Human Energy®

chevron in appalachia:

# managing performance, measuring results

2017 report

# chevron's commitment to responsible development

At Chevron, our vision is to be the global energy company most admired for its people, partnership, and performance. We are passionate about our business and serious about conducting our work in an environmentally and socially responsible manner.

Our commitment to safe and responsible development shapes our business and operational decisions. That commitment includes responsibly developing the energy potential of the Marcellus and Utica Shale formations in the Appalachian region. We have designed operating practices that protect water, land, air, and the communities where we work, and we continually work to reduce impacts from our developments. Our performance measures are intended to drive continual improvement in our operations.

In this report, we have provided performance data for our operations through 2016. In many cases, and where applicable, this information is provided within the context of our four-year performance history, so readers can identify and understand trends in our operations. This report embodies our commitment to operating with integrity and building trust among our stakeholders. By sharing this information, we hope to encourage ongoing dialogue about our operations with members of the communities in which we operate.

**Stacey Olson**
President, Chevron Appalachia, LLC
Chevron U.S.A. Inc.

# operational overview 2016

Chevron is a significant leaseholder in the Marcellus Shale and the Utica Shale, primarily located in southwestern Pennsylvania, eastern Ohio and the West Virginia panhandle.

**Marcellus Shale** In the Marcellus Shale, the company holds approximately 472,000 net acres. During 2016, a total of seven company-operated wells were drilled. The company also participated in 12 nonoperated wells during 2016. Development is proceeding at a measured pace and was focused on improving execution capability, well performance and cost effectiveness.

**Utica Shale** The company also holds a position in the Utica Shale, with approximately 309,000 net acres. Activity during 2016 included the drilling of an exploration well. This activity was focused on acquiring data necessary for potential future development.

1. Fayette County, PA
2. Greene County, PA
3. Washington County, PA
4. Westmoreland County, PA
5. Marshall County, WV
6. Harrison County, OH
7. Tuscarawas County, OH
8. Mercer County, PA
9. Allegheny County, PA (regional headquarters)

**In 2016, the company delivered:**

An average daily production (gross) of:

**597** million standard cubic feet of natural gas

and

**4224** barrels of condensate and oil

**47** wells drilled and/or completed

and

**40** wells began producing natural gas

# center for responsible shale development

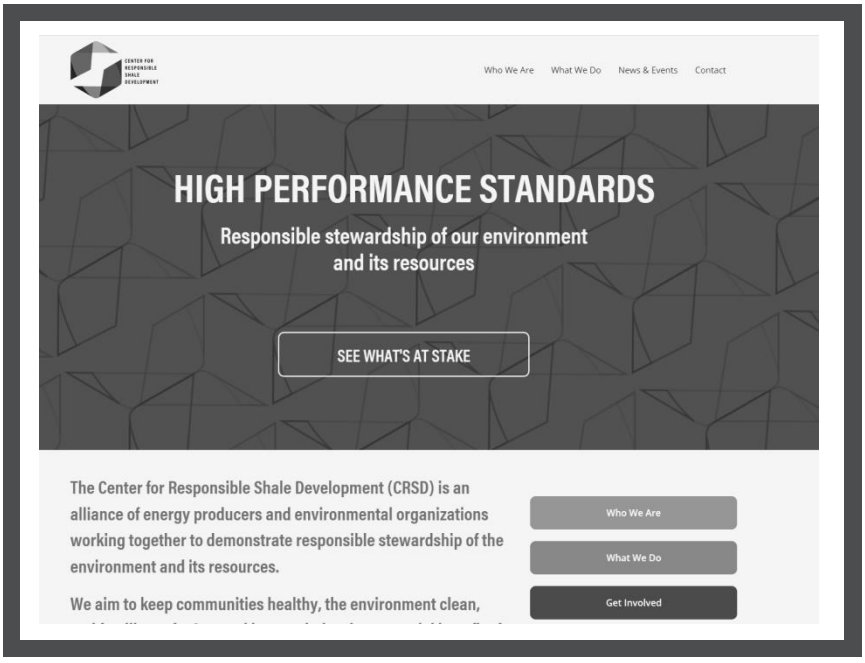
Chevron is committed to advancing the industry's operational performance through technological innovation and the sharing of best practices. We have participated in several efforts to establish recommended practices and standards for the Appalachian region, including being a founding member of the Center for Responsible Shale Development (CRSD).

