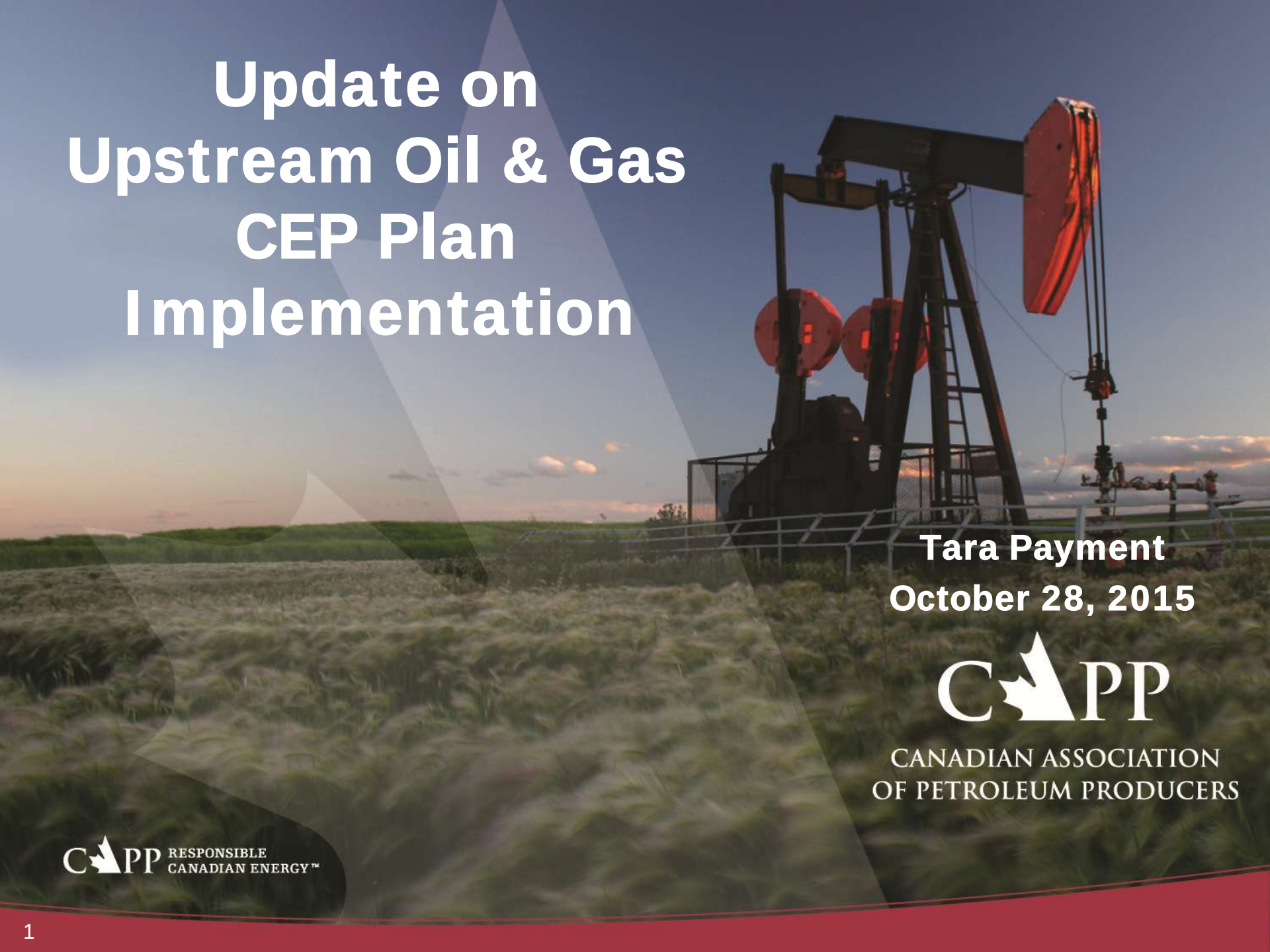
Update on Upstream Oil & Gas CEP Plan Implementation



