



## Firebag Project



# **SUNCOR FIREBAG ENHANCED THERMAL SOLVENT (ETS) IN-SITU PILOT PROJECT**

Suncor Energy Inc.  
Submission to the  
Alberta Energy and Utilities Board  
April 8, 2003

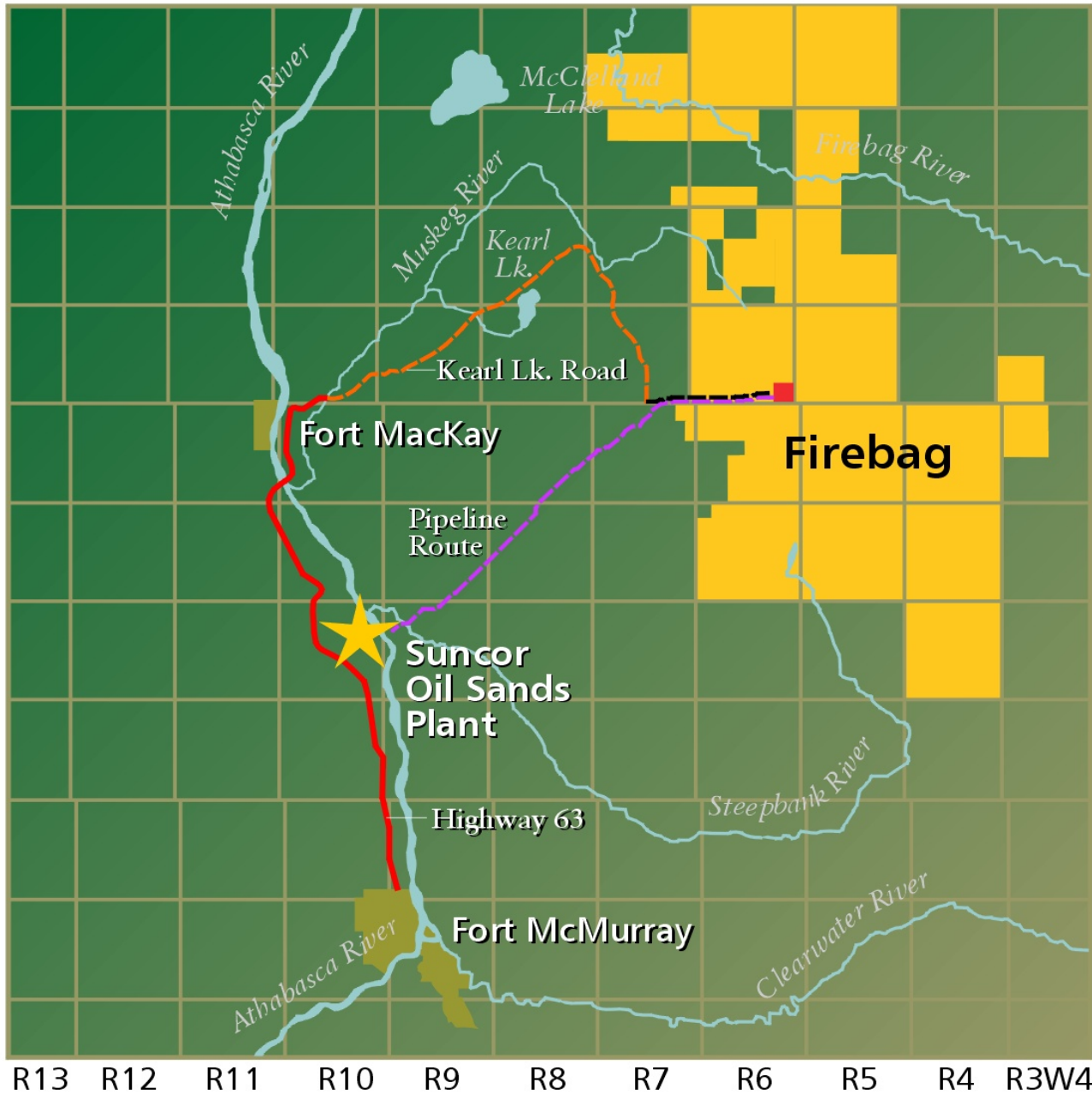
# Project Summary

- ⌘ A pilot project to construct, operate and reclaim a thermal solvent experimental scheme for production of crude bitumen from the McMurray formation
- ⌘ Technology used: Enhanced Thermal Solvent (ETS) - Suncor patent pending in-situ recovery process
- ⌘ Approvals:
  - ☑ EUB Approval No. 8683, confidential status until October 31, 2005
  - ☑ AEPEA Approval No. 82973-00-01 (as amended to permit on-site electric generation)
  - ☑ AEPEA Approval No. 82973-00-03 (as amended to permit the use of additional solvents)

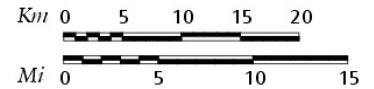
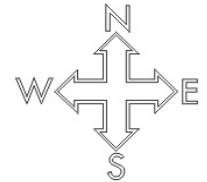
# Project Location & Description

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- ⌘ Located on the area of the Suncor Firebag In-Situ Oil Sands Project (the Firebag Project).
- ⌘ Project area is approximately 65 km northeast of Fort McMurray in Section 1, Township 95, Range 6, W4M, adjacent to Well Pad 2 of Stage 1 of the Firebag Project.
- ⌘ The ETS Pilot Project is intended to be operated for approx. 10 years to demonstrate in-situ recovery technology
- ⌘ This technology may be incorporated into later stages of the commercial Firebag project.



