

# **WASKADA UNIT NO. 12**

## **WATERFLOOD PROGRESS REPORT**

**January 1, through December 31, 2011**

### **PennWest Exploration**

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## **INTRODUCTION**

The Waskada Unit No.12 pressure maintenance project commenced water injection into the Mission Canyon designed and in accordance with Manitoba Energy and Mines Approval No. PM 48. (See Appendix A – Area Map)

**PRESSURE MAINTENANCE:** Governed by Board Order No. PM 48

### **UNIT INFORMATION:**

**UNITIZED ZONE:** Mission Canyon

**Original Unit:** April.1, 1986 – Board Order, Voluntary

**POOL:** Waskada Mission Canyon 3a A (03 43A)

This report documents the performance of the Waskada Unit No.12 pressure maintenance project for the period of January 1 to December 31, 2011.

Unit # 12 is part of main Waskada. 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 (WPM).

The Waskada Fields produce light density crude (approximately 36° API), predominantly from the Lower Amaranth formation. The interlaminated, shallow marine to subtidal succession of sandstones, siltstones, and shale progressively onlaps 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 founded 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 meters 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.

## **UNIT HISTORY**

### **Waskada Unit # 12 (Unit History)**

<b>Abbreviated Well ID</b>	<b>Date Well Spudded</b>	<b>On Prod YYYY/MM</b>	<b>Org Operator Name</b>	<b>Ground Elevation (m)</b>	<b>TVD (m)</b>
00/01-23-001-26W1/2	6/29/1982	1989/05	NCE Petrofund Corp	466.3	953
00/07-23-001-26W1/0	9/18/1982	1982/12	Omega Hydcbens Ltd	466.4	947
00/08-23-001-26W1/0	8/30/1982	1982/12	Omega Hydcbens Ltd	466.2	956
A0/08-23-001-26W1/2	2/25/1991	1992/07	NCE Petrofund Corp	463.8	963
02/09-23-001-26W1/0	7/14/1983	1984/04	Omega Hydcbens Ltd	464.4	951
00/10-23-001-26W1/0	8/25/1982	1983/01	Omega Hydcbens Ltd	465.2	952
02/15-23-001-26W1/0	7/10/1983	1983/08	Omega Hydcbens Ltd	464.3	950
00/01-24-001-26W1/0	1/10/1981	1981/02	Omega Hydcbens Ltd	464.2	957
00/08-24-001-26W1/0	10/23/1981	1981/11	Omega Hydcbens Ltd	467.8	955
00/09-24-001-26W1/0	11/28/1981	1982/02	Omega Hydcbens Ltd	468.8	944
00/12-24-001-26W1/0	11/3/1981	1981/11	Omega Hydcbens Ltd	463.9	952
00/13-24-001-26W1/0	11/7/1981	1982/04	Omega Hydcbens Ltd	465.8	952

Abbreviated Well ID	Date Well Spudded	On Prod YYYY/MM	Org Operator Name	Ground Elevation (m)	TVD (m)
00/03-25-001-26W1/0	7/14/1981	1981/07	Omega Hydcbens Ltd	467	955
02/03-25-001-26W1/0	9/5/1982	1982/12	Omega Hydcbens Ltd	466.5	952
00/04-25-001-26W1/0	8/17/1981	1981/09	Omega Hydcbens Ltd	466.6	963
00/01-26-001-26W1/0	9/14/1981	1981/10	Omega Hydcbens Ltd	466.1	960
02/01-26-001-26W1/0	7/8/1994	1994/07	Omega Hydcbens Ltd	467.5	930
00/02-26-001-26W1/2	11/17/1981	1989/07	NCE Petrofund Corp	463.1	952

### Waskada Unit #12 (Production & Injection History)

Abbreviated Well ID	First Prod YYYY/MM	On Inject. YYYY/MM	Last Prod. YYYY/MM	Cumulative OIL Prod. (m3)	Cumulative WTR Prod. (m3)	First 12 mo. Ave WC%	Last Inject. YYYY/MM
00/01-23-001-26W1/2	1989/05		2002/06	404	507	58.5	
00/07-23-001-26W1/0	1982/12		1983/11	223	2486	91.8	
00/08-23-001-26W1/0	1982/12		1996/06	5623	44452	52.9	
A0/08-23-001-26W1/2	1992/07		1992/10	16	78	82.9	
02/09-23-001-26W1/0	1984/04	1987/06	1984/09	115	1485	92.8	1993/03
00/10-23-001-26W1/0	1983/01		1993/10	2608	3424	32.5	
02/15-23-001-26W1/0	1983/08	1986/05	1990/08	313	2527	86.2	1988/03
00/01-24-001-26W1/0	1981/02	1986/04	1986/03	3802	474	20.3	1988/11
00/08-24-001-26W1/0	1981/11		2011/11	10952	25297	21.7	
00/09-24-001-26W1/0	1982/02		1991/12	839	465	4.2	

Abbreviated Well ID	First Prod YYYY/MM	On Inject. YYYY/MM	Last Prod. YYYY/MM	Cumulative OIL Prod. (m3)	Cumulative WTR Prod. (m3)	First 12 mo. Ave WC%	Last Inject. YYYY/MM
00/12-24-001-26W1/0	1981/11		2011/11	2322	5451	69.7	
00/13-24-001-26W1/0	1982/04		1990/07	2925	12238	68.6	
00/03-25-001-26W1/0	1981/07		1982/12	1690	1035	31.4	
02/03-25-001-26W1/0	1982/12		2011/08	11047	23022	5.1	
00/04-25-001-26W1/0	1981/09		2011/11	1986	3759	19.3	
00/01-26-001-26W1/0	1981/10		1990/11	293	1341	74.8	
02/01-26-001-26W1/0	1994/07		2010/01	6784	16288	48.3	
00/02-26-001-26W1/2	1989/07		1991/09	318	494	70.9	

## **DISCUSSION:**

### **Production Performance**

The Waskada MC3a A Pool was discovered in January, 1981 with the completion of the well Omega Waskada 1-24-1-26 (WPM) in the Mission Canyon 3a zone, the Pool has since developed was unitized in early 1986. Currently included in the Unit Area are 4 active producers, with 12 suspended or abandoned wells, and 2 abandoned injectors. (see Appendix D for oil, water and injection rates). The Mission Canyon 3a zone is the lower porous unit of the Mission Canyon 3 Member. Table No. 1 illustrates the severity of the primary production decline in the Waskada MC3a A Pool and emphasizes the need for pressure maintenance operations. The Table lists average daily oil production in the first month which each well produced at least 20 days and the corresponding rate for March, 1986 (or earlier, if shut-in) for each well. In April and May 1986, waterflooding began in the Pool. The average length of production prior to water injection is about 25 months, but over this time, oil rates have declined to 36% of the initial rates. Appendix B shows the production history of the unit wells.

**Voidage Replacement Ratio Calculation:**

Upon review of the voidage replacement ratio (VRR) for the Waskada Unit # 12 area, it was shown that the area has been under injected. This is shown by instantaneous and cumulative VRR for the Waskada Unit # 12 (Please see the Appendix C). Currently there is no active injector in this unit, and PennWest has no plan to re-activate any of the old injectors.

**Corrosion and Scale Prevention Program**

We currently inject ScalCor down all the new horizontal wells. Plus, PennWest will be installing cathodic protection on the wells. Also, the new gathering system is Fiberglass and as such is not susceptible to corrosion.

**SUMMARY AND RECOMMENDATIONS****Producers:****Current Producing Wells**

1. 00/08-24-001-26W1/0
2. 00/12-24-001-26W1/0
3. 02/03-25-001-26W1/0
4. 00/04-25-001-26W1/0

**Current Suspended Producing Wells**

1. 00/01-23-001-26W1/2 (since 2002/07)
2. 00/02-26-001-26W1/2 (since 1991/10)

**Abandoned Producing Wells**

1. 00/07-23-001-26W1/0 (since 1983/12)
2. 00/08-23-001-26W1/0 (since 1996/07)
3. A0/08-23-001-26W1/2 (since 1992/11)
4. 00/10-23-001-26W1/0 (since 1993/11)

5. 02/15-23-001-26W1/0 (since 1990/09)
6. 00/09-24-001-26W1/0 (since 1992/01)
7. 00/13-24-001-26W1/0 (since 1990/08)
8. 00/03-25-001-26W1/0 (since 1983/01)
9. 00/01-26-001-26W1/0 (since 1990/12)
10. 02/01-26-001-26W1/0 (since 2010/02)

### **Injectors**

#### **Current Injecting Wells**

None

#### **Current Suspended Injection Wells**

None

#### **Abandoned Injection Wells**

1. 02/09-23-001-26W1/0 (since 1993/04)
2. 00/01-24-001-26W1/0 (since 1988/12)

The behavior of a Lower Amaranth Unit 1 producers are indicated by examining the oil rate versus time plots (see Appendix B). It exhibited relatively high initial oil productivity (most of the wells drilled in the past were verticals), rapidly declining to flat/low decline rates, with almost no discernible water flood response. This behavior can be explained by drop in the reservoir pressure from initial (approximately 8700 kPag) to above in some wells or below in others bubble point pressure (about 4200 kPag) followed by solution gas breakout which adversely affected the relative permeability to oil. (see Table # 2) Also, it is believed that fracture stimulation treatments, performed on these wells prior to initiation of water injection, “broke” through into the higher productivity Mississippian and that 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.



Currently, there are only four active producers and no injection well in this unit; we do not have any plan for this unit other than monitoring the producers. PennWest Exploration's plan is to concentrate on Lower Amaranth Formation for now.

## **TABLES**

### **Waskada Unit #12**

**Table 1: Rate History**

Date	Oil		Water		Inj Water	
Year	m3/year	m3/day	m3/year	m3/day	m3/year	m3/day
1981	1,817	4.98	993	2.72	0	0.00
1982	5,337	14.62	2,460	6.74	0	0.00
1983	5,126	14.04	6,662	18.25	0	0.00
1984	3,811	10.44	4,872	13.35	0	0.00
1985	2,901	7.95	5,065	13.88	0	0.00
1986	3,067	8.40	8,584	23.52	24,010	65.78
1987	2,789	7.64	9,856	27.00	21,950	60.14
1988	2,055	5.63	6,597	18.07	7,842	21.49
1989	2,454	6.72	8,797	24.10	346	0.95
1990	1,807	4.95	7,577	20.76	554	1.52
1991	1,772	4.85	5,500	15.07	5,719	15.67
1992	1,552	4.25	7,107	19.47	4,596	12.59
1993	869	2.38	8,489	23.26	1,232	3.38
1994	2,016	5.52	6,304	17.27	0	0.00
1995	1,279	3.50	7,184	19.68	0	0.00
1996	1,162	3.18	4,552	12.47	0	0.00
1997	1,125	3.08	3,227	8.84	0	0.00
1998	937	2.57	3,105	8.51	0	0.00
1999	897	2.46	3,119	8.55	0	0.00
2000	899	2.46	2,896	7.93	0	0.00
2001	809	2.22	2,798	7.67	0	0.00
2002	802	2.20	2,010	5.51	0	0.00
2003	807	2.21	2,222	6.09	0	0.00
2004	757	2.07	2,548	6.98	0	0.00
2005	846	2.32	2,399	6.57	0	0.00
2006	1,052	2.88	2,836	7.77	0	0.00
2007	1,186	3.25	4,600	12.60	0	0.00
2008	848	2.32	4,867	13.33	0	0.00
2009	616	1.69	3,633	9.95	0	0.00
2010	464	1.27	1,777	4.87	0	0.00
2011	400	1.27	2190	6.00	0	0.00

