PMCL

WATER USE AT FORT HUACHUCA MILITARY RESERVATION

Presented by

PLANNING AND MANAGEMENT CONSULTANTS, LTD.

1 April 1993

USF200008255

PMCL

STUDY OBJECTIVES

- Develop Unrestricted Seasonal Disaggregated Forecasts of Potable and Nonpotable Water Requirements (1995-2025)
- Develop Restricted Forecasts Under Conservation and Mobilization Scenarios
- Summarize the Findings of the Study and Implications on Water Management

USF200008256

PMCL

STUDY OBJECTIVES

10 TASKS

- Initial Site Visit and Review of Intended Work Effort
- Data Collection
- Data Preparation and Analysis
- Model Calibration/Verification
- Development of Unrestricted Water Requirements Forecasts
- Development of Conservation Effectiveness and Restricted Water Use Forecasts
- Mobilization Consideration in Water Forecasts
- Preparation of Draft Report and Briefings
- Final Report
- Site Implementation of IWRAPS©

USF200008257

PMCL

STUDY OBJECTIVES

10 TASKS

- ***INITIAL SITE VISIT AND REVIEW OF INTENDED WORK EFFORT***
- Data Collection
- Data Preparation and Analysis
- Model Calibration/Verification
- Development of Unrestricted Water Requirements Forecasts
- Development of Conservation Effectiveness and Restricted Water Use Forecasts
- Mobilization Consideration in Water Forecasts
- Preparation of Draft Report and Briefings
- Final Report
- Site Implementation of IWRAPS©

USF200008258

PMCL

10 TASKS

INITIAL SITE VISIT AND REVIEW OF INTENDED WORK EFFORT

- Meeting With Key FHMR Personnel and Environmental Attorney (USALC) to Discuss IWRAPS© Application to FHMR (August 27, 1992)
- Collection and Verification on Actual Square Footage, Meter Readings, and Research and Development Buildings
- List of Additional Data Requirements Provided to FHMR Personnel

USF200008259

PMCL

STUDY OBJECTIVES

10 TASKS

- Initial Site Visit and Review of Intended Work Effort
- ***DATA COLLECTION***
- Data Preparation and Analysis
- Model Calibration/Verification
- Development of Unrestricted Water Requirements Forecasts
- Development of Conservation Effectiveness and Restricted Water Use Forecasts
- Mobilization Consideration in Water Forecasts
- Preparation of Draft Report and Briefings
- Final Report
- Site Implementation of IWRAPS©

USF200008260

PMCL

DATA COLLECTION

TYPE OF FHMR DATA INPUT AND SOURCE

IWRAPS© Data Input	Description	Source
Actual area	Existing base year square footage of each building	Space Utilization Report (PCN AKJ-007)
Allowed area	Authorized square footage of each FCG based on space planning algorithms assigned for missions	RPLANS
Conservation	Five potential measures for FHMR and their respective reduction and coverage factors for the forecasted year	DEH
Construction/ Demolition	Projected construction and demolition of buildings (in square feet) for forecast years 1995, 2000, 2005, 2010, 2015, 2020, and 2025	DEH
Effective population	Estimated average monthly populations of military personnel, their family members, and civilians at FHMR for FY91	DEH

USF200008261

PMCL

DATA COLLECTION

TYPE OF FHMR DATA INPUT AND SOURCE (cont)

IWRAPS© Data Input	Description	Source
Improved acreage	Improved grounds that are maintained and repaired at FHMR (in acres)	DEH
Water production data	Well production (KG) of eight potable wells (1981 to 1992)	DEH
Water use data	Historical readings of 136 water meters (1981 to 1992)	DEH
Weather	Monthly rainfall in inches and monthly temperature in degrees F for 1981 to 1992	DEH
Research & development	Actual area; proportion of water use sectors for R&D buildings	Site survey and DEH
Special purpose category (except research & development)	Water use quantities at vehicle wash, swimming pools, etc.	DEH and points of contact at specific facilities

USF200008262

PMCL

STUDY OBJECTIVES

10 TASKS

- Initial Site Visit and Review of Intended Work Effort
- Data Collection
- ***DATA PREPARATION AND ANALYSIS***
- Model Calibration/Verification
- Development of Unrestricted Water Requirements Forecasts
- Development of Conservation Effectiveness and Restricted Water Use Forecasts
- Mobilization Consideration in Water Forecasts
- Preparation of Draft Report and Briefings
- Final Report
- Site Implementation of IWRAPS©

USF200008263

PMCL

10 TASKS

DATA PREPARATION

- IWRAPS© Sector Development
- Data Adjustments
- Weather Data Analysis
- Water Use Coefficient Development for FHMR
- Data Assumptions

USF200008264

PMCL

10 TASKS

DATA PREPARATION

- ***IWRAPS© SECTOR DEVELOPMENT***
- Data Adjustments
- Weather Data Analysis
- Water Use Coefficient Development for FHMR
- Data Assumptions

USF200008265

PMCL

DATA PREPARATION

IWRAPS© SECTOR DEVELOPMENT

- 21 IWRAPS© Sectors Identified
- 54 Water Using Facility Category Groups at FHMR Selected for 21 IWRAPS© Sectors
- 18 Special Purpose Water Use Categories: 13 Potable and 5 Nonpotable
- R & D Sector With Three Separate Water Using Characteristics— Administration/Operations, Maintenance, and Warehouse

USF200008266

PMCL

10 TASKS

DATA PREPARATION

- IWRAPS© Sector Development
- ***DATA ADJUSTMENTS***
- Weather Data Analysis
- Water Use Coefficient Development for FHMR
- Data Assumptions

USF200008267

DATA PREPARATION

DATA ADJUSTMENTS

Adjustment of Real Property data for the period September 1990 through June 1992 to reflect the base year (FY 91) square footage. A total of 170,872 square feet constructed and 39,667 square feet demolished in the period.

