Fw: Chief Scientist Investigation
CSG Review [redacted] 14/08/2013 02:02 PM
Sent by: Rebecca Radford

History: This message has been replied to.

[redacted]

From: "Adrian Ingleby" <rufusyb@bigpond.com>
To: <csg.review@chiefscientist.nsw.gov.au>
Date: 14/08/2013 01:13 PM
Subject: Chief Scientist Investigation

From: Adrian Ingleby, 67 Station Road, Otford NSW 2508 Tel: (02) 4294 3047

Hi,

I forwarded a report via email to the office of the NSW Chief Scientist on 05.06.2013 in relation to her investigation into Coal Seam Gas mining. Ref: SUB 0228.

I recently came across a copy of the National Geographic - March 2013 which has an article titled, "The New Oil Landscape" written by Edwin Dobb. (12 pages attached) The article is about "Oil drilling" as opposed to "Coal Seam Gas drilling" however a similar method of extraction by "drilling" and "fracking" is used and in my respectful view may be useful as it gives a good overview of such mining practices in western North Dakota. We may be able to learn from those experiences.

No doubt you have received submissions from Agricultural Farmers throughout NSW and I feel this article accurately describes the impact the oil drilling has had on Agricultural Farmers in the USA., Many of the farmers in America would no doubt share the same concerns that the Farmers in Australia have about Coal Seam Gas mining.

In America the States have control and responsibility for mining, it is not a Federal responsibility. The same applies in Australia and I believe that the States, in Australia (and America) have a conflict of interest, as they receive, want and need the mining royalties from the mining to run the State.

I respectfully submit that in Australia the Federal Government needs to take overall 'command and control' of Coal Seam Gas mining to ensure that our water, land and air is not damaged and that each State and Territory is acting to that end under potential strict

new Federal laws and guidelines.

I hope that the article might be of interest and assistance during your deliberations . A 4 page summary of the article is also attached or on a following email .

Regards,

Adrian Ingleby National Geographic - 2013 - Summary.doc The New Oil Landscape Nat Geo 2013.pdf

The New Oil Landscape Nat Geo 2013_0001.pdf The New Oil Landscape Nat Geo 2013_0002.pdf

National Geographic
VOL. 223 No. 3
March 2013

The New Oil Landscape
By Edwin Dobb

A summary of some of the comments and statistics supplied in the article
(4 pages)

P34:
Water truck driver Susan Connell pulls up on the Fort Berthold Reservation in western North Dakota next to six 3 storey high tanks. Five contain oil and the sixth contains everything else, 'produced water' which the truckies call 'dirty water.' We have to climb a steel catwalk 30 feet above ground, she says that one of the first times she opened the hatch atop a dirty water tank, she was overcome by fumes. "I fell to my knees." No one had warned her about the dozens of chemicals in the water, including hydrogen sulphide, H2S, its rotten-egg odor created by bacteria growing inside wells. In high enough concentrations it can be poisonous, even lethal. Eventually someone gave her an H2S detector which she clipped to her collar whenever she approached a well that had turned "sour" enough to be hazardous. Once she was pumping dirty water from her tanker truck when the detector sounded. She scrambled away, thinking she'd escaped harm. But hours later she felt stabbing pains in her stomach, the prelude to a weeklong bout of vomiting. Her next purchase was a gas mask.

Since 2006 production has increased nearly 150 fold, to more than 660,000 barrels a day. North Dakota is second place among domestic supplier, behind Texas and ahead of Alaska.

The number of wells could increase from 8,000 operating today to between 40,000 and 50,000.

P37:
Another risk is environmental damage. Hydraulic fracturing or fracking. Where will the clean water come from? How will the dirty water that's pumped out be prevented from contaminating groundwater, as has happened in other parts of the country?

The extraction technology has convinced some experts that the carbon-based economy can continue much longer than they'd imagined. Billionaire oil-man Harold Hamm argues that the assumption we're running out of oil and gas is false. America, in his view, needs a national policy based on abundance, one that doesn't favour developing renewable sources of energy. Either way, you're not likely to hear anyone in the oil patch mention what's ultimately at stake if we keep burning fossil fuels with abandon.

"Climate change?" Connell says, "We don't talk about that here."

P44:
Harold Hamm's Continental Resources and other nimble companies had refined that technology by extending the lateral leg as far as two miles and altering the fracking-solution recipe. In 2006 an EOG Resources well produced oil under so much pressure that the company had to shut down the well until a second one could be drilled to reduce the pressure. "That created huge excitement," recalls Lynn Helms, director of the North Dakota Department of Mineral Resources. Anticipation was building. The turning point came at the end of 2009, when Brigham Oil & Gas split the single lateral leg of a well south of Williston into 25 legs, each of which was fracked separately, making it possible to reach more oil-hundreds of barrels a day.

Helms calculated that the first year of every new well, from drilling to fracking to early production, would entail 2,0000- truck trips. This didn't include the hauling out of huge amounts of oil and salt water during the remainder of a well's life.

P45:
I visited a well northeast of Williston. A leak had developed at the bottom of the vertical leg, about two miles underground. To bring the pipe to the surface, a derricklike structure, similar to a drill rig but smaller, had been erected. On a deck about 30 feet up the rig, four roughnecks were removing the entire 10, 750 feet of pipe, one 32 foot, 500 pound segment at a time, a task both tedious and highly dangerous. A device underneath the deck held each segment in place as it emerged, to prevent the pressure of the oil from sending all two miles of pipe, some 84 tons of steel, rocketing into the sky. As if to remind us of that possibility, a fountain of oil suddenly burst from the hole, covering the men, their hard hats, faces, everything. The odor of gas permeated the air. More fountains followed. Here were guys who knew what they were doing, who were exposed to constant peril, who were paid well, and who, because of that, had ample reason to be proud. It was skilled manual labor in perilous circumstances, which in our age of high-tech jockeys and private-equity sharks seemed exotic, almost heroic.

Seven years ago Power Fuels, a Watford City-based company that specializes in transporting oil, water and other fluids, had a staff of 50. Today it has 1,200 employees in four different towns and is building eleven 42 unit apartment complexes to house them. An 18-wheeler tank truck can bring in $40,000 a month- if everything goes right.