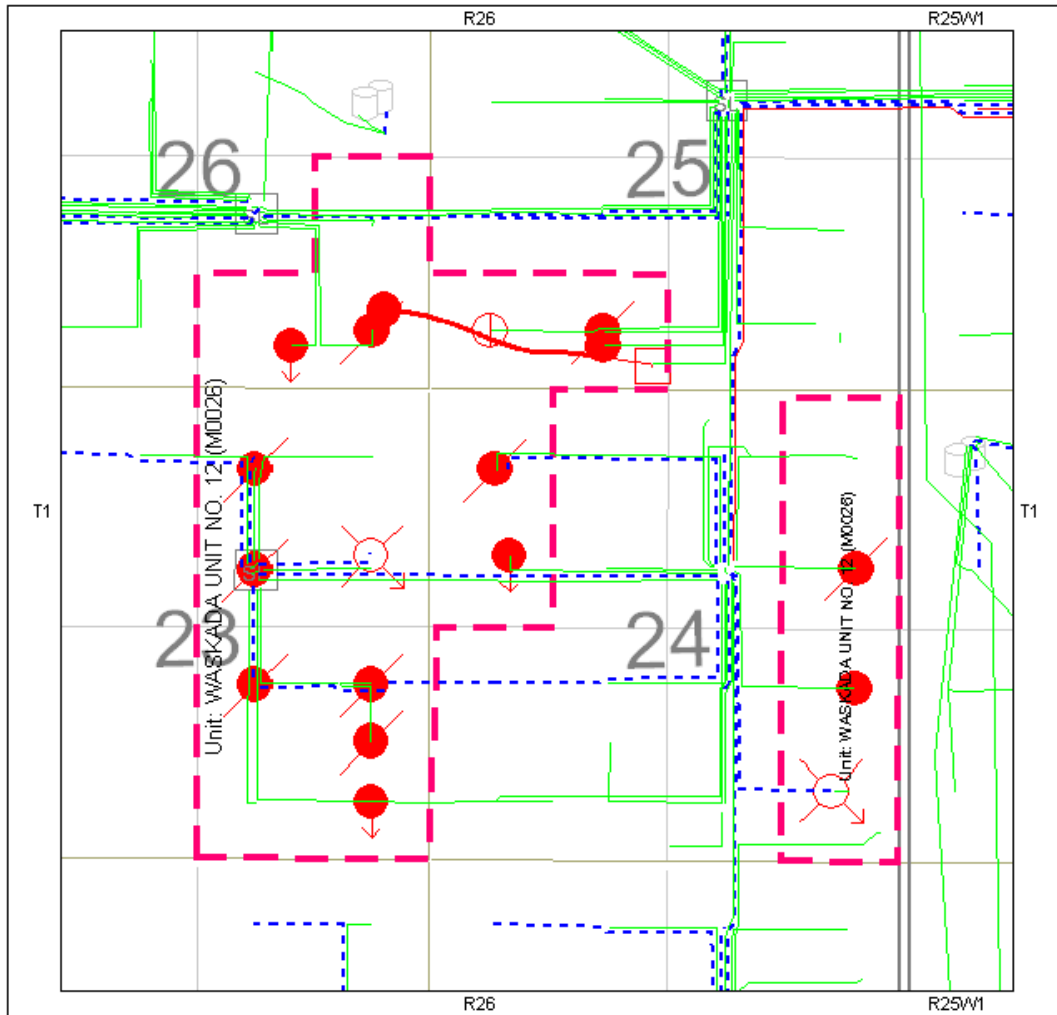
## Waskada Unit #12

**Table 2: Pressure Surveys**

<b>Location</b>	<b>Shut In Date</b>	<b>Date of Survey</b>	<b>Type of Survey</b>	<b>Pressure @ Datum Depth (kPa)</b>
00/08-23-001-26W1/0	Mar-91	(7 days)	Static Gradient	3989
00/13-24-001-26W1/0	Nov-89	(6 days)	Static Gradient	9035
02/03-25-001-26W1/0	11-Dec-06	19-Dec-06	Acoustic Build Up	922

## **APPENDIX A**

## Appendix A – Area Map

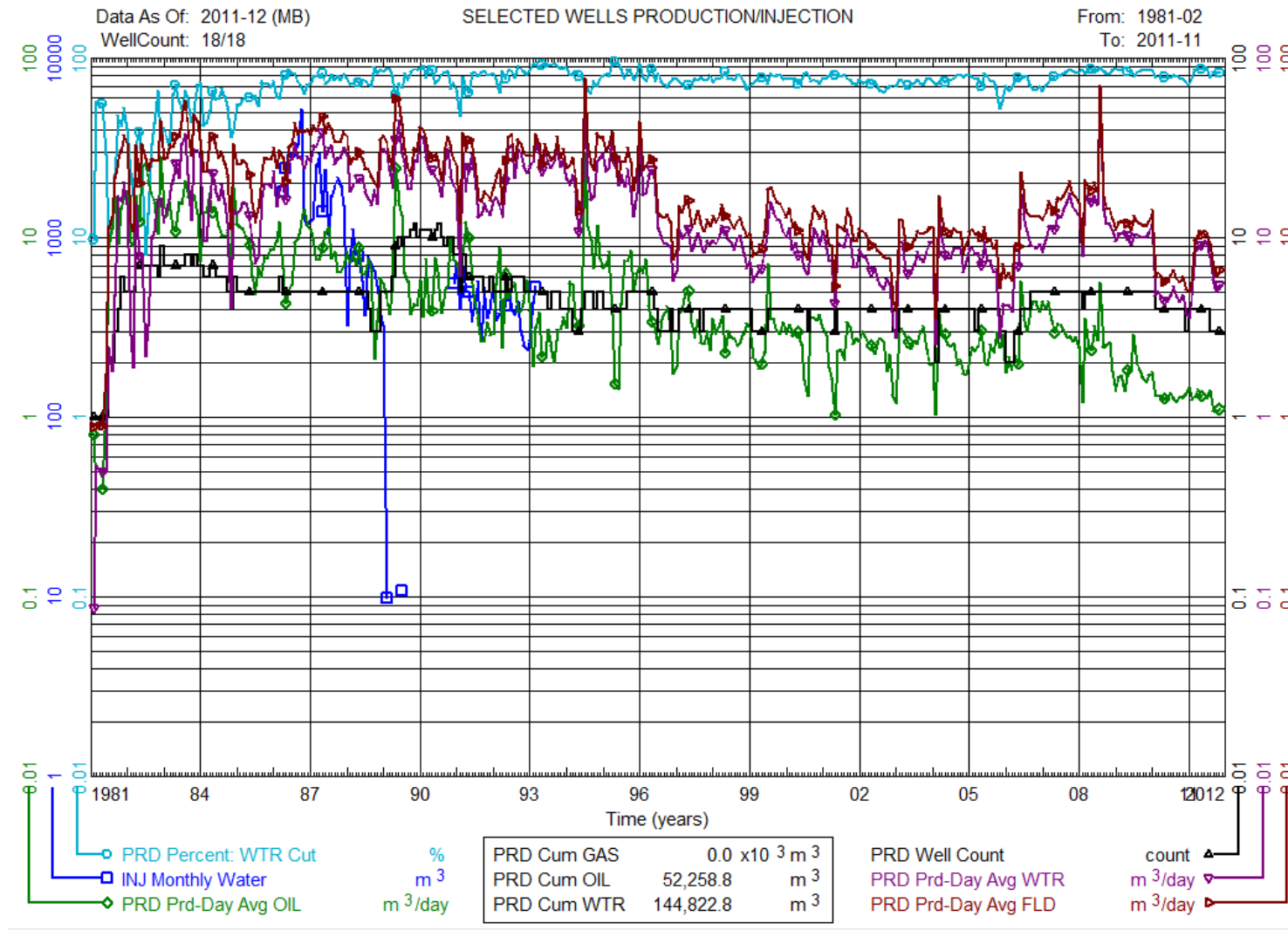


WELL SYMBOLS									
• OIL	✂ AO	⬮ PTN	⬮ D&A	⬮ WI					
○ LCT	✂ AWI	⬮ STN	⬮ CMM	⬮ DRL					
⊙ RDR	⊙ WD	⊙ AWS	⊙ AWD	⊙ SWI					
▲ SO	⊙ WSC	• J&A	□ SL						

<b>PennWest</b> Exploration		
Waskada Unit #12		
<b>geoSCOUT</b> www.geoscout.com	By :	Date : 2011/04/14
	Scale = 1:18541	Project : Waskada

## **APPENDIX B**

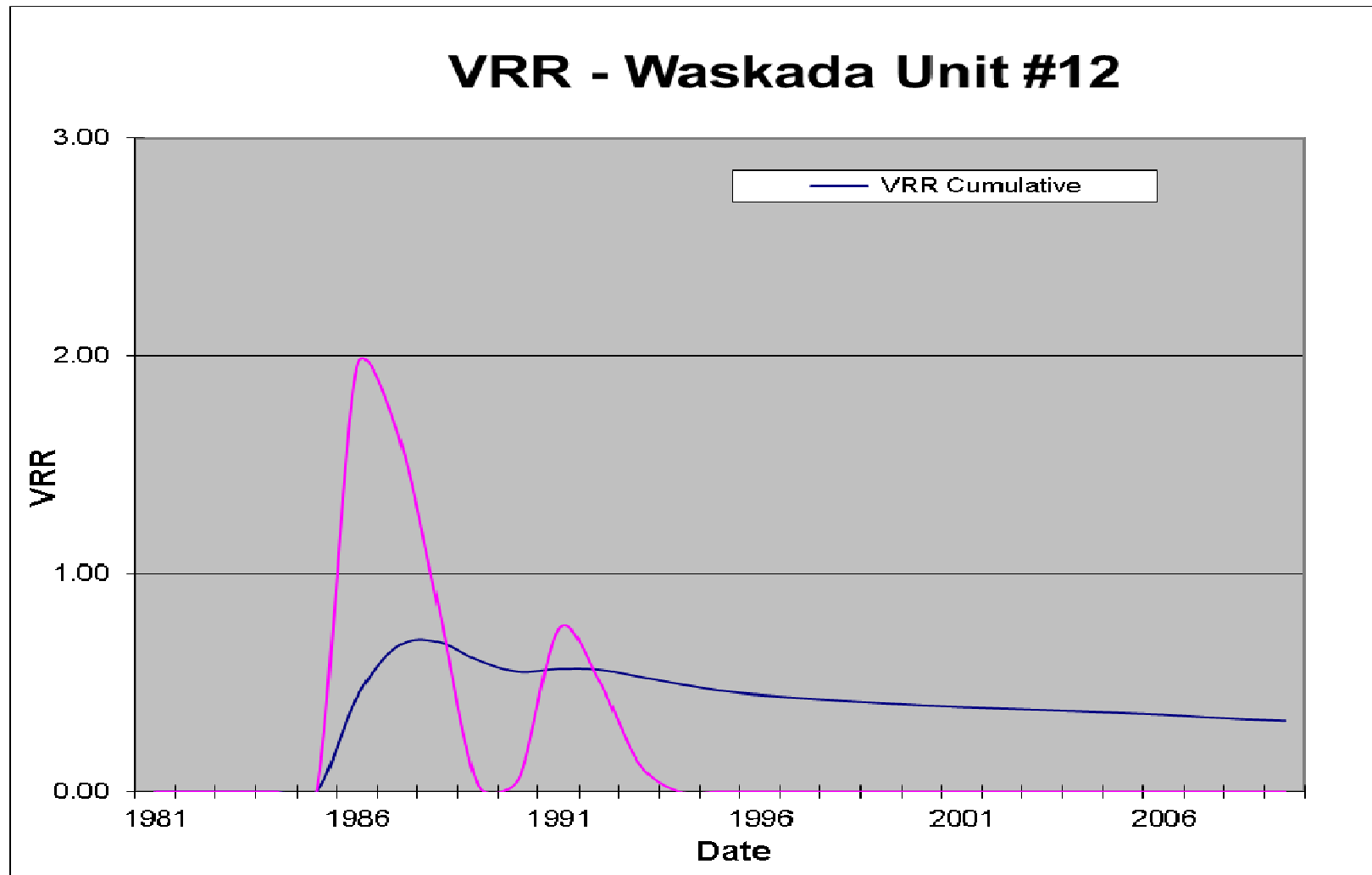
## Appendix B – Production and Injection History plot



## **APPENDIX C**

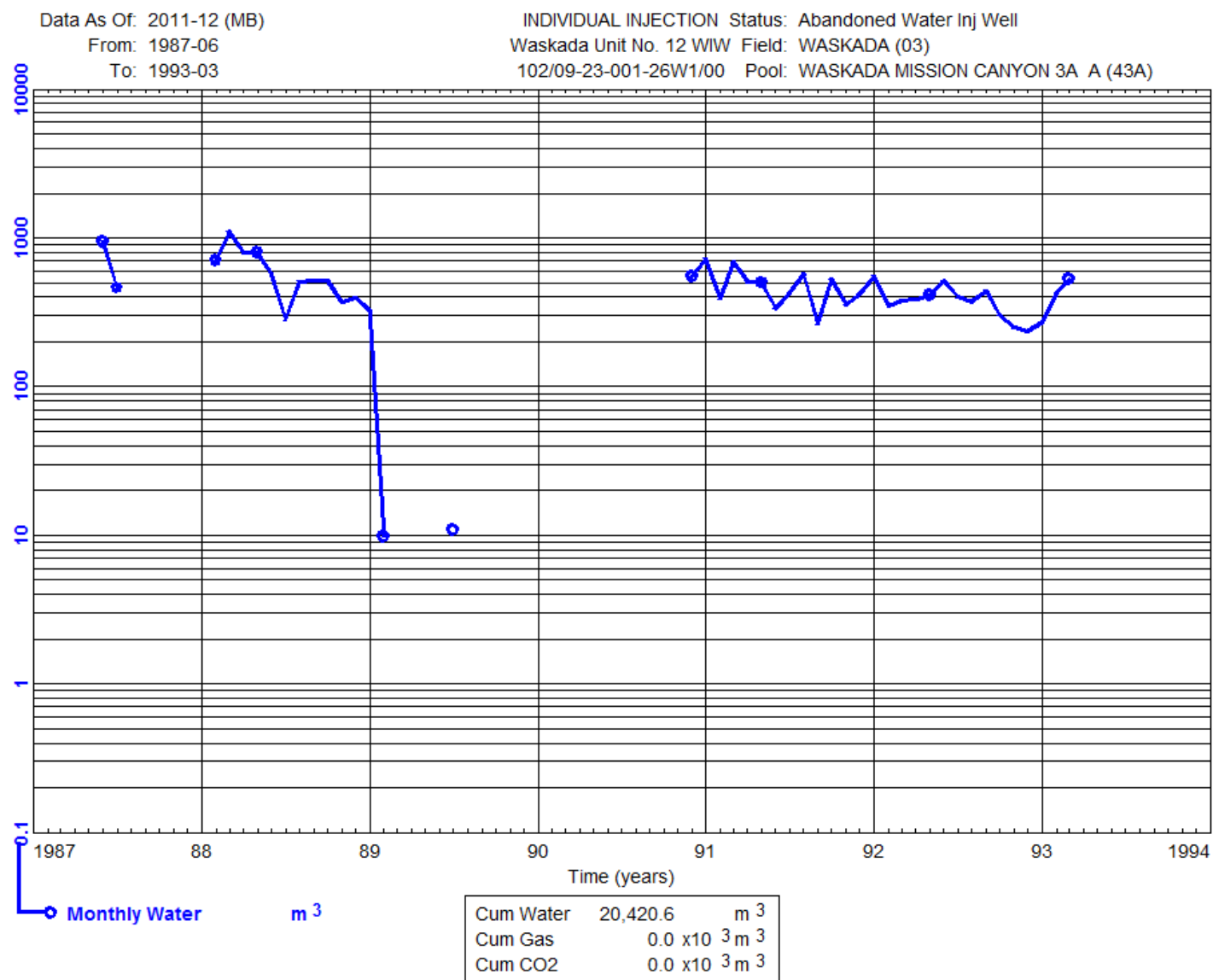


Appendix C – Voidage Replacement Ratio VRR



## **APPENDIX D**

## Appendix D – Production and Injection Profiles



Data As Of: 2011-12 (MB)