USF200008268

PMCL

DATA PREPARATION

ACTUAL AREA OF REAL PROPERTY BUILDINGS AT FHMR

FCG NO.	FCG DESCRIPTION	Actual Area (sq. ft)	IWRAPS© Sector
17140	AR CENTER	5,000	AR
17160	TASC	28,000	A
21110	MNT HANGAR AVUM	52,000	M
•			
•			
51010	HOSPITAL	111,000	HOS
54010	DENTAL CLINIC	20,000	HDC
55010	HEALTH CLINIC	17,000	HDC
•			
•			
74028	PHYS FIT CTR	57,000	G
74032	TRANS HGS FAC	50,000	GH
74033	COMMUNITY CTR	7,000	C
•			
•			
Total Square Footage		7,685,480	
Base Year Adjustments Square Footage:	Construction	170,872	
	Demolition	39,667	
Net Base Year Square Footage		7,816,685	

USF200008269

PMCL

DATA PREPARATION

SUMMARY OF ALLOWED OVER ACTUAL SQUARE FOOTAGE RATIO

Category	Actual Area[c]	Allowed Area[c]	Allowed/Actual Ratio	Proportion of Actual Area as Percent of Adjusted Total
Administration/operations	1,736.00	1,223.00	0.704	22.21
Army National Guard	5.00	64.00	12.800	0.06
Bachelor officers quarters	216.00	321.00	1.486	2.76
Banks/credit unions	12.48	12.48	1.000	0.16
Barracks	617.00	847.00	1.373	7.89
Bowling center	21.00	28.00	1.333	0.27
Commissary	75.00	48.00	0.640	0.96
Community	243.00	281.00	1.156	3.11
Dining	102.00	98.00	0.961	1.30
Exchange	112.00	69.00	0.616	1.43
Family housing	3,224.00	3,224.00	1.000	41.25
Guest housing	50.00	50.00	1.000	0.64

USF200008270

PMCL

DATA PREPARATION

SUMMARY OF ALLOWED OVER ACTUAL SQUARE FOOTAGE RATIO (con't)

Category	Actual Area[c]	Allowed Area[c]	Allowed/Actual Ratio	Proportion of Actual Area as Percent of Adjusted Total
Gymnasium	57.00	59.00	1.035	0.73
Health/dental clinics	37.00	27.00	0.730	0.47
Hospital	111.00	91.00	0.820	1.42
Laundromat	27.00	27.00	1.000	0.35
Maintenance	417.00	233.00	0.559	5.33
Restaurants	25.00	12.00	0.480	0.32
Schools	166.00	166.00	1.000	2.12
Service stations	7.00	7.00	1.000	0.09
Warehouse	425.00	560.00	1.318	5.44
Total[a]	7,685.480	7,447.480		100.00
Adjusted total[b]	7,816.685	7,578.685		

a Total reflects the RPLANS data
b Refers to adjustments of square footage for the base year
c Square feet in thousands

USF200008271

PMCL

10 TASKS

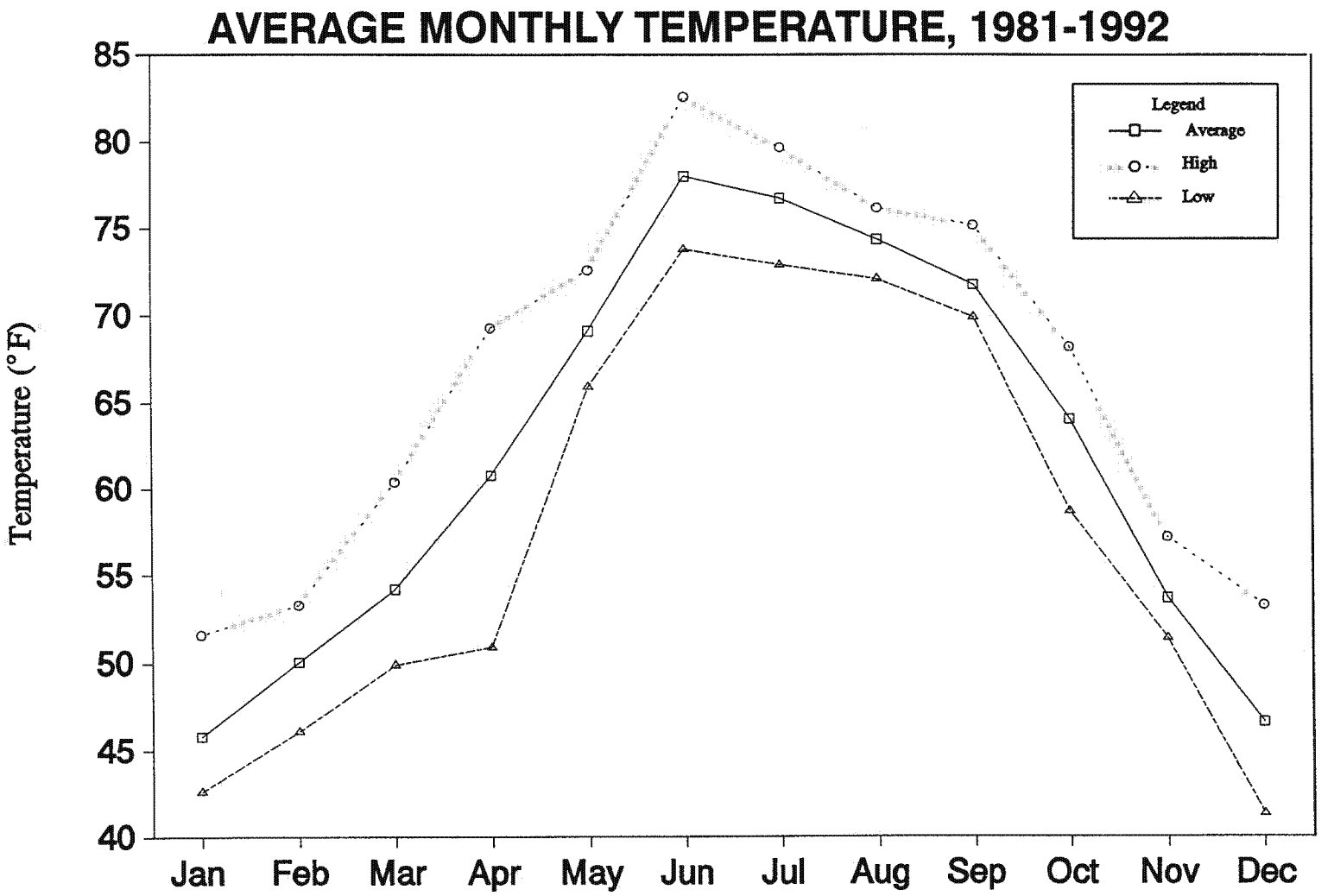
DATA PREPARATION

- IWRAPS© Sector Development
- Data Adjustments
- ***WEATHER DATA ANALYSIS***
- Water Use Coefficient Development for FHMR
- Data Assumptions