The CRSD is an unprecedented collaboration built on constructive engagement among environmental organizations, philanthropic foundations and energy companies from across the Appalachian Basin who share the objective of continuous improvement of safe and environmentally responsible development of our abundant shale resources. The CRSD developed and published a series of 15 science-based performance standards covering air, climate and water protection and offers voluntary third-party operator certification using these standards.

**Additional information about CRSD can be found at:** responsibleshaledevelopment.o

## center of excellence

Chevron is a founding member of the CRSD, an unprecedented collaboration for the development of natural gas from shale



These CRSD standards meet or exceed government regulations and the Center continues work so that companies that qualify for certification maintain these standards. CRSD's 15 standards focus specifically on the areas of:

**Water Performance:**

- Eliminating waste water discharge
- Recycling water
- Eliminating pits and moving toward closed-loop drilling
- Conducting geologic risk assessments
- Monitoring groundwater
- Protecting groundwater

**Air Performance:**

- Using reduced emission completions
- Reducing engine emissions
- Limiting emissions from storage tanks and other production equipment

## first to certification

In 2014, Chevron was the first company to be certified by the CRSD through their independent certification process. In 2016, Chevron was recertified.

# efficient land use

### Planning

Before building a well site, we plan pads, access roads and facilities to reduce impacts to wildlife and agriculture.

### Avoiding sensitive areas

We work with landowners to maintain their farming and ranching activities. We avoid sensitive areas, such as archaeological sites or habitats of endangered species.

### Reducing the number/size of well sites

We reduce the number and size of our well sites and environmental footprint by drilling multiple wells per pad. Drilling more wells per well pad allows us to use land more efficiently.

### Controlling erosion and sedimentation

We also implement erosion and sedimentation plans that include detailed engineering designs to control storm water releases to prevent erosion and limit sediment traveling into streams.

We use multi-well pads and horizontal drilling to gather gas from a large reservoir area with minimal surface disturbance. In 2015 and 2016, our average length of horizontal drilling was greater than one mile.

### Eliminating in-ground pits

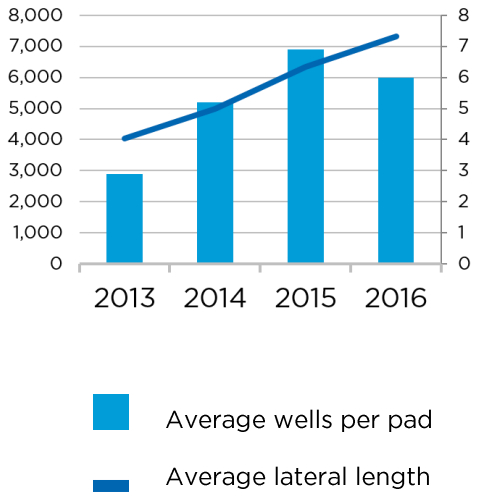
Since 2014, Chevron has eliminated the use of in-ground, lined storage pits in favor of above-ground storage tanks that hold liquids and associated settled solids. These tanks have reduced the size of the surface footprint for our temporary drilling and completions sites. Additionally, the tanks reduce the amount of time land is under construction.

### Reclaiming and restoring

We work with landowners to reclaim the land and restore its topography as close as possible to its original condition. We use hydro-seeding to accelerate regrowth of indigenous grass.

**Efficient land use**

By drilling multiple wells per pad and increasing lateral length, we can reduce the surface footprint of our operations

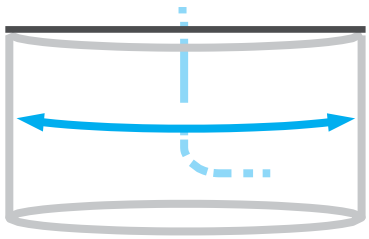


# protecting groundwater

Our Marcellus wells are designed and drilled with control systems to protect groundwater throughout the life of the well.

