U.S. Rail Crude Oil Traffic

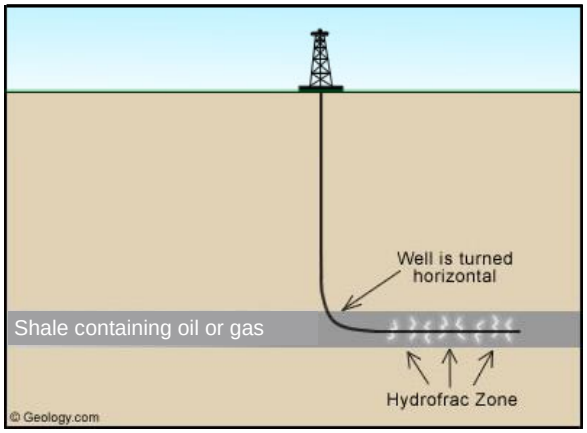
ASSOCIATION OF AMERICAN RAILROADS MAY 2017

Summary

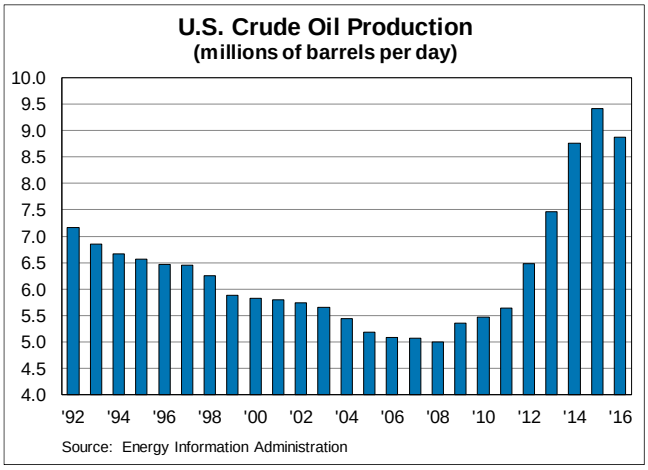
U.S. crude oil production has risen sharply in recent years, with much of the increased output moving by rail. In 2008, U.S. Class I railroads originated 9,500 carloads of crude oil. In 2014, they originated 493,146 carloads, an increase of nearly 5,100 percent. However, rail volumes fell to 409,949 carloads in 2015 and to 211,986 carloads in 2016. Rail crude oil volumes are affected by a variety of factors, including pipeline capacity and crude oil price spreads.

The Shale Revolution Has Led to Sharply Higher Crude Oil Production

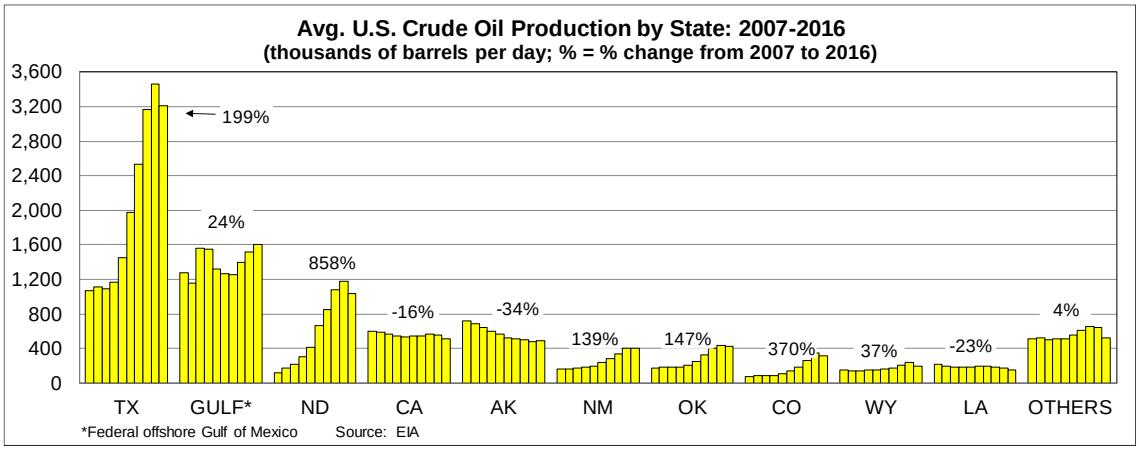
- Throughout the world, huge quantities of crude oil and natural gas are trapped in non-permeable shale rock. In recent years, technological advances in hydraulic fracturing ("fracking") and horizontal drilling have made recovery of much of this oil and gas economically feasible.



