Production Plot & Decline Curve Analysis Java Applet

**by John R. Victorine**

Introduction

The Production Plot & Decline Curve Analysis web app has 2 sources for importing well data, 1) the user's PC or 2) the Kansas Geological Survey (KGS) ORACLE Database.

This is the production plot & decline curve analysis web application, which allows the user to access production data from the Kansas Geological Survey (KGS) Database for Leases, Fields, Operators and Counties. The web application was designed to read production from the user's PC as an ASCII Extensible Markup Language (XML) file or as a comma-separated values (CSV) file. A "spread sheet" like table was provided to display the data retrieved, but editable to allow the user to add data to the existing list, i.e., download production data from the KGS Database and insert missing months or previous years that may not be recorded.

The Program allows the user to save the raw production data as an ASCII Extensible Markup Language (XML) file or as a comma-separated values (CSV) file. The Program allows the user to save the Production Plot Java Image to their PC as a Portable Network Graphics (PNG) Image, the Program will then display a web page with the image file with a link at the top of the page that will allow the user to launch the PDF Web Applet to convert the PNG Image File to a Portable Document Format (PDF) File.

A decline curve analysis dialog was included to allow the user to predict the economic limit for a specific lease, field, operator and county. This analysis uses three methods for predicting the decline of a reservoir, exponential, harmonic and hyperbolic[1].

To access Profile go to **http://www.kgs.ku.edu/software/production/**. At the top of the web page there is a menu "Main Page|Description|Applet|Help|Copyright & Disclaimer|". Select the "Applet" menu option a "Warning - Security" Dialog will appear. The program has to be able to read and write to the user's PC and access the Kansas Geological Survey (KGS) Database and File Server, ORACLE requires this dialog.

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[1] SPE 83470: A Decline Curve Analysis Model Based on Fluid Flow Mechanisms by Kewen Li, SPE, and Roland N. Horne, SPE, Stanford University **http://pangea.stanford.edu/~kewenli/spe83470.pdf**

The program does not save your files to KGS, but allows you to access the KGS for well information that may be missing in your Kansas logs. The program does not use Cookies or any hidden software it only reads the XML (Extensible Markup Language) and CSV (Comma Separated Values) files for the Production Plot Session and writes a XML (Extensible Markup Language) or CSV (Comma Separated Values) File to your PC to save your Production Data imported into the web app. The blue shield on the warning dialog is a symbol that the Java web app is created by a trusted source, which is the University of Kansas. Select the "Run" Button, which will show the Production Plot "Enter" Panel illustrated below,
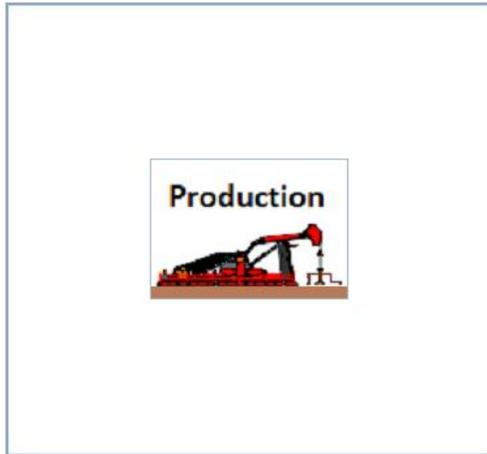
Enter

Table of Contents

Loading Well Data

Click the "Production Plot Enter" Icon Button, which will show the "Load Data" Dialog. The dialog below displays an example of the Arroyo Field production data loaded from the "Load KGS Data" icon button. The radio buttons & icon buttons in the Data Source Panel assists the user in loading well data into the Production Plot & Decline Curve Analysis Applet.

KGS: Search KGS Production Data
Search the Kansas Geological Survey Database (KGS) production data by Lease, Field Operator or County.

PC: Read Production ASCII Data
This panel allows the user to read in production data by 2 file types,
1. Comma Separated Values (CSV) ASCII File
2. Extensible Markup Language (XML) ASCII File, which must be by a specific format defined by (DTD) Document Type Definition.

Production Data Table (Editable)
This panel holds the records that will be plotted.
• Header Information for production data, identifies the type, name and if the information comes from the KGS Database the Unique KEY and DOR Number if available.

Production Data Table (Editable) Buttons:
• **Add Row** – The user can add production record by clicking on the "Add Row" button, which will add a row to the Editable Production Data Table.
• **Remove Row** – The user can remove production record from the table
• **Sort Data** – The user can order the production history by date.

Load Data Dialog Buttons
• **Plot Data** – Transfers the contents of the Production Data Table to the Production Plot Control Dialog.
• **Clear** – clears the Production Data Loaded into this dialog.
• **Exit** – Exit Dialog

Data Source Panel

The Data Source Panel provides two methods of importing data into the Production Data & Decline Curve Analysis Web App. The Kansas Geological Survey (KGS) Database and the user's PC. The "Load KGS Data" icon button assists the user in locating a set of production data by Lease, Field, County and Operator in Kansas. The data shows the current status of the production history at the time the user accesses the data. The "Load PC Data" icon button along with the 2 radio buttons assists the user to load Brine data by 2 possible ASCII File methods,

1. Comma Separated Values (CSV).
2. Extensible Markup Language (XML) Files.

The CSV (Comma Separated Values) radio button under the "PC: Read Production ASCII Data Text File" panel are expecting a general type of data presentation. Although the order of the specific data columns is not important, the "Mnemonics" of the data column is. The CSV Search Dialog will use the first two lines of the CSV file to automatically match the file column data mnemonics with the web app curve mnemonics, but if the program does not recognize the file data mnemonic then it will leave it blank and expect the user to match the file data mnemonic to the web app curve mnemonics, this will be explained later.

The Extensible Markup Language (XML) radio button under the "PC: Read Production ASCII Data Text File" panel are expecting a specific Document Type Definition (DTD) to read the file. The DTD is used in retrieve both the data coming from the Kansas Geological Survey Database or as the output from the Production Plot & Decline Curve Analysis Java Web App. The DTD will be presented later.

KGS (Database) - Importing Production Data - By Lease

The Kansas Geological Survey (KGS) has a good collection of production data stored in the ORACLE Database. In this example the user will download the well data available from the KGS Lease Production Database Table. The ORACLE Database is accessed by making Stored Procedure PL/SQL calls to the ORACLE Database from which an Extensible Markup Language (XML) data stream is created containing the lease production data that is passed back to the web app making the request.

Select the "By Lease" radio button and left click on the "Load KGS Data" Icon Button in the Data Source Panel of the Load Data Dialog to display the "Search for Data on KGS Server" dialog.

Search for Data in KGS
• **Name (Partial Phrase)** – The user can search for production data by lease partial phrase, i.e. "Kendrick", which will look for all leases with the phrase "Kendrick" in the lease name.
• **Section-Township-Range** – Search for a list of leases by a specific area.

List of Leases with Production History Data, note that each lease can have multiple wells assigned.

Dialog Buttons:
Select – Transfers the Production History back to the main dialog.
Close – Exit Dialog

This dialog allows the user to search the KGS database for lease production data. In this example, the lease of interest will be the Kendrick 23-1 this lease contains all the lease production history records that can be retrieved from the KGS Database.

As the Summary image suggests there are 2 methods for searching for the lease production data within this dialog,

- Name (Partial Phrase) – The stored procedure used to retrieve the list of lease production data from the KGS Database allows the user to enter a partial phrase, in this example Kendrick. The program places a '%' in front and back of the phrase and sends the request to the Database, i.e. "%Kendrick%".

- By Township Range Section – This search is for brine samples in Kansas by, e.g. to look for the Kendrick 23-1 lease production history, enter Township as 29 set the S (South) Radio button and Range as 41 set the W (West) Radio button. This example left off the section, but you can include it to narrow the search.

The user only needs to enter the above data and select the "Search" Button to display the list of leases in the Kansas Database that match the search criteria. In the image below the Lease Name "Kendrick" was entered to search for all leases in Kansas with the Phrase Kendrick in it. The user searches through the list until they find the lease of interest.

To import the lease production history data click the "Select" button, which will transfer the data back to the "Load Data" Dialog.
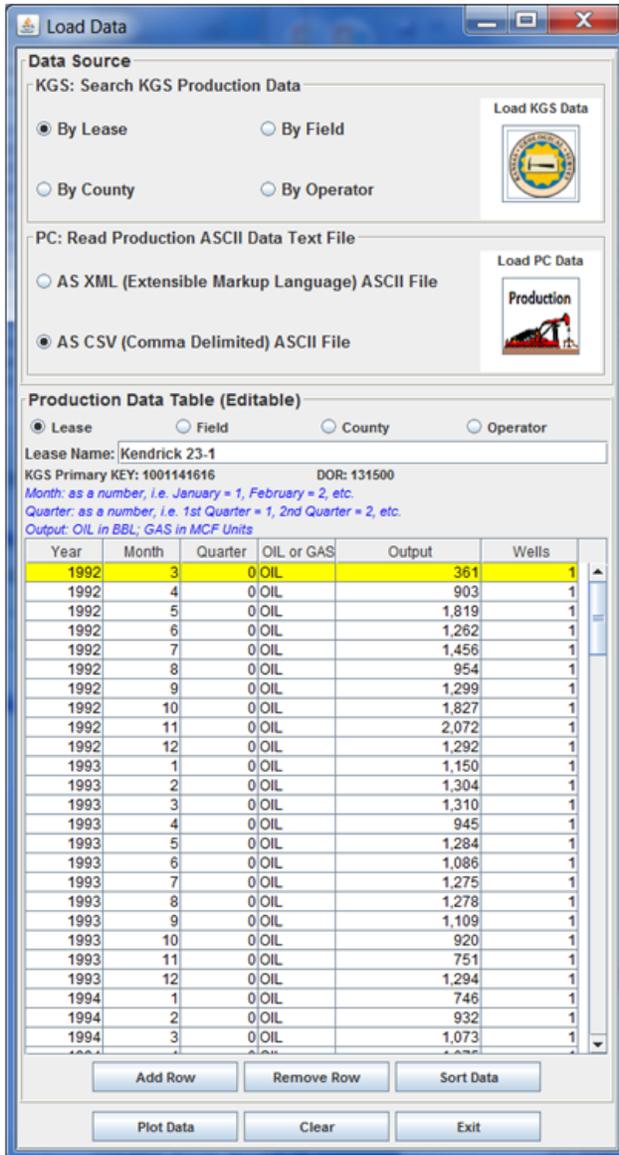
Production Data Table (Editable)
• Header Information for production data, sets the "Lease" radio button to identify the search, the Lease Name, i.e. Kendrick 23-1 and the KGS Primary Key 1001141616 and the DOR 131500.
• List of Raw Oil Production Records

Click on the "Plot Data" to display the Production Plot and Control Dialogs.

KGS (Database) - Importing Production Data - By Field

The Kansas Geological Survey (KGS) has a good collection of production data stored in the ORACLE Database. In this example the user will download the well data available from the KGS Field Production Database Table. The ORACLE Database is accessed by making Stored Procedure PL/SQL calls to the ORACLE Database from which an Extensible Markup Language (XML) data stream is created containing the field production data that is passed back to the web app making the request.

Select the "By Field" radio button and left click on the "Load KGS Data" Icon Button in the Data Source Panel of the Load Data Dialog to display the "Search for Data on KGS Server" dialog.

Search for Data in KGS
• **Name (Partial Phrase)** – The user can search for production data by field partial phrase, i.e. "Arroyo", which will look for all fields with the phrase "Arroyo" in the field name.

List of Fields with Production History Data.

Dialog Buttons:
Select – Transfers the Production History back to the main dialog.
Close – Exit Dialog

As the Summary image suggests there is only 1 method for searching for the field production data within this dialog,

- Name (Partial Phrase) – The stored procedure used to retrieve the list of field production data from the KGS Database allows the user to enter a partial phrase, in this example Arroyo. The program places a '%' in front and back of the phrase and sends the request to the Database, i.e. "%Arroyo%".

The user only needs to enter the above data and select the "Search" Button to display the list of fields in the Kansas Database that match the search criteria. In the image below the Field Name "Arroyo" was entered to search for all leases in Kansas with the Phrase Arroyo in it. The user searches through the list until they find the field of interest.

To import the field production history data click the "Select" button, which will transfer the data back to the "Load Data" Dialog.
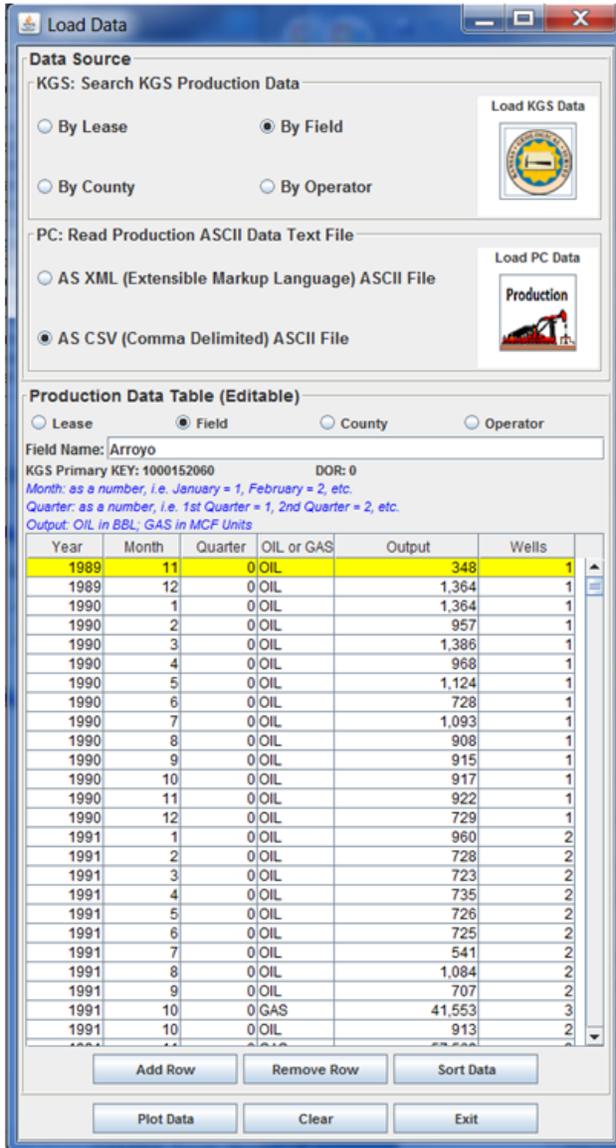
Production Data Table (Editable)

- Header Information for production data, sets the "Field" radio button to identify the search, the Field Name, i.e. Arroyo and the KGS Primary Key 1000152060.
- List of Raw Oil & Gas Production Records

Click on the "Plot Data" to display the Production Plot and Control Dialogs.

KGS (Database) - Importing Production Data - By Operator

The Kansas Geological Survey (KGS) has a good collection of production data stored in the ORACLE Database. In this example the user will download the well data available from the KGS Operator Production Database Table. The ORACLE Database is accessed by making Stored Procedure PL/SQL calls to the ORACLE Database from which an Extensible Markup Language (XML) data stream is created containing the operator production data that is passed back to the web app making the request.

Select the "By Operator" radio button and left click on the "Load KGS Data" Icon Button in the Data Source Panel of the Load Data Dialog to display the "Search for Data on KGS Server" dialog.

Search for Data in KGS
• **Name (Partial Phrase)** – The user can search for production data by operator partial phrase, i.e. "Kerr-McGee", which will look for all fields with the phrase "Kerr-McGee" in the operator name.

List of Operators with Production History Data.

Dialog Buttons:
Select – Transfers the Production History back to the main dialog.
Close – Exit Dialog

As the Summary image suggests there is only 1 method for searching for the operator production data within this dialog,

- Name (Partial Phrase) – The stored procedure used to retrieve the list of operator production data from the KGS Database allows the user to enter a partial phrase, in this example Kerr-McGee. The program places a '%' in front and back of the phrase and sends the request to the Database, i.e. "%Kerr-McGee%".

The user only needs to enter the above data and select the "Search" Button to display the list of fields in the Kansas Database that match the search criteria. In the image below the Field Name "Arroyo" was entered to search for all leases in Kansas with the Phrase Arroyo in it. The user searches through the list until they find the field of interest.

To import the operator production history data click the "Select" button, which will transfer the data back to the "Load Data" Dialog.
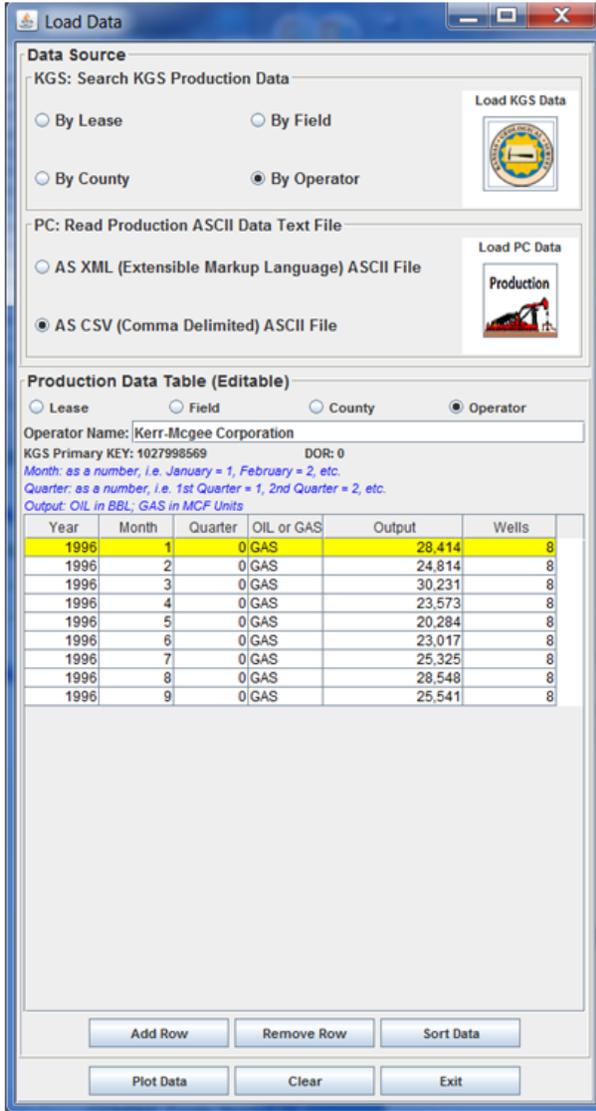
Production Data Table (Editable)
• Header Information for production data, sets the "Operator" radio button to identify the search, the Operator Name, i.e. Kerr-Mcgee Corporation and the KGS Primary Key 1027998569.
• List of Raw Oil & Gas Production Records

Click on the "Plot Data" to display the Production Plot and Control Dialogs.

