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09-AFC-9
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March 8, 2010

Eric Solorio
Project Manager
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814

RE: Ridgecrest Solar Power Project (RSPP), Docket No. 09-AFC-9, Responses to CEC Data Requests for Cultural Resources (DR 89) and Traffic (DR 265-267) and City of Ridgecrest Master Drainage Report

Dear Mr. Solorio:

As requested, attached please find Ridgecrest Solar I, LLC's responses to CEC Data Requests CULT-89, and TRAFFIC 265-267. Please also find the City of Ridgecrest Master Drainage Report.

If you have any questions on these data responses to the Staff's Data Requests, please feel free to contact me at 510-809-4662 (office) or 949-433-4049 (cell).

Sincerely,

Billy Owens
Director, Project Development

DR-TRAFFIC-265

Information Required:

Please provide traffic counts for the new project and alternatives.

Response:

The Project alternatives are estimated to generate approximately the same volume of workforce related commute traffic during peak construction periods as the reconfigured Project. The primary difference between the Project and the alternatives will be the duration of construction. The alternatives are expected to require a construction period of approximately 17 months, which is approximately 60 percent of the time period needed for the reconfigured Project. Peak construction workforces for the Project alternatives would be approximately the same size as for the reconfigured project, or approximately 633 workers. The average workforce for the alternatives is also expected to be similar to that of the reconfigured Project, or approximately 400 workers.

DR-TRAFFIC-266

Information Required:

Please provide documents and maps pertaining to each jurisdiction's ownership, easement or right-of-ways (including any alternative access point considered) within the project areas and for areas affected by the project's access.

Response:

Maps and a list of ownership were provided previously to the CEC as Appendix A of the AFC, submitted September 1, 2009 and as Figure 249-1 of the Data Responses, submitted on January 25, 2010. The figures and ownership list has been revised with the reconfigured Project and are provided at the end of this section in Attachment DR-TRAFFIC-266.

Existing ROWs within the Project area are described in the Land Use section of the Data Adequacy Volume 3 Supplement, submitted to the CEC on October 27, 2010. A revised figure of the Master Title Plats (MTPs) of the reconfigured Project site is provided at the end of this section. The reconfigured Project does not impact any new existing ROWs within the plant site. Figures of the MTPs covering the water pipeline route are also provided at the end of this section in Attachment DR-TRAFFIC-266. According to the MTPs, four ROWs currently exist within the water pipeline route. CACA 019124 is a 0.34 acre ROW owned by the Indian Wells Valley Water District (IWVWD) for the water tank that the Project will connect to. CACA 23092 is a ROW for a 50 acre overhead fiber optics cable line owned by Verizon that runs along China Lake Blvd. CACA 001766 is a 0.057 acre ROW owned by Kern County. R 07494 is owned by the Department of Navy for Direction Markers. There are two expired or terminated ROWs that no longer exist within the water pipeline route (CA 04242 and CACA 020233).

Table DR-TRAFFIC-266 provides a description of the ROWs the Project elements will affect. The entire length of the water line will be in Caltrans or Kern County or City of Ridgecrest ROW or within IWVWD easement.

Table DR-TRAFFIC-266 Road and Utility ROWs

Project Element	Width	Jurisdiction
Water Pipeline (parallel encroachment of S. China Lake Blvd.)	400 feet (total existing road ROW) Water pipeline requires 30 feet (within the above ROW)	Kern County
Water Pipeline (parallel encroachment of Brown Road)	60 feet (total existing road ROW) Water pipeline requires 30 feet (within the above ROW)	Kern County
Water Pipeline (U.S. Highway 395 drilled crossing)	250 feet (total existing road ROW) Drilled crossing, no permanent easement, temporary space ~50' x 75' for drilling pit and ~50' X 50' for receiving pit; elsewhere in the Caltrans easement either side of the drilled crossing, the water pipeline will require a 30 foot wide construction easement	CalTrans
Water Pipeline (from S. China Lake Blvd to IWVWD pumping facility)	Existing ROW width n/a; water pipeline to be installed within an existing Indian Wells Valley Water District (IWVWD) easement, adjacent an existing water pipeline; 30-foot wide construction easement required	Indian Wells Valley Water District (IWVWD)
Rerouted 115kV and 230kV SCE Transmission Line	375 feet (proposed)	BLM
Alternative Site Access Point-Brown Road	60 feet ROW to be improved to 110 feet. Improvements may include: westbound deceleration/right turn lane; westbound acceleration lane; eastbound deceleration/ left turn lane; eastbound acceleration lane.	Kern County
Alternative Site Access Point-US Highway 395	250 feet (total existing road ROW). Improvements may include: southbound right turn/deceleration lane; southbound left turn lane; southbound acceleration lane; northbound left turn lane.	CalTrans

DR-TRAFFIC-267

Information Required:

Please provide any available as-builts, improvements plans, etc. illustrating roadway conditions and actual right-of-way of roadways within the project areas and for areas affected by the project's access.

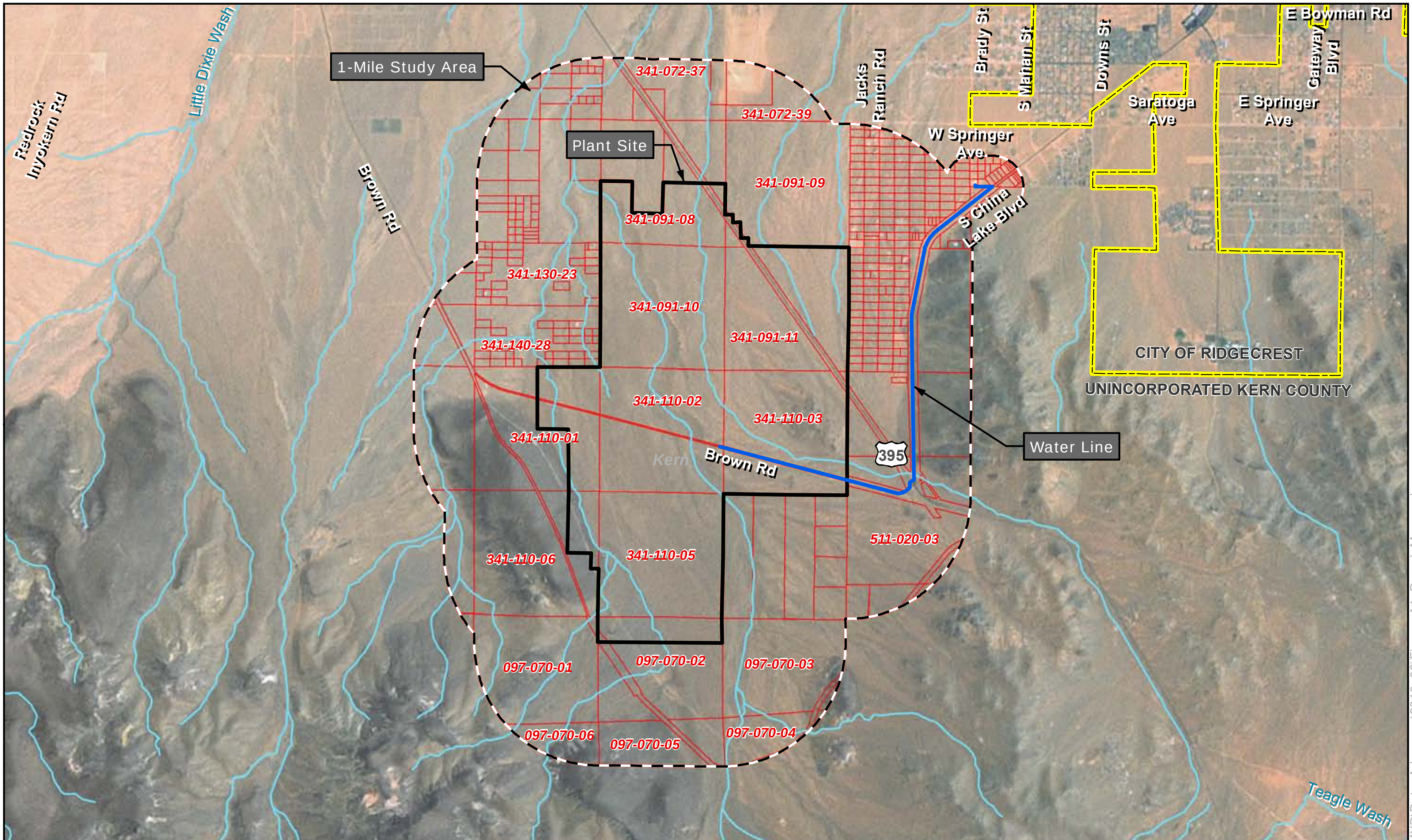
Response:

ROW maps and case maps of China Lake Blvd, Brown Road and U.S. Highway 395 obtained from Kern County are provided in Attachment DR-TRAFFIC-267. Figure DR-TRAFFIC-267 is a high resolution aerial of the intersection of U.S. Highway 395, China Lake Blvd. and Brown Road. U.S. Highway 395 and China

Lake Blvd are two lane roads with paved shoulders. Brown Road is a two lane road with unpaved shoulders. China Lake Blvd contains overhead power lines but no underground utility lines. Brown Road and U.S. Highway 395 do not contain either overhead power lines or underground utility lines.

