CITY OF JUNCTION CITY
Water System Master Plan
Junction City, Oregon

CHAPTER 5

PRESENT AND FUTURE WATER DEMANDS

Chapter Outline

PRESENT AND FUTURE WATER DEMANDS — CHAPTER 5

5.1 INTRODUCTION

A primary measure of the size of a municipal water system is the total amount of water that it delivers to consumers. This capacity is the sum of water required for domestic, commercial and industrial uses, water that is lost out of the system through leakage, in addition to water required for fire protection.

Future water demands have been prepared based on a number of variables including the following:

- Population projections
- Historical water demand
- Land use zoning within the study area
- Projected fire flows

The demand characteristics developed in this chapter will serve as the basis for evaluating the City's existing water system infrastructure and for sizing supply, treatment, storage and distribution infrastructure across the planning period.

5.2 TERMS AND DEFINITIONS

5.2.1 System Demand

The following terms are used to describe system demand:

Consumption – Consumptive demand is water delivered to the system's users through service connections. Consumption is generally less than demand, the difference being system loss. Consumption is measured by the consumer's meter and is accordingly the metered portion of demand.

Demand – The total amount of water entering the distribution system from water sources and storage facilities to meet various user needs. Demand equals consumption plus system loss and is usually measured by system master meters.

Fire Flow Demand – Demand required for fire fighting purposes. Fire flow demands vary by structure type and use and are proscribed by the City and/or fire code. Fire flow demand is considered to be met if the system can deliver the required flow rate while maintaining a minimum residual pressure in the distribution system of 20psi.

System Loss – System loss is water that cannot be accounted for. It is the difference between the total system demand and the total consumption. System loss is not necessarily the same as leakage. Although the majority of system losses are typically the result of leaks, losses can also be attributed to meter error, as well as unmetered uses such as street flushing, hydrant testing and similar activities.

5.2.2 Demand Variations

Water demands in municipal water systems vary widely across time. Seasonal, monthly, daily and hourly demand rates are utilized to evaluate and size various components of the overall water system. For the purposes of this report the following demand classifications will be used. The definitions are generally listed in order of increasing magnitude.

Average Day Demand (ADD) – The total volume of water that enters the system over a period of one year, divided by 365 days.

Maximum Day Demand (MDD) – The largest total volume of water that enters the system in a 24-hour period. MDD is commonly used to size water treatment plants, large diameter transmission mains and factors into the sizing of reservoirs.

Maximum Month Demand (MMD) – The largest total volume of water that enters the system in a one-month period, divided by 30 days.

Peak Hour Demand (PHD) – The greatest flow occurring in any one-hour period. PHD is used as one criterion for sizing distribution waterlines and factors into the equations used to size pump stations and reservoirs.

Minimum Hour Demand (MHD) – The lowest flow occurring in any one-hour period. MHD is used as one criterion for determining the ability of the water system to recharge storage facilities during periods of low demand.

5.3 POPULATION

Population projections serve as the basis for future water demand projections. Much of the challenge in projecting water system growth relates to the difficulty in accurately tracking or projecting actual populations.

The planned development of the DOC correctional facilities and the DHS psychiatric hospital in 2010-2013 is a significant influence to the existing municipal population. Accordingly, this section evaluates anticipated growth from a review of two data sources; historical municipal data, and planned development data for the DOC and DHS facilities. Separate discussions of each are presented below followed by a summary section that integrates the data from each category and establishes a combined growth curve for the planning period.

5.3.1 Historical and Future Municipal Population

Population histories provide a tool for determining the future growth rate of the municipal water system. The population in Junction City has steadily increased from approximately 700 people in 1920 to 4,721 in 2000. The current population of Junction City is approximately 5,900. Growth forecasting was performed using the exponential growth formula shown below:

$$P = P_0 e^{rt}$$

Where P = Population at time (t) in years

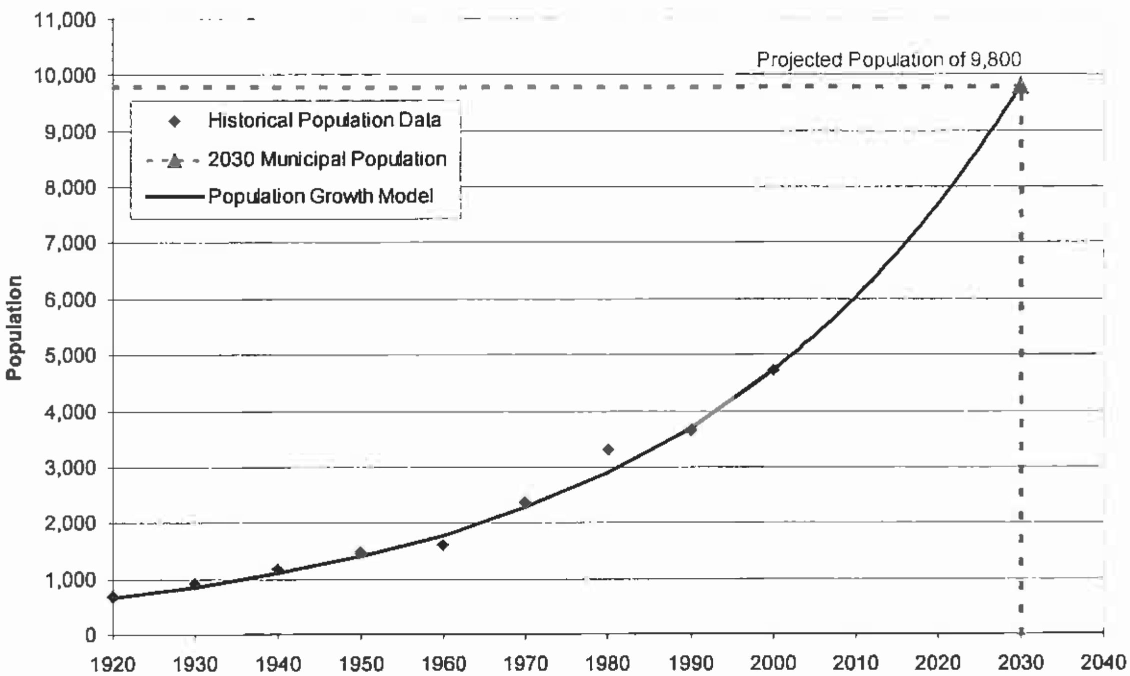
P_0 = Initial population

r = Average annual growth rate

t = Time elapsed from basis year

Figure 5-1 summarizes census data from the US Census Bureau from 1920 to 2000[8] superimposed with the growth rate curve fit to that data using the above equation and an average annual growth rate of 2.43% compounded from the 2000 US Census population figure.

Figure 5-1 | Municipal Population Growth Trend



The historical growth model predicts a 2030 population of 9,800 and is consistent with the findings of a 2005 study by the City, Lane Council of Governments (LCOG), and the Oregon Division of Land Conservation and Development (DLCD).

5.3.2 Future Prison and Hospital Populations

The DOC and DHS facilities will be located at the southernmost end of the UGB at a site approximately three miles south of town. The combined site comprises roughly 250 acres, half of which is outside the UGB. Both facilities are to be served by the City's water system.

Future populations for these two facilities are stipulated in an Intergovernmental Agreement (IGA) between the City and the respective agencies. Construction of the facilities is planned to begin in 2010 with inmate, patient and staff populations arriving in 2013. Table 5-1 summarizes the population groups in residence at the DOC and DHS facilities.

This report assumes that 950 of the 2,500 combined support staff for the two facilities will live in Junction City and contribute to the municipal residential demand base, with the remainder commuting from the Eugene-Springfield area or other areas outside the City. This new municipal population group is identified as the municipal influx population in the table below.

[8] United States Bureau of Census—Decennial Census Data, 2000

Table 5-1 | Summary of Prison and Hospital Populations

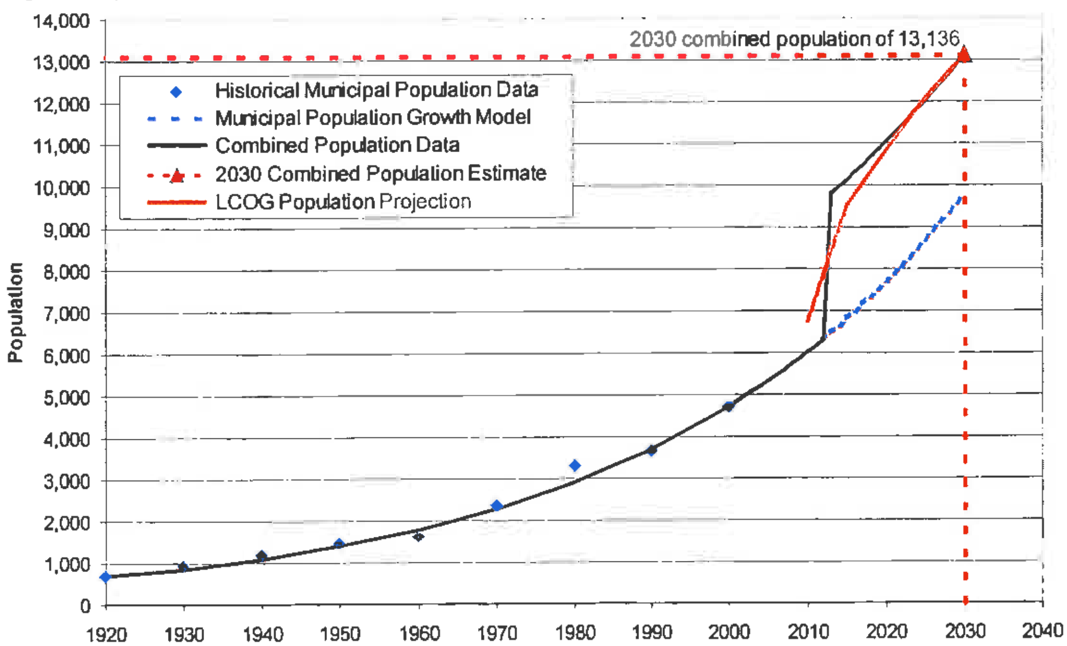
Facility	IGA Facility Populations	Municipal Influx Population
DOC		
Inmate Population	2,024	--
Staff Population (500 total)	--	190
DHS		
Patient Population	360	--
Staff Population (2,000 total)	--	760
Total	2,384	950

Unlike conventional municipal populations, the DOC and DHS populations are anticipated to establish rapidly and early in the planning period and remain at relatively fixed levels thereafter. Accordingly, this report conservatively assumes a 100-percent occupancy rate from the planned commissioning date for each facility.