KGS (Database) - Importing Production Data - By County

The Kansas Geological Survey (KGS) has a good collection of production data stored in the ORACLE Database. In this example the user will download the well data available from the KGS County Production Database Table. The ORACLE Database is accessed by making Stored Procedure PL/SQL calls to the ORACLE Database from which an Extensible Markup Language (XML) data stream is created containing the lease & production data that is passed back to the web app making the request.

Select the "By County" radio button and left click on the "Load KGS Data" Icon Button in the Data Source Panel of the Load Data Dialog to display the "Search for Counties on KGS Server" dialog.

In this example Stanton County is selected. To import the Stanton county production history data click the "Select" button, which will transfer the data back to the "Load Data" Dialog.
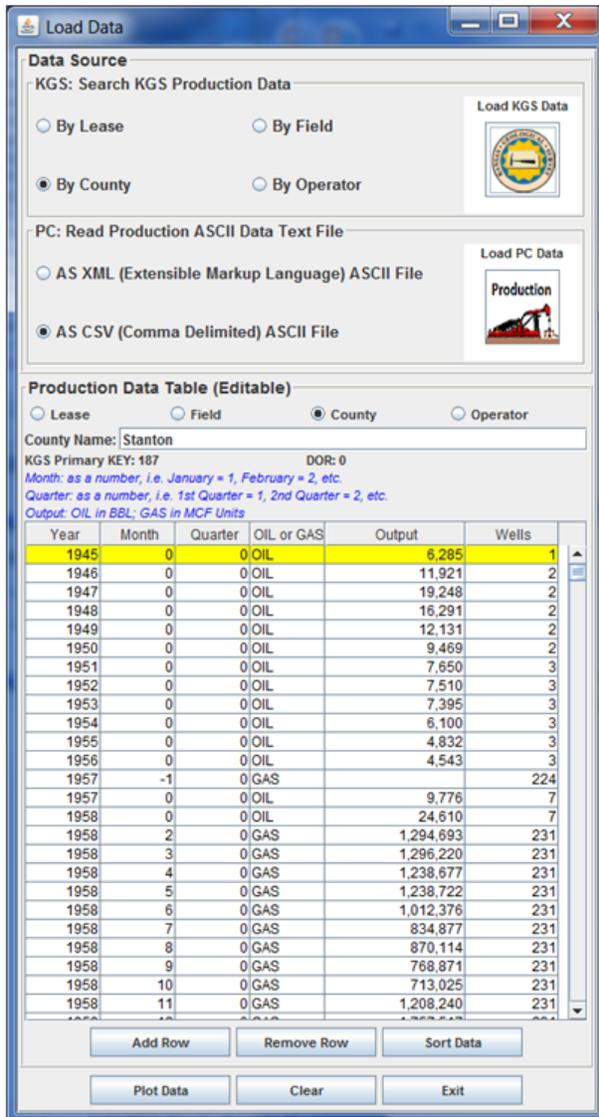
Production Data Table (Editable)
• Header Information for production data, sets the "County" radio button to identify the search, the County Name, i.e. Stanton and the KGS Primary Key 187.
• List of Raw Oil & Gas Production Records

Click on the "Plot Data" to display the Production Plot and Control Dialogs.

Importing PC Data - Download Production Data to PC

Download either the ASCII Text Files directly or the Zip files extracting the contents into a directory. The problem with the ASCII Text Files being downloaded directly from a web page is that the web page will alter the contents so it does not retain the basic structure and add HTML text to the file. The preferred method if you have Zip or WinZip is to download the zip files to your PC and extract.

Arroyo Field Production Data Stanton County, Kansas

Type	ASCII Text Files
CSV	http://www.kgs.ku.edu/Gemini/Tools/documentation/production-Arroyo-Field.csv
XML	http://www.kgs.ku.edu/Gemini/Tools/documentation/production-Arroyo-Field-XML.xml

Type	Zip Files
CSV	http://www.kgs.ku.edu/Gemini/Tools/documentation/production-Arroyo-Field.zip
XML	http://www.kgs.ku.edu/Gemini/Tools/documentation/production-Arroyo-Field-XML.zip

Importing PC Data – Field Production XML (Extensible Markup Language) ASCII File.

This web app allows the user to save and read Production Data as Extensible Markup Language (XML) file. The data that is retrieved from the Kansas Geological Survey database is retrieved as a XML data stream that is parsed and loaded into the Production Plot & Decline Curve Analysis web app. This program allows the user to save the data as a XML file, which uses the same Document Type Definition (DTD) to format the data.
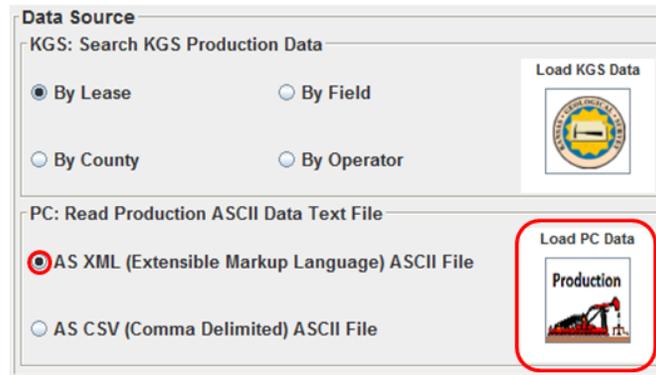
Select the "XML (Extensible Markup Language) ASCII File" radio button and then left click on the "Load PC Data" Icon Button in the Data Source Panel of the Load Data Dialog. This will display the "Select XML File from your PC" Dialog. This dialog allows the user to search their PC for the file of interest. In this example it is the Arroyo Field Production XML file production-Arroyo-Field-XML.xml, highlighted below.
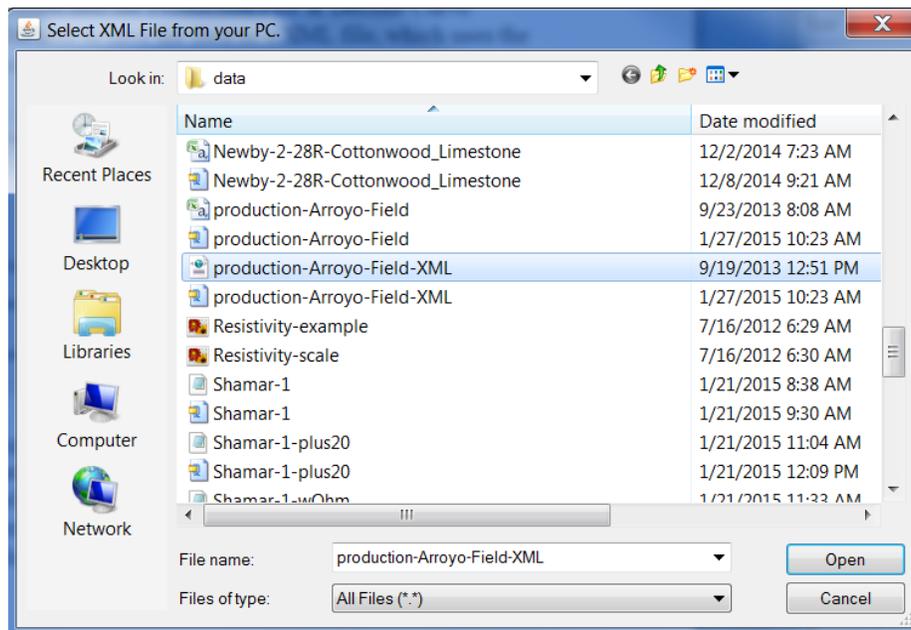
Select the "Open" button to load the contents of the XML File into the "Load Data" dialog.

Production Data Extensible Markup Language (XML) Document Type Definition (DTD).

The Production Data DTD defines the contents of the Extensible Markup Language (XML) File. The Document Type Definition (DTD) for the Production Data is as follows,

```
<?xml version="1.0"?>
<!DOCTYPE production [
<!ELEMENT production (data*)>
<!ATTLIST production records CDATA #REQUIRED
          key     CDATA #REQUIRED
              id      CDATA #IMPLIED
              type    CDATA #REQUIRED
              name  CDATA #REQUIRED
              app     CDATA #IMPLIED
              v1      CDATA #IMPLIED
              v2      CDATA #IMPLIED
              v3      CDATA #IMPLIED>
<!ELEMENT data  EMPTY>
<!ATTLIST data  year CDATA #REQUIRED
                month   CDATA #IMPLIED
                quarter CDATA #IMPLIED
                product CDATA #REQUIRED
                unit      CDATA #IMPLIED
                output   CDATA #REQUIRED
                sources  CDATA #IMPLIED>]>
```

where **production** contents are,

records – The number of data records in file

key   – Primary key for the production data, present if the data was retrieved from the KGS Database otherwise key="0".

id   – KS Department of Revenue Lease Code (DOR) Code

type   – Type of search (Lease, Field, County, Operator)

Name – Name of data, e.g., Arroyo (Field Name)

app   – URL used to retrieve the data only for KGS Data

v1   – Search Criteria, e.g., Field=arroyo

v2, v3 not used

where **data** contents are,

year   – Date - Year of production (format YYYY)

month   – Date - Month of production, e.g., 1,2,3, … 11 or 12

quarter – Date – Quarter or production, e.g., 1,2,3, or 4

product – OIL or GAS (The web app assumes upper case)

unit   – Data of production data, BBL for Oil or MCF for GAS

output   – Production Value

sources – Number of Wells contributing to data
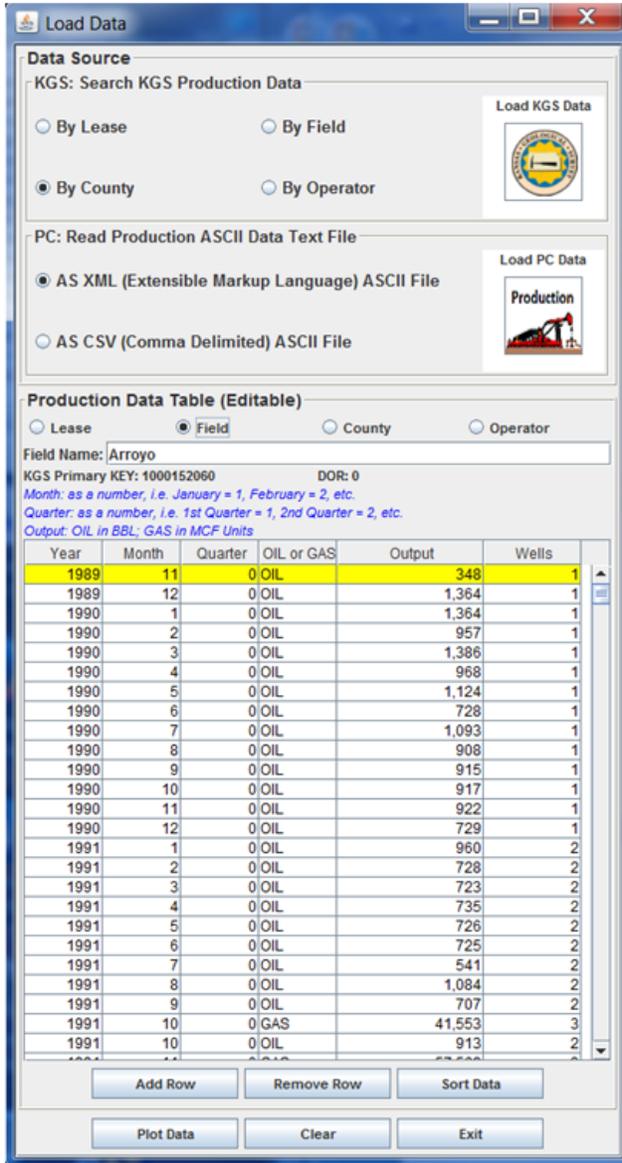
Production Data Table (Editable)

• Header Information for production data, sets the "Field" radio button to identify the search, the Field Name, i.e. Arroyo and the KGS Primary Key 1000152060.

• List of Raw Oil & Gas Production Records

Click on the "Plot Data" to display the Production Plot and Control Dialogs.

Importing PC Data – Field Production CSV (Comma Separated Values) ASCII File.

This web app allows the user to save and read Production Data as Comma Separated Values (CSV) file. The data that is retrieved from the Kansas Geological Survey database is retrieved as a XML data stream that is parsed and loaded into the Production Plot & Decline Curve Analysis web app. This program allows the user to save the data as a CSV file.
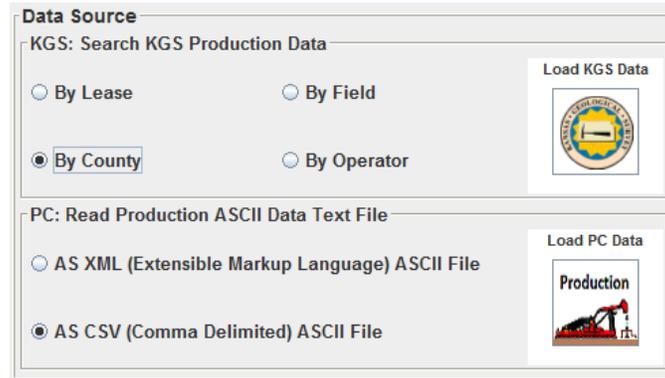
Select the "CSV (Comma Delimited) ASCII File" radio button and then left click on the "Load PC Data" Icon Button in the Data Source Panel of the Load Data Dialog. This will display the "Select CSV File from your PC" Dialog. This dialog allows the user to search their PC for the file of interest. In this example it is the Production Field CSV file production-Arroyo-Field.csv, highlighted below. Select the Open button to display the "Map File Column Number to Production Column" Dialog.
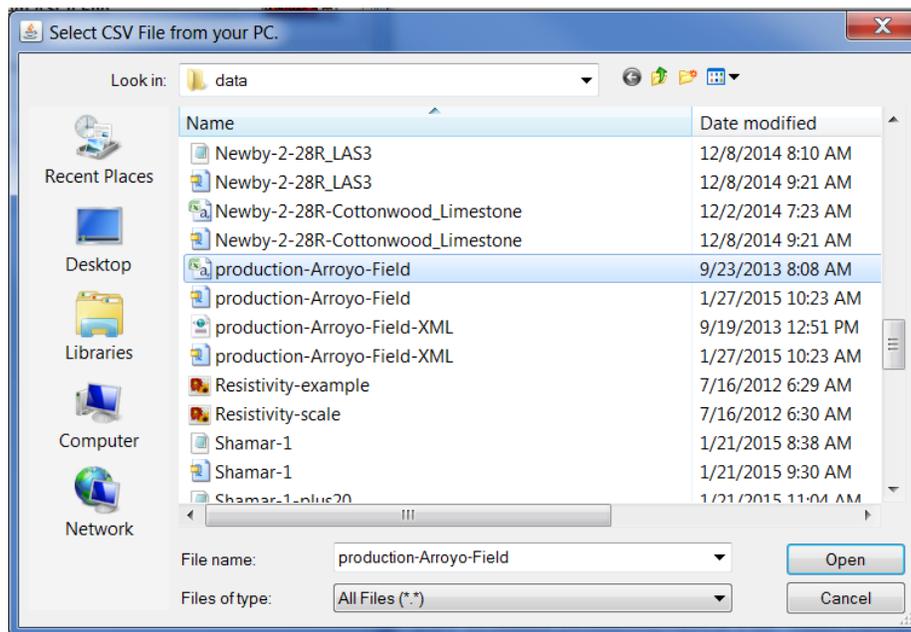
Select the "Open" button to load the contents of the XML File into the "Load Data" dialog. Click on the "Plot Data" to display the Production Plot and Control Dialogs.

```
production.csv – Comma Delimited  ASCII File
KEY=1000152060  FIELD=Arroyo  app=http://chasm.kgs.ku.edu/pls/abyss/iqstrat.production_pkg.getXML?sField=1000152060
Year, Month, Product, Output, sources
1989, 11, OIL, 348.0, 1
1989, 12, OIL, 1364.0, 1
1990, 1, OIL, 1364.0, 1
1990, 2, OIL, 957.0, 1
1990, 3, OIL, 1386.0, 1
1990, 4, OIL, 968.0, 1
1990, 5, OIL, 1124.0, 1
1990, 6, OIL, 728.0, 1
1990, 7, OIL, 1093.0, 1
1990, 8, OIL, 908.0, 1
1990, 9, OIL, 915.0, 1
1990, 10, OIL, 917.0, 1
1990, 11, OIL, 922.0, 1
1990, 12, OIL, 729.0, 1
1991, 1, OIL, 960.0, 2
1991, 2, OIL, 728.0, 2
1991, 3, OIL, 723.0, 2
1991, 4, OIL, 735.0, 2
1991, 5, OIL, 726.0, 2
1991, 6, OIL, 725.0, 2
1991, 7, OIL, 541.0, 2
1991, 8, OIL, 1084.0, 2
1991, 9, OIL, 707.0, 2
1991, 10, GAS, 41553.0, 3
1991, 10, OIL, 913.0, 2
1991, 11, GAS, 57569.0, 3
1991, 11, OIL, 739.0, 2
1991, 12, GAS, 144027.0, 3
1991, 12, OIL, 909.0, 2
1992, 1, GAS, 146182.0, 12
1992, 1, OIL, 865.0, 12
1992, 2, GAS, 140563.0, 12
1992, 2, OIL, 887.0, 12
1992, 3, GAS, 154415.0, 12
1992, 3, OIL, 1235.0, 12
1992, 4, GAS, 149544.0, 12
1992, 4, OIL, 2146.0, 12
...
```
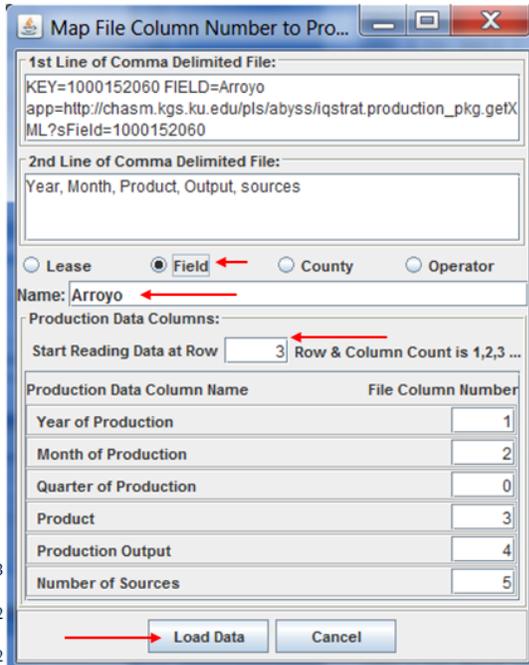
The "Map File Column Number to Production Column" Dialog was created to read a Comma Delimited ASCII File containing raw production data. The first two lines of the Comma Delimited File should contain the following
• 1st Line – The production data information
• 2nd Line – Column Labels
The user only needs to map any missing the File Columns to the Program Data Columns. Also set the Type Radio button to the type of production data, i.e., Lease, Field, County or Operator. Enter the Name of the production data in the "Name:" text field. Also set the starting line number to begin reading the data, i.e. this example is line 3 the default.