Attachment DR-TRAFFIC-266

Figures



Map Location

Legend

- Water Line
- Parcels Within Study Area
- Plant Site
- 1 Mile Study Area
- City Limits

0 | 6,000 | 12,000 Feet

1 inch = 6,000 feet

N S E W

Ridgecrest Solar Power Project

Figure A-1
Parcel Map

Solar Millennium

AECOM

Date: February 2010

Y:\Projects\Solar_Millennium\RSPP\MXD\Data_Adequacy\2010_02\Figure_A1_Parcel_Map.mxd

APN9	APN_LABEL	Assessee Name	Street Number	Street Direction	Street Name	Street Type	City	State	Zip Code
097070015	097-070-01	U S A			UNKNOWN			CA	
097070023	097-070-02	U S A			UNKNOWN			CA	
097070031	097-070-03	U S A			UNKNOWN			CA	
097070049	097-070-04	U S A			UNKNOWN			CA	
097070056	097-070-05	U S A			UNKNOWN			CA	
097070064	097-070-06	U S A			UNKNOWN			CA	
097140016	097-140-01	U S A			UNKNOWN			CA	
341072015	341-072-01	RUDNICK ESTATES TR	5401		BUSINESS PARK SOUTH		BAKERSFIELD	CA	93309
341072023	341-072-02	U S A			UNKNOWN			CA	
341072122	341-072-12	SHAPIRO RUTH	19333	W	COUNTRY CLUB	DR	AVENTURA	FL	33180
341072130	341-072-13	WEDDERIEN DELORES A REV TR	1749		VIA ALLENA		OCEANSIDE	CA	92056
341072148	341-072-14	ARCHERD ARMAND A	10750		WILSHIRE	BL	LOS ANGELES	CA	90024
341072155	341-072-15	MELLON SALLY A	5320		ALCOVE	AV	NO HOLLYWOOD	CA	91607
341072163	341-072-16	VALOV WILLIAM	2339		MONTERA		HACIENDA HGTS	CA	91745
341072171	341-072-17	GREENE SHANKLIN TR							
34107219016	341-072-19	RAYNOR WILLIAM & BETTY H	11479		AMIGO	AV	NORTHRIDGE	CA	91326
341072205	341-072-20	BENNETT VONNE GODFREY TR			P O BOX 2242		RANCHO SANTE FE	CA	92067
341072213	341-072-21	ABELLA CAL PROP LLC	433		JADE TREE	ST	MONTEREY PARK	CA	91754
341072221	341-072-22	SEMBACH BETTYE R			P O BOX 1956		RIDGECREST	CA	93555
341072254	341-072-25	LUNING ASSOCIATIES	3300	S	LAKESHORE	RD	CHELAN	WA	98816
341072288	341-072-28	HIKIDA LARRY K & SU CHENG S	436	S	PORTER	AV	TUCSON	AZ	85710
341072296	341-072-29	MC GINTY JOHN & KAY	13660		EL RIO	RD	VICTORVILLE	CA	92392
341072304	341-072-30	MORSHEAD FMLY BYPASS TR	25124		AVENIDA RONDEL		VALENCIA	CA	91355
341072312	341-072-31	LYNCH ROBERT B							
341072320	341-072-32	BARILLE JOSEPH & PATRICIA	614	W	COSO	AV	RIDGECREST	CA	93555
341072338	341-072-33	NALBANTIAN JEAN & ARMINE	1815	W	ALAMEDA	AV	BURBANK	CA	91506
341072346	341-072-34	BOYD THEOPHILUS	1950		BARRETT LAKES	BL	KENNESAW	GA	30144
341072353	341-072-35	KHALSA SIMRAN S			PO BOX 1283		SANTA CRUZ	NM	85767
341072361	341-072-36	COUNTY OF KERN	1115		TRUXTUN	AV	BAKERSFIELD	CA	93301
341072379	341-072-37	U S A			UNKNOWN			CA	
341072387	341-072-38	COUNTY OF KERN	1115		TRUXTUN	AV	BAKERSFIELD	CA	93301
341072395	341-072-39	U S A			UNKNOWN			CA	
341091015	341-091-01	THILMONY OLIVENA E	7882		LAKE	DR	ALGONAC	MI	48001
341091023	341-091-02	RUDNICK ESTATES TR	5401		BUSINESS PARK SOUTH		BAKERSFIELD	CA	93309
341091031	341-091-03	MALEK AMAL & MERVIETT S TR	433		JADE TREE	DR	MONTEREY PARK	CA	91754
341091049	341-091-04	U S A			UNKNOWN			CA	
341091056	341-091-05	BOWMAN DORWIN & VERONICA	765		CENTERWOOD	RD	WILLISTON	SC	29853
341091064	341-091-06	LEWIS RICHARD D TR	2409		HWY 14 NORTH		INYOKERN	CA	93527
341091072	341-091-07	SEMBACH BETTYE R			P O BOX 1956		RIDGECREST	CA	93555
341091080	341-091-08	U S A			UNKNOWN			CA	
341091098	341-091-09	U S A			UNKNOWN			CA	
341091106	341-091-10	U S A			UNKNOWN			CA	
341091114	341-091-11	U S A			UNKNOWN			CA	
341103208	341-103-20	CHONG SUNG K & WON SO	944	S	NEW HAMPSHIRE	AV	LOS ANGELES	CA	90006
341103216	341-103-21	PACHOL MARK	16375		FOX GLEN	RD	RIVERSIDE	CA	92504
341103224	341-103-22	WIKNICH THOMAS R	105	S	HOLLY CANYON		RIDGECREST	CA	93555
341110013	341-110-01	U S A			UNKNOWN			CA	
341110021	341-110-02	U S A			UNKNOWN			CA	
341110039	341-110-03	U S A			UNKNOWN			CA	
341110054	341-110-05	U S A			UNKNOWN			CA	
341110062	341-110-06	U S A			UNKNOWN			CA	

341110070	341-110-07	BULLOCK MARK	821	W	INYOKERN	RD	RIDGECREST	CA	93555
341110096	341-110-09	BECK MICHAEL W			P O BOX 10252		BEDFORD	NH	03110
341110112	341-110-11	SRIKANTH VINOD & ANJARIA JALPA K	6362		ENGLISH IVY	WY	SPRINGFIELD	VA	22152
341110120	341-110-12	HILBURG RIAL GLENDA ARLEEN TR	34131		AMBER LANTERN	ST	DANA POINT	CA	92629
341110138	341-110-13	KIM FAMILY TRUST	9563		GARDEN GROVE	BL	GARDEN GROVE	CA	92844
341110146	341-110-14	LEE RICHARD P & LINDA C	21781		EAGLE LAKE	CI	LAKE FOREST	CA	92630
341120038	341-120-03	U S A			UNKNOWN			CA	
341120046	341-120-04	U S A			UNKNOWN			CA	
341130029	341-130-02	STREET MARY L	3192		OAK GROVE	RD	LOS ALAMITOS	CA	90720
341130037	341-130-03	STREET MARY L	3192		OAK GROVE	RD	LOS ALAMITOS	CA	90720
341130045	341-130-04	ALLEN JESSE R	51		GRISTMILL PATH		MARSTONS MILLS	MA	02648
341130052	341-130-05	STREET MARY L	3192		OAK GROVE	RD	LOS ALAMITOS	CA	90720
341130060	341-130-06	NEWELL JACQUELINE M ET AL	4000		PAIGE	ST	LOS ANGELES	CA	90031
341130078	341-130-07	GORDON PAULA Q	117	E	E	ST	TEHACHAPI	CA	93561
341130086	341-130-08	ALLEN VERA L	37		KELLEY	RD	S YARMOUTH	MA	02664
341130094	341-130-09	CASS CHARLIE ROBERT & JOYCE ANN	1335	W	DOLPHIN	AV	RIDGECREST	CA	93555
341130102	341-130-10	GALLOWAY DAVID TR ET AL	4855		LA MONTANA	CI	TARZANA	CA	91356
341130110	341-130-11	GERMAN JOHN W			PO BOX 754		INYOKERN	CA	93527
341130144	341-130-14	DE JOHN DONALD A & PATRICIA	2511		CALVERT BOX 364		INYOKERN	CA	93527
341130151	341-130-15	DE JOHN DONALD A & PATRICIA	2511		CALVERT BOX 364		INYOKERN	CA	93527
341130169	341-130-16	SCHROEDER FAMILY TRUST	8016		RANCHO FANITA	DR	SANTEE	CA	92071
341130177	341-130-17	DAVIS ROSE E	2810	N	VAN NESS	BL	FRESNO	CA	93704
341130185	341-130-18	BELL GERALD D REVOCABLE TRUST	2894		PREECE	ST	SAN DIEGO	CA	92111
341130193	341-130-19	NELSON GEORGE B YORK			P O BOX 1702		INYOKERN	CA	93527
341130235	341-130-23	U S A			UNKNOWN			CA	
341130243	341-130-24	GERMAN RONALD L			P O BOX 754		INYOKERN	CA	93527
341130250	341-130-25	HARRELL LIV TR			P O BOX 21426		CARSON CITY	NV	89721
341130268	341-130-26	DE JOHN DONALD A & PATRICIA A			P O BOX 364		INYOKERN	CA	93527
341130276	341-130-27	GERMAN RONALD LEE			P O BOX 754		INYOKERN	CA	93527
341130284	341-130-28	GERMAN RONALD LEE			P O BOX 754		INYOKERN	CA	93527
341140010	341-140-01	WOOD CLAUD H & MIRACLE ARLENE			P O BOX 747		BENTON CITY	WA	99320
341140028	341-140-02	O'BRIEN ERIN	2328		BANDEROLA		SAN LUIS OBISPO	CA	93401
341140036	341-140-03	WOOD STANLEY L & BEULAH E	7655		SANTA YNEZ	AV	ATASCADERO	CA	93422
341140044	341-140-04	DJAVAHERI MONIR	265		PACHECO	DR	TRACY	CA	95376
341140051	341-140-05	BHANA HARSHAD RAI	10327		GARVEY	AV	EL MONTE	CA	91733
341140069	341-140-06	TRAVERS JOSEPH ET AL	113		POPLAR	WY	BRICK	NJ	08724
341140077	341-140-07	BURTON IRENE J TRUST	1920		FRESHWATER	RD	EUREKA	CA	95503
341140085	341-140-08	GRAHAM FAMILY TR	157		LOWELL	AV	GLENDORA	CA	91741
341140093	341-140-09	DECKERT ARTHUR J	9609	NW	25TH	AV	VANCOUVER	WA	98665
341140101	341-140-10	SCHNELL ROBERT & NANCY FAMILY TRUST	2345		ROCK VIEW GLEN		ESCONDIDO	CA	92026
341140119	341-140-11	U S A			UNKNOWN			CA	
341140127	341-140-12	WILLIAMS TOM W			P O BOX 1383		INYOKERN	CA	93527
341140135	341-140-13	DE JOHN DONALD A & PATRICIA A	2511		CALVERT BOX 364		INYOKERN	CA	93527
341140143	341-140-14	WILLIAMS TOM W			P O BOX 1383		INYOKERN	CA	93527
341140150	341-140-15	CLEMENTS TOMMY JAY & DIANE ROBIN	119		GARDEN	CI	CLOVERDALE	CA	95425
341140168	341-140-16	BIAS ROBERT L II	628	W	7TH	AV	ESCONDIDO	CA	92025
341140176	341-140-17	HARRELL LIV TR			P O BOX 21426		CARSON CITY	NV	89721
341140184	341-140-18	DE JOHN DONALD A & PATRICIA A	2511		CALVERT BOX 364		INYOKERN	CA	93527
341140192	341-140-19	DAVIS THOMAS	49930		ELISE	ST	LANCASTER	CA	93536
341140200	341-140-20	DAVIS THOMAS	49930		ELISE	ST	LANCASTER	CA	93536
341140218	341-140-21	ANTU STEVE CARRINGTON	2681		MONTEREY	RD	SAN JOSE	CA	95013
341140226	341-140-22	LAW LAWRENCE W	8817		CACHE	ST	LEONA VALLEY	CA	93551