P50:
But viewed at close range, the apparent robustness of the Bakken boom sometimes looks like a collection of fragile mini-booms. Within six months of Connell's lucky layover in Parshall, for instance, her new boss didn't have enough work to keep her on.

Of everything that's happening here today-of all the change and growth-what will last? Will the enduring things be the most desirable things? These questions haunt Dan Kalil, chairman of the Williams County Board of Commissioners. "Oil is a rental business," he says, meaning that it doesn't stay in one place, doesn't owe any allegiance to the traditional farming and ranching way of life, which Kalil's family has been doing west of Williston, the county seat, for more than a hundred years. Perhaps nothing better symbolizes the contrast than the two most iconic structures on

this part of the prairie-the itinerant drill rig and the steadfast grain silo. "When the industry goes south, and it will go south," Kalil says, "they just walk away." Kalil doesn't oppose development, only development that's run amok, which is how he sees this boom. "Slow it down." He urges, echoing a sentiment-a recurring, ever louder counterchorus-heard throughout the oil patch. Contain it before it destroys the closely bound communities and easygoing lifestyle that, during the best of times, have been the hallmarks of the region.

The only effective way (to slow things down) would be to limit the number of drill rigs or well permits, and state officials have no appetite for either. "It breaks my heart," Kalil says.

P51:
The Jorgensons' place in the northwest corner of Mountrail County, fields of wheat, alfalfa and sunflowers spread to the horizon. … We arrived at White Earth River, the valley floor is where a company called Alliance Pipeline plans to locate a 12-inch high-pressure gas conduit that would connect an existing gas-processing plant in Tioga to its main line some 80 miles away. The Jorgensons and several of their neighbors vehemently oppose the project. "I don't want a bomb in my backyard." Richard says, meaning a possible gas explosion.

P56:
But Alliance has gone to court, threatening to use eminent domain, the controversial process by which private property can be seized in the name of a larger public good, in this instance, providing energy the U.S. demands. 800 feet from their house a Petro-Hunt pump jack runs day and night, with the attendant noise, traffic, and contamination risks.

North Dakota allows landowners to separate surface rights from mineral rights. …. Richard's father had purchased a thousand acres from someone who didn't tell him he had sold the mineral rights-in five-acre parcels-to people all over the country. Further complicating the picture, the rights have since been bequeathed many times. After poring over records at the county courthouse, Brenda discovered to her horror that 110 strangers owned the minerals beneath the 40 acres surrounding her house. If a petroleum company can persuade 51 percent of mineral rights owners to agree- and given that they will make money, perhaps lots of it, without taking any risk, they usually do-it can drill on land that doesn't belong to them.

The minerals leasing and exploration phase is largely over in western North Dakota, giving people who don't live and work on the land the power to dictate the fate of many who do.

Taking the bad with the good may indeed be inescapable, even if the good isn't good for long and the "public good" often favors private interests.

P57:
The booms permanent legacy will also include several large pipelines for conveying oil out of the region, as many as 50,000 two-mile-deep oil wells, hundreds of waste-disposal wells, and an unknown number of waste-reprocessing and storage facilities. The depth of the shale formations and the intervening rock layers make it unlikely

fracking fluids will migrate upward for enough to contaminate shallow aquifers. But no one knows for sure. This is the first time fracking has been used under these geological circumstances. The more we experiment with underground drilling the more we discover that "impermeable" layers can be surprisingly permeable and fractures in the rock can be interlinked in unexpected ways.

Of special concern are the hundreds of fracking components, some of which contain chemicals known to be or suspected of being carcinogenic or otherwise toxic. Increasing the likelihood of unwanted environmental effects is so-called Halliburton loophole, named after the company that patented an early version of hydraulic fracturing. Passed during the Bush-Cheney Administration, the loophole exempts the oil and gas industry from the requirements of the Safe Drinking Water Act. What's more, manufacturers and operators are not required to disclose all their ingredients, on the principle that trade secrets might be revealed.

Even George P. Mitchell, the Texas wildcatter who pioneered the use of fracking, has called for more transparency and tighter regulation. In the absence of well-defined federal oversight, states are starting to assert control. In 2011 the North Dakota Legislature passed a bill that said, in effect, fracking is safe, end of discussion.

Looking further ahead, it's uncertain how long oil well casings and plugs will last. A recent U.S. Geological Survey study of decades-old wells in eastern Montana found plumes of salt water migrating into aquifers and private wells, rendering the water from them unfit for drinking. And catastrophic casing failures can happen at any time.

The EPA is now investigating a 2011 blowout during fracking in a well near Killdeer that pierced the aquifer the town relies on.

So far western North Dakota has been spared drought, but agriculture survives there only because farmers and ranchers have strictly husbanded fresh water, of which there is precious little. Local landowners now worry that the oil industry will deplete their aquifers.

This four (4) page summary of "The New Oil Landscape" was prepared by Adrian Ingleby of Otford, NSW., on 14.08.2013.

VOL. 223 • NO. 3
MARCH 2013

NATIONAL GEOGRAPHIC

"How do we want western North Dakota to look in 20 years?"
page 58

The fracking frenzy in North Dakota has boosted the U.S. fuel supply—but at what cost?

The New Oil Landscape

When Susan Connell arrives at the first oil well of the day, she tosses her stylish black-rimmed glasses onto the dashboard of her 18-wheeler, climbs down from the cab,

and pulls the zipper on her fire-resistant coveralls up to her neck. It's early July, about 7 a.m. We're on the Fort Berthold Reservation, in western North Dakota. Connell, 39, the mother of two young girls and one of the few female big-rig drivers in the oil patch, is hauling water. Produced water, as it's officially known. The drivers call it dirty water. During the early days of pumping at a new well, oil is accompanied by fluids and other substances used during drilling, along with salt water, which is abundant above the subterranean layers of rock where the coveted sweet crude is found. Eventually the man-made additives diminish, leaving mostly salt water. Five of the three-story-high tanks in front of us contain oil; the sixth, everything else. That's what Connell is here to transfer to a waste-disposal well.