Step 2: Map the Comma Delimited File columns to the Production Data Columns, i.e., this example

Columns

No.	File	Production Data
1	Year	Year of Production
2	Month	Month of Production
4	Product	Product
5	Output	Product Output
6	sources	Number of Sources.

Select the "Load Data" Button.

Production Data Comma-Separated Values (CSV) File Format

The Production CSV Header is very simple in that it only requires two lines of the data file. The first two lines of the Comma Delimited File should contain the following

- 1st Line – The production data information
    - Type of production data (lease, field, operator, county),
    - Name of the data, e.g., Arroyo
- 2nd Line – Column Labels, i.e., Year, Month, Quarter, Product, Output, sources
    - year   – Date - Year of production (format YYYY)
    - month   – Date - Month of production, e.g., 1,2,3, … 11 or 12
    - quarter – Date – Quarter or production, e.g., 1,2,3, or 4
    - product – OIL or GAS (The web app assumes upper case)
    - unit   – Data of production data, BBL for Oil or MCF for GAS
    - output   – Production Value
    - sources – Number of Wells contributing to data
    -

Arroyo.csv – Example File Snippet - Created by the Production Applet

KEY=1000152060 FIELD=Arroyo
app=http://chasm.kgs.ku.edu/pls/abyss/iqstrat.production_pkg.getXML?sField=1000152060
Year, Month, Product, Output, sources
1989, 11, OIL, 348.0, 1
1989, 12, OIL, 1364.0, 1
1990, 1, OIL, 1364.0, 1
1990, 2, OIL, 957.0, 1
1990, 3, OIL, 1386.0, 1
1990, 4, OIL, 968.0, 1
1990, 5, OIL, 1124.0, 1
1990, 6, OIL, 728.0, 1
1990, 7, OIL, 1093.0, 1
        …
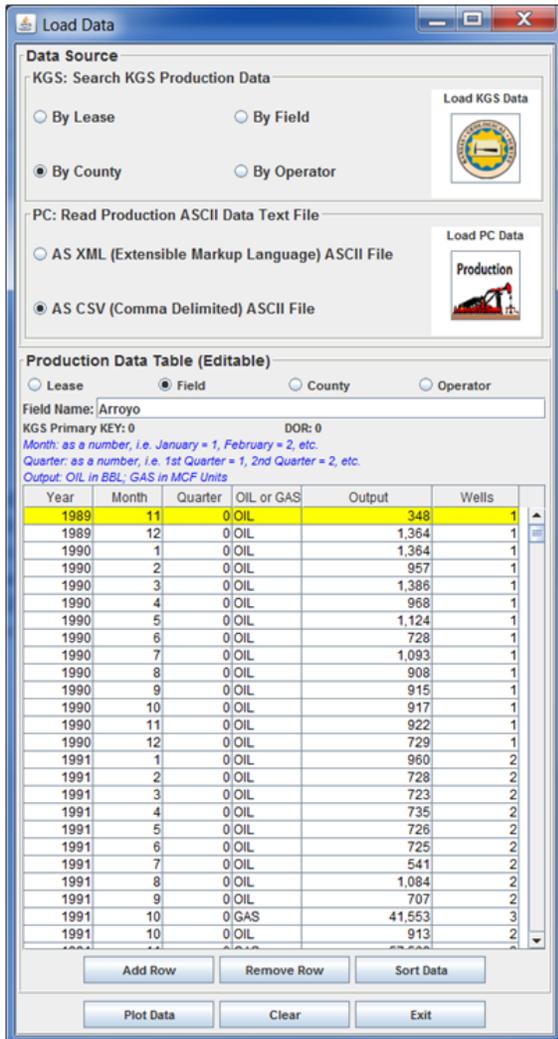
Production Data Table (Editable)

• Header Information for production data, the "Field" radio button had to be selected since the CSV File was not parsed for that information. The Field Name, i.e. Arroyo had to be added since the CSV File was not parse for that information.

• List of Raw Oil & Gas Production Records

Click on the "Plot Data" to display the Production Plot and Control Dialogs.

Production Plot Dialog Control & Modify Limits Dialog
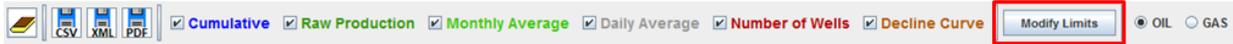
Click on the "Modify Limits" button to display the "Limits" dialog.

Limits Dialog

Change the plot titles

Change the plot x-y axis minimum, maximum and increment.

Changing the X-Axis Minimum Value
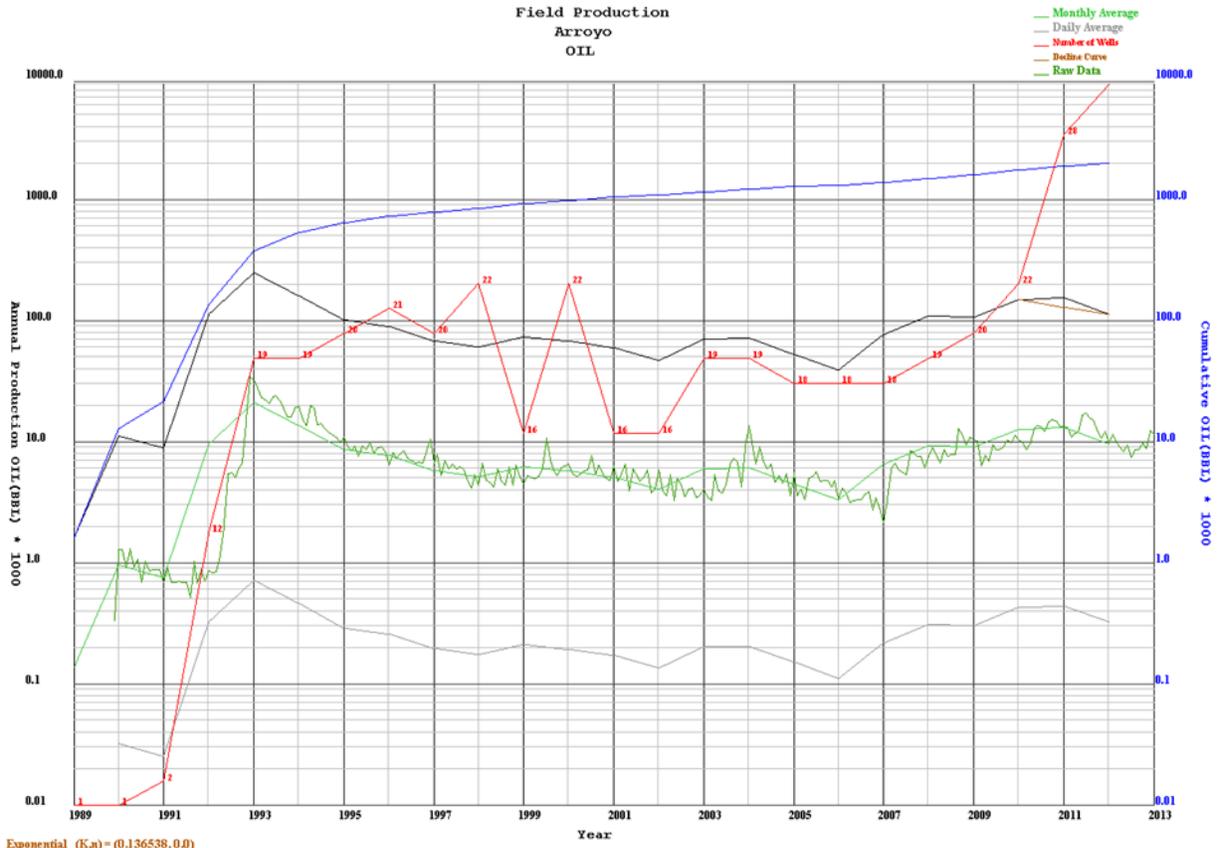
Field Production
Arroyo
OIL

Exponential (K,n) = (0.136538, 0.0)
Initial Production Year Rate (Qi): 162384 BBL at 2010
Present Production Year Rate (Qt): 123672 BBL at 2012
Decline Rate (De): 11.92 % Per Year
Economic Limit Year Rate (Qf): 5475.0 BBL at 2034

Cumulative to Data: 2238177 BBL
Computed: 2229758 BBL
Cumulative at Limit: 3095429 BBL
Remaining Reserves: 857252 BBL

X-Axis			Y-Axis		
	Year			Production/Cumulative	
Minimum:		1989	Minimum:		1
Maximum:		2013	Maximum:		10000
Increment:		2	Cycles:		4

Changing the Minimum X-Axis:
Notice the plot above all the curves are present, but lets change the lower x-axis limit to 1990. Edit the X-Axis Minimum text field from 1989 to 1990 and tab out to text field the plot limits will automatically change.

25

Field Production
Arroyo
OIL

Exponential (K,n) = (0.136538, 0.0)
Initial Production Year Rate (Qi): 162384 BBL at 2010
Present Production Year Rate (Qt): 123672 BBL at 2012
Decline Rate (De): 11.92 % Per Year
Economic Limit Year Rate (Qf): 5475.0 BBL at 2034

Cumulative to Data: 2238177 BBL
Computed: 2229758 BBL
Cumulative at Limit: 3095429 BBL
Remaining Reserves: 857252 BBL

X-Axis

Year	
Minimum:	1990
Maximum:	2013
Increment:	2

Y-Axis

Production/Cumulative	
Minimum:	0.01
Maximum:	10000.0
Cycles:	6

Changing the Minimum X-Axis:
Notice the plot x-axis limits automatically changed from 1989 to 1990.

26

Changing the X-Axis Maximum Value

Field Production
Arroyo
OIL

Exponential (K,n) = (0.136538, 0.0)
Initial Production Year Rate (Qi): 162384 BBL at 2010
Present Production Year Rate (Qt): 123672 BBL at 2012
Decline Rate (De): 11.92 % Per Year
Economic Limit Year Rate (Qf): 5475.0 BBL at 2034

Cumulative to Data: 2238177 BBL
Computed: 2229758 BBL
Cumulative at Limit: 3095429 BBL
Remaining Reserves: 857252 BBL

X-Axis		
	Year	
Minimum:		1990
Maximum:		2013
Increment:		2

Y-Axis		
	Production/Cumulative	
Minimum:		0.01
Maximum:		10000.0
Cycles:		6

Changing the Maximum X-Axis:
Now change the upper x-axis limit to 2020. Edit the X-Axis Maximum text field from 2013 to 2020 and tab out to text field the plot limits will automatically change.

Field Production
Arroyo
OIL

Exponential (K,n) = (0.136538, 0.0)
Initial Production Year Rate (Qi): 162384 BBL at 2010
Present Production Year Rate (Qt): 123672 BBL at 2012
Decline Rate (De): 11.92 % Per Year
Economic Limit Year Rate (Qf): 5475.0 BBL at 2034

Cumulative to Data: 2238177 BBL
Computed: 2229758 BBL
Cumulative at Limit: 3095429 BBL
Remaining Reserves: 857252 BBL

Changing the Maximum X-Axis:
Notice the plot x-axis limits automatically
changed from 2013 to 2020.

Changing the X-Axis Increment Value

Field Production
Arroyo
OIL

Decline Curve automatically extends.

Exponential (K,n) = (0.136538, 0.0)
Initial Production Year Rate (Qi): 162384 BBL at 2010
Present Production Year Rate (Qt): 123672 BBL at 2012
Decline Rate (De): 11.92 % Per Year
Economic Limit Year Rate (Qf): 5475.0 BBL at 2034

Cumulative to Data: 2238177 BBL
Computed: 2229758 BBL
Cumulative at Limit: 3095429 BBL
Remaining Reserves: 857252 BBL

X-Axis			Y-Axis	
	Year			Production/Cumulative
Minimum:		1990	Minimum:	0.01
Maximum:		2020	Maximum:	10000.0
Increment:		2	Cycles:	6

Changing the Increment X-Axis:
Now change the increment x-axis to 5 years. Edit the X-Axis Increment text field from 2 to 5 years and tab out to text field the plot limits will automatically change.
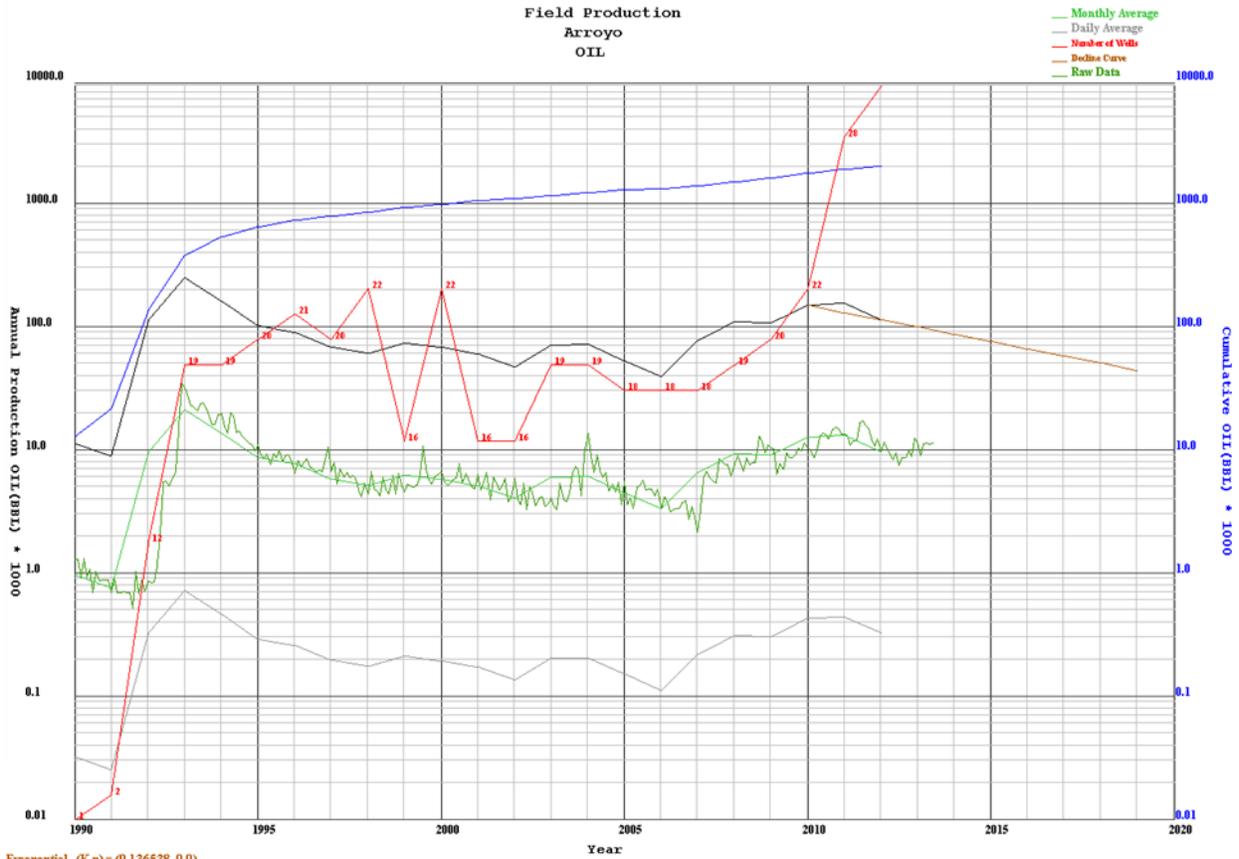
Field Production
Arroyo
OIL

Legend:
- Monthly Average
- Daily Average
- Number of Wells
- Decline Curve
- Raw Data

Exponential (K,n) = (0.136538, 0.0)
Initial Production Year Rate (Qi): 162384 BBL at 2010
Present Production Year Rate (Qt): 123672 BBL at 2012
Decline Rate (De): 11.92 % Per Year
Economic Limit Year Rate (Qf): 5475.0 BBL at 2034

Cumulative to Data: 2238177 BBL
Computed: 2229758 BBL
Cumulative at Limit: 3095429 BBL
Remaining Reserves: 857252 BBL

X-Axis		Y-Axis	
Year		**Production/Cumulative**	
Minimum:	1990	Minimum:	0.01
Maximum:	2020	Maximum:	10000.0
Increment:	5	Cycles:	6

Changing the Increment X-Axis:
Notice the plot x-axis increment automatically changed from 2 to 5 years.

