

**PennWest**

# Waskada Unit No.7

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## Waterflood Progress Report

**January 1<sup>st</sup> – December 31<sup>st</sup>, 2014**

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## **INTRODUCTION:**

The Waskada Unit No.7 pressure maintenance project commenced water injection into the Lower Amaranth designed and in accordance with Manitoba Energy and Mines Approval No. PM 58.

Please refer to Attachment 1 – Area Map.

PRESSURE MAINTENANCE: Governed by Board Order No. PM 58

## **UNIT INFORMATION**

UNITIZED ZONE: Lower Amaranth  
Original Unit, November 1, 1986 Board Order – Voluntary

POOL: Waskada Lower Amaranth A (03 29A)

This report documents the performance of the Waskada Unit No. 7 pressure maintenance project for the period of January 1 to December 31, 2013. The Unit had 20 active producers and no active injectors at the end of 2014.

Please refer to Attachment 1A – Area Map of New Drills

Unit No. 7 is part of the main Waskada field. The Waskada field is situated on the northeast rim of the Williston Basin in southern Manitoba. It comprises a large portion of Township 1 and 2, Ranges 25 and 26 W1

## **GEOLOGY**

The Waskada Fields produce light density crude (approximately 36° API), predominantly from the Lower Amaranth formation. This is an interlaminated, shallow marine to subtidal succession of sandstones, siltstones, and shale progressively on laps the Mississippian unconformity surface from basin center, up dip to the north and eastern basin limits in Saskatchewan and Manitoba. The fine grained reservoir rock has a complex reservoir characterization with 13 to 16 % porosity and permeability on the order of 0.5 to 15 md. The Lower Amaranth, the oldest Mesozoic unit, is a clastic red bed sequence lying directly on the Paleozoic erosional surface. It consists of a series of dolomitic siltstones and sandstones interbedded with argillaceous siltstones and shales. The section is usually subdivided into a lower sandy unit and an overlying shale unit. The lower sequence is the oil production zone. The bulk of pay is found in the laminated sandstone/siltstone facies.

The Lower Amaranth has been classified into four general lithological types:

1. Interbedded shale/siltstone/sandstone by grain size, color and texture
2. Siltstone – This lithology occurs in distinct intervals up to two or three metres in thickness. It is generally light green in color and dolomitic.
3. Laminated sandstone – This occurs in distinct sandy intervals with a wide range of grain sizes and primary sedimentary structures.
4. Massive sandstone – This lithology occurs in thin intervals and usually associated with the laminated sandstones facies. Beds are usually light grey to reddish grey in color and coarse to medium – grained.

## **DISCUSSION**

### **Production and Injection Performance**

Board Order No. PM 58 provided for pressure maintenance operations in Waskada Unit No.7. From the startup of injection in January 1987, injection rates fluctuated to the same degree in each injector, making it difficult to link any production responses to any injector. The Unit includes 5 injection wells; at the end of 2014 none are currently active. Injection ceased essentially in 1998. There are currently 20 active producers; no new wells were drilled in 2014.

Please refer to Attachment 2 – A Summary of the Unit Well List and History with New Drills

Please refer to Attachment 3 – A Production and Injection plot of the Unit.

Please refer to Attachment 4 – A Summary of Unit Annual Volumes and Rates.

Please refer to Attachment 5 – A Cumulative Production and Injection plot of the Unit.

### **Voidage Replacement Ratio Calculation:**

The Cumulative VRR from production start is at 0.17; the Cumulative VRR from injection start is at 0.18. Both have dropped from 0.9 and 1.7 respectively in the last 4 years due to essentially no injection from 1998 onwards and the startup of new producers. Currently there are no active injectors in this Unit hence Monthly VRR is zero. PennWest has no plans to reactivate at this time any of the old injectors.

Please refer to Attachment 6 – A Unit Voidage Replacement Ratio Plot.

Please refer to Attachment 7 – Individual Injection Well Performance Plots (5).

### **Pressure Surveys:**

There were no pressure surveys conducted in 2014.

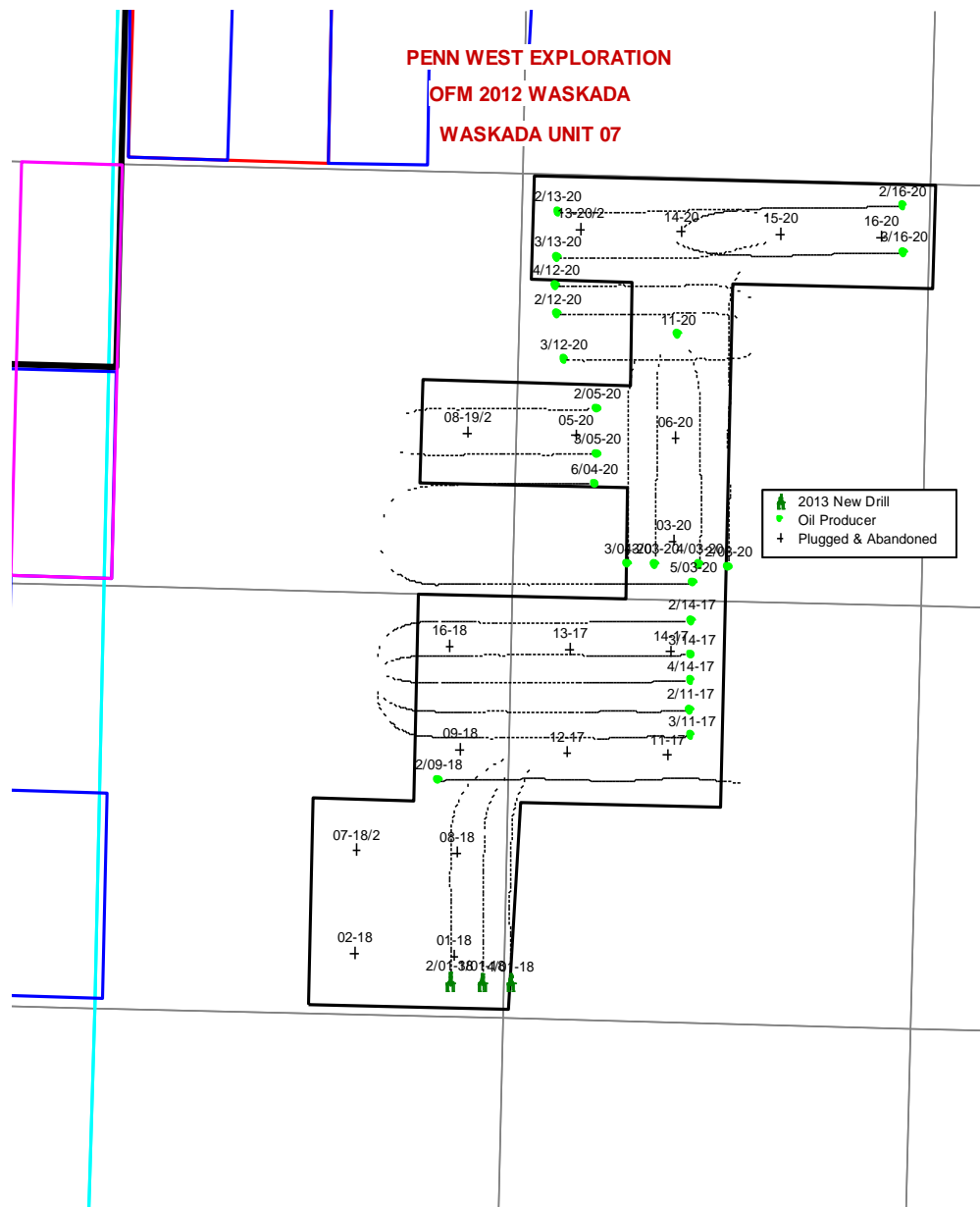
**Corrosion and Scale Prevention Program:**