5.3.3 Future Population Summary

The combination of the slower long-term municipal and rapid short-term prison/hospital growth rates form the basis for the combined population growth curve of this report. Figure 5-2 depicts the shift in the municipal growth curve model with the addition of prison and hospital populations in 2013. The rapid influx of the DOC and DHS group quarter population and the influx of facility staffing has the net effect of raising the total population at the end of the planning period from the previously established LCOG value of 9,800 to 13,136. A similar approach is used to forecast water demands in subsequent sections of this chapter.

Figure 5-2 | Combined Population Projection



In order to ensure that these projections maintain compatibility with local and statewide planning goals and are consistent with regional growth trends, the above methodology was compared to population forecasts solicited from LCOG. Lane County is currently developing coordinated numbers for the cities under its jurisdiction and although the final projections have yet to be formalized, preliminary forecasts were available. A complete listing of these data appears in Appendix X. Population figures from the LCOG data for 2015 through 2030 are superimposed on the projections of Figure 5-2.

Upon examination, the model correlates well with historical trends as well as regional estimates and will be used to project the existing municipal population across the planning period for the remainder of this report. A tabulation of population data for select years of the full planning period follows in Table 5-2.

It is currently estimated that the release of the final County coordinated population numbers will not occur until September 2009.

Table 5-2 | Combined Population Projections

Year	Municipal Population	DOC Resident Population	DHS Resident Population	Total
2010	6,022	–	–	6,022
2013[1]	7,429	2,024	360	9,813
2015	7,752	2,024	360	10,136
2020	8,632	2,024	360	11,016
2025	9,627	2,024	360	12,011
2030	10,752	2,024	360	13,136

[1] Commencement year for prison and hospital populations

5.4 HISTORICAL WATER DEMAND

Historical records of water demand provided by the City were evaluated to determine usage rates and demand fluctuations. The nine year period from 2000 to 2008 was used as a basis to establish historical water demands. The information of this section combined with the population data of Section 5.3 forms the basis for estimating future water demands as presented in Section 5.5.

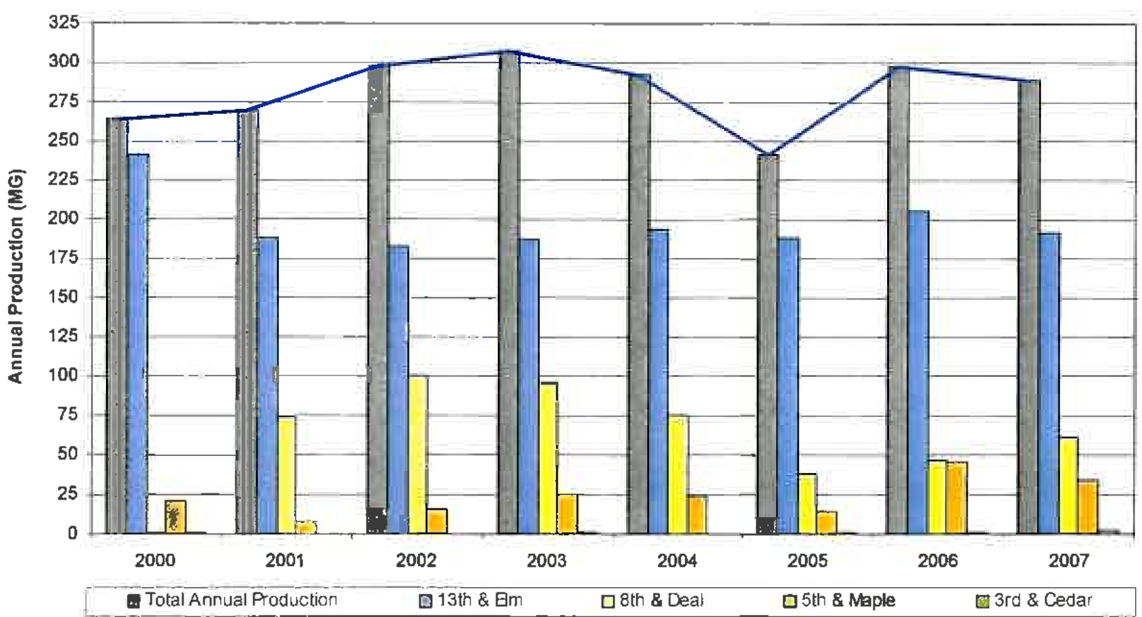
5.4.1 Water Production

The City currently owns six municipal wells and utilizes a combination of four of these facilities to meet their production needs. Annual water production is based on master meter readings at each of the utilized well sites and is presented in Table 5-3 and in Figure 5-3. Data for 2008 has been omitted from this tabulation due to incomplete data collection for the month of July.

Table 5-3 | Annual Water Production

Year	Total (MG)	13th & Elm (gallons)	8th & Deal (gallons)	5th & Maple (gallons)	3rd & Cedar (gallons)
2000	265	241,671,900	952,000	20,613,500	1,418,600
2001	269	187,720,100	74,054,445	7,671,900	37,300
2002	297	182,121,300	100,131,000	14,976,600	121,100
2003	308	187,109,700	95,129,000	24,937,700	674,400
2004	293	193,716,800	74,890,300	23,781,600	481,200
2005	241	188,218,300	37,752,300	14,549,900	763,900
2006	298	204,934,970	46,232,000	45,221,530	1,547,100
2007	289	191,551,000	61,197,200	33,878,500	2,678,800
Average Percent Production by Well		69.8%	21.7%	8.2%	0.3%

Figure 5-3 | Annual Water Production and Production by Well



Observation of the annual production rates in Figure 5-3 show a drop in production for 2005. Total production for this year was 18% below average after normalizing total production against population. Variations in annual demand are often influenced by fluctuations in weather patterns and the magnitude, and particularly the duration, of temperature and precipitation swings can significantly affect demand patterns. Interestingly, a review of historical temperatures and precipitation for 2005 showed no weather-based anomalies corresponding to the reduced demand of this year. For purposes of conservatism this report excludes the 2005 data from demand metrics.

A series of charts depicting detailed production variations across the water year for the years 2000-2007 appears at the end of this section. These charts show that for a given year demands generally begin rising in mid-May, peak in the month of July and August, and typically decline back to the winter season baseline by mid-October. Maximum month demand (MMD) almost exclusively occurs in July and only occasionally in August with an average demand of 59,200 gallons (excluding year 2005).

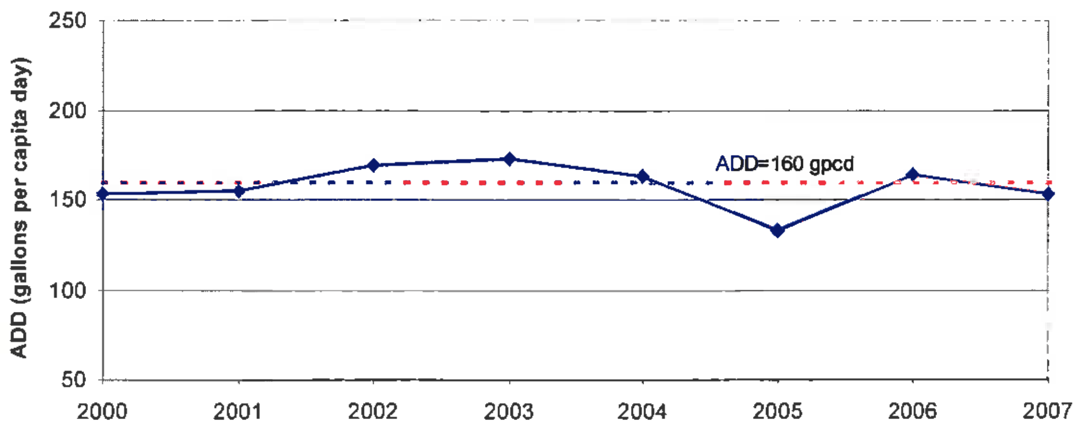
These charts also depict the number of wells operating during a given day. Intuitively, a higher number of wells are required to supply periods of peak demand. On average, one well (typically 13th & Elm) runs alone, delivering nearly 70% of total system demand across 47% of the days in a given year. By comparison, four pumps running in combination deliver demand for only 7% of the year. Clearly reliability and redundancy issues are paramount for the 13th & Elm facility. These issues are discussed further in Section 6.5.

5.4.2 Average Day Demand

Water demand is defined as the sum of all water produced and delivered to the City. It includes water consumed in all use categories and includes water loss. Water demand varies across seasonal periods, days of the week, and hours of the day. The establishment of an average day demand rate serves as the baseline against which other more intensified demands are measured.

Table 5-4 summarizes the historical water system production records normalized against population for the past nine years. Due to the size of this table and for the formatting purposes of this report the table appears at the end of this section. Figure 5-4 below is a graph of the per capita ADD values from that table. An examination of the ADD line shows that with the exception of year 2005, per capita ADD has been relatively consistent. This report establishes the ADD as 160 gpcd by averaging demand across these years with the exclusion of 2005 data.

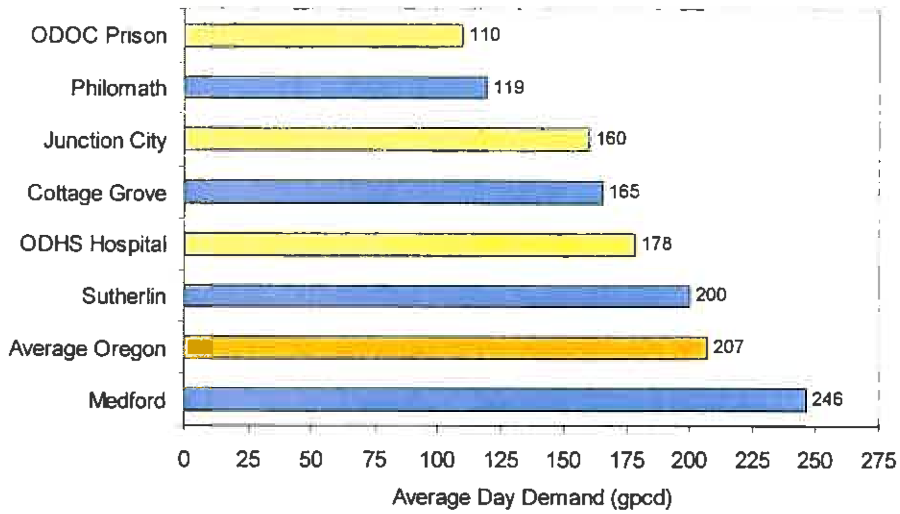
Figure 5-4 | Average Day Demand Trend



Averaged day demand for Junction City is also presented in Figure 5-5 along with ADDs for the future DOC and DHS facilities. This figure offers a comparative evaluation of Junction City's ADD with other regional municipalities as well as the statewide use for Oregon[9].