30

Changing the Y-Axis Minimum Value

Field Production
Arroyo
OIL

Exponential (K,n) = (0.136538, 0.0)
Initial Production Year Rate (Qi): 162384 BBL at 2010
Present Production Year Rate (Qt): 123672 BBL at 2012
Decline Rate (De): 11.92 % Per Year
Economic Limit Year Rate (Qf): 5475.0 BBL at 2034

Cumulative to Data: 2238177 BBL
Computed: 2229758 BBL
Cumulative at Limit: 3095429 BBL
Remaining Reserves: 857252 BBL

X-Axis		
	Year	
Minimum:		1989
Maximum:		2013
Increment:		2

Y-Axis		
	Production/Cumulative	
Minimum:		1
Maximum:		10000
Cycles:		4

Changing the Minimum Y-Axis:
Notice the plot above all curves have been selected but the Daily Average Curve does not appear on the plot. Edit the Y-Axis Minimum text field from 1 to .01 and tab out to text field the plot limits will automatically change.
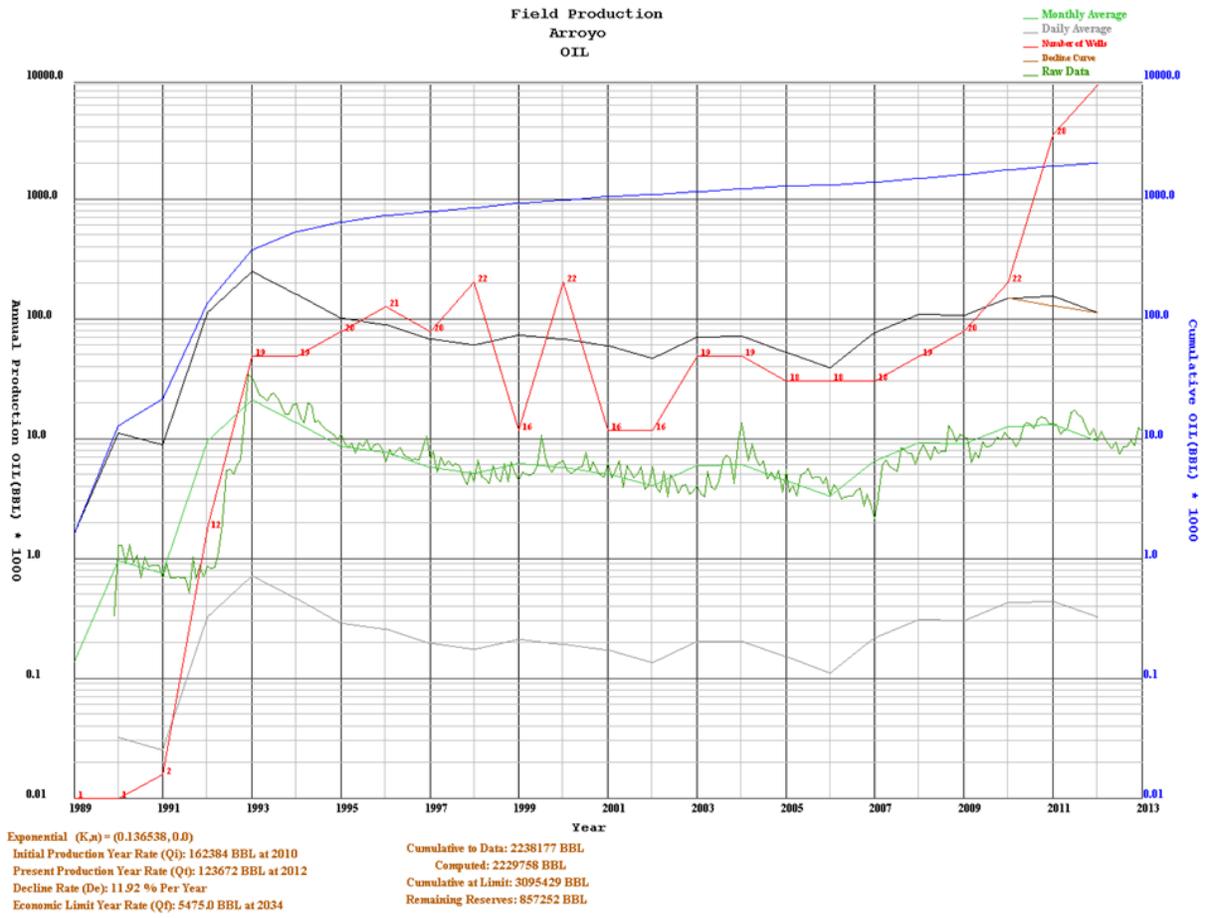
Field Production
Arroyo
OIL

Exponential (K,n) = (0.136538, 0.0)
Initial Production Year Rate (Qi): 162384 BBL at 2010
Present Production Year Rate (Qt): 123672 BBL at 2012
Decline Rate (De): 11.92 % Per Year
Economic Limit Year Rate (Qf): 5475.0 BBL at 2034

Cumulative to Data: 2238177 BBL
Computed: 2229758 BBL
Cumulative at Limit: 3095429 BBL
Remaining Reserves: 857252 BBL

X-Axis		Y-Axis	
	Year		Production/Cumulative
Minimum:	1989	Minimum:	0.01
Maximum:	2013	Maximum:	10000.0
Increment:	2	Cycles:	6

Changing the Minimum Y-Axis:
Notice the plot above all curves are now visible. Also notice the Y-Axis Cycles automatically changed to 6.

Changing the Y-Axis Maximum Value
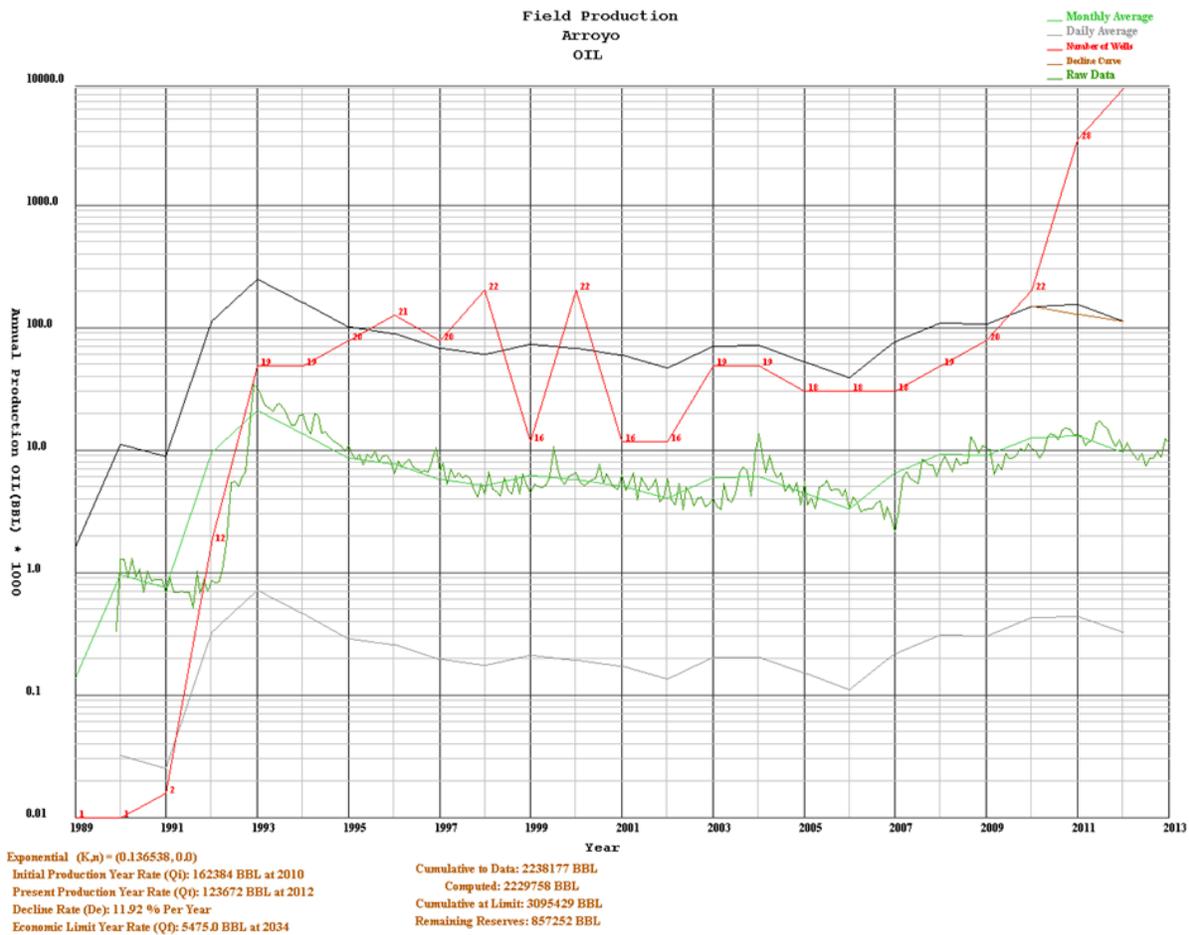
Field Production
Arroyo
OIL

Legend:
- Monthly Average
- Daily Average
- Number of Wells
- Decline Curve
- Raw Data

Y-axis: Annual Production OIL(BBL) * 1000 (10000.0, 1000.0, 100.0, 10.0, 1.0, 0.1, 0.01)

X-axis: Year (1989, 1991, 1993, 1995, 1997, 1999, 2001, 2003, 2005, 2007, 2009, 2011, 2013)

Exponential (K,n) = (0.136538, 0.0)
Initial Production Year Rate (Qi): 162384 BBL at 2010
Present Production Year Rate (Qt): 123672 BBL at 2012
Decline Rate (De): 11.92 % Per Year
Economic Limit Year Rate (Qf): 5475.0 BBL at 2034

Cumulative to Data: 2238177 BBL
Computed: 2229758 BBL
Cumulative at Limit: 3095429 BBL
Remaining Reserves: 857252 BBL

X-Axis

Year	
Minimum:	1989
Maximum:	2013
Increment:	2

Y-Axis

Production/Cumulative	
Minimum:	0.01
Maximum:	10000.0
Cycles:	6

Changing the Maximum Y-Axis: Notice the plot above all curves have been selected but the Cumulative Curve does not appear on the plot. Edit the Y-Axis Maximum text field from 10000 to 1000 and tab out to text field the plot limits will automatically change.

Field Production
Arroyo
OIL

— Monthly Average
— Daily Average
— Number of Wells
— Decline Curve
— Raw Data

Exponential (K,n) = (0.136538, 0.0)
Initial Production Year Rate (Qi): 162384 BBL at 2010
Present Production Year Rate (Qt): 123672 BBL at 2012
Decline Rate (De): 11.92 % Per Year
Economic Limit Year Rate (Qf): 5475.0 BBL at 2034

Cumulative to Data: 2238177 BBL
Computed: 2229758 BBL
Cumulative at Limit: 3095429 BBL
Remaining Reserves: 857252 BBL

X-Axis			Y-Axis	
	Year		Production/Cumulative	
Minimum:	1989	Minimum:	0.01	
Maximum:	2013	Maximum:	1000.0	
Increment:	2	Cycles:	5	

Changing the Maximum Y-Axis:
Notice the plot above the upper Y-Axis has changed to fit the data better. Also notice the Y-Axis Cycles automatically changed to 5.

Changing the Y-Axis Increment Value
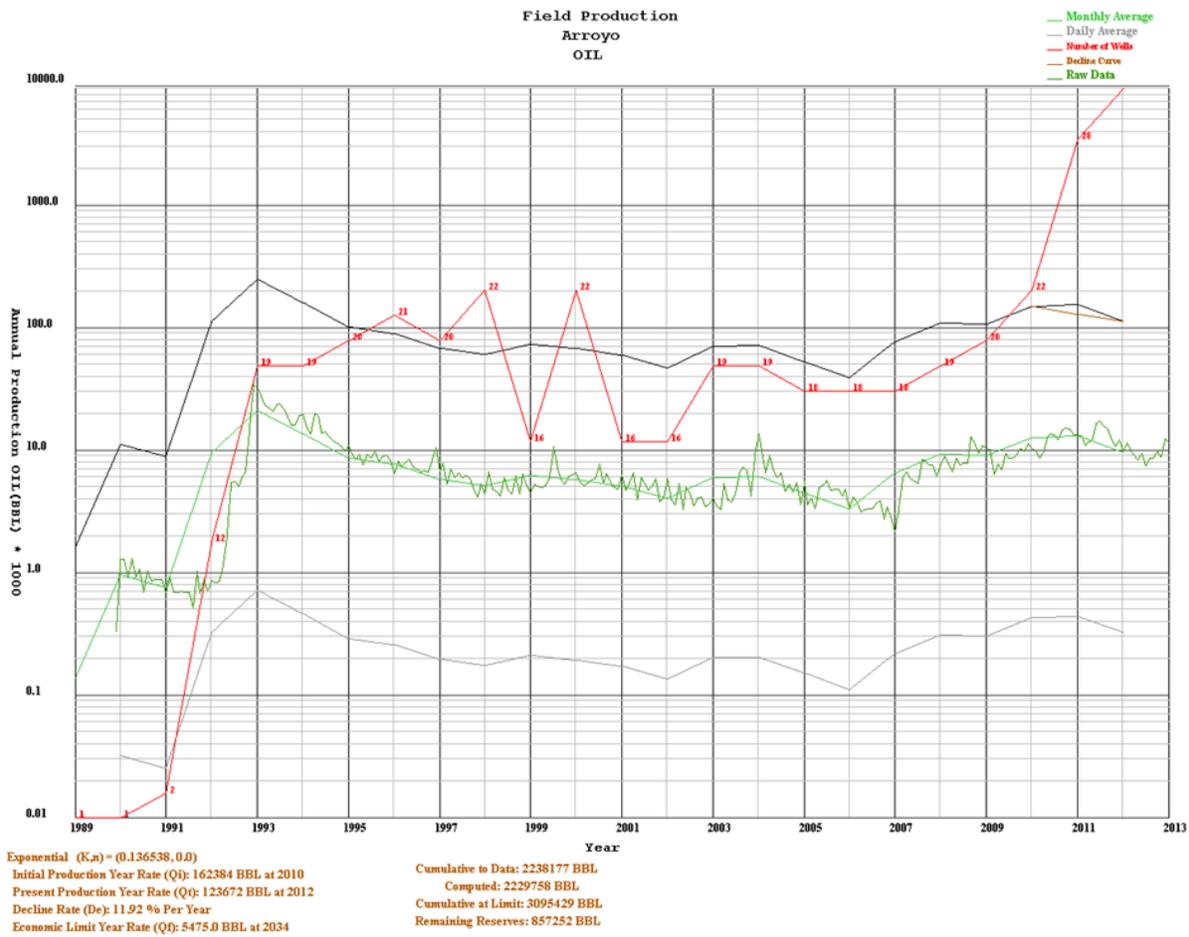
Field Production
Arroyo
OIL

Legend:
- Monthly Average
- Daily Average
- Number of Wells
- Decline Curve
- Raw Data

Y-axis: Annual Production OIL(BBL) * 1000
X-axis: Year

Exponential (K,n) = (0.136538, 0.0)
Initial Production Year Rate (Qi): 162384 BBL at 2010
Present Production Year Rate (Qt): 123672 BBL at 2012
Decline Rate (De): 11.92 % Per Year
Economic Limit Year Rate (Qf): 5475.0 BBL at 2034

Cumulative to Data: 2238177 BBL
Computed: 2229758 BBL
Cumulative at Limit: 3095429 BBL
Remaining Reserves: 857252 BBL

X-Axis		Y-Axis	
Year		**Production/Cumulative**	
Minimum:	1989	Minimum:	0.01
Maximum:	2013	Maximum:	10000.0
Increment:	2	Cycles:	6

Changing the Cycles Y-Axis:
Notice the plot above all curves have been selected but the Cumulative Curve does not appear on the plot. Edit the Y-Axis Cycles text field from 6 to 5 and tab out to text field the plot limits will automatically change.

Field Production
Arroyo
OIL

Legend:
- Monthly Average
- Daily Average
- Number of Wells
- Decline Curve
- Raw Data

Annual Production OIL (BBL) * 1000

Exponential (K,n) = (0.136538, 0.0)
Initial Production Year Rate (Qi): 162384 BBL at 2010
Present Production Year Rate (Qt): 123672 BBL at 2012
Decline Rate (De): 11.92 % Per Year
Economic Limit Year Rate (Qf): 5475.0 BBL at 2034

Cumulative to Data: 2238177 BBL
Computed: 2229758 BBL
Cumulative at Limit: 3095429 BBL
Remaining Reserves: 857252 BBL

X-Axis		
	Year	
Minimum:		1989
Maximum:		2013
Increment:		2

Y-Axis		
	Production/Cumulative	
Minimum:		0.01
Maximum:		1000.0
Cycles:		5

Changing the Cycles Y-Axis:
Notice the plot above the upper Y-Axis has changed to fit the data better. When the Cycles are changed the Y-Axis Maximum is computed from the Y-Axis Minimum and the number of Cycles Entered.