341140234	341-140-23	U S A			UNKNOWN			CA	
341140242	341-140-24	PARKER ALBION V	3417		EL CAMINITO		LA CRESCENTA	CA	91214
341140259	341-140-25	NEWMAN LIV TR	23		WALKING DIAMOND	DR	PRESCOTT	AZ	86301
341140267	341-140-26	PAYTON JANET A & PAUL L	92		REVERE	RD	EUREKA	MT	59917
341140275	341-140-27	TKACHUK SARAH N TR ET AL	1106		RANDALL	ST	RIDGECREST	CA	93555
341140283	341-140-28	U S A			UNKNOWN			CA	
341140309	341-140-30	WICKENDEN ROGER C	974		APOKULA	PL	KAILUA	HI	96734
341300010	341-300-01	JOHNSON BILLY JOE	953		DOGWOOD		COSTA MESA	CA	92627
341300028	341-300-02	MC GINNIS JOHN H	636		JOYNER		RIDGECREST	CA	93555
341300036	341-300-03	ROMAN CATHOLIC BISHOP FRESNO	1550	N	FRESNO	ST	FRESNO	CA	93703
341300044	341-300-04	BLACK MARY BETH	130	E	IDLEWOOD	ST	MORTON	IL	61550
341300051	341-300-05	SEARS LIVING TR	2000		18TH	ST	BAKERSFIELD	CA	93301
341300069	341-300-06	WADDINGTON JERRY W & HELEN E	15190		SORREL	RD	VICTORVILLE	CA	92394
341300077	341-300-07	ANDERSON ROBERT L	508		RANDALL	ST	RIDGECREST	CA	93555
341300085	341-300-08	PARISH JACQUELINE Y			P O BOX 8747		LOS ANGELES	CA	90008
341300093	341-300-09	LAWSON DAVID E	543		FREDERICK	LN	PRESCOTT	AZ	86301
341300101	341-300-10	MILLER ERIC A			P O BOX 293484		PHELON	CA	92329
341300119	341-300-11	PROFESSIONAL EQUITIES INTERNATIONAL	23201		MILL CREEK	DR	LAGUNA HILLS	CA	92653
341300127	341-300-12	DENNIS THOMAS K & ALICE S	1290		WILLET	CI	ANAHEIM	CA	92807
341300135	341-300-13	VENEY JOHN	2292		WEKIVA VILLAGE	LN	APOPKA	FL	32703
341300143	341-300-14	LUNA MICHAEL EDWARD	6009		AMES LAKE	RD	CARNATION	WA	98014
341300150	341-300-15	WEST DOUGLAS E & CHRISTINA			P O BOX 50		YUBA CITY	CA	95992
341300168	341-300-16	GOBOURNE LLOYD G JR & WANDA M	2704		APACHE	DR	BIG SPRING	TX	79720
341300176	341-300-17	OROZCO ISIDRO & MARICELA	3818		ALSACE	AV	LOS ANGELES	CA	90008
341300184	341-300-18	YOUNG NAK PRESBYTERIAN CH OF L A CORP	1721	N	BROADWAY		LOS ANGELES	CA	90031
341300192	341-300-19	WILSON BERNICE F	601	S	ELM	ST	MOUNTAIN GROVE	MO	65711
341300200	341-300-20	GUERRERO ANDRADE VERONICA	521		HOWELL	RD	CHOWCHILLA	CA	93610
341300218	341-300-21	ALLMARK ENTERPRISES	5556		BILL CODY	RD	HIDDEN HILLS	CA	91302
341300226	341-300-22	LOWE LELAND K	7252		VINE	ST	HIGHLAND	CA	92346
341300234	341-300-23	BATEMAN VIRGIL C & CATHERINE E	3410		28TH	AV	SACRAMENTO	CA	95820
341300242	341-300-24	BEAGAN SANDRA J	464		SULLIVAN	WY	MOUNTAIN HOUSE	CA	95391
341300259	341-300-25	GARCIA ALEJANDRA BAZA DE	2278		CASA DULCE	WY	PLUMAS LAKE	CA	95961
341300267	341-300-26	SCHUMANN GEORGE & GEORGIA FMLY TR	2425		MAHAN	WY	SAN PABLO	CA	94806
511010019	511-010-01	U S A			UNKNOWN			CA	
511010027	511-010-02	U S A			UNKNOWN			CA	
511020018	511-020-01	U S A			UNKNOWN			CA	
511020026	511-020-02	CAVALLIERE S G & DERSCHON M L	3601	S	CHINA LAKE	BL	RIDGECREST	CA	93555
511020034	511-020-03	U S A			UNKNOWN			CA	
511031163	511-031-16	U S A			UNKNOWN			CA	
511031205	511-031-20	WINTON LAWRENCE L	240		LARK	ST	OXNARD	CA	93033
511031213	511-031-21	U S A			UNKNOWN			CA	
511031239	511-031-23	U S A			UNKNOWN			CA	
511031247	511-031-24	U S A			UNKNOWN			CA	
511031254	511-031-25	U S A			UNKNOWN			CA	
511031262	511-031-26	U S A			UNKNOWN			CA	
511031270	511-031-27	U S A			UNKNOWN			CA	
511031288	511-031-28	U S A			UNKNOWN			CA	
511031296	511-031-29	U S A			UNKNOWN			CA	
511031304	511-031-30	U S A			UNKNOWN			CA	
511031312	511-031-31	U S A			UNKNOWN			CA	
511031320	511-031-32	U S A			UNKNOWN			CA	
511031338	511-031-33	U S A			UNKNOWN			CA	

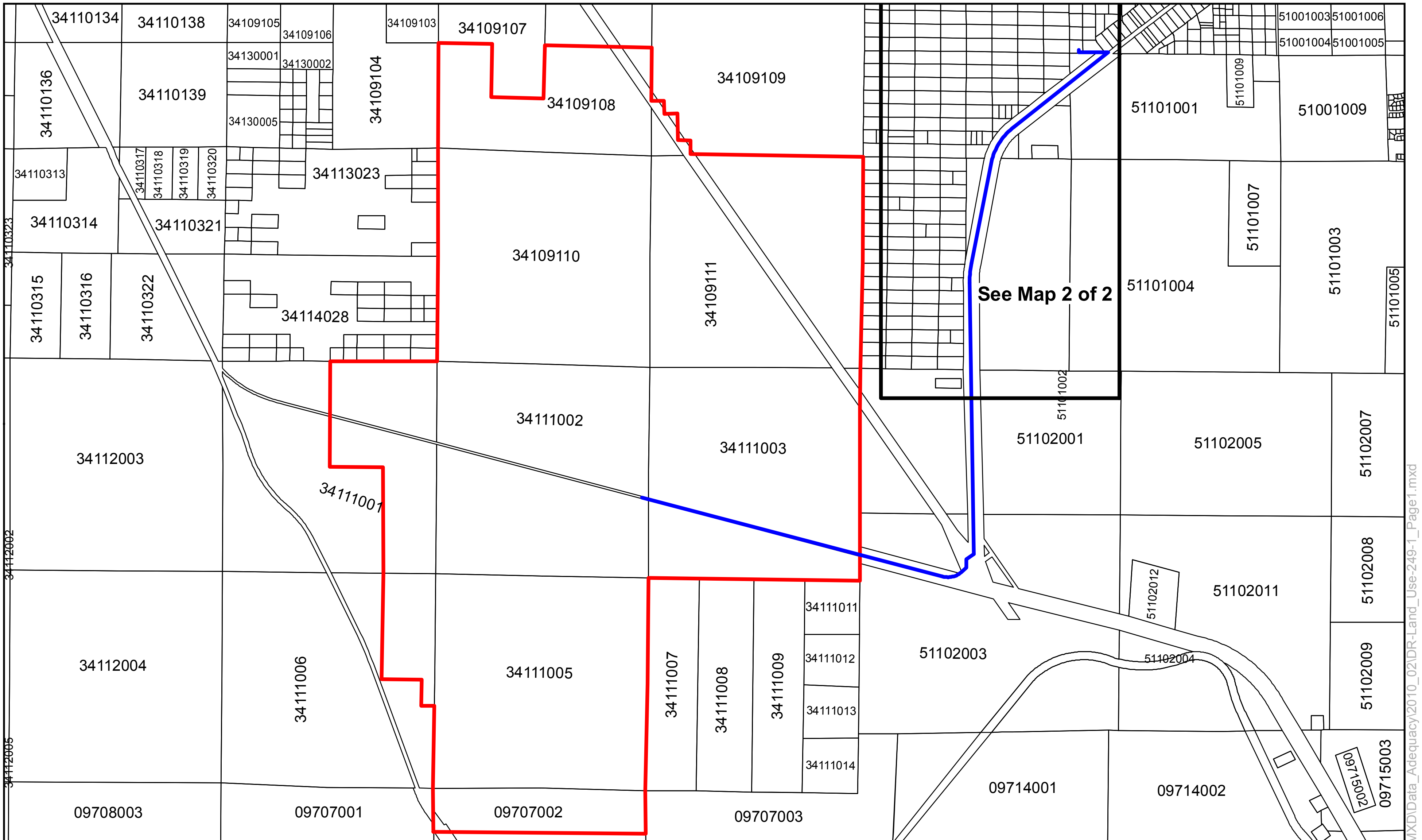
511031346	511-031-34	U S A			UNKNOWN			CA	
511031353	511-031-35	U S A			UNKNOWN			CA	
511031361	511-031-36	U S A			UNKNOWN			CA	
511032013	511-032-01	SINGER GREGORY & KATHLEEN	9014		CENTRAL	AV	BROOKSVILLE	FL	34613
511032021	511-032-02	LATHAM LAWRENCE ALAN	2335	W	SPRINGER	AV	RIDGECREST	CA	93555
511032039	511-032-03	MALNASSY LINDA	5928		COURVILLE	CT	FAIR OAKS	CA	95628
511032054	511-032-05	U S A			UNKNOWN			CA	
511032062	511-032-06	U S A			UNKNOWN			CA	
511032070	511-032-07	DE VOUS LILLIAN	22019		VANOWEN	ST	CANOGA PARK	CA	91303
511032088	511-032-08	DE VOUS LILLIAN	22019		VANOWEN	ST	CANOGA PARK	CA	91303
511032096	511-032-09	U S A			UNKNOWN			CA	
511032104	511-032-10	GIRE DAVID L & MARGARET D LIV TR			P O BOX 880		RIDGECREST	CA	93556
511032112	511-032-11	WYDA ROBERT F & TSUMENO	237	N	ALVORD		RIDGECREST	CA	93555
511032120	511-032-12	AHMED IQBAL & MEHNEZ	4507		WHEELER	AV	LA VERNE	CA	91750
511032138	511-032-13	U S A			UNKNOWN			CA	
511032146	511-032-14	U S A			UNKNOWN			CA	
511032153	511-032-15	U S A			UNKNOWN			CA	
511032161	511-032-16	LYNN ANNA M	1857		MIKES TRAIL	RD	RIDGECREST	CA	93555
511032179	511-032-17	LIUJANN DIANE	12837		BOMBARDIER	AV	NORWALK	CA	90650
511032187	511-032-18	WISDOM ALAN JEFFERY			P O BOX 1152		RIDGECREST	CA	93556
511032195	511-032-19	IBERICO MARCELO A	424		BELLFLOWER	BL	LONG BEACH	CA	90814
511032203	511-032-20	KINMAN DARRY M	1031	N	SIERRA VIEW	ST	RIDGECREST	CA	93555
511032211	511-032-21	HOOPER JOHN O	1261		PALO VERDE	DR	RIDGECREST	CA	93555
511032229	511-032-22	SCHOSTAG ALFRED M & ELEANOR M TRUST	1112		NEWPORT	WY	ROSEVILLE	CA	95661
511032237	511-032-23	MITTMAN EMIL	11872		SIMON RANCH	RD	SANTA ANA	CA	92705
511032245	511-032-24	WHITWORTH NINA	7343		LOUISE	AV	VAN NUYS	CA	91406
511032252	511-032-25	BEBEE DERREL W & SHARON F	704		NEVADA	ST	RIDGECREST	CA	93555
511032260	511-032-26	SHELTON RUBY E	17225		LOS ALIMOS		GRANADA HILLS	CA	91344
511032278	511-032-27	MURPHY JERRY T	11306		SHELDON	ST	SUN VALLEY	CA	91352
511032286	511-032-28	MERK SOPHIA ANNE	2062	S	MIKES TRAIL	RD	RIDGECREST	CA	93555
511032294	511-032-29	SISON CORNELIO L & EDITH A	3595		INLAND EMPIRE	BL	ONTARIO	CA	91764
511032302	511-032-30	U S A			UNKNOWN			CA	
511032310	511-032-31	U S A			UNKNOWN			CA	
511032328	511-032-32	VIQUEZ DENNIS R & MARY ANN	415		ESCANABA	LN	MUSKEGON	MI	49442
511032336	511-032-33	DOTTERY CINDY GIN & WILLIAM ROBERT JR	2400	W	KENDALL	AV	RIDGECREST	CA	93555
511041014	511-041-01	U S A			UNKNOWN			CA	
511041022	511-041-02	U S A			UNKNOWN			CA	
511041030	511-041-03	U S A			UNKNOWN			CA	
511041048	511-041-04	U S A			UNKNOWN			CA	
511041055	511-041-05	U S A			UNKNOWN			CA	
511041063	511-041-06	U S A			UNKNOWN			CA	
511041071	511-041-07	U S A			UNKNOWN			CA	
511041089	511-041-08	U S A			UNKNOWN			CA	
511041097	511-041-09	U S A			UNKNOWN			CA	
511041105	511-041-10	U S A			UNKNOWN			CA	
511041113	511-041-11	U S A			UNKNOWN			CA	
511041121	511-041-12	U S A			UNKNOWN			CA	
511041139	511-041-13	U S A			UNKNOWN			CA	
511041147	511-041-14	U S A			UNKNOWN			CA	
511041154	511-041-15	U S A			UNKNOWN			CA	
511041162	511-041-16	U S A			UNKNOWN			CA	
511041170	511-041-17	BEITNES PHILIP M			P O BOX 1012		RIDGECREST	CA	93556

