CHAPTER 5. WATER SUPPLY RELIABILITY

10631 (c) Describe the reliability of the water supply and vulnerability to seasonal or climatic shortage, to the extent practicable, and provide data for each of the following:

(1) An average water year

(2) A single-dry water year

(3) Multiple-dry water years

For any water source that may not be available at a consistent level of use, given specific legal, environmental, water quality, or climatic factors, describe plans to supplement or replace that source with alternative sources or water demand management measures, to the extent possible.

RELIABILITY OF SURFACE WATER SUPPLIES

In September 2006, the 2006 Settlement Agreement was filed in the U.S. District Court in Sacramento that ended an 18-year legal dispute over the operation of Friant Dam. The 2006 Settlement Agreement resolved legal claims brought by a coalition of conservation and fishing groups, which were led by the National Resources Defense Council (NRDC). The 2006 Settlement Agreement provides for substantial river channel improvements and sufficient water flow to sustain a salmon fishery upstream from the confluence of the Merced River tributary, while still providing water supply to the Friant Division of the CVP. As part of the 2006 Settlement Agreement, water year types were developed and simulated for the contracts in the Friant Division of the CVP. The water year types used in the Settlement Agreement included:

- Wet
- Normal-wet
- Normal-dry
- Dry
- Critical-high
- Critical-low

A normal year was assumed equal to the average of a Normal-wet and Normal-dry year for supply comparison purposes. Water year classification was used during this evaluation of supply reliability to help estimate the water supply expected to be available during various hydrologic conditions.

Reliability of Surface Water Supplies from the City's FID Contract

For the analysis of the reliability of surface water supplies from the City's FID contract, WYA used the 2006 Settlement Agreement as a proxy to help project Kings River availability during various hydrologic conditions because the KRWA does not provide this information; as noted in Chapter 4, KRWA determines the "pre-project" entitlements on a daily basis. KRWA further divides the entitlements into a portion delivered to the contracts and a portion stored in Pine Flat Reservoir. Using the defined Settlement Agreement conditions provided a common base from

which to compare the reliability of both supplies, while also allowing for better accounting for demand reductions during drier hydrologic periods.

Table 5-1 summarizes the average and proposed "applicable" diversions for FID, by hydrologic year classification based on available data from 1964 to 2002. This data is graphically shown on Figure 5-1. Because a Normal year was not defined in the 2006 Settlement Agreement, the Normal year diversion is estimated to be approximately 390,000 af (based on the weighted average of Normal-wet and Normal-dry years).

Table 5-1. Available FID Diversion Quantity Based on the 2006 Settlement Agreement

Water Year Classification	Total Diversion between 1964 and 2002 by Water Year Classification, af [1]	Number of Years within Water Year Classification [2]	Average Diversion by Water Year Classification, af[(a)] [3] = [1]/[2]	Proposed Diversion Quantity, for Water Supply Planning, af [4]
Wet	5,149,216	11	468,111	468,100
Normal-wet	3,839,518	9	426,613	426,600
Normal[(b)]	Normal Year not defined in 2006 Settlement Agreement			390,000
Normal-dry	3,571,299	10	357,130	357,100
Dry	2,244,530	7	320,647	320,600
Critical-high	232,257	1	232,257	232,200
Critical-low	202,300	1	202,300	202,300

(a) Average entitlement calculated by dividing the total entitlement by the number of years.
(b) Normal year assumed equal to the weighted average of Normal-wet and Normal-dry for this analysis.

The surface water available for the City to purchase, based on its 1976 agreement with FID, was determined by multiplying the percentage allocation (presented in Chapter 4, Table 4-2) by the adopted "applicable" diversion quantities summarized in Table 5-1. Table 5-2 presents the Kings River water available to the City, based on hydrologic water year classification defined by the 2006 Settlement Agreement.

Table 5-2. FID Kings River Diversions Available to the City

Classification	FID Kings River Diversions Available to the City[(a)], af/yr					
	2005	2010	2015	2020	2025	2030
Wet	110,600	113,800	126,400	139,100	151,800	159,900
Normal-wet	100,800	103,700	115,200	126,800	138,400	145,800
Normal	92,200	94,800	105,400	115,900	126,500	133,300
Normal-dry	84,400	86,800	96,500	106,200	115,800	122,000
Dry	75,800	77,900	86,600	95,300	104,000	109,600
Critical-high	54,900	56,500	62,800	69,100	75,400	79,400
Critical-low	47,800	49,200	54,600	60,100	65,600	69,100

(a) Based on hydrologic year classification as defined by the 2006 Settlement Agreement.