36

Dialog Menu Options

File Menu Option

Save Production Data as an Extensible Markup Language (XML) ASCII File

Click on the XML Icon Button at the top of the "Prodution Plot" dialog to open the "Select a Different Directory Path" Dialog.
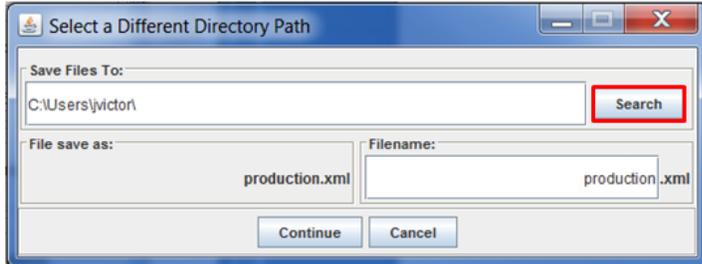
Select the "Search" Button in the "Select a Different Directory Path" Dialog to search your PC for the correct directory path.

Highlight the Directory you wish to place the XML File.

Select the "Select" Button.
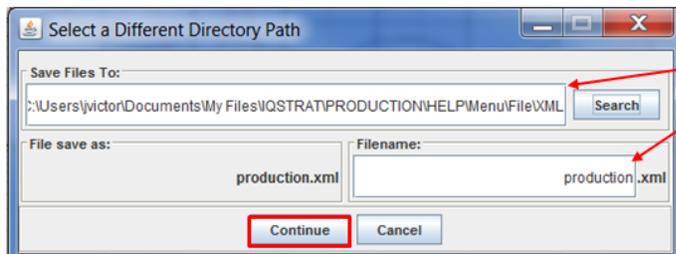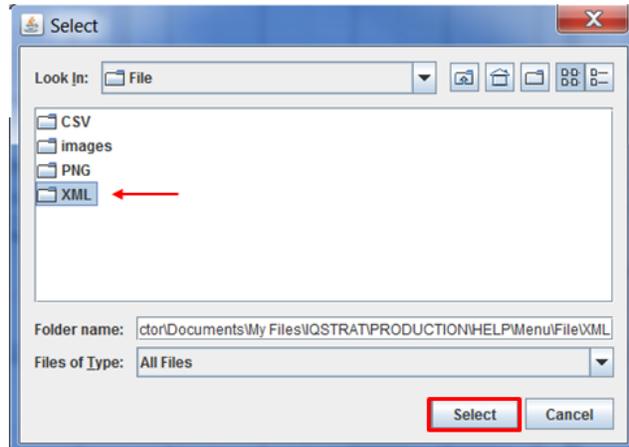
The Directory path is transferred to the "Save Files To:" text field.

"production" is the default filename, you can alter the name to any name you wish. The "File save as:" text field will show what the file name will be saved as.

Select the "Continue" Button to save file.
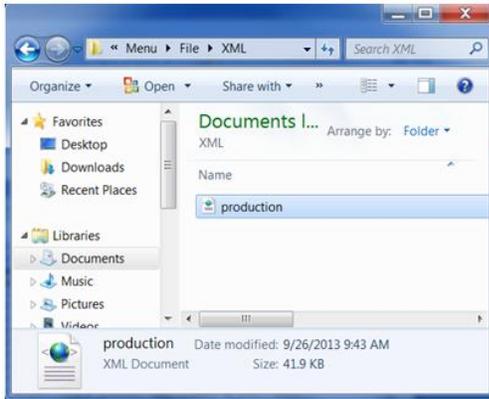
To view the XML File created just go to the directory you saved the XML file and double click and a web page will display the production plot XML File. Since this data was originally retrieved from the KGS Database it will contain the URL and search term to retrieve the data as well as the Primary Key of the record as well as Name.

```xml
<?xml version="1.0"?>
<!DOCTYPE production>
<production v1="sField=1000152060"
app="http://chasm.kgs.ku.edu/pls/abyss/iqstrat.production_pkg.getXML"
name="Arroyo" type="FIELD" key="1000152060" records="543">
    <data sources="1" output="348.0" product="OIL" month="11" year="1989"/>
    <data sources="1" output="1364.0" product="OIL" month="12" year="1989"/>
    <data sources="1" output="1364.0" product="OIL" month="1" year="1990"/>
    <data sources="1" output="957.0" product="OIL" month="2" year="1990"/>
    <data sources="1" output="1386.0" product="OIL" month="3" year="1990"/>
    <data sources="1" output="968.0" product="OIL" month="4" year="1990"/>
    <data sources="1" output="1124.0" product="OIL" month="5" year="1990"/>
    <data sources="1" output="728.0" product="OIL" month="6" year="1990"/>
    <data sources="1" output="1093.0" product="OIL" month="7" year="1990"/>
    <data sources="1" output="908.0" product="OIL" month="8" year="1990"/>
    <data sources="1" output="915.0" product="OIL" month="9" year="1990"/>
    <data sources="1" output="917.0" product="OIL" month="10" year="1990"/>
    <data sources="1" output="922.0" product="OIL" month="11" year="1990"/>
    <data sources="1" output="729.0" product="OIL" month="12" year="1990"/>
    <data sources="2" output="960.0" product="OIL" month="1" year="1991"/>
    <data sources="2" output="728.0" product="OIL" month="2" year="1991"/>
    <data sources="2" output="723.0" product="OIL" month="3" year="1991"/>
    <data sources="2" output="735.0" product="OIL" month="4" year="1991"/>
    <data sources="2" output="726.0" product="OIL" month="5" year="1991"/>
    <data sources="2" output="725.0" product="OIL" month="6" year="1991"/>
    <data sources="2" output="541.0" product="OIL" month="7" year="1991"/>
    <data sources="2" output="1084.0" product="OIL" month="8" year="1991"/>
    <data sources="2" output="707.0" product="OIL" month="9" year="1991"/>
    <data sources="3" output="41553.0" product="GAS" month="10" year="1991"/>
    <data sources="2" output="913.0" product="OIL" month="10" year="1991"/>
    <data sources="3" output="57569.0" product="GAS" month="11" year="1991"/>
    <data sources="2" output="739.0" product="OIL" month="11" year="1991"/>
    <data sources="3" output="144027.0" product="GAS" month="12" year="1991"/>
    <data sources="2" output="909.0" product="OIL" month="12" year="1991"/>
    <data sources="12" output="146182.0" product="GAS" month="1" year="1992"/>
    <data sources="12" output="865.0" product="OIL" month="1" year="1992"/>
    <data sources="12" output="140563.0" product="GAS" month="2" year="1992"/>
    <data sources="12" output="887.0" product="OIL" month="2" year="1992"/>
    <data sources="12" output="154415.0" product="GAS" month="3" year="1992"/>
    <data sources="12" output="1235.0" product="OIL" month="3" year="1992"/>
    <data sources="12" output="149544.0" product="GAS" month="4" year="1992"/>
    <data sources="12" output="2146.0" product="OIL" month="4" year="1992"/>
    <data sources="12" output="237113.0" product="GAS" month="5" year="1992"/>
    <data sources="12" output="5831.0" product="OIL" month="5" year="1992"/>
    <data sources="12" output="266472.0" product="GAS" month="6" year="1992"/>
```
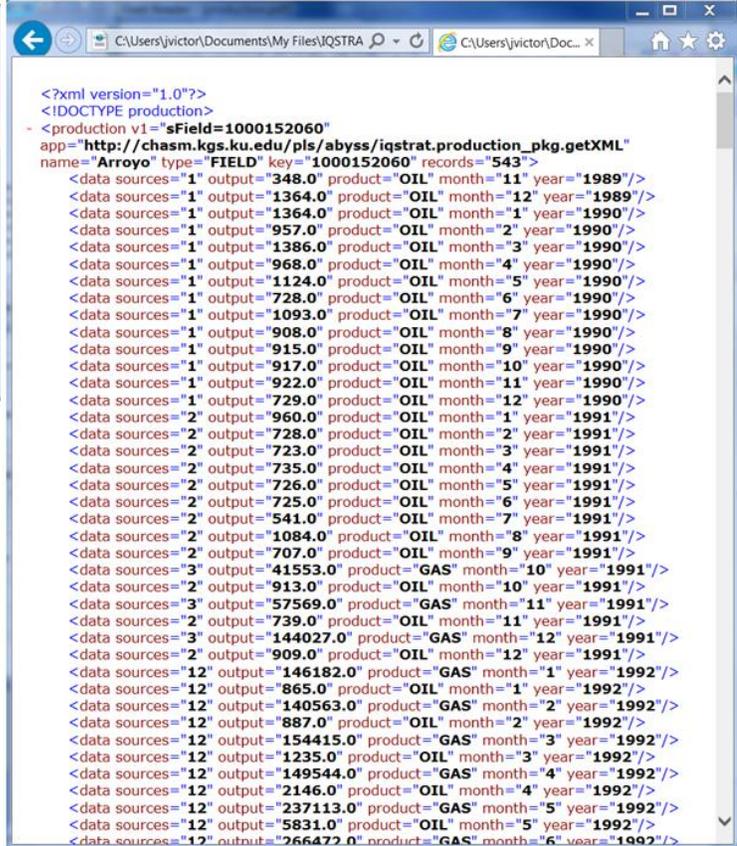
Save Production Data as a Comma Separated Values (CSV) ASCII File

Click on the CSV Icon Button at the top of the "Prodution Plot" dialog to open the "Select a Different Directory Path" Dialog.
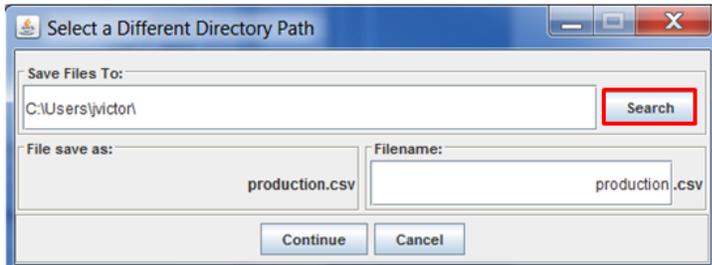
Select the "Search" Button in the "Select a Different Directory Path" Dialog to search your PC for the correct directory path.

Highlight the Directory you wish to place the CSV File.

Select the "Select" Button.
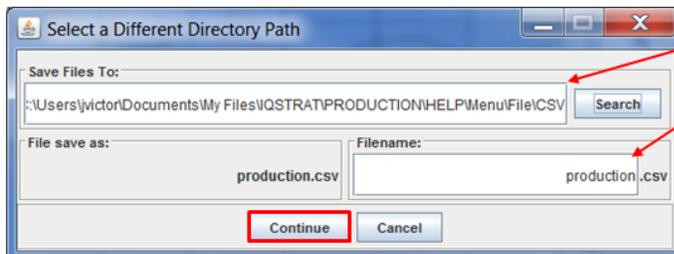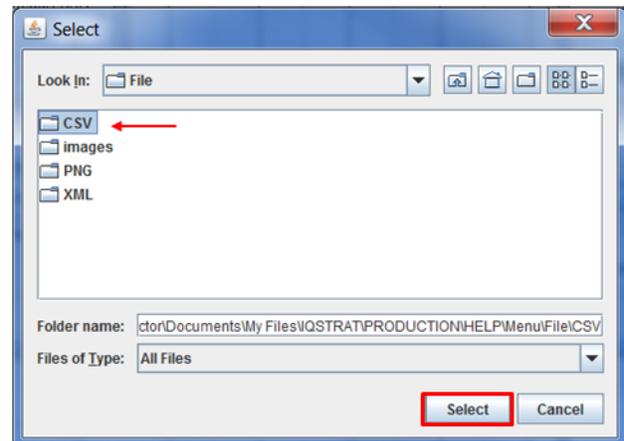
The Directory path is transferred to the "Save Files To:" text field.
"production" is the default filename, you can alter the name to any name you wish. The "File save as:" text field will show what the file name will be saved as.
Select the "Continue" Button to save file.

KEY=1000152060 FIELD=Arroyo app=http://chasm.kgs.ku.edu/pls/abyss/iqstrat.production_pkg.getXML?sField=1000152060

	Year	Month	Product	Output	sources
	1989	11	OIL	348	1
	1989	12	OIL	1364	1
	1990	1	OIL	1364	1
	1990	2	OIL	957	1
	1990	3	OIL	1386	1
	1990	4	OIL	968	1
	1990	5	OIL	1124	1
	1990	6	OIL	728	1
	1990	7	OIL	1093	1
	1990	8	OIL	908	1
	1990	9	OIL	915	1
	1990	10	OIL	917	1
	1990	11	OIL	922	1
	1990	12	OIL	729	1
	1991	1	OIL	960	2
	1991	2	OIL	728	2
	1991	3	OIL	723	2
	1991	4	OIL	735	2
	1991	5	OIL	726	2
	1991	6	OIL	725	2
	1991	7	OIL	541	2
	1991	8	OIL	1084	2
	1991	9	OIL	707	2
	1991	10	GAS	41553	3
	1991	10	OIL	913	2
	1991	11	GAS	57569	3
	1991	11	OIL	739	2
	1991	12	GAS	144027	3

To view the CSV File created just go to the directory you saved the CSV File. To view the CSV File you can open the file in a Notepad text editor or you can double click on the file and a Microsoft Excel Application will launch and display the contents of the file.

production
Microsoft Office Excel Comma Separated Values File
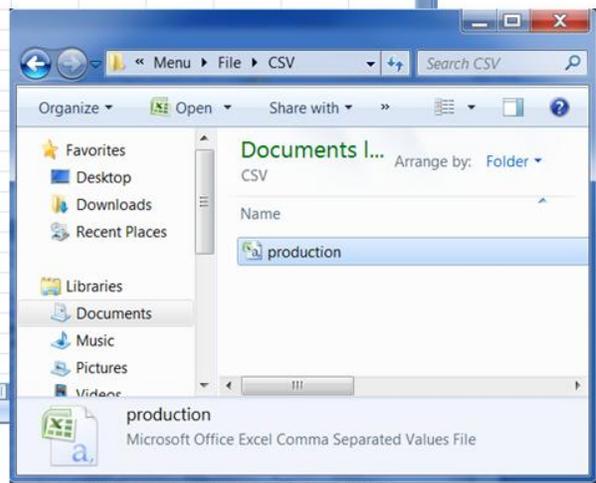
**Save Production Image as a Portable Network Graphics (PNG) Image File**

Click on the PDF Icon Button **PDF** at the top of the "Prodution Plot" dialog to open the "Select a Different Directory Path" Dialog.
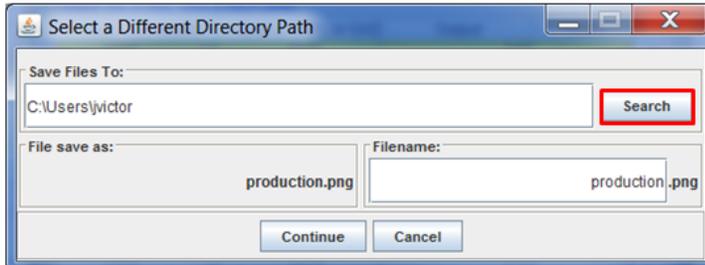
Select the "Search" Button in the "Select a Different Directory Path" Dialog to search your PC for the correct directory path.

Highlight the Directory you wish to place the PNG File.

Select the "Select" Button.
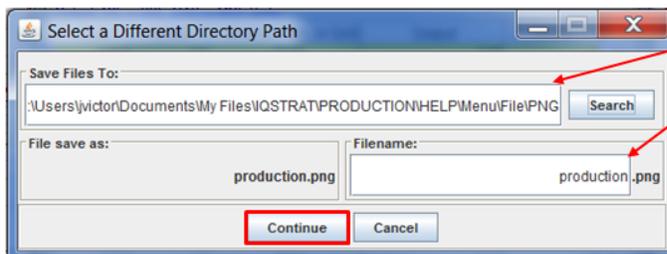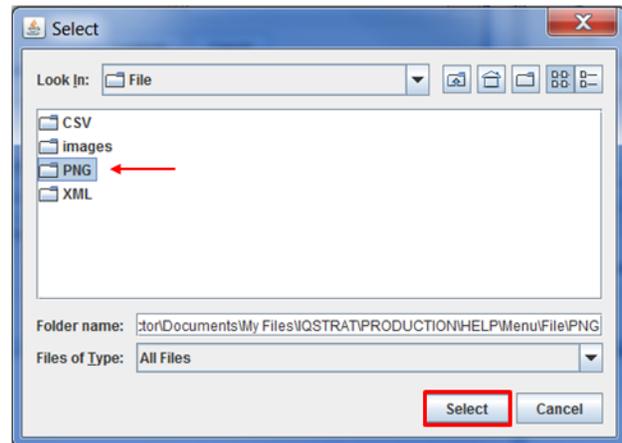
The Directory path is transferred to the "Save Files To:" text field.

"production" is the default filename, you can alter the name to any name you wish. The "File save as:" text field will show what the file name will be saved as.