"Just don't pass out on me," Connell says, half in jest. We've scaled a steep stairway to a narrow steel catwalk 30 feet above the ground, but she's not referring to the height. She says that one of the first times she opened the hatch atop a dirty water tank, she was overcome by fumes. "I fell to my knees." No one had warned her about the dozens of chemicals in the water, including hydrogen sulfide, H_2S, its rotten-egg odor created by bacteria growing inside wells. In high enough concentrations it can be poisonous, even lethal.

Ironically, the gas poses the greatest risk when it deadens your sense of smell, another safety lesson Connell had to learn on her own. Eventually someone gave her an H_2S detector, which she

By Edwin Dobb
Photographs by Eugene Richards

clipped to her collar whenever she approached a well that had turned "sour" enough to be hazardous. Once she was pumping dirty water from her tanker truck when the detector sounded. She scrambled away, thinking she'd escaped harm. But hours later she felt stabbing pains in her stomach, the prelude to a weeklong bout of vomiting. Her next purchase was a gas mask.

Connell tells me to stand upwind, then gingerly lifts the hatch. No fumes. It's what she expected, having often hauled water from this well, but, she says, you never know when a routine activity will be interrupted by a nasty surprise. She unwinds a measuring tape into the tank. For a moment, from the vantage of the catwalk, I'm granted a bird's-eye view of the surrounding country. Just outside the coral-colored gravel of the well site are patches of flax and sunflowers, then sealike fields of wheat, alfalfa, and canola, and beyond them, heavily eroded badlands through which the Missouri River has cut a wide, sweeping bend. The understated glory of the northern plains.

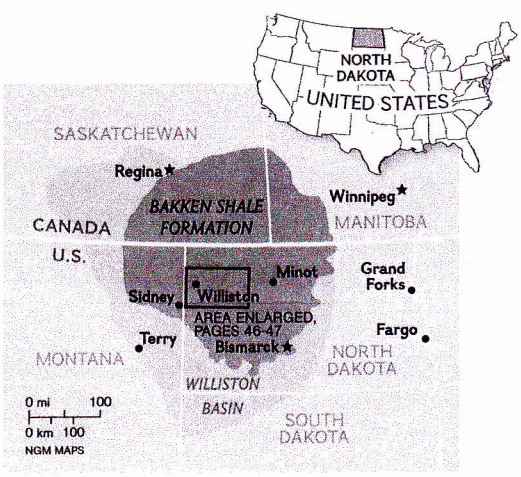
But my pastoral interlude is cut short. Connell has descended the stairs and is removing a 20-foot hose—like a fire hose, only heavier—from the side of the truck. Though only five feet six inches tall and weighing just a hundred pounds, she moves quickly, leaning forward to get traction as she drags the thick hose along the ground. She attaches one end to the rear of the truck tank, the other to an outlet at the base of the storage tank. She then pulls a long metal handle, opening the storage valve. If you don't look closely, you might miss the brunette pigtails that fall to Connell's shoulders, the blue eyes in the shadow cast by her well-worn baseball cap.

A half hour later we're back in the cab, a hundred barrels heavier, rolling away. Connell doesn't use the clutch much. "Just like a pro," she says with a mischievous smile, before admitting it took months to master shifting gears at stoplights.

Truck driving is the most common job in the oil patch, an area about the size of West Virginia where advances in drilling and extraction technology have made it possible to remove oil from deep, widely dispersed deposits. Since early 2006, production from what's known as the Bakken formation has increased nearly 150-fold, to more than 660,000 barrels a day, moving North Dakota into second place among domestic suppliers, behind Texas and ahead of Alaska.

No one but a handful of industry insiders saw that coming. Now some optimistic oilmen predict that the state's daily output could eventually close in on Texas'—at two million barrels. The number of wells could increase from the roughly 8,000 operating today to between 40,000 and 50,000. By the time the frenzy ends, perhaps 20 years from now, as many as 14 billion barrels of high-quality crude may have been removed. Until more pipelines are built in this landlocked rural region, most of the oil and water will be transported by truck. So will everything else needed for swift, large-scale development: gravel, construction materials, tools, machinery. The prairie is being industrialized. If the transformation needs an emblem, there's no better candidate than Connell's 18-wheeler.

Change of such scope and intensity is bound to raise questions. Thousands of people are converging on the area, looking for work, looking for redemption, looking for trouble. And jobs are plentiful. In Williston, in the heart of the oil patch, the unemployment rate is less than one percent. But how does a region of farms and small



Edwin Dobb covered a controversial mine in Alaska in December 2010. Eugene Richards portrayed the emptying of North Dakota in January 2008.

towns weather the human onslaught? Another risk is environmental damage. Most attention has focused on hydraulic fracturing, or fracking, by which large amounts of fresh water combined with sand and other substances, some toxic, are driven under high pressure down wells drilled into deep layers of shale, creating cracks through which bubbles of trapped oil and natural gas can escape into the well. Where will all the clean water come from? How will the dirty water that's pumped out be prevented from contaminating groundwater, as has happened in other parts of the country? Stepping back for a broader view, can the inestimable values of the prairie—silence, solitude, serenity—be preserved in the face of full-throttle, regionwide development, of extracting as much oil as possible as fast as possible?

The implications are already reverberating far beyond North Dakota. Bakken-like shale formations occur across the U.S., indeed, across the world. The extraction technology refined in the Bakken is in effect a skeleton key that can be used to open other fossil fuel treasure chests.

That technology, stunning enough in itself, coupled with shifts in the marketplace that favor exploiting deposits that are harder, and therefore more expensive, to tap has convinced some experts that the carbon-based economy can continue much longer than they'd imagined. Billionaire oilman and Bakken pioneer Harold Hamm argues that the assumption we're running out of oil and gas is false. America, in his view, needs a national policy based on abundance, one that doesn't favor developing renewable sources of energy. Either way, you're not likely to hear anyone in the oil patch mention what's ultimately at stake if we keep burning fossil fuels with abandon.