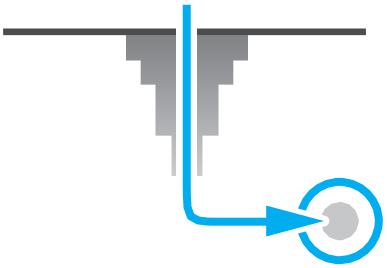
1

Assess the subsurface geology within a 1,000+ foot radius



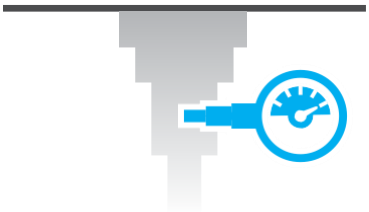
2

Drill thousands of feet vertically and horizontally



3

Test integrity of wellbore and casing



### 1. Site review before drilling

Before drilling occurs at any of our well sites, we assess the subsurface geology within a minimum radius of 1,000 feet of the well pad. This process includes a review to identify and mitigate risks associated with groundwater aquifers, faults and geological pathways, historical wells in the area, active and inactive coal mining areas and shallow gas reservoirs. This information guides our plan and design of our wells.

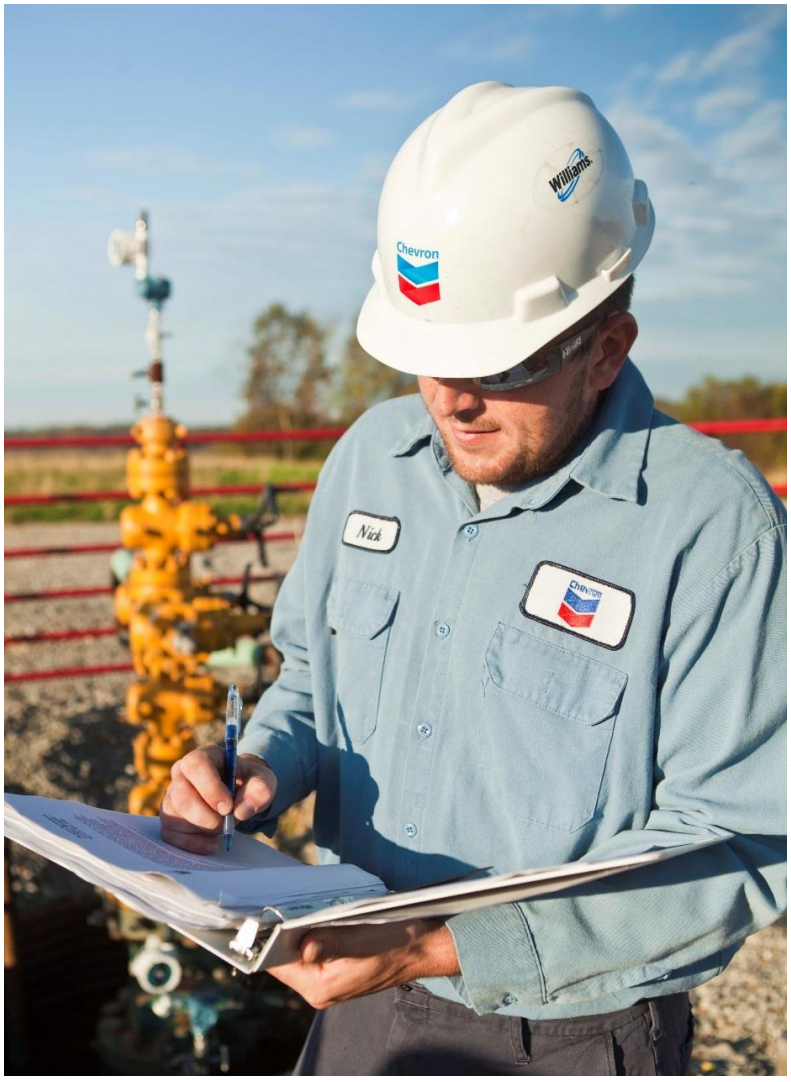
### 2. Drilling

We drill vertically down thousands of feet and then steer the drill bit horizontally to drill thousands of feet into the targeted production zone.

### 3. Testing before hydraulic fracturing

After the well is drilled we verify the integrity of a well's multiple layers of casing. The company conducts a combination of tests including strength tests on cement used and wellbore pressure tests prior to hydraulic fracturing activities.