[9] USGS, 2000

Figure 5-5 | Average Day Demand—Regional Municipalities



It should be noted that Oregon's per capita water use exceeds the national average of 183 gpcd. Although the current water use levels in Junction City are in alignment with other comparable municipalities, the City should continue to take a proactive approach to water conservation as a means to perserve this valuable public resource.

5.4.3 Peaking Factors

Variations in water demand are typically expressed as ratios to the average day demand. Peak demands are important planning factors since facilities must be sized for maximum, not average demands.

5.4.3.1 Maximum Day Demand

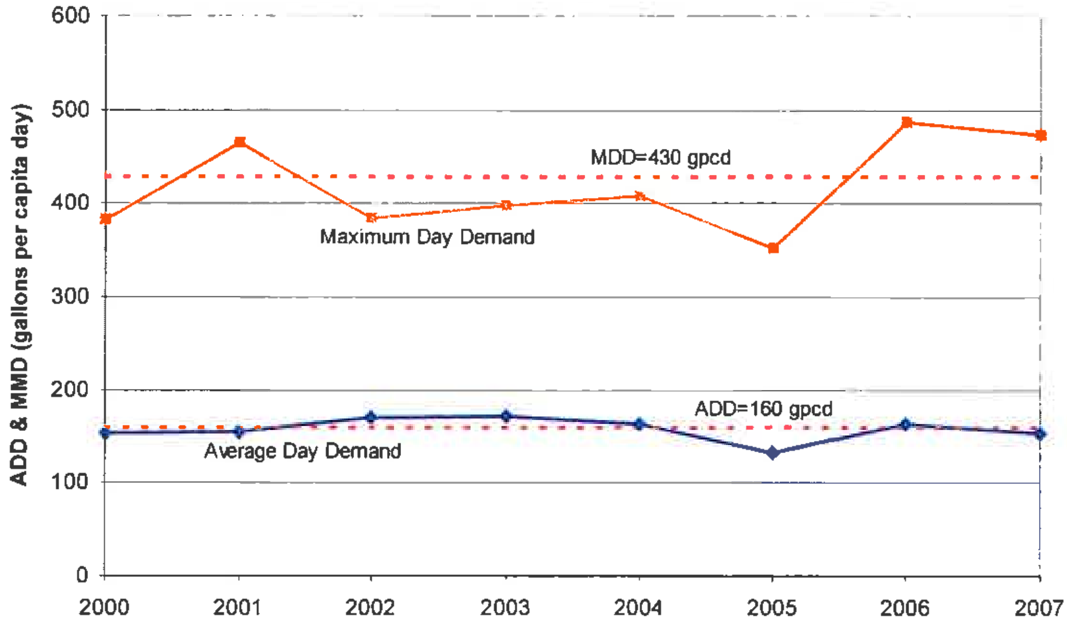
MDD is traditionally defined as the highest production day within the highest production month. MDD values are conventionally utilized to size treatment plant capacity, large diameter transmission mains and factors into the sizing of reservoirs.

A summary of maximum month and maximum day demands for historical municipal production is presented in Table 5-8 at the end of this section. Maximum day demands have been selected strictly on a peak flow basis regardless of the fact that they occasionally fall outside of the maximum month demand calculated on a calendar month basis. Figure 5-6 is a graph of the per capita MDD values from that table. ADD values are also charted for reference.

Although the year 2005 demand has been excluded from the overall demand projections as previously discussed, the peaking factor for that year remains valid. MDD peaking factors for the period of review ranged from 2.31 to 3.07. The average ADD:MDD peaking factor for this period—2.70—has been selected as the MDD peaking factor for this report. The value is reasonable when compared to literature ranges of 1.5 to 3.5[10]. Later sections of this report will apply this peaking factor against population projections to establish MDDs across the planning period.

[10] Mays, 2000

Figure 5-6 | Maximum Day Demand and Average Day Demand Trends

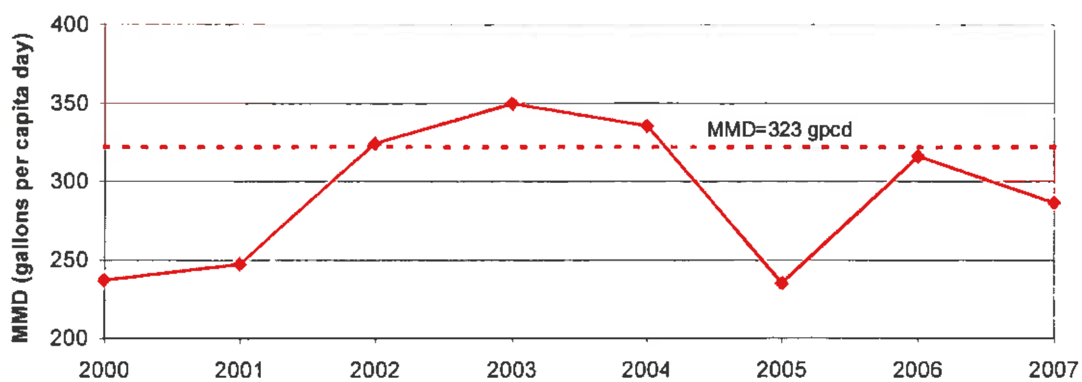


It is interesting to note that the ADD:MDD ratio has been increasing since 2002 with an accelerated rate of increase in 2006 and 2007. Peaking factors typically decrease with population growth due to the increased variety of water usage in larger systems.

5.4.3.2 Maximum Month Demand

Maximum month demands normalized against population are depicted in Figure 5-7 below. Data for the years 2000, 2001 and 2005 were discarded in favor of more uniform and current data. These values were averaged to establish an MDD of 323 gpcd, a value that yields an ADD:MMD peaking factor of 2.0. Maximum month demand is perhaps the most variable of the peaking factors as the period is long enough to capture the full effect of seasonal weather trends.

Figure 5-7 | Maximum Month Demand Trend



5.4.3.3 Peak Hour Demand

Due the short duration of peak hour demands and the large cost of constructing source and treatment facilities to match peak demands, peak hour demand, unlike maximum day demand, is satisfied with reservoir storage. The distribution network must be capable of supplying this demand with a minimum residual pressure of 20psi throughout the system.

The City does not currently collect demand data on an hourly basis. Although hourly production data from the wells is available, no hourly reservoir level data is available to reconcile net inflow and outflow for the hour in question. Hourly production rates were evaluated for a two-day window on either side of the maximum day demand for 2004, 2006 and 2007. Peak hour well production ranged between 2,350 gpm and 2,550 gpm and generally occurred between 6:00 and 9:00 p.m. The City's operations staff confirm that peak hour demand is met with full production from the following wells; 13th & Elm, 8th & Deal, 5th & Maple and 3rd & Cedar. In some instances the south fire pump is required to transfer water from the ground storage facility.

A comparison of this flow rate with the total volume in the City's existing elevated reservoir predicts a 40-45 minute turnover in the reservoir at this flow rate. Due to the elevated reservoir's short residence time, the peak production rate from the wells was relied on as a reasonable approximation of peak hour demand. This approach yields an ADD:PHD peaking factor ranging from 4.21 to 4.41 and falls within the range of literature values listing ADD:PHD ratios from 2.0 to 7.0[11]. Because of the conservatism typically utilized at the master planning level a peaking factor of 5.0 was selected and will be used throughout this report for municipal demands as well as DOC and DHS demands.

5.4.3.4 Minimum Hour Demand

Reservoir storage deficits are greatest at the minimum hour demand following the peak of the MDD day. This period typically occurs after midnight and is the condition under which the reservoirs are filling and the highest operational pressures in the distribution system are experienced.

An observation of the well production charts for the MDD day of 2007 and 2008 show a low flow period occurring between 10:00 p.m. and 5:00 a.m. This low use period has excellent correlation with the predicted low use period of 11:00 p.m. to 5:00 a.m. as discussed in the paragraph to follow regarding demand patterns. As with peak hour flows, the hourly well production charts were utilized to estimate minimum hour flow and yielded an approximate minimum hour demand between 70% and 90% of ADD.

5.4.3.5 Demand Patterns

Water use throughout a distribution system modulates due to continuously varying demands. Demand patterns were developed for residential, commercial/industrial, and prison populations to capture the variation of demand over time. These demand patterns were utilized in the hydraulic model to replicate demand variations across time.

Of these patterns, residential demand patterns conventionally exhibit the highest variability. A generalized demand curve was developed using hourly well production records and the results of an AWWA Research Foundation study on residential water use. Despite the limited nature of the

[11] Mays, 2000

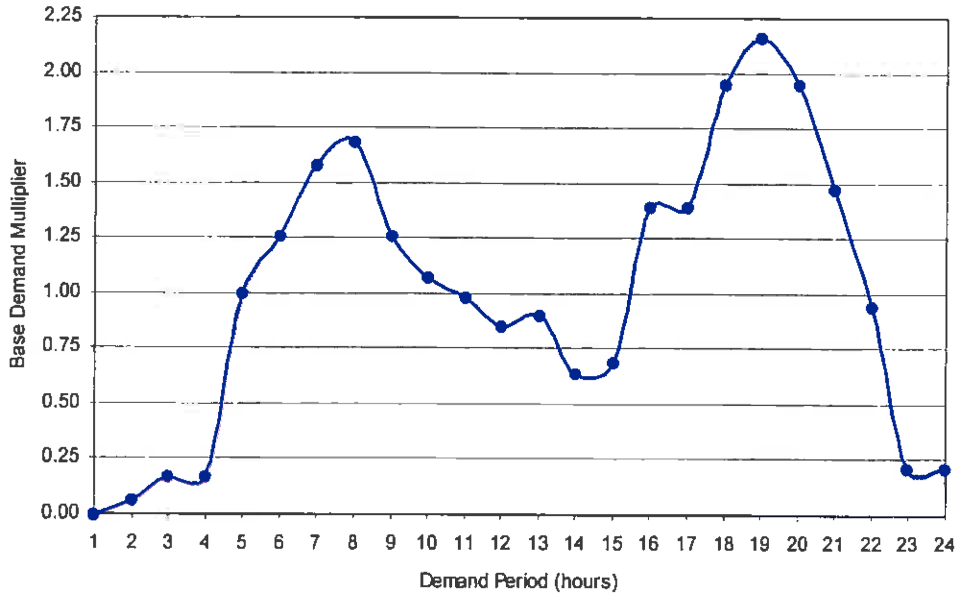
City's hourly demand data, the generalized pattern adds value to the report and may be refined with future data collection efforts.