"Climate change?" Connell says. "We don't talk about that here."

North Dakota has boomed before, in the 1950s and '80s. But besides being much larger and likely to last much longer, the current boom differs from earlier ones because it has coincided with an economic malaise. For refugees from the recession, the Bakken is a chance—often the last chance—to escape ruin.

Can the inestimable values of the prairie—silence, solitude, serenity—be preserved in the face of full-throttle development, of extracting as much oil as possible as fast as possible?

So it was for Susan Connell. While we head for the disposal site on a two-lane highway chewed up by truck traffic, she describes how she came to be behind the wheel of a Kenworth Anteater. The trouble started in 2009, when she and her husband could no longer find construction work in southwestern Montana, where they live. By the fall they were three months behind on their house payments. The bank sent threatening letters. Then Connell heard that truckers were needed in North Dakota. The Delaware native had driven a commercial bus between Philadelphia and Atlantic City, also an airport transit bus in Portland, Oregon. How much harder could an 18-wheeler be? But to qualify she would have to upgrade her license, and for that she would need to attend a special training program. Cost: $4,000. At a time when Connell and her husband could scarcely buy groceries for their kids, they charged the fee to a credit card. "It was a big gamble," she says, referring less to the likely availability of work than to the reception she would almost certainly get in what she calls the "testosterone cloud."

When she was a teenager, Connell did stand-up comedy in cafés in Philadelphia. HBO and *Saturday Night Live* expressed interest, but her abiding love was art—painting, filmmaking, and especially writing stories *(Continued on page 44)*

"My town was dying," says Brent Sanford, mayor of Watford City, a community that's been transformed by the boom. "This is a full-scale mining operation, and I'm all for it. Now we can get back to work."

and acting them out, sometimes with props, before audiences. She was the lead singer in a rock band for six years. All that experience bred in her a cheerful, disarming fearlessness. Now she was auditioning for a demanding new role.

On a frigid day in mid-December, Connell fixed pancakes for her daughters, fought back tears as she said goodbye, then made the seven-hour trip from southwestern Montana to the Montana–North Dakota border. With the temperature dropping at night to well below zero, she alternated between sleeping in her car and staying in shabby motels while applying at more than a dozen trucking companies. All turned her down. Several managers said women didn't belong in the oil patch. One guy in Tioga told her it was a sacrilege that she wasn't home tending to her children. She was angry. "They were messing with my livelihood," she says.

When the first offer came, after the holidays, it was to haul grain, not water or oil, and for considerably less pay, over a territory covering most of western North Dakota as well as eastern Montana and southern Saskatchewan. To make matters worse, the winter of 2010-2011 was unusually severe. This was no place to be piloting an 18-wheeler for the first time—and alone. "I was so nervous I thought I was going to die," Connell says of her inaugural trip. Everywhere she drove, the roads were iced over. "I chained up all the time," she says. After much trial and error, occasionally featuring a cursing farmer, she learned how to back up an 18-wheeler across snow-laden fields, then to unload silos while standing atop the trailer in 20-below weather, often in the dark, sleet and grain dust pelting her face. She did her own truck maintenance, including oiling hubs and greasing bearings.

During the first months of 2011, Connell continued to apply for oil jobs. The odds were improving because the need for semi operators was increasing rapidly. Since the 1990s fracking had been combined with directional drilling—excavating horizontally from the bottom of the vertical portion of a well into thin layers of oil- and gas-bearing rock. In the Bakken, Harold Hamm's Continental Resources and other nimble companies had refined that technology by extending the lateral leg as far as two miles and altering the fracking-solution recipe. In 2004 Continental had brought in the first commercially viable well in the state. Two years later an EOG Resources well produced oil under so much pressure that the company had to shut down the well until a second one could be drilled to reduce the pressure.

"That created huge excitement," recalls Lynn Helms, director of the North Dakota Department of Mineral Resources. Anticipation was building. The turning point came at the end of 2009, when Brigham Oil & Gas split the single lateral leg of a well south of Williston into 25 legs, each of which was fracked separately, making it possible to reach more oil—hundreds of barrels a day. Helms calculated that the first year of every new well, from drilling to fracking to early production, would entail 2,000 truck trips. This didn't include the hauling out of huge amounts of oil and salt water during the remainder of a well's life. State officials were already thinking in terms of tens of thousands of new wells, most of which would be located in only four counties bordering the Missouri River—Williams, Mountrail, McKenzie, and Dunn. The implications were staggering. "A flag went up," Helms says. Much more of

everything—manpower, highways, railroads, electricity lines, patience—would be needed.

"This is a full-scale mining operation," says Brent Sanford, mayor of Watford City, a McKenzie County community that's been transformed by the boom. "And I'm all for it." The 40-year-old, fourth-generation native sits in front of a computer monitor in his office at S & S Motors, which his grandfather started in 1946 and he took over when he moved back home nine years ago. While scanning for bargains on a car-auction website, he explains his enthusiasm. "My town was dying," he says. Watford City was one of dozens facing the same plight, which once prompted geographers to propose that the region be turned over to the buffalo again, a notion you don't want to bring up with Sanford or any of his neighbors unless you're itching for a fight. Every year western North Dakota was becoming emptier—of promise as well as people. The fracking boom has reversed the decline. "Now we can get back to work," Sanford says.

To appreciate the nature of the work, I visited a well northeast of Williston. A leak had developed at the bottom of the vertical leg, about two miles underground. To bring the pipe to the surface, a derricklike structure, similar to a drill rig but smaller, had been erected. On a deck about 30 feet up the rig, four roughnecks were removing the entire 10,750 feet of pipe, one 32-foot, 500-pound segment at a time, a task both tedious and highly dangerous. A device underneath the deck held each segment in place as it emerged, to prevent the pressure of the oil from sending all two miles of pipe, some 84 tons of steel, rocketing into the sky. As if to remind us of that possibility, a fountain of oil suddenly burst from the hole, covering the men, their hard hats, faces, everything. The odor of gas permeated the air. More fountains followed. Here were guys who knew what they were doing, who were exposed to constant peril, who were paid well, and who, because of all that, had ample reason to be proud. It was skilled manual labor in perilous circumstances, which in our age of high-tech jockeys and private-equity sharks seemed exotic, almost heroic.