Select the "Continue" Button to save file.
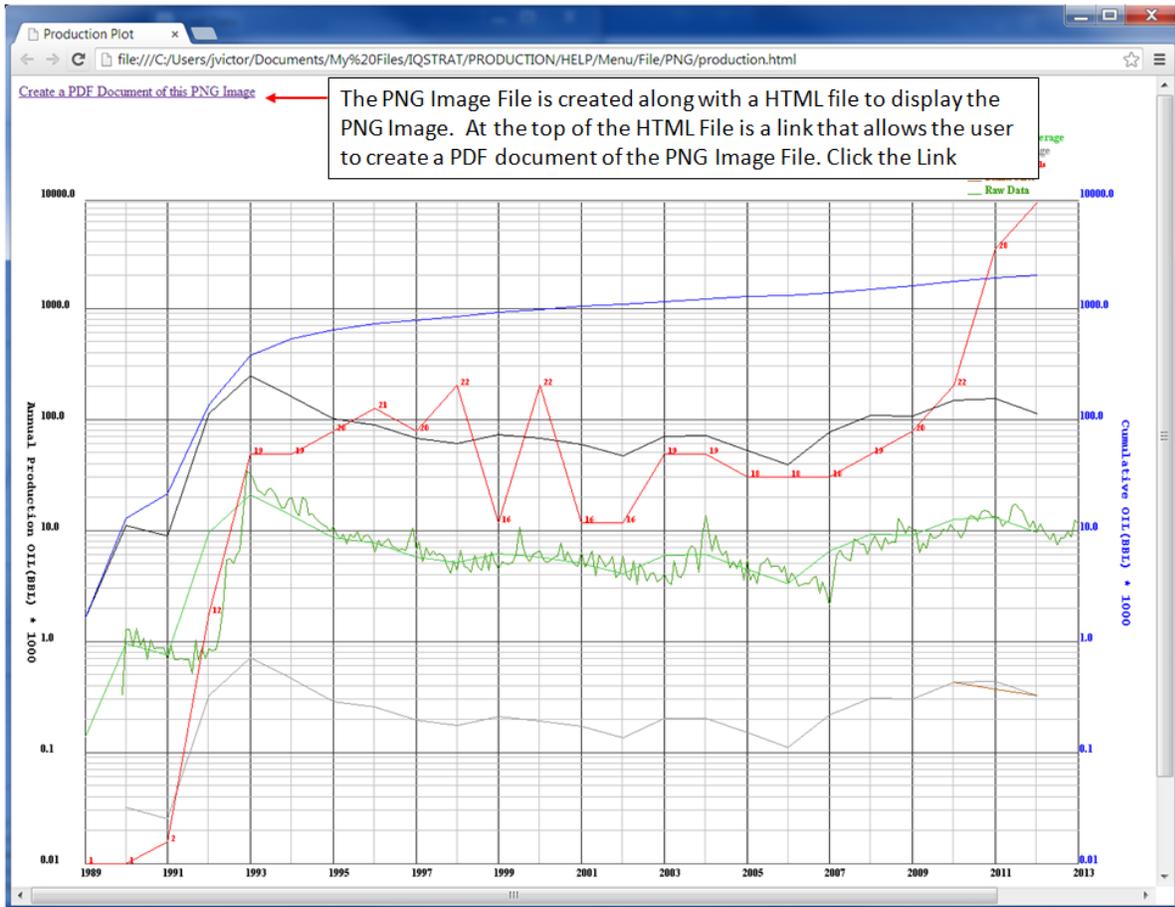
The PNG Image File is created along with a HTML file to display the PNG Image. At the top of the HTML File is a link that allows the user to create a PDF document of the PNG Image File. Click the Link
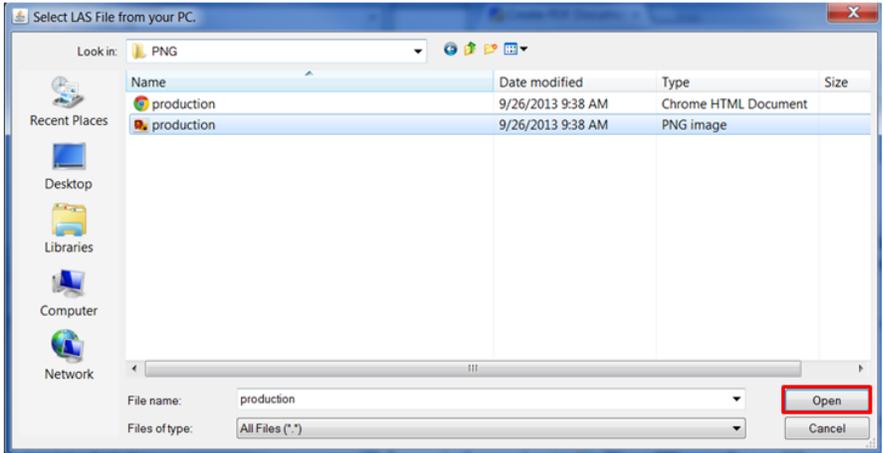
The Create PDF from Image Applet will run. Displaying a "Select LAS File from your PC" Dialog, select the PNG Image and select the "Open" Button, to build the PDF Document File. The PDF document will automatically display the document.
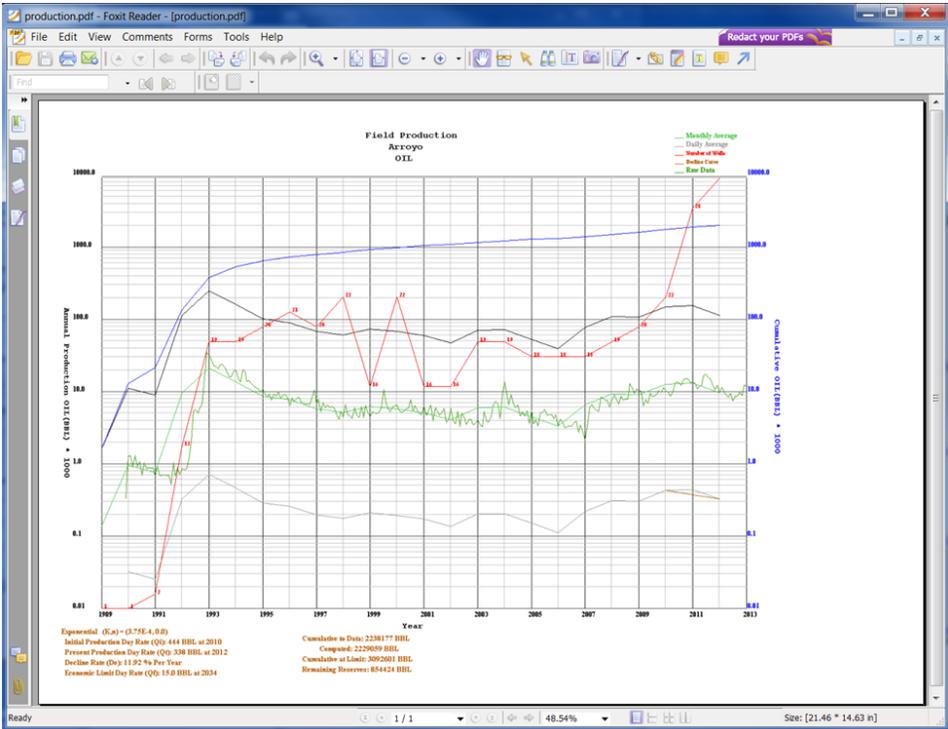
Product Menu Option

Go to the top of the "Production Plot" dialog and click on the "OIL" radio button to display the Oil Production Data. The Default Product data is Oil or if OIL not available then GAS.
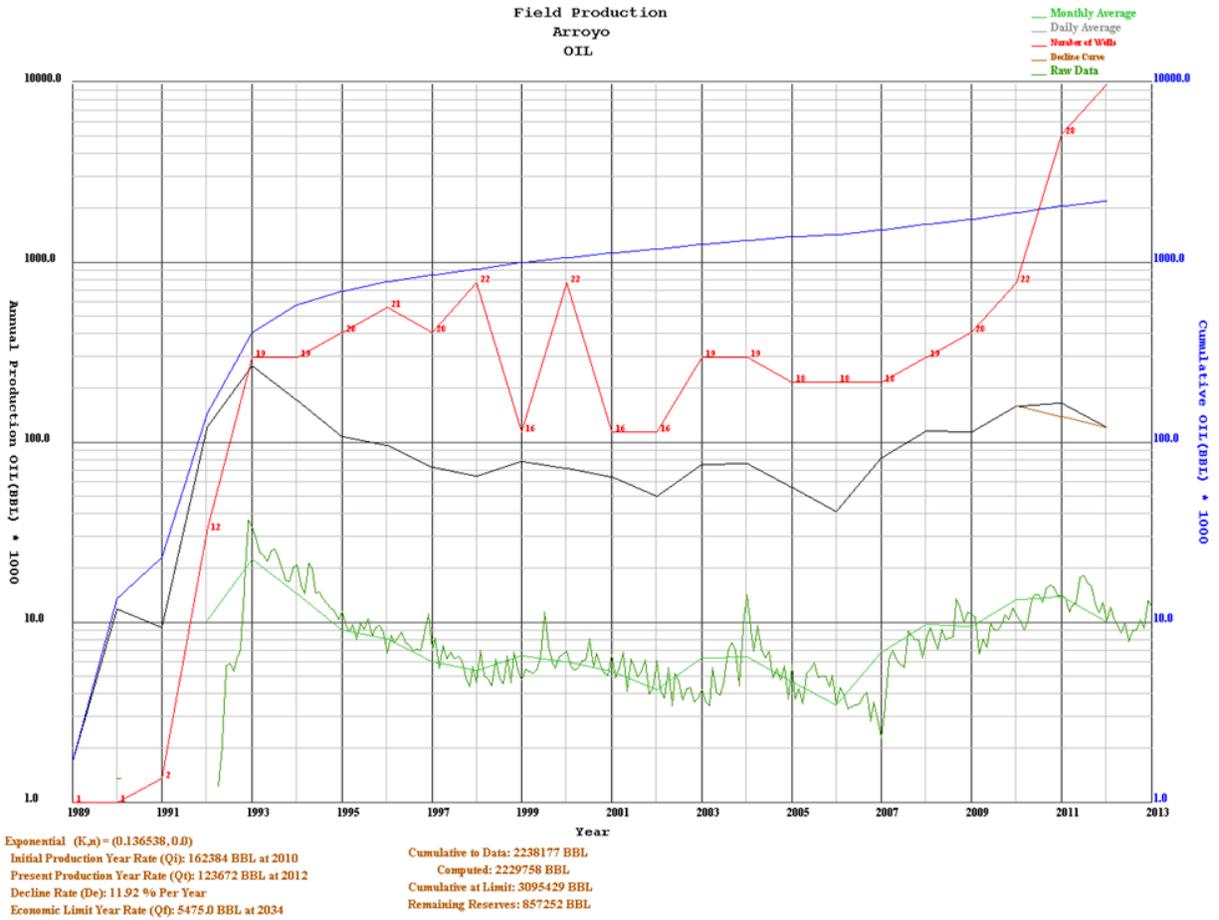
Go to the top of the "Production Plot" dialog and click on the "Gas" radio button to display the Gas Production Data. Note if you turned on any of the Other Curves then the plot will display the other curves when the new product is loaded.
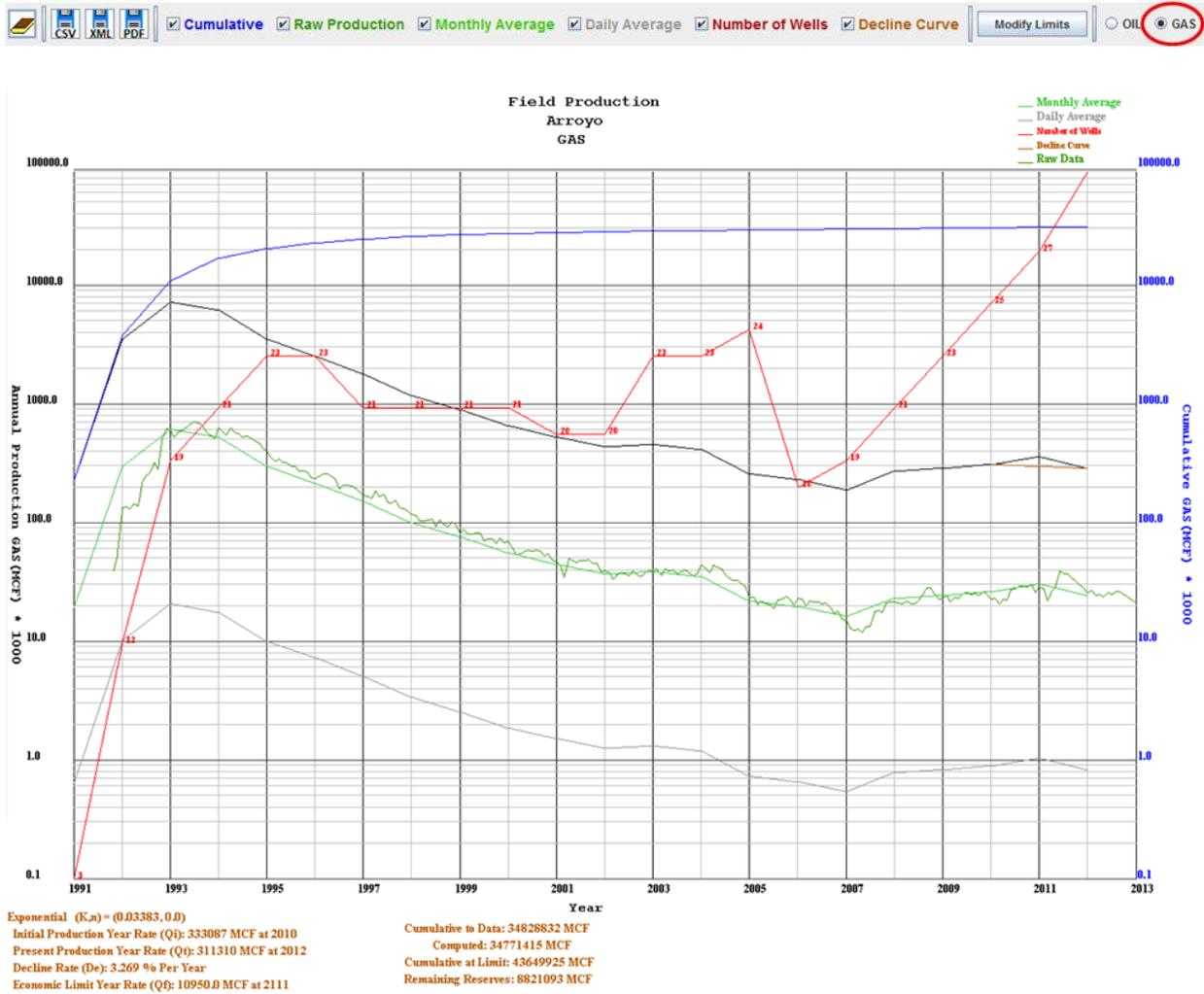
Plot Curves ON/OFF Menu Option
Production/Cumulative Curves ON/OFF Radio Buttons

