lower depreciation deductions later in the life of the project. However, the refining companies can (and do) invest the money saved through the accelerated write-offs, thereby boosting their own income. On a net present value basis, these write-offs provide a net subsidy of between $1.0 and $1.8 billion to the three refining companies, under alternative assumptions of capital costs (5% or 9%) and asset life (20 or 30 years).

If $1.0-$1.8 billion were invested in water infrastructure projects, it would create between 9,960 and 17,928 direct jobs, and between 19,767 and 35,581 total jobs. It would also create between 8,500 and 15,300 total jobs in the construction and manufacturing industries alone. These figures are summarized in Table 11b below, along with a mid-range estimate of $1.4 billion.

Table 11b. Annual Job Creation from Investing Value of KXL-Related Subsidy Into Water Infrastructure

Subsidy Value (billions $)	Construction & Manufacturing	Direct Jobs	Total Jobs
$1.0	8,500	9,960	19,767
$1.4	11,900	13,944	27,674
$1.8	15,300	17,928	35,581
Keystone XL 5-State (annual)	9,163	16,265	33,836
KXL (3-State annual)	5,700	10,112	21,037

A compelling takeaway emerges from this analysis: investing the value of the Keystone XL-related tax subsidy in water infrastructure in a given year *could create as many or more jobs as the Keystone XL project itself in that year*. The mid-range estimate of the value of the subsidy, $1.4 billion, if invested in water infrastructure, would create over 3,000 more direct jobs per year, 6,000 more total jobs per year, 6,000 more construction and manufacturing jobs per year than Keystone XL 3-state. The upper estimate, $1.8 billion, would create over 1,600 more direct jobs, 1,700 more total jobs and 6,000 more construction jobs than Keystone XL 5-state. These jobs would accrue nationally, as would the jobs in building the Keystone XL pipeline, should it be approved.

VIII. Replacement Gap Analysis

Comparing the Keystone XL pipeline with the total replacement needs for wastewater, drinking water and gas distribution main pipelines in the project-relevant states gives a clear result: replacing the water and gas pipes creates more jobs in total, and more jobs per unit of investment. But aren't these investments going to be made anyway, sooner or later?

We cannot predict with certainty how many miles of pipe are going to be replaced in the future. But we can extrapolate from recent trends in the replacement of pipes to make an educated guess at how many miles are likely to be replaced. We can compare that replacement estimate with a desirable hypothetical replacement project and thus identify a "replacement gap," the filling of which would represent added expenditures that would create jobs above and beyond the existing rate of replacement. This section examines the investment gaps in gas distribution mains, wastewater and drinking water infrastructure, and indicates the potential for job creation from filling those gaps.

A. Gas Distribution Main Replacement Gap

Data from Yardley and Associates (2012) indicates that national replacement of life-elapsed gas distribution mains occurs at a rate of approximately 2.45%.[46] Similarly, replacement of life-elapsed gas distribution service lines is occurring at approximately 3%. If we apply those figures to the miles of gas distribution line needing replacement in five project-relevant states, we arrive at a total expected annual number of miles replaced (see Tables 12a and 12b below). If these states follow the national averages, we can expect that a total of 1267 (=927+340) jobs are being created per year on an ongoing basis, through the pipe replacement process.

[46] This calculation stems from Yardley and Associates' (2012) reported figures of 195,000 miles of mains needing replacement in 1990, versus 112,000 in 2011. The average (net) rate of replacement over the 22-year interval was (195,000 – 112,000)/22 = 3,770 miles per year. This number translates into an average of 2.45% of the pipes needing replacement over that time: 3,770 / [(195,000 + 112,000) / 2] = 0.02457, or 2.45%.