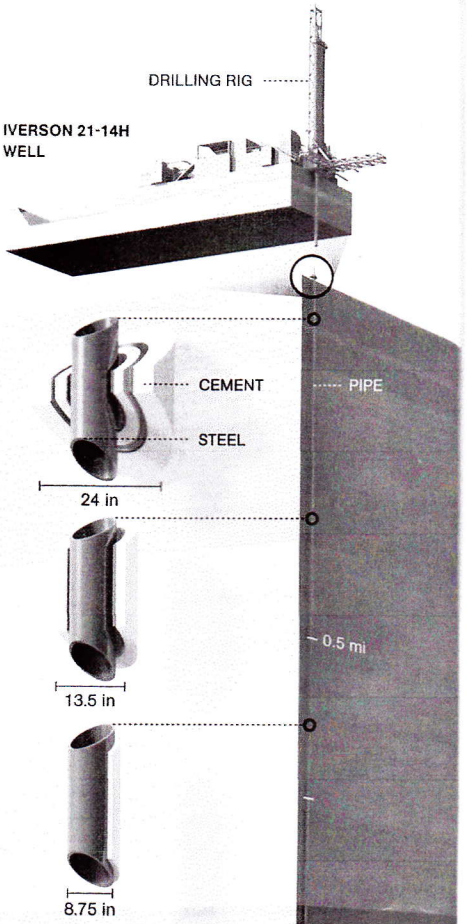
Sanford isn't blind to the trauma Watford City is undergoing. A population that in the past two years has soared from about 1,700 to at least 6,000 and, Sanford estimates, perhaps as many as 10,000. A housing shortage so acute that men—and it's still mostly men—are forced to sleep in their trucks or in overpriced motels; pay "gouge-zone" fees to park their campers, RVs, and house trailers; or live in one of the expensive prefab, dormlike "man camps" that serve as instant but sterile bedroom communities for towns and work sites. Streets clotted with noisy, exhaust-belching tanker trucks, gravel trucks, flatbeds, dump trucks, service trucks, and—the personal vehicle of choice in the oil patch—oversize, gas-gorging pickups. More crime, more highway accidents, more medical emergencies. People on fixed incomes forced to move because they can't afford steep rent hikes. Overtaxed water and sewer systems. Prostitution. Registered sex offenders at large in the community.

But Sanford, a former CPA, believes the media have overemphasized the negative side of the ledger. Not only will Watford City survive intact, he insists, but the eventual benefits will far outweigh the costs. Regarding housing, "our greatest problem," he says the difficulties should be seen as part of an evolution from temporary lodging like RVs and man camps to "rooftops"—new apartment buildings and, eventually, single-family homes. Already the elementary school has been expanded. A new recreation center, a public housing and day-care complex, and a hospital will soon be built. Roads are being repaired, upgraded, widened. All across town old businesses—including S & S Motors—are flourishing, and new ones are opening their doors.

Trucking is one of the most lucrative enterprises. Seven years ago Power Fuels, a Watford City–based company that specializes in transporting oil, water, and other fluids, had a staff of 50. Today it has 1,200 employees in four different towns and is building eleven 42-unit apartment

1 DRILL

A well is drilled nearly two miles down, then curves at the bottom and runs into the Bakken formation. The Iverson well (right) used 350 pieces of pipe, weighing 87 tons.



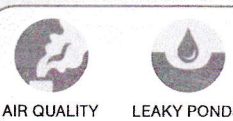
DISPOSAL WELL

GROUNDWATER

Waste pools are prohibited in North Dakota. Trucks haul away waste fluid and pump it into deep wells.

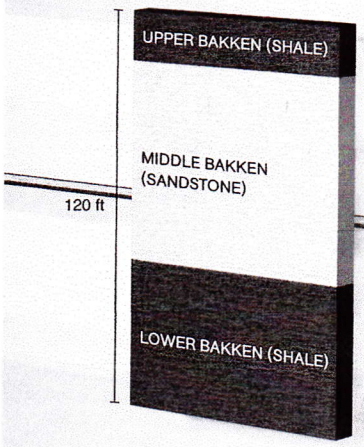
2 PROTECT

Cement and steel casings are inserted to guard against seepage from the pipe into groundwater.



CAUSES FOR CONCERN?

The states, not the federal government, regulate fracking, so procedures differ across the country. Well locations, underlying geology, and whether oil or natural gas is the target also affect the procedures. Worries about fracking vary too. One main concern now is that gas leaks worsen air quality. The long-term consequences of fracking are unknown.



THE BAKKEN FORMATION
In this oil-rich formation, the well descends through shale, then travels horizontally through sandstone.

The well is more than seven Empire State Buildings deep (1,454 feet each).

VIRGINIA W. MASON, NGM STAFF; ART: JOE LERTOLA, BRYAN CHRISTIE DESIGN
SOURCES: NORTH DAKOTA DEPARTMENT OF MINERAL RESOURCES; WHITING PETROLEUM CORPORATION; ANTHONY INGRAFFEA, CORNELL UNIVERSITY

Fracking the Prairie

There are three basic steps in hydraulic fracturing, or fracking, the pumping of fluids at extreme pressure into rock deep beneath the Earth's surface to extract the embedded oil. The oil well depicted here is the Iverson 21-14H, in western North Dakota. It plunges 10,500 feet to frack sandstone and shale in layers of rock called the Bakken formation. The area produces some 660,000 barrels of oil daily, which has created a boom for the state but has also given rise to concerns about the environmental costs.

THIS WELL'S FRACTURING FLUID

80.5% WATER

19% PROPPANT

Proppant is a combination of natural quartz sand and man-made ceramics. It props open fractures in the rock so oil can flow more freely.

0.5% CHEMICALS

Additives, many toxic, are used to inhibit bacterial growth, minimize friction, and increase viscosity.

WHERE DOES THE USED FLUID GO?