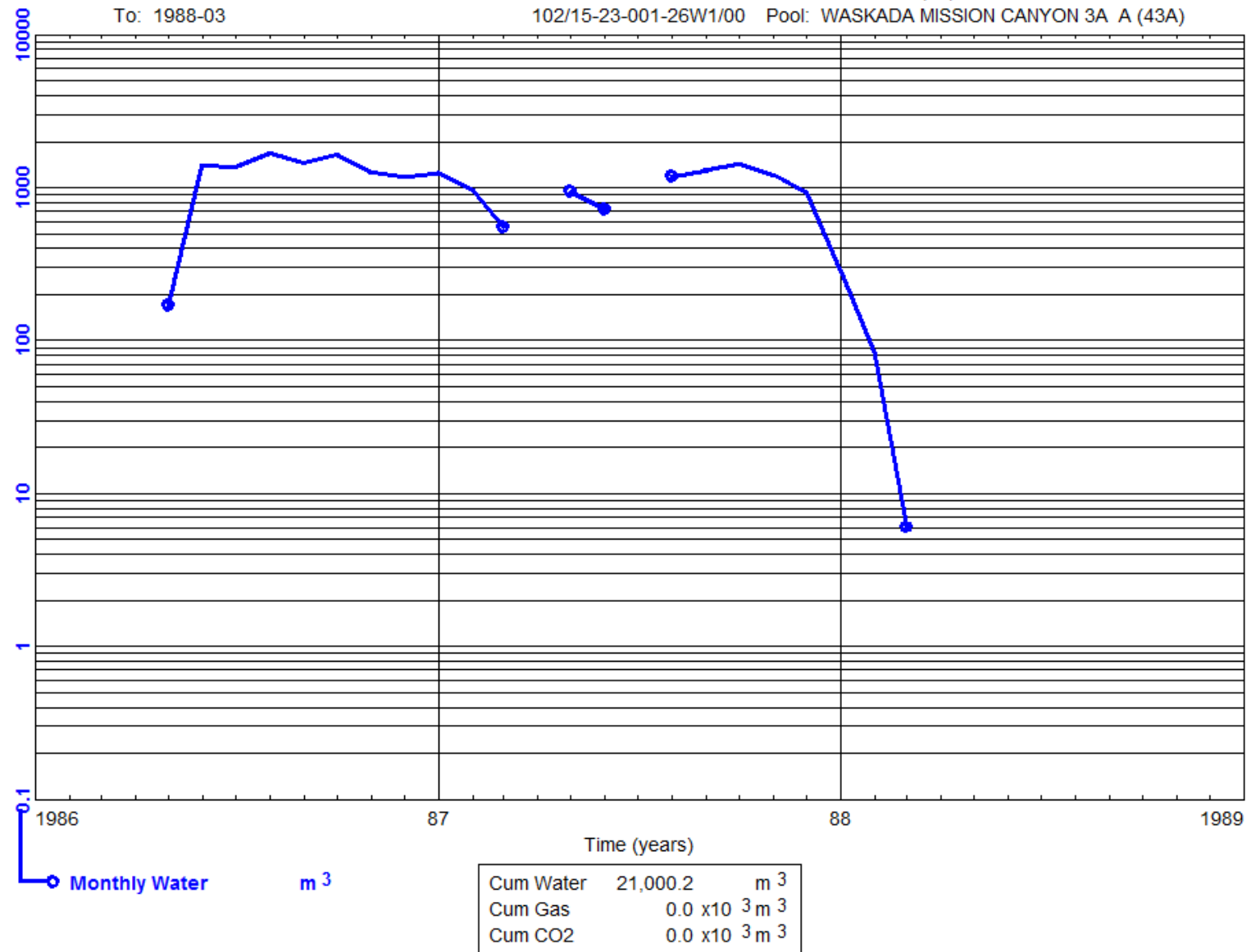
From: 1986-05

To: 1988-03

INDIVIDUAL INJECTION Status: Abandoned Producer

Waskada Unit No. 12 Field: WASKADA (03)

102/15-23-001-26W1/00 Pool: WASKADA MISSION CANYON 3A A (43A)



Data As Of: 2011-12 (MB)

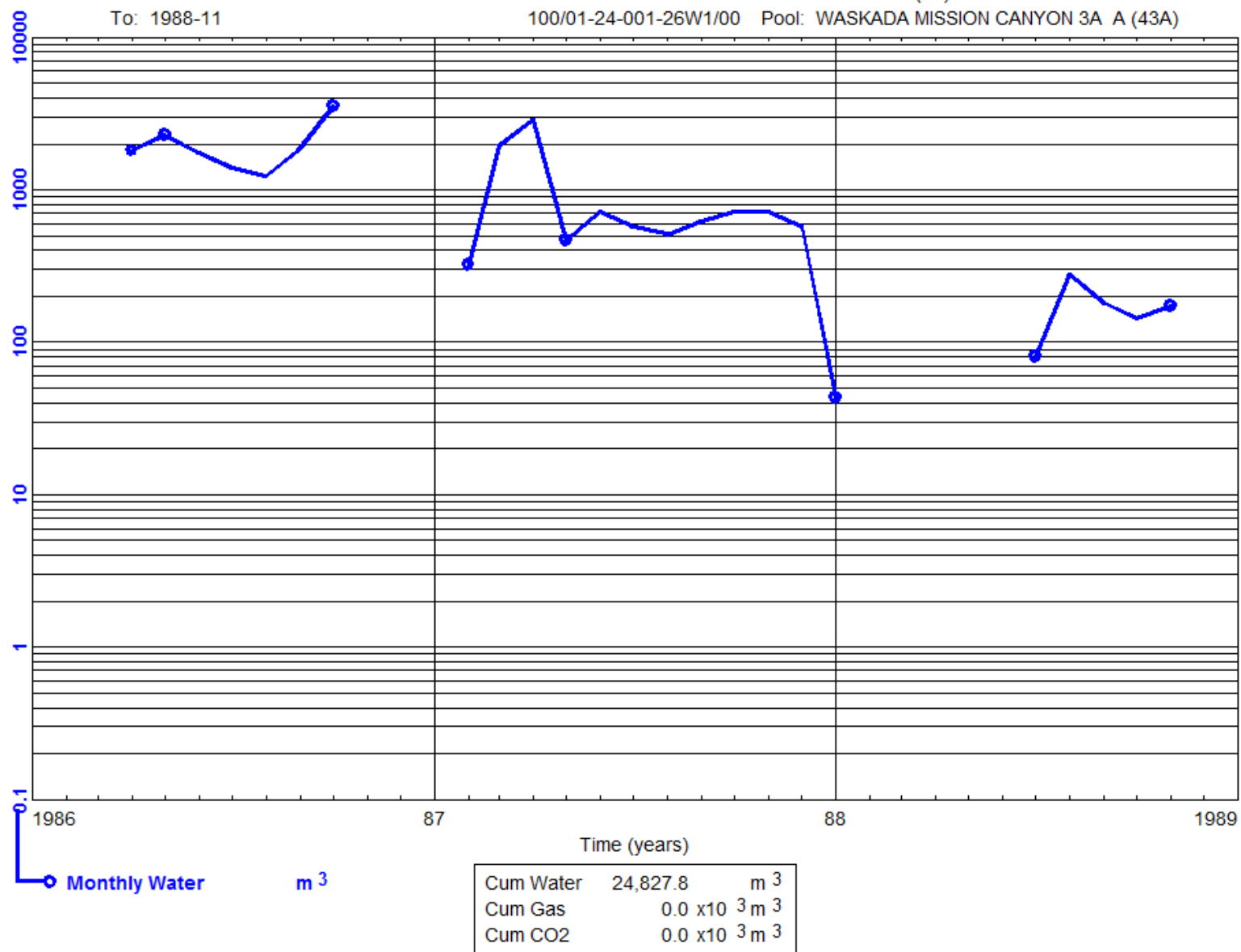
From: 1986-04

To: 1988-11

INDIVIDUAL INJECTION Status: Abandoned Water Inj Well

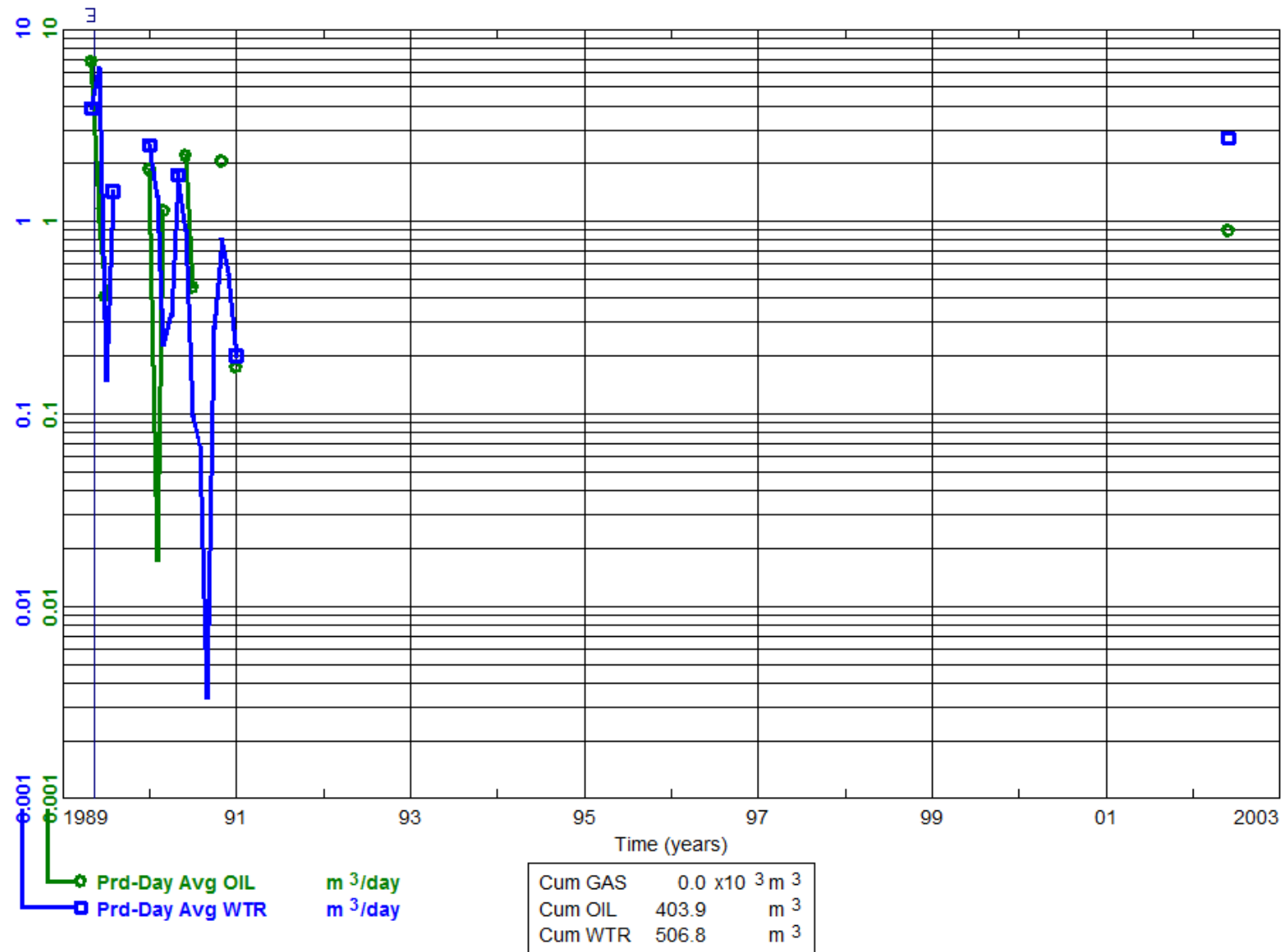
Waskada Unit No. 12 Prov. W Field: WASKADA (03)

100/01-24-001-26W1/00 Pool: WASKADA MISSION CANYON 3A A (43A)