Table 12a. Estimated Average Annual Replacement Miles By State[46]

			Annual Estimates			
State	Leak-Prone Mains (mi)	Miles Replaced	Expenditures (thousands $)	Direct Jobs	Indirect and Induced Jobs	Total Jobs
Montana	11	0	$46	1	0	1
South Dakota	61	1	$253	3	3	6
Nebraska	1,607	39	$6,653	80	65	146
Oklahoma	1,978	48	$8,189	99	81	179
Texas	6,567	161	$27,188	328	268	595
TOTAL: 3-State	**1,679**	**41**	**$6,951**	**84**	**68**	**152**
TOTAL: 5-State	**10,224**	**250**	**$42,328**	**510**	**417**	**927**

Table 12b. Estimated Average Annual Gas Replacement Miles By State

			Annual Estimates			
State	Leak-Prone Services (mi)	Miles Replaced	Expenditures (thousands $)	Direct Jobs	Indirect and Induced Jobs	Total Jobs
Montana	7	0	$39	0	0	1
South Dakota	27	1	$141	2	1	3
Nebraska	69	2	$355	4	3	8
Oklahoma	705	22	$3,647	44	36	80
Texas	2,199	67	$11,372	137	112	249
TOTAL: 3-State	**104**	**3**	**$535**	**6**	**5**	**12**
TOTAL: 5-State	**3,008**	**92**	**$15,554**	**187**	**153**	**340**

Sources and Assumptions: Annual replacement rate 1990-2011 is 3.06%, author's calculations from Yardley and Associates (2012). Average replacement cost per mile is $168,980.70, author's calculations from Thompson (2012).

However, this rate of replacement implies a long time frame for the necessary replacement of life-elapsed pipes (51 years, in the case of the distribution mains). These remaining life-elapsed pipes represent a liability to natural gas consumers and firms. It would be possible to reduce this liability by speeding up the rate of replacement to ensure that all life-elapsed pipes are replaced within a given timeframe, say 20 years. The difference between the number of miles replaced under our proposal and those we would expect to be replaced by following the trend, we will call the *replacement gap*. The replacement gap is calculated in Tables 13a and 13b below. According to Tables 13a and 13b, 444 additional miles of gas distribution main and 58 miles of service lines in the five relevant states would have to be replaced, per year, in order to complete the necessary work within 20 years.

Table 13a. Gas Distribution Main Replacement Gap

State	Total Miles Needing Replacement	Required Annual Miles Replaced for 20-Year Replacement	Estimated Annual Miles Replaced (Table 12)	Annual Replacement Gap
Montana	11	1	0	0
South Dakota	61	3	1	2
Nebraska	1,607	80	39	41
Oklahoma	1,978	184	48	136
Texas	6,567	328	161	167
TOTAL: 3-State	**1,679**	**84**	**41**	**43**
TOTAL: 5-State	**13,904**	**695**	**250**	**445**

Table 13b. Gas Distribution Service Line Replacement Gap

State	Total Miles Needing Replacement	Required Annual Miles Replaced for 20-Year Replacement	Estimated Annual Miles Replaced (Table 12)	Annual Replacement Gap
Montana	7	0	0	0
South Dakota	27	1	1	1
Nebraska	69	3	2	1
Oklahoma	705	35	22	14
Texas	2,199	110	67	43
TOTAL: 3-State	**104**	**5**	**3**	**2**
TOTAL: 5-State	**3,008**	**150**	**92**	**58**

How many additional jobs would filling this replacement gap create? This number is easily calculated from the expenditure and job multiplier figures we have already used in Section III. Table 14 provides the figures and the result. The expenditure gap is derived by multiplying the replacement gap by the per-mile construction costs of $168,980.70. The direct and total additional jobs creation figures are derived by using the job multipliers of 12.05 and 21.89 direct and total jobs per $1 million of investment, respectively. Table 14 indicates that an *additional* **650 direct jobs**, and **1,180 total jobs,** would be created per year if the natural gas distribution companies in the five relevant states committed to replacing all of their leak- and corrosion-prone distribution mains over the next 20 years. Over 20 years, this accelerated program would result in an additional **12,994 direct jobs** and **23,606 total jobs.**[47]

[47] This analysis abstracts from the costs of financing the replacements.