Scale corrosion programs are implemented throughout the field. Wells and pipelines have mitigation measures in place.

**SUMMARY AND RECOMMENDATIONS**

The behavior of Waskada Unit 7 producers are indicated by good initial oil productivity, rapidly declining to low rates, with almost no discernible water flood response. It is also believed that fracture stimulation treatments, performed on these wells prior to initiation of water injection, “broke through” into the higher productivity Mississippian and that the majority of injected water to date has entered this zone. This is one of the major explanations for lack of waterflood response to date and the continued decline in oil productivities.

## ATTACHMENT 1 – UNIT AREA MAP



## ATTACHMENT 2- UNIT HISTORY

Unit History : Waskada -Unit #7														
UWI	Completion Date	Operator	Status	New Drills	Kb Elevation	Total Depth	First prd Date	Cum Oil Prd	Cum Water Prd	Last Prd Date	First Inj Date	Cum Water Inj	Cum Gas Inj	Last Inj Date
					m	m		m3	m3			m3	scm	
00/01-18-001-25W1/0	6/28/1984	OMEGA HYDROC	ABD-OIL	<N/A>	470.90	951.00	7/1/1984	1218.60	4170.40	9/1/1989		0.00	0.00	
00/02-18-001-25W1/0	6/7/1984	OMEGA HYDROC	ABD-OIL	<N/A>	471.20	957.50	7/1/1984	470.50	2009.90	1/1/1989		0.00	0.00	
00/03-20-001-25W1/0	3/12/1983	PENN WEST	ABD-OIL	<N/A>	471.70	957.00	3/1/1984	619.10	1304.70	7/1/1988		0.00	0.00	
00/05-20-001-25W1/0	8/4/1985	PENN WEST	ABD-OIL	<N/A>	472.60	959.00	9/1/1985	301.40	33.90	11/1/1986	1/1/1987	19243.90	0.00	1/1/1998
00/06-20-001-25W1/0	8/1/1985	PENN WEST	ABDZ-OIL	<N/A>	473.50	959.00	12/1/1985	1739.10	15353.40	11/1/1989		0.00	0.00	
00/07-18-001-25W1/2	6/12/1984	PENN WEST	ABD-OIL	<N/A>	471.40	951.50	7/1/1984	552.00	1360.10	11/1/1986	1/1/1987	22094.10	0.00	6/1/1989
00/08-18-001-25W1/0	11/12/1983	OMEGA HYDROC	ABD-OIL	<N/A>	472.30	971.30	1/1/1984	994.90	1770.70	6/1/1989		0.00	0.00	
00/08-19-001-25W1/2	7/26/1985	PENN WEST	ABD-OIL	<N/A>	472.90	957.00	9/1/1985	1429.70	680.50	2/1/1993		0.00	0.00	
00/09-18-001-25W1/0	11/4/1983	OMEGA HYDROC	ABD-OIL	<N/A>	474.00	940.00	12/1/1983	471.50	801.20	5/1/1989		0.00	0.00	
00/11-17-001-25W1/0	8/18/1983	OMEGA HYDROC	ABD-OIL	<N/A>	473.20	950.00	9/1/1983	3113.60	2822.80	3/1/1991		0.00	0.00	
00/11-20-001-25W1/0	3/1/1983	PENN WEST	OIL	<N/A>	473.60	950.00	3/1/1983	17020.40	2242.20	11/1/2013		0.00	0.00	
00/12-17-001-25W1/0	8/14/1983	PENN WEST	ABD-OIL	<N/A>	471.50	945.10	9/1/1983	2445.20	3725.20	1/1/1991		0.00	0.00	
00/13-17-001-25W1/0	8/5/1983	PENN WEST	ABD-WINJ	<N/A>	473.40	942.00	8/1/1983	575.30	546.10	11/1/1986	1/1/1987	18710.40	0.00	3/1/1991
00/13-20-001-25W1/2	9/30/1983	PENN WEST	ABD-WINJ	<N/A>	473.70	944.00	12/1/1983	1796.30	3158.00	11/1/1986	1/1/1987	26629.60	0.00	2/1/1998
00/14-17-001-25W1/0	11/10/1982	PENN WEST	ABD-OIL	<N/A>	471.60	952.00	12/1/1982	3329.50	3407.10	2/1/1991		0.00	0.00	
00/14-20-001-25W1/0	6/30/1984	PENN WEST	ABDZ-OIL	<N/A>	473.90	950.00	11/1/1984	14474.70	31844.60	2/1/1996		0.00	0.00	
00/15-20-001-25W1/0	10/29/1982	PENN WEST	ABD-OIL	<N/A>	474.70	952.80	12/1/1982	2110.60	1140.30	11/1/1986	1/1/1987	36758.50	0.00	2/1/1998
00/16-18-001-25W1/0	7/29/1983	OMEGA HYDROC	ABD-OIL	<N/A>	472.40	933.90	8/1/1983	392.40	1633.10	9/1/1987		0.00	0.00	
00/16-20-001-25W1/0	7/13/1984	PENN WEST	ABD-OIL	<N/A>	475.20	941.00	8/1/1984	470.60	2593.20	8/1/1989		0.00	0.00	
02/01-18-001-25W1/0	1/20/2013	PENN WEST	OIL	2013	475.00	1858.00	3/1/2013	1976.40	6312.80	1/1/2015		0.00	0.00	
02/03-20-001-25W1/0	1/27/2012	PENN WEST	OIL	<N/A>	475.60	2128.00	3/1/2012	1772.20	34521.10	10/1/2014		0.00	0.00	
02/05-20-001-25W1/0	7/25/2012	PENN WEST	OIL	<N/A>	467.70	1687.00	9/1/2012	4319.60	25732.00	1/1/2015		0.00	0.00	
02/09-18-001-25W1/0	7/27/2010	PENN WEST	OIL	<N/A>	471.80	2042.00	10/1/2010	5691.20	10498.90	11/1/2014		0.00	0.00	
02/11-17-001-25W1/0	8/14/2012	PENN WEST	OIL	<N/A>	472.30	2097.00	10/1/2012	4331.50	6987.60	1/1/2015		0.00	0.00	
02/13-20-001-25W1/0	12/10/2011	PENN WEST	OIL	<N/A>	474.60	1712.00	3/1/2012	15560.20	34666.10	1/1/2015		0.00	0.00	
02/14-17-001-25W1/0	7/29/2012	PENN WEST	OIL	<N/A>	471.80	2108.00	10/1/2012	2537.70	7662.20	1/1/2015		0.00	0.00	
02/16-20-001-25W1/0	3/7/2011	PENN WEST	OIL	<N/A>	474.40	1731.00	10/1/2011	5518.10	8901.50	1/1/2015		0.00	0.00	
03/01-18-001-25W1/0	1/27/2013	PENN WEST	OIL	2013	475.00	1778.00	3/1/2013	2226.10	6089.10	1/1/2015		0.00	0.00	
03/03-20-001-25W1/0	7/14/2012	PENN WEST	OIL	<N/A>	469.70	1686.00	8/1/2012	3584.30	32225.30	1/1/2015		0.00	0.00	
03/05-20-001-25W1/0	7/30/2012	PENN WEST	OIL	<N/A>	471.70	1665.00	9/1/2012	5220.40	3289.20	1/1/2015		0.00	0.00	
03/11-17-001-25W1/0	8/20/2012	PENN WEST	OIL	<N/A>	472.40	2140.00	10/1/2012	2222.60	4240.90	1/1/2015		0.00	0.00	
03/13-20-001-25W1/0	12/19/2011	PENN WEST	OIL	<N/A>	475.70	1720.00	4/1/2012	12380.80	159913.20	1/1/2015		0.00	0.00	
03/14-17-001-25W1/0	8/3/2012	PENN WEST	OIL	<N/A>	471.70	2075.00	10/1/2012	2427.90	8597.90	1/1/2015		0.00	0.00	
03/16-20-001-25W1/0	3/2/2011	PENN WEST	OIL	<N/A>	474.40	1734.00	10/1/2011	4963.40	27679.40	1/1/2015		0.00	0.00	
04/01-18-001-25W1/0	2/1/2013	PENN WEST	OIL	2013	475.00	1734.00	3/1/2013	2304.60	7952.60	1/1/2015		0.00	0.00	
04/03-20-001-25W1/0	7/10/2012	PENN WEST	OIL	<N/A>	473.30	1704.50	9/1/2012	5414.20	73602.40	1/1/2015		0.00	0.00	
04/12-20-001-25W1/0	7/4/2012	PENN WEST	OIL	<N/A>	474.00	1694.00	8/1/2012	6911.70	40919.50	1/1/2015		0.00	0.00	
04/14-17-001-25W1/0	8/9/2012	PENN WEST	OIL	<N/A>	472.20	2078.00	10/1/2012	3247.80	13648.60	1/1/2015		0.00	0.00	
05/03-20-001-25W1/0	7/9/2012	PENN WEST	OIL	<N/A>	472.30	2106.00	9/1/2012	4798.40	11188.10	1/1/2015		0.00	0.00	