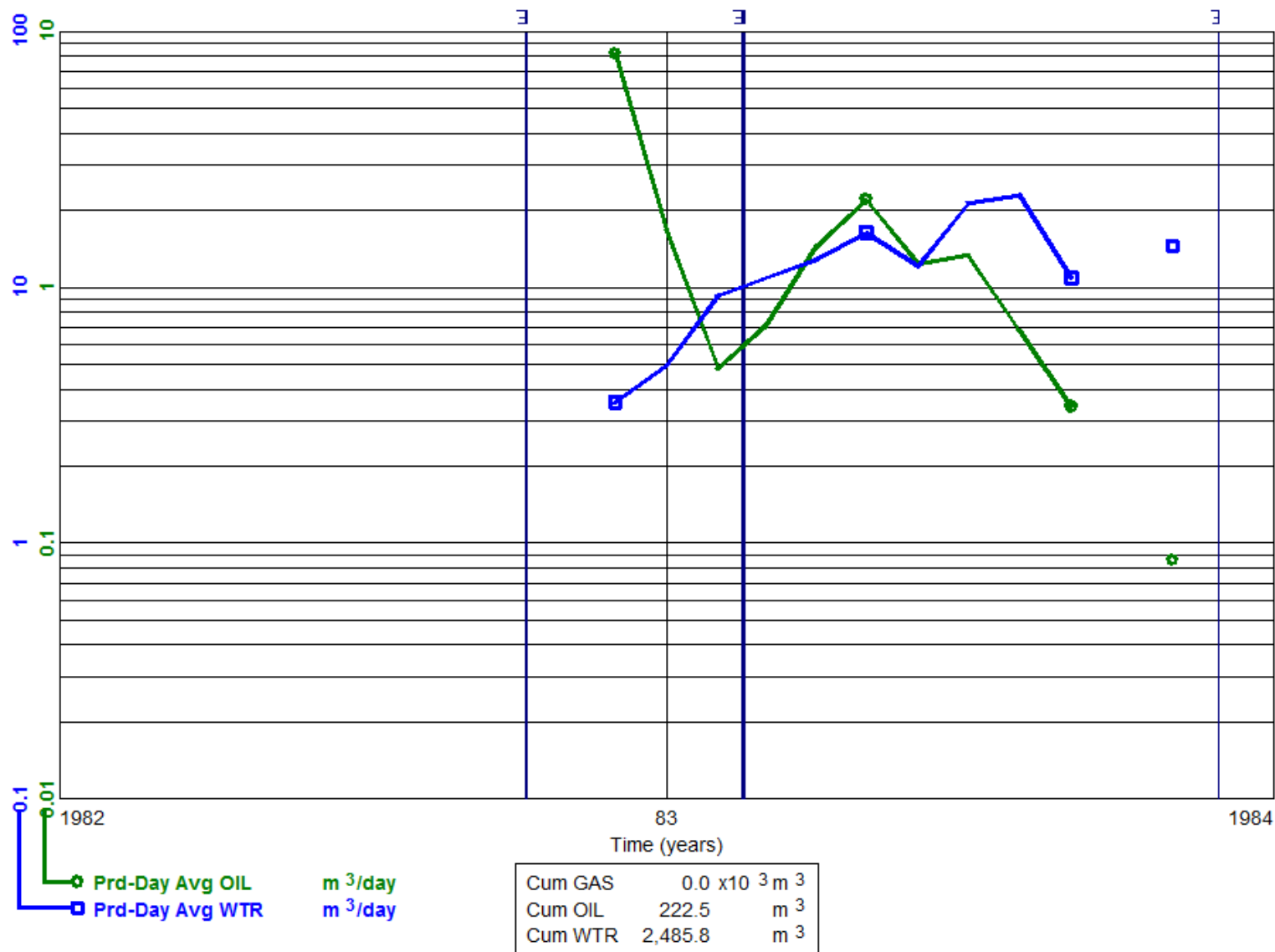
Data As Of: 2011-12 (MB)  
 From: 1989-05  
 To: 2002-06

INDIVIDUAL PRODUCTION Status: Comingled  
 Waskada Unit No. 4 COM Field: WASKADA (03)  
 100/01-23-001-26W1/02 Pool: WASKADA MISSION CANYON 3A A (43A)



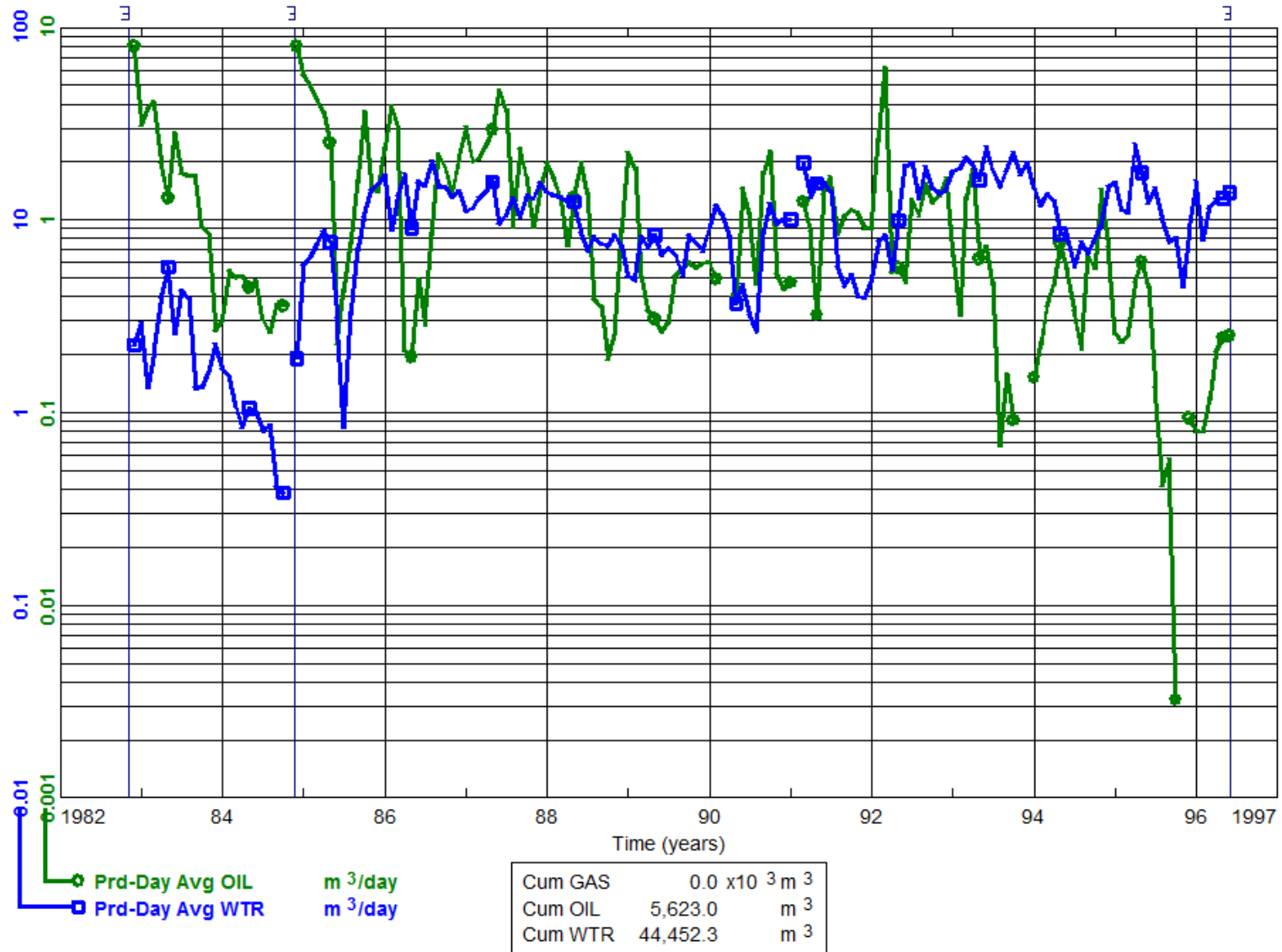
Data As Of: 2011-12 (MB)  
 From: 1982-12  
 To: 1983-11

INDIVIDUAL PRODUCTION Status: Abandoned Producer  
 Waskada Unit No. 4 WIW Field: WASKADA (03)  
 100/07-23-001-26W1/00 Pool: WASKADA MISSION CANYON 3A A (43A)



Data As Of: 2011-12 (MB)  
 From: 1982-12  
 To: 1996-06

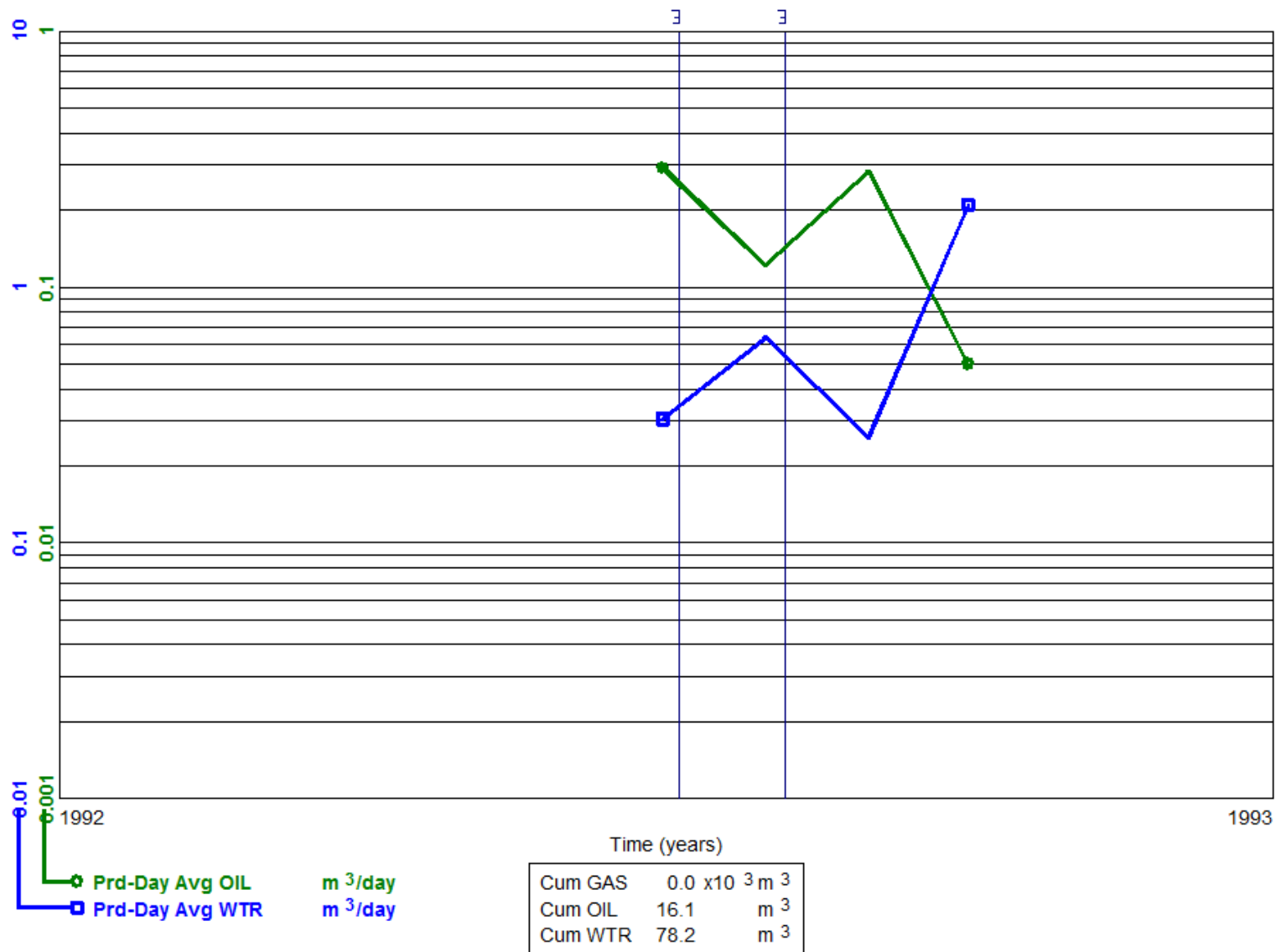
INDIVIDUAL PRODUCTION Status: Abandoned Producer  
 Waskada Unit No. 12 Field: WASKADA (03)  
 100/08-23-001-26W1/00 Pool: WASKADA MISSION CANYON 3A A (43A)