Reliability of Surface Water Supplies from the City's USBR Contract

Similar to the FID supplies, the reliability of the City's USBR Class 1 water was also evaluated based on the 2006 Settlement Agreement. Table 5-3 summarizes the USBR water deliveries allocated to the City in the 2006 Settlement Agreement by hydrologic year classification based on simulated data from 1922 to 2003. This data is graphically shown on Figure 5-2. As mentioned previously, a Normal year is not defined in the 2006 Settlement Agreement; therefore, Normal year supplies were assumed equal to the weighted average supply during a Normal-wet and Normal-dry years.

Table 5-3. Available USBR Entitlement Adopted from the 2006 Settlement Agreement

Classification	Total Delivery between 1922 and 2003, af [1]	Number of Years within Classification [2]	Average Delivery, af[(a)] [3] = [1]/[2]	Adopted Diversion Quantity, for Water Supply Planning, af
Wet	959,600	16	60,000	60,000
Normal-wet	1,499,700	25	60,000	60,000
Normal	Normal Year not defined in 2006 Settlement Agreement			58,200
Normal-dry	1,349,700	24	56,200	56,200
Dry	477,900	12	39,800	39,200
Critical-high	100,700	4	25,200	25,200
Critical-low	13,900	1	13,900	13,900

(a) Data obtained from the 2006 Settlement Agreement.
(b) The entitlement available during a critical-low year was assumed equal to the entitlement delivered in 1977 to provide additional conservatism for planning purposes.

The projected surface water available for the City to purchase from the USBR during each hydrologic year defined by the 2006 Settlement Agreement is summarized in Table 5-4. As shown in Table 5-4, the projected water supply from the USBR, during each hydrologic year type, does not change in the future. Unlike the City's contract with FID, the entitlement the City has with the USBR is not tied to growth of the City's water service area.

Table 5-4. USBR Entitlement Available to the City for Each Hydrologic Year Type

Classification	USBR Entitlement Available to the City[(a)], af/yr					
	2005	2010	2015	2020	2025	2030
Wet	60,000	60,000	60,000	60,000	60,000	60,000
Normal-wet	60,000	60,000	60,000	60,000	60,000	60,000
Normal	58,200	58,200	58,200	58,200	58,200	58,200
Normal-dry	56,200	56,200	56,200	56,200	56,200	56,200
Dry	39,200	39,200	39,200	39,200	39,200	39,200
Critical-high	25,200	25,200	25,200	25,200	25,200	25,200
Critical-low	13,900	13,900	13,900	13,900	13,900	13,900

(a) Based on available USBR entitlement adopted from the 2006 Settlement Agreement (see Table 5-3).

Reliability of Surface Water Available through Recycled Water Activities

Although total wastewater flows might be reduced slightly, recycled water is essentially 100 percent reliable even during drought events. This is because wastewater flows are primarily generated from indoor water uses which are not reduced significantly during drought conditions. Therefore, the City should be able to continue to percolate treated effluent near the wastewater treatment plant under all hydrologic conditions. Based on a 16-year record, the average annual quantity of treated wastewater percolated by the City is approximately 57,200 af per year. Therefore, there appears to be sufficient percolation to allow the City to continue to pump 30,000 afa of groundwater (maximum annual pumpage allowed) into the FID canals (assumes 10-year maximum of 100,000 af will be overlooked, as in the past).

Based on a 46 percent return from FID on the 30,000 afa of previously percolated, treated effluent that is pumped from the groundwater basins and provided to FID, the City should be able to obtain 13,800 afa of Kings River water from FID. For planning purposes, it was assumed that language in the City's 1976 Agreements with FID regarding this issues that states "insofar as is feasible and practical…" implied that FID could supply up to 13,800 afa of surface water supply during all hydrologic conditions.

Reliability of All Surface Water Supplies under Various Hydrologic Conditions

Table 5-5 presents the total surface water available to the City under all hydrologic conditions based on the discussion provided above.