To monitor water quality throughout the development process, we test freshwater supplies within 2,500 feet of all of our wells four times: before drilling, after drilling, after the last well on the pad is hydraulically fractured, and one year after production begins. We compare each sample result to the original, pre-drill samples, and we share the test results with state agencies and all respective landowners. From 2013 through 2016, Chevron took more than 1,600 water samples from supplies in the Appalachian region. To date, we have never been cited by the states in which we operate for any water quality impacts.




**1,600**

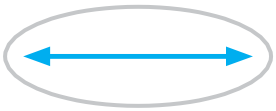
water supplies sampled by Chevron from 2013 - 2016

We test freshwater supplies within

**2,500 ft.**

of all our wells to monitor water quality

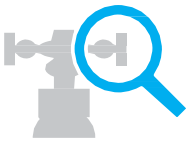
# preventing spills



**100-foot**

buffer zone between wells and rivers, streams and lakes

Ongoing visual inspections



On March 28, 2017, our business unit achieved

**3 years**

without a Tier 1 loss of primary containment*

We take multiple steps to prevent any fluids from contacting the land or surface water.

**Establishing buffer zones**

We maintain at least a 100-foot buffer zone between wells and rivers, streams and lakes.

**Lining work areas**

All well pads are constructed with a synthetic liner placed under drilling and hydraulic fracturing operations, which includes the drilling rigs, hydraulic fracturing equipment and chemical storage units. Any spills or leaks on the liner are removed with vacuum trucks and either reused or sent to a Chevron-approved recycle or disposal facility.

**Inspecting and confirming**

We complete visual inspections to identify and mitigate potential leakage from on-site equipment or activities. This includes daily well site inspections during drilling and completion activity as well as inspections of operating well pads during routine operator visits.

**WellSafe: Quality Assurance Certification Program**

In 2012, Chevron introduced a quality assurance certification program focused on well control, called WellSafe. This program is based on the U.S. Navy's SUBSAFE program, and it includes ongoing written requirements for personnel involved in drilling operations. The program delivers the maximum reasonable assurance that well control will be maintained while reducing the potential of a loss of containment during drilling operations. In 2015, Chevron's Appalachian region operations received the first stage of WellSafe certification.

*defined by API Recommended Practice 754

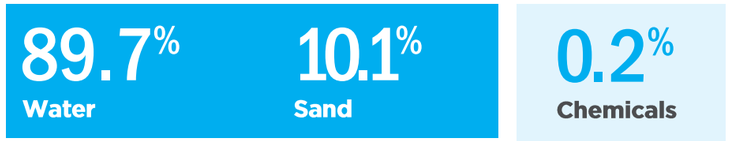
# hydraulic fracturing fluid composition

To develop natural gas from the Marcellus Shale, we use hydraulic fracturing. This is a technology that involves pumping water, sand and chemical additives into a targeted section of rock to fracture the rock so natural gas can flow to the wellbore.

The chemicals we use, and their concentrations, vary from well to well in order to address the unique geology at each site. Some of these chemicals are potentially harmful to people, and some are not. To prevent health or environmental impact, we design, maintain and inspect our wells and equipment to keep all fluids contained. These chemicals are on the drill site for a short period of time.

Residual amounts of the chemicals, which may remain in the well, flow back from underground when production starts, and are managed with any produced water via treatment, reuse, or proper disposal.

Typical Hydraulic Fracturing Fluid*




This table outlines the chemicals used in our operations in the region. Since many have multiple names, we included each compound's corresponding Chemical Abstracts Service (CAS) number.

These numbers are unique identifiers for chemical substances, making it easier to search for and get more information about them.

The name, concentration and volume of chemicals used in each well are posted on a third-party website, www.FracFocus.org.