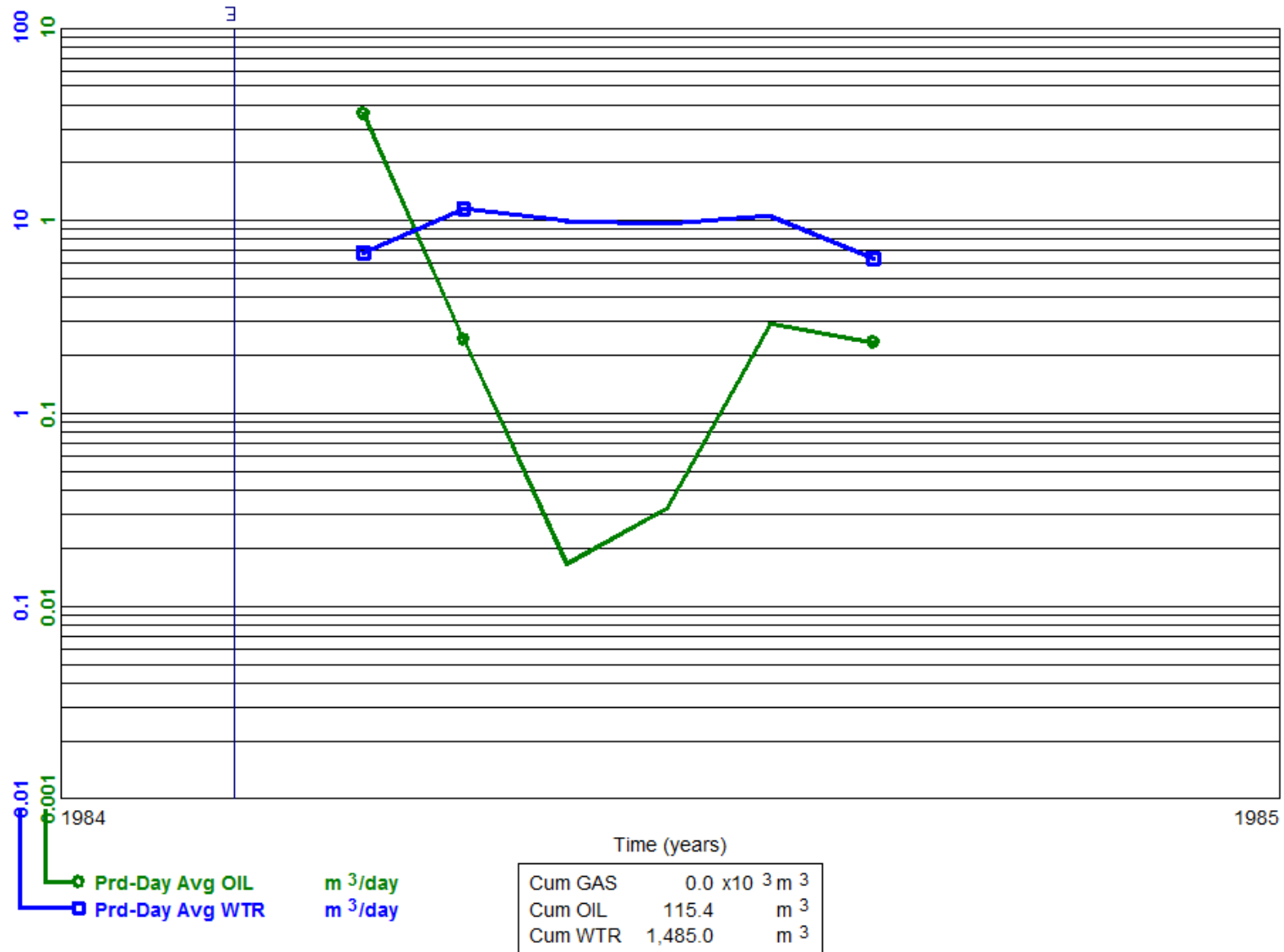
Data As Of: 2011-12 (MB)  
 From: 1992-07  
 To: 1992-10

INDIVIDUAL PRODUCTION Status: Abandoned Producer  
 Waskada Unit No. 4 Field: WASKADA (03)  
 1A0/08-23-001-26W1/02 Pool: WASKADA MISSION CANYON 3A A (43A)



Data As Of: 2011-12 (MB)  
 From: 1984-04  
 To: 1984-09

INDIVIDUAL PRODUCTIONS Status: Abandoned Water Inj Well  
 Waskada Unit No. 12 WIW Field: WASKADA (03)  
 102/09-23-001-26W1/00 Pool: WASKADA MISSION CANYON 3A A (43A)



Data As Of: 2011-12 (MB)

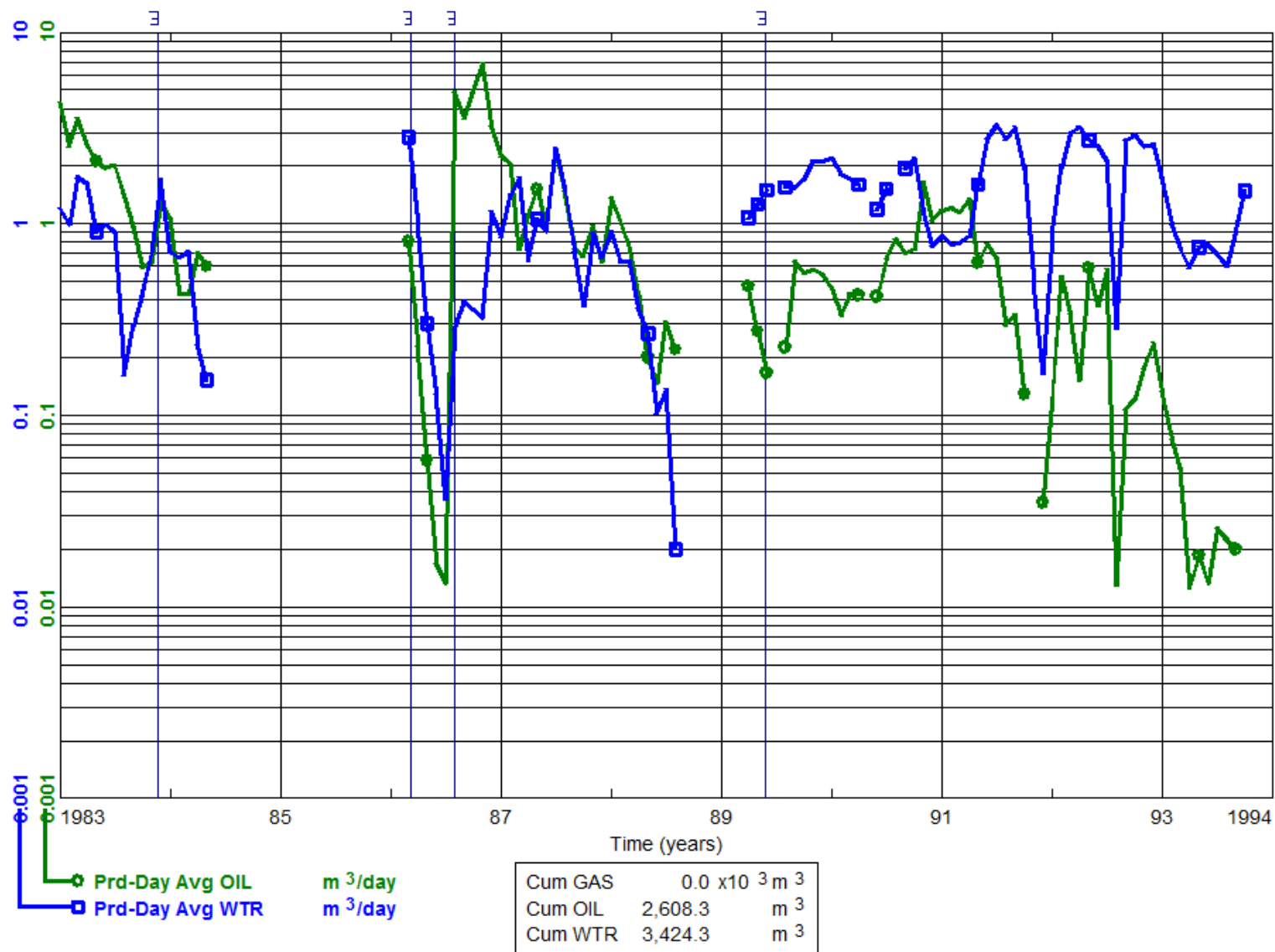
From: 1983-01

To: 1993-10

INDIVIDUAL PRODUCTION Status: Abandoned Producer

Waskada Unit No. 12 Field: WASKADA (03)

100/10-23-001-26W1/00 Pool: WASKADA MISSION CANYON 3A A (43A)



Data As Of: 2011-12 (MB)

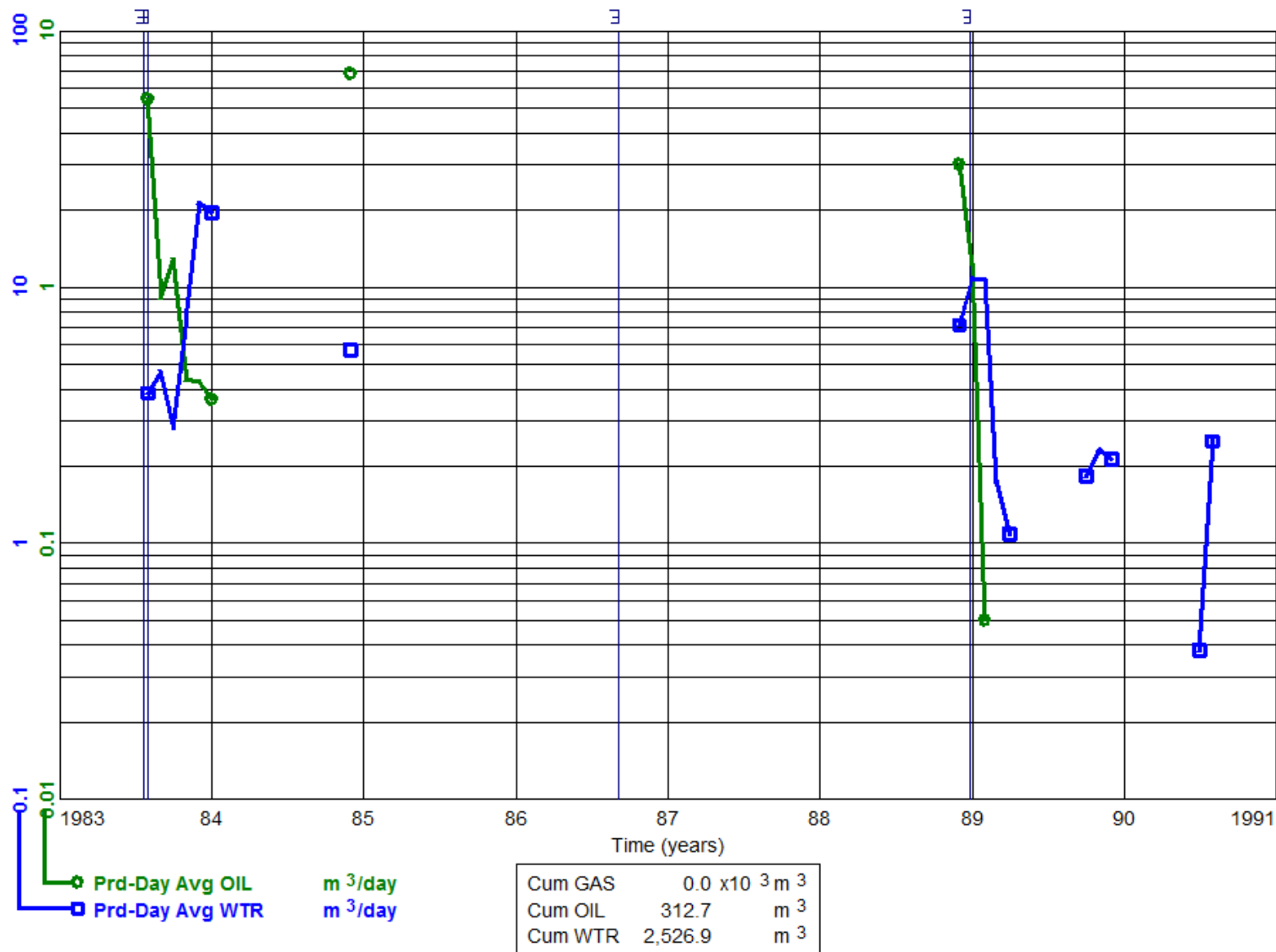
From: 1983-08

To: 1990-08

INDIVIDUAL PRODUCTION Status: Abandoned Producer

Waskada Unit No. 12 Field: WASKADA (03)

102/15-23-001-26W1/00 Pool: WASKADA MISSION CANYON 3A A (43A)



Data As Of: 2011-12 (MB)