# Firebag Location Map

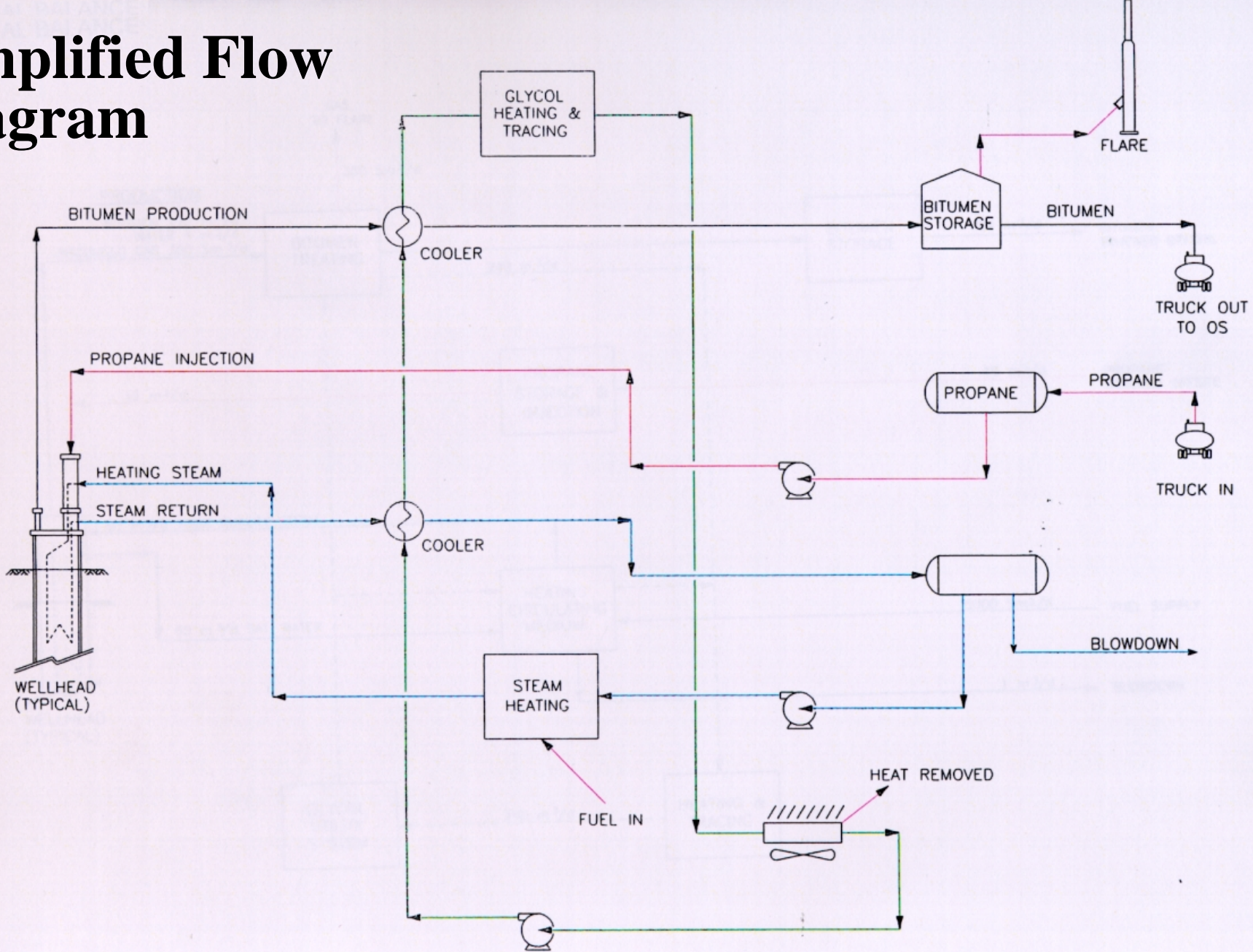


# Bitumen Recovery Process

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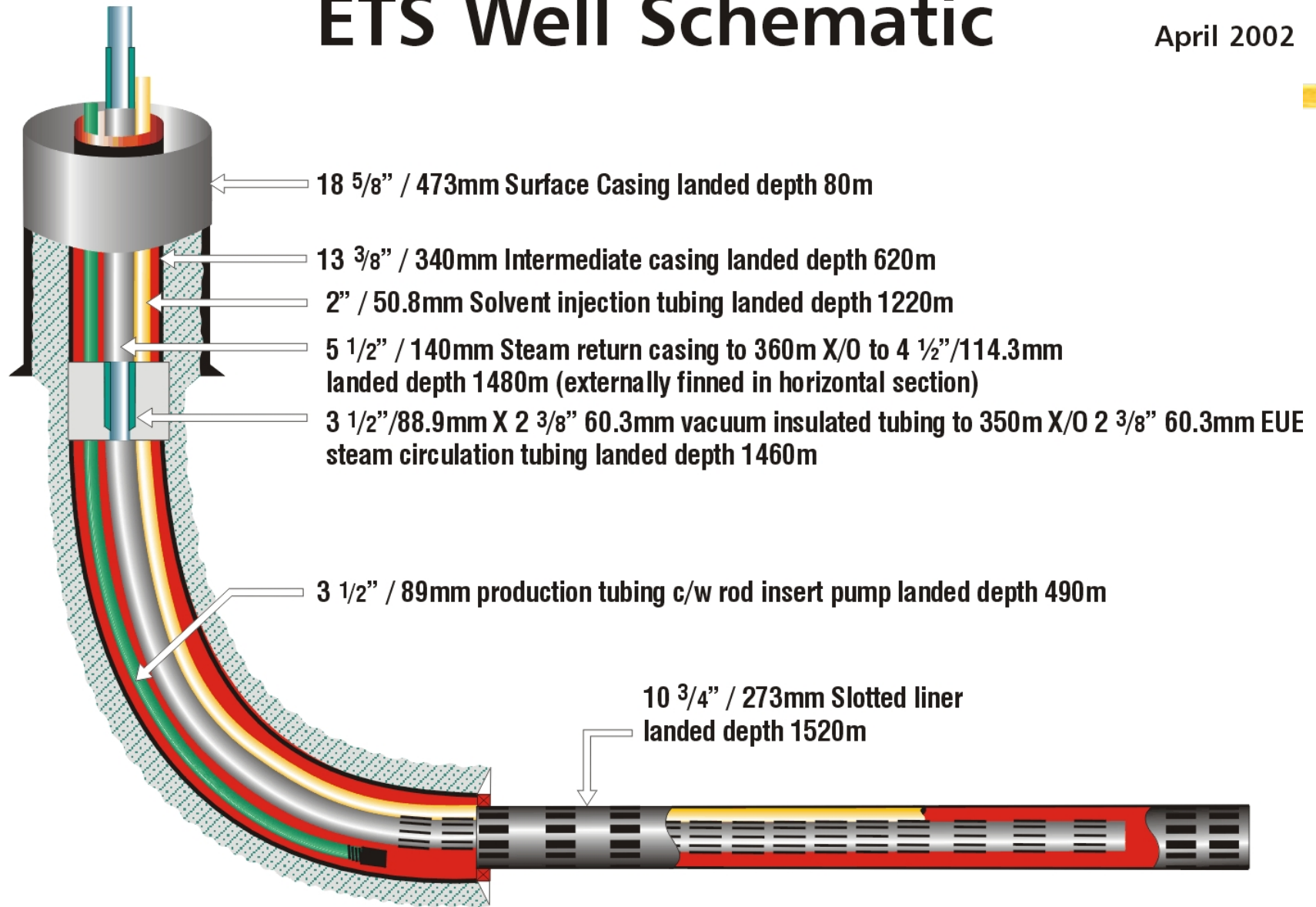
- ⌘ The ETS technology involves the injection of hydrocarbon solvents (currently using propane, butane) into a heated horizontal well completed in the oil sands pay. The solvent comes in contact with the bitumen, diffuses into it reducing its viscosity allowing it to flow into the well. A vapour chamber is formed within the oil swept sand region above the well.
- ⌘ The heat of the wellbore boils off the solvent entrained in the bitumen recycling it back to the reservoir.
- ⌘ The oil that drains to the well bore is recovered using artificial lift.