- The most important U.S. shale deposits are the Bakken, mainly in North Dakota; Barnett, Eagle Ford, and Permian in Texas; Marcellus in the east, especially Pennsylvania and Ohio; and Niobrara in Wyoming and Colorado. Some areas contain more natural gas than crude oil; others contain more oil than natural gas. Thanks to shale, economically recoverable U.S. gas and oil reserves are much greater than they were thought to be just a few years ago.



- U.S. crude oil production in 1970 averaged 9.6 million barrels per day. By 2008, it had fallen to just 5.0 million barrels per day as new fields failed to keep pace with depletion of older fields. However, thanks mainly to growth in shale oil, U.S. crude oil production grew to 9.4 million barrels per day in 2015 before falling somewhat in 2016.



- Much of the recent increase has been in North Dakota, where crude oil production rose from an average of 81,000 barrels per day in 2003 to 1.2 million barrels per day in 2015 and 1.0 million barrels per day in 2016, making North Dakota the second-largest oil producing state. Crude oil output in Texas has skyrocketed since 2009, reaching an average of 3.5 million barrels per day in 2015 and 3.2 million in 2016.

- It's difficult to overstate the economic benefits associated with growth in domestic crude oil production. Among other things, it has meant:

  ✓ Reduced reliance on oil from sources in the world that are not secure and whose interests do not necessarily correspond well to those of the United States.

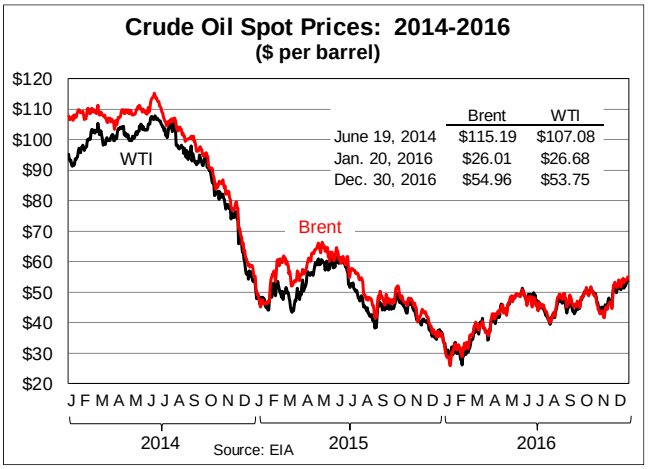
  ✓ Reduced vulnerability to oil shocks that in the past have caused immense harm to the U.S. economy.

  ✓ New and better employment and economic development opportunities for communities all over the country.

  ✓ Billions of dollars in new tax revenues.

  ✓ Reductions in the U.S. trade deficit of tens of billions of dollars every year.

- The surge in U.S. crude oil output, combined with relatively weak global demand for crude oil due to economic weakness in many countries, led to an oversupply of crude oil and a sharp decline in crude oil prices beginning around June 2014. By January 2016, crude oil spot prices were more than 70 percent lower than they were in June 2014 (see the chart at right). Some U.S. producers who could not extract oil profitably at that price level were forced out of the market, which helps explain why U.S. crude oil production was a bit lower in 2016 than in 2015. Continued technological advances have allowed many U.S. producers to lower their "break even" price point, setting the state for renewed growth in U.S. crude oil production.



Volumes of Crude Oil by Rail

The growth in domestic crude oil production presents a tremendous opportunity for the United States to move closer to energy independence. Railroads have been crucial to this effort:

- Crude oil has little value unless it can be transported to refineries, but most U.S. refineries are located in traditional crude oil production areas (Texas, Oklahoma, Louisiana) or on the coasts where crude oil transported by tanker is readily accessible (California, Washington, New England, Gulf of Mexico), rather than near new production areas like North Dakota. It's impossible for refineries to come on line quickly near the new production areas, in part because it takes so long to obtain necessary permits.