USF200008272

PMCL

DATA PREPARATION

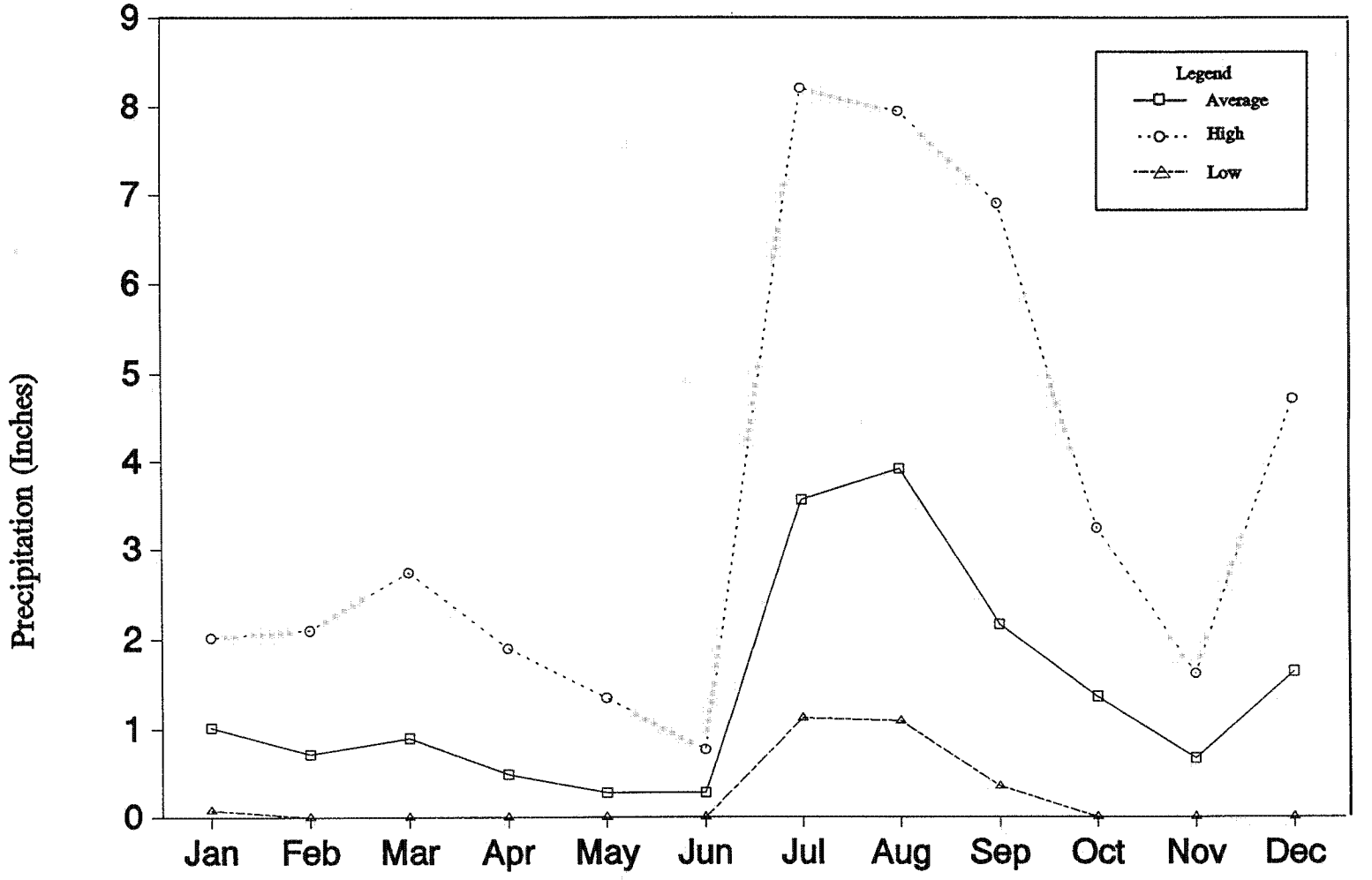


USF200008273

PMCL

DATA PREPARATION

AVERAGE MONTHLY PRECIPITATION, 1981-1992

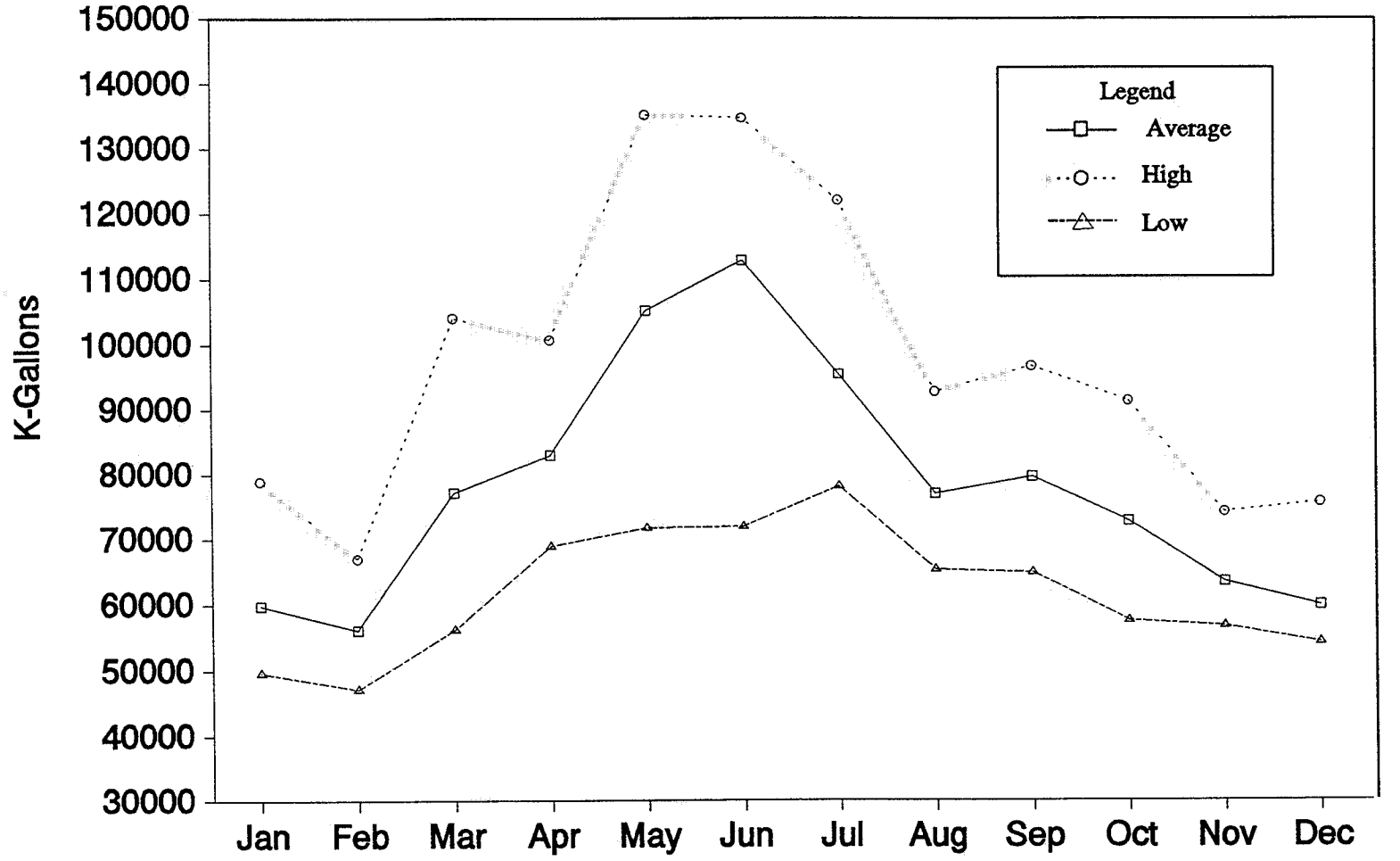


USF200008274

PMCL

DATA PREPARATION

AVERAGE MONTHLY WATER PRODUCTION OF EIGHT POTABLE WELLS, 1982-1991



Note: Water production figure for December 1987 excluded.

USF200008275

PMCL

10 TASKS

DATA PREPARATION

- IWRAPS© Sector Development
- Data Adjustments
- Weather Data Analysis
- ***WATER USE COEFFICIENT DEVELOPMENT FOR FHMR***
- Data Assumptions

USF200008276

PMCL

DATA PREPARATION

COMPUTER WATER USE COEFFICIENTS OF IWRAPS©
SECTORS OTHER THAN FAMILY HOUSING

Sector	Observed Coefficients	Meter(s) Used	Actual/ Allowed Ratio	Normalized Coefficient
Restaurant/cafeteria	0.28701	PX cafeteria Burger King Pizza Pub	1.0	0.28701
Exchange	0.06761	PX Class VI Store	1.0	0.06761
Schools	0.04866	Johnston School Myer School Smith School	1.0	0.04866
Banks	0.06234	Credit Union First Interstate Bank	1.0	0.06234
Commissary	0.06471	Commissary	1.0	0.06471
Community	0.08946	Enlisted Club	1.0	0.08946
Warehouse	0.02603	Post Office	1.0	0.02603

USF200008277

PMCL

DATA PREPARATION

SUMMARY OF ASSIGNED WATER USE COEFFICIENTS

IWRAPS© Sectors	Assigned Normalized Water Use Coefficient	Source
Administration/Operations	0.20915	CONUS
Army National Guard	0.05255	CONUS
Barracks	0.15611	CONUS
Bowling Center	0.04341	CONUS
Banks/Credit Union	0.06234	FHMR
Bachelor Officer's Quarters	0.02500	CONUS
Community	0.08946	FHMR
Commissary	0.06471	FHMR
Dining	0.23112	CONUS
Family Housing	0.0000	
Gyms	0.14719	CONUS