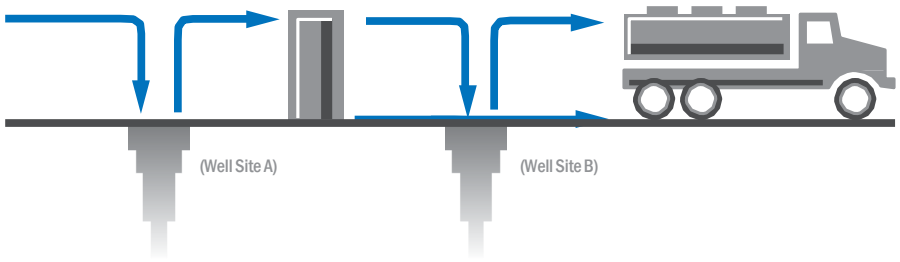
| Fluid Component | CAS Number | Purpose in Well Completion[1] | Purpose Explained |
|---|---|---|---|
| Water | 7732-18-5 | Carrier/Base Fluid | Pumped into well to fracture rock |
| Sand | 14808-60-7 | Proppant | Holds the cracks in the rock open so natural gas can be produced |
| Polypropylene Glycol | 25322-69-4 | Antifoam Agent | Prevents formation of air bubbles in the well completion fluid when sand is mixed in. This enables pumping the fluid into the well |
| Hydrochloric Acid | 7647-01-0 | Perforation Cleanup | Helps dissolve minerals and initiate cracks in the rock |
| Polyethylene Glycol | 25322-68-3 | Biocide | Biocide prevents the formation of bacteria growth on well pipe walls or in the gas reservoir. Minimizes corrosive impact to maintain the integrity of the well and ensures open spaces in the gas reservoir |
| 2,2-Dibromo-3-Nitrilopropionamide | 10222-01-2 | | |
| Glutaral | 111-30-8 | | |
| Dibromoacetonitrile | 3252-43-5 | | |
| Ammonium Sulfate | 7783-20-2 | Friction Reducer | Friction reducer reduces the energy needed to pump fluid into the well to fracture subsurface formation |
| Petroleum Distillates, Hydrotreated Light | 64742-47-8 | | |
| Urea | 57-13-6 | | |
| Ammonium Acetate | 631-61-8 | | |
| Alcohol Ethoxylates | * | | |
| Carbohydrate Polymer | * | Gelling Agent | Forms a gel to ensure the sand is carried into the cracks in the rock to hold them open |
| Hemicellulase Enzyme | 9012-54-8 | Gel Breaker | Causes gel to decompose after it has carried the sand into cracks in the rock |
| Methanol | 67-56-1 | Corrosion Inhibitor, Iron Control | Minimizes corrosive impact to maintain the integrity of the well |
| Aliphatic Alcohols, Ethoxylayed #1 | * | | |
| Aliphatic Acids | * | | |
| Prop-2-yn-1-ol | 107-19-7 | | |
| Tetrasodium Etylenediaminetetraacetate | 64-02-8 | Iron Chelating Agent | |
| Trisodium Nitrilotriacetate (Impurity) | 5064-31-3 | | |
| Sodium Hydroxide | 1310-73-2 | | |
| Sodium Erythorbate | 6381-77-7 | Iron Stabilizer | |
| Ethylene Glycol | 107-21-1 | Iron Control, Scale Inhibitor Scale | |
| Trisodium Ortho Phosphate | 7601-54-9 | Inhibitor | |
| Ethane-1,2-diol | 107-21-1 | Inhibitor | |

*The figures represent an average of randomly selected wells completed by Chevron. The table lists the chemical category that the supplier has provided noting that the specific compound name and CAS number are proprietary

1. Defined by FracFocus
2. RM is Rheology Modifier

Between 15-20 compounds were used in each well completion in 2016

# managing water resources




Our strategy is to reduce both our freshwater consumption and the need for water transportation, transfer and disposal.

1. **Water is pumped in**

   The water that is used in our hydraulic fracturing fluid is a variable blend of brine and freshwater. This fluid is pumped into the well during hydraulic fracturing.

2. **Water flows back to surface**

   When the well begins producing natural gas, a portion of the water pumped into the well flows back to the surface through the pipe as brine.