Tara Payment

October 28, 2015

CAPP

CANADIAN ASSOCIATION OF PETROLEUM PRODUCERS

CAPP RESPONSIBLE CANADIAN ENERGY™

Water Conservation, Efficiency and Productivity Plan – Upstream Oil & Gas Sector (March 2011)

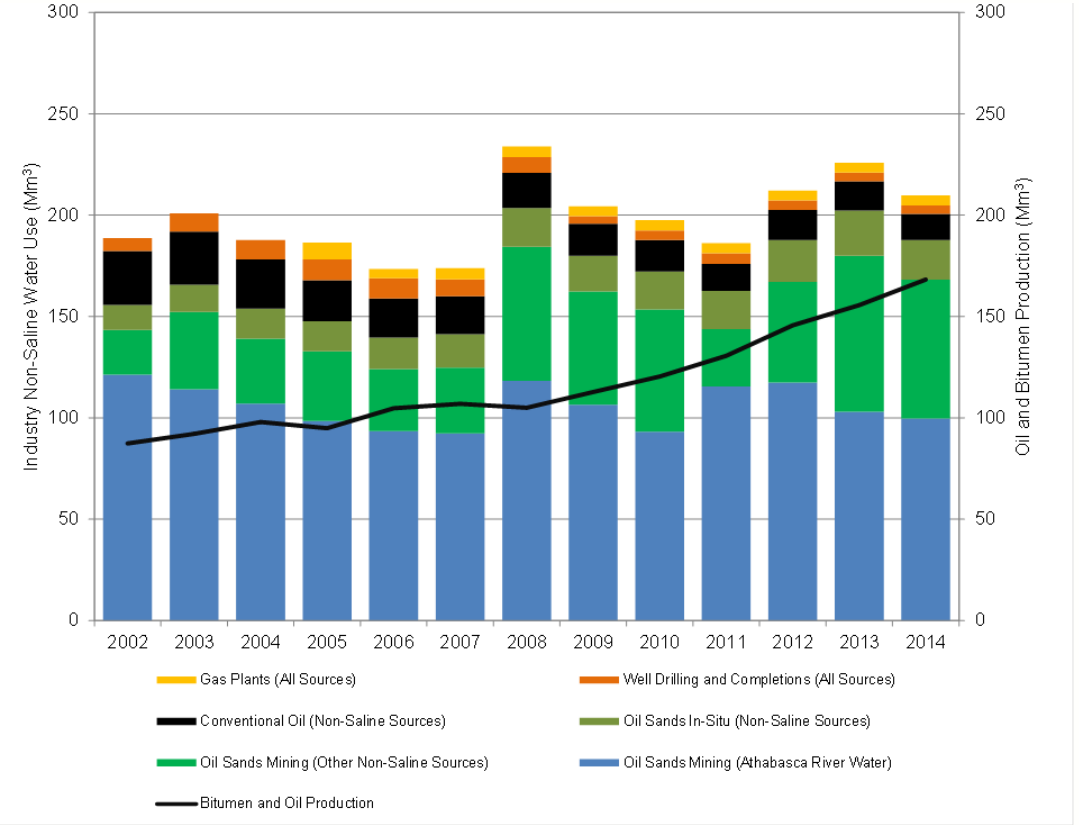
- **Scope included water used for:**
  - Oil sands mining production
  - Oil sands in situ production
  - Conventional oil production
  - Well drilling and completions
  - Gas plants
- **Excluded:**
  - Shale gas production (due to lack of available data)
  - Midstream or downstream oil & gas activities
- **Provided actual production and water use statistics from 2000 to 2009, and projections to 2015**
- **CEP performance measure:**
  - Non-saline water use productivity; i.e., the volume of non-saline water used per volume of hydrocarbon produced
  - Projected improvements compared to baseline (average of 2002 to 2004)