# ATTACHMENT 3 – UNIT PRODUCTION AND INJECTION PLOT

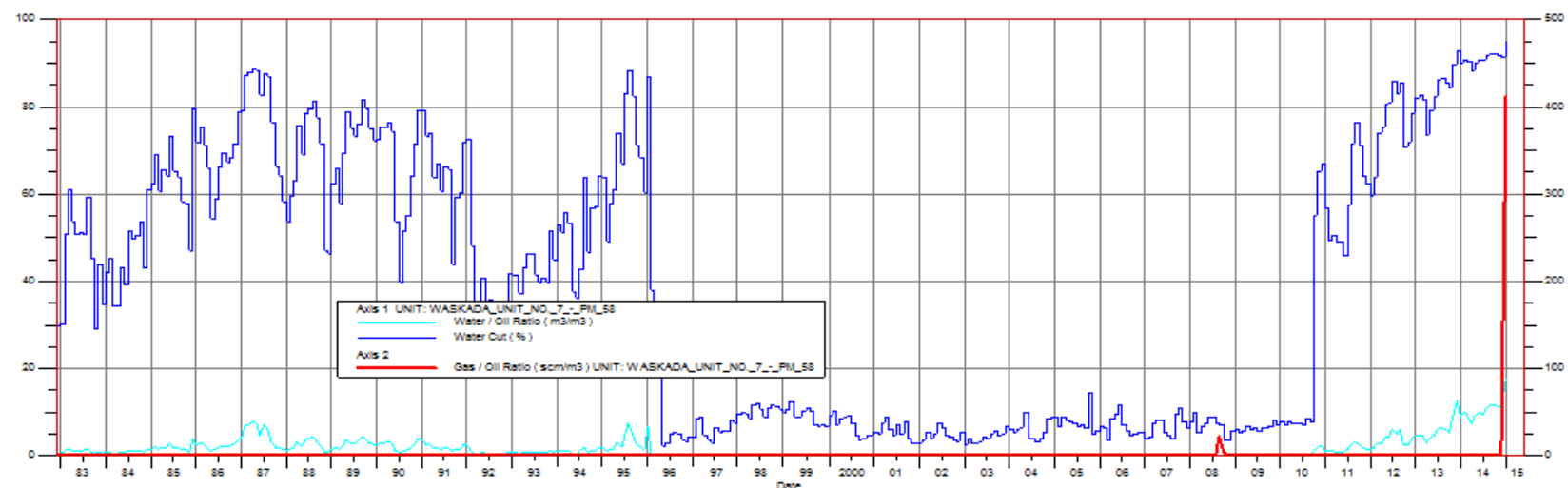
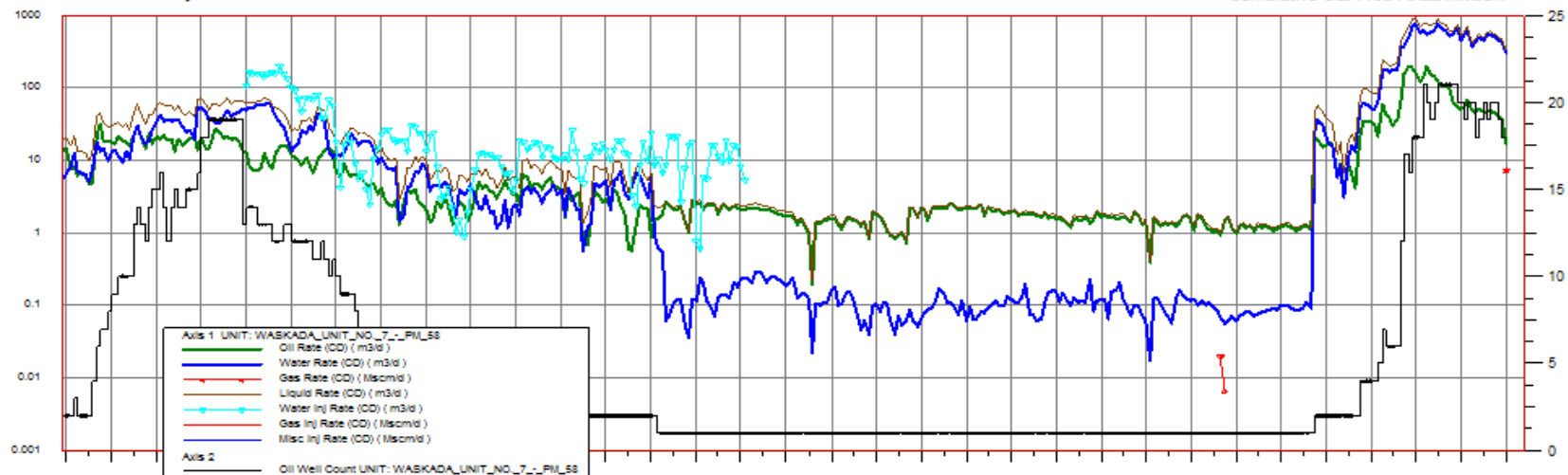
PENN WEST