511041188	511-041-18	THON SCOTT			P O BOX 1935		RIDGECREST	CA	93556
511041196	511-041-19	THON SCOTT			P O BOX 1935		RIDGECREST	CA	93556
511041204	511-041-20	THON SCOTT			P O BOX 1935		RIDGECREST	CA	93556
511041212	511-041-21	THON SCOTT			P O BOX 1935		RIDGECREST	CA	93556
511041220	511-041-22	GUARRERA J J & RYSKOWSKI TR	78904		NARANJA	DR	PALM DESERT	CA	92211
511041238	511-041-23	SMITH PHYLLIS D			P O BOX 703		INYOKERN	CA	93527
511041246	511-041-24	AULD HOWARD E & BARBARA	641		MAMIE	ST	RIDGECREST	CA	93555
511041253	511-041-25	HUFF DAVID B & ALADYS M TRUST	1113	N	SIERRA VIEW	ST	RIDGECREST	CA	93555
511041261	511-041-26	AULD HOWARD E & BARBARA L	641		MAMIE		RIDGECREST	CA	93555
511041279	511-041-27	AULD H E & B L & VANDERBECK J	641		MAMIE	AV	RIDGECREST	CA	93555
511041287	511-041-28	AULD HOWARD E & BARBARA	641		MAMIE	ST	RIDGECREST	CA	93555
511041295	511-041-29	U S A			UNKNOWN			CA	
511041303	511-041-30	U S A			UNKNOWN			CA	
511041337	511-041-33	FARRIS WILLIAM H & CHERIE A	2600	S	CHINA LAKE	BL	RIDGECREST	CA	93555
511042012	511-042-01	U S A			UNKNOWN			CA	
511042020	511-042-02	U S A			UNKNOWN			CA	
511042038	511-042-03	U S A			UNKNOWN			CA	
511042046	511-042-04	U S A			UNKNOWN			CA	
511042053	511-042-05	U S A			UNKNOWN			CA	
511042061	511-042-06	U S A			UNKNOWN			CA	
511042079	511-042-07	U S A			UNKNOWN			CA	
511042087	511-042-08	U S A			UNKNOWN			CA	
511042095	511-042-09	U S A			UNKNOWN			CA	
511042103	511-042-10	U S A			UNKNOWN			CA	
511042111	511-042-11	U S A			UNKNOWN			CA	
511042129	511-042-12	U S A			UNKNOWN			CA	
511042137	511-042-13	U S A			UNKNOWN			CA	
511042145	511-042-14	U S A			UNKNOWN			CA	
511042152	511-042-15	U S A			UNKNOWN			CA	
511042160	511-042-16	U S A			UNKNOWN			CA	
511042178	511-042-17	HARVEY JOHN D	24609	SE	156TH	AV	KENT	WA	98042
511042186	511-042-18	KRUEGER JO ANN	2321		MIKES	TL	RIDGECREST	CA	93555
511042194	511-042-19	U S A			UNKNOWN			CA	
511042202	511-042-20	GROSSARDT TAMMIE	2321		PRIMAVERA	ST	RIDGECREST	CA	93555
511042210	511-042-21	SIBREL KIMBERLY A & CHRISTOPHER R	2332	S	DESERT CASSIA	ST	RIDGECREST	CA	93555
511042228	511-042-22	BOMBARD MISCHELLE R	2250		LAURA	AV	RIDGECREST	CA	93555
511042236	511-042-23	TORKELSON GRANT M	2343		MIKES	TR	RIDGECREST	CA	93555
511042244	511-042-24	GREER EDNA CLAUDINE	2352	S	JACKS RANCH	RD	RIDGECREST	CA	93555
511042251	511-042-25	KARAJERJIAN ABRAHAM	4401		MEDLEY	PL	ENCINO	CA	91316
511042269	511-042-26	HIATT CAROLYN			912-A ATKINS		RIDGECREST	CA	93555
511042277	511-042-27	EPPS NYDIA D	6333		LA JOLLA	BL	LA JOLLA	CA	92037
511042285	511-042-28	POTTS CLARA A	1329		MAYO	ST	RIDGECREST	CA	93555
511042293	511-042-29	TORKELSON GRANT M	2343		MIKES	TR	RIDGECREST	CA	93555
511042301	511-042-30	AUMAN BENNIE L	212	N	FLORENCE	ST	RIDGECREST	CA	93555
511042319	511-042-31	WOLFF MARY E FAMILY TRUST	326		VISCAINO	WY	SAN JOSE	CA	95119
511042327	511-042-32	BEITNES PHILIP M			P O BOX 1012		RIDGECREST	CA	93556
511042335	511-042-33	CATE FAMILY TRUST	131	N	GWEN	DR	RIDGECREST	CA	93555
511042343	511-042-34	SIMPSON GARY & MARY	2319		CATALINA	LN	RIDGECREST	CA	93555
511042350	511-042-35	REDDEMANN ALAN W & MARIETA C	2461		CATALINA	LN	RIDGECREST	CA	93555
511051013	511-051-01	ORR JOHN L	2924	S	CHINA LAKE	BL	RIDGECREST	CA	93555
511051021	511-051-02	WOLFF ESTHER C TR	10801		LINDLEY	AV	GRANADA HILLS	CA	91344
511051039	511-051-03	U S A			UNKNOWN			CA	