CEP Plan Projected Improvements

Activity	Non-saline water use productivity (m^3 non-saline water/m^3 oil or bitumen)		
	Baseline (2002-04)	Projected (2015)	Improvement (%)
Oil sands mining (Athabasca only)	3.18	2.30	28%
Oil sands mining (total fresh)	4.04	2.83	30%
Oil sands in situ	0.63	0.34	47%
Conventional oil	0.70	0.60	15%
Total	**1.98**	**1.50**	**24%**

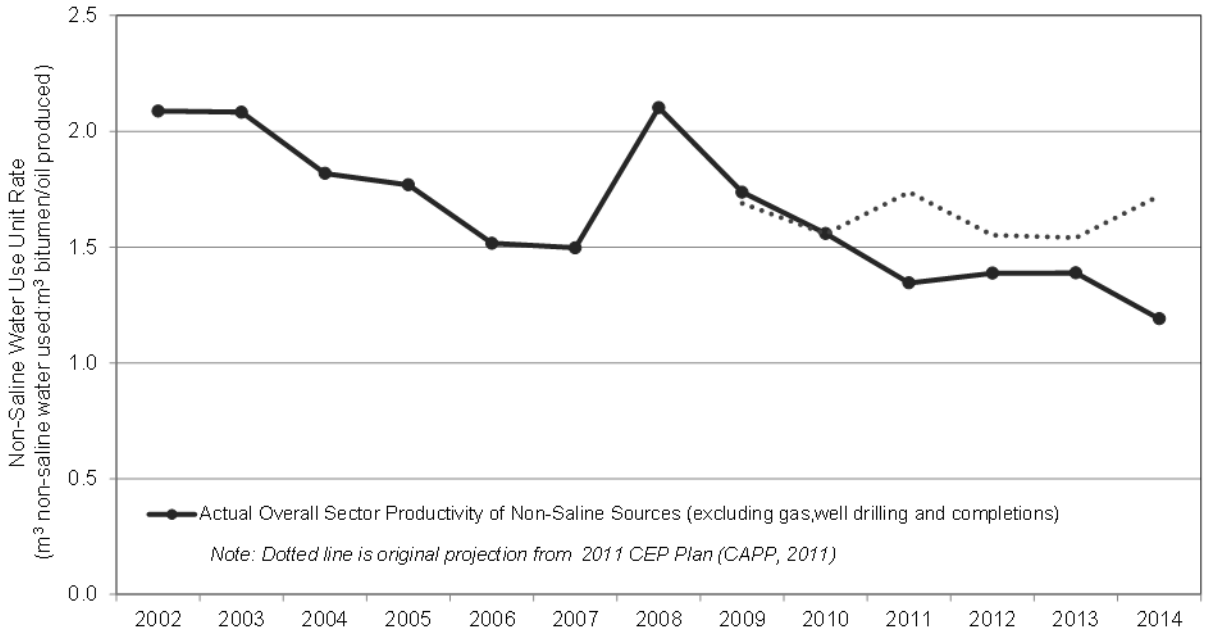
Sector Non-Saline Water Use

- **Production increased by 82% between the baseline period and 2014**
  - Baseline: 92.5 Mm3 OE
  - 2014: 168.2 Mm3 OE
- **Total non-saline water use increased 10%**
  - Baseline: 183.1 Mm3
  - 2014: 200.7 Mm3