Residential diurnal demand patterns typically depict four distinct use periods that can generally be defined as follows:[12]

- Lowest usage during the night (11 p.m. to 5 a.m.)
- Highest usage in the morning (5 a.m. to 11 a.m.)
- Moderate usage during midday (11 a.m. to 6 p.m.)
- High evening usage (6 p.m. to 11 p.m.)

In contrast to the above data, the City's hourly well production charts during peak season, indicate that the evening peak occurs between 6:00 and 9:00 p.m. and is larger than the conventional morning peak as described above. This is possibly due to a peak in residential irrigation during the latter part of the day. The generalized demand curve from the above study was accordingly modified to better fit the observed peaking periods. This demand pattern was then utilized for all residential demands and is depicted in Figure 5-8. Low and high-density residential areas utilize the same demand pattern with a the application of the applicable base flow.

Figure 5-8 | Residential Demand Pattern



A commercial/industrial pattern was developed and consisted of a uniformly distributed demand across a 12-hour period (6 a.m. to 6 p.m.). Demands for the top 25 large volume water users were simulated with the facility specific base flow and distributed according to either a residential or commercial/industrial demand pattern as applicable.

DOC prison use was approximated as a variable pattern with four steadily diminishing demand peaks occurring at 6:00 a.m., 12:00 p.m., 5:00 p.m. and 10:00 p.m. Flows for this user group are

[12] DeOreo, William et. al., 1999

essentially zero between the hours of 10:00 p.m. and 5:00 a.m. DHS demands were approximated using the residential demand curve with a facility specific base flow.

5.4.4 Water Loss

Water loss or unaccounted water is comprised of the difference in water produced and water consumed and consists of all unmetered uses and system leakage. It is important to differentiate these two categories of water loss. Unmetered use is commonly the result of inaccurate metering of consumer demand, unmetered or unauthorized connections, inaccurate or unrecorded flows for hydrant and main flushing, unmetered water for construction or operations & maintenance uses (street sweeping), unmetered water for fire fighting, and reservoir overflows. System leakage, as the name implies, is water lost due to deteriorating pipe, pipe joints, service connections and the like. With proper record keeping and metering of water, the percentage of unaccounted for water approaches the net volume lost to leakage. Conventionally acceptable rates of water loss range between 10 and 15 percent[13].

Oregon Administrative Rule (OAR) 690-086-0150(4)(a) requires municipalities to conduct annual water loss audits. Leak repair programs are required when net system leakage exceeds 10%. In 2007, Junction City provided oversight for a waterline leak location study. The two week study utilized sonic detection equipment to locate and quantify distribution system leaks at 873 discrete points comprised of hydrants, valves and water services. The study surveyed approximately 6 miles of pipe in the older portions of the distribution system in the downtown core. Water loss for the survey area was determined to be 10% to 12%.

In an effort to examine leakage rates outside of this downtown area, billing records for the period of June 2007 through May 2008 were compared with total water production from the wells for this same period. The result was an average water loss of 10.1% confirming that most of the water loss is occurring in pipes of older construction.

Chapter 9 of this report discusses the proposed increase to the City's operating pressure that will result from new elevated reservoirs constructed to a higher hydraulic grade line. Future planning efforts should review billing and production rates after the construction of these facilities to quantify the effect a higher operating pressure has on water loss. The recommendation to replace deteriorating small diameter pipe as identified in Chapter 8 will also contribute to a reduction of this rate.

5.4.5 Water Use by Category

Water consumption by use category was determined by reviewing available water-billing records for fiscal year 2008. Residential use is the largest use category and comprises 53 percent of the consumed water total, increasing slightly in the summer months. Commercial uses and multi-family/bulk users comprise 34 and 13 percent respectively. This data generally reflects the breakdown of water meter population by account type as previously reported in Section 4.1.2

5.4.5.1 Residential Demand

The application of unit demands based on common planning units is often helpful when evaluating the impact of future residential developments. Unit demands are commonly calculated

[13] Praifska, 1994 and Mays, 2000

on the basis of demand per equivalent dwelling unit (EDU). Unit demands have been prepared based on the residential consumption records for 2008 and the residential meter population for that same period. Using this method it was determined that the average single family household uses 216 gallons per day. Planning data provided by the City shows an average density of 2.6 people per household. This equates to an average per capita consumption of 83 gpcd. It should be noted that this value unlike the comparisons of Section 5.4.2 is strictly a measure of residential consumption and excludes industrial and commercial usage as well as water loss.

The application of this metric in future planning efforts should take into consideration the significant influence residential density has on water demand. There is a direct correlation between lot size and water use per EDU. Planning estimates using these demand factors should consider this influence whenever a development is designed with large lots and in particular where no limits to irrigation uses will be imposed.

Future planning efforts should update this value to include the results of curtailment and conservation programs currently under development.

5.4.5.2 Non-Residential Demand

Non-residential demand for Junction City is divided among commercial, industrial, technological and public facility consumer categories. Such consumer groups have a wide range of water demands ranging at times from less than to significantly more than typical residential demand rates. Although water consumption by user groups can be tabulated from City billing records, there is no available information for the developed acreage associated with each account. This prevents the calculation of average demands per acre by land use. Should this information become available in the future, the City's actual demands can be compared to the conventional water demands based on land use as shown in Table 5-4.

Table 5-4 | Unit Demands for Non-Residential Uses[14]

	Demand (gpad)	
Land Use	Range	Average
Office Commercial	1,100 – 5,100	2,030
Retail Commercial	1,100 – 5,100	2,040
Light Industrial	200 – 4,700	1,830
Heavy Industrial	200 – 4,800	4,830
Schools	400 – 2,500	620
Parks	400 – 3,100	730

5.4.6 Large Volume Water Users

A list of the top 25 water users was compiled from billing records for June of 2007 and 2008. The account types in this group were primarily commercial, multi-family residences and public accounts. Consumption for this group averaged 6.6% of total system consumption for these

[14] Mays, 2000

recording periods. The top five users and their two-year average maximum month demands are listed in Table 5-5.

Table 5-5 | Top Five Municipal Water Users

Account	Average MMD (gpd)
Scandia Village	22,876
Lochmead Dairy	15,334
Safeway	12,990
Oak View Apartments	10,846
Norseman Village	10,659

5.5 PROJECTED WATER DEMAND

This section builds on the discussions of population projections in Section 5.3 and the discussion of historical water demand as presented in Section 5.4. The basis for projecting future water demands is based in the establishment of a historical demand baseline along with historical peaking factors. The population projections of Section 5.3 will be combined with historical per capita usage rates and peaking factors established in Section 5.4 to forecast future water demands.

5.5.1 Projected Municipal Water Demand

Projected municipal demands have been based on the following assumptions:

- It is assumed that the ratio of residential to non-residential use (commercial, industrial and public uses) will remain constant. In other words, future commercial and industrial developments will track population growth.
- It is assumed that the long-term per capita water demands will not exceed the City's historical averages. Since the efficacy of planned water conservation programs is unknown at this time, the water demand projections of this report exclude conservation. The future success of the City's water conservation policies will serve to further increase the margins of safety used to plan and design the water system infrastructure.
- It is assumed that new commercial and industrial developments will not be large water users; no provision has been made for new industries with heavy water demands such as food processing or beverage production.
- It is assumed that the population projections of Section 5.3 are reasonable estimates of future municipal populations and that the forecasted peaking factors established in Section 5.4 are reasonable estimates of future demand variations.
- It assumes that future water loss will not exceed the City's historical averages.

5.5.2 Projected Prison and Hospital Demands

The IGA between the City, DOC and DHS defines ADDs for the prison and hospital at 110 and 178 gallons per day per bed respectively. These rates were established from operating records of similar facilities and from planning estimates. As previously presented in Figure 5-6, the prison and hospital ADD rates are 31% below and 11% above the City's ADD respectively.

As discussed in Section 5.3.2, it has been assumed that a total of 950 support staff for the two facilities will live in Junction City and contribute to the municipal residential demand base, with the balance commuting from the Eugene-Springfield area or other areas outside the City. Although DOC and DHS water demand planning assumptions are listed on a per bed basis, it should be noted that these rates include demand for all staff.

5.5.3 Projected Water Demand Summary

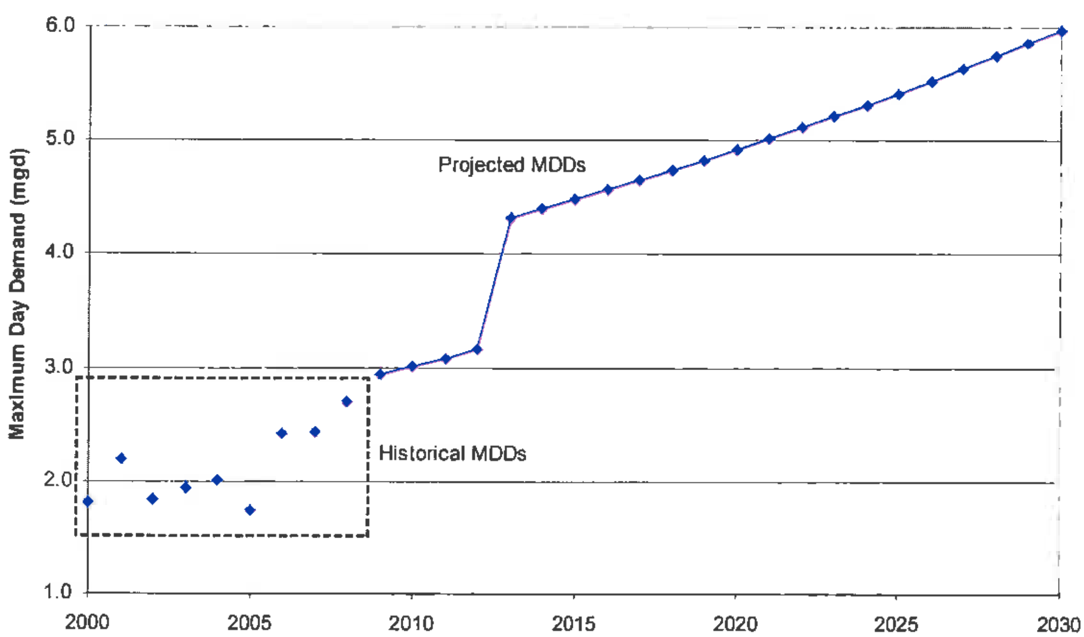
Future water demand for the municipal population is calculated by multiplying the base ADD rate by the appropriate peaking factor and multiplying again by the projected population for the planning year in question. A similar approach is used for the DOC and DHS facilities using the facility specific ADDs and peaking factors as summarized in Table 5-6 below.