511051047	511-051-04	PIEPMEIER TRUST			P O BOX 789		RIDGECREST	CA	93556
511051054	511-051-05	GRAUS SEVERN JAMIE	2165		LUND	AV	RIDGECREST	CA	93555
511051062	511-051-06	MAHONEY B & JEAN			P O BOX 1726		RIDGECREST	CA	93555
511051070	511-051-07	LY ANNA	5772		GARDEN GROVE	BL	WESTMINSTER	CA	92683
511051088	511-051-08	GOLDSTENE FAMILY TR	1214		BUCKNELL	DR	DAVIS	CA	95616
511051096	511-051-09	U S A			UNKNOWN			CA	
511051104	511-051-10	MERRY STEVEN P	2865		DOLE	RD	MYRTLE CREEK	OR	97457
511051112	511-051-11	GURUNIAN LIVING TR	638	N	BEL AIRE	DR	BURBANK	CA	91501
511051120	511-051-12	U S A			UNKNOWN			CA	
511051138	511-051-13	NICHOLS SUSAN JEAN	10282		VISTA DE LA CRUZ		LA MESA	CA	91941
511051146	511-051-14	U S A			UNKNOWN			CA	
511051153	511-051-15	U S A			UNKNOWN			CA	
511051161	511-051-16	SIEBENTHAL FAMILY TR	1202		LOMA	DR	OJAI	CA	93023
511051179	511-051-17	LUNING ASSCS L P	3300	S	LAKESHORE	RD	CHELAN	WA	98816
511051187	511-051-18	NELSON LELAND & FRANCISA G	7111		CASPER	AV	INYOKERN	CA	93527
511051195	511-051-19	SMITH ERVIN R			BX 931		RIDGECREST	CA	93555
511051203	511-051-20	U S A			UNKNOWN			CA	
511051211	511-051-21	GIORDANO NICK V & VICKY Y TR	6211		MARYLAND	DR	LOS ANGELES	CA	90048
511051229	511-051-22	KUBLIN HARRY SAUL	215	S	SANTA FE	AV	LOS ANGELES	CA	90012
511051237	511-051-23	U S A			UNKNOWN			CA	
511051245	511-051-24	SEYMOUR KEVIN C & NANCY E	2313		BELLE VISTA		RIDGECREST	CA	93555
511051252	511-051-25	GHORMLEY LLELAND B	3119		MIKES TRAIL		RIDGECREST	CA	93555
511051260	511-051-26	U S A			UNKNOWN			CA	
511051278	511-051-27	DONALDSON ARTHUR			BOX 241		RIDGECREST	CA	93555
511051286	511-051-28	KOOGLER MARY J	2525	N	BOURBON	ST	ORANGE	CA	92865
511051294	511-051-29	ALBERT KENNETH W	1540		HARBOR DRIVE NORTH		OCEANSIDE	CA	92054
511051302	511-051-30	SMITH FRANCIS	390	SE	110TH	AV	BLUFF CITY	KS	67018
511051310	511-051-31	SMITH FRANCIS	390	SE	110TH	AV	BLUFF CITY	KS	67018
511051328	511-051-32	DONALDSON ARTHUR			P O BOX 241		RIDGECREST	CA	93556
511051336	511-051-33	SEYMOUR KEVIN C	2313	W	BELLE VISTA		RIDGECREST	CA	93555
511051344	511-051-34	KEATING NANCY E	2313	W	BELLE VISTA		RIDGECREST	CA	93555
511052011	511-052-01	U S A			UNKNOWN			CA	
511052029	511-052-02	U S A			UNKNOWN			CA	
511052037	511-052-03	TALAMANTES ELOISA	1921		DARBY	ST	SAN BERNARDINO	CA	92407
511052045	511-052-04	U S A			UNKNOWN			CA	
511052052	511-052-05	U S A			UNKNOWN			CA	
511052060	511-052-06	MALONE B E & WYLIE M K	3735		CR 402 WEST		HENDERSON	TX	75654
511052078	511-052-07	HOLLAR LINDA D	429		DEBRA	LN	RIDGECREST	CA	93555
511052086	511-052-08	U S A			UNKNOWN			CA	
511052094	511-052-09	GAREY KIMBERLEY J	2115		SKYLARK	AV	RIDGECREST	CA	93555
511052102	511-052-10	TALAMANTES ANGEL	1408		MEEKER	AV	LA PUENTE	CA	91746
511052110	511-052-11	U S A			UNKNOWN			CA	
511052128	511-052-12	U S A			UNKNOWN			CA	
511052136	511-052-13	LE MON ROSE J	315		SILVER RIDGE	DR	RIDGECREST	CA	93555
511052144	511-052-14	KLINE TR	2721	E	6TH	ST	LONG BEACH	CA	90814
511052151	511-052-15	MERAZ DANIEL JR	224		PRESIDENT	WY	RIDGECREST	CA	93555
511052169	511-052-16	BRIDGE MIKE D	14405		DICE	CT	RAPID CITY	SD	55701
511052177	511-052-17	TESTA TROY	6216	N	CARR	RD	INYOKERN	CA	93527
511052185	511-052-18	IRA SRVCS/FIRST REGIONAL BK FBO KAHNG JOHN			P O BOX 7080		SAN CARLOS	CA	94070
511052193	511-052-19	BENNETT HERBERT D & ELIZABETH	212		BENSON	AV	RIDGECREST	CA	93555
511052201	511-052-20	MC MAHAN MICHAEL R	2336		TREAT	AV	RIDGECREST	CA	93555
511052219	511-052-21	MC MAHAN JENNIFER R & DIAZ CESAR	2336	W	TREAT	AV	RIDGECREST	CA	93555

511052227	511-052-22	EUKEL BRONSON	102		WAGON WHEEL	WY	DAYTON	NV	89403
511052235	511-052-23	EUKEL BRONSON	102		WAGON WHEEL	WY	DAYTON	NV	89403
511052243	511-052-24	SLAYTON LEON	2311		S MIKES TRAIL		RIDGECREST	CA	93555
511052250	511-052-25	BREHMER JAMES E	126		ALVARADO	ST	BRISBANE	CA	94005
511052268	511-052-26	HALVERSON CHARLES	13516		NECK YOKE	RD	RAPID CITY	SD	57702
511052276	511-052-27	U S A			UNKNOWN			CA	
511052284	511-052-28	U S A			UNKNOWN			CA	
511052292	511-052-29	FALLS PETER G			PO BOX 1174		SPRINGVILLE	CA	93265
511052300	511-052-30	AURORA DORRANCELLC			P O BOX 973		RIDGECREST	CA	93556
511052318	511-052-31	AURORA DORRANCE LLC			P O BOX 973		RIDGECREST	CA	93556
511052326	511-052-32	U S A			UNKNOWN			CA	
511052334	511-052-33	U S A			UNKNOWN			CA	
511052342	511-052-34	U S A			UNKNOWN			CA	
511052359	511-052-35	RWH INV LLC	3159		VIA MAZATLAN		CORONA	CA	92882
511081127	511-081-12	REMELL ALLEN G	1548		HARTLEY	AV	RIDGECREST	CA	93555
511081135	511-081-13	SNODGRASS NICHOLE J & RODNEY W JR	500		HEATHERGLEN	DR	RIDGECREST	CA	93555
511081200	511-081-20	KALLBERG MICHAEL & JEANNETTE JO	128		BARBARA	AV	RIDGECREST	CA	93555
511082026	511-082-02	BAGGE RICHARD L			P O BOX 906		RIDGECREST	CA	93556
511082034	511-082-03	MORGAN SHEILA E	1943	S	GUAM	ST	RIDGECREST	CA	93555
511082042	511-082-04	MATLOOB NASSER & FARNAZ			P O BOX 2473		BEVERLY HILLS	CA	90213
511082059	511-082-05	GLENMAT PROP L L C			P O BOX 2473		BEVERLY HILLS	CA	90213
511082067	511-082-06	GLAVINICK FAMILY BYPASS TR	328		ASHTON	ST	RIDGECREST	CA	93555
511082075	511-082-07	MC CARTY SCOTT & KATHI A	4385		MT VERNON	ST	CHINO	CA	91710
511082083	511-082-08	COUCH ANDY & LISA	2000		MONACHE	ST	RIDGECREST	CA	93555
511082091	511-082-09	SIMOLON BRUCE A & CHRISTINE L FAMILY TRUST	228	S	GREENLAWN	ST	RIDGECREST	CA	93555
511082109	511-082-10	COWAN MARK E	76		SPRING BROOK	CI	SACRAMENTO	CA	95831
511082117	511-082-11	LEE JO ANNE & GARY D	1229	W	BOSTON	AV	RIDGECREST	CA	93555
511082125	511-082-12	CARRASCO CHAD F & ADRIENNE	2021	S	MONACHE	ST	RIDGECREST	CA	93555
511082133	511-082-13	INDIAN WELLS VALLEY WATER DIST			P O BOX 399		RIDGECREST	CA	93556
511082141	511-082-14	INDIAN WELLS VALLEY WATER DIST			P O BOX 399		RIDGECREST	CA	93556
511082158	511-082-15	JEGLUM PATRICIA	645		CHESTNUT	AV	LONG BEACH	CA	90802
511082166	511-082-16	GUNN JENNIFER M & ERIC	1958	S	BRADY	ST	RIDGECREST	CA	93555
511082174	511-082-17	LEMING ELIZABETH & STEPHEN	1922	S	BRADY	ST	RIDGECREST	CA	93555
511083016	511-083-01	MOLLER ALFRED M & SARA			P O BOX 2194		APPLE VALLEY	CA	92307
511091241	511-091-24	GLAVINICK FAMILY BYPASS TR	328		ASHTON	ST	RIDGECREST	CA	93555
097080030	097-080-03	U S A			UNKNOWN			CA	
341101384	341-101-38	WOODCLIFF WASHINGTON LLC	707		WILSHIRE STE 4450	BL	LOS ANGELES	CA	90017
341101392	341-101-39	WOODCLIFF WASHINGTON LLC	707		WILSHIRE STE 4450	BL	LOS ANGELES	CA	90017
341103190	341-103-19	KABAYAN BEDROS ET AL	1785	N	SINALOA	AV	PASADENA	CA	91104
341130011	341-130-01	CASS CHARLES R & JOYCE A	1335	W	DOLPHIN	AV	RIDGECREST	CA	93555
341130227	341-130-22	CASS CHARLES R & JOYCE A	1335	W	DOLPHIN	AV	RIDGECREST	CA	93555
511010043	511-010-04	U S A			UNKNOWN			CA	
511020042	511-020-04	UNION PACIFIC R/R CO	1700		FARNAM 10TH FL SOUTH	ST	OMAHA	NE	68102
511031122	511-031-12	VANDERBECK JOHN P & GERTRUE M TRUST	732	W	KINNETT	AV	RIDGECREST	CA	93555
511031197	511-031-19	GARCIA JAMIE	31		CASTILLO	ST	IRVINE	CA	92620
511031221	511-031-22	U S A			UNKNOWN			CA	
511081051	511-081-05	ALLRED GARY L & CINDY L	1855	S	GUAM	ST	RIDGECREST	CA	93555
511082018	511-082-01	BAGGE RICHARD L			P O BOX 906		RIDGECREST	CA	93556
511091225	511-091-22	MC CARTY SCOTT & KATHI A	4385		MT VERNON	ST	CHINO	CA	91710
511091233	511-091-23	SHUKLA KULLAMANDIRI M	1230	S	GAFFEY #4	ST	SAN PEDRO	CA	90731
511091258	511-091-25	GLAVINICK FAMILY BYPASS TR	328		ASHTON	ST	RIDGECREST	CA	93555
511092017	511-092-01	BOJORQUEZ MARIO & NADEAN	1024	W	GRAAF APT A	AV	RIDGECREST	CA	93555

511092025	511-092-02	AHMED IQBAL & MEHNEZ	4507		WHEELER	AV	LA VERNE	CA	91750
511092033	511-092-03	AGUERO JEAN V TR	13502		BLUEGROVE	AV	BELLFLOWER	CA	90706
511092124	511-092-12	BERTELL MICHAEL J & VERONICA L	4842		WEST L-2	AV	QUARTZ HILL	CA	93536
511092140	511-092-14	LEIGHTON DAVID W			PO BOX 273		RIDGECREST	CA	93555
511092116	511-092-11	GLAVINICK FAMILY BYPASS TR	328		ASHTON	ST	RIDGECREST	CA	93555