# Simplified Flow Diagram



# Firebag ETS Well Schematic

April 2002




# Bitumen Recovery Process

- ⌘ Compared to SAGD, ETS technology has the potential to;
  - ⏏ reduce capital cost
    - ⊗ less steam generation (expected SOR = 0.5)
    - ⊗ closed loop heating system - no water recycle
    - ⊗ low water:oil ratio - minimal oil treating
    - ⊗ offset somewhat by increased number and density of wells
  - ⏏ reduce operating costs
    - ⊗ lower gas consumption
    - ⊗ reduced oil treating and water treating costs
    - ⊗ offset somewhat by cost of solvent inventory
  - ⏏ reduced environmental impact
    - ⊗ greenhouse gas emissions reduced by 60-75%
    - ⊗ less water make-up and disposal
    - ⊗ land impacts are similar
  - ⏏ can be used on thinner reservoirs

# Project Objectives

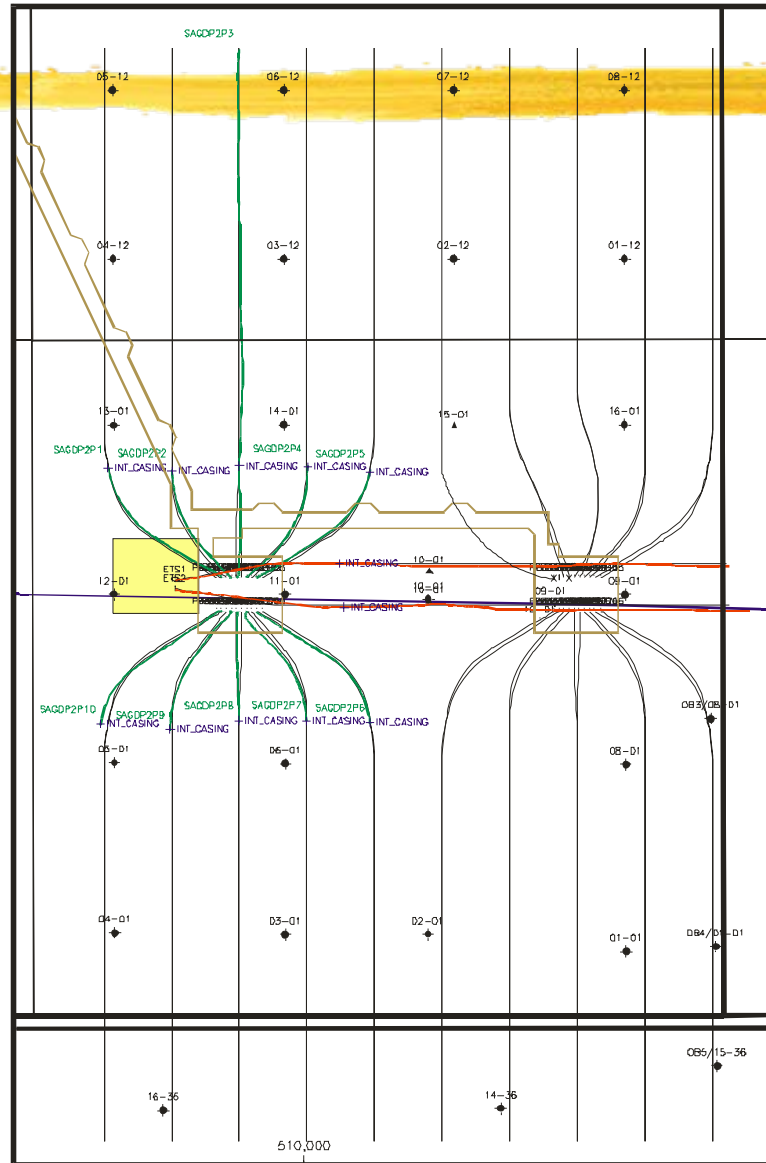
- ⌘ To field test the ETS process at Firebag and establish the economic parameters for commercial development
- ⌘ Secondary Objectives
  - ☒ demonstrate drilling/completion technology
  - ☒ test a range of solvents; propane, butane and others available from the oil sands operation
  - ☒ determine the effectiveness of the in-situ solvent recycle process by monitoring:
    - ☒ heat transfer capabilities of the completion
    - ☒ effectiveness of the artificial lift
    - ☒ oil production rate
    - ☒ steam oil ratio
    - ☒ solvent oil ratio
  - ☒ determine the degree of in-situ upgrading and viscosity enhancement
  - ☒ determine operation parameters related to GHG emission factors