Table 14. Gas Distribution Line Replacement Gap: Annual Expenditures and Job Creation

	Annual Estimates			
State	Replacement Gap (miles)	Expenditure Gap (thousands $)	Additional Direct Jobs	Additional Total Jobs
Montana	0.4	$72	1	2
South Dakota	2	$352	4	8
Nebraska	42	$7,150	86	157
Oklahoma	149	$10,835	131	237
Texas	210	$35,507	428	777
TOTAL: 3-State	**45**	**$7,574**	**91**	**166**
TOTAL: 5-State	**503**	**$53,916**	**650**	**1,180**

B. Water Infrastructure Investment Gaps

To extend the counterfactual analysis to drinking water and wastewater pipe replacement requires taking a different approach: identifying the per capita investment gaps measured by EPA (2002), and translating those gaps into job figures. Following EPA (2002), we find that public investment in drinking water and wastewater infrastructure has fluctuated over the last five decades, around an overall upward trend. Yet this trend has not kept pace with the expenditures necessary to maintain our water infrastructure at a high level of quality. As a result, our nation's water systems suffer from stress; for example, 1.2 trillions of gallons of water overflow our sewer systems every year, and many drinking water systems suffer 20% loss of water supply through leakage (CBO 2002). Meanwhile, federal funding to local governments has been insufficient to keep pace with growing needs, even as federal regulators have enforced mandates more tightly; local governments currently finance 97% of all water infrastructure needs (Anderson 2010). We draw from EPA (2002) to estimate the job creation potential of filling the wastewater and drinking water infrastructure replacement gap.

i. Wastewater Investment Gap

EPA (2002) calculated the 20-year investment gap between projected revenues and necessary expenditures on wastewater and drinking water. They calculated the payments gap, or the gap in spending including financing costs, under two assumptions: no revenue growth, and revenue growth of 3%. There are two components to the payments gap: capital payments and operations and maintenance (O&M). The point estimate for the national 20-year capital payments gap in wastewater infrastructure is $122 billion in the no-growth scenario and $21 billion in the 3% revenue growth scenario.[48] The point estimate for the O&M payments gap is $148 billion in the no-growth scenario and $10 billion in the 3% growth scenario.

[48] EPA (2002) also gives the low and high end of the range of estimates. The range of estimates for the capital payments gap in the no-growth scenario is $73-$177 billion, and the range in the 3% growth scenario is $0-$94 billion.

The study assumes that growth in revenue devoted to water infrastructure tracks growth in real GDP; since average real GDP growth rate over the period 2000-2012 was approximately 2% per year, we can assume that existing revenues cover two-thirds of the gap between the growth and no-growth scenarios. If we make the assumption that revenue growth for wastewater expenditures does in fact track real GDP growth, we arrive at a 20-year wastewater infrastructure capital payments gap of $54.67 billion in 2001 dollars, which translates to $71.91 billion in 2013 dollars.[49]

Following the same method as above, the corresponding O&M investment gap is $56 billion in 2001 dollars, which is equivalent to $73.84 billion in 2013 dollars. Our best estimate for the total national wastewater infrastructure investment gap, then, is 71.91 + 73.84 = $145.75 billion over 20 years, or $7.2875 billion per year. This breaks down to $462.70 per capita over 20 years, or **$23.14 per person, per year**.

Applying the per capita averages to the five relevant states, the annual wastewater infrastructure payment gap will thus total $777 million, and the 20-year gap for these states will total $15.54 billion. Applying the PERI multipliers for water infrastructure job creation, we find that such expenditures will create **an additional 7,737 direct jobs** per year, and **an additional 15,354 total jobs** per year. Summing over 20 years, filling the wastewater infrastructure investment gap will yield us an **additional 154,740 direct person-years** of employment in the five relevant states, and an **additional 307,080 total person-years** of employment. It is safe to assume that these jobs *would not otherwise be created* by existing or planned future investments, even under optimistic projections of revenue growth. These figures are summarized below in Table 15 below.