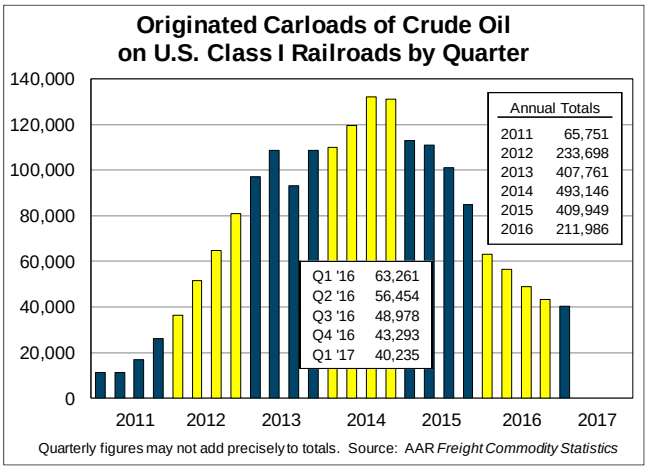
U.S. Crude Oil Refineries and Pipelines

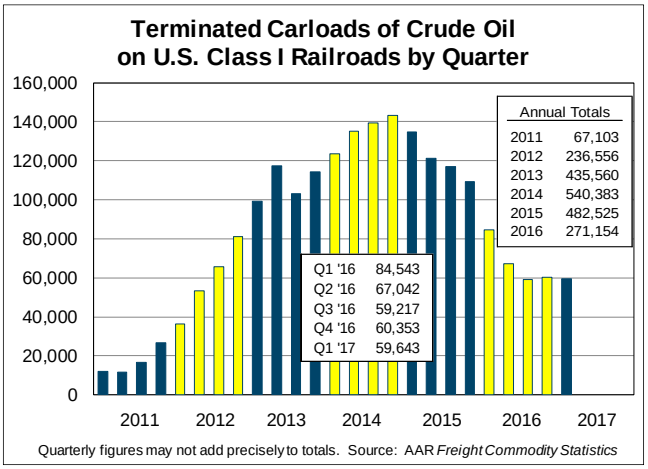
- Historically, pipelines have transported most crude oil. However, in North Dakota, higher crude oil production outpaced growth in crude oil pipeline capacity. Railroads helped fill this gap. In fact, as U.S. crude oil output surged, so too did crude oil carloads on U.S. railroads. Originated carloads of crude oil on U.S. Class I railroads (including the U.S. subsidiaries of Canadian railroads) rose from 9,500 in 2008 to 493,146 in 2014. Terminated carloads of crude oil on U.S. Class I railroads rose from 9,344 in 2008 to 540,383 in 2014.[1]

- However, growth in pipeline capacity, a narrowing in the "spread" between domestic and imported oil, and other factors have led to a sharp decline in rail shipments of crude oil. After peaking in 2014, originated carloads of crude oil on U.S. Class I railroads fell to 409,949 in 2015 (down 17 percent from 2014) and 211,986 carloads in 2016 (down 57 percent from 2014). In the first quarter of 2017, U.S. Class I railroads originated 40,235 carloads of crude oil, down 36% from the first quarter of 2016 and the lowest for any quarter since the first quarter of 2012. Terminated Class I carloads of crude oil were 484,525 in 2015 (down 11 percent from 2014's peak) and 271,154 carloads in 2016 (down

[1] "Originated" carloads are loaded carloads beginning a rail journey; "terminated" carloads are loaded carloads completing a rail journey. U.S. Class I originations do not equal U.S. Class I terminations because some crude oil that originates on U.S. Class I railroads is terminated by U.S. short line railroads or by railroads in Canada. Likewise, some crude oil that terminates on U.S. Class I railroads originates on railroads in Canada or on U.S. short line railroads.

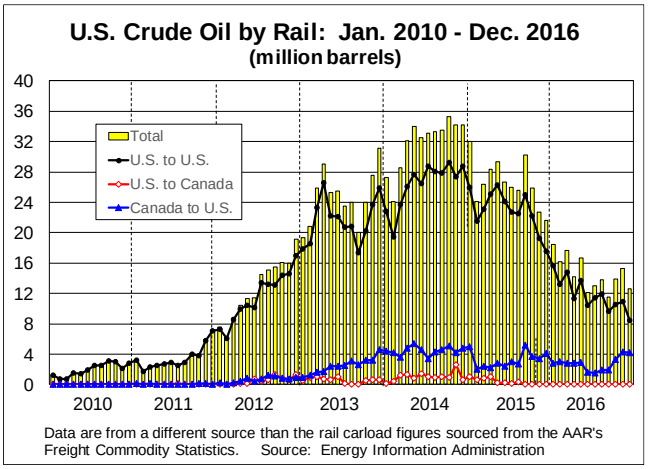
50 percent from 2014 — see the charts below). The decline continued into 2017 — in the first quarter, U.S. Class I railroads terminated 59,643 carloads of crude oil, down 29% from terminations in the first quarter of 2016.