Map Location

Legend

- Water Line
- Parcels
- Right-of-Way

N W E S

1 inch equals 3,500 feet

0 1,750 3,500 7,000 Feet

Ridgecrest Solar Power Project
DR-Land Use-249-1
Parcel Map

Map 1 of 2

Solar Millennium

AECOM

Date: February 2010

Map Location

Legend

Water Line

Parcels

1 inch = 1,000 feet

0 1,000 2,000 Feet

N W E S

Ridgecrest Solar Power Project DR-Land Use 249-1 Parcel Map

Map 2 of 2

Solar Millennium

AECOM

Date: February 2010

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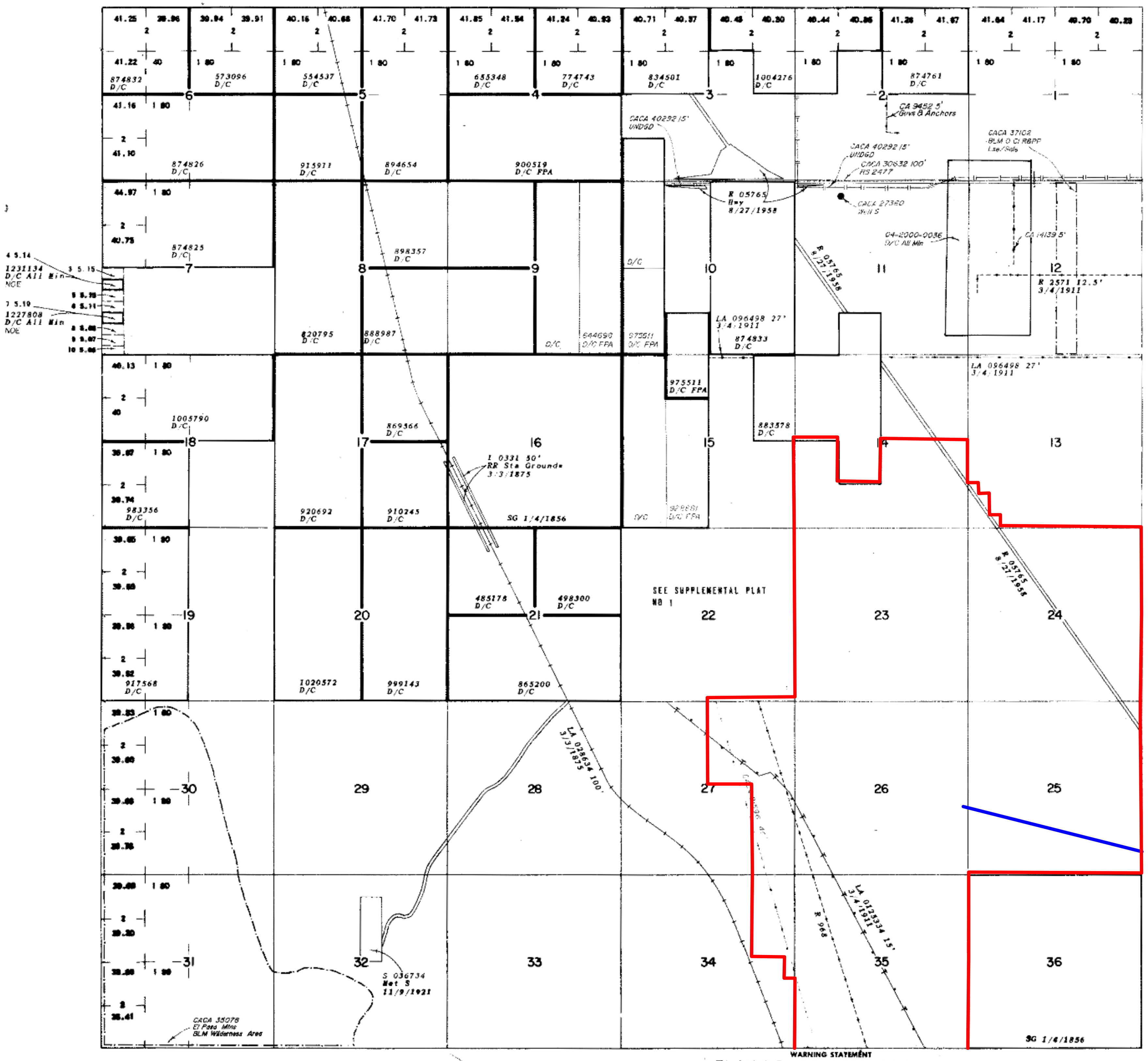
TOWNSHIP 27 SOUTH RANGE 39 EAST OF THE MOUNT DIABLO MERIDIAN, CALIFORNIA

KERN COUNTY

CALIFORNIA DESERT DISTRICT SEC 3

RIDGECREST RA



WARNING STATEMENT

This plat is the Bureau's Record of Title, and should be used only as a graphic display of the township survey data. Records hereon do not reflect title changes which may have been effected by lateral movements of rivers or other bodies of water. Refer to the cadastral surveys for official survey information.

SCALE in Chains

STATUS OF PUBLIC DOMAIN
LAND AND MINERAL TITLES

MT PLAT

INDEX TO SEGREGATED TRACTS

RESURVEY	ORIGINAL SURVEY			
TRACT NO	T	R	SEC	SUBDIVISION

SO 11/11/1929 Wat Pwr S Cl 241, all land lying within 20' of center line R/W Trans line L 02165
Sec 4: W1/2NE1/4, W1/2SE1/4, SE1/4SE1/4
Sec 9: E1/2NE1/4, NE1/4SE1/4
Sec 10: W1/2SW1/4
Sec 15: W1/2NW1/4, W1/2SW1/4
Sec 22: N1/2NW1/4, SE1/4NW1/4
E1/2SW1/4, SW1/4SE1/4
Sec 27: W1/2NE1/4, N1/2SE1/4, SE1/4SE1/4
Sec 34: E1/2NE1/4, NE1/4SE1/4
Sec 35: W1/2SW1/4

All Tp included in Wdl Calif Gr Dist No 1
SO 4/8/1935

All Tp included in R 258 BLM O Cl Non-suitable for Agri

ST Pat may be Subj to R/W for roadway & public utility

All Tp within designated California Desert Conserv Area Act of Cong 10/21/1976

CACA 23919 R/W Airspace Reservation. Airspace above 75'
Sec 1: All
Sec 2: SE1/4
Sec 11: E1/2
Sec 12: NE1/4, E1/2NW1/4, SW1/4SW1/4,
E1/2SW1/4, SE1/4
Sec 13: All
Sec 14: E1/2
Sec 23: E1/2
Sec 24: All
Sec 25: All
Sec 26: E1/4

FOR ORDERS EFFECTING DISPOSAL OR USE OF UNIDENTIFIED LANDS REFER TO INDEX OF MISCELLANEOUS DOCUMENTS.

CURRENT TO	CURRENT TO

USE PLATS

MD Mer
T. 27 S
R. 39 E

TOWNSHIP 28 SOUTH RANGE 39 EAST OF THE MOUNT DIABLO MERIDIAN, CALIFORNIA

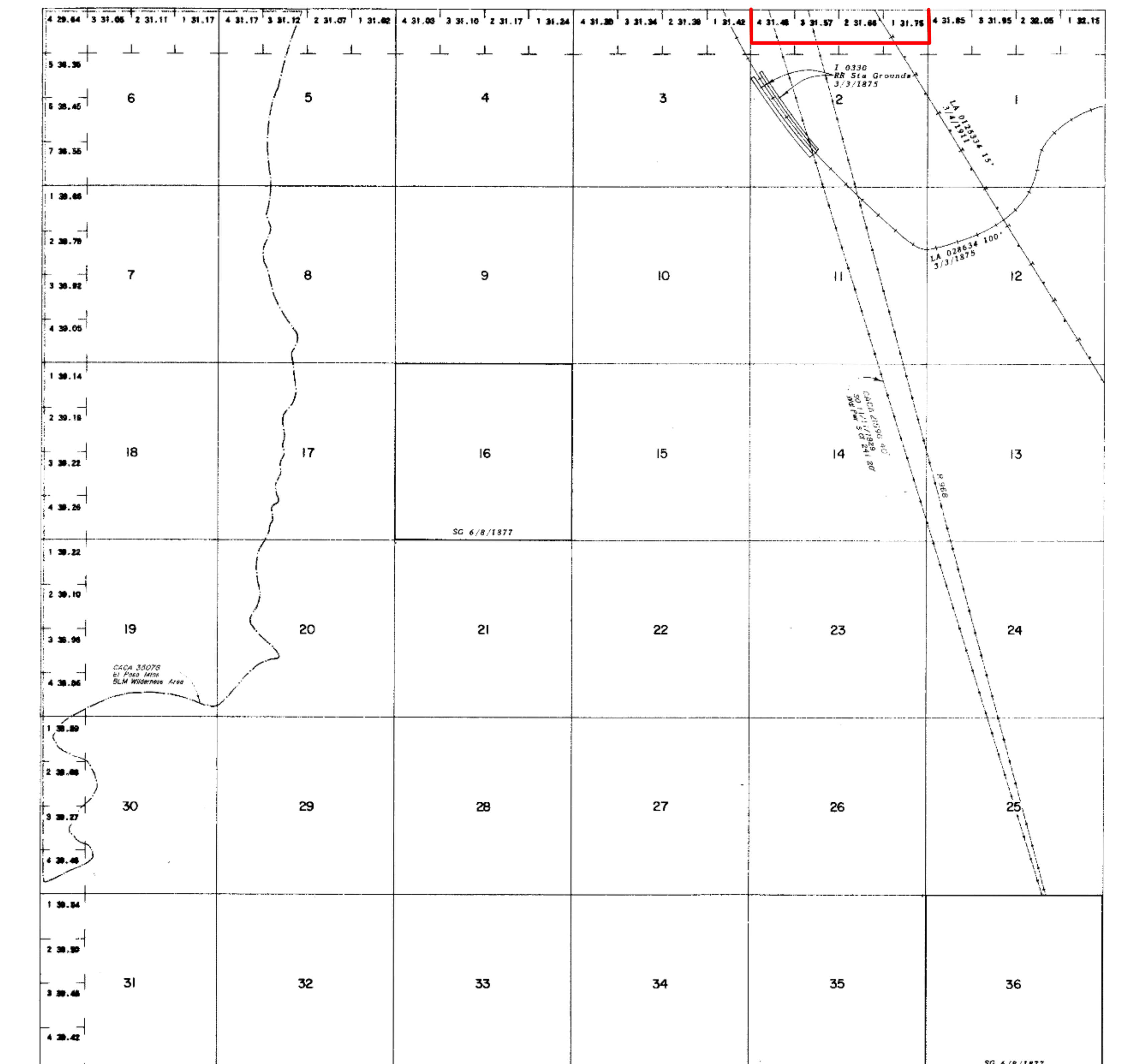
KERN COUNTY

BAKERSFIELD DISTRICT SEC 3

RIDGECREST RA

STATUS OF PUBLIC DOMAIN
LAND AND MINERAL TITLES

MT PLAT



INDEX TO SEGREGATED TRACTS				
RESURVEY	ORIGINAL SURVEY			
TRACT NO	T	R	SEC	SUBDIVISION

All Tp included in Wdl Calif Gr Dist No 1 SO 4/8/1935

All Tp within designated California Desert Conserv Area Act of Cong 10/21/1976

FOR ORDERS EFFECTING DISPOSAL OR USE OF UNIDENTIFIED LANDS REFER TO INDEX OF MISCELLANEOUS DOCUMENTS.