Table 15. Total Wastewater Infrastructure (Capital and O&M) Replacement Gap: Expenditures and Jobs By State [50]

State	Population (thousands, 2012)	Total Expenditure Need (millions $)	Direct Jobs	Total Jobs
Montana	1,005	$23.3	232	460
South Dakota	833	$19.3	192	381
Nebraska	1,856	$42.9	428	849
Oklahoma	3,815	$88.3	879	1,745
Texas	26,059	$603.0	6,006	11,920
TOTAL: 3-State	**3,694**	**$85.5**	**851**	**1,690**
TOTAL: 5-State	**33,568**	**$776.8**	**7,737**	**15,354**

[49] To make the conversion, we use the BLS inflation calculator at http://www.bls.gov/data/inflation_calculator.htm.
[50] Population data from US Census (2012); Annual Per Capita Gap of $23.14 and Total Expenditure Need calculated from EPA (2002); Direct Jobs Created and Total Jobs Created calculated from water infrastructure multipliers given in Heintz et al (2009).

The above analysis covers all categories of wastewater infrastructure, which include not only pipe replacements but treatment plants, pumping stations, new sewers and the like.[51]

ii. Drinking Water Investment Gap

EPA (2002) also estimates the corresponding gaps for drinking water. The capital payments gap is estimated (in 2001 dollars) at $105 billion in the no-growth scenario and $45 billion in the 3% revenue growth scenario; we can thus assume a gap of $65 billion (2001 dollars), or $85.5 billion (2013 dollars) nationwide based on revenue growth projections of 2%. The O&M gap is estimated at $161 billion in the no growth scenario and $0 in the 3% growth scenario; based on our 2% scenario we estimate an O&M gap of $53.67 billion (2001 dollars), or $70.76 billion (2013 dollars). The total drinking water infrastructure gap is thus $156.26 billion over 20 years, or $496.06 per person. Annually, the gap is $7.813 billion, or $24.80 per person.

Table 16 below indicates the expenditure and job creation impacts in the five relevant states from filling the drinking water infrastructure gap. Across the five states, filling this gap will require expenditures of approximately $832.5 million, which will create an additional **8,292 direct jobs** and **16,456 total jobs**. Summed over twenty years, filling the gap will create 165,840 direct jobs and 329,120 total jobs.

Table 16. Total Drinking Water Infrastructure (Capital and O&M) Gap: Expenditures and Jobs By State[52]

State	Population (thousands, 2012)	Total Expenditure Need (millions $)	Direct Jobs	Total Jobs
Montana	1,005	$24.9	248	493
South Dakota	833	$20.7	206	409
Nebraska	1,856	$46.0	458	910
Oklahoma	3,815	$94.6	942	1,870
Texas	26,059	$646.3	6,437	12,775
TOTAL: 3-State	**3,694**	**$91.6**	**912**	**1,811**
TOTAL: 5-State	**33,568**	**$832.5**	**8,292**	**16,456**

iii. Drinking Water Pipe Replacement Gap

Drinking water pipe replacement needs are a subset of total drinking water investment needs. Thus, from the larger estimate of the total drinking water infrastructure gap, we can derive the portion of this gap that stems from pipe replacements alone. Pipe replacements alone represent 55.3% of drinking water infrastructure capital needs; pipe replacements do not enter into O&M expenditures. Hence the pipe

[51] A full description of the categories of wastewater infrastructure can be found at the website of the EPA's Clean Watersheds Needs Survey: http://water.epa.gov/scitech/datait/databases/cwns/

[52] Population data from US Census (2012); Annual Per Capita Gap of $24.80 and Total Expenditure Need calculated from EPA (2002); Direct Jobs Created and Total Jobs Created calculated from water infrastructure multipliers given in Heintz et al (2009).

replacement investment gap is 55.3% of the capital needs gap, or $47.3 billion in 2013 dollars. (In this analysis, pipe replacements cover both transmission lines and distribution mains.) The drinking water pipe replacement capital gap translates into approximately $150 per person nationwide over 20 years, or $7.50 per person, per year.

