CARMON CREEK PROJECT
IN SITU HEAVY OIL
Alberta’s heavy oil resources contain an estimated 1.7 trillion barrels of oil in place. Some 170 billion barrels of this heavy oil, or bitumen, are rated economically recoverable—making them the world’s third largest crude reserve.
Canada’s heavy oil deposits represent a secure and reliable energy source to help meet growing energy demand.

Global energy demand is predicted to double between 2000 and 2050 as a result of population growth and improved standards of living in emerging economies.

Alberta’s heavy oil resources contain an estimated 1.7 trillion barrels of oil in place. Some 170 billion barrels of this heavy oil, or bitumen, are rated economically recoverable — making them the world’s third largest crude reserve. Alberta has three main heavy oil deposits in the Athabasca, Cold Lake and Peace River areas. Only about 20 per cent of bitumen reserves that lie within 70 metres of the earth’s surface are economically accessible by open pit mining while the remaining 80 per cent are buried too deeply to be mined and must be recovered in situ (Latin for in place) by drilling wells. This involves much less surface disturbance than mining operations.

Heavy oil development is proceeding under comprehensive federal and provincial government regulations that govern all aspects of air, water, land, wildlife, human health and socio-economic impacts.

**Canada’s Oil Sands Contain**

170,000,000,000 Barrels

Contributes

Powering our vehicles, from the smallest urban car to the biggest 400 tonne dump truck.

A reliable source of energy for business across Canada.

Heating and powering our cities in both work places and homes.

Economic stability, jobs and growth for North America.

Contributes

Contributes

Contributes

Contributes
SHELL’S HEAVY OIL IN SITU OPERATIONS
Shell’s in situ heavy oil operations are located in both the Cold Lake and Peace River regions.
Shell’s heavy oil in situ operations include a SAGD (Steam Assisted Gravity Drainage) production facility in the Cold Lake region and two bitumen production facilities in the Peace River oil area.

The Peace River Complex uses enhanced oil recovery methods. This involves injecting steam into the reservoir to make the bitumen fluid enough to be pumped to the surface. The Clifftdale Battery uses cold production methods. It is referred to as cold production since the bitumen in some parts of the reservoir is fluid enough to be pumped to the surface unaided by steam.

In 2012, the Peace River Complex, and the Clifftdale Battery had a combined production of approximately 17,000 barrels of bitumen per day.

The Carmon Creek Project will produce approximately 80,000 barrels per day of bitumen using steam recovery methods.

- 80% of heavy oil deposits must be recovered by drilling wells
- 20% of heavy oil deposits are recoverable by mining
Shell acquired leases in the Peace River area in the 1950s and over the years has experimented with a number of technologies to unlock the potential of this vast resource.

Shell began producing bitumen from its leases in 1979 with the Peace River In Situ Project (PRISP), a thermal pilot project. In 1986 we started up a 12,600-barrel-per-day “demonstration” project called PREP (Peace River Expansion Project). PREP continues to operate today as the Peace River Complex (PRC). In 2007, Shell began producing bitumen from its Cliffdale cold production facility.

In all its operations, Shell is committed to minimizing environmental impacts while producing the energy resources essential to the economy. Shell has been a member of the Peace River community for more than 30 years. In that time we’ve made improvements to our operations to manage environmental issues and meet the expectations of the community.

Some of the gas co-produced with Cliffdale bitumen is captured and sent to Genalta’s power plant (shown above) to generate electricity in the local region.

Shell installed vapor recovery tanks on all of its Cliffdale production tanks to eliminate venting.
Shell aims to minimize environmental impacts while producing the energy resources essential to the economy.

Image of a lynx captured by the camera mounted at the pipeline crossing to track wildlife usage.
Most recently, we’ve responded to residents’ concerns about cumulative impacts of gas venting from heated field tanks, as the industry increases cold production from heavy oil reserves in the region. Shell has installed vapour recovery units on all its Cliffdale cold production tanks in order to eliminate venting from our tanks.

Three years ago we stopped burning slightly sour (i.e. containing small amounts of hydrogen sulphide) casing-vent gas from our PRC as boiler fuel and began re-injecting it into a subsurface formation to eliminate it as an odour source. At the same time, we upgraded our nearby Cliffdale cold production operations to capture sweet casing-vent gas, eliminating those emissions and using the captured gas as fuel for PRC boilers.