UNIT: WASKADA\_UNIT\_NO\_7\_-\_PM\_58

Last Prod/Inj Date: 201501

Cumulative Gas Inj : 0.00 MMscm  
Cumulative Water Inj : 123.44 Mm3  
Cumulative Misc Inj : 0.00 MMscm

Cumulative Water Prod : 605.23 Mm3  
Cumulative Oil Prod : 150.93 Mm3  
Cumulative Gas Prod : 0.22 MMscm





**ATTACHMENT 4 –UNIT ANNUAL VOLUMES AND RATES**

<b>Unit : Waskada- Unit # 7 -- PM58</b>								
<b>Rates and Volume History</b>								
<b>Date</b>	<b>Annual Oil Prd</b>	<b>Annaul Oil Prd rate</b>	<b>Annual Water Prod</b>	<b>Annual Water Rate</b>	<b>Annual Water Inj</b>	<b>Annual Water Inj Rate</b>	<b>Annual Gas Inj</b>	<b>Annual Gas Inj Rate</b>
	<b>m3</b>	<b>m3/d</b>	<b>m3</b>	<b>m3/d</b>	<b>m3</b>	<b>m3/d</b>	<b>Mscm</b>	<b>Mscm/d</b>
1/1/1981	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00
1/1/1982	409.20	1.12	175.40	0.48	0	0.00	0.00	0.00
1/1/1983	4630.40	12.69	3543.80	9.71	0	0.00	0.00	0.00
1/1/1984	7337.30	20.05	6432.70	17.58	0	0.00	0.00	0.00
1/1/1985	6906.00	18.92	12628.10	34.60	0	0.00	0.00	0.00
1/1/1986	7259.00	19.89	15665.50	42.92	0	0.00	0.00	0.00
1/1/1987	4083.30	11.19	17409.20	47.70	56975	156.10	0.00	0.00
1/1/1988	3990.00	10.90	9108.40	24.89	24688	67.45	0.00	0.00
1/1/1989	2166.90	5.94	5782.50	15.84	4055	11.11	0.00	0.00
1/1/1990	1090.30	2.99	2399.20	6.57	8295	22.73	0.00	0.00
1/1/1991	780.70	2.14	1532.70	4.20	2560	7.01	0.00	0.00
1/1/1992	1420.40	3.88	870.70	2.38	3335	9.11	0.00	0.00
1/1/1993	1698.10	4.65	1271.00	3.48	5099	13.97	0.00	0.00
1/1/1994	961.80	2.64	1065.10	2.92	4636	12.70	0.00	0.00
1/1/1995	806.10	2.21	1750.30	4.80	4386	12.02	0.00	0.00
1/1/1996	700.40	1.91	270.20	0.74	5135	14.03	0.00	0.00
1/1/1997	855.00	2.34	53.80	0.15	3863	10.58	0.00	0.00
1/1/1998	762.30	2.09	88.50	0.24	409	1.12	0.00	0.00
1/1/1999	492.40	1.35	49.40	0.14	0	0.00	0.00	0.00
1/1/2000	524.50	1.43	39.60	0.11	0	0.00	0.00	0.00
1/1/2001	504.70	1.38	27.50	0.08	0	0.00	0.00	0.00
1/1/2002	796.40	2.18	38.90	0.11	0	0.00	0.00	0.00
1/1/2003	774.10	2.12	33.80	0.09	0	0.00	0.00	0.00
1/1/2004	661.20	1.81	42.10	0.12	0	0.00	0.00	0.00
1/1/2005	561.80	1.54	47.00	0.13	0	0.00	0.00	0.00
1/1/2006	601.80	1.65	43.10	0.12	0	0.00	0.00	0.00
1/1/2007	496.60	1.36	36.90	0.10	0	0.00	0.00	0.00
1/1/2008	480.80	1.31	34.10	0.09	0	0.00	0.00	0.00
1/1/2009	429.90	1.18	29.20	0.08	0	0.00	0.00	0.00
1/1/2010	2053.00	5.62	2896.20	7.93	0	0.00	0.00	0.00
1/1/2011	5472.60	14.99	8828.20	24.19	0	0.00	0.00	0.00
1/1/2012	27678.00	75.62	92243.60	252.03	0	0.00	0.00	0.00
1/1/2013	45054.40	123.44	232319.30	636.49	0	0.00	0.00	0.00
1/1/2014	17956.10	49.19	178769.60	489.78	0	0.00	0.00	0.00
Sum	150395.50		595525.60		123437			