Table 5-6 | Peaking Factor Summary

Population Group	ADD (gpcd)	ADD:MDD Peaking Factor	ADD:MMD Peaking Factor	ADD:PHD Peaking Factor
Municipal	160	2.70	2.0	5.00
DOC	110	1.75	--	5.00
DHS	178	1.75	–	5.00

The calculated demands for each population group are then combined to create a composite demand curve that is extrapolated across the planning period. Figure 5-9 depicts the results of this process for MDDs and Table 5-9, on page 5-19, summarizes the full set of calculated demands for each year in the planning period.

Figure 5-9 | Projected Maximum Day Demands



5.6 FIRE FLOW

The water distribution system is a community's primary resource for fighting fires. Storage facilities and fire hydrants must be suitably sized and configured to reliably deliver the required fire flows to all areas within the city limits. The Insurance Services Office (ISO) and Uniform Fire Code (UFC) provide guidelines to determine fire flows for various structures.

The ISO standards require a minimum flow of 1,000 gpm for a 2 hour duration in residential areas and a flow of 3,500 gpm for a 3 hour duration in commercial areas. The UFC recommends fire flows based in part on an evaluation of the construction materials used in a structure, its physical configuration, separation from other structures and occupancy. On this basis, fire flows for large commercial, industrial and multi-family developments are typically higher than 3,500 gpm.

The City has adopted a policy of requiring adequate fire flow capacity as a prerequisite for future development and has codified the fire flow requirements in the Public Works Design Standards. This information is summarized in Table 5-7. It should be noted that these minimum recommendations do not supersede fire flows required by the Oregon building and fire codes.

Table 5-7 | Minimum Fire Flow Requirements

Location	Recommended Fire Flow (gpm)	Duration (hours)	Required Volume (gallons)
Low Density Residential, R-1	1,000	2	120,000
Medium Density Residential, R-2	1,250	2	150,000
Residential Commercial, RC	2,500	3	450,000
Public (Schools & Institutions)	3,500	3	630,000
Commercial/Industrial, C-1, C-2, I			
Existing Facilities	Up to 4,000	4	960,000
New Facilities	6,000	4	1,440,000

Fire flows in general, are orders of magnitude greater than MDD or PHD flows. In order to limit the size of water mains delivering fire flows to large combustible structures and the overall volume of water required to suppress a fire, some cities have adopted policies stating that all buildings requiring fire flows greater than 2,500 gpm install an automatic sprinkler system.

In September 2008, the International Residential Fire Code Fire Sprinkler Coalition, a U.S. association comprised of more than 100 fire service, building code official, and safety organizations representing 45 states, voted unanimously to modify the International Residential Code (IRC) and require sprinkler systems for all new one- and two-family homes and townhouses. The change will first appear in the 2009 IRC. Forty-six states (including Oregon) use the IRC as the model document for their codes regulating new home construction. Future announcements will determine an implementation schedule for this trend in residential fire protection.

Lastly, in addition to the required flow rates presented above, OAR 333-061-0025 requires that a minimum pressure of 20 psi must be maintained in the distribution system at all times, inclusive of fire flow events. Evaluations of the distribution system—existing and future—to deliver the adopted fire flows are presented in Section 8.4.3 of this report.

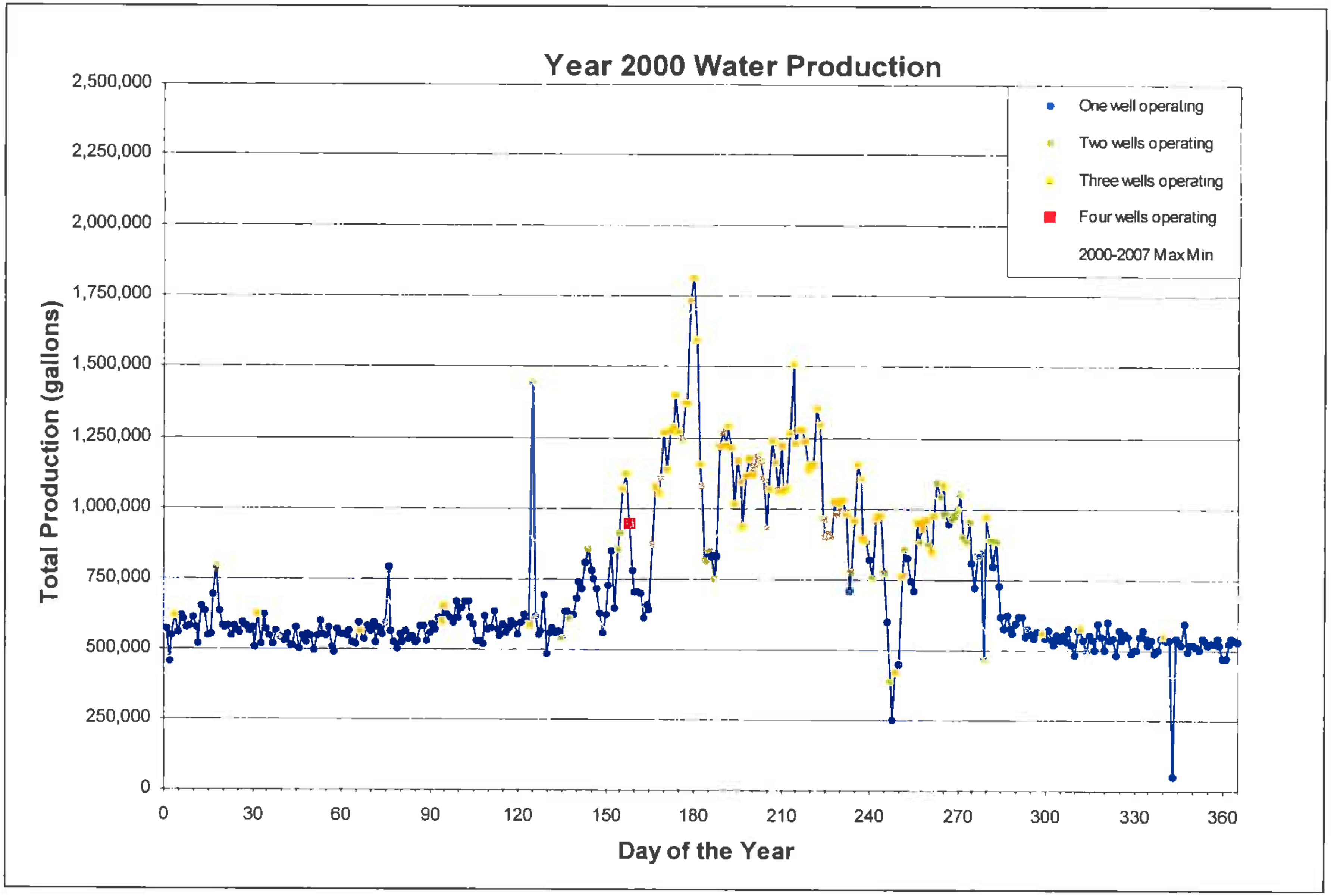
Table 5-8 | Historical Water Production Records

Year	Population	Total Production (MG)	ADD		MDD			MMD	
			(gpcd)	(gal)	(gpcd)	(mgd)	Date	(gpcd)	Month
2000	4,721	264.7	153	723,104	384	1.81	6/28/00	237	July
2001	4,730	269.5	156	736,294	465	2.20	6/21/01	248	July
2002	4,790	297.4	170	812,432	385	1.84	7/11/02	324	July
2003	4,890	307.9	173	841,122	399	2.01	7/31/03	350	July
2004	4,910	292.9	163	800,191	409	1.74	7/23/04	336	July
2005	4,945	241.3	133	659,247	353	2.42	7/19/05	236	July
2006	4,965	297.9	164	814,032	487	2.43	7/25/06	317	August
2007	5,135	289.3	154	790,452	473	2.67	7/13/07	287	July
2008	5,736	—[1]							

[1] *Unknown, since production data for the maximum month of this year was unavailable.*

Table 5-9 | Projected Water Demand

Year	Base Municipal Population	DOC / DHS Municipal Population	DOC Inmates	DHS Patients	TOTAL Population	MDD (mgd) Base Municipal	DOC + DHS Municipal	DOC + DHS Facilities	Projected MDD	ADD (mgd)	MMD (mgd)
2007	5,598					2.4			2.4	0.9	44
2008	5,736					2.7			1.8	1.0	2.7
2009	5,877					2.9			2.9	1.1	54
2010	6,022					3.0			3.0	1.1	56
2011	6,171					3.1			3.1	1.2	57
2012	6,323					3.2			3.2	1.2	58
2013	6,479	950	2,024	360	9,813	3.2	0.4	0.6	4.3	1.6	90
2014	6,638	950	2,024	360	9,972	3.3	0.4	0.6	4.4	1.6	92
2015	6,802	950	2,024	360	10,136	3.4	0.4	0.6	4.5	1.7	93
2016	6,970	950	2,024	360	10,304	3.5	0.4	0.6	4.6	1.7	95
2017	7,141	950	2,024	360	10,475	3.6	0.4	0.6	4.6	1.7	96
2018	7,317	950	2,024	360	10,651	3.7	0.4	0.6	4.7	1.8	98
2019	7,498	950	2,024	360	10,832	3.7	0.4	0.6	4.8	1.8	99
2020	7,682	950	2,024	360	11,016	3.8	0.4	0.6	4.9	1.8	101
2021	7,872	950	2,024	360	11,206	3.9	0.4	0.6	5.0	1.8	103
2022	8,066	950	2,024	360	11,400	4.0	0.4	0.6	5.1	1.9	105
2023	8,264	950	2,024	360	11,598	4.1	0.4	0.6	5.2	1.9	107
2024	8,468	950	2,024	360	11,802	4.2	0.4	0.6	5.3	2.0	108
2025	8,677	950	2,024	360	12,011	4.3	0.4	0.6	5.4	2.0	110
2026	8,891	950	2,024	360	12,225	4.4	0.4	0.6	5.5	2.0	112
2027	9,110	950	2,024	360	12,444	4.6	0.4	0.6	5.6	2.1	114
2028	9,334	950	2,024	360	12,668	4.7	0.4	0.6	5.7	2.1	116
2029	9,564	950	2,024	360	12,898	4.8	0.4	0.6	5.9	2.2	119
2030	9,800	950	2,024	360	13,134	4.9	0.4	0.6	6.0	2.2	121
2040	12,501	950	2,024	360	15,835	6.3	0.4	0.6	7.3	2.7	146
2050	15,947	950	2,024	360	19,281	8.0	0.4	0.6	9.1	3.4	178