As we continue to develop our Cliffdale leases, the gas produced with the bitumen exceeds our ability to be able to use the gas as fuel for our own facilities. To efficiently use this gas, we negotiated an agreement with Genalta Power Inc. to redirect the gas to a new power plant. Genalta will use the gas to generate electricity that will contribute to power supply in the region while offsetting the need for much more greenhouse-gas-intensive, coal-fired power. The power plant is capable of generating four megawatts of electric power – which is enough power to meet the needs of 4800 residential homes in Alberta.

Shell takes a life-cycle approach to developing its resources to not only minimize the environmental footprint during operations but to consider how to incorporate best practices to reclaim the land once development has concluded. Some examples of measures Shell takes to minimize footprint include: use of existing disturbances where practical when building new facilities and planning new disturbances to avoid sensitive environmental areas; aligning linear disturbances into one right-of-way and drilling multiple wells per pad to minimize surface impacts. To reduce fragmentation of habitat we’ve also installed wildlife crossings over our above-ground pipelines and cameras have shown that they’re readily used by a variety of species.

Shell is a partner in several collaborative research initiatives occurring on its leases to help develop reclamation best practices. Shell has donated more than $500,000 over a five-year period to NAIT’s Boreal Research Institute in Peace River and has provided test plots on its leases for research activities. In 2013, Shell was awarded the Major Reclamation Award from the Alberta Chamber of Resources (ACR) for a peatland well pad reclamation program being conducted on its Peace River leases.

To reduce fragmentation of habitat we’ve also installed wildlife crossings over our above-ground pipelines and cameras have shown that they’re readily used by a variety of species.
The Carmon Creek project will use state-of-the-art technology to produce 80,000 barrels per day of bitumen (12,600 cubic metres) using vertical steam drive technology. About one year after Carmon Creek starts up Shell will decommission the existing Peace River Complex processing facilities and reclaim the site to standards set by the province and tie in producing wells to the new Carmon Creek facilities.

The Carmon Creek development will include:

1. **Vertical Steam Drive Wells**
   
   Vertical deviated steam (VSD) drive wells will be used to heat the reservoir and produce the bitumen. VSD wells use dedicated injectors and producers to drive the heated oil horizontally through the rock from the injector to the producer. This results in continuous production – unlike cyclic steam stimulation (CSS) methods where the same well is used to inject and produce bitumen resulting in repeated cycles of steam and production. While Shell will use CSS methods in the early stages to loosen the bitumen between the injectors and producers, VSD recovery methods (which operate at lower pressures and have greater recovery efficiency than CSS) will primarily be used over the life of the development.

2. **Well Pads**
   
   Thirteen well pads, averaging 48 wells per pad, will be drilled to provide production for start-up of both phases. To offset natural production decline, two to four new well pads will be drilled each year for the life of the project. When production from well pads declines and they reach the end of their lifespan (10 – 15 years) the disturbed land will be reclaimed to minimize the overall project footprint. Well pad equipment will be re-used as practical.

48 wells will be drilled per pad.
CARMON CREEK
PROJECT SCOPE

1. Vertical Steam Drive Wells
2. Well Pads
3. Bitumen Processing
4. Co-generation
   Cogeneration and Steam Facilities
5. Water Treatment
6. Rights-of-way
   - On-site
   - Off-site

- Excess Power to Regional Grid
- Make-up Water
- Produced Bitumen, Water and Gas
- Sold Steam and Condensed Water
- Condensed Water
- Produced Sweet Fuel Gas
- Recycled Water
- Steam and Bulk Water
- Treated Gas
- Diluent

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CARMON CREEK
PROJECT SCOPE

2 Well Pads
3 Bitumen Processing
4 Co-generation
6 Rights-of-way
   - On-site
   - Off-site
7 Bitumen Sales
8 People

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3 Bitumen Processing

The project will be built in two phases of 40,000 barrels per day. Each phase will have a Central Processing Facility (CPF) that will generate steam and separate the produced fluids from the wells into oil, water and gas.

- **Oil** will be diluted with natural gas condensate for pipeline transportation to market.

- **Produced water** will be routed to a central water treatment facility and then recycled for steam production.

- **Produced gas** will be treated to remove hydrogen sulphide (H₂S) and then used as fuel to generate steam. Gas from Shell’s nearby Cliffdale cold production operation will also be fed to the co-generation power plants as fuel.

4 Co-generation

Three co-generation electric power plants will be built within the CPFs. They will use natural gas to generate low-emissions electricity, and generate steam for bitumen recovery from the waste heat.

5 Water Treatment

Each CPF will have a water treatment facility to recycle the water needed for steam production. Process water will be continuously treated and recycled. On occasion more water will be needed for steam generation than is available from the recycled produced water. Shell is proposing to draw make-up water from the Leduc subsurface formation.

6 On-site Rights-of-way

Most rights-of-way will run relatively short distances within the Shell Carmon Creek lease area. New above-ground steam pipelines will carry steam from the co-generation facilities to well pads. Pipelines will carry oil, gas and water from the field to the CPFs. Water lines will carry make-up water from Leduc underground formation wells to the CPF’s water treatment facilities. A pipeline will carry fresh water from the old Peace River Complex to the
CPFs for on-site utilities and emergency backup. Another pipeline will carry H₂S and associated CO₂ from the CPFs to deep injection wells. Roads will be required to interconnect the construction campsite, field, CPFs, as well as Leduc-formation water wells and deep disposal wells.

7 Off-site Rights-of-way

A new pipeline will move purchased diluent from the existing Nipisi terminal to Shell’s CPFs and another pipeline will carry diluted bitumen from these facilities to the terminal. These pipelines will use the existing Cliffdale pipeline right-of-way where possible. A 240 KV electric power line will connect the co-generation facilities to the power grid.

8 People

The number of full-time, permanent employees and contractors needed to operate the Carmon Creek facilities is not yet determined - we estimate that the number would be about 250. Additionally, Shell’s joint-venture drilling company will require additional staff on a continuing basis.

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CARMON CREEK AND THE ENVIRONMENT
Shell has more than 30 years of operating experience in the Peace River area and our current operations have a number of measures in place to protect the environment.

As part of the Carmon Creek regulatory application, Shell submitted an Environmental Impact Assessment (EIA) that identified potential environmental, health and socio-economic impacts of the project during construction, operation and reclamation and ways to mitigate or avoid those impacts as well as ways to maximize benefits of the project. The EIA also considered First Nations traditional uses of the lease area and an important aspect of the project will be ongoing consultation with First Nations to minimize or avoid impacts of the project on their traditional land use.

Since submitting the regulatory application Shell continued to mature design plans to further reduce impacts that were identified in the application. The project will implement a number of best practices to: minimize fresh water usage, reduce land footprint, utilize modern low-air-emissions generators and treat the gas co-produced with the bitumen to avoid sulphur dioxide emissions.

With our Carmon Creek project we will be a leader among in situ operations with our efforts to minimize impacts to air, water and land.
The project has been designed to make most efficient use of the gas that is produced with the bitumen and to minimize sulphur dioxide (SO₂) and nitrogen oxides (NOₓ) emissions.

The gas that is co-produced with the bitumen will be treated to remove hydrogen sulphide (H₂S) and then used as fuel in the facilities to produce steam. The removed H₂S will be sent by pipeline to an underground reservoir where it will be re-injected into suitable strata deep below the Carmon Creek bitumen reservoir in accordance with provincial regulations. Gas from Cliffdale cold production operations will also be tied in and used as a fuel source for Carmon Creek. In this way we use gas produced from the Peace River reservoir efficiently and reduce the need for purchased gas.

NOₓ is emitted from vehicles and industrial sources. Shell will use Ultra Low NOₓ burners to reduce emissions from the co-generation turbines. This not only reduces emissions but also reduces noise.

**Greenhouse Gas (GHG) Management**

Rather than use boilers to generate steam required for the project, the project will use waste heat from the three co-generation facilities to create the steam required for the thermal oil extraction. The co-generation process produces both steam and electricity within a single facility from a single fuel (gas). This is a much more energy efficient way of meeting both the steam and electricity needs of the project.

The three co-generation electric power plants will produce an annual average of 630 megawatts (MW) of power. About 120–130 MW of this electricity will supply the requirements of our operations while approximately 500 MW of the power will be sold to the northwest Alberta grid. This is enough surplus to generate power for about half a million homes. Using natural gas for electric power generation reduces demand for coal-fired power and the electricity that Carmon Creek provides to the grid produces about 65 per cent less CO₂ than if the same amount of power were provided by a coal-fired power generating facility.
Steam is a necessary part of the in situ recovery process to maximize our bitumen recovery. The water used to create the steam can come from a number of sources. The biggest source of water for the project is the water that is co-produced with the bitumen which is called produced water. Produced water will be cleaned up and re-used to create steam. This recycling process will exceed all regulatory requirements for water management for in situ projects.

A supply of water for steam generation is required during start-up before there is a supply of produced water to recycle. Shell continues to pursue plans that may entirely eliminate the need to use river water during start-up. Peace River water will be used as make-up water if the water from the Leduc is unavailable due to a process upset or if there is a sudden temporary shift in the water quality. A minimal amount of river water will still be needed for site operations that can’t use recycled water such as dust control, wash water, or drilling water.

Our plans for water conservation would mean that the project ranks amongst the best of all in situ operations in Alberta in terms of fresh water management.
The Carmon Creek Project is designed and will be built to minimize surface footprint and area impacts by: use of existing disturbances where practical (such as aligning linear disturbances into one right-of-way), planning new disturbances to avoid sensitive environmental areas; and drilling multiple wells per pad to minimize surface impacts.

Since filing our Carmon Creek Project Application in 2010, we’ve matured engineering and design of the project to reduce the net land use required for the project facilities (smaller plant site, well pads, borrow pits and roads) by 27 per cent. Shell consulted its offshore design experts to find ways to minimize wasted space within facilities designs and well pad layouts. Steps that Shell took to reduce footprint from our regulatory application include:

- Each CPF will include a single water treatment facility rather than separate plants for river water, brackish water and produced water from oil wells.
- A single campsite for construction workers has replaced two camps for each CPF (originally four were planned).

**Progressive Reclamation**

We anticipate 13 well pads will be needed at the startup of Phase One and Two to sustain production at approximately 80,000 barrels of bitumen per day. In addition to maintaining production, Shell will reclaim the land disturbed by well pads as production from these wells declines and they are taken out of service. Wherever practical, we will reuse equipment from decommissioned well pads. In addition, we have conducted extensive research on reclamation to find the best ways to return former well-pad sites to their surrounding ecosystems.

To protect the Western Boreal Toad, which has been identified as ‘special concern’ under Canada’s Species at Risk Act (SARA), construction sites are assessed and any toads or other amphibians located within rights-of-way are captured and re-located to safe locations.
By reclaiming well pads at the end of their lives, the project will limit surface disturbance to approximately five per cent of the total Carmon Creek development area at any one time.
Construction of Shell’s two Carmon Creek CPFs, initial field installations and supporting infrastructure will require a peak construction workforce of 1,200 tradespeople. During this period, the local area will experience increased traffic related to worker transit and movements of materials and construction vehicles.

To maximize efficiency, control costs and maintain scheduling, major portions of the project will be built in modular construction yards offsite. Current plans call for pre-built modules to be moved to the region by rail and truck. Road transport of the modules will be timed to minimize obstruction of local traffic.

To minimize adverse impacts on local infrastructure, a construction camp will be built to house construction workers. All workers will be transported to and from the site using buses to minimize traffic and HSE (Health, Safety, Environment) risks. The camp being built for the project is a joint venture (JV) established by ATCO Structures with the Woodland Cree First Nations. The JV partnership will be supporting camp services for the project which includes camp management, catering, and housekeeping.

The construction camp has been designed to be as self-sufficient as possible. It will be sized and designed to house, feed and entertain the entire construction complement. Rooms will be larger than industry standard and each will be self-contained, with private washroom and shower facilities. The camp will also include weight training facilities, a gymnasium and running track. Additionally, the camp will be built to permanent-housing standards and provide accommodations for commuting Calgary personnel and contractors involved in future maintenance and operations projects. An onsite health clinic will minimize the impact of our activities on local health services.
Our Carmon Creek construction workforce will peak at 1,200 in 2015 and 2016. We will give preference to qualified local job applicants.

We’ve examined our vendor requirements and will work with local businesses to bid for supply and service agreements. Successful local contractors will need to be cost-competitive and meet Shell’s stringent safety and environmental performance standards. We also require our main contractors to provide opportunities for local businesses, and will work with them to ensure local businesses are aware of contracting opportunities.

Beyond hiring and contracting, Shell actively participates in the capacity-building efforts of the region. We’ve invested in important regional education programs to support local job aspirants, including Aboriginal people, in accessing employment opportunities. In 2013, Shell provided $500,000 toward a new lab for the Peace River Regional Power Engineering Program at Northern Lakes College.

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In addition to the benefits provided during the initial construction period of the project, there are ongoing employment and contracting opportunities associated with continued drilling, wellpad and infrastructure construction over the life of the project. This also creates secondary employment and business opportunities. Operation of the facilities over 35+ years will provide sustained benefits in the form of royalties and taxes and Shell will continue to contribute to the well-being of local communities through its social investment program that provides funding to not-for-profit organizations.

In 2013, Shell opened an office in the town of Peace River where local individuals and businesses can get information on the project, including contracting and employment opportunities.