CURRENT TO	CURRENT TO

USE PLATS.

WARNING STATEMENT

This plat is the Bureau's Record of Title, and should be used only as a graphic display of the township survey data. Records hereon do not reflect title changes which may have been effected by lateral movements of rivers or other bodies of water. Refer to the cadastral surveys for official survey information

SCALE in Chains

10 5 0 10 20 30 60

29S 39E | 29S 40E

MD Mer

T. 28 S

R. 39 E

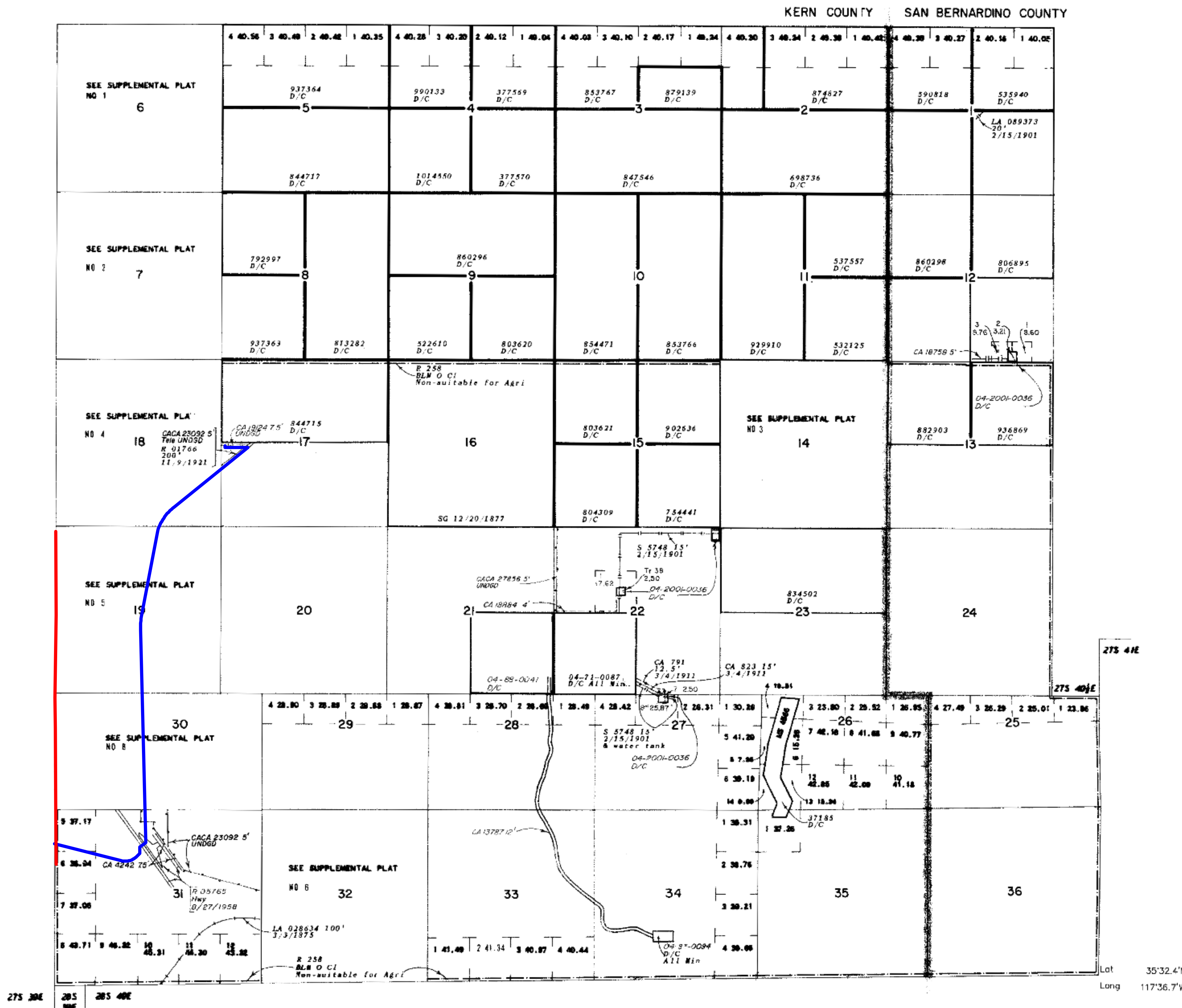
TOWNSHIP 27 SOUTH RANGE 40 EAST OF THE MOUNT DIABLO MERIDIAN, CALIFORNIA

BAKERSFIELD FIELD OFFICE

SEC 3

STATUS OF PUBLIC DOMAIN
LAND AND MINERAL TITLES

MT PLAT



INDEX TO SEGREGATED TRACTS				
RESURVEY	ORIGINAL SURVEY			
TRACT NO	T	R	SEC	SUBDIVISION

All Tp included in Wdl Calif Cr Dist No 1 SO 4/8/1935

ST Pat may be Subj to R/W for roadway & public utility

All Tp within designated California Desert Conserv Area Act of Cong 10/21/1976

CACA 23919 R/W Airspace Reservation. Airspace above 75'
- Sec 12: SE1/4
- Sec 13: S1/2
- Sec 23: E1/2SE1/4
- Sec 24: All
- Sec 25: Lots 1, 2, 3, 4 & S1/2
- Sec 26: Lots 1, 2, 8, 9, 10 & 11
- Sec 35: NE1/4
- Sec 36: N1/2

FOR ORDERS AFFECTING DISPOSAL OR USE OF UNIDENTIFIED LANDS REFER TO INDEX OF MISCELLANEOUS DOCUMENTS.

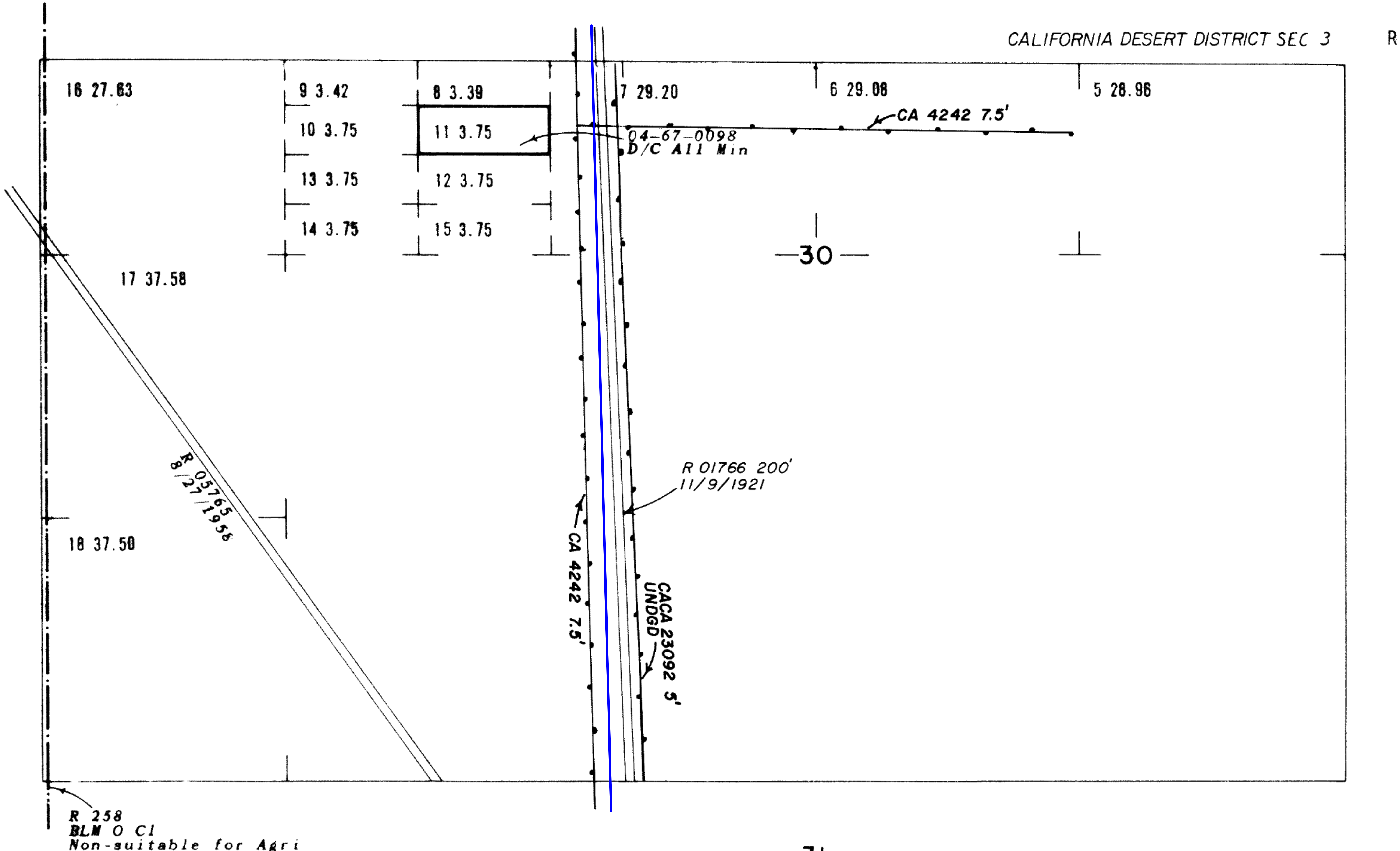
WARNING STATEMENT

This plat is the Bureau's Record of Title, and should be used only as a graphic display of the township survey data. Records hereon do not reflect title changes which may have been effected by lateral movements of rivers or other bodies of water. Refer to the cadastral surveys for official survey information.