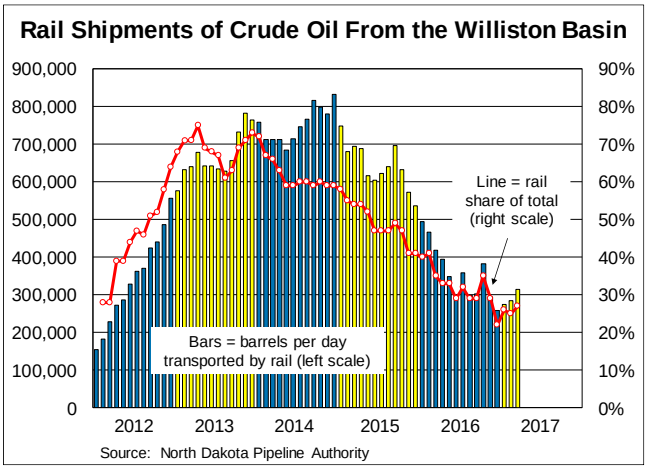




- All told, from the first quarter of 2009 through the first quarter of 2017, U.S. Class I railroads originated 1.9 million carloads of crude oil and terminated 2.1 million carloads. At its peak in 2014, crude oil accounted for 1.6 percent of total originated carloads on Class I railroads. In 2016, it accounted for 0.8 percent.

- The amount of crude oil in a rail carload varies depending on (among other things) the source of the oil, the type of tank car used, and the season of the year. In 2016, the average carload of crude oil originated in the United States carried approximately 700 barrels of oil. Using that, the 211,986 carloads of crude oil originated by U.S. Class I railroads in 2016 was equivalent to around 407,000 barrels per day. According to data from the Energy Information Administration (EIA), U.S. crude oil production in 2016 averaged 8.9 million barrels per day, so the rail share was approximately 4.6 percent of total production. In 2014, the peak year for rail crude oil shipments, railroads accounted for around 11 percent of U.S. crude oil production.

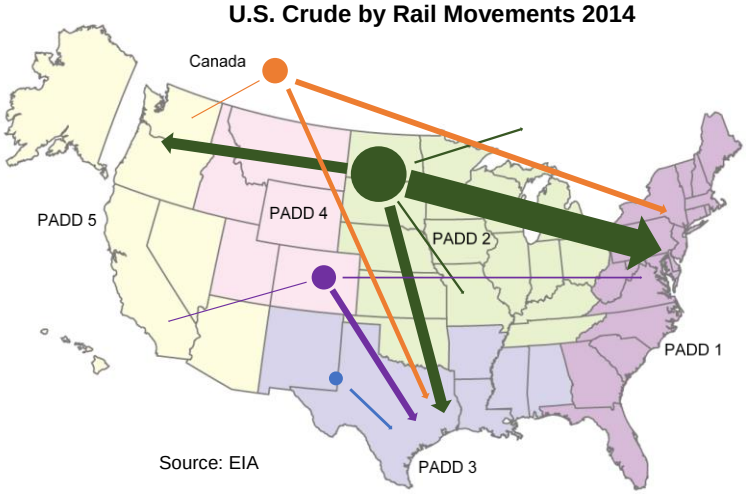




- The Bakken region has accounted for the vast majority of rail crude oil originations in recent years. According to the North Dakota Pipeline Authority, near the end of 2014 around 800,000 barrels of crude oil per day were moving out of the area by rail. By the end of 2016, though, this was down to well under 300,000 barrels per day (see the bars in the chart on the bottom right of the previous page). The rail share of North Dakota crude oil movements averaged around 62 percent in 2014, but only around 32 percent in 2016. Meanwhile, the pipeline share rose from around 31 percent in 2014 to around 57 percent in 2016. According to the North Dakota Pipeline Authority, pipeline capacity for movement of Williston Basin crude oil rose from 170,000 barrels per day in 2007 to 1.2 million barrels per day in 2017.

- The EIA combines data from the AAR and elsewhere to estimate movements of crude oil by rail by month between the United States and Canada and between U.S. Petroleum Administration for Defense Districts (PADDs). The maps on this page and the tables on the next page are based on EIA data.