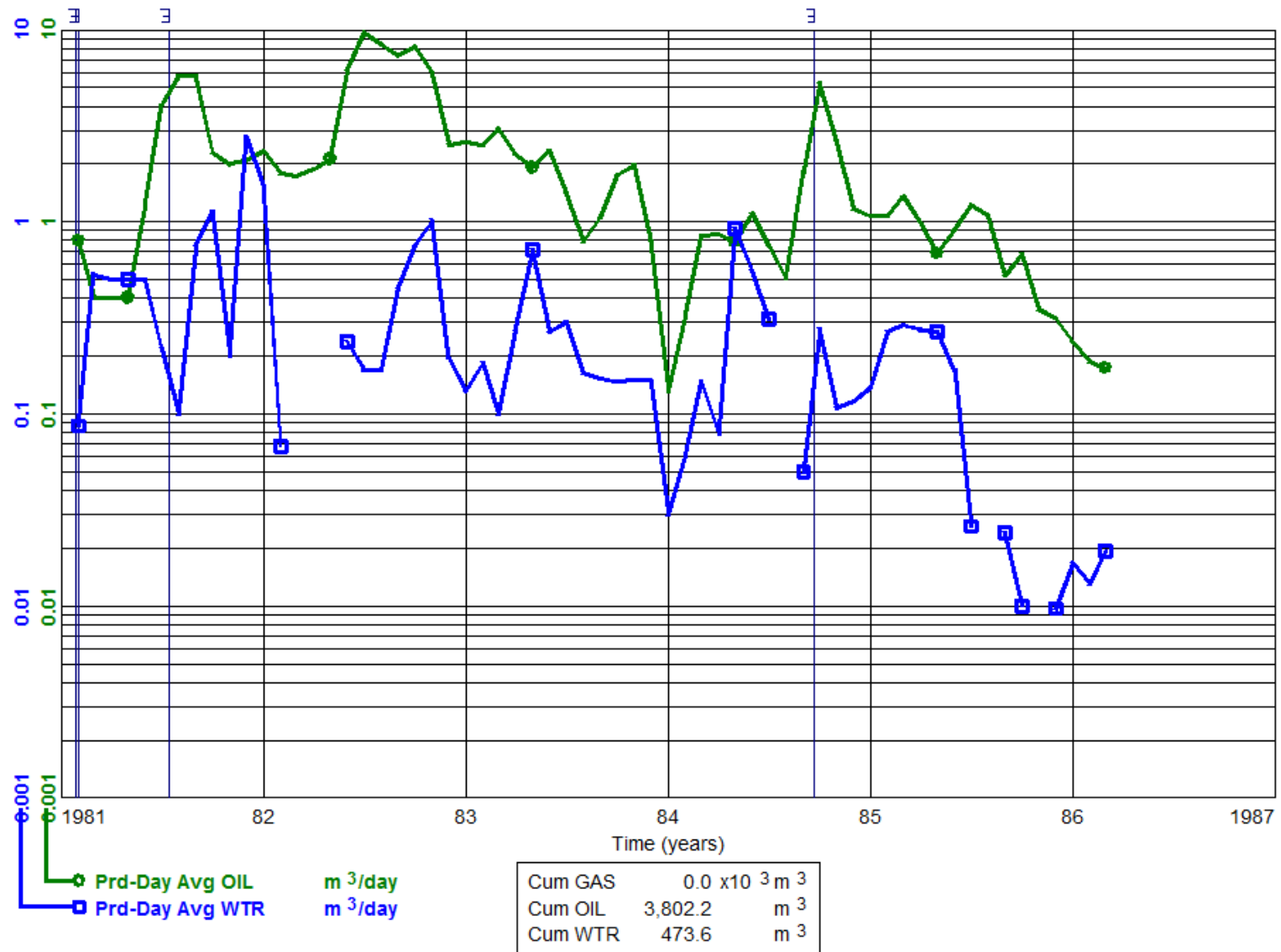
From: 1981-02

To: 1986-03

INDIVIDUAL PRODUCTION Status: Abandoned Water Inj Well

Waskada Unit No. 12 Prov. W Field: WASKADA (03)

100/01-24-001-26W1/00 Pool: WASKADA MISSION CANYON 3A A (43A)



Data As Of: 2011-12 (MB)

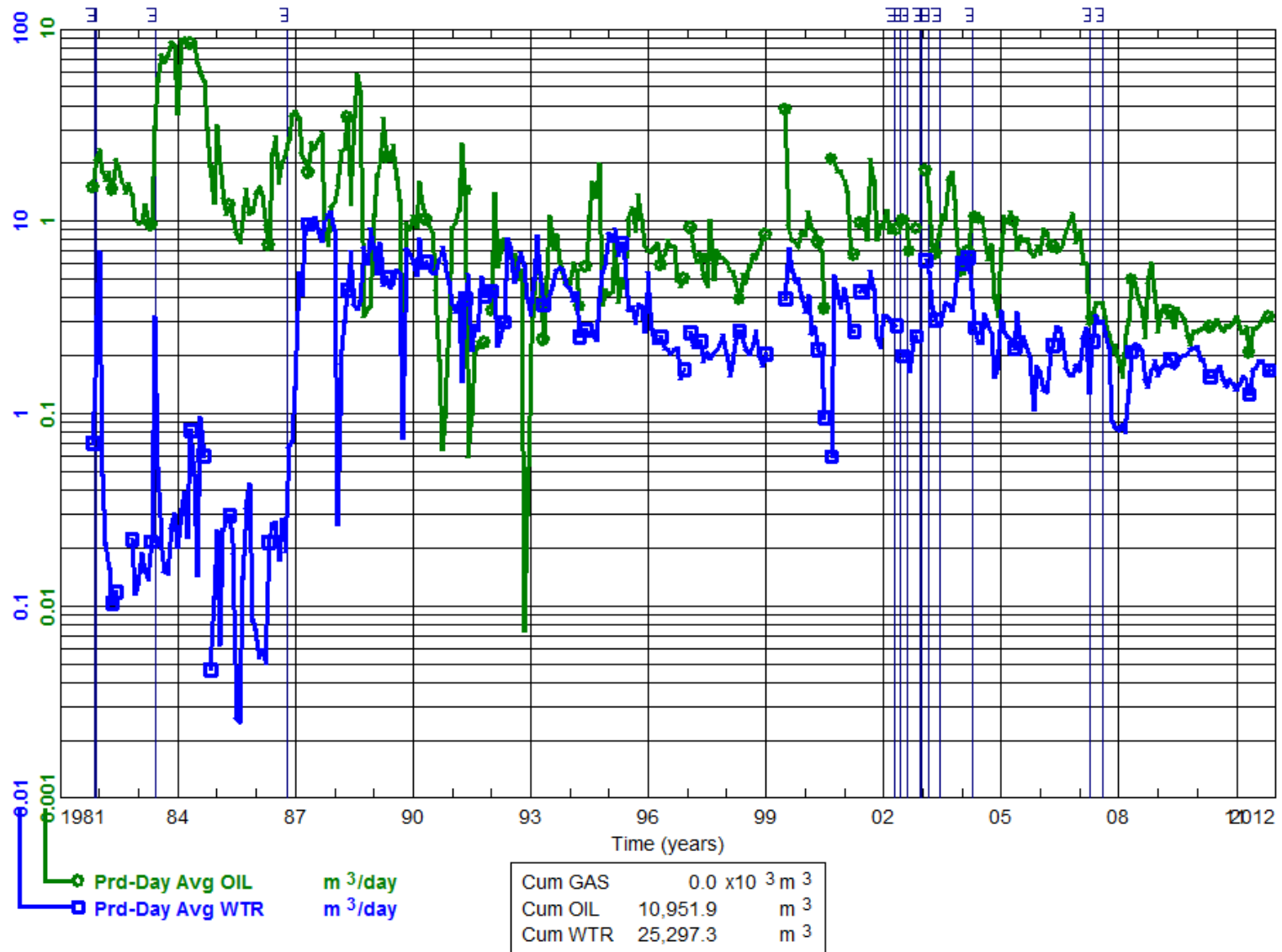
From: 1981-11

To: 2011-11

INDIVIDUAL PRODUCTION Status: Capable Of Oil Prod

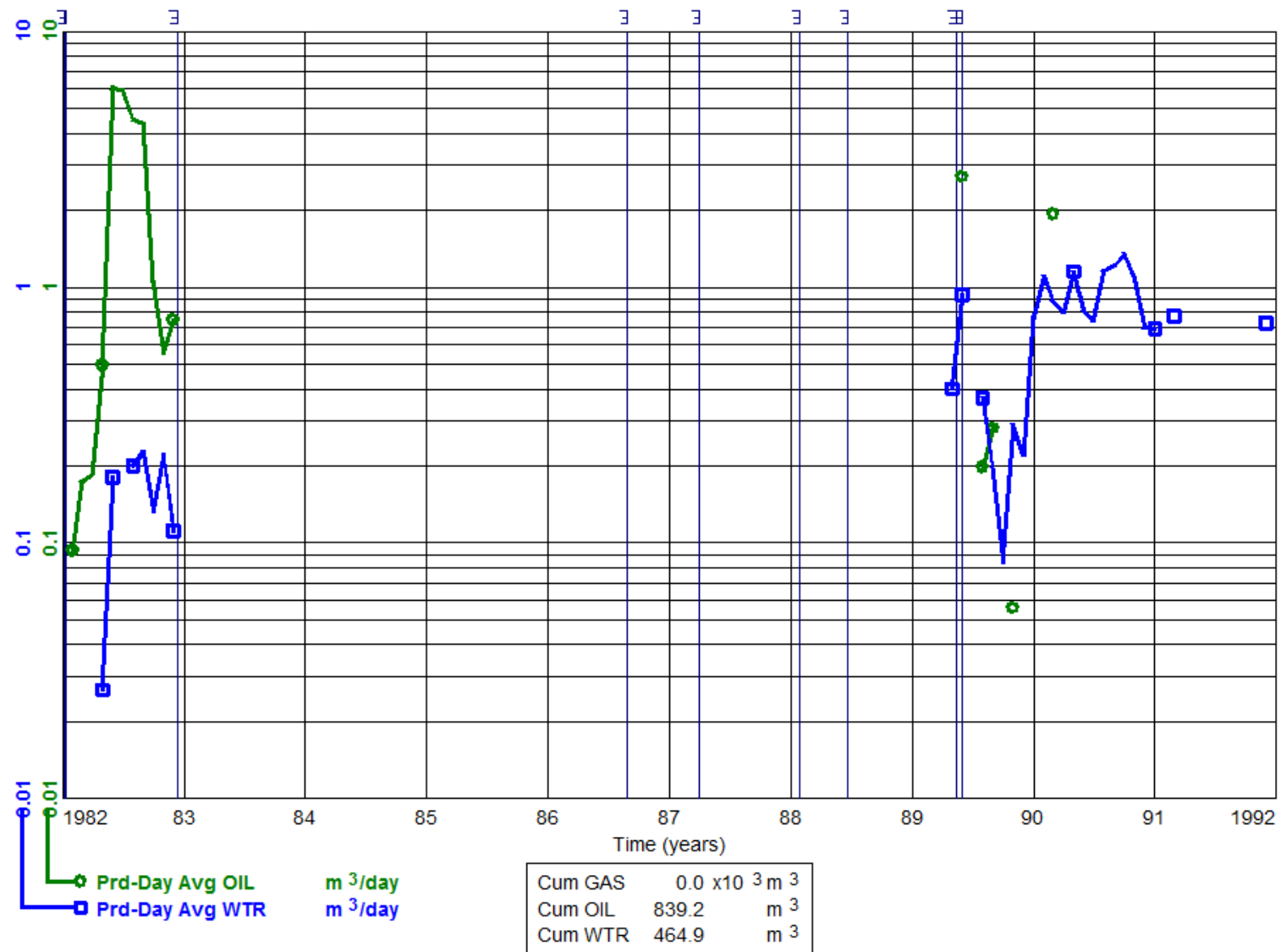
Waskada Unit No. 12 Prov. Field: WASKADA (03)

100/08-24-001-26W1/00 Pool: WASKADA MISSION CANYON 3A A (43A)



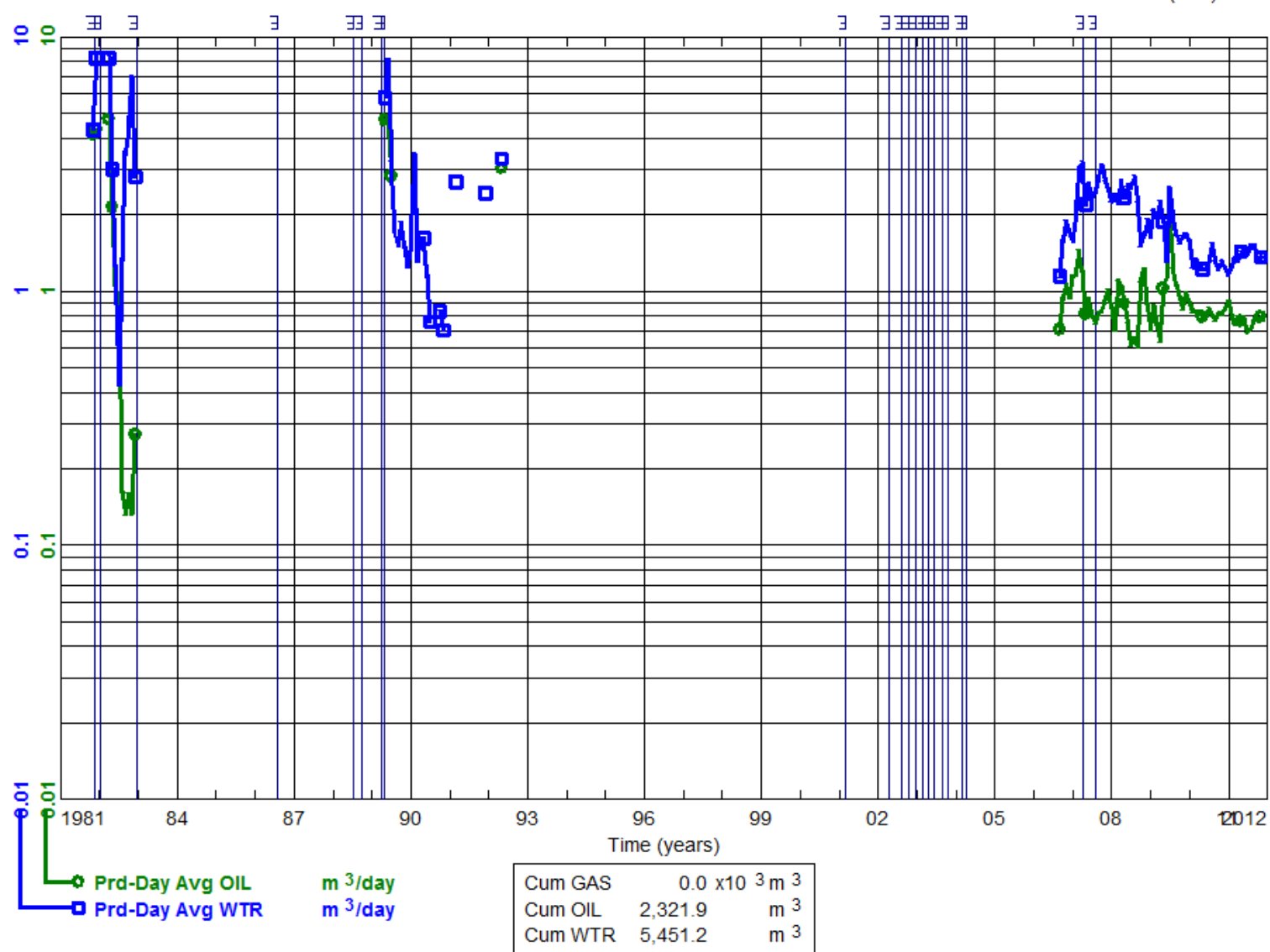
Data As Of: 2011-12 (MB)  
 From: 1982-02  
 To: 1991-12