Table 5-5. Surface Water Supply Available to the City Under All Hydrologic Conditions

Classification	Surface Water Available to the City[(a)], af/yr					
	2005	2010	2015	2020	2025	2030
Wet	184,400	187,600	200,200	212,900	225,600	233,700
Normal-wet	174,600	177,500	189,000	200,600	212,200	219,600
Normal	164,200	166,800	177,400	187,900	198,500	205,300
Normal-dry	154,400	156,800	166,500	176,200	185,800	192,000
Dry	128,800	130,900	139,600	148,300	157,000	162,600
Critical-high	93,900	95,500	101,800	108,100	114,400	118,400
Critical-low	75,500	76,900	82,300	87,800	93,300	96,800

[(a)] Includes surface water supplies from FID Kings River Diversions (see Table 5-2), USBR entitlement (see Table 5-4), and surface water available to the City based on the recycled water exchange agreement with FID (13,800 afa).

As described in Chapter 4, the City's ability to use all of its available surface water supplies is limited by its current surface water treatment capacity and the capacity of its intentional recharge facilities. One of the primary objectives of the City's future water supply plan is to maximize the use of its available surface water supplies either through treatment and direct use or intentional recharge.

As previously shown in Table 4-12, future surface water treatment capacity has been planned such that, under most hydrologic conditions, the surface water treatment facilities can continue to operate at full capacity. Only under critically dry conditions (either Critical-High or Critical-Low) would surface water supplies be limited such that the proposed surface water treatment facilities would not be able to operate at their full production capacities. For example, in 2030, the planned surface water treatment capacity is 123,400 af/yr. However, in 2030, under Critical-low conditions, only 96,800 af/yr of surface water is available. Therefore, in 2030, under Critical-low conditions, the surface water treatment facilities would only be able to operate at about 78 percent of their full capacities (96,800 af/yr divided by 123,400 af/yr). This reduction in treated surface water supply in critically dry years is discussed further in Chapter 7 of this UWMP.

RELIABILITY OF GROUNDWATER SUPPLIES

The City has relied on groundwater supplies since the City first began operating a water system in 1876. Over the years, the City's groundwater operations have changed in response to changing conditions and regulations. In the future, groundwater will continue to be an important

component of the City's water supply portfolio. The primary concerns with groundwater reliability are ability to pump the required supply using existing well facilities and the quality of the groundwater. One of the primary objectives of the City's future water supply plan is to balance groundwater operations by 2025. This objective, to be achieved by increasing intentional recharge while reducing groundwater pumpage, and increasing surface water treatment facilities, will provide two benefits. Firstly, it will help to stabilize groundwater levels so that groundwater levels do not continue to decline. Secondly, it will help to mitigate the migration of contaminants within the basin and reduce the potential for additional quality issues that can occur as groundwater levels decline. Based on these operational changes, it is anticipated that the City's future groundwater supply will be reliable.

RELIABILITY OF RECYCLED WATER SUPPLIES

As discussed above, although total wastewater flows might be reduced slightly, recycled water is essentially 100 percent reliable even during drought events. This is because wastewater flows are primarily generated from indoor water uses which are not reduced significantly during drought conditions. Therefore, it is anticipated that the City should be able to continue to produce and deliver recycled water as planned in the City's future water supply plan under all hydrologic conditions.

SUMMARY OF OVERALL WATER SUPPLY RELIABILITY

Table 5-6 presents a summary of the City's overall water supply reliability under various hydrologic conditions. As shown in Table 5-6, single dry years are assumed to have Critical-low supply conditions (corresponding to the Critical-low classification defined in the 2006 Settlement Agreement). Multiple dry years are assumed to be Normal-dry for the first two years, Dry for the third and fourth years, and Critical-low for the fifth year.

Table 5-6. Overall Supply Reliability (DWR Table 8)

Supply Source	Normal Water Year, af/yr	Single Dry Water Year, af/yr	Multiple Dry Water Years, af/yr				
			Year 1	Year 2	Year 3	Year 4	Year 5
Assumed Hydrologic Water Year Condition[(a)]	Normal	Critical-low	Normal-dry	Normal-dry	Dry	Dry	Critical-low
Groundwater	100%	100%	100%	100%	100%	100%	100%
Treated Surface Water[(b)]	100%	71-100%	100%	100%	100%	100%	71-100%
Recycled Water	100%	100%	100%	100%	100%	100%	100%

(a) Based on the hydrologic year classifications provided in the 2006 Settlement Agreement. See Table 5-7 for basis of water year data.

(b) Reliability of treated surface water is reduced in critically dry years based on projected availability of surface water supplies. Reliability ranges from 71 to 100 percent depending on the year and the surface water treatment capacity available in that year.