MD Mer

CURRENT TO		
3-15-2006	PV	RF

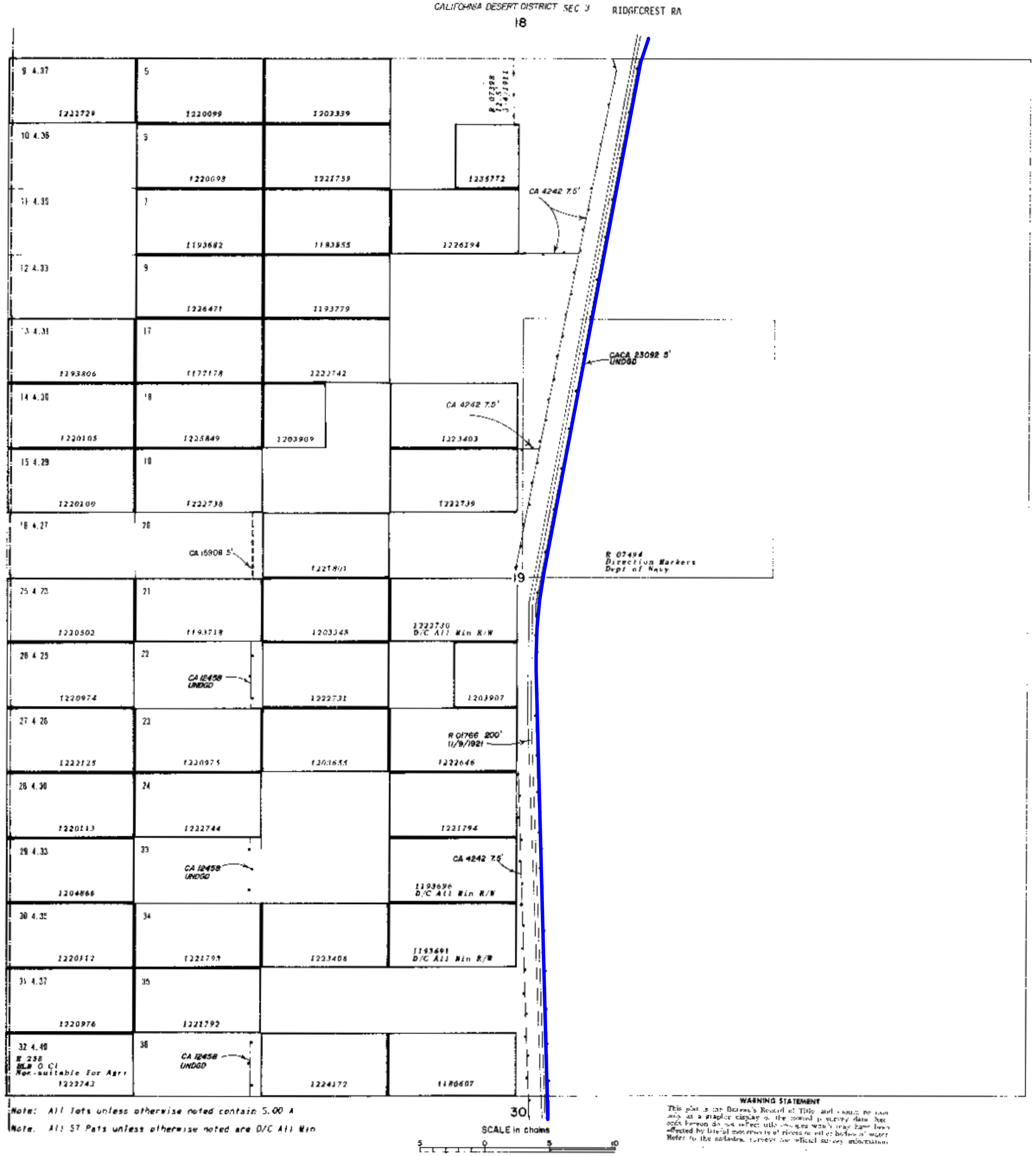
T 27 S
R 40 E


16 27.63
9 3.42
8 3.39
7 29.20
6 29.08
5 28.96
10 3.75
11 3.75
CA 4242 7.5'
04-67-0098
D/C All Min
13 3.75
12 3.75
14 3.75
15 3.75
30
17 37.58
R 01766 200'
11/9/1921
R 05765
8/27/1958
18 37.50
CA 4242 7.5'
CACA 23092 5'
UNDGD
R 258
BLM O Cl
Non-suitable for Agri
31

TOWNSHIP 27 SOUTH RANGE 40 EAST OF THE MOUNT DIABLO MERIDIAN, CALIFORNIA

KERN COUNTY

CALIFORNIA DESERT DISTRICT SEC 3 RIDGECREST RA



Note: All lots unless otherwise noted contain 5.00 A

Note. All ST Pats unless otherwise noted are D/C All Min

WARNING STATEMENT

This plat is the Bureau's Record of Title and should be used only as a graphic display of the township survey data. Records hereon do not reflect title changes which may have been effected by lateral movements of rivers or other bodies of water. Refer to the cadastral surveys for official survey information.

NO 5

STATUS OF PUBLIC DOMAIN LAND AND MINERAL TITLES

MTP
SUPPL Sec 19

INDEX TO SEGREGATED TRACTS				
RESURVEY	ORIGINAL SURVEY			
TRACT NO	T	R	SEC	SUBDIVISION

All Sec 19 included in Wdl Calif Gr Dist No 1 SO 4/8/1935

ST Pat may be Subj to R/W for roadway & public utility

All Sec 19 within designated California Desert Conserv Area Act of Cong 10/21/1976

FOR ORDERS EFFECTING DISPOSAL OR USE OF UNIDENTIFIED LANDS REFER TO INDEX OF MISCELLANEOUS DOCUMENTS.

CURRENT TO	CURRENT TO

USE PLATS: MI-C Sheet

NO 5

MD Mer

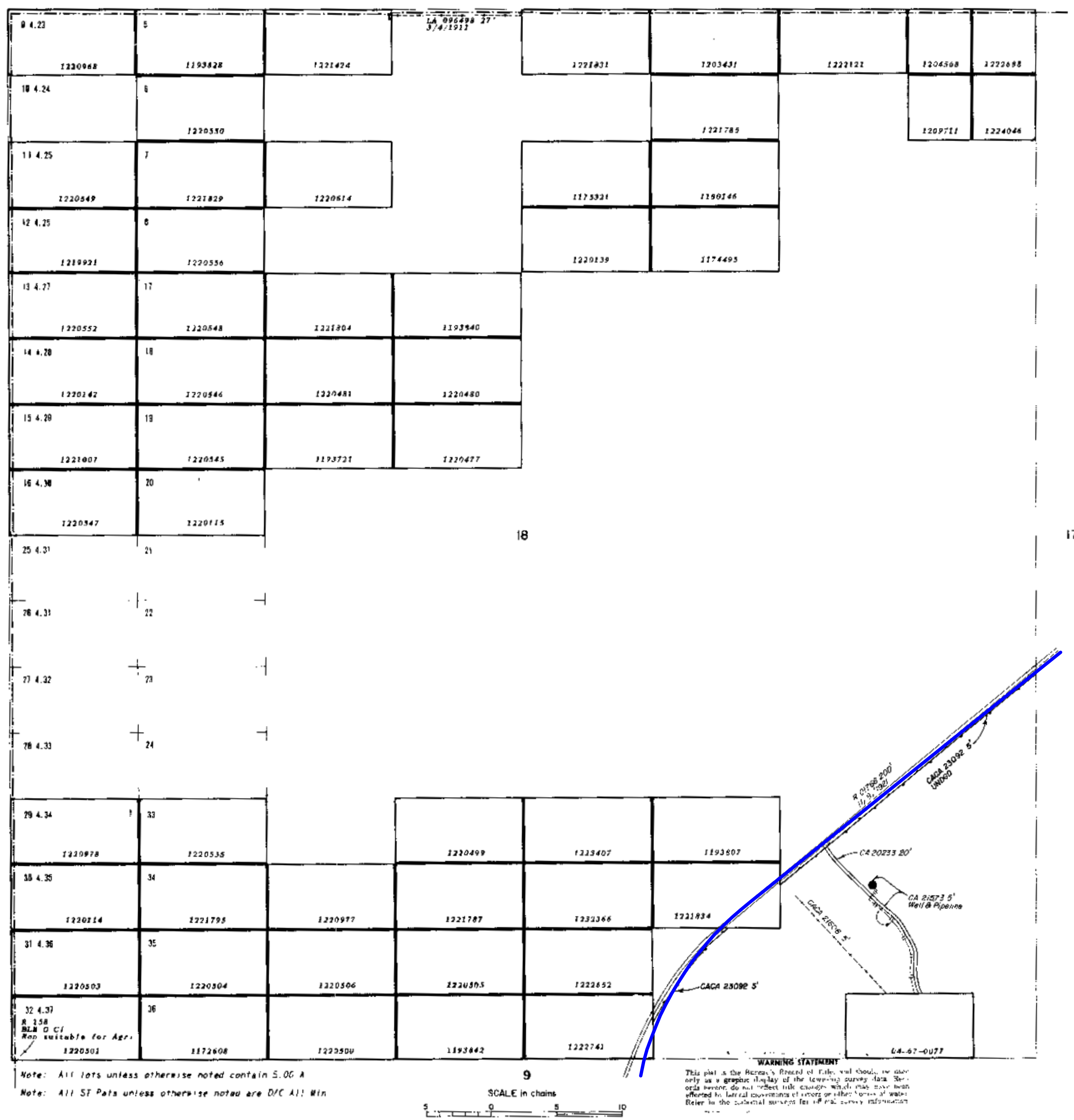
T. 27 S

R. 40 E

TOWNSHIP 27 SOUTH RANGE 40 EAST OF THE MOUNT DIABLO MERIDIAN, CALIFORNIA

KERN COUNTY

CALIFORNIA DESERT DISTRICT SEC 3 RIDGECREST RA



WARNING STATEMENT

NO 4

STATUS OF PUBLIC DOMAIN
LAND AND MINERAL TITLES

MTP
SUPPL Sec 18

INDEX TO SEGREGATED TRACTS

RESURVEY	ORIGINAL SURVEY			
TRACT NO	T	R	SEC	SUBDIVISION

All Sec 18 included in Wal Calif Gr Dist No 1 SO 4/8/1935

ST Pat may be Subj to R/W for roadway & public utility

All Sec 18 within designated California Desert Conserv Area Act of Cong 10/21/1976

FOR ORDERS EFFECTING DISPOSAL OR USE OF UNIDENTIFIED LANDS REFER TO INDEX OF MISCELLANEOUS DOCUMENTS

CURRENT TO	CURRENT TO
AUG 1 1997	

USE PLATS WL-C Sheet