3. **Water is reused**

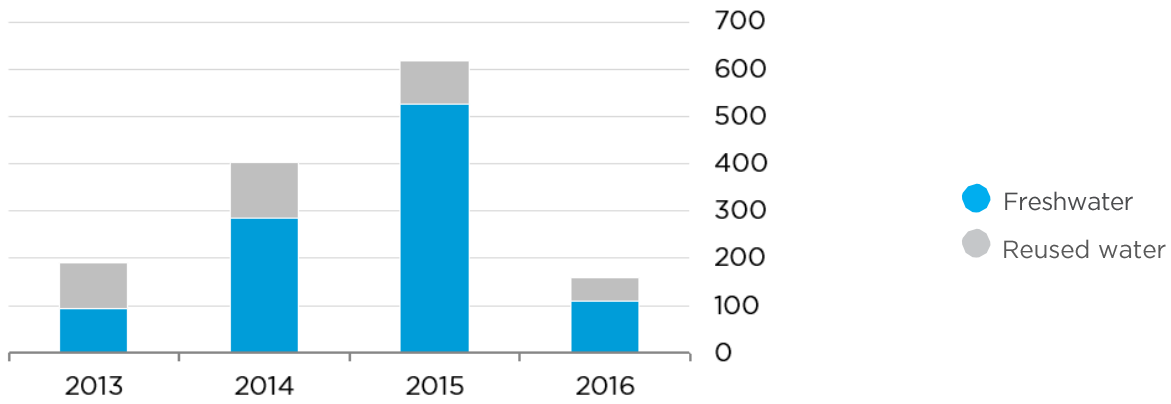
   We transport most recycled brine to other sites for use in future operations. The remainder is safely taken by third-party disposal companies to permitted injection wells.

Chevron strives to maximize the reuse of its Appalachian brine. In 2016, we reused 91 percent of our brine in future Chevron operations. Our brine reuse rate satisfies the standard established by the Center for Responsible Shale Development. Water that we cannot reuse is disposed in federally-regulated wastewater disposal wells. In addition to federal regulations, Chevron conducts its own due diligence to ensure water is properly transported, handled, and disposed.

### Hydraulic fracturing water sources

We reuse brine in our well completions, reducing the need for freshwater.

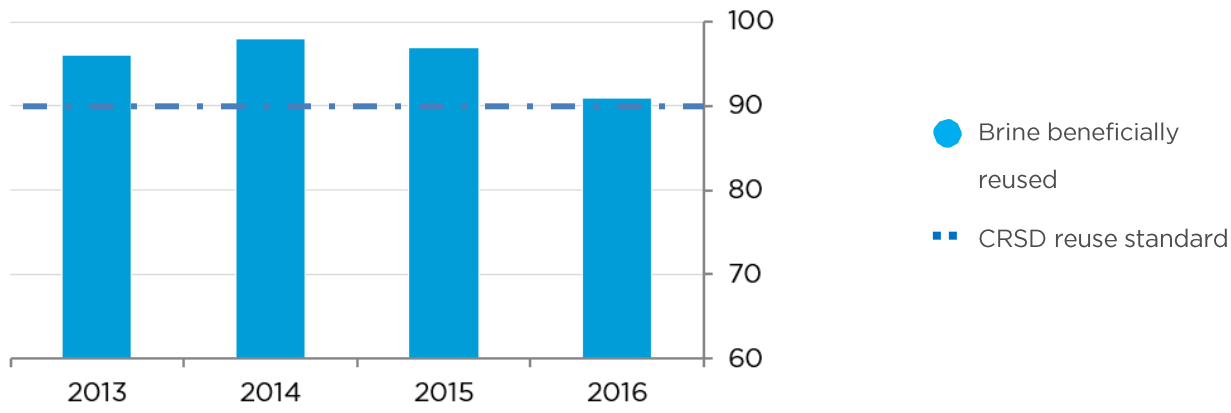
Millions of gallons supplied to well completions




### Brine reuse rate

In 2016, we reused less brine water than in years prior because we had less development activity. The more development activity we have, the more brine water we can reuse. Nonetheless, our brine reuse rate remains above the CRSD standard.