# Reservoir Properties

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⌘ Depth	320 m
⌘ Pressure	800 kPa
⌘ Temperature	8 C
⌘ Average net pay	35 - 40 m
⌘ Permeability	6 - 10 darcy
⌘ Porosity	32 %
⌘ Bitumen saturation	85 %
⌘ Bitumen viscosity	10 million cp

# Well Pads/X-Sections



# Progress

- ⌘ Two experimental wells were drilled:
  - ⊞ Suncor ETS1 Firebag 12-6-95-5, license 0246816
    - ⊞ spud 4 Jan 2001, R.R. 13 Feb 2001
    - ⊞ TVD 307m, MD 1530m
  - ⊞ Suncor ETS2 Firebag 12-6-95-5, license 0246817
    - ⊞ spud 9 Jan 2001, R.R. 12 Jan 2001 (surface hole)
    - ⊞ spud 27 Aug 2001, R.R. 14 Sep 2001 (main hole)
    - ⊞ TVD 307m, MD 1581m
- ⌘ Two vertical observation wells drilled:
  - ⊞ Suncor ETS OB1 Firebag 10-1-95-6, license 0244563
    - ⊞ spud 8 Jan 2001, R.R. 11 Jan 2001, TVD/MD 343m
  - ⊞ Suncor ETS OB2 Firebag 10-1-95-6, license 0244564
    - ⊞ spud 4 Jan 2001, R.R. 7 Jan 2001, TVD/MD 344m
    - ⊞ instrumented well with fiber optics cable for a continuous vertical temperature profile