80% DISPOSED OF

Most is pumped into injection wells at least 2,500 feet below potable water.

20% RECYCLED

PRODUCTS USED IN LIFE OF ONE WELL

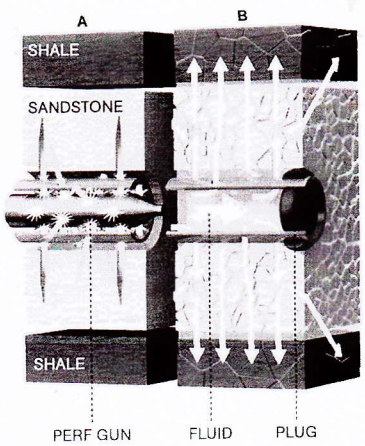
2 MILLION GALLONS OF WATER

4 MILLION POUNDS OF PROPPANT

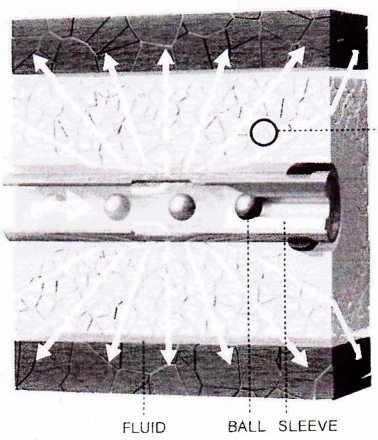
350+ BARRELS OF CHEMICALS

3 FRACTURE AND OIL FLOW

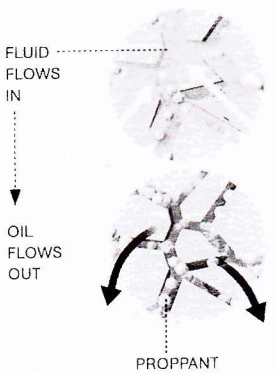
Fluid is pumped under high pressure down the well and into the rock to the end of the pipe, fracturing the rock in stages to release the oil. Two methods are used, with the sliding sleeve (below right) employed first.



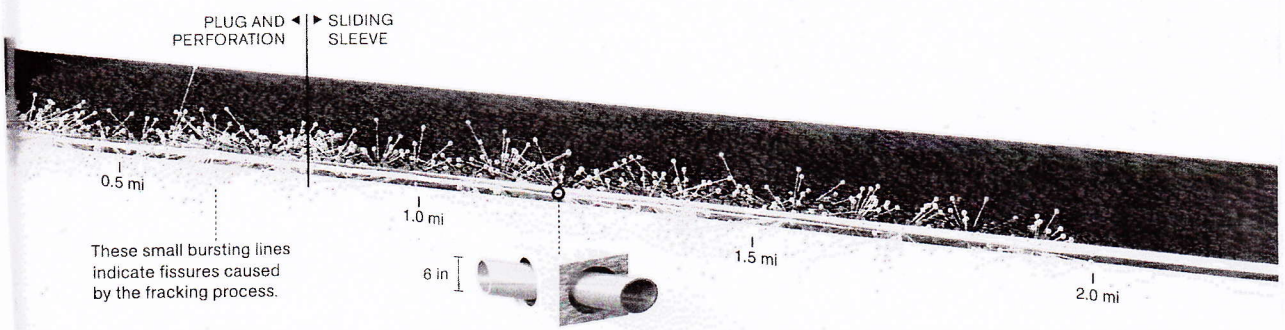
PLUG AND PERFORATION A plug blocks off a section of pipe, and a "perf gun" blasts small holes in the sandstone (A). Fluid is pumped in at high pressure (B), releasing the oil.



SLIDING SLEEVE Plastic balls are forced down the pipe, pushing open sliding sleeves to expose holes in the pipe. Fluid shoots out through the holes, fracturing the rock.



Fracking fluid expands cracks in the rock, releasing oil, which flows back up the well.



complexes to house them. An 18-wheeler tank truck can bring in $40,000 a month—if everything goes right.

One night in early April 2011, waiting out the "umpteenth blizzard" of the season with two dozen oil and water drivers at a Cenex gas station in Parshall, Connell insinuated herself into conversations, inquiring about jobs and collecting phone numbers of trucking firms. Someone asked her where her rig had slid into the ditch. Turns out that Connell, the only female driver in the room, was also the only driver who hadn't gone off the road during the storm.

The following day, she got up at 5 a.m., shoveled out her snowbound 18-wheeler, and was the first of the stranded drivers back on the road. That didn't escape the notice of her newfound admirers, including one of the guys Connell had talked to the night before—the owner of a small water-hauling company based in Killdeer, who had one truck and wanted someone to help him drive. Soon afterward he called and offered her a job. Her pay jumped from $600 a week to $2,000. There would be no more worrisome letters from the bank. She'd saved the family house.

In western North Dakota stories like this are commonplace—among drivers, construction workers, and roughnecks; service providers and equipment suppliers; geologists, engineers, and drilling specialists. But viewed at close range, the apparent robustness of the Bakken boom sometimes looks like a collection of fragile mini-booms. Within six months of Connell's lucky layover in Parshall, for instance, her new boss didn't have enough work to keep her on.

Of everything that's happening here today—of all the change and growth—what will last? Will the enduring things be the most desirable things? These questions haunt Dan Kalil, chairman of the Williams County Board of Commissioners. "Oil is a rental business," he says, meaning that it doesn't stay in one place, doesn't owe any allegiance to the traditional farming and ranching way of life, which Kalil's family has been doing west of Williston, the county seat, for more than a hundred years. Perhaps nothing better symbolizes the contrast than the two most iconic structures on this part of the prairie—the itinerant drill rig and the steadfast grain silo. "When the industry goes south, and it will go south," Kalil says, "they just walk away."

Kalil doesn't oppose development, only development that's run amok, which is how he sees this boom. "Slow it down," he urges, echoing a sentiment—a recurring, ever louder counterchorus—heard throughout the oil patch. Contain it before it destroys the closely bound communities and easygoing lifestyle that, during the best of times, have been the hallmarks of the region. Even if slowing things down were still possible—and Kalil has all but lost hope of that—the only effective way would be to limit the number of drill rigs or well permits, and state officials have no appetite for either.