# ATTACHMENT 5 – UNIT CUMULATIVE PRODUCTION AND INJECTION PLOT

PENNWEST

UNIT: WASKADA\_UNIT\_NO.\_7\_-\_PM\_58

Cumulative Water Prod : 605.23 Mm3

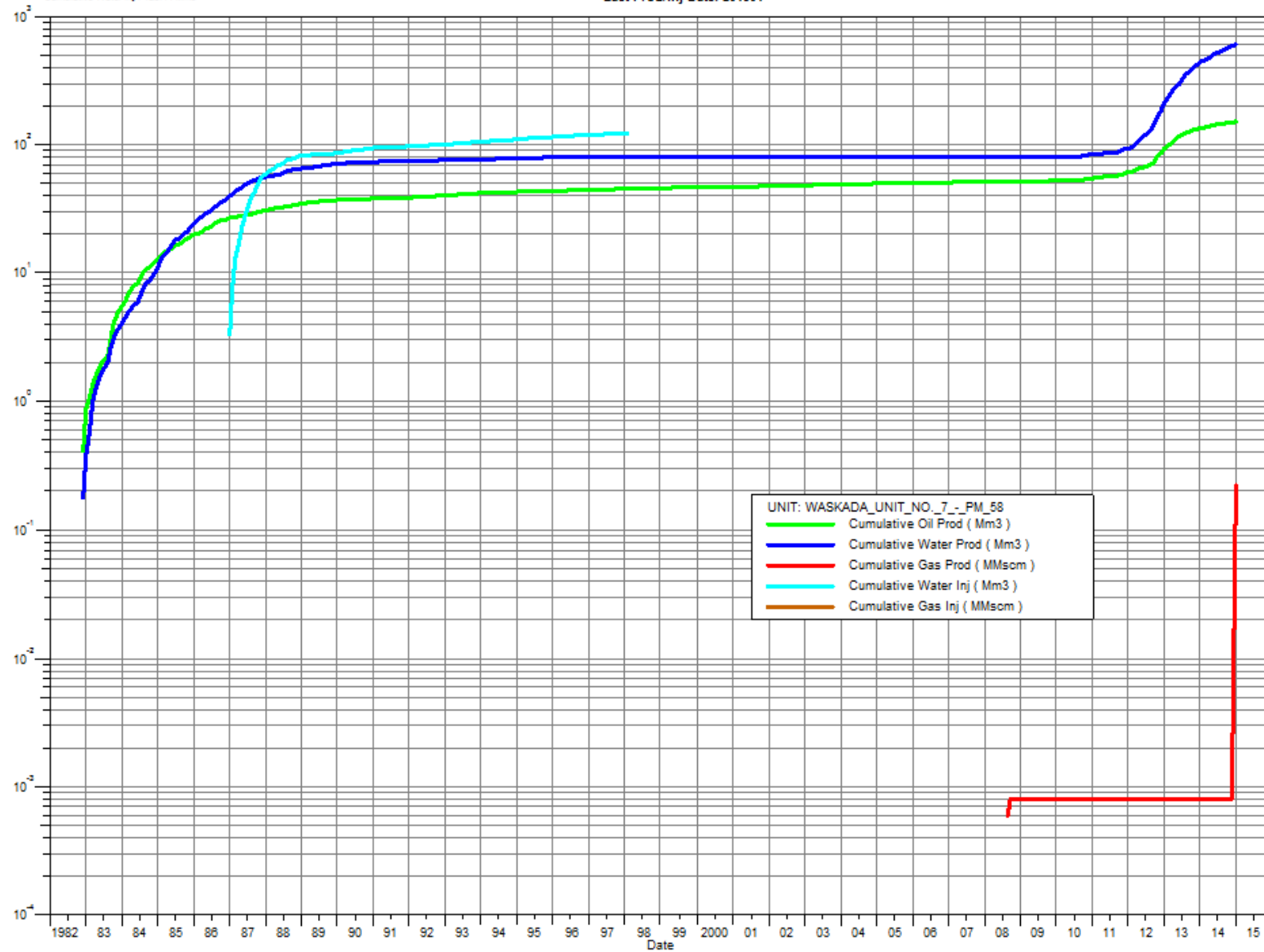
Cumulative Oil Prod : 150.93 Mm3

Cumulative Gas Prod : 0.22 MMscm

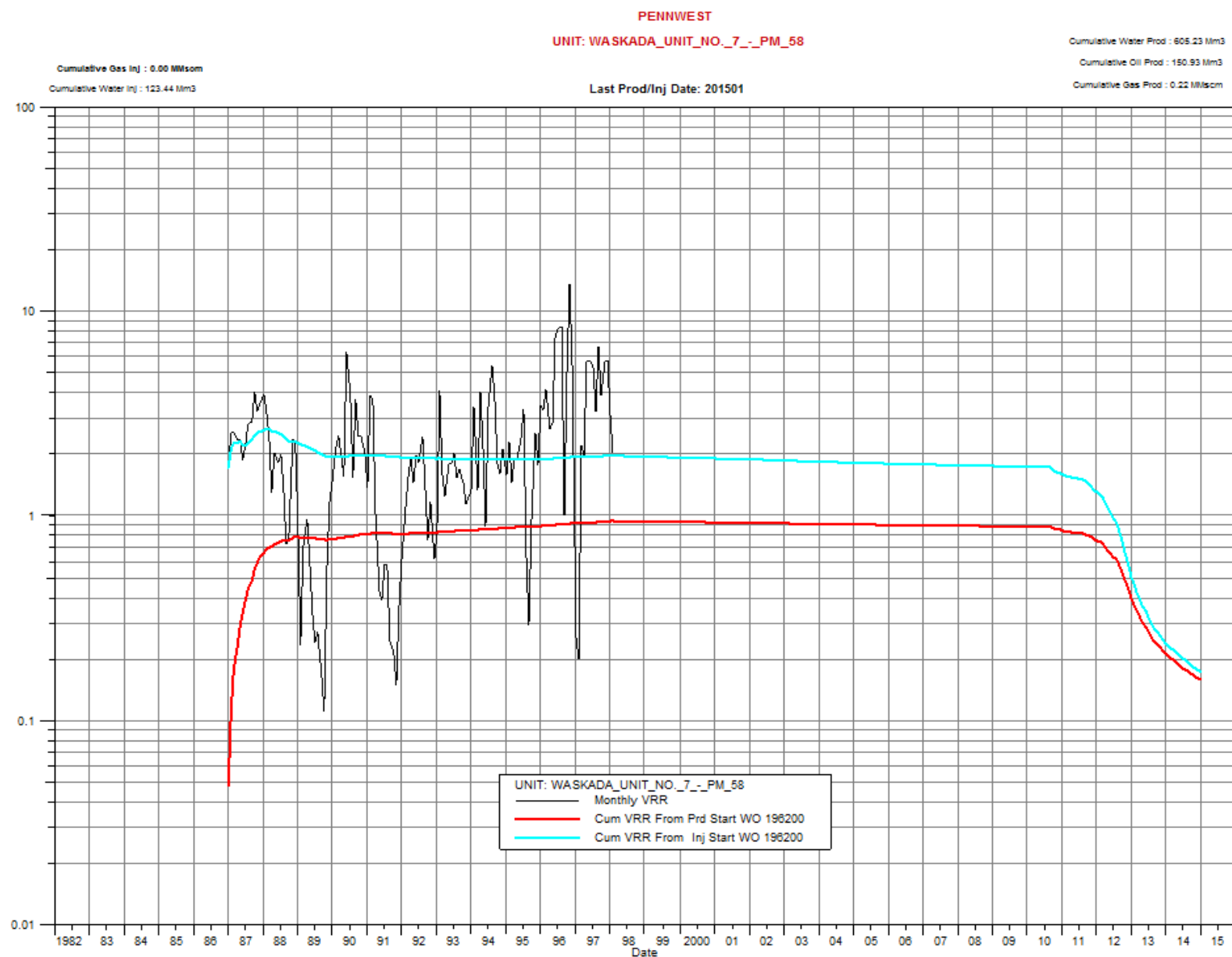
Cumulative Gas Inj : 0.00 MMscm

Cumulative Water Inj : 123.44 Mm3

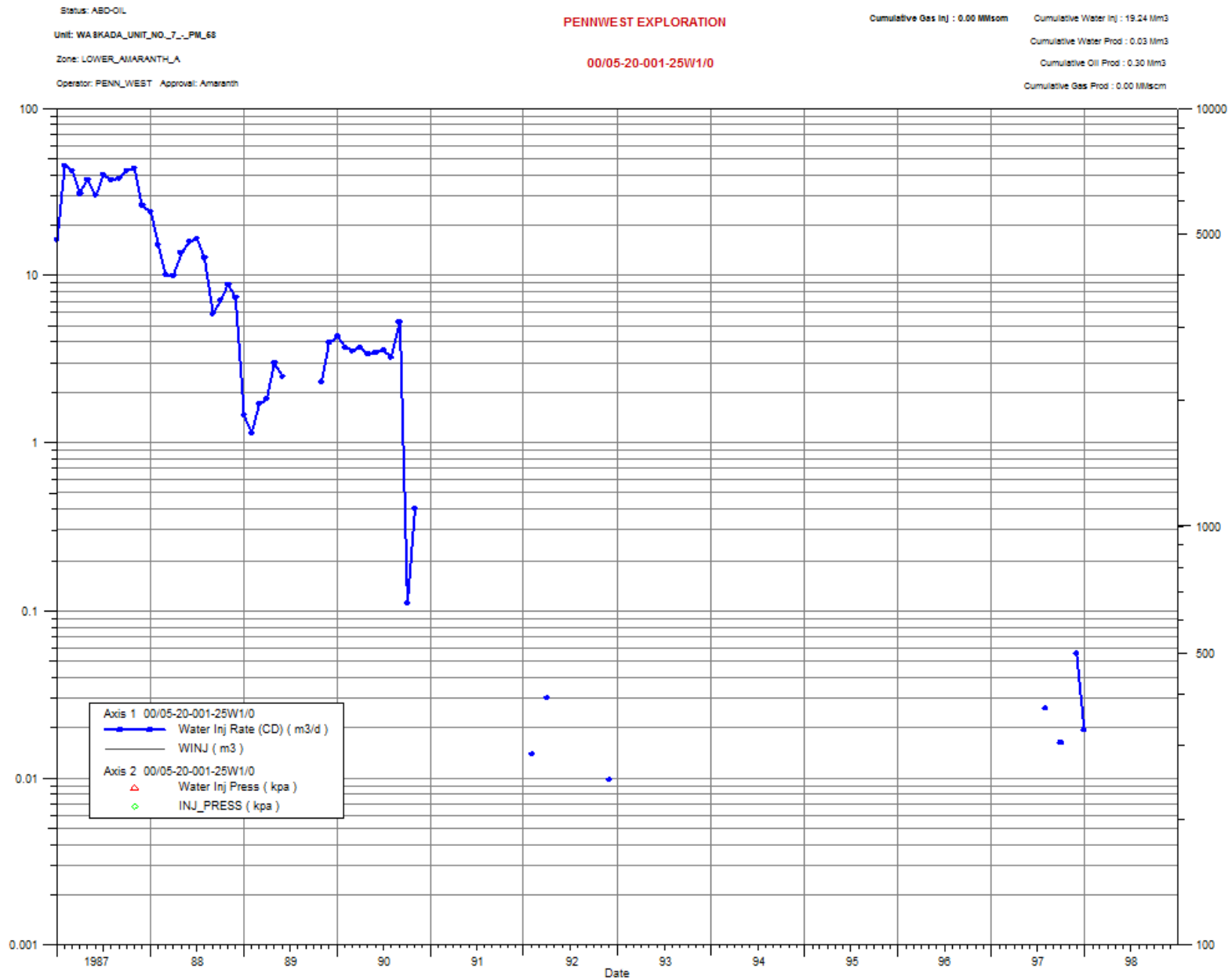
Last Prod/Inj Date: 201501