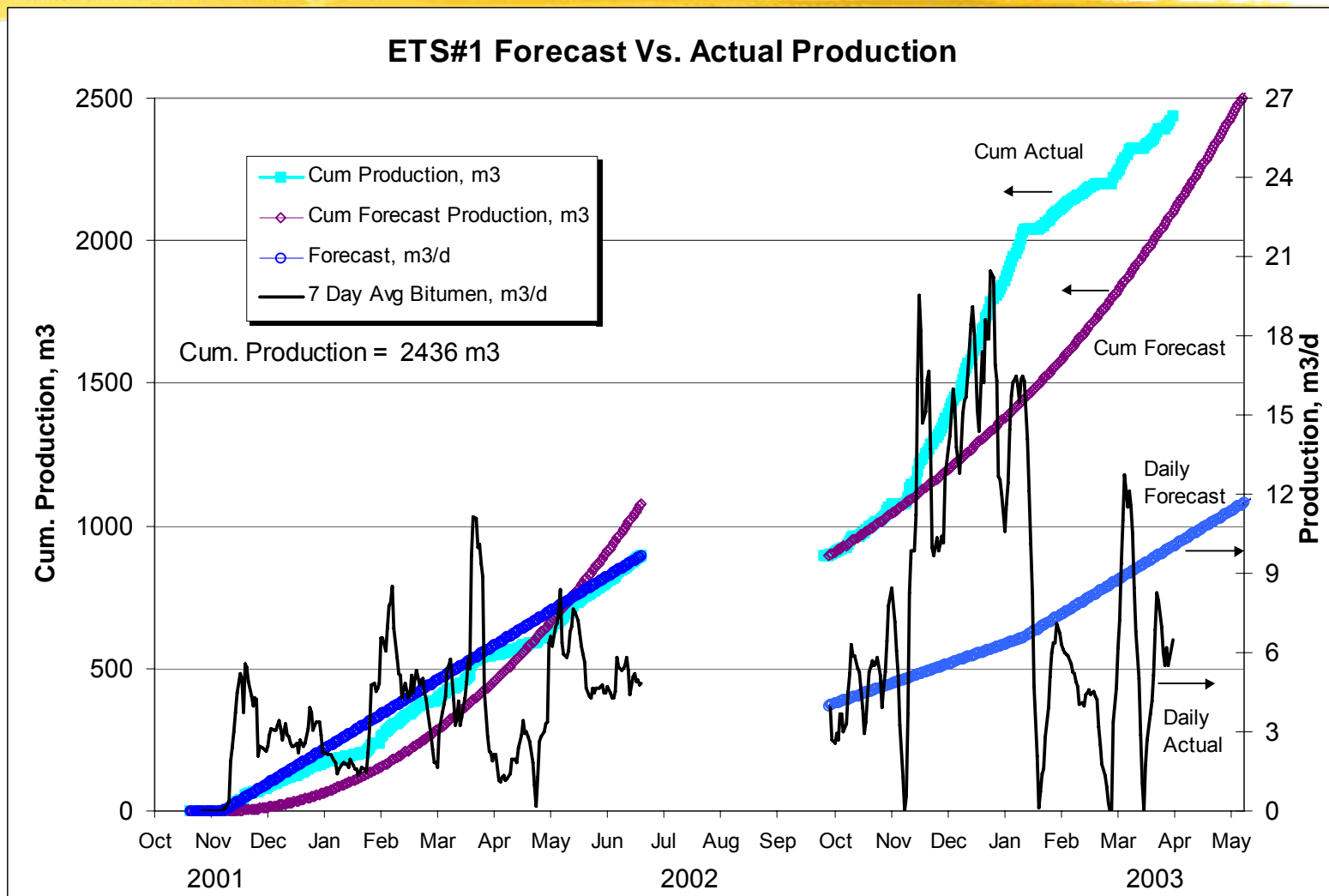
# Progress cont'd

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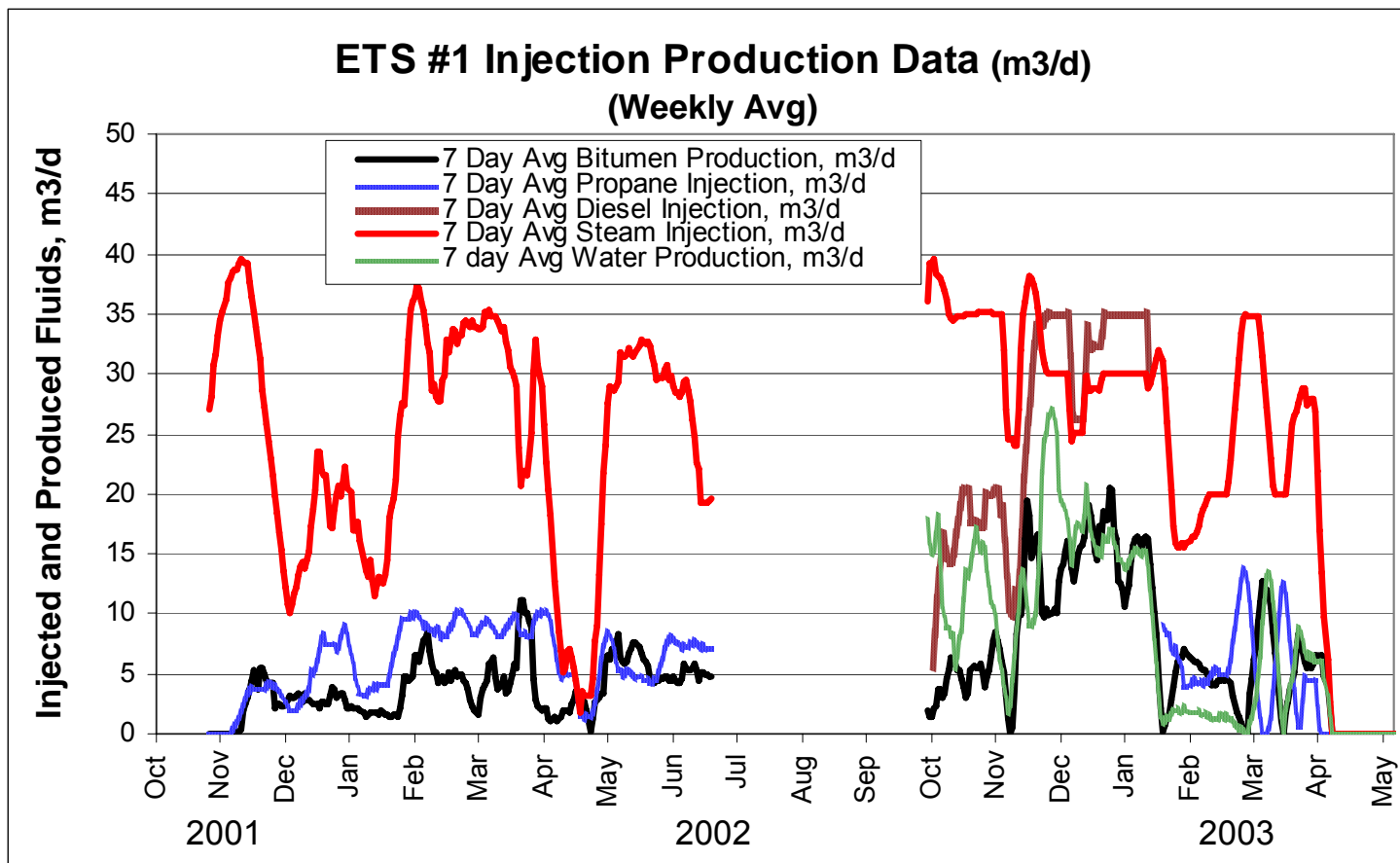
## **Important Events**

- ⌘ Pilot plant construction from August to October 2001
- ⌘ Plant operations began October 28, 2001
- ⌘ Temperature survey of the wells in April, 2002
- ⌘ Shut down the pilot due to forest fire in June, 2002
- ⌘ Recompletion of the wells in August, 2002
- ⌘ Diesel conditioning in ETS#1 started in September, 2002
- ⌘ Propane injection in ETS#1 started in January, 2003
- ⌘ Diesel conditioning in ETS#2 began in March, 2003
- ⌘ Butane injection in ETS#2 began in March, 2003