Year 2000 Water Production
Total Production (gallons)
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1,000,000
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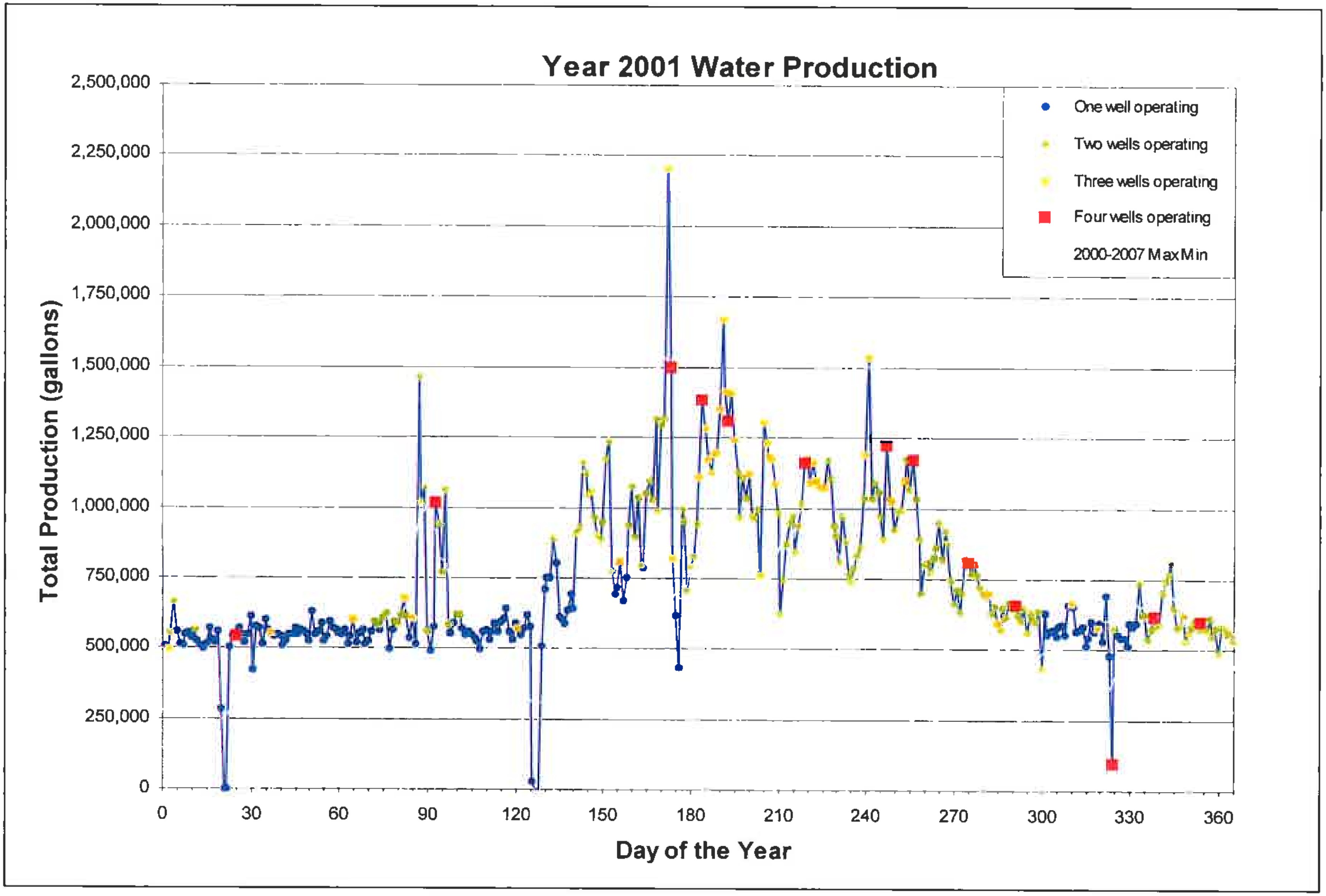
240
270
300
330
360
Day of the Year
One well operating
Two wells operating
Three wells operating
Four wells operating