"It breaks my heart," Kalil says.

I put the blessing-or-curse question to Connell, who's gone from boom to bust and back again several times, including finding steady work with a large trucking company based on the Fort Berthold Reservation when the Killdeer operator's work slowed. Connell is on the last run of a 12-hour shift, and we're back at the reservation well with the breathtaking view of the Missouri, loading more dirty water. "How could I be a part of this?" she says, referring to the drunken fights and homelessness, oil leaks and dirty-water spills. "I struggled. But I finally made my peace with it." Behind us a gas flare, its ten-foot flame roaring upward, suddenly expands and becomes more violent, sounding like a blast furnace. There are few gathering pipelines in the Bakken, so at least a third of the natural gas that comes up with the crude is burned off, a waste all regret and the state hopes to end soon. At night in some areas the prairie is ablaze with giant candles, a sight both wondrous and unsettling. "During the winter," Connell says wistfully, as if recalling a cherished childhood memory, "we'd park next to the flares to stay warm."

She writes down the amount of water she's removed from the storage tank: another hundred barrels. "There's good and bad in everything," she says, straining to articulate something that defies explanation. "I just accept it." Which isn't

to say she wouldn't rather move on. "I've been trying to leave," she says, explaining that the work is exhausting, unreliable, and lonely. The separations from her family have been getting more difficult for everyone; every time she leaves home, her daughters beg her not to go. And in the testosterone cloud, physical threats and attempts at sexual extortion have occurred often enough to convince her that she should never go anywhere without weapons. Brandishing a steel rod is usually all she needs to discourage those who menace her. But well-paid work is still in short supply back home, and, she says, that's not the only thing keeping her here. She's proved she can do the job, and do it better than many of her fellow drivers. Most important, she's made a place for herself in life. "After working hard all day," she says, "I start to feel feisty, like the guys." She chuckles, adding with a sly smile, "I'm a badass trucker."

The owner of a small water-hauling company, who had one truck and wanted someone to help him drive, offered Susan Connell a job. Her pay jumped from $600 a week to $2,000.

The day I drove to the Jorgensons' place, in the northwest corner of Mountrail County, was the day I fell under the spell of the prairie. North of Tioga I turned off Route 40, heading east. On both sides of the gravel road, fields of wheat, alfalfa, and sunflowers spread to the horizon. In this part of the country, if you're not in a hurry, you can't help but notice the sound. There's so little of it, for one thing, and it's orchestrated mostly by the wind, howling, thrumming, or, as on that morning, whispering, as it sifted through the still-green crops. I continued for eight miles on a road without bends in a land without contours, none of which prepared me for my destination—the White Earth Valley, a wide, grassy basin whose subtle charm owes much to the flatness of the area surrounding it. Here, on a bluff above the valley, Richard and Brenda Jorgenson, both 59, have lived for more than 30 years.

While Richard drove a swather in a nearby field, cutting pungent alfalfa for cattle feed, Brenda gave me a tour on an ATV with two of her grandchildren, seven-year-old Ashley, sitting on her lap, and five-year-old daredevil Kyle, riding hands free next to me in the back. We headed north of the house, skirting patches of virgin prairie—home to coneflowers, blue-eyed grass, and blanket flowers—and coulees, where ash trees and Juneberry bushes were abundant.

Brenda was still in college when Richard first showed her the valley. "It was instant love," she says. Making a go of it, however, has never been easy. Eight years passed before they were able to build a house, which they did themselves, moving in on Easter weekend in 1980. Farming in this part of the country rarely provides enough income to support a family, and like most landowners I met in the oil patch, Richard held a second job, not retiring until 2006. Brenda worked part-time.

We arrived at a spot that afforded a view of the White Earth River, a narrow stream that winds through the Jorgensons' best farmland. The valley floor is where a company called Alliance Pipeline plans to locate a 12-inch, high-pressure gas conduit that would connect an existing gas-processing plant in Tioga to its main line some 80 miles away. Today is supposed to be the last day company surveyors will traipse around the ranch. The Jorgensons and several of their neighbors vehemently oppose the project. "I don't want a bomb in my backyard," Richard says, meaning a possible gas explosion. But Alliance has gone to court, threatening to

Catastrophic well-casing failures can happen at any time. The EPA is now investigating a 2011 blowout during fracking in a well near Killdeer that pierced the aquifer the town relies on.

use eminent domain, the controversial process by which private property can be seized in the name of a larger public good, in this instance, providing energy the U.S. demands.

While the Jorgensons fight to retain control of their bottomland, they're already living with the intrusive consequences of drilling. Eight hundred feet from their house a Petro-Hunt pump jack runs day and night, with the attendant noise, traffic, and contamination risks. They had no say. North Dakota allows landowners to separate surface rights from mineral rights, and during hard times some have been tempted to sell or trade the latter—for, say, needed equipment, like a new tractor. Richard's father had purchased a thousand acres from someone who didn't tell him he had sold the mineral rights—in five-acre parcels—to people all over the country. Further complicating the picture, the rights have since been bequeathed many times. After poring over records at the county courthouse, Brenda discovered to her horror that 110 strangers owned the minerals beneath the 40 acres surrounding her house. If a petroleum company can persuade 51 percent of mineral rights owners to agree—and given that they will make money, perhaps lots of it, without taking any risk, they usually do—it can drill on land that doesn't belong to them.

Perhaps farsighted action on the part of the state legislature could have corrected this bizarre arrangement, but now the minerals leasing and exploration phase is largely over in western North Dakota, giving people who don't live and work on the land the power to dictate the fate of many who do. This predicament bears out a larger truth: Benefits from the oil boom are being widely dispersed. To be sure, local landowners who have retained mineral rights can earn a great deal of money from leasing. But much more wealth is leaving the region. Truck drivers like Connell and other temporary workers are paying down debts in their home states. Profits are flowing to oil company executives living in Canada, Texas, and Oklahoma, as well as to shareholders everywhere. The costs, by contrast, are localized. Taking the bad with the good may indeed be inescapable, even if the good isn't good for long and the "public good" often favors private interests. But in western North Dakota the bad must be borne largely by the long-term residents. They have the most to lose, and any fair calculation of risk would make their interests paramount.