Across the five relevant states, the annual drinking water pipe replacement capital gap will be $251.76 million. Pipe replacement alone would generate an additional **2,508 direct jobs** per year, and an additional **4,977 total jobs** per year, if filled. The total 20-year payment gap across the five states will be $5.04 billion, which would generate an additional **50,150 direct person-years** of employment, and an additional **99,530 total person-years** of employment. *These numbers represent jobs in pipefitting and related construction industries that would be created through responsible public investment in drinking water infrastructure, but are not currently being created due to under-investment.* These results are summarized in Table 16b below.

Table 17. Drinking Water Pipe Capital Payments Gap: Expenditures and Jobs By State

State	Population (thousands, 2012)	Total Expenditure Need (millions $)	Direct Jobs	Total Jobs
Montana	1,005	$7.5	75	149
South Dakota	833	$6.3	62	124
Nebraska	1,856	$13.9	139	275
Oklahoma	3,815	$28.6	285	566
Texas	26,059	$195.4	1,947	3,863
TOTAL: 3-State	**3,694**	**$27.7**	**276**	**548**
TOTAL: 5-State	**33,568**	**$251.8**	**2,508**	**4,977**

C. Job Creation from Filling Water and Gas Infrastructure Gaps

We return to the broader category of water infrastructure to arrive at estimates of the job creation potential of filling the investment gap across the three categories of drinking water, wastewater, and gas distribution infrastructure. Summing across all three categories of infrastructure, we find that under conservative assumptions, there exists a documented ***annual*** unmet need for investment expenditures in gas and water infrastructure that would yield an additional **16,678 direct jobs**, and **32,990 total jobs per year** in the five states relevant to the Keystone XL pipeline project, including the Gulf Coast Segment. As Table 17 demonstrates, these numbers are comparable to the projected annual job creation figures for Keystone XL in the five-state case. The take-away message is:

Filling projected annual investment shortfalls in water and gas infrastructure in the five Keystone XL-relevant states could create as many jobs per year as would be created in building the pipeline.

Table 18a. Annual Expenditures and Job Creation Related to Infrastructure Replacement Gap: 5-State Total

	Expenditures (millions $)	Direct Jobs	Total Jobs
Gas Distribution	$53.9	650	1,180
Wastewater	$776.8	7,737	15,354
Drinking Water	$832.5	8,292	16,456
TOTAL	**$1,663.2**	**16,678**	**32,990**
Keystone XL 5-State	$2,493.1	16,265	33,836
Ratio to Keystone XL 5-State	0.7	1.0	1.0

Table 18b. Annual Expenditures and Job Creation Related to Infrastructure Replacement Gap: 3-State Total

	Expenditures (millions $)	Direct Jobs	Total Jobs
Gas Distribution	$7.6	91	166
Wastewater	$85.5	851	1,690
Drinking Water	$91.6	912	1,811
TOTAL	**$184.3**	**1,855**	**3,666**
Keystone XL 3-State, in-State Hiring	$1,550.0	2,187	5,800
Ratio to Keystone XL	$0.1	0.85	0.63

The investment gaps estimated by EPA (2002) and used in this analysis are relatively conservative; other studies project much higher funding shortfalls.[53] The American Society of Civil Engineers, for example, estimated in 2009 that the nation as a whole faced an *annual* shortfall of $11 billion in replacement of aging drinking water and wastewater infrastructure (Anderson 2010). On a per-capita basis, that shortfall translates into approximately $35 per person per year, or $1.175 billion total across the five relevant states. Making up a reported investment shortfall of that magnitude would create an additional **11,702 direct jobs** and **23,224 total jobs**, *on an annual basis.* In 2000, the Water Infrastructure Network estimated an even higher annual funding gap for drinking water and wastewater infrastructure: $23 billion per year, of which $12 billion represented drinking water and $11 billion wastewater. The shortfall calculated by WIN includes both capital spending and operations and maintenance (O&M) spending; our estimates above include only capital spending. O&M spending has exceeded capital spending in every decade since the 1980s (Anderson 2010). Filling the total infrastructure funding gap, including O&M spending, reported