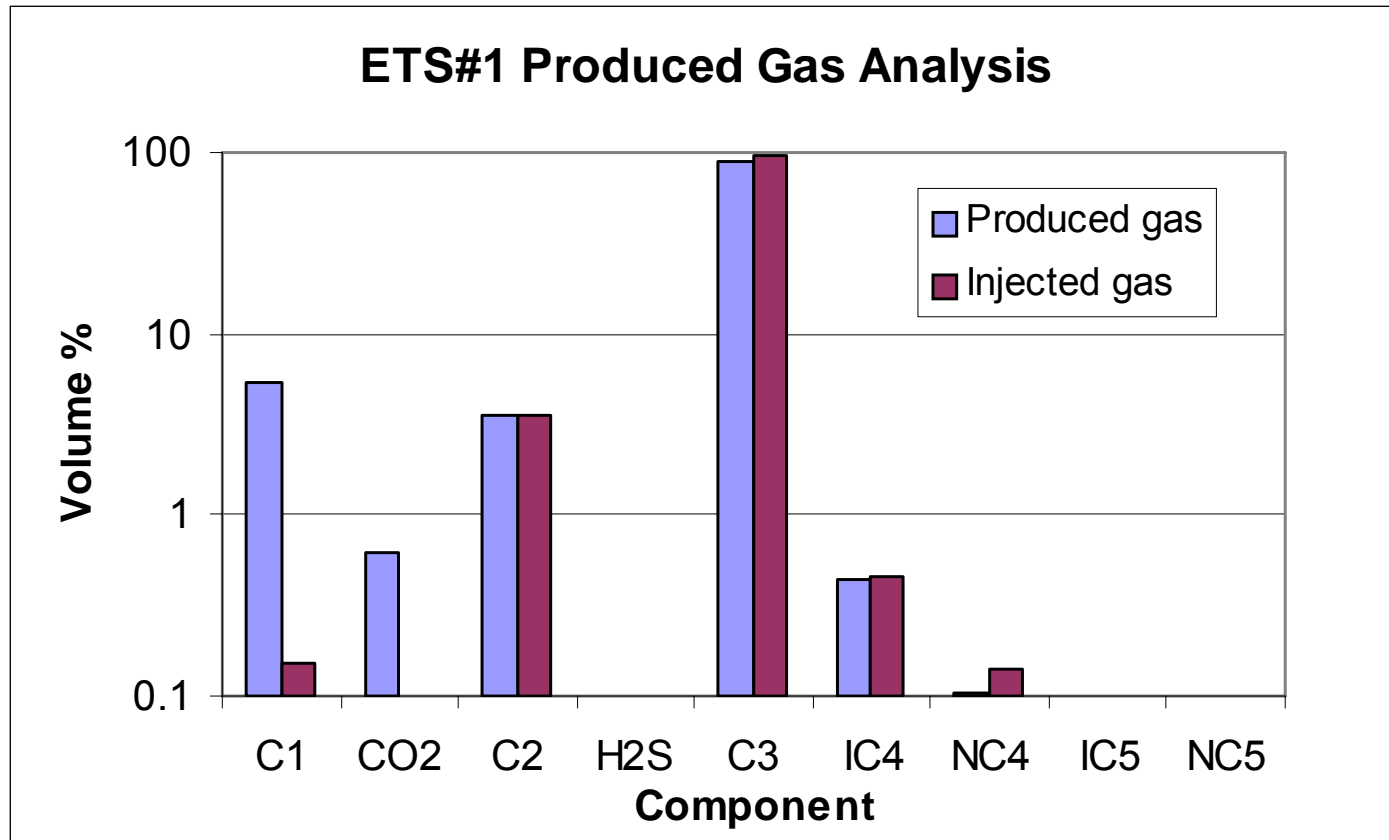
# Actual vs. Predicted Performance



# Actual Production/Injection Rates



# Gas Composition



# Recovery Evaluation

## ETS #1

⌘ Cumulative Steam Oil Ratio:	4.6
⌘ Cumulative Propane Oil Ratio:	1.5
(only for the period of operation with propane injection)	
⌘ Cumulative Water Oil Ratio:	0.8
⌘ Cumulative bitumen produced:	2436 m <sup>3</sup>
⌘ Cumulative propane injected:	1890 m <sup>3</sup>
⌘ Cumulative diesel injected:	2713 m <sup>3</sup>
⌘ Cumulative steam circulated:	11235 m <sup>3</sup>
⌘ Recovery to date:	0.25 %

# Performance Discussion

## ETS#1

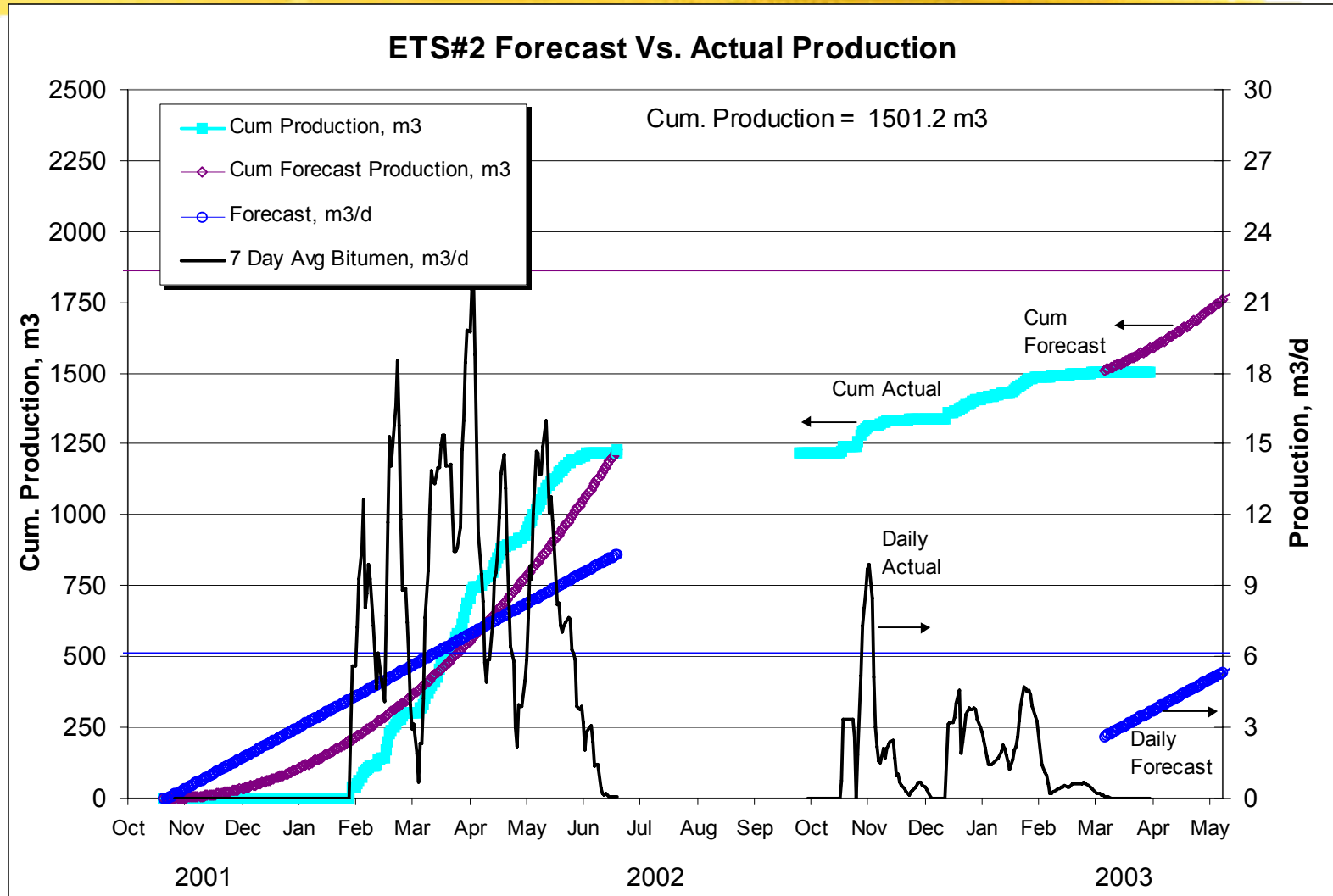
- ⌘ Various mode of propane injection and steam circulation was tried.
- ⌘ Early performance was lower than predicted.
- ⌘ Temperature survey indicated problems in heat distribution inside the well bore.
- ⌘ Forest fire in the nearby area required plant shut down.
- ⌘ It was decided to start after the necessary modification.
- ⌘ Heating tubulars were reconfigured in August 2002.
- ⌘ Other solvents were used on restart of the well operation to condition the reservoir.