Guest Housing	1.82504	CONUS
Health/Dental Clinic	0.12282	CONUS
Hospital	0.76046	CONUS
Laundromat/Dry Cleaner	1.04664	CONUS
Maintenance	0.26235	CONUS
Restaurant/Cafeteria	0.28701	FHMR
Schools	0.04866	FHMR
Service Stations	0.07842	CONUS
Warehouse	0.02603	FHMR
Exchange	0.06761	FHMR

USF200008278

PMCL

DATA PREPARATION

SELECTED CATEGORIES OF WATER USE AND COEFFICIENT CALCULATION, SINGLE FAMILY DWELLINGS

Size of Housing Unit (ft^2)	Number of Metered Units	Total Number of Units in a Housing Category	Total Area for All Units of This Size (ft^2)	Weights	Observed Coefficient	Weighted Coefficient
1,582	14	49	77,518	0.17590	0.26993	0.04748
1,809	26	73	132,057	0.29967	0.24902	0.07462
2,050	9	39	79,950	0.18142	0.13095	0.02376
2,318	8	55	127,490	0.28930	0.13271	0.03839
2,437	1	1	2,437	0.00553	0.16678	0.00092
4,724	1	1	4,724	0.01072	0.08158	0.00087
4,771	1	1	4,771	0.01083	0.14041	0.00152
5,623	1	1	5,623	0.01276	0.05281	0.00067
6,112	1	1	6,112	0.01387	0.03727	0.00052
Total	62		440,682			0.18876

USF200008279

PMCL

DATA PREPARATION

SELECTED CATEGORIES OF WATER USE AND COEFFICIENT CALCULATION, DUPLEX FAMILY HOUSING

Size of Housing Unit (ft^2)	Number of Metered Units	Total Number of Units in a Housing Category	Total Area for All Units of This Size (ft^2)	Weights	Observed Coefficient	Weighted Coefficient
1,520	8	64	97,280	0.10505	0.10976	0.01153
1,559	24	184	286,856	0.30976	0.17956	0.05562
1,645	19	54	88,830	0.09592	0.23754	0.02279
1,770	8	122	215,940	0.23318	0.03047	0.00711
1,844	11	46	84,824	0.09160	0.28105	0.02574
1,904	18	80	152,320	0.16448	0.18615	0.03062
Total	88		926,050			0.15340