INDIVIDUAL PRODUCTION Status: Abandoned Producer  
 Waskada LAm Unit No. 1 Field: WASKADA (03)  
 100/09-24-001-26W1/00 Pool: WASKADA MISSION CANYON 3A A (43A)



Data As Of: 2011-12 (MB)  
 From: 1981-11  
 To: 2011-11

INDIVIDUAL PRODUCTION Status: Comingled  
 Waskada Unit No. 12 COM Field: WASKADA (03)  
 100/12-24-001-26W1/00 Pool: WASKADA MISSION CANYON 3A A (43A)





Data As Of: 2011-12 (MB)

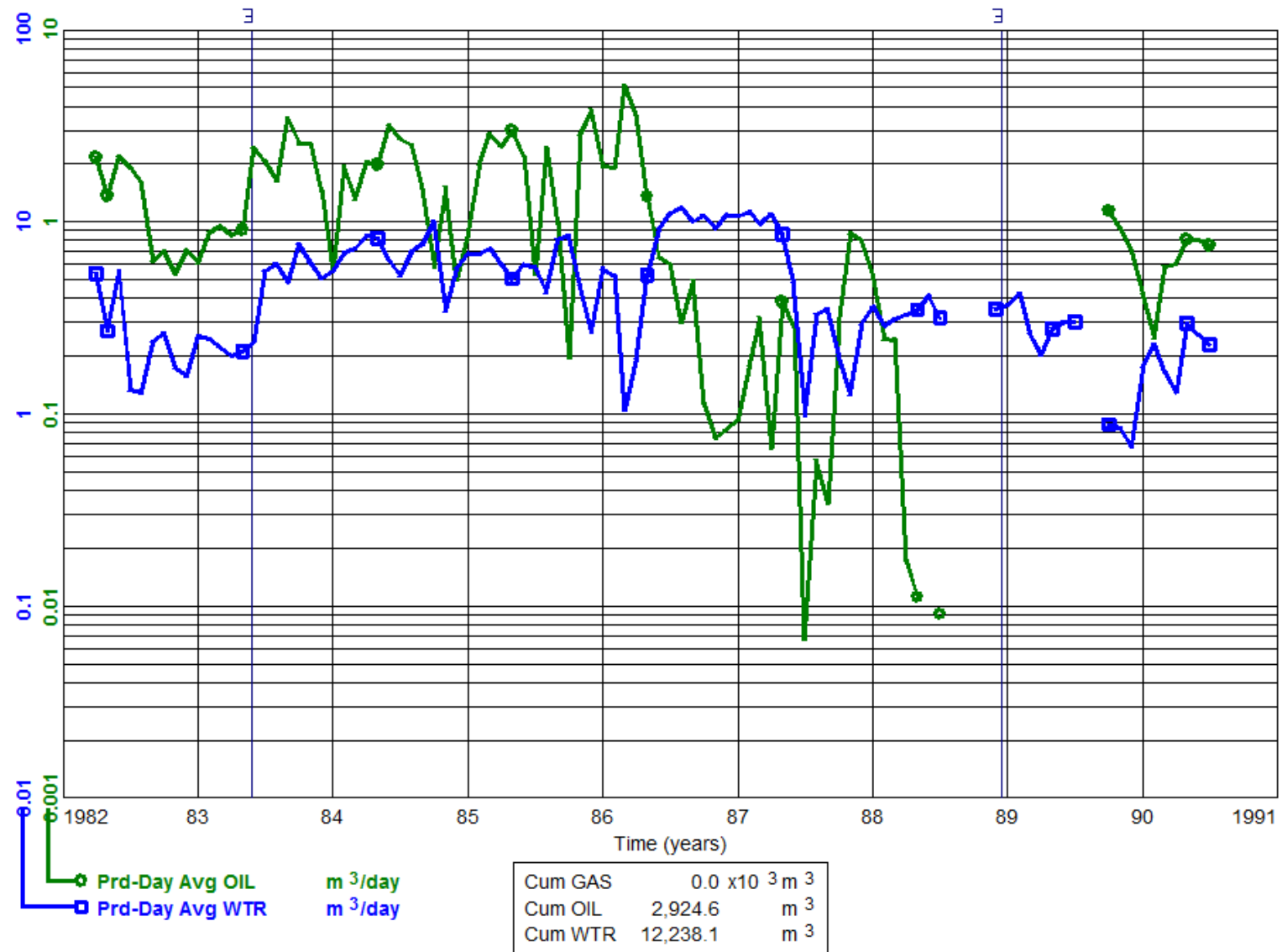
From: 1982-04

To: 1990-07

INDIVIDUAL PRODUCTION Status: Abandoned Producer

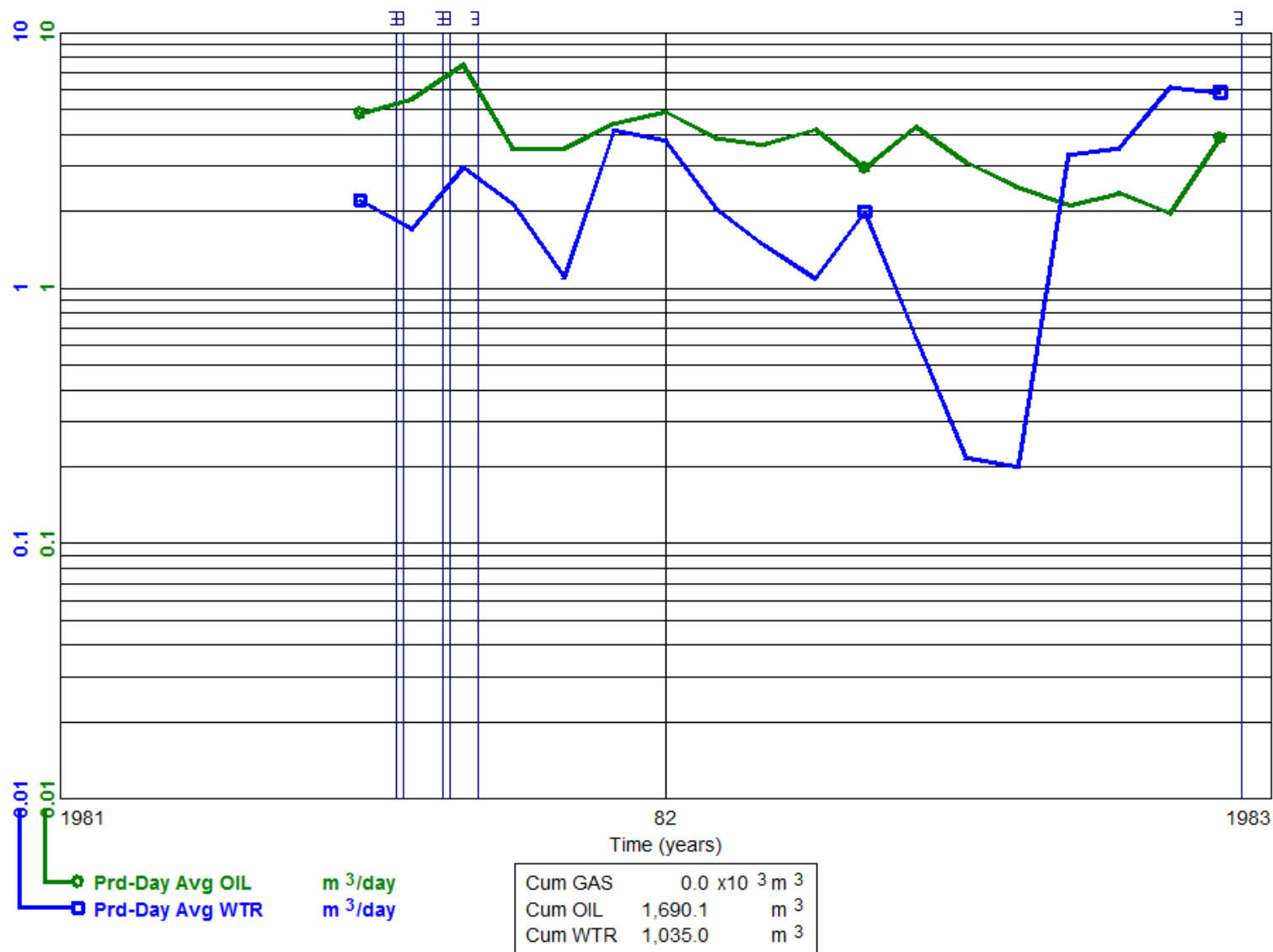
Waskada Unit No. 12 Field: WASKADA (03)

100/13-24-001-26W1/00 Pool: WASKADA MISSION CANYON 3A A (43A)



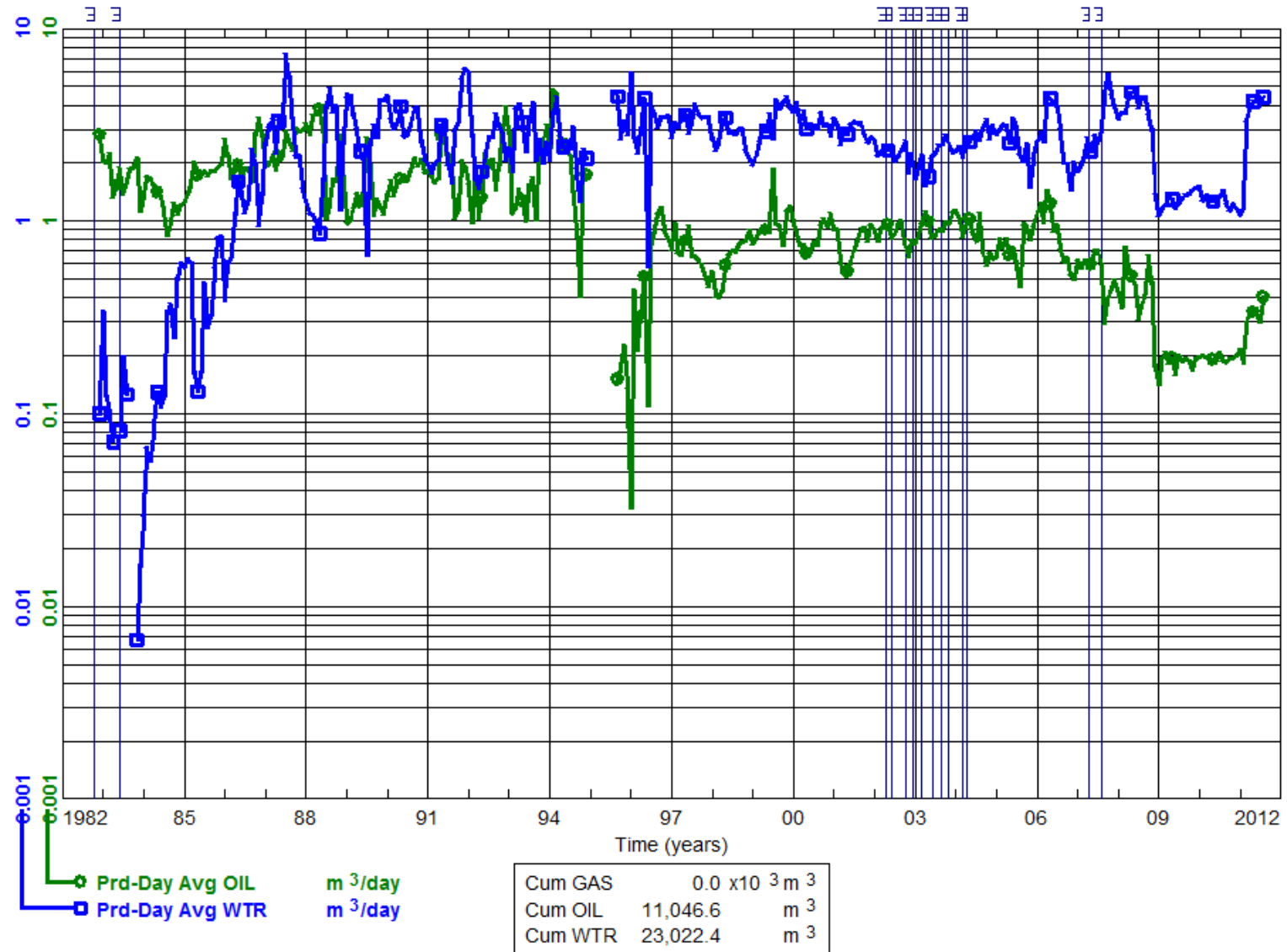
Data As Of: 2011-12 (MB)  
 From: 1981-07  
 To: 1982-12