# Performance Discussion

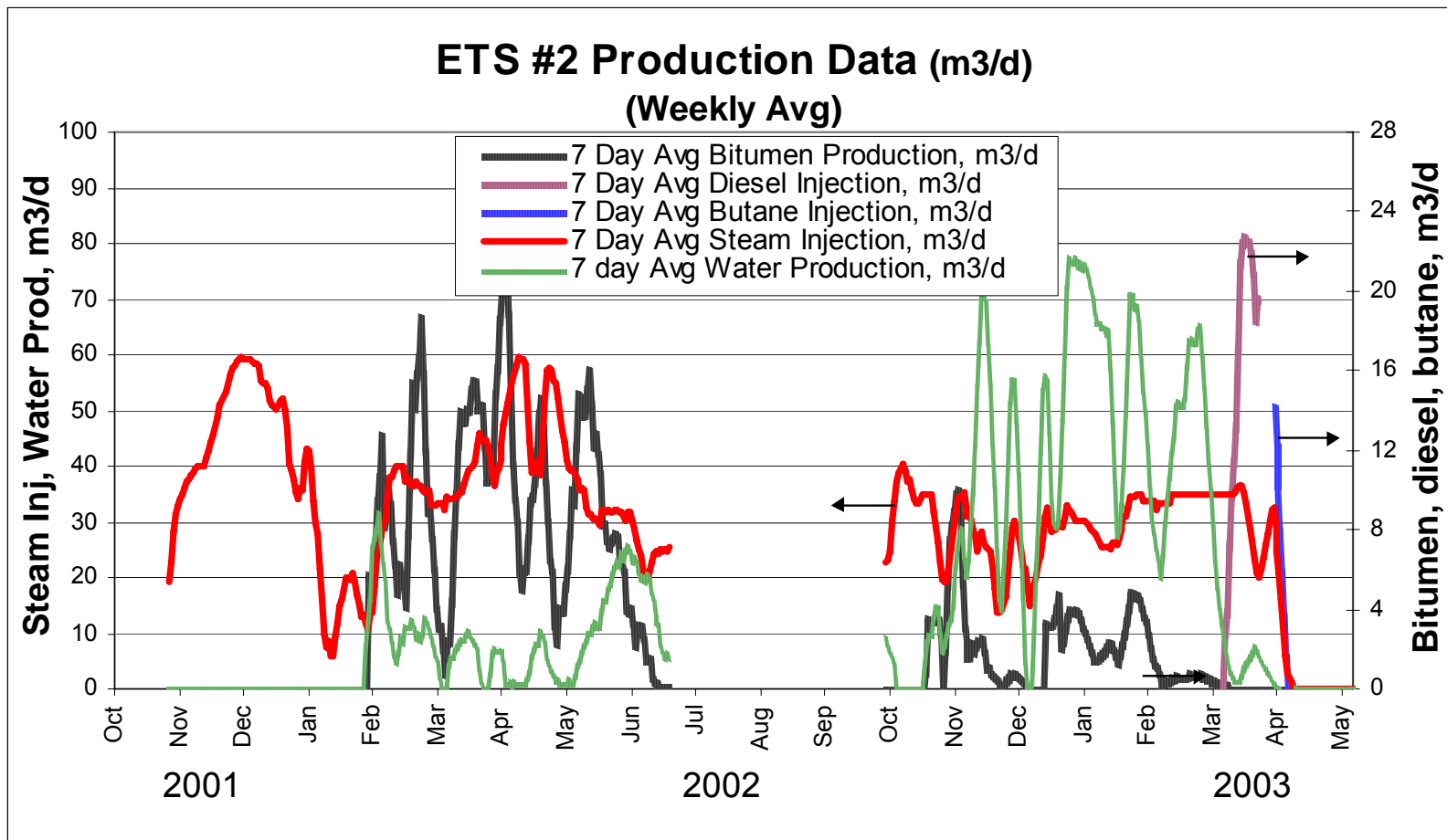
## **ETS#1 (Continued)**

- ⌘ Plants and facilities were modified to accommodate this change.
- ⌘ Normal operation with diesel conditioning and steam circulation began in late September, 2002 after receiving approval from AEPEA.
- ⌘ Diesel conditioning results were encouraging.
- ⌘ Propane injection started on Jan 13, 2003.
- ⌘ Optimization of solvent injection and steam circulation is being continued.