USF200008280

PMCL

DATA PREPARATION

SELECTED CATEGORIES OF WATER USE AND COEFFICIENT CALCULATION, MULTIPLEX FAMILY HOUSING

Size of Housing Unit (ft^2)	Number of Metered Units	Total Number of Units in a Housing Category	Total Area for All Units of This Size (ft^2)	Weights	Observed Coefficient	Weighted Coefficient
6,236	1	7	43,652	1.00000	0.18330	0.18330
Total	1		43,652			0.18330

USF200008281

PMCL

DATA PREPARATION

LIST OF SPECIAL PURPOSE CATEGORIES

SECTOR	UNITS	
Barnes Pool	1	each
Brown Field	12.4	acres
Cemetery	7.4	acres
*Chaffee Parade Field	1	each/10.25 acres
Family Housing:		
Multiplexes (0.18330)	303,066	square feet
Duplexes (0.15340)	1,582,920	square feet
Single Dwellings (0.18876)	1,338,025	square feet
Fish Holding Facility	6	tanks
Fundraiser Carwashes		unknown
Garden Plots	2.8	acres
*Golf Course	1	each/18 hole
Grierson Pool	1	each
Irwin Pool	1	each
*Leadership Reaction Course Tanks	2	each
Research And Development		
R&D 1(administration/operations type) (0.20915)	340,206	square feet
R&D 2 (maintenance type) (0.26235)	11,340	square feet
R&D 3 (warehouse type) (0.02603)	26,460	square feet
RV Park	20	units
*Stabilization Ponds	3	each
*USFS Slurry Tanks	18,000	gallons
Vehicle Wash Facility	22	each
Water Catchment Tanks	8	each

*Uses nonpotable water NOTE: Numbers in parentheses show adjusted standardized water use coefficients for the respective sectors.

USF200008282

PMCL

DATA PREPARATION

R&D ANALYSIS FOR FHMR

Building Name	Cat Code	Fac #	Area (SF)	% Admin	% Maint	% Wrhs	A Area	M Area	W Area
Electron Equip Fac	31740	16502	2,960	100	0	0	2,960.0	0.0	0.0
Electron Equip Fac	31740	15680	800	100	0	0	800.0	0.0	0.0
Electron Equip Fac	31740	12586	971	100	0	0	971.0	0.0	0.0
Electron Equip Fac	31740	12624	487	100	0	0	487.0	0.0	0.0
Comm Eqp Fac	31710	55332	800	100	0	0	800.0	0.0	0.0
Comm Eqp Fac	31710	55324	800	100	0	0	800.0	0.0	0.0
Comm Eqp Fac	31710	55326	800	100	0	0	800.0	0.0	0.0
Comm Eqp Fac	31710	55338	800	100	0	0	800.0	0.0	0.0
Comm Eqp Fac	31710	55340	3,200	100	0	0	3,200.0	0.0	0.0
Comm Eqp Fac	31710	55336	800	100	0	0	800.0	0.0	0.0
Comm Eqp Fac	31710	55334	800	100	0	0	800.0	0.0	0.0
Comm Eqp Fac	31710	55328	800	100	0	0	800.0	0.0	0.0
Comm Eqp Fac	31710	55330	800	100	0	0	800.0	0.0	0.0
Electron Equip Fac	31740	55350	41,769	100	0	0	41,769.0	0.0	0.0
Comm Eqp Fac	31710	56301	30,000	100	0	0	30,000.0	0.0	0.0
Electron Equip Fac	31740	91302	7,200	100	0	0	7,200.0	0.0	0.0
Electron Equip Fac	31740	13576	3,415	50	0	50	1,707.5	0.0	1,707.5
Electron Equip Fac	31740	11520	1,854	0	0	100	0.0	0.0	1,854.0
Electron Equip Fac	31740	12508	13,100	33	0	67	4,323.0	0.0	8,777.0
IAI/TRW Facility #1	No #	No #	4,000	100	0	0	4,000.0	0.0	0.0
IAI/TRW Facility #2	No #	No #	4,000	100	0	0	4,000.0	0.0	0.0
Detect Eqp Fac	31720	11669	3,200	100	0	0	3,200.0	0.0	0.0

USF200008283

PMCL

DATA PREPARATION

R&D ANALYSIS FOR FHMR (con't)

Building Name	Cat Code	Fac #	Area (SF)	% Admin	% Maint	% Wrhs	A Area	M Area	W Area
Electron Equip Fac	31740	11667	222	100	0	0	222.0	0.0	0.0
Electron Equip Fac	31740	14658	9,300	100	0	0	9,300.0	0.0	0.0
Electron Equip Fac	31740	81701	12,000	50	0	50	6,000.0	0.0	6,000.0
Electron Equip Fac	31740	80830	4,000	100	0	0	4,000.0	0.0	0.0
Electron Equip Fac	31740	90706	32,172	90	0	10	28,954.8	0.0	3,217.2
Comm Eqp Fac	31710	55322	800	0	0	100	0.0	0.0	800.0
Comm Eqp Fac	31710	57305	93,000	100	0	0	93,000.0	0.0	0.0
Comm Eqp Fac	31710	57430	1,600	100	0	0	1,600.0	0.0	0.0
Comm Eqp Fac	31710	57431	1,840	100	0	0	1,840.0	0.0	0.0
Comm Eqp Fac	31710	57435	1,600	100	0	0	1,600.0	0.0	0.0
Comm Eqp Fac	31710	57428	18,988	100	0	0	18,988.0	0.0	0.0
Electron Equip Fac	31740	82814	1,572	0	100	0	0.0	1,572.0	0.0
Electron Equip Fac	31740	82812	10,240	0	100	0	0.0	10,240.0	0.0
Comm Eqp Fac	31710	53301	40,000	100	0	0	40,000.0	0.0	0.0
Electron Equip Fac	31740	80810	4,000	50	0	50	2,000.0	0.0	2,000.0
Electron Equip Fac	31740	80811	4,000	100	0	0	4,000.0	0.0	0.0
Electron Equip Fac	31740	80812	4,800	100	0	0	4,800.0	0.0	0.0
Electron Equip Fac	31740	71450	1,152	100	0	0	1,152.0	0.0	0.0
Antenna Test Facility	No #	No #	600	100	0	0	600.0	0.0	0.0
Total Sampled Area (SF)			365,242				329,074.3	11,812.0	24,355.7
Percent of Total Area							90%	3%	7%