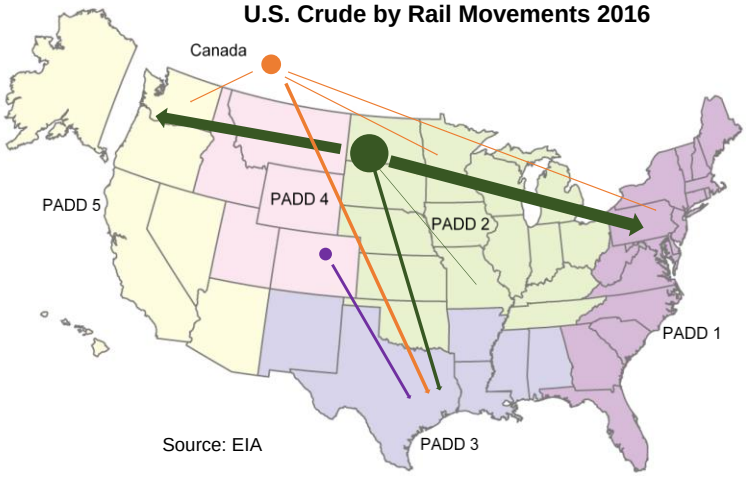
U.S. Crude by Rail Movements 2014



- EIA's data show that PADD 2 (mainly North Dakota) has been, and remains, by far the dominant source of U.S. crude oil moved by rail. From 2011 through 2016, PADD 2 accounted for 83 percent of U.S. crude-oil-by-rail originations, far ahead of PADD 4 (Rocky Mountain region, 10 percent) and PADD 3 (Texas and the Gulf Coast, 6 percent).

- In 2014, 261 million barrels of oil originated by rail in PADD 2, with more than half going to PADD 1 (the East Coast) and 20 percent going to both PADD 3 and PADD 5 (the West Coast). By contrast, in 2016, according to EIA data, PADD 2 rail originations had fallen to 124 million barrels — 52 percent lower than in 2014.

U.S. Crude by Rail Movements 2016



- For PADD 4, rail originations fell from 48.9 million barrels in 2014 to 14.3 million barrels in 2016, a 71 percent decline. For PADD 3, rail originations fell from 16 million barrels in 2014 to virtually nothing in 2016. And for crude oil originating in Canada and moving by rail down into the United States, volumes fell from 53.2 million barrels in 2014 to 33.1 million barrels in 2016, according to EIA data.

CRUDE OIL BY RAIL FROM PADD 2 TO:

	PADD 1	PADD 2	PADD 3	PADD 5	Canada	TOTAL
	(million barrels)					
2011	1.97	11.71	15.21	1.37	0.26	30.52
2012	20.05	14.50	71.15	7.28	6.22	119.19
2013	84.35	19.93	88.76	30.80	7.22	231.06
2014	134.57	10.23	52.45	52.93	10.90	261.08
2015	135.17	8.43	29.30	50.06	4.42	227.38
2016	58.07	1.87	15.58	48.74	0.00	124.05
	(% of PADD 2 total)					
2011	6%	38%	50%	4%	1%	100%
2012	17%	12%	60%	6%	5%	100%
2013	37%	9%	38%	13%	3%	100%
2014	52%	4%	20%	20%	4%	100%
2015	59%	4%	13%	22%	2%	100%
2016	47%	2%	13%	39%	0%	100%

PADD 4 = 0 for all years Source: EIA

CRUDE OIL BY RAIL FROM PADD 3 TO:

	PADD 2	PADD 3	PADD 5	Canada	TOTAL
	(million barrels)				
2011	0.20	7.21	0.00	0.00	7.42
2012	0.28	17.68	0.39	0.00	18.35
2013	0.00	20.79	0.57	0.00	21.37
2014	0.00	14.03	1.97	0.00	16.00
2015	0.00	5.26	1.85	0.00	7.11
2016	0.00	0.72	0.55	0.00	1.27
	(% of PADD 2 total)				
2011	3%	97%	0%	0%	100%
2012	2%	96%	2%	0%	100%
2013	0%	97%	3%	0%	100%
2014	0%	88%	12%	0%	100%
2015	0%	74%	26%	0%	100%
2016	0%	56%	44%	0%	100%

PADD 1 & 4 = 0 all years Source: EIA

CRUDE OIL BY RAIL FROM PADD 4 TO:

	PADD 1	PADD 2	PADD 3	PADD 5	Canada	TOTAL
	(million barrels)					
2011	0.00	0.00	0.96	0.00	0.00	0.96
2012	0.00	0.69	3.54	0.24	0.00	4.48
2013	0.13	0.30	8.75	0.87	0.17	10.21
2014	9.40	2.59	30.93	4.28	1.71	48.90
2015	7.24	1.36	28.97	4.12	0.00	41.82
2016	0.58	0.00	13.51	0.21	0.00	14.32
	(% of PADD 4 total)					
2011	0%	0%	100%	0%	0%	100%
2012	0%	15%	79%	5%	0%	100%
2013	1%	3%	86%	8%	2%	100%
2014	19%	5%	63%	9%	3%	100%
2015	17%	3%	69%	10%	0%	100%
2016	4%	0%	94%	1%	0%	100%

PADD 4 = 0 for all years Source: EIA

CRUDE OIL BY RAIL FROM CANADA TO:

	PADD 1	PADD 2	PADD 3	PADD 5	TOTAL
	(million barrels)				
2011	0.02	0.00	0.46	0.27	0.75
2012	4.47	0.33	2.41	0.60	7.81
2013	11.77	1.24	14.01	2.46	29.48
2014	26.36	0.64	21.91	4.24	53.15
2015	9.64	1.64	23.39	4.48	39.15
2016	4.91	5.62	17.48	4.52	33.09
	(% of from Canada total)				
2011	3%	0%	62%	36%	100%
2012	57%	4%	31%	8%	100%
2013	40%	4%	48%	8%	100%
2014	50%	1%	41%	8%	100%
2015	25%	4%	60%	11%	100%
2016	15%	17%	53%	14%	100%

PADD 4 = 0 for all years Source: EIA

Advantages of Transporting Crude Oil by Rail

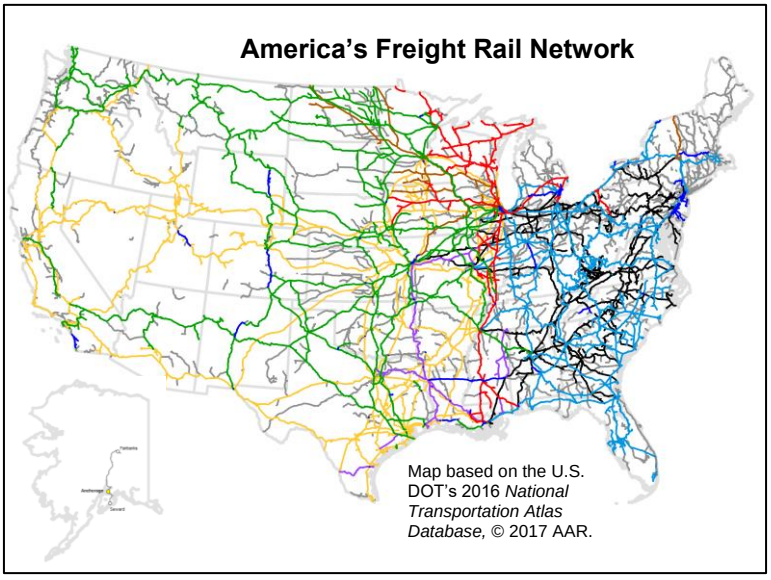
Pipelines transport most crude oil, but railroads have become critical players. In addition to the critical fact that railroads have been able to provide transportation capacity in areas where pipeline capacity has been insufficient, railroads offer other advantages:

- Geographical flexibility. Railroads serve or could serve nearly every refinery in the United States and Canada, giving market participants enormous flexibility to shift product quickly to different places in response to market needs and price opportunities.
- Responsiveness. Rail facilities can almost always be built or expanded much more quickly than pipelines and refineries, making it much more likely that railroads will be able to keep up with production growth in emerging oil fields.

Railroad Crude Oil Loading and Unloading Terminals

- Efficiency. As new rail facilities are developed, railroads are involved every step of the way. For example, at origin and destination sites, railroad economic development and operations teams help facility owners decide where to locate assets and how to lay out rail infrastructure on the site to maximize efficiency.

  Railroads also help crude oil customers find ways to load and unload tank cars more quickly and reduce en-route delays. Promoting unit train shipments is often a key part of this process. Unit trains are long trains (usually at least 50 and sometimes more than 100 cars) consisting of a single commodity. They often use dedicated equipment and generally follow direct shipping routes to and from facilities designed to load and unload them efficiently. A unit train might carry more than 70,000 barrels of oil and be loaded or unloaded in 24 hours.



- Spending. In recent years, railroads have spent tens of billions of dollars on infrastructure and equipment to enhance their ability to transport crude oil and other commodities.