[53] They also represent low estimates by EPA's (2002) admission. EPA (2002) writes: "It is important to recognize that the funding gaps occur only if capital and O&M spending remains unchanged from present levels. *This assumption clearly understates future spending*." (author's emphasis added)

by WIN in the five Keystone XL states alone would yield approximately an additional **23,000 direct jobs** and **46,000 total jobs,** *per year.*

IX. Conclusion: The Case for Infrastructure Investment

Given a still-weak economy and high unemployment rate, there are scarce resources available for job creation projects. These resources should be spent on projects, programs and policies that create real long-term and short-term benefits to the American economy in the form of family-supporting jobs, increased incomes and a clean environment. Keystone XL is not one of those projects; while it creates a non-negligible number of jobs in the short run, in the long run it will have virtually no effect. By contrast, a comprehensive national infrastructure upgrade will create benefits in both the short and the long run.

There is a growing chorus of voices throughout the United States academic, government, and professional communities that advocates for such an upgrade. This group of advocates includes professional associations such as the American Society of Civil Engineers and American Water Works Association, academic institutes such as the Political Economy Research Institute at the University of Massachusetts Amherst, think tanks such as the Center for American Progress, as well as government departments and agencies such as the EPA, the Department of Transportation, and the Treasury.

The Department of the Treasury (2012), for example, recently wrote an analysis supporting the President's proposal for a national Infrastructure Bank on economic grounds. This analysis proposed the renewal of Great Recession financing instruments, such as Build America Bonds, to facilitate private sector investment into public infrastructure projects. Build America Bonds have been endorsed by a wide array of political and industry groups including the U.S. Conference of Mayors, the Council of State Governments, and the Securities Industry and Financial Markets Association (SIFMA) as "improving efficiency, liquidity and transparency for borrowers and investors alike" (Department of the Treasury 2013). This kind of financial instrument can and should also be endorsed by labor unions and sustainability advocates as an important means of creating family-supporting jobs in clean industries.

Finally, this report only compares the short-run job impacts of identified necessary infrastructure investments and leaves out the broader question of the long-run economic impact of such investments. American Society of Civil Engineers (ASCE 2011) argues that the long-run economic impact of failure to invest in water infrastructure will be severe:

> Doing nothing and living with water shortages, and higher rates (rationing through price increases); major outlays by businesses and households, including expenditures incurred by moving to where infrastructure is still reliable, purchasing and installing equipment to conserve water or recycle water, and increasing reliance on self-supplied water and/or wastewater treatment (i.e., installing individual wells and septic waste systems when municipal facilities and services are not available options); and incurring increased medical costs to address increases in water-borne illnesses due to unreliable

delivery and wastewater treatment services. (ASCE 2011, v)

ASCE (2011) estimates that by 2040, the cumulative direct cost of all of these damages to the national economy will be *$2.2 trillion*, *1.2 million jobs* will be at risk, and total cumulative losses to GDP will be *$4.1 trillion*. These figures assume that current trends in water infrastructure investment continue.

In summary, we conclude that labor organizations in the pipefitting and construction industries should withdraw their support from Keystone XL and instead use their voices to campaign for rehabilitated and upgraded infrastructure, particularly in the areas of water and natural gas. Replacement of aging wastewater, drinking water and gas distribution main pipes is a more efficient job creator than Keystone XL, measured per unit of investment. There exists significant unmet water and gas infrastructure capital investment need within the five states covered by Keystone XL, including the Gulf Coast Segment. Meeting the currently unmet water and gas infrastructure replacement needs in the five relevant states will create many more jobs in the medium to long run, and more construction-related jobs in the short run, than Keystone XL. And the jobs created by the infrastructure replacements will be more heavily concentrated in pipefitting and related construction sectors than the jobs created by Keystone XL.

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