NOTE: A Area = Administration area; M Area = Maintenance area; W Area = Warehouse area

USF200008284

PMCL

DATA PREPARATION

POND LOCATION AND SIZE

Pond Location/Name	Approximate Surface Area
Gravel pit	6 acres
Officers Club	1.5 acres
Golf Course	6 acres

$$I_{surf} + I_{sub} + P = O_{surf} + O_{sub} + E_o + (V_2 - V_1)$$

WHERE

I_{surf} = volume of surface inflows from streams

I_{sub} = volume of subsurface inflows from groundwater

P = volume of precipitation onto pond surface

O_{surf} = volume of surface outflows to streams

O_{sub} = volume of subsurface outflows to groundwater

E_o = volume of water evaporated

V_1 = volume of pond at beginning of measurement period

V_2 = volume of pond at end of measurement period

USF200008285

PMCL

10 TASKS

DATA PREPARATION

- IWRAPS© Sector Development
- Data Adjustments
- Weather Data Analysis
- Water Use Coefficient Development for FHMR
- ***DATA ASSUMPTIONS***

USF200008286

PMCL

DATA PREPARATION

DATA ASSUMPTIONS

- 15 Percent Estimated Water Loss
- Mobilization Mission Does Not Require Additional Building Construction

USF200008287

PMCL

STUDY OBJECTIVES

10 TASKS

- Initial Site Visit and Review of Intended Work Effort
- Data Collection
- Data Preparation and Analysis
- ***MODEL CALIBRATION/VERIFICATION***
- Development of Unrestricted Water Requirements Forecasts
- Development of Conservation Effectiveness and Restricted Water Use Forecasts
- Mobilization Consideration in Water Forecasts
- Preparation of Draft Report and Briefings
- Final Report
- Site Implementation of IWRAPS©

USF200008288

PMCL

MODEL CALIBRATION/ VERIFICATION

- Calibration of Summer Model
- Development of Base Year (FY 91) Backcast

USF200008289

PMCL

MODEL CALIBRATION/ VERIFICATION

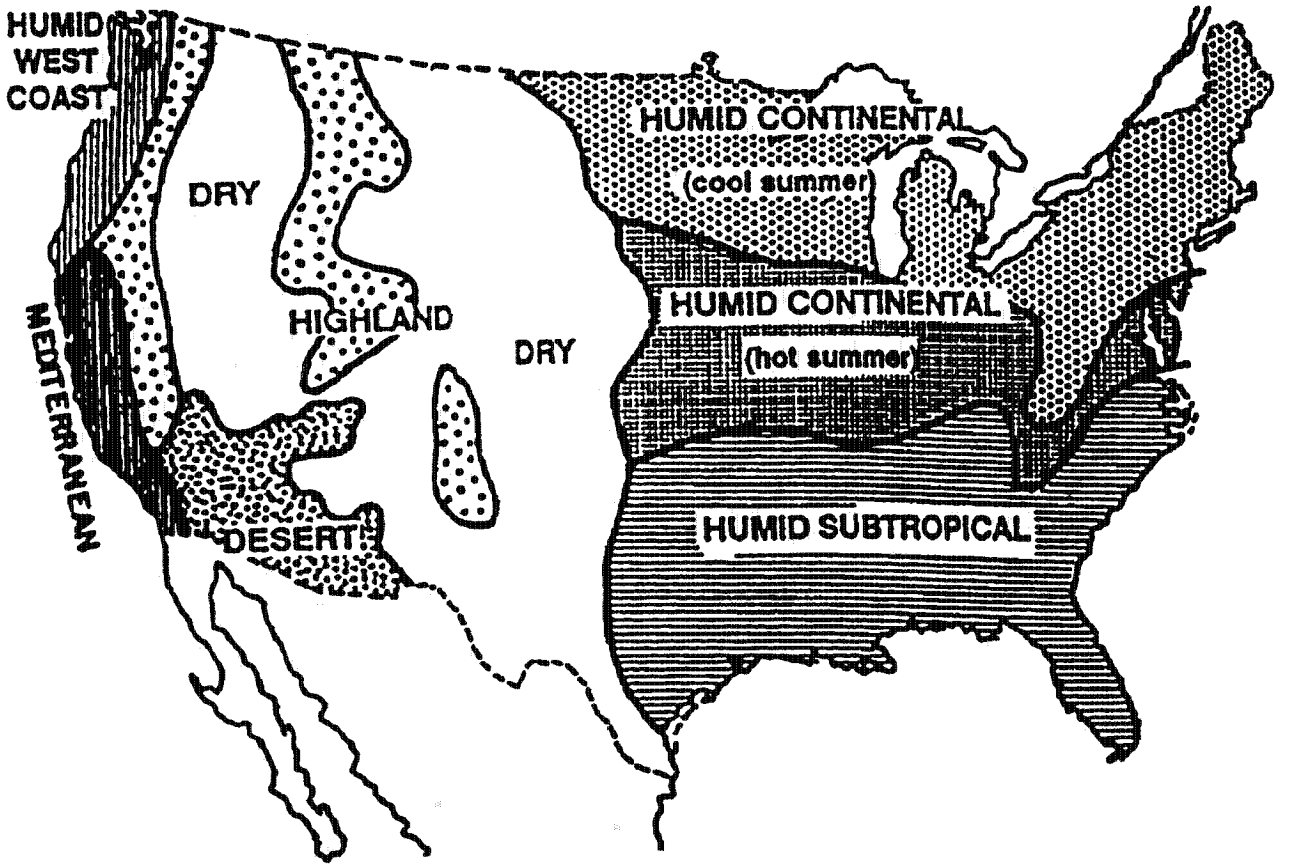
- ***CALIBRATION OF SUMMER MODEL***
- Development of Base Year (FY 91) Backcast

USF200008290

PMCL

MODEL CALIBRATION/ VERIFICATION

CLIMATIC REGIONS IN THE SUMMER MODEL



USF200008291

PMCL

MODEL CALIBRATION/ VERIFICATION

- Calibration of Summer Model
- ***DEVELOPMENT OF BASE YEAR (FY 91) BACKCAST***

USF200008292

PMCL

MODEL CALIBRATION/ VERIFICATION

ACCURACY OF FHMR WATER REQUIREMENT BACKCAST (FY91)