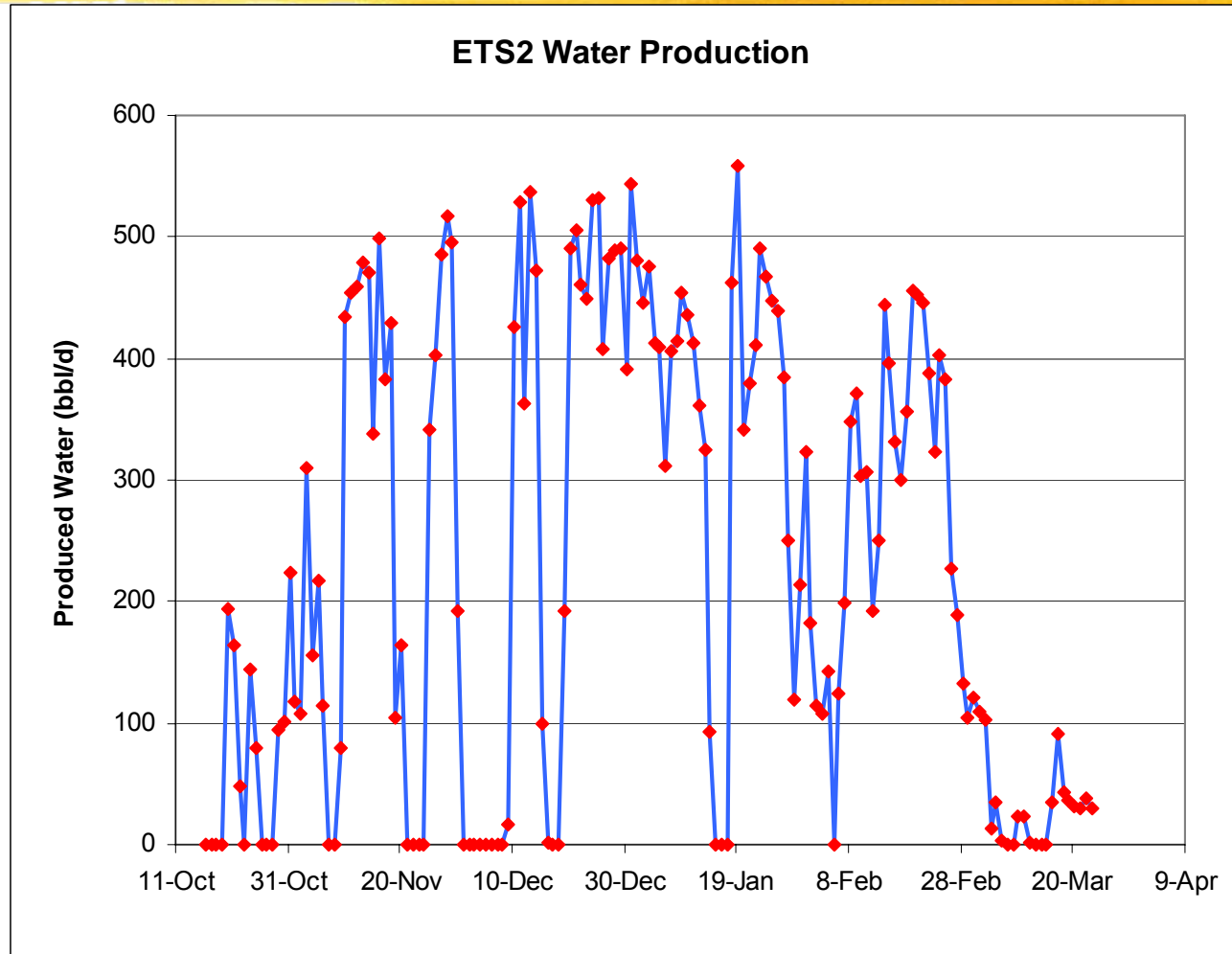
# Actual vs. Predicted Performance



# Daily Injection & Production Data



# ETS #2 Water Production Data



# Recovery Evaluation

## ETS #2

⌘ Cumulative Steam Oil Ratio:	9.5
⌘ Cumulative Water Oil Ratio:	4.8
⌘ Cumulative bitumen produced:	1501 m3
⌘ Cumulative diesel injected:	326 m3
⌘ Cumulative steam circulated:	14301 m3
⌘ Cumulative water production:	7225 m3
⌘ Recovery to date:	0.15 %

# Performance Discussion

## ETS#2

- ⌘ Early production response was encouraging.
- ⌘ Temperature survey indicated poor heat distribution inside the well bore.
- ⌘ High water production lead to termination of operation.
- ⌘ Near by well bores were investigated through cement bond log, water flow log, etc.
- ⌘ Well 10-01-95-06 was identified as the source of this water. Several slugs of cements with different water shut off chemicals were injected to prevent the communication behind the casing.

# Performance Discussion

## **ETS#2 (Continued)**

- ⌘ Recent results showed drop in water production indicating success of the remedial action.
- ⌘ Diesel was injected in the well to condition prior to butane injection. Production during diesel conditioning period minimal.
- ⌘ Butane injection started on March 25, 2003.

# Learnings & Observations

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- ⌘ Uniform heat distribution is important for the process
- ⌘ Diesel appeared effective in conditioning the reservoir after an extended period of propane injection.
- ⌘ No apparent upgrading or asphaltene precipitation.
- ⌘ No sand production
- ⌘ Use of the same well bore for injection/circulation poses serious operational problem. ETS2 project proposed to further test this observation.

# Learnings & Observations (Cont'd..)

## **Problems encountered**

- ▶ Multi-tasking the same well is causing serious operational problems.
- ▶ Pumping aspect is seriously limiting the option for injection rates.
- ▶ Injection of solvent at high rate causes cooling in the vertical section of the well bore which in turn affects pumping.
- ▶ High steam circulation rate creates high pressure at the casing and depresses the fluid level in the annulus.
- ▶ Higher solvent injection rate causes vapor lock at the pump. A new generation of rod pump has been deployed to mitigate this problem.

# Future Plans

- ⌘ ETS #1
  - ☒ Operate with propane
  - ☒ Continue optimization of solvent injection and steam circulation
- ⌘ ETS #2
  - ☒ Operate with butane and optimize performance
- ⌘ ETS-SAGD tie-in notice issued to EUB
  - ☒ Tie-in was contemplated in initial application supplemental responses for the following benefits
    - ☒ eliminate trucking of oil and water
    - ☒ lower emissions by shutting in steam generator, diesel electrical generator, converting fuel system to natural gas
    - ☒ lower operating costs
- ⌘ Apply for a ETS2 project to study commercial viability
  - ☒ one production well with a revised well configuration based upon current learning
  - ☒ demonstrate the effectiveness of the revised configuration
  - ☒ exploit an area of thinner pay

# Compliance Issues

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- ⌘ The pilot was operated with total compliance of the approval.

# Conclusions

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- ⌘ Operation of the experimental scheme is in compliance with all regulation and approvals.
- ⌘ Performance so far is encouraging, although this has been severely affected by the well configuration and water production.
- ⌘ Modified well arrangements may be necessary to prove the viability of the reservoir process.