Table 5-7 shows the basis of the water year data used to determine supply reliability. As previously shown in Figure 5-2, recent years, including 1999 to 2003, had Normal-wet or Normal-dry conditions; therefore, for purposes of this 2008 UWMP, 2003 is considered to be representative of a recent Normal water year. As previously shown in Figures 5-1 and 5-2, Critical-low supply conditions occurred in 1977. For purposes of this 2008 UWMP, 1977 is therefore assumed to be representative of the Single-Dry Water Year condition. The worst multiple-dry year sequence occurred in the six-year period from 1987 to 1992. Individual years within this six-year period were either Dry or Normal-dry. As shown above in Table 5-6, for the purposes of this 2008 UWMP, it has been assumed that the five-year multiple dry year sequence will have two Normal-dry years, followed by two Dry years and one Critical-low year. Because it includes a Critical-low year, this assumed five-year multiple-dry year period is thus somewhat drier than the historical multiple-dry year period.

Table 5-7. Basis of Water Year Data (DWR Table 9)

Water Year Type	Base Year(s)	Historical Sequence
Normal Water Year	2003 (Normal-wet)	One year: 2003
Single-Dry Water Year	1977 (Critical-low as defined by 2006 Settlement Agreement)	One year: 1977
Multiple-Dry Water Years	1987-1992 (Dry and Normal-dry as defined by 2006 Settlement Agreement)	Six-years: 1987-1992

Several factors can affect a supply sources reliability and consistency. As discussed above, the City's surface water supply from FID and USBR is subject to contractual conditions and potential reductions due to dry year conditions. The City's recycled water exchange with FID is also subject to institutional constraints per the City's agreement with FID. The City's groundwater supplies, although considered very reliable, do have water quality concerns, requiring the City to provide wellhead treatment on many of its wells. Recycled water, although highly regulated in its use, is considered to be a very reliable and consistent source of supply. Table 5-8 provides a summary of the potential factors which could result in supply inconsistency.

Table 5-8. Factors Resulting in Inconsistency of Supply (DWR Table 10)

Supply Source	Institutional/ Contractual	Legal	Environmental	Water Quality	Climatic
Surface Water from FID	✓				✓
Surface Water from USBR	✓				✓
Surface Water from Recycled Water Exchange	✓				
Groundwater				✓	
Recycled Water					

WATER QUALITY IMPACTS ON RELIABILITY

10634. The plan shall include information, to the extent practicable, relating to the quality of existing sources of water available to the supplier over the same five-year increments as described in subdivision (a) of Section 10631, and the manner in which water quality affects water management strategies and supply reliability.

Surface Water

Federal and state water quality regulations related to surface water treatment are subject to on-going and future review and revision. The City's existing and future SWTFs are and will continue to be operated to meet all applicable water quality regulations. If required, modifications will be made to treatment operations to ensure compliance with applicable regulations. Therefore, it is not anticipated that future changes in surface water quality or surface water quality regulations will impact the availability or reliability of surface water supplies in the future.

Groundwater

Federal and state water quality regulations related to groundwater quality are subject to on-going and future review and revision. In addition, as described in Chapter 4, the groundwater basin underlying the City is subject to several chemical contaminants which have either rendered wells unusable or have required the installation of wellhead treatment systems. The City has received several legal settlements from a number of lawsuits related to groundwater contamination which has provided for the construction and on-going operation of many of these wellhead treatment systems. In the future, groundwater regulations may change or existing contaminants may migrate, requiring the construction of additional wellhead treatment systems. Planning for this potential additional wellhead treatment has been included in the City's future water supply plan. Overall, the City's future water supply plan includes reducing groundwater pumpage by the City, so as not to cause additional water quality degradation through increased pumpage. Therefore, it is not anticipated that future changes in groundwater quality or groundwater quality regulations

will impact the availability or reliability of groundwater supplies in the future, beyond what has already been planned for.

Recycled Water

Federal and state water quality regulations related to recycled water are subject to on-going and future review and revision. The City's existing and future wastewater treatment facilities (RWRF, North Fresno WRF and other future facilities) are and will continue to be operated to meet all applicable water quality regulations. If required, modifications will be made to treatment operations to ensure compliance with applicable regulations. Therefore, it is not anticipated that future changes in recycled water quality or recycled water quality regulations will impact the availability or reliability of recycled water supplies in the future.

Table 5-9 indicates that there are no projected water supply changes due to water quality issues.