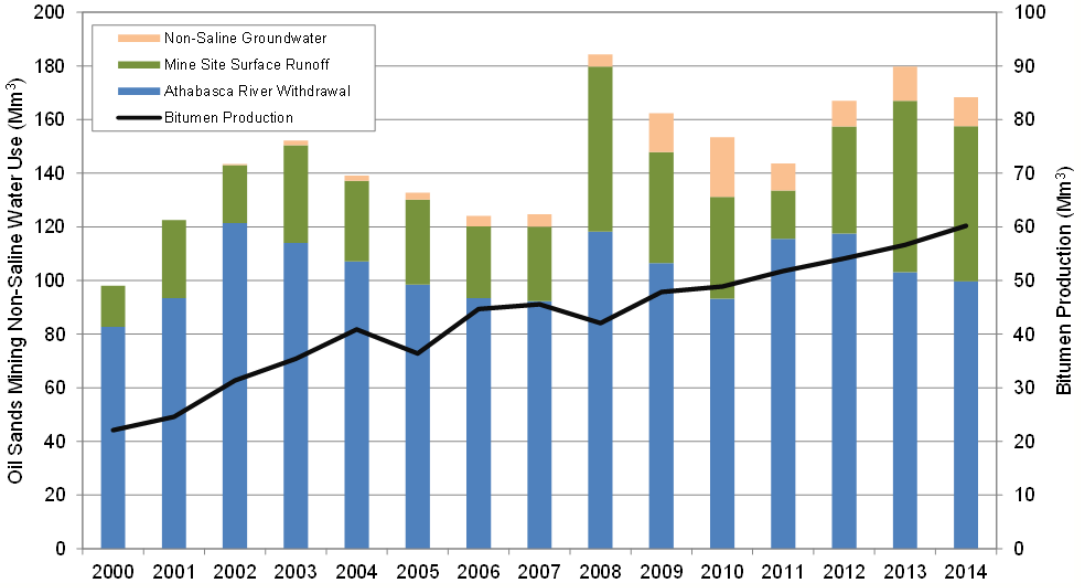
Sector Non-Saline Water Use Productivity

- **Improved 40% between the baseline period and 2014**
  - Baseline: 1.98:1
  - 2014: 1.19:1



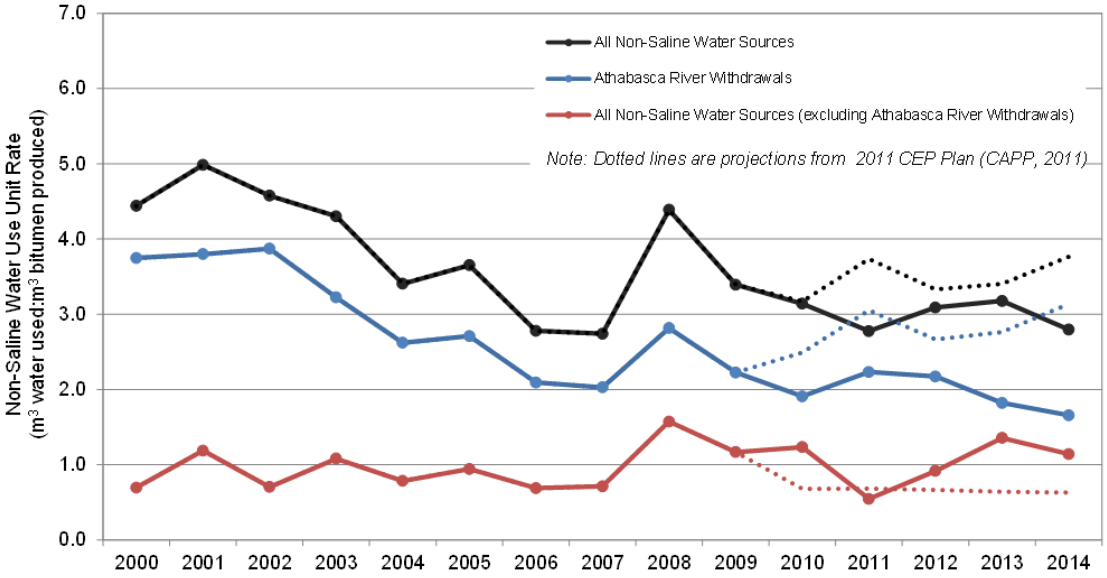
Oil Sands Mining Non-saline Water Use

- **Between the baseline period and 2014**
  - 68% increase in bitumen production
  - 16% increase in non-saline water use
- **Mined bitumen production**
  - Baseline: 35.9 Mm3
  - 2014: 60.2 Mm3
- **Non-saline water use**
  - Baseline: 144.9 Mm3
  - 2014: 168.3 Mm3
  - Use from Athabasca decreased over decade 114.2 ->99.7 Mm3