Go to the top of the "Production Plot", all the curves are selected. The check boxes are the same color as the plotted curve.
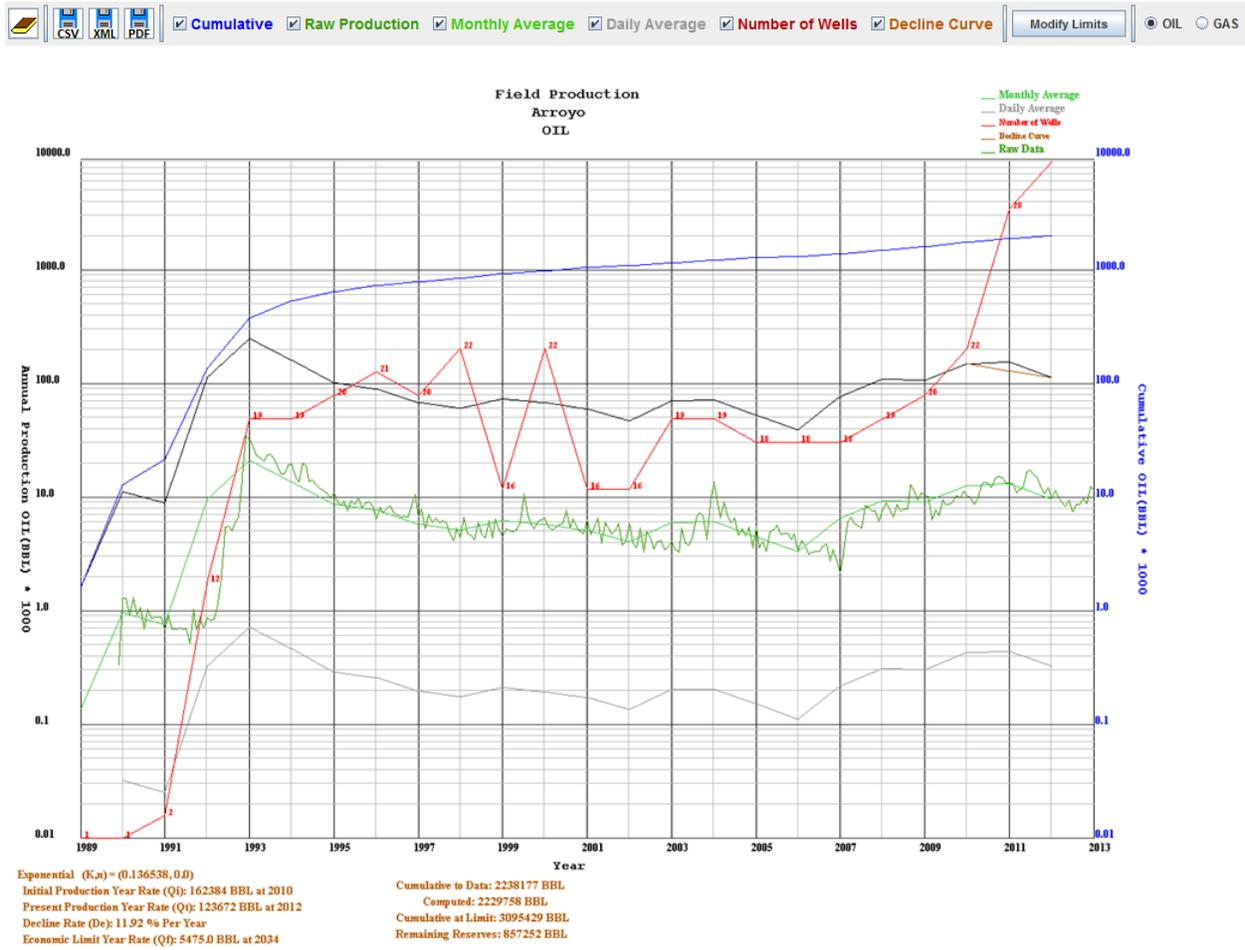
Go to the top of the "Production Plot" Dialog and deselect the "Cumulative" checkbox to remove the Cumulative Production Curve from the Production Plot.
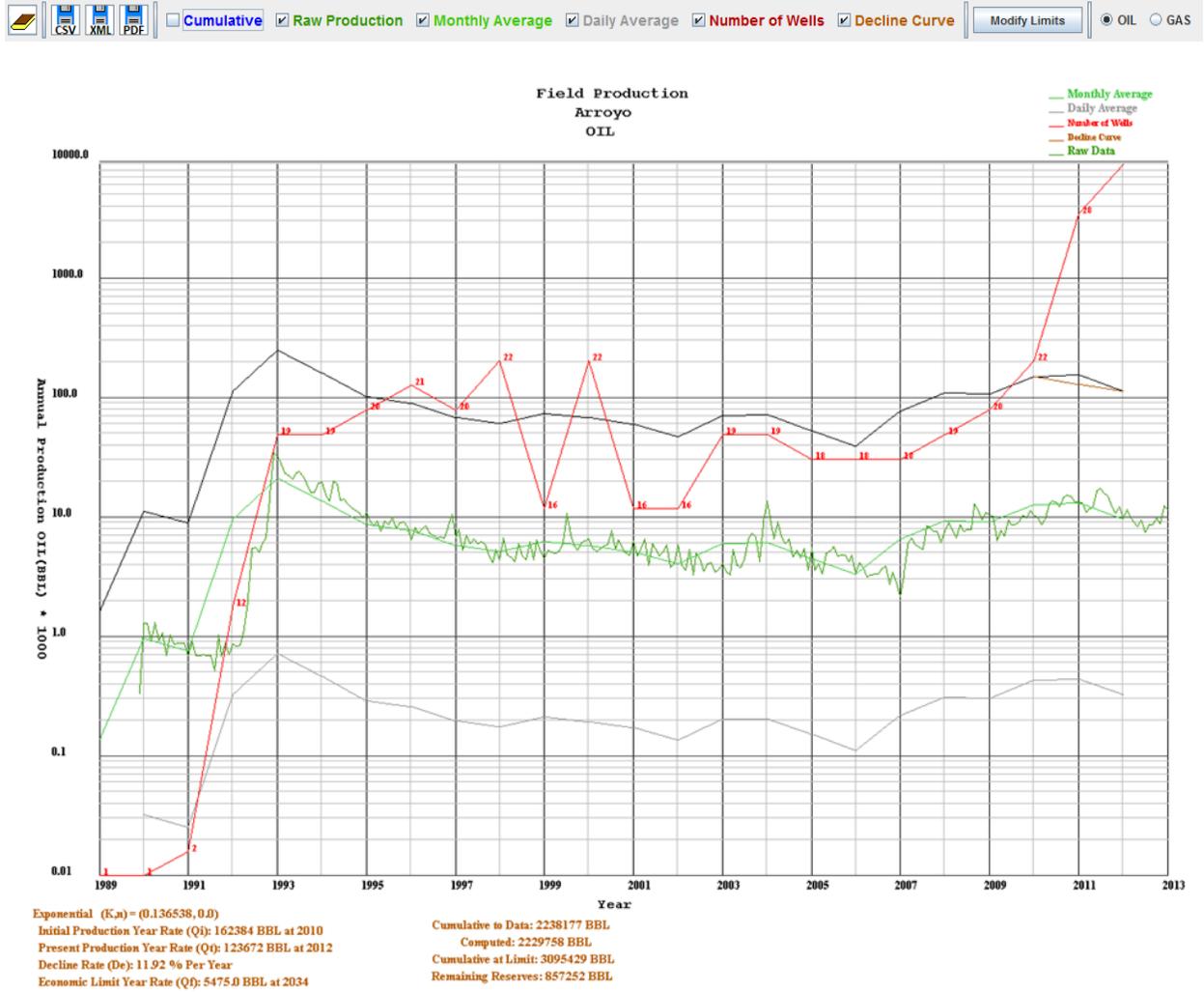
Other Plot Curves ON/OFF Radio Buttons

Go to the top of the "Production Plot" Dialog. Only the Cumulative and Decline Curves are selected.
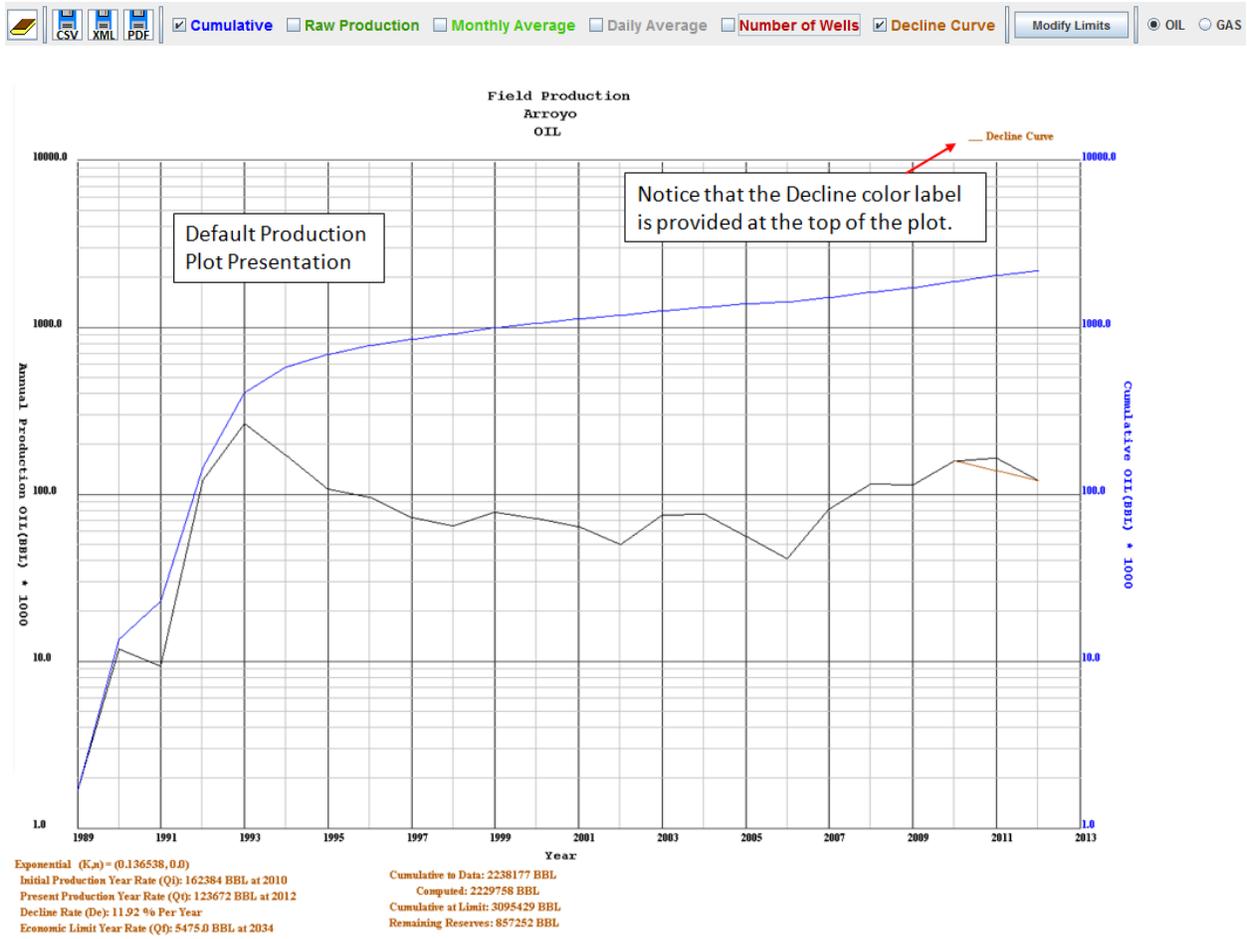
Go to the top of the "Production Plot". The Raw Production, Monthly Average Production, Daily Average Production and the Number of Wells Curves are not selected. Click on the each of the check boxes to turn on the curve you wish to view on the production plot.
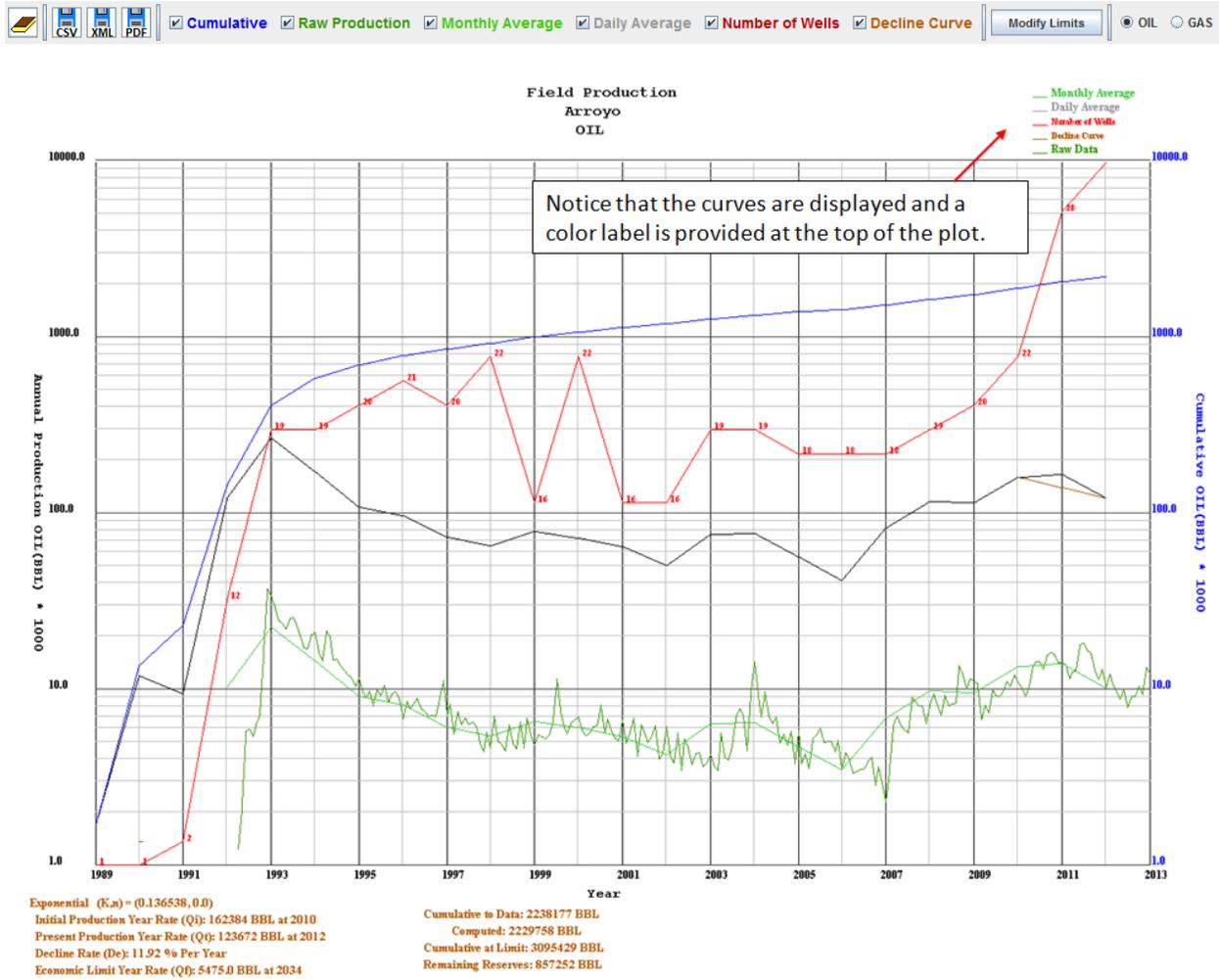
Decline Curve Analysis Calculator Panel

These panels illustrate the change to the Decline Curve Constant (K) for different decline curve methods. The user decides how to fit the curve to the production data plotted. The Decline Curve will define the economic limit depending on the parameters selected. By Default the "Exponential" Decline Method is selected. The time in this case is in units of year.

Exponential:
$$K = \ln(Q_i/Q_t) / t$$

Harmonic:
$$K = [(Q_i/Q_t) - 1.0] / t$$

Hyperbolic:
$$K = \{\exp[n * \ln(Q_i/Q_t)] - 1.0\} / (n*t)$$

where

- Q_i – Initial Production Rate
- Q_t – Final Production Rate
- Q_{iy} – Initial Production Year
- Q_{ty} – Final Production Year
- t – Time = $(Q_{ty} - Q_{iy})$
- n – Decline Curve Exponent
- K – Decline Curve Constant

Exponential Decline Curve Method

Field Production
Arroyo
OIL

—— Decline Curve

Exponential Decline Curve Method

$Q = Q_i * exp(-1.0*K*t)$

where

Q_i – Initial Production Rate (Q_i=162,384 BBL/year)
Q_{iy} – Initial Production Year   (Q_{iy} = 2010)
Q_f – Production at Economic Limit (Q_f=15 BBL/day)
Q_{fy} – Production Date at Economic Limit (Q_{fy}=2034)
t   – Time = $(Q_{fy} - Q_{iy})$ [Years]
K   – Decline Curve Constant (K=0.1365) [1/Years]

Annual Production OIL(BBL) * 1000

Cumulative OIL(BBL) * 1000

Year

Exponential (K,n) = (0.136538, 0.0)
Initial Production Year Rate (Qi): 162384 BBL at 2010
Present Production Year Rate (Qt): 123672 BBL at 2012
Decline Rate (De): 11.92 % Per Year
Economic Limit Year Rate (Qf): 5475.0 BBL at 2034

Cumulative to Data: 2238177 BBL
Computed: 2229758 BBL
Cumulative at Limit: 3095429 BBL
Remaining Reserves: 857252 BBL

Harmonic Decline Curve Method

Field Production
Arroyo
OIL

—— Decline Curve

Harmonic Decline Curve Method

$Q = Q_i / (1.0 + K*t)$

where

Q_i – Initial Production Rate (Q_i=162,384 BBL/year)
Q_{iy} – Initial Production Year   (Q_{iy} = 2010)
Q_f – Production at Economic Limit (Q_f=15 BBL/day)
Q_{fy} – Production Date at Economic Limit (Q_{fy}=2129)
t   – Time = $(Q_{fy} - Q_{iy})$ [Years]
K   – Decline Curve Constant (K=0.157) [1/Years]

Annual Production OIL(BBL) * 1000

Cumulative OIL(BBL) * 1000

Year

Harmonic (K,n) = (0.157, 0.0)
Initial Production Year Rate (Qi): 162384 BBL at 2010
Present Production Year Rate (Qt): 123672 BBL at 2012
Decline Rate (De): 11.92 % Per Year
Economic Limit Year Rate (Qf): 5475.0 BBL at 2192

Cumulative to Data: 2238177 BBL
Computed: 2228673 BBL
Cumulative at Limit: 5452278 BBL
Remaining Reserves: 3214101 BBL

Hyperbolic Decline Curve Method

Field Production
Arroyo
OIL

Hyperbolic Decline Curve Method

$$Q = Q_i / (1.0 + n*K*t)^{(1/n)}$$

where

Q_i – Initial Production Rate (Q_i=162,384 BBL/year)
Q_{iy} – Initial Production Year (Q_{iy} = 2010)
Q_f – Production at Economic Limit (Q_f=15 BBL/day)
Q_{fy} – Production Date at Economic Limit (Q_{fy}=2054)
t – Time = ($Q_{fy} - Q_{iy}$) [Years]
n – Decline Curve Exponent (n=1.1)
K – Decline Curve Constant (K=0.1752) [1/Years]

Hyperbolic (K,n) = (0.175189, 1.1)
Initial Production Year Rate (Qi): 162384 BBL at 2010
Present Production Year Rate (Qt): 123672 BBL at 2012
Decline Rate (De): 11.92 % Per Year
Economic Limit Year Rate (Qf): 5475.0 BBL at 2054

Cumulative to Data: 2238177 BBL
Computed: 2209935 BBL
Cumulative at Limit: 5686806 BBL
Remaining Reserves: 3448629 BBL

Compute Decline Curve Constant (K) Production Rate By Date

These panels illustrate the change to the Decline Curve Constant (K) for different Production Times. The user decides which time factor suites the data that is plotted. The Decline Curve will define the economic limit depending on the parameters selected. By Default the "Exponential" Decline Method is selected and the time & production rates are set to units of year. Notice that changing the radio buttons will automatically change the "Rate" for both the initial and production, where the units for the rate depend on the radio buttons.

Daily:
$$t = (Q_{ty} - Q_{iy}) * 365.0 \; [\text{Days}]$$

Monthly:
$$t = (Q_{ty} - Q_{iy}) * 12.0 \quad [\text{Months}]$$

Yearly:
$$t = (Q_{ty} - Q_{iy}) \qquad [\text{Years}]$$

Decline Curve Method: Exponential
$$K = \ln(Q_i/Q_t) / t$$

where
- Q_i – Initial Production Rate
- Q_t – Final Production Rate
- Q_{iy} – Initial Production Year
- Q_{ty} – Final Production Year
- t – Time, units depend on radio button
- n – Decline Curve Exponent
- K – Decline Curve Constant

Plot By-Yearly Production Rate

The Decline Curve Calculator Panel illustrate the Yearly Production Rate. The user decides which time factor suites the data that is plotted. The Decline Curve will define the economic limit depending on the parameters selected. By Default the "Exponential" Decline Method is selected and the time & production rates are set to units of year. The Initial Production Rate (Q_i) and the Final Production Rate (Q_t) are both yearly rates.