Table 5-9. Current and Projected Water Supply Changes Due to Water Quality (DWR Table 39)

Supply Source	2005	2010	2015	2020	2025	2030
Surface Water	No water supply changes due to water quality anticipated					
Groundwater						
Recycled Water						

Figure 5-1. FID Kings River Water Applicable to City's Agreement

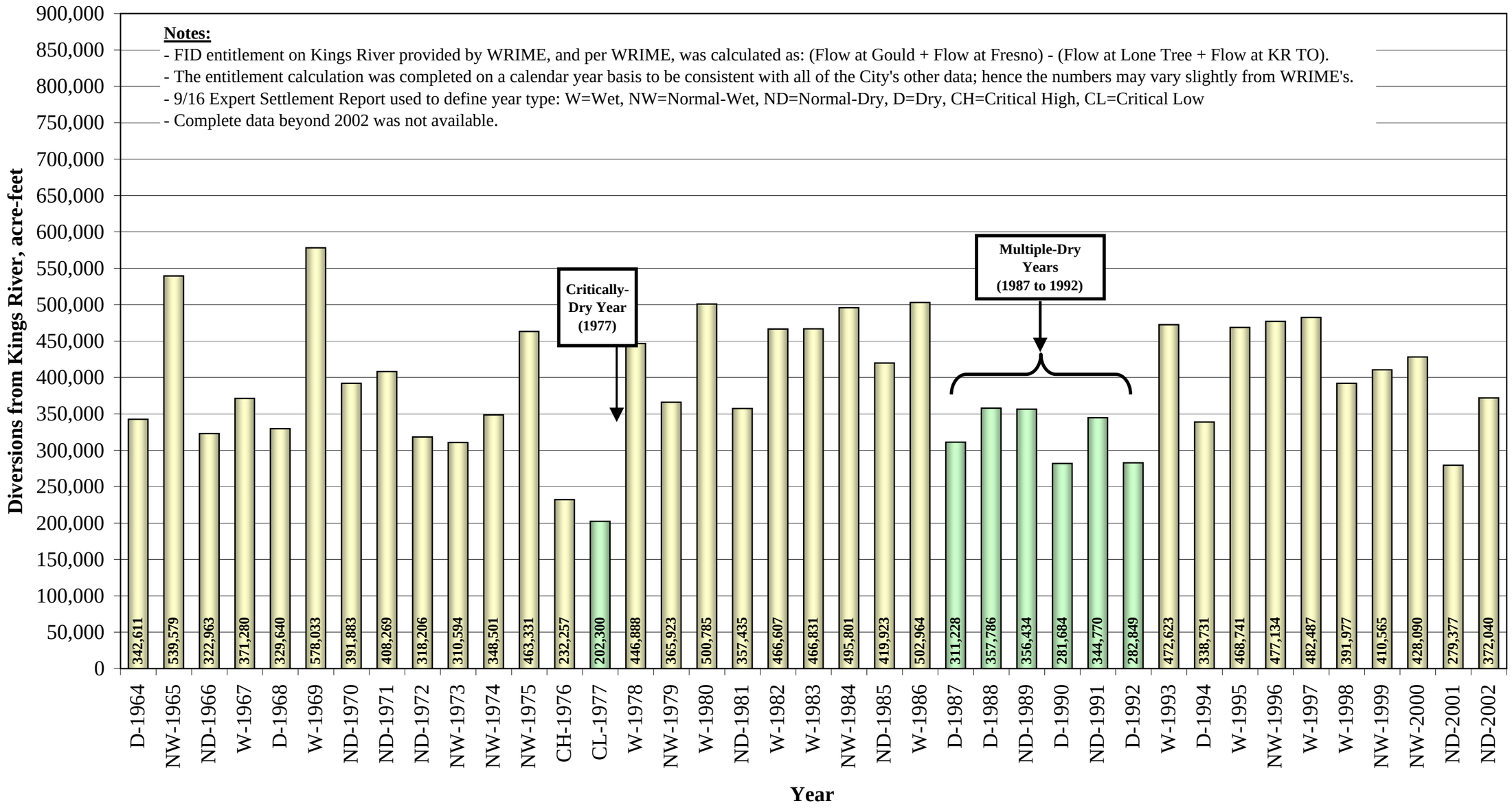

Figure 5-2. Bureau Deliveries to the City of Fresno Adopted from the 2006 Settlement Agreement