	IWRAPS© Backcast (MG)	Actual Water Use (MG)	Backcast/ Actual
Winter	261.61	264.79	98.8%
Summer	604.34	611.92	98.8%
Annual	865.95	876.71	98.8%

USF200008293

PMCL

STUDY OBJECTIVES

10 TASKS

- Initial Site Visit and Review of Intended Work Effort
- Data Collection
- Data Preparation and Analysis
- Model Calibration/Verification
- ***DEVELOPMENT OF UNRESTRICTED WATER REQUIREMENTS FORECASTS***
- Development of Conservation Effectiveness and Restricted Water Use Forecasts
- Mobilization Consideration in Water Forecasts
- Preparation of Draft Report and Briefings
- Final Report
- Site Implementation of IWRAPS©

USF200008294

PMCL UNRESTRICTED FORECASTS

UNRESTRICTED POTABLE WATER USE FORECASTS (1995-2025)

Year	Unrestricted Winter Water Use (MG)		Unrestricted Summer Water Use (MG)		Unrestricted Annual Water Use (MG)		Tot. Potable Unrestrict. (Acre-feet)
	IWRAPS©	IWRAPS© + Tent City	IWRAPS©	IWRAPS© + Tent City	IWRAPS©	IWRAPS© + Tent City	
1991	261.61	-	604.34	-	865.95	-	2,657.50
1995	275.96	298.61	633.62	665.72	909.58	964.33	2,959.42
2000	282.22	304.87	648.07	680.17	930.29	985.04	3,022.98
2005	287.88	310.53	661.14	693.24	949.02	1,003.77	3,080.46
2010	291.03	313.68	668.44	700.54	959.47	1,014.22	3,112.53
2015	292.29	314.94	671.36	703.46	963.65	1,018.40	3,125.35
2020	292.29	314.94	671.36	703.46	963.65	1,018.40	3,125.35
2025	292.29	314.94	671.36	703.46	963.65	1,018.40	3,125.35

USF200008295

PMCL

UNRESTRICTED FORECASTS

ESTIMATED NONPOTABLE AND EFFLUENT WATER USE AT FHMR

Water User	Estimated Water Use (Acre-feet per Year)
Nonpotable Water	
Ponds (a) Golf course pond	35.42
(b) Gravel pit pond	35.42
(c) Officer's Club pond	8.85
Leadership reaction course	3.70
Fire fighting and dust control	Not known
TOTAL	83.39*
Effluent Water	
Evaporation Ponds and Chaffee Parade Field	1,806.0
Golf course	318.5
TOTAL	2,124.5

*This figure does not include nonpotable water use for fire fighting and dust control.

USF200008296

PMCL UNRESTRICTED FORECASTS

UNRESTRICTED POTABLE AND NONPOTABLE WATER REQUIREMENTS

	Water Requirements (Acre-Feet)							
	1991	1995	2000	2005	2010	2015	2020	2025
Potable water	2,657.5	2,959.4	3,023.0	3,080.5	3,112.5	3,125.4	3,125.4	3,125.4
Nonpotable water*	83.4	83.4	83.4	83.4	83.4	83.4	83.4	83.4
TOTAL	2,740.9	3,042.8	3,106.4	3,163.9	3,195.9	3,208.8	3,208.8	3,208.8

*This figure does not include nonpotable water use for fire fighting and dust control.

USF200008297

PMCL

STUDY OBJECTIVES

10 TASKS

- Initial Site Visit and Review of Intended Work Effort
- Data Collection
- Data Preparation and Analysis
- Model Calibration/Verification
- Development of Unrestricted Water Requirements Forecasts
- ***DEVELOPMENT OF CONSERVATION EFFECTIVENESS AND RESTRICTED WATER USE FORECASTS***
- Mobilization Consideration in Water Forecasts
- Preparation of Draft Report and Briefings
- Final Report
- Site Implementation of IWRAPS©

USF200008298

PMCL CONSERVATION ANALYSIS

CONSERVATION MEASURES EVALUATED AT FHMR

MEASURE	DESCRIPTION
Education	Water conservation education through media and other communication methods designed to inform water use customers of efficient water use practices
Plumbing retrofit	Incremental replacement of standard plumbing fixtures with low-flow fixtures
Pressure reduction	Installation of pressure-reducing valves to help reduce water loss due to leakages
Evapotranspiration sprinkler	A mechanism that attaches to the sprinkling system and automates irrigation based on a preset moisture deficit (i.e., dryness of the soil)
Infrastructure leak detection	Methodical program designed to find and repair system leaks

USF200008299

PMCL CONSERVATION ANALYSIS

CONSERVATION EFFECTIVENESS BY MEASURE, 1995-2025

	Conservation Effectiveness (Percent)* with Respect to All IWRAPS© Sectors						
	1995	2000	2005	2010	2015	2020	2025
Education	30.93 (3.4)	31.63 (3.4)	32.27 (3.4)	32.62 (3.4)	32.76 (3.4)	32.76 (3.4)	32.76 (3.4)
Plumbing Retrofit	20.02 (2.2)	50.28 (5.4)	75.40 (7.9)	100.52 (10.5)	100.52 (10.4)	100.52 (10.4)	100.52 (10.4)
Pressure reduction	7.73 (0.8)	23.72 (2.6)	40.33 (4.2)	61.17 (6.4)	81.91 (8.5)	81.91 (8.5)	81.91 (8.5)
E.T. sprinkler	0.00 (0.0)	7.79 (0.8)	15.57 (1.6)	15.57 (1.6)	15.57 (1.6)	15.57 (1.6)	15.57 (1.6)
Leak detection	0.00 (0.0)	1.05 (0.1)	2.14 (0.2)	3.24 (0.5)	4.34 (0.5)	4.34 (0.5)	4.34 (0.5)
Total reduction in water use	58.68 (6.4)	114.47 (12.3)	165.71 (17.3)	213.12 (22.2)	235.09 (24.4)	235.09 (24.4)	235.09 (24.4)

*Conservation effectiveness is shown in MG with the corresponding percentage figures in parentheses. The effectiveness refers to the reduction of the unrestricted water use in the forecast years.