INDIVIDUAL PRODUCTION Status: Abandoned Producer  
 Waskada LAm Unit No. 1 Field: WASKADA (03)  
 100/03-25-001-26W1/00 Pool: WASKADA MISSION CANYON 3A A (43A)



Data As Of: 2011-12 (MB)  
 From: 1982-12  
 To: 2011-08

INDIVIDUAL PRODUCTION Status: Capable Of Oil Prod  
 Waskada Unit No. 12 Field: WASKADA (03)  
 102/03-25-001-26W1/00 Pool: WASKADA MISSION CANYON 3A A (43A)



Data As Of: 2011-12 (MB)

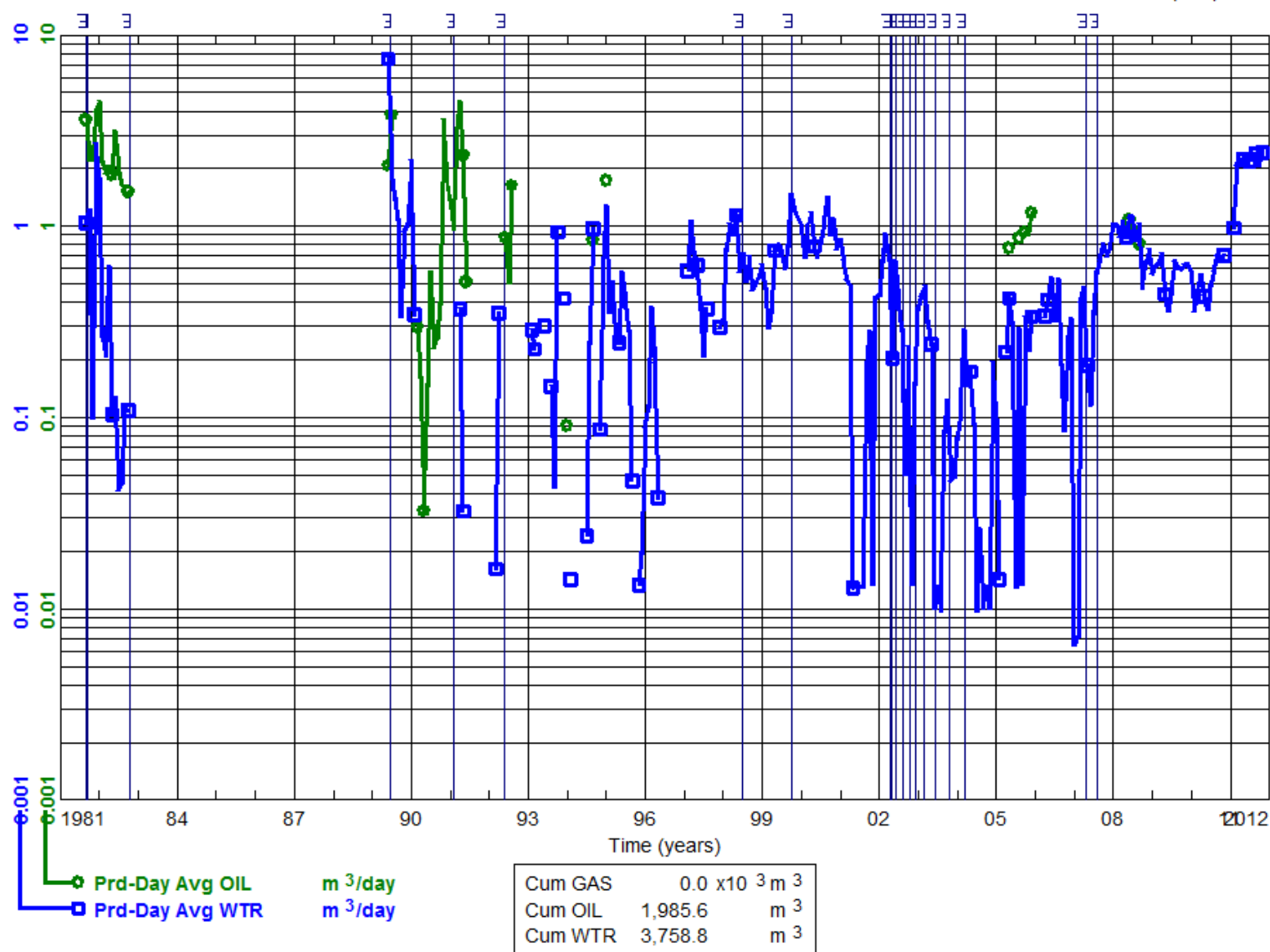
From: 1981-09

To: 2011-11

INDIVIDUAL PRODUCTION Status: Comingled

Waskada Unit No. 12 COM Field: WASKADA (03)

100/04-25-001-26W1/00 Pool: WASKADA MISSION CANYON 3A A (43A)



Data As Of: 2011-12 (MB)

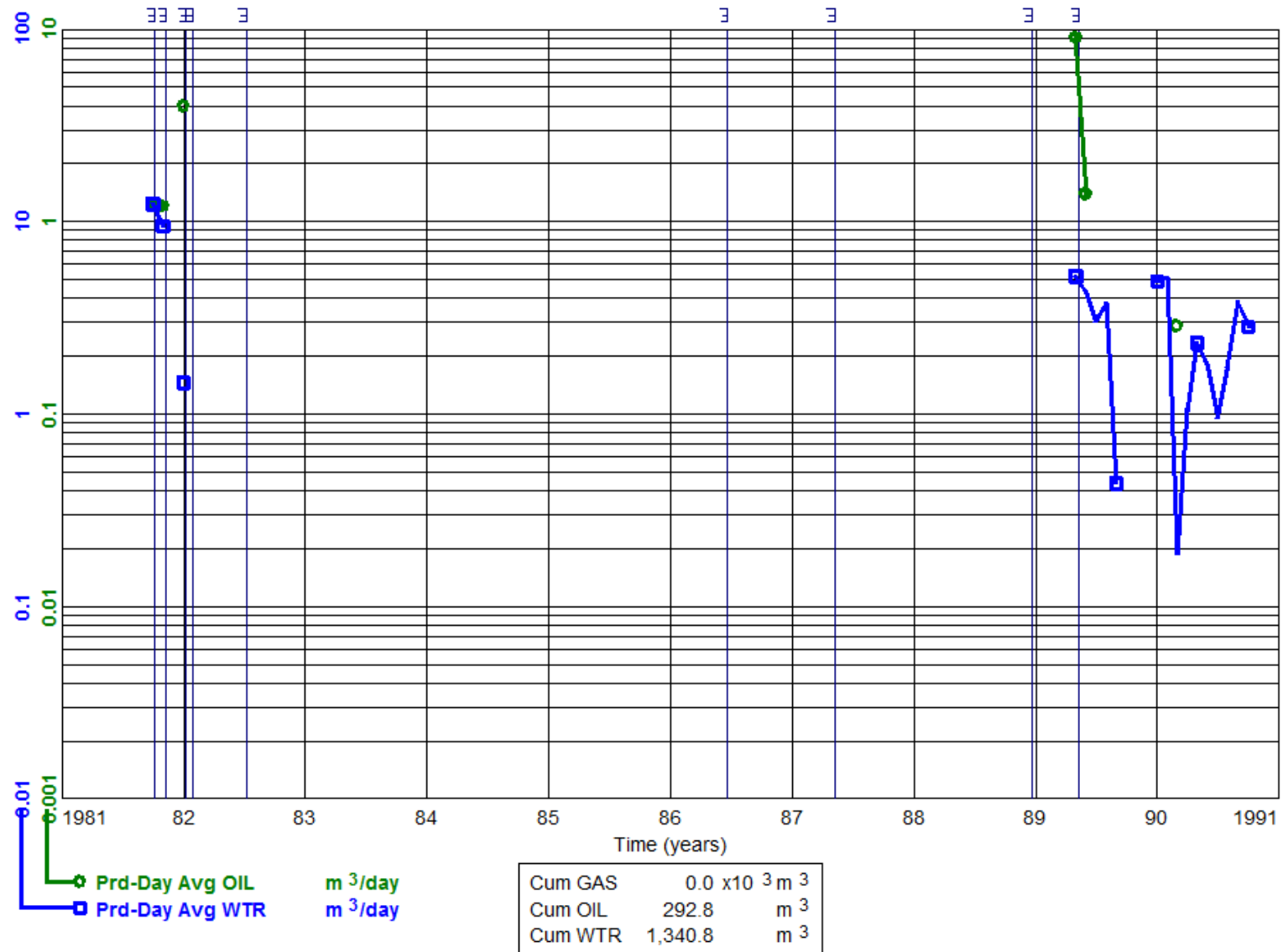
From: 1981-10

To: 1990-11

INDIVIDUAL PRODUCTION Status: Abandoned Producer

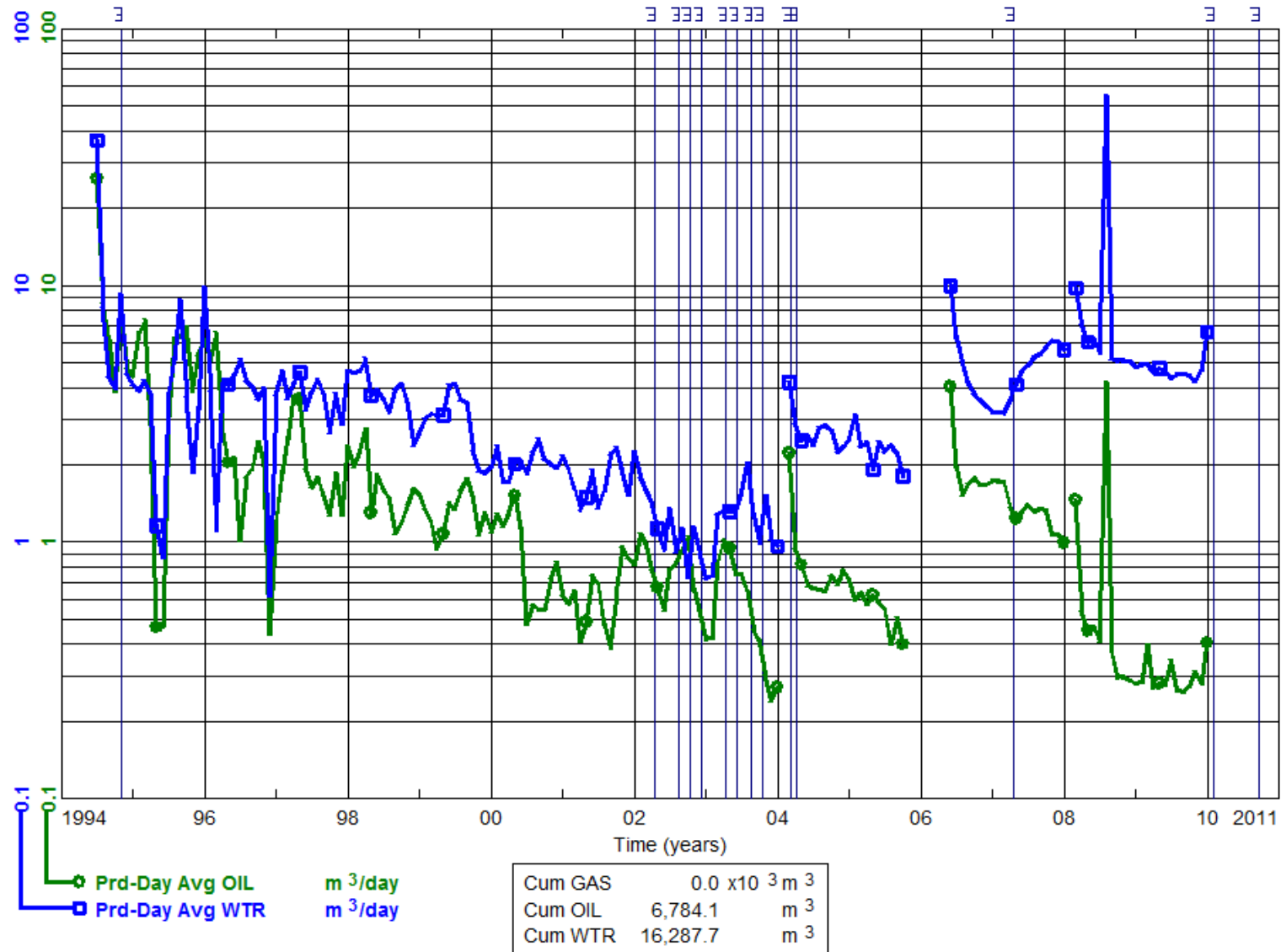
Waskada LAm Unit No. 1 Field: WASKADA (03)

100/01-26-001-26W1/00 Pool: WASKADA MISSION CANYON 3A A (43A)



Data As Of: 2011-12 (MB)  
 From: 1994-07  
 To: 2010-01

INDIVIDUAL PRODUCTION Status: Abandoned Producer  
 Waskada LAM Unit No. 1 HZN Field: WASKADA (03)  
 102/01-26-001-26W1/00 Pool: WASKADA MISSION CANYON 3A A (43A)



Data As Of: 2011-12 (MB)  
 From: 1989-07  
 To: 1991-09

INDIVIDUAL PRODUCTION Status: Comingled  
 Waskada LAm Unit No. 1 COM Field: WASKADA (03)  
 100/02-26-001-26W1/02 Pool: WASKADA MISSION CANYON 3A A (43A)