Percent of brine reused



# reducing traffic with water pipelines

**54%**

of water transported by pipeline in 2016

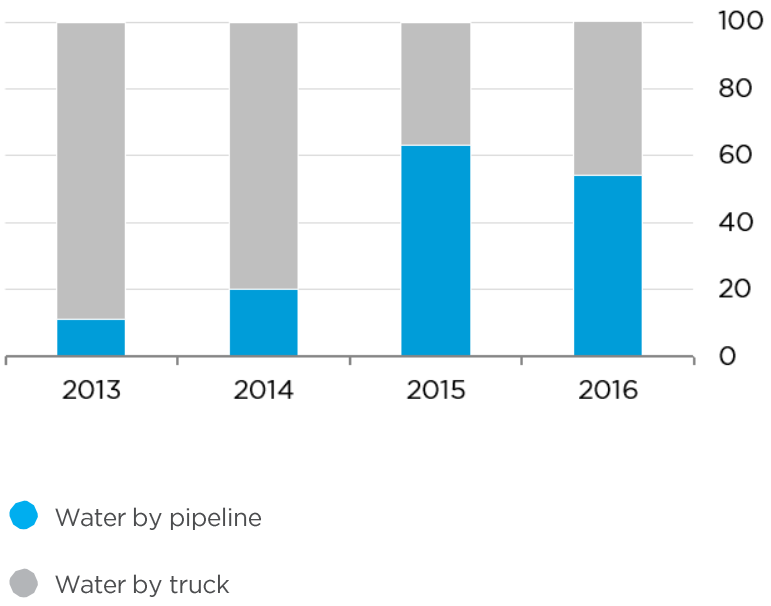
**80,000**

truckloads eliminated from the surrounding roadways in 2016

In 2016, Chevron transported 54 percent of its total water volume by pipeline in the Appalachian region, which eliminated about 80,000 truckloads from the surrounding roadways. This is part of a trend in which we are working to transport a larger portion of water to our well pads via pipeline, reducing the number of water delivery trips our trucks make on public roads, reducing traffic and air emissions from trucking.

In 2016, we used pipelines to deliver most of the water needed for well completions to well pads in Marshall County, West Virginia and Fayette County, Pennsylvania.

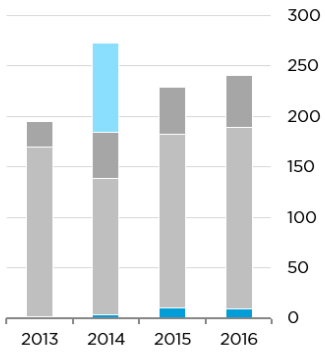
**Percent of water delivered by pipeline**



# managing air emissions

**Greenhouse gas emissions**
We track and report our greenhouse gas emissions.

**Thousand metric tons $CO_2eq$**




- Venting and flaring from the 2014 Pennsylvania well control incident
- Venting and flaring from well development activity
- Well drilling and completion equipment, heating for gas processing
- Other equipment

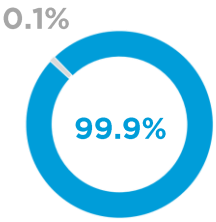
We design, construct and operate our wells to minimize air emissions and we monitor all of our well pads to maintain their integrity.

**In our operations:**

- We use production pipe with high quality connections and seals so that all fluids and gas will be contained in the wellbore at all times.
- We verify the integrity of our wells and production equipment with regular inspections, and we test our safety control equipment to confirm our controls are working.
- Our leak detection and repair program inspections occur weekly by operators and annually with infrared technology.

Chevron has a formal program in which we inspect all of our well pads for leaks — when we detect that any components are leaking, we repair them. Since initiating the program, less than 0.1 percent of the equipment on our well pads was identified as leaking during inspections. In each instance, after the leaking equipment was identified, the company made the necessary repairs.

Our drilling rig fleet in the Appalachian region enables us to create a smaller physical and carbon footprint. All of our drilling rigs used in 2016 met standards for lower particulate emissions. Our entire fleet has the capability of drilling longer laterals; by using these rigs we are able to reach resources without needing to construct additional well pads.




**Facilities monitored in 2016**
All of our facilities are monitored for leaking equipment and all leaks are repaired.

- Equipment without leaks
- Equipment with leaks identified and repaired

# reduced emission completions

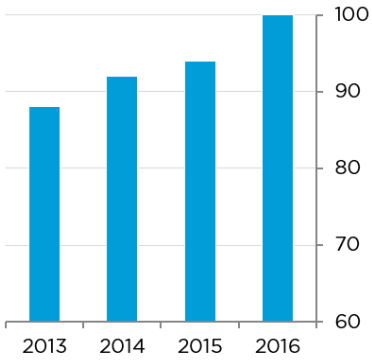
To limit emissions after hydraulic fracturing, Chevron uses a process known as reduced emission completions, which is the process of capturing any flow of natural gas at the well head immediately after well completion and directing the gas to the pipeline for sale, rather than allowing it to escape into the atmosphere.

The EPA requires implementation of reduced emission completions for non-exploratory wells developed after 2015. We implemented the process in 2013, and since 2014, all of our non-exploratory wells turned onto production utilized reduced emission completions. In 2016, we completed all of our wells without flaring.