Last August, Connell spent a day hauling oil pipe on an 18-wheel flatbed. She relished the chance to try something new. A "huge guy" at the storage yard held her by the waist while showing her the proper way to tie down a load. "He was awesome," she says. Becoming a badass pipe hauler would be a prudent move, because the next stage of development in the Bakken will include replacing a large portion of the oil and water fleet with a regionwide network of gathering pipes. Governor Jack Dalrymple, hoping to reduce the negative effects of truck hauling and to lower oil transportation costs, has urged pipeline companies to build the network as fast as possible. He and other state officials envision 6,000 to 8,000 miles of feeder line being constructed for each of the four well products—flow back, which is the mix of fluids both natural and man-made that's used in fracking; sweet crude; natural gas; and salt water. That's enough pipe crisscrossing western North Dakota to encircle the planet.

The boom's permanent legacy will also

include several large pipelines for conveying oil out of the region, as many as 50,000 two-mile-deep oil wells, hundreds of waste-disposal wells, and an unknown number of waste-reprocessing and storage facilities. The depth of the shale formations and the intervening rock layers make it unlikely fracking fluids will migrate upward far enough to contaminate shallow aquifers. But no one knows for sure. This is the first time fracking has been used under these geologic circumstances. The more we experiment with underground drilling, the more we discover that "impermeable" layers can be surprisingly permeable and fractures in the rock can be interlinked in unexpected ways.

Of special concern are the hundreds of fracking components, some of which contain chemicals known to be or suspected of being carcinogenic or otherwise toxic. Increasing the likelihood of unwanted environmental effects is the so-called Halliburton loophole, named after the company that patented an early version of hydraulic fracturing. Passed during the Bush-Cheney Administration, the loophole exempts the oil and gas industry from the requirements of the Safe Drinking Water Act. What's more, manufacturers and operators are not required to disclose all their ingredients, on the principle that trade secrets might be revealed. Even George P. Mitchell, the Texas wildcatter who pioneered the use of fracking, has called for more transparency and tighter regulation. In the absence of well-defined federal oversight, states are starting to assert control. In 2011 the North Dakota legislature passed a bill that said, in effect, fracking is safe, end of discussion.

Looking further ahead, it's uncertain how long oil well casings and plugs will last. A recent U.S. Geological Survey study of decades-old wells in eastern Montana found plumes of salt water migrating into aquifers and private wells, rendering the water from them unfit for drinking. And catastrophic casing failures can happen at any time. The EPA is now investigating a 2011 blowout during fracking in a well near Killdeer that pierced the aquifer the town relies on. As for the thousands of miles of gathering pipelines, they're another immense experiment. Many different companies, some less careful than others, will be involved, but even well-built pipes leak and rupture. The state lacks the resources to oversee a construction project of this magnitude, and once a line is approved, decisions as to where the pipes will be located and how they'll be monitored during their decades-long life span will be left to the landowners, or most likely the landowners' descendants, and the pipeline company, assuming it's still in business.

If the Bakken oil boom is a classic Greek drama, the second act is starting now, and the prairie chorus is once again issuing a warning.

"Warming tied to extremes" read the headline in the July 11, 2012, issue of the *Minot Daily News*, a conservative paper in a conservative town on the eastern edge of the oil patch. Warming, meaning man-made climate change, and weather extremes, meaning events such as a recent record heat wave in Texas, part of a severe drought that afflicted much of the West and Midwest last year. So far western North Dakota has been spared drought, but agriculture survives there only because farmers and ranchers have strictly husbanded fresh water, of which there is precious little. Local landowners now worry that the oil industry will deplete their aquifers. They argue that the Missouri River, not groundwater, should be the primary source of water used in fracking. However that controversy is resolved, an oil boom is under way in a region that may yet suffer drought for decades—prolonged and intensified, according to recent studies, by the burning of fossil fuels. If the cliché that there's no free lunch is true, then what's the price of an all-you-can-eat buffet?

North Dakota is still in a position to parlay the boom into something lastingly beneficial. Of every dollar the oil industry earns, the state takes 11.5 cents, which produced revenues of more than two billion dollars from July 2011 to October 2012. One-third of that has been

deposited in a permanent fund, the interest on which cannot be touched until 2017. The rest is to be divided between the state and local jurisdictions. How the money will be spent remains uncertain, although plans are in the works to send some of it back to the oil patch for new roads, power lines, and municipal services like firefighting and law enforcement, and to help build schools, hospitals, and recreation facilities.

Another opportunity is at hand. Narayana Kocherlakota, an influential economist and president of the Federal Reserve Bank that oversees the district that includes North Dakota, told reporters in Williston last August that the boom is a onetime windfall that should be invested in long-range social programs and sustainable economic development. "How do we want western North Dakota to look in 20 years?" he asked.

To believe the old lifestyle will survive intact is to ignore the wrenching changes that have already reshaped this corner of the prairie. Even so, the state could use its oil bonanza to finally free itself from its boom-bust history by taking advantage of a natural resource both abundant and inexhaustible—the ever present wind. North Dakota's wind resource is ranked sixth in the country, according to the American Wind Energy Association, which helps explain why in 2010 Google chose the state for its first investment in commercial-scale wind farms.

Meanwhile, for a generation to come, and maybe longer, plenty of jobs will be available for roughnecks, construction workers, and truck drivers. To someone like Susan Connell, riding a roller coaster of mini-booms is better than the alternative. Besides the money, even though it fluctuates greatly, and the pride she takes in what she does, she says there are intangibles she's come to value. "I'm on a well, it's night, I'm alone." Stars overhead, gas flares in the distance, maybe the far-off cry of a coyote. Connell's standing on the catwalk, high above the ground, opening the hatch on a tank of clear salt water that came from thousands of feet beneath the surface, in the middle of the continent. She leans forward and breathes deeply. "It smells just like the ocean," she says. □