2000-2007 Max Min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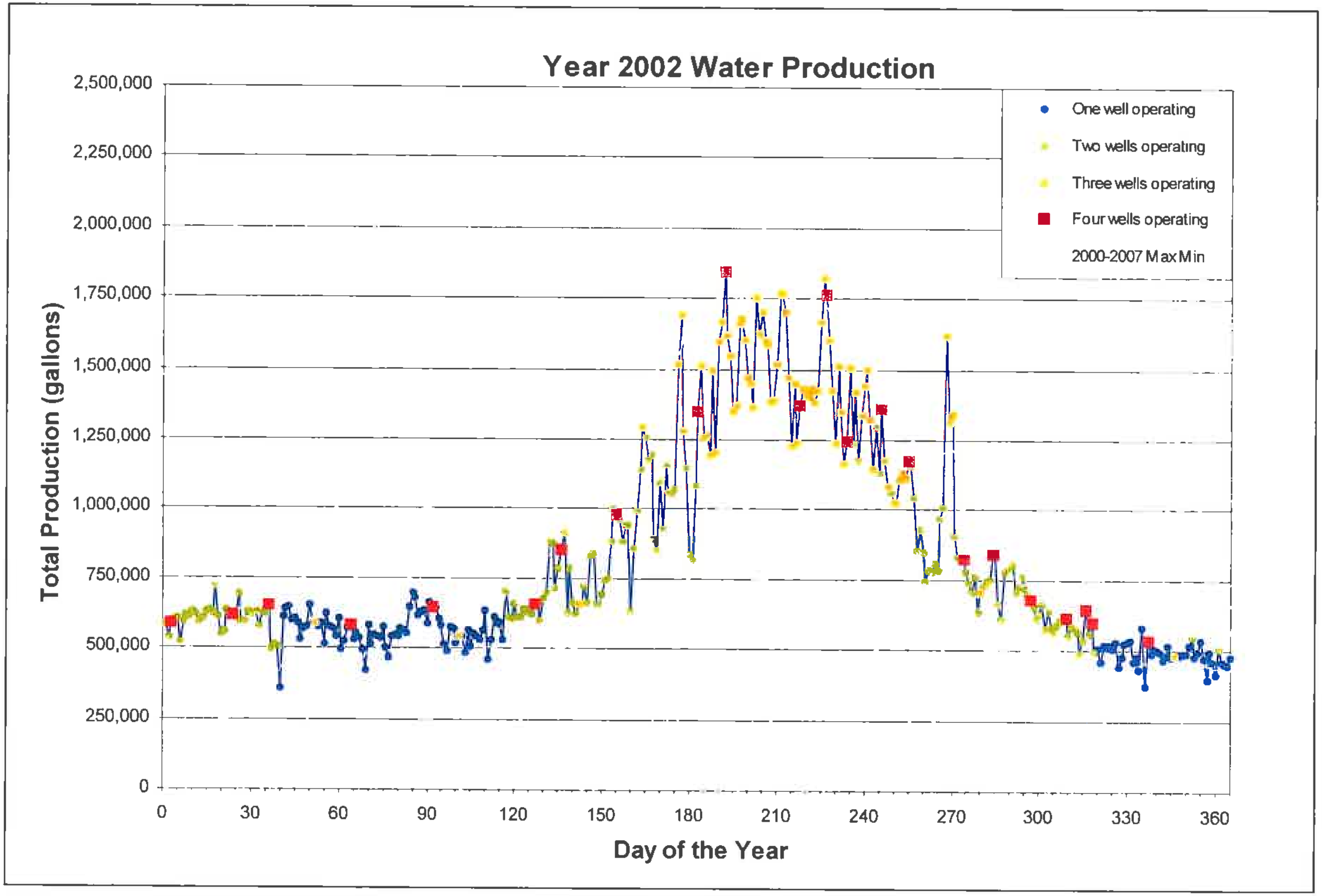
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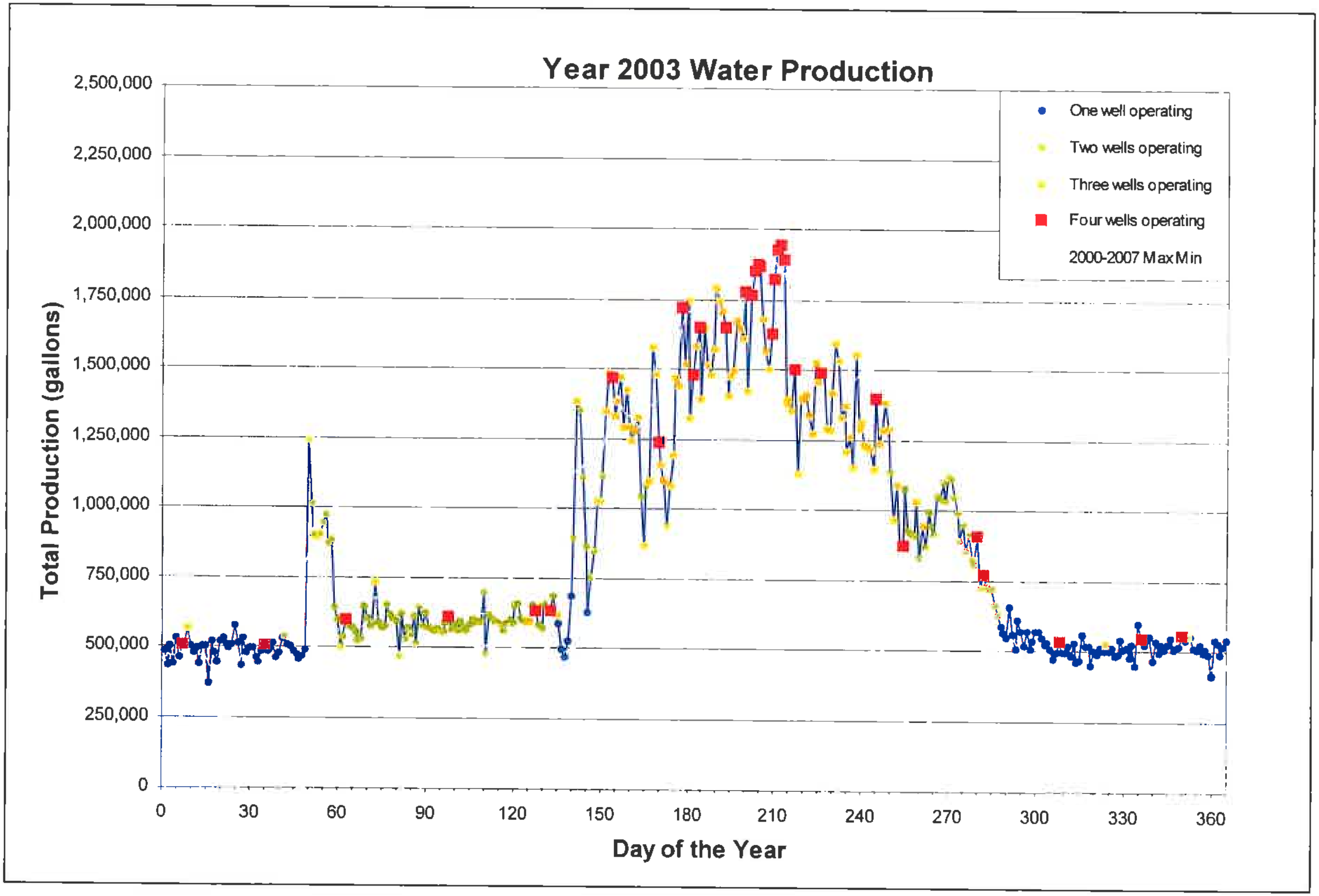
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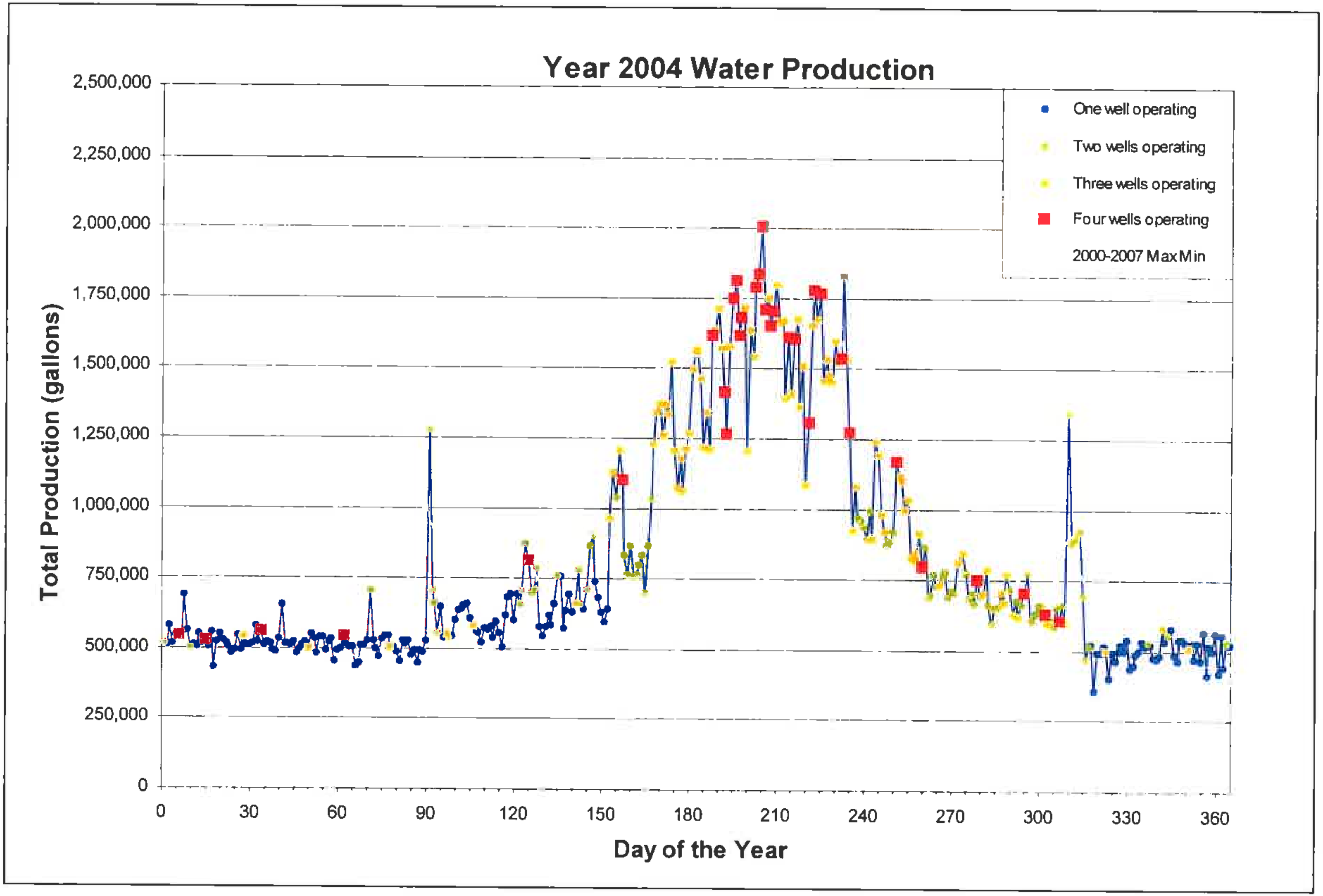
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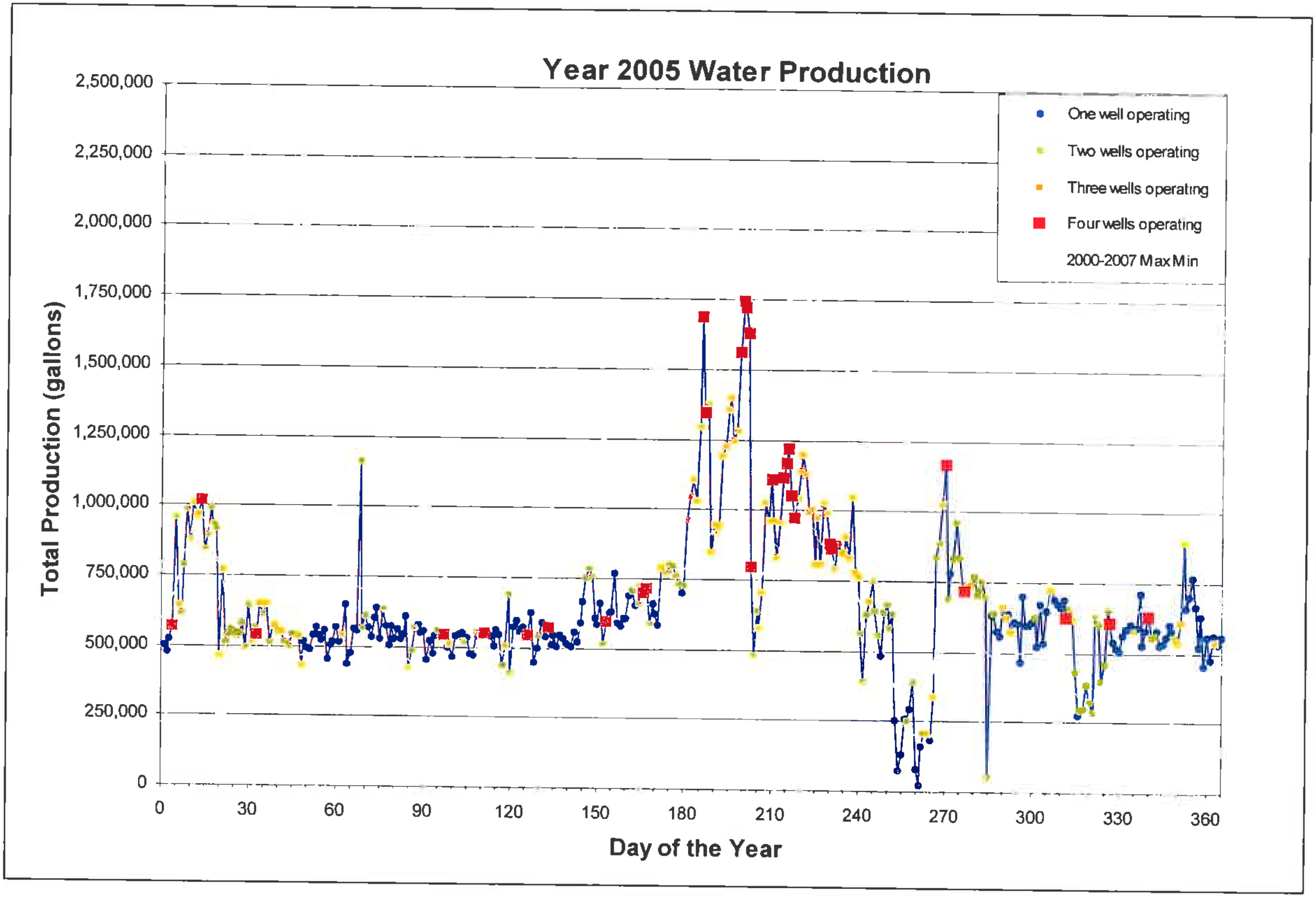