**Reduced emission completions**

We implemented reduced emission completions over a year before the EPA requirement to reduce flaring. In 2016, we completed all of our wells without flaring.

**Percent of all well**




**completions without flaring**

# minimizing traffic impacts

**$21 million**

spent improving 428 miles of roads since 2013

We aim to do our part to make the region's roads safe, and we take our commitments to communities and local governments seriously. We secure road bonds for all sections of road that we may use in our operations, and we work with state and local governments and other road users so that road maintenance and improvements are completed in a timely and responsible manner. In 2016, we improved or repaired 66 miles of roads in our area of operations. Since 2013, we spent more than $21 million improving 428 miles of road in Pennsylvania, Ohio, and West Virginia.

In addition to road maintenance, we take steps to reduce traffic and require our drivers to follow safe driving practices.

**Some of the efforts include:**

- Reducing the number of truck trips by 80,000 in 2016 by delivering more water by pipeline.
- Working with local officials and schools to determine best routes to avoid high-traffic sensitive areas or school bus routes. We obtain permits to drive only those routes, and we use GPS tracking to confirm these routes are being followed
- Seeking alternative solutions, where possible, to reduce the volume of truck traffic, such as the use of centralized water facilities from which water is piped to multiple well pad locations
- Verifying Chevron-contracted drivers are trained in Smith System® defensive driving
- Equipping trucks with monitoring equipment to gather data on drivers' speed and safe stops. The data is reviewed to provide feedback to the drivers
- Enforcing strict rules against distracted driving
- Enforcing a drug and alcohol testing program for our drivers, including contractors

**monitoring equipment**

on trucks gather data on speed and safe stops and provides immediate feedback to drivers

# improving workforce safety

We identify and mitigate risks by using our Operational Excellence Management System (OEMS) and by enhancing our technology, tools, and competency at all levels of the workforce.

We have a stringent safety policy. We consistently train our workforce. And our employees and contractors are empowered with the authority to stop work if they believe conditions are unsafe. We take steps so that our contractors meet the same safety principles by making our expectations clear and verifying compliance with safe work practices.

Since the beginning of 2015, we have worked more than 6 million hours with zero days-away-from-work injuries, which means that for more than two calendar years, each one of our employees and contractors went home without a serious injury. We are proud of this achievement and will strive to continue this trend.

In addition to promoting safety at work, we are a corporate leader in providing health awareness and education programs to our employees, their families, and to the residents of communities where we operate.

**6 million hours**

of work since 2015 with zero days-away-from- work injuries

# supporting our communities

Chevron has a strong commitment to the communities where we live and work, and partnership is very important to us. Since 2011, we have donated more than $15.7 million to organizations in Ohio, Pennsylvania, and West Virginia. Our investments support community needs, public safety, education, and economic development.

**$15 million**

contributed through 2016 to support education, community needs, public safety and workforce development

**Education**

Chevron takes a comprehensive approach to investments in education, and we aim to get kids excited about science, technology, engineering and math (STEM) through exposure to hands-on, project-based learning opportunities. We support programs such as Project Lead the Way and Fab Labs in more than 90 schools through the region.

**Economic development**

We fund job training programs such as ShaleNET, Southwest Training Services, and Catalyst Connect, to provide residents of the region with skills and career awareness that can help them obtain good jobs.

**Community needs and public safety**

Our volunteers support food banks, shelters, local parks, and community events that inspire people and celebrate diversity. Since 2012, we have made 395 donations to public safety officials in areas where we operate, supporting police, firefighters, and haz-mat teams.

**Appalachia Partnership Initiative**

In 2014, Chevron committed $20 million to launch the Appalachia Partnership Initiative along with our partners Allegheny Conference on Community Development, the Claude Worthington Benedum Foundation, the Grable Foundation, Catalyst Connection, and RAND Corporation. This initiative supports enhanced STEM education and workforce development programs. Through 2016, we have attracted an additional $9 million from corporations, nonprofits, and public sources focused on education and workforce development.

Chevron North America
Exploration and Production Company
700 Cherrington Parkway Coraopolis,
PA 15108, USA www.chevron.com

For more information:
www.chevron.com/shale
or email
chevroninappalachia@chevron.com

© 2017 Chevron Corporation. All rights reserved.