Yearly:

$$t = (Q_{ty} - Q_{iy}) \qquad [\,\text{Years}\,]$$

Decline Curve Method: Exponential

$$K = \ln(Q_i / Q_t) / t$$

where

- Q_i — Initial Production Rate
- Q_t — Final Production Rate
- Q_{iy} — Initial Production Year
- Q_{ty} — Final Production Year
- t — Time, units depend on radio button
- K — Decline Curve Constant

Field Production
Arroyo
OIL

Yearly Production Rate Decline Curve extended to economic Limit
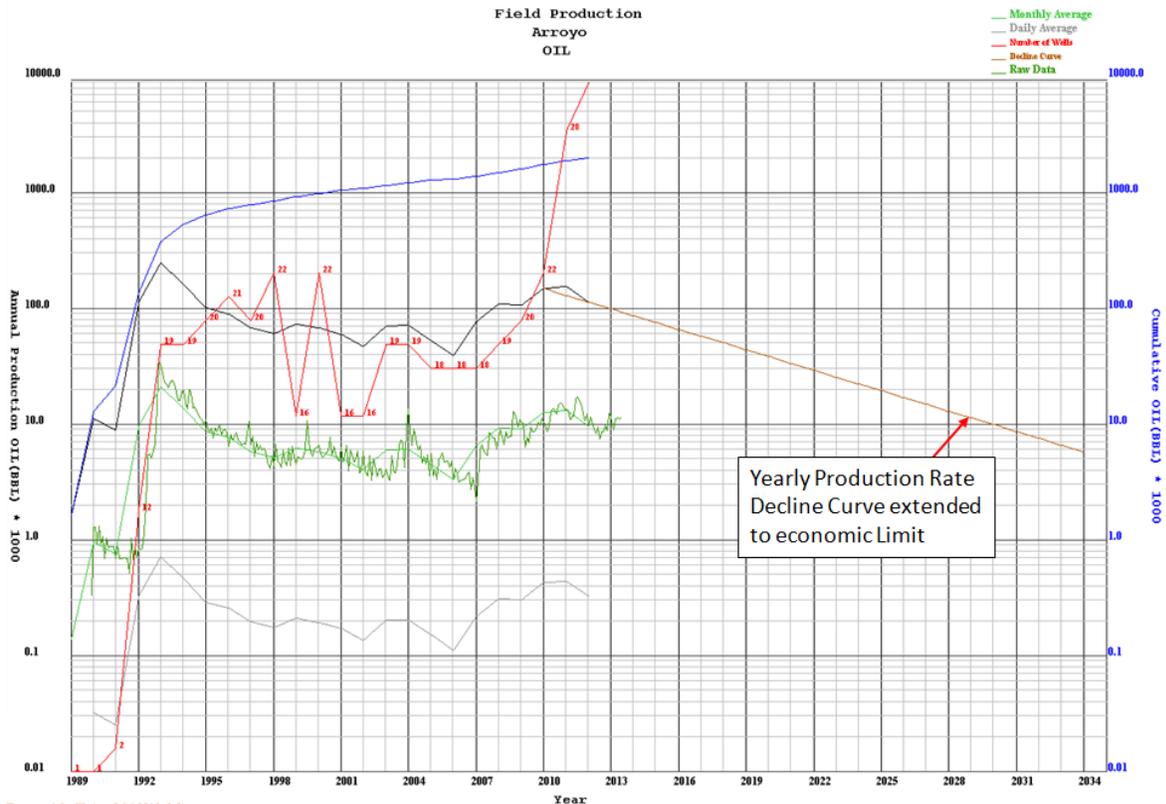
Exponential (K,n) = (0.136538, 0.0)
Initial Production Year Rate (Qi): 162384 BBL at 2010
Present Production Year Rate (Qt): 123672 BBL at 2012
Decline Rate (De): 11.92 % Per Year
Economic Limit Year Rate (Qf): 5475.0 BBL at 2034

Cumulative to Data: 2238177 BBL
Computed: 2229758 BBL
Cumulative at Limit: 3095429 BBL
Remaining Reserves: 857252 BBL

Plot By-Monthly Production Rate

The Decline Curve Calculator Panel illustrate the Monthly Production Rate. The user decides which time factor suites the data that is plotted. The Decline Curve will define the economic limit depending on the parameters selected. Selecting the "Monthly" Production Radio Button will automatically change the Initial Production Rate (Q_i) and the Final Production Rate (Q_t) to monthly rates.

Monthly:
$$t = (Q_{ty} - Q_{iy}) * 12.0 \quad [\text{Months}]$$

Decline Curve Method: Exponential
$$K = \ln(Q_i/Q_t) / t$$

where
Q_i – Initial Production Rate
Q_t – Final Production Rate
Q_{iy} – Initial Production Year
Q_{ty} – Final Production Year
t – Time, units depend on radio button
K – Decline Curve Constant

Monthly Production Rate Decline Curve extended to economic Limit
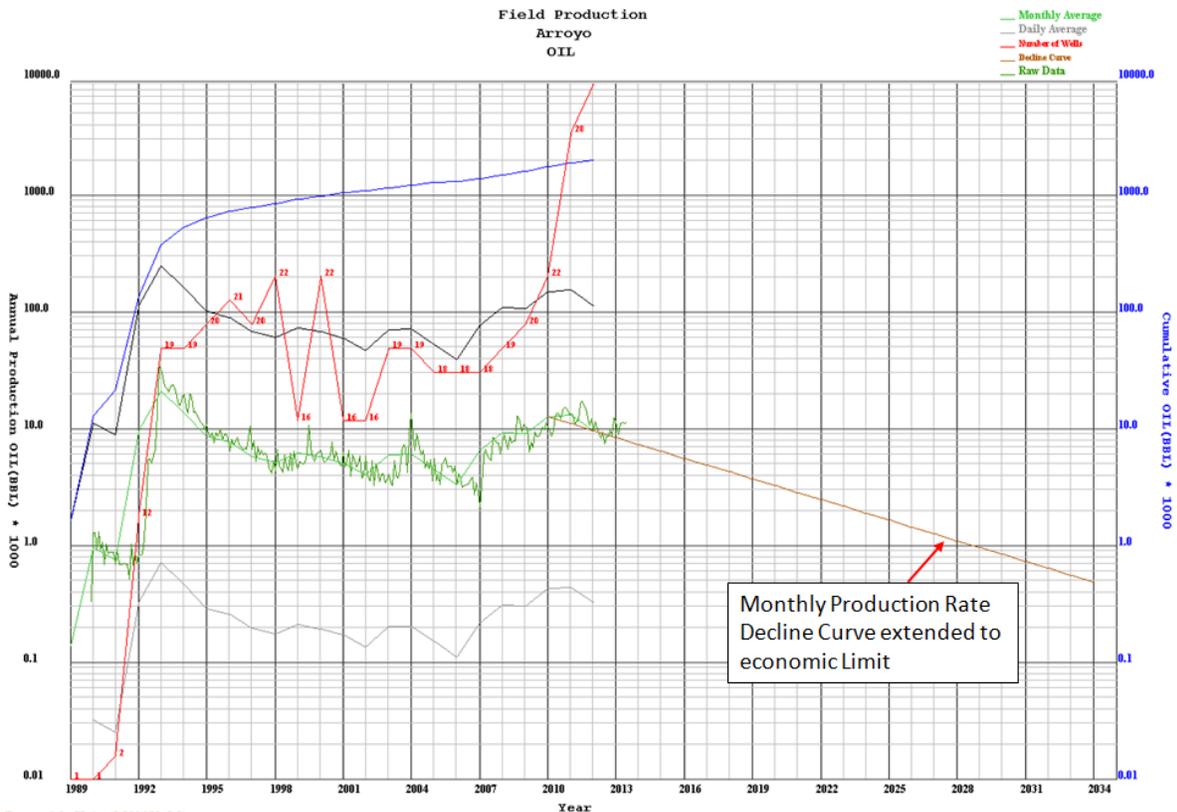
Exponential (K,n) = (0.011379, 0.0)
Initial Production Month Rate (Qi): 13532 BBL at 2010
Present Production Month Rate (Qt): 10306 BBL at 2012
Decline Rate (De): 11.92 % Per Year
Economic Limit Month Rate (Qf): 180.0 BBL at 2041

Cumulative to Data: 2238177 BBL
Computed: 2229737 BBL
Cumulative at Limit: 3119622 BBL
Remaining Reserves: 881445 BBL

Plot By-Daily Production Rate

The Decline Curve Calculator Panel illustrate the Daily Production Rate. The user decides which time factor suites the data that is plotted. The Decline Curve will define the economic limit depending on the parameters selected. Selecting the "Daily" Production Radio Button will automatically change the Initial Production Rate (Q_i) and the Final Production Rate (Q_t) to daily rates.

Daily:
$$t = (Q_{ty} - Q_{iy}) * 365.0 \ [\text{ Days }]$$

Decline Curve Method: Exponential
$$K = \ln(Q_i/Q_t) / t$$

where
- Q_i – Initial Production Rate
- Q_t – Final Production Rate
- Q_{iy} – Initial Production Year
- Q_{ty} – Final Production Year
- t – Time, units depend on radio button
- K – Decline Curve Constant
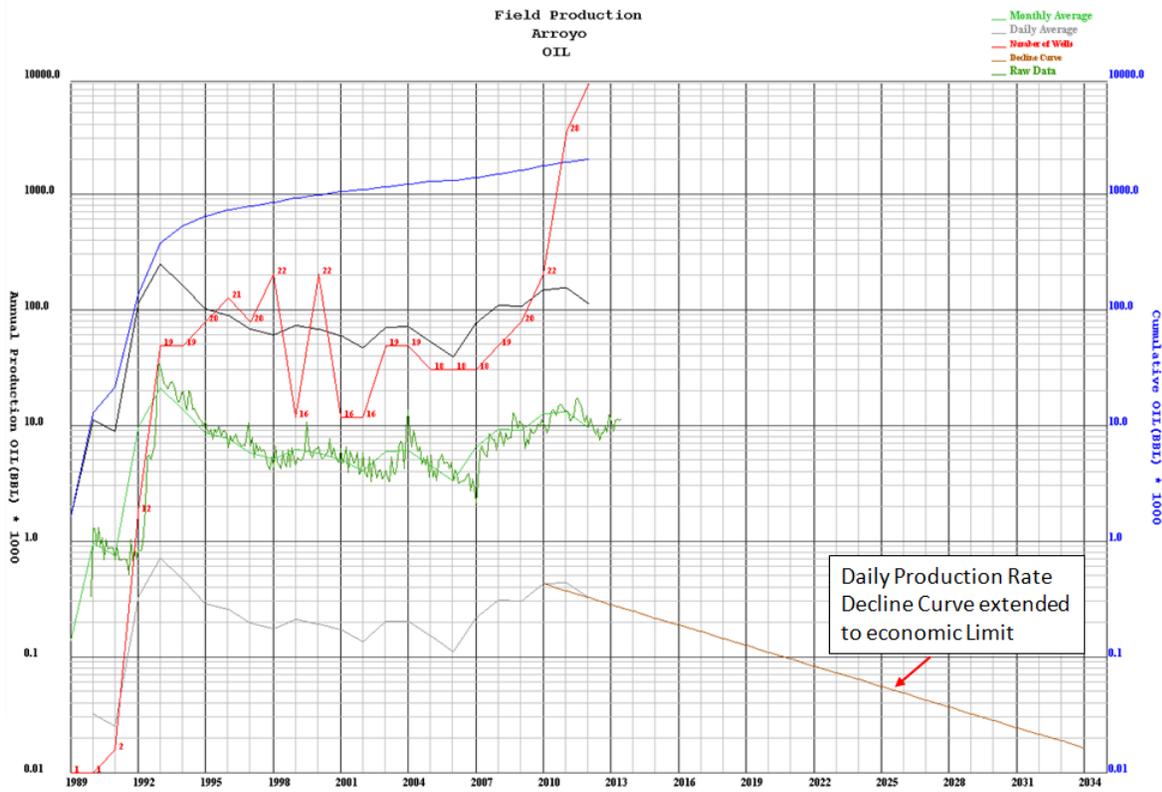
Compute Present Cumulative Production

Computed Cumulative Production for Present is found by finding the Cumulative Production at the Initial Production Rate (Q_i) and computing the Production Rate (Q_c) out to the Present Date.

Cumulative (Computed) = Cumulative @ Q_{iy} + Q_c @ Present

where Q_c is computed by Decline Curve Method as follows,

Exponential:
$$Q_c = (Q_i-Q_t) / K$$
Harmonic:
$$Q_c = Qi * \ln(Q_i/Q_t) / K$$
Hyperbolic:
$$Q_c = \{Q_i - Q_t* \exp[n*\ln(Q_i/Q_t)]\} / [(1.0-n) * K]$$

where
Q_i – Initial Production Rate
Q_{iy} – Initial Production Year
Q_t – Final Production Rate
n – Decline Curve Exponent
K – Decline Curve Constant
Q_c – Cumulative Production Rate

Compute Production Economic Limit Date (Qf)

The Production Date at Economic Limit (Q_{fy}) is computed from the Production Rate at Economic Limit (Q_f) by first computing the time from the Decline Curve Equations and converting the time to years as follows,

Time by Decline Curve Analysis Method:
Exponential: $t = \ln(Q_i/Q_f) / K$
Harmonic: $t = [(Q_i/Q_f) - 1.0] / K$
Hyperbolic: $t = \{\exp[n * \ln(Q_i/Q_f)] - 1.0\} / (K*t)$

Time converted to Date:
Day: $Q_{fy} = Q_{iy} + t / 365.0$
Month: $Q_{fy} = Q_{iy} + t / 12.0$
Year: $Q_{fy} = Q_{iy} + t$

where
Q_i – Initial Production Rate
Q_{iy} – Initial Production Year
Q_f – Production Rate at Economic Limit
Q_{fy} – Production Date at Economic Limit
t – Time
n – Decline Curve Exponent
K – Decline Curve Constant

Compute Economic Limit (EUR) and Reserves (RR)

Economic Limit (EUR) is computed by finding the Cumulative Production at the Initial Production Rate (Q_i) and compute the Production Rate (Q_c) out to the economic limit date.

Economic Limit (EUR) = Cumulative @ Q_{iy} + Q_c @ Q_{fy}

where Q_c is computed by Decline Curve Method as follows,
Exponential:
$$Q_c = (Q_i - Q_f) / K$$
Harmonic:
$$Q_c = Q_i * \ln(Q_i/Q_f) / K$$
Hyperbolic:
$$Q_c = \{Q_i - Q_f * \exp[n*\ln(Q_i/Q_f)]\} / [(1.0-n) * K]$$

where
Q_i – Initial Production Rate
Q_{iy} – Initial Production Year
Q_f – Production Rate at Economic Limit
Q_{fy} – Production Date at Economic Limit
n – Decline Curve Exponent
K – Decline Curve Constant
Q_c – Cumulative Production Rate

The Reserves (RR) is computed from the Economic Limit (EUR) subtracting the Actual Cumulative Production.

Reserves (RR) = Economic Limit (EUR) - Actual Cumulative

Extend to Limit Button

The decline curve analysis control dialog allows the user to extend the outer plot limit to the economic limit. In the "Production at Economic Limit" Panel the "Date" text field must have a value greater than the Initial Production Year. Select the "Extend to Limit" Button at the bottom of the panel to extend the production plot limit and note that the X-Axis Maximum text field will automatically change.
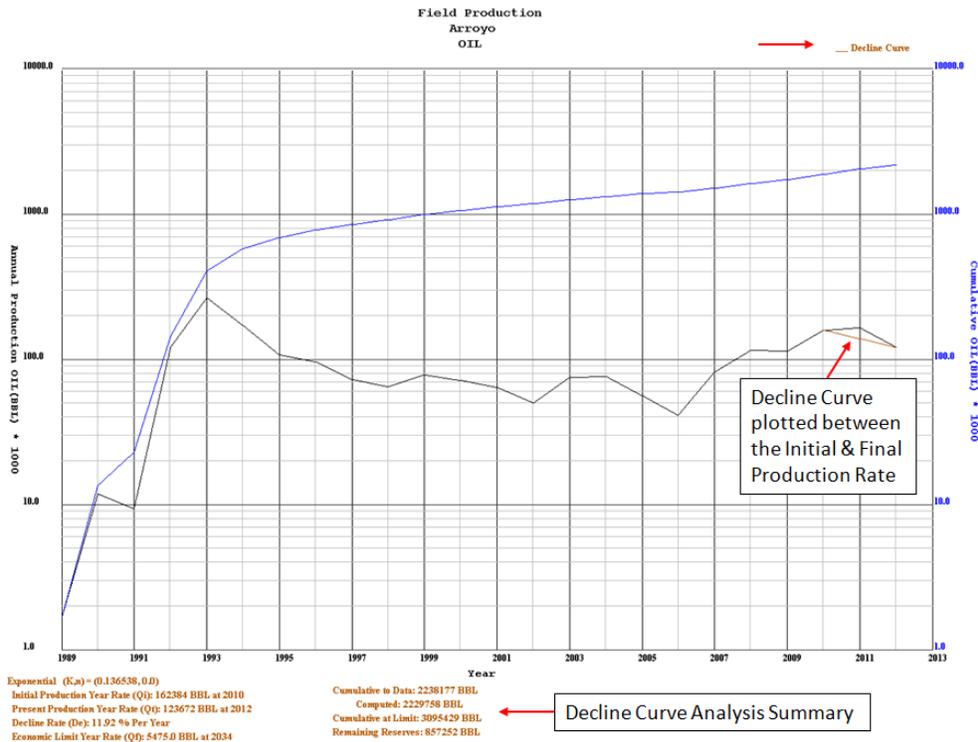
Notice that the X-Axis Maximum automatically changed to the Economic Limit Date plus 1 year. The "Extend to Limit" Button changed the text to "Reset Plot Limit", which will allow the user to restore the plot back to the original outer limit.