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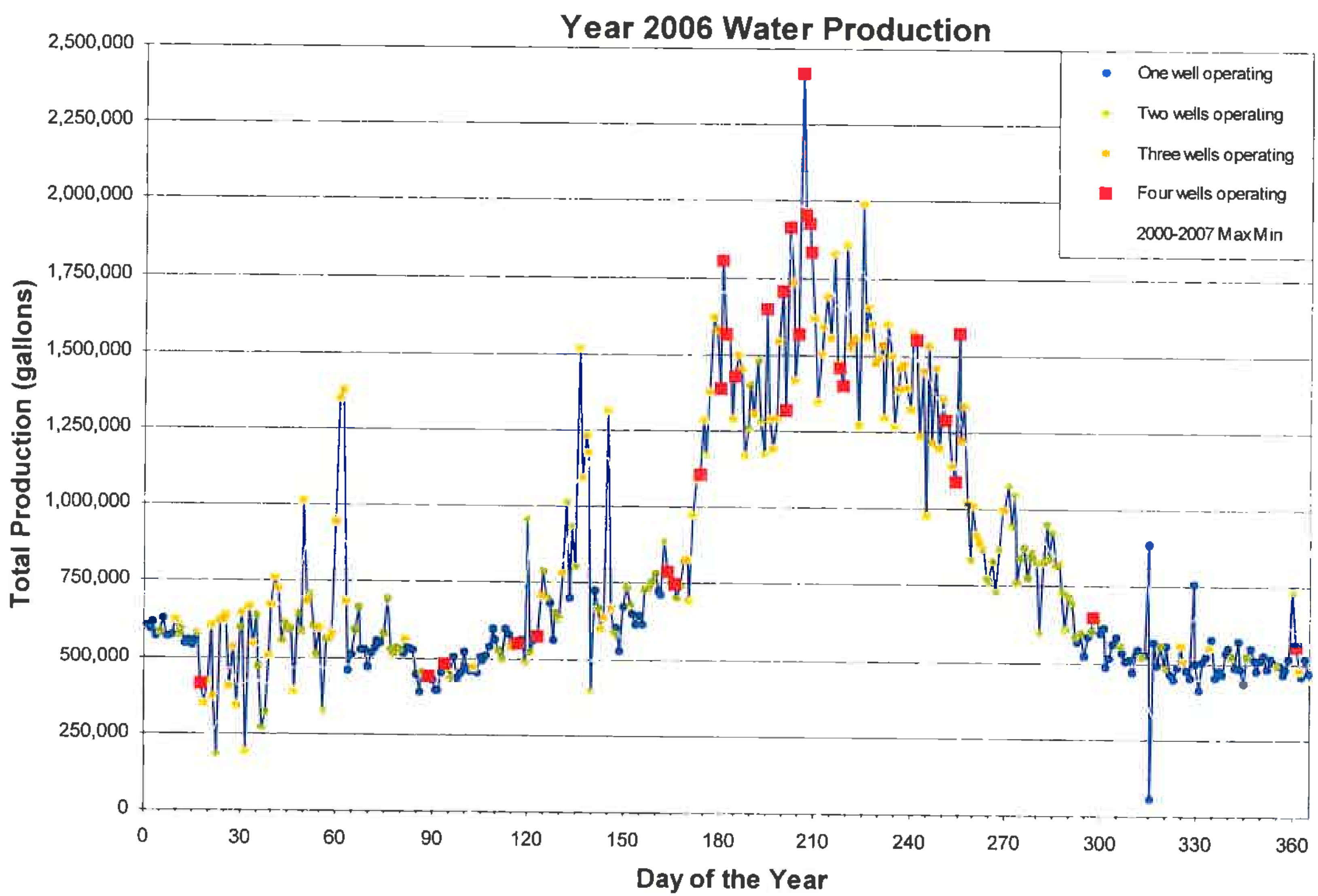
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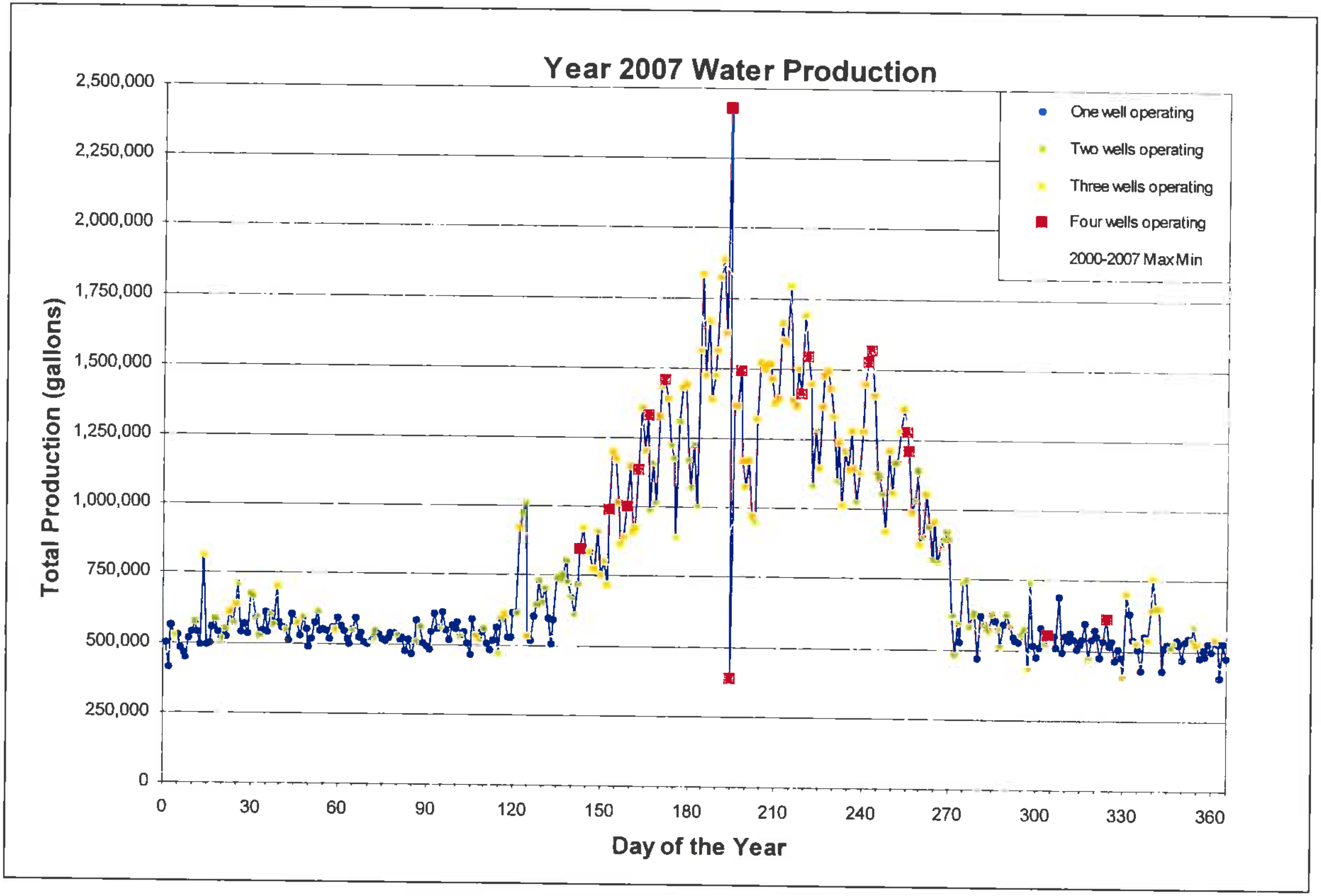
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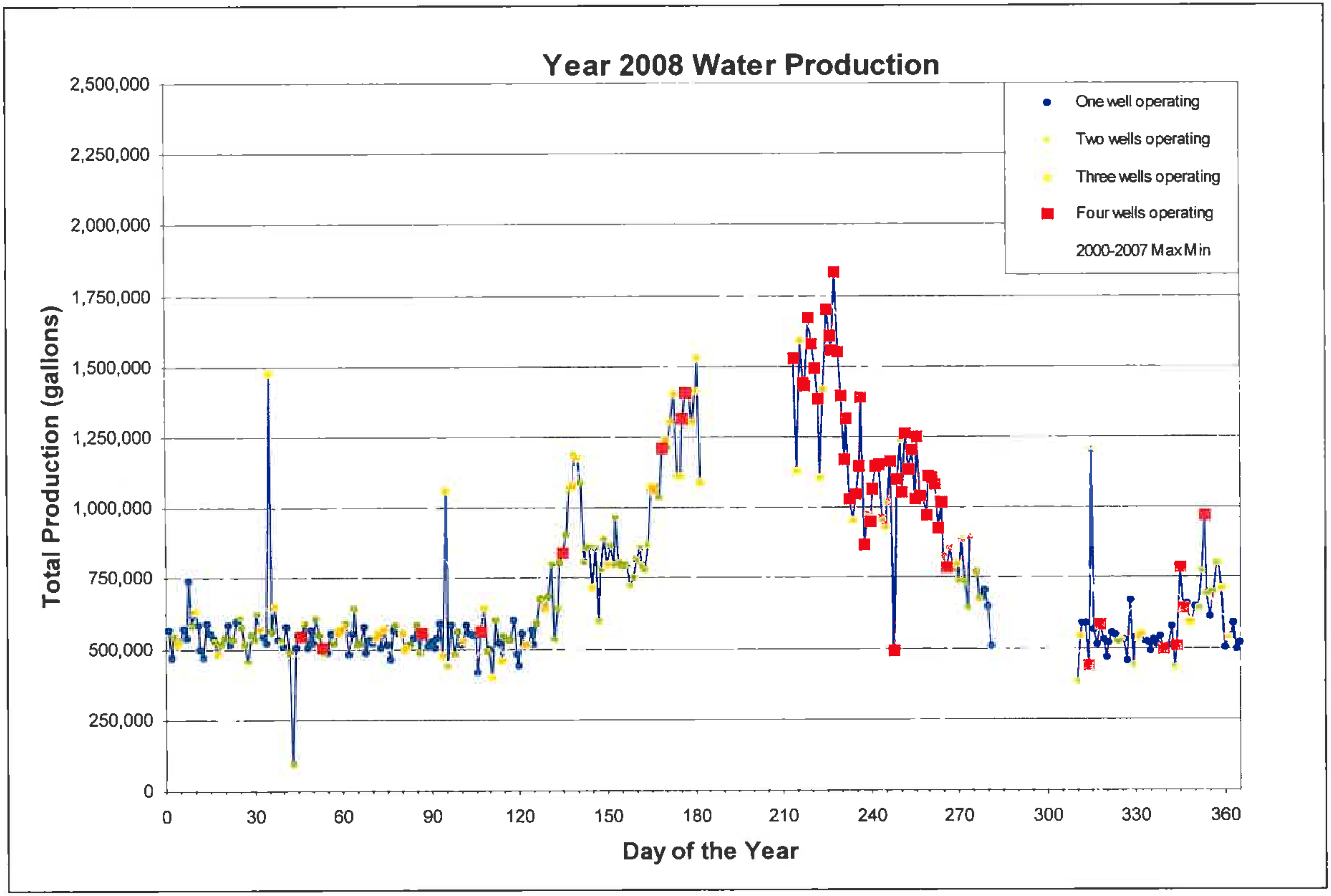
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