USF200008300

PMCL CONSERVATION ANALYSIS

UNRESTRICTED AND RESTRICTED FORECASTS WITH PERCENT OF REDUCTION IN WATER USE (In MG)

	Forecast Years						
	1995	2000	2005	2010	2015	2020	2025
Unrestricted IWRAPS© forecast							
Winter	275.96	282.22	287.88	291.03	292.29	292.29	292.29
Summer	633.62	648.07	661.14	668.44	671.36	671.36	671.36
Annual	909.58	930.29	949.02	959.47	963.65	963.65	963.65
Restricted IWRAPS© forecast							
Winter	258.27	247.81	238.63	227.00	221.59	221.59	221.59
Summer	592.63	568.01	546.45	519.36	506.97	506.97	506.97
Annual	850.90	815.82	785.08	746.36	728.56	728.56	728.56
Percentage reduction							
Winter	6.4	12.2	17.1	22.0	24.2	24.2	24.2
Summer	6.5	12.3	17.3	22.3	24.5	24.5	24.5
Annual	6.4	12.3	17.3	22.2	24.4	24.4	24.4

USF200008301

PMCL

STUDY OBJECTIVES

10 TASKS

- Initial Site Visit and Review of Intended Work Effort
- Data Collection
- Data Preparation and Analysis
- Model Calibration/Verification
- Development of Unrestricted Water Requirements Forecasts
- Development of Conservation Effectiveness and Restricted Water Use Forecasts
- ***MOBILIZATION CONSIDERATION IN WATER FORECASTS***
- Preparation of Draft Report and Briefings
- Final Report
- Site Implementation of IWRAPS©

USF200008302

PMCL MOBILIZATION CONSIDERATION

POTABLE WATER REQUIREMENTS WITH MOBILIZATION

	Forecast Years						
	1995	2000	2005	2010	2015	2020	2025
Annual unrestricted water use	964.33	985.04	1,003.77	1,014.22	1,018.40	1,018.40	1,018.40
Annual increase in water use due to mobilization (64%)	617.2	630.4	642.4	649.1	651.8	651.8	651.8
Annual water requirement with mobilization	1,581.5 (4,853.4)	1,615.5 (4,957.7)	1,646.2 (5,051.9)	1,663.3 (5,104.5)	1,670.2 (5,125.6)	1,670.2 (5,125.6)	1,670.2 (5,125.6)

Note: Figures expressed in MG with acre-feet in parentheses

USF200008303

PMCL

MOBILIZATION CONSIDERATION

DECISION RULES

If Mobilization Coverage is:	
Case I 1.0	$Q_{Unrestricted}$ + [$Q_{Unrestricted}$ * Mobilization Factor * Mobilization Coverage]
Case II 0.0	$Q_{Unrestricted}$
Case III >0 or <1	$Q_{Unrestricted}$ + [$Q_{Unrestricted}$ * Mobilization Factor * Mobilization Coverage]

Where: Mobilization Factor = $\frac{\text{Change in Premobilization Troop Strength}}{\text{Number of Premobilization Troops}}$

Mobilization Coverage = Proportion of Water use Sector Affected by Mobilization

USF200008304

PMCL

MOBILIZATION CONSIDERATION

POTABLE WATER REQUIREMENTS WITH MOBILIZATION
(Troop Strength 8159, Δ = 5,237)

	Forecast Years						
	1995	2000	2005	2010	2015	2020	2025
Total Mobilization (MG)							
Winter	333	341	348	352	353	353	353
Summer	768	788	804	812	815	815	815
Annual	1,101	1,129	1,152	1,164	1,168	1,168	1,168
Total Mobilization w/ Tent City (MG)							
Winter	355	364	371	374	376	376	376
Summer	800	820	836	844	847	847	847
Annual	1,155	1,184	1,207	1,218	1,223	1,223	1,223
Total Mobilization w/Tent CIty (A/F)							
Winter	1,092	1,118	1,140	1,150	1,154	1,154	1,154
Summer	2,456	2,517	2,568	2,591	2,601	2,601	2,601
Annual	3,548	3,635	3,708	3,741	3,755	3,755	3,755

USF200008305

PMCL

SUMMARY OF FINDINGS

SUMMARY OF WATER REQUIREMENTS AT FHMR (In Acre-Feet)

	Forecast Years						
	1995	2000	2005	2010	2015	2020	2025
Annual Potable Unrestricted Water Requirements	2,959.4	3,023.0	3,080.5	3,112.5	3,125.4	3,125.4	3,125.4
Annual Potable Restricted Water Requirements (with Conservation)	2,779.3	2,671.7	2,577.3	2,458.5	2,403.9	2,403.9	2,403.9
Annual Potable Restricted Water Requirements (with Mobilization)	3,548	3,635	3,708	3,741	3,755	3,755	3,755
Nonpotable Water	83.4	83.4	83.4	83.4	83.4	83.4	83.4
Effluent Water	2,124.5	2,124.5	2,124.5	2,124.5	2,124.5	2,124.5	2,124.5

USF200008306

PMCL

STUDY OBJECTIVES

10 TASKS

- Initial Site Visit and Review of Intended Work Effort
- Data Collection
- Data Preparation and Analysis
- Model Calibration/Verification
- Development of Unrestricted Water Requirements Forecasts
- Development of Conservation Effectiveness and Restricted Water Use Forecasts
- Mobilization Consideration in Water Forecasts
- ***PREPARATION OF DRAFT REPORT AND BRIEFINGS***
- Final Report
- Site Implementation of IWRAPS©

USF200008307

PMCL

STUDY OBJECTIVES

10 TASKS

- Initial Site Visit and Review of Intended Work Effort
- Data Collection
- Data Preparation and Analysis
- Model Calibration/Verification
- Development of Unrestricted Water Requirements Forecasts
- Development of Conservation Effectiveness and Restricted Water Use Forecasts
- Mobilization Consideration in Water Forecasts
- Preparation of Draft Report and Briefings
- ***FINAL REPORT***
- Site Implementation of IWRAPS©

USF200008308

PMCL

STUDY OBJECTIVES

10 TASKS

- Initial Site Visit and Review of Intended Work Effort
- Data Collection
- Data Preparation and Analysis
- Model Calibration/Verification
- Development of Unrestricted Water Requirements Forecasts
- Development of Conservation Effectiveness and Restricted Water Use Forecasts
- Mobilization Consideration in Water Forecasts
- Preparation of Draft Report and Briefings
- Final Report
- ***SITE IMPLEMENTATION OF IWRAPS©***

USF200008309