## ATTACHMENT 6 – UNIT VOIDAGE REPLACEMENT RATIO PLOT



# ATTACHMENT 7 – INDIVIDUAL INJECTION WELL PERFORMANCE PLOTS (5 WELL)



Status: ABD-OIL

Unit: WASKADA\_UNIT\_NO\_7\_-\_PW\_68

Zone: LOWER\_AMARANTH\_A

Operator: PENN\_WEST Approval: Amaranth

PENNWEST EXPLORATION

00/07-18-001-25W1/2

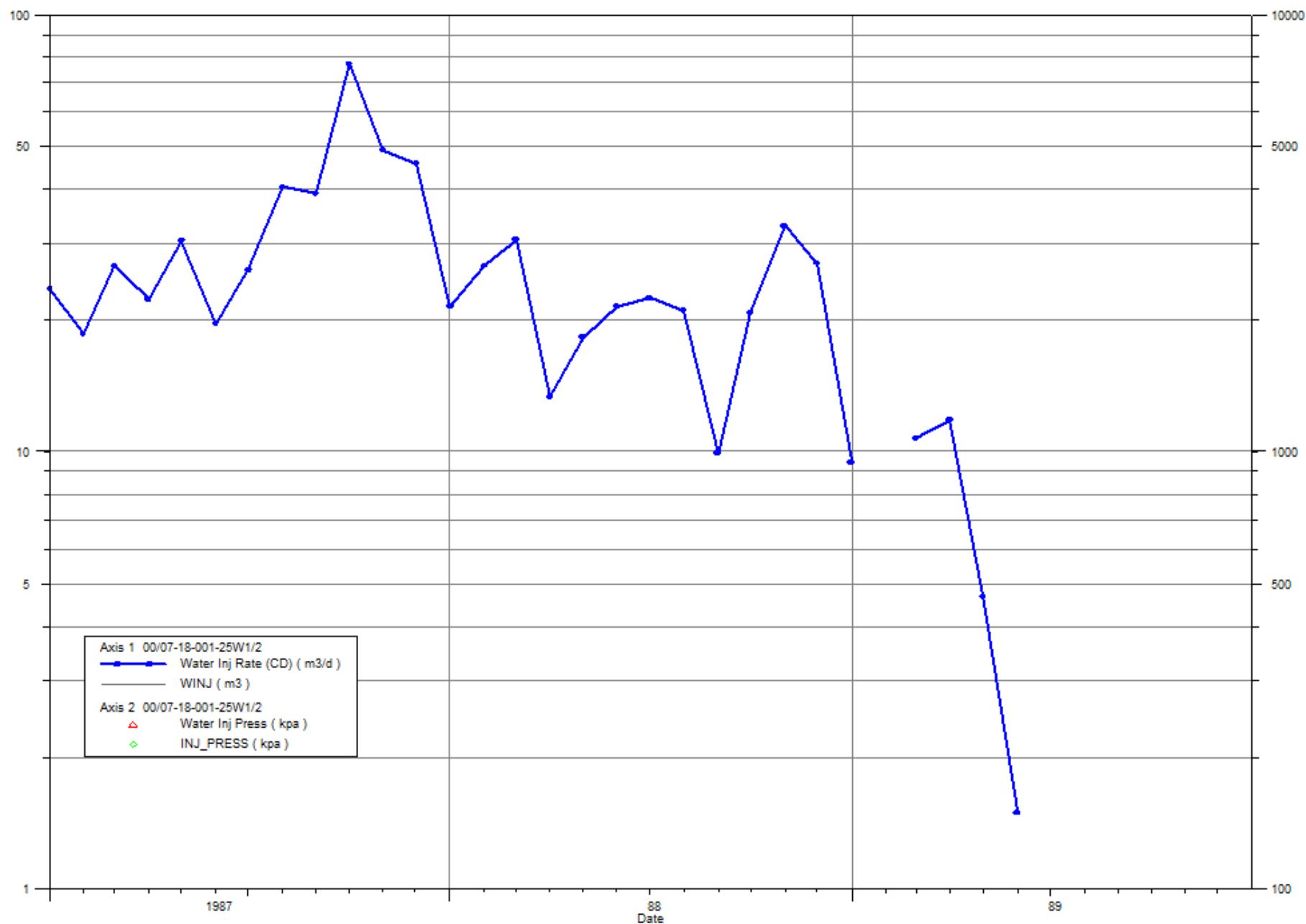
Cumulative Gas Inj : 0.00 MMscm

Cumulative Water Inj : 22.09 Mm3

Cumulative Water Prod : 1.36 Mm3

Cumulative Oil Prod : 0.55 Mm3

Cumulative Gas Prod : 0.00 MMscm



Status: ABD-OIL

Unit: WASKADA\_UNIT\_NO\_7\_-\_PW\_68

Zone: LOWER\_AMARANTH\_A