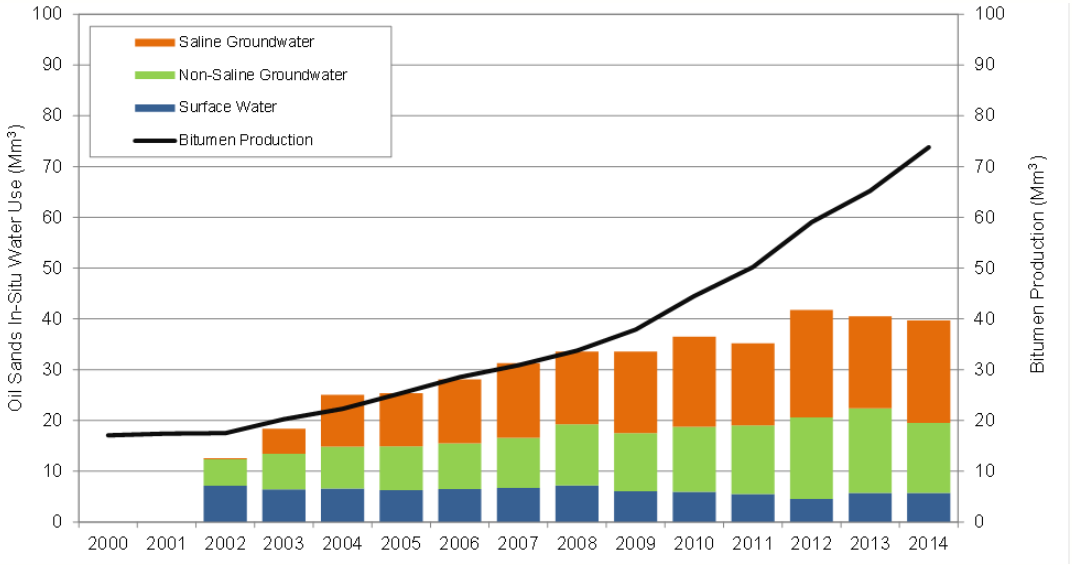
Oil Sands Mining Non-Saline Water Use Productivity

- **Improved 31% between the baseline period and 2014**
  - Baseline: 4.04:1
  - 2014: 2.79:1
- **Athabasca River water use productivity improved 48%**
  - Baseline: 3.18:1
  - 2014: 1.66:1
  - Proportion sourced from Athabasca decreased 79% -> 59%
  - Increased proportion from runoff and mine depressurization water



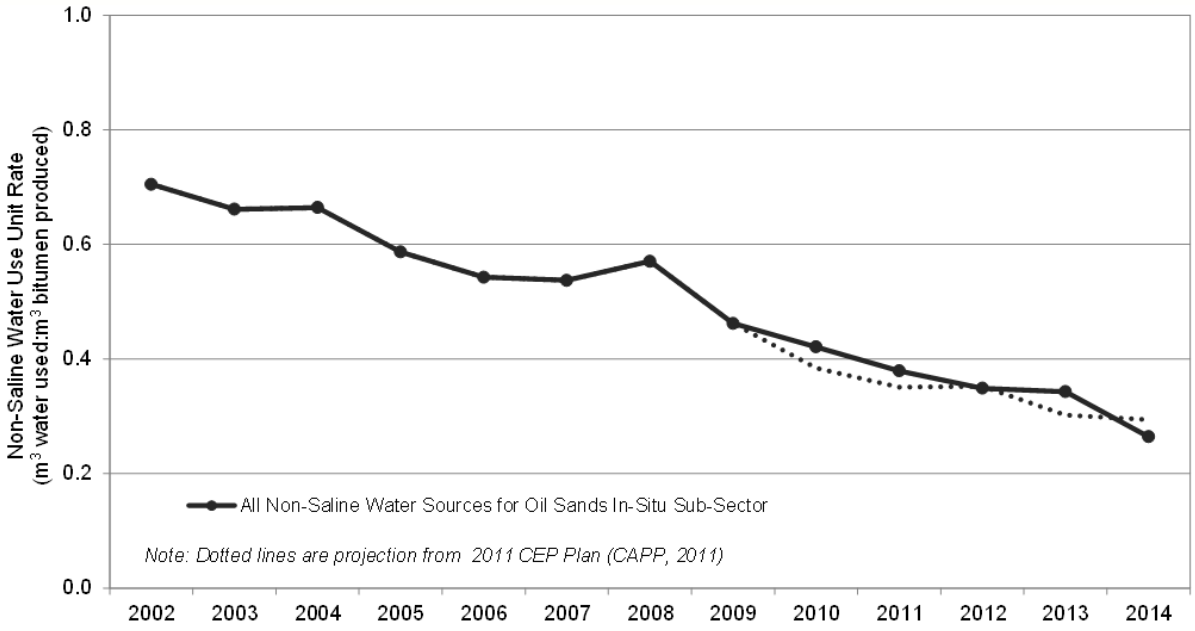
Oil Sands In Situ Non-saline Water Use

- **Between the baseline period and 2014**
  - 269% increase in bitumen production
  - 56% increase in non-saline water use
- **In situ bitumen production**
  - Baseline: 20 Mm3 OE
  - 2014: 73.8 Mm3
- **Non-saline water use**
  - Baseline: 12.5 Mm3
  - 2014: 19.5 Mm3



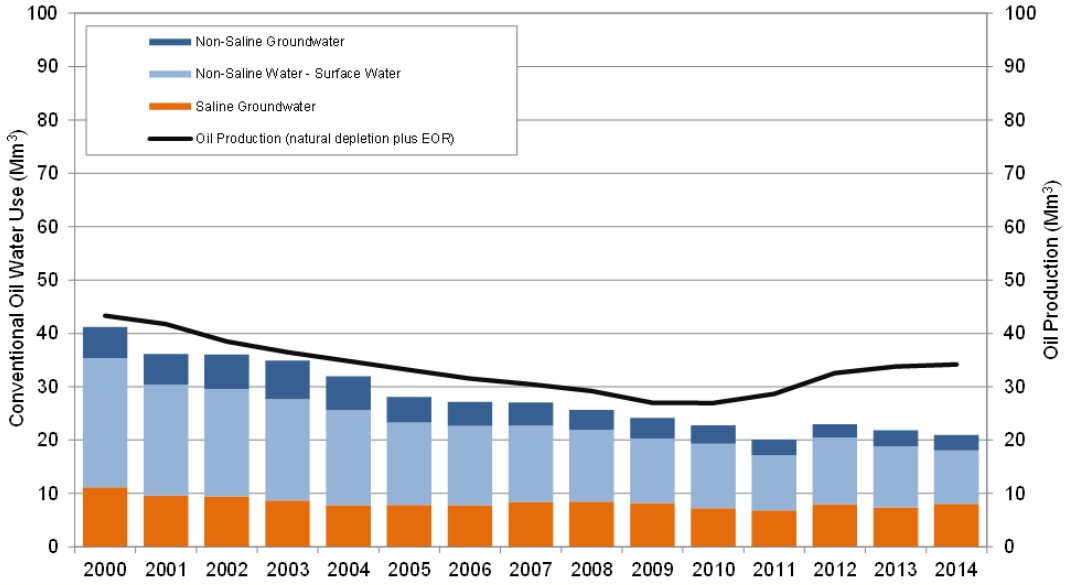
Oil Sands In Situ Non-Saline Water Use Productivity

- **Improved 58% between the baseline period and 2014**
  - Baseline: 0.63:1
  - 2014: 0.26:1
- **Primarily due to:**
  - Saline groundwater use for steam generation
  - Reuse of mining wastewater streams for in situ makeup water



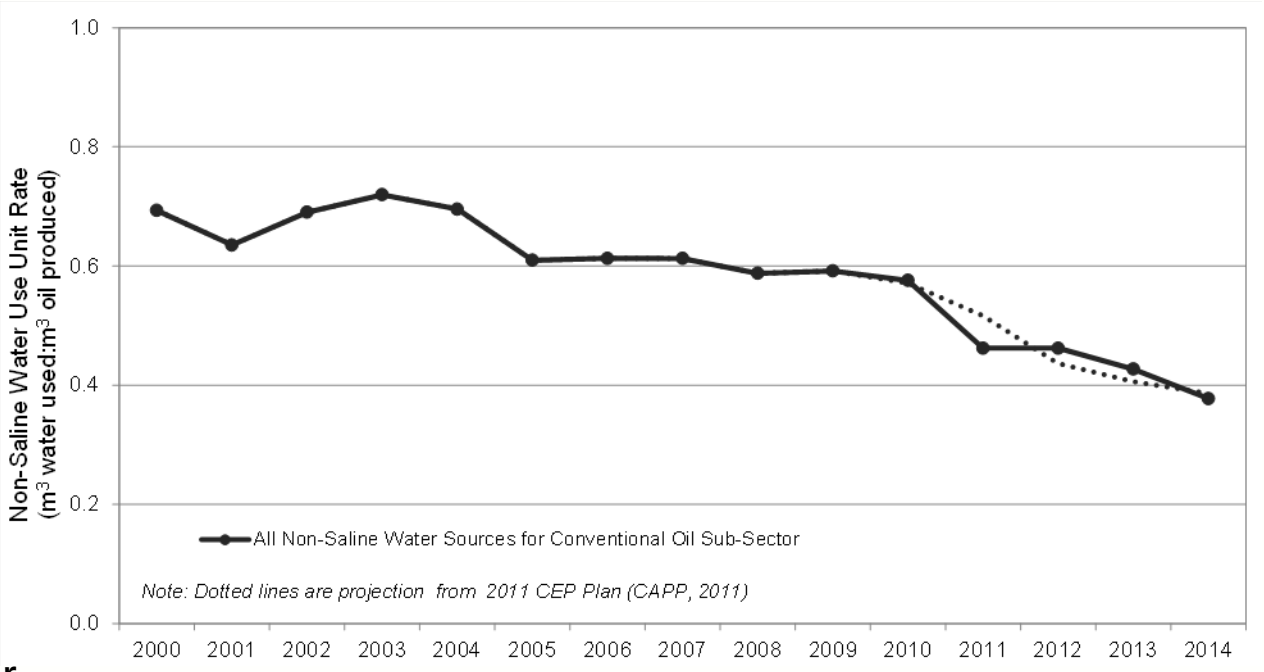
Conventional Oil Non-saline Water Use

- **Between the baseline period and 2014**
  - 7% decrease in production
  - 50% decrease in non-saline water use
- **Conventional oil production**
  - Baseline: 36.6 Mm3
  - 2014: 34.2 Mm3
- **Non-saline water use**
  - Baseline: 25.7 Mm3
  - 2014: 12.9 Mm3
  - Proportion of non-saline water decreased from 75% to 62%



Conventional Oil Non-Saline Water Use Productivity

- **Improved 46% between the baseline period and 2014**
  - Baseline: 0.70:1
  - 2014: 0.38:1
- **Primarily due to**
  - Increased reuse
  - Use of alternative water sources
  - Saline groundwater volumes remained relatively constant



Performance Relative to Baseline

Activity	Non-saline water use productivity (m^3 non-saline water/m^3 oil or bitumen)			
	Baseline (2002-04)	Actual (2014)	Actual Improvement	Projected Improvement
Oil sands mining (Athabasca only)	3.18	1.66	48%	28%
Oil sands mining (total fresh)	4.04	2.79	31%	30%
Oil sands in situ	0.63	0.26	58%	47%
Conventional oil	0.70	0.38	46%	15%
Total	**1.98**	**1.19**	**40%**	24%

Adoption of New Best Practices and Technologies

- **21 CEP opportunities were identified in the 2011 CEP plan that**
  - Reduce the volume of non-saline water required to produce bitumen, oil or gas; or
  - Reduce the environmental impact of water use
- **CAPP members were surveyed to evaluate the 21 opportunities for**
  - Level of adoption
  - Challenges
  - Successes
- **Opportunities were assessed for impact on water use**

CEP Opportunities with Moderate to High Impact

- Reuse mining wastewater streams for in situ makeup water; e.g., blowdown from upgraders, tailings pond water
- Use saline groundwater for in situ steam generation
- Recycle produced water from oil and gas wells instead of disposal or release
- Updates to equipment and operating procedures for improved water efficiency
- Alternative, less water-intensive oil sands tailings technologies and management techniques
- Alternatives to non-saline water for drilling or fracturing fluids

CEP Opportunities with Low to Moderate Impact

- Treat waste/produced/saline water for reuse rather than disposal
- Reuse municipal wastewater instead of diverting new water
- Use saline groundwater for pressure maintenance
- Use evaporator technology to treat blowdown at in situ operations
- Add polymers to waterfloods for improved productivity
- Treat water to increase recycling rate from tailings ponds

CEP Opportunities Not Adopted

- **Regulatory uncertainty**
  - Redefine water regs to prioritize use of lower quality non-saline water
    - Water Conservation Policy will identify alternative water sources - not released yet
- **In pilot or evaluation stages**
  - CO2 injection to enhance recovery instead of water injection
  - Solvent injection to enhance recovery for in situ
  - Combustion to enhance recovery for in situ
- **Cost and technical challenges**
  - Non-water-based mining extraction methods
  - Storage of water in aquifers for future use
  - Reduce evaporation from ponds

Concurrent Environmental or Social Benefits of CEP Efforts

- **Surface water storage options for oil sands mining**
  - Does not reduce water use, but can change timing of withdrawals to reduce impacts to aquatic ecosystems.
- **Less water-intensive tailings technologies**
  - Lower dependence on water from tailings ponds -> smaller ponds
  - Lower energy and GHG emissions since less water needs to be reheated for use in bitumen extraction
- **Updated equipment & operating procedures**
  - Water security
  - Reduced trucking (noise, dust, air emissions, costs)
  - Competitive advantage
  - Improved social licence to operate
- **Recycle produced water from oil and gas wells**
  - Reduced trucking
  - Reduced fresh water use

Concurrent Benefits cont'd

- **Evaporator technology**
  - Smaller physical footprint
- **Polymer waterfloods**
  - Lower GHG emissions

Environmental Tradeoffs of CEP Efforts

- **Reduction of river flows**
  - Where wastewater would have been released
- **Increased land disturbance / surface footprint**
  - Pipelines used to move water, rather than source wells on-site or trucking
  - New infrastructure
- **Increased GHG emissions**
  - Pumping alternative water sources over distances requires energy
  - Trucking water in
  - Water treatment processes
  - Evaporator technology
- **Risk of spills / pipeline failures**
  - Transmission of saline/produced/waste water
- **Additional waste generation**
  - Water treatment processes

Adjustments Needed to Sector Plan

- **Inclusion of shale gas, tight gas and tight oil water use**
  - Once water use statistics are available
- **Address overlap between existing CEP opportunities**
  - Combine if a plan update is undertaken

Summary

- **Upstream oil and gas sector has made significant improvements in non-saline water use productivity**
- **Improvements were equal to or higher than originally projected across all sub-sectors**
  - Oil sands mining - Athabasca River only: 48% (projected: 28%)
  - Oil sands mining - total: 31% (projected: 28%)
  - Oil sands in situ: 58% (projected: 47%)
  - Conventional oil: 46% (projected: 15%)
- **Overall, the sector had a productivity increase of 40%**
  - 2011 CEP plan projection: 24%
  - Exceeded the Alberta target of 30% improvement relative to baseline
- **Improvements were made due to many changes, especially:**
  - Operational and equipment improvements allowing the switching from non-saline water to other quality-impaired sources (e.g., saline groundwater, produced water, and municipal/industrial wastewater)