Operator: PENN\_WEST Approval: Amaranth

PENNWEST EXPLORATION

00/07-18-001-25W1/2

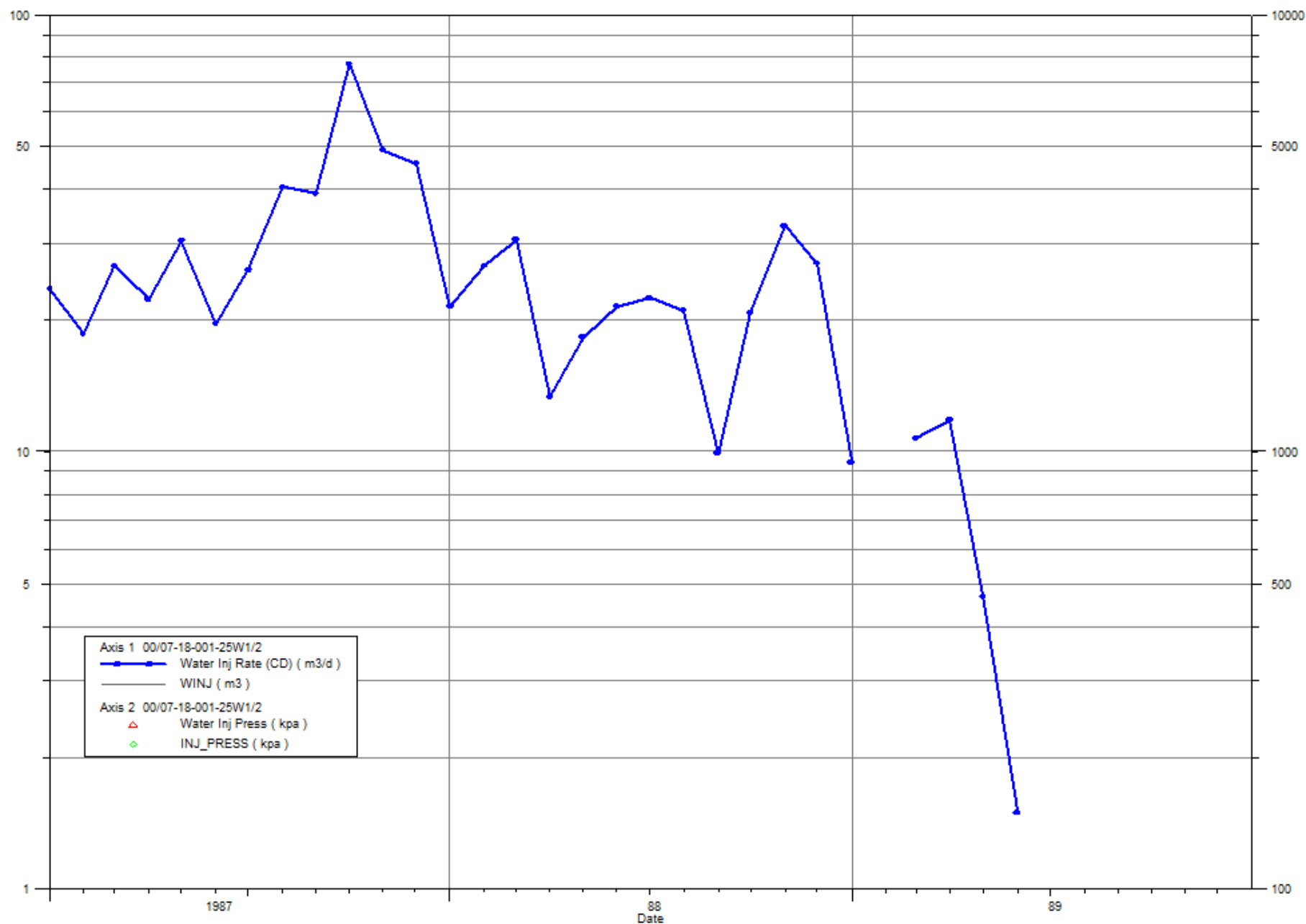
Cumulative Gas Inj : 0.00 MMscm

Cumulative Water Inj : 22.09 Mm3

Cumulative Water Prod : 1.36 Mm3

Cumulative Oil Prod : 0.55 Mm3

Cumulative Gas Prod : 0.00 MMscm



Status: ABD-WINJ

Unit: WASKADA\_UNIT\_NO\_7\_-\_PM\_68

Zone: LOWER\_AMARANTHA

Operator: PENN\_WEST Approval: Amaranth

# PENNWEST EXPLORATION

00/13-20-001-25W1/2

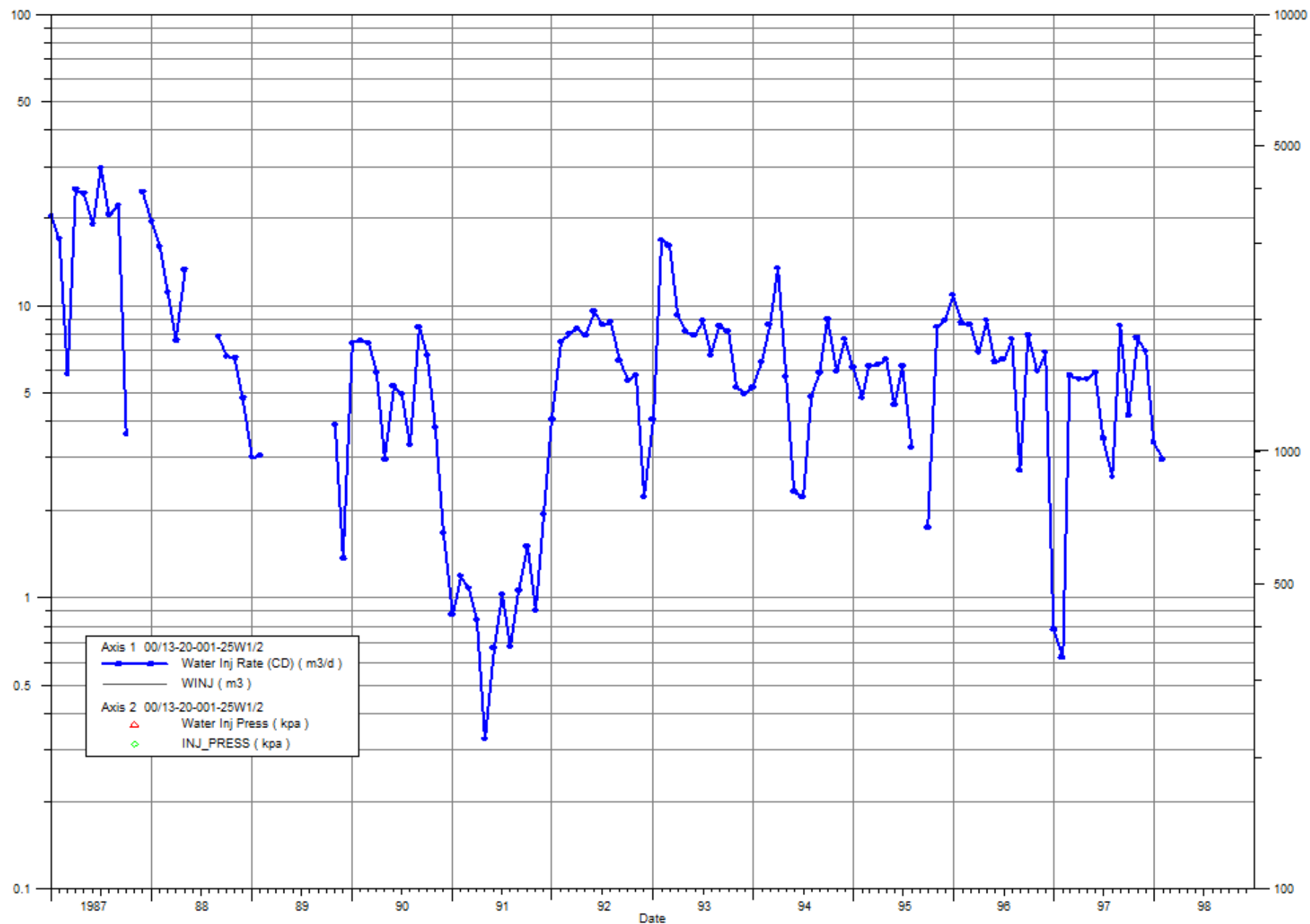
Cumulative Gas Inj : 0.00 MMsm

Cumulative Water Inj : 26.63 Mm3

Cumulative Water Prod : 3.16 Mm3

Cumulative Oil Prod : 1.80 Mm3

Cumulative Gas Prod : 0.00 MMsm



Status: ABD-OIL

Unit: WASKADA\_UNIT\_NO\_7\_-\_PM\_68

Zone: LOWER\_AMARANTH\_A

Operator: PENN\_WEST Approval: Amaranth

# PENNWEST EXPLORATION

00/15-20-001-25W1/0

Cumulative Gas Inj : 0.00 MMscm

Cumulative Water Inj : 36.76 Mm3

Cumulative Water Prod : 1.14 Mm3

Cumulative Oil Prod : 2.11 Mm3

Cumulative Gas Prod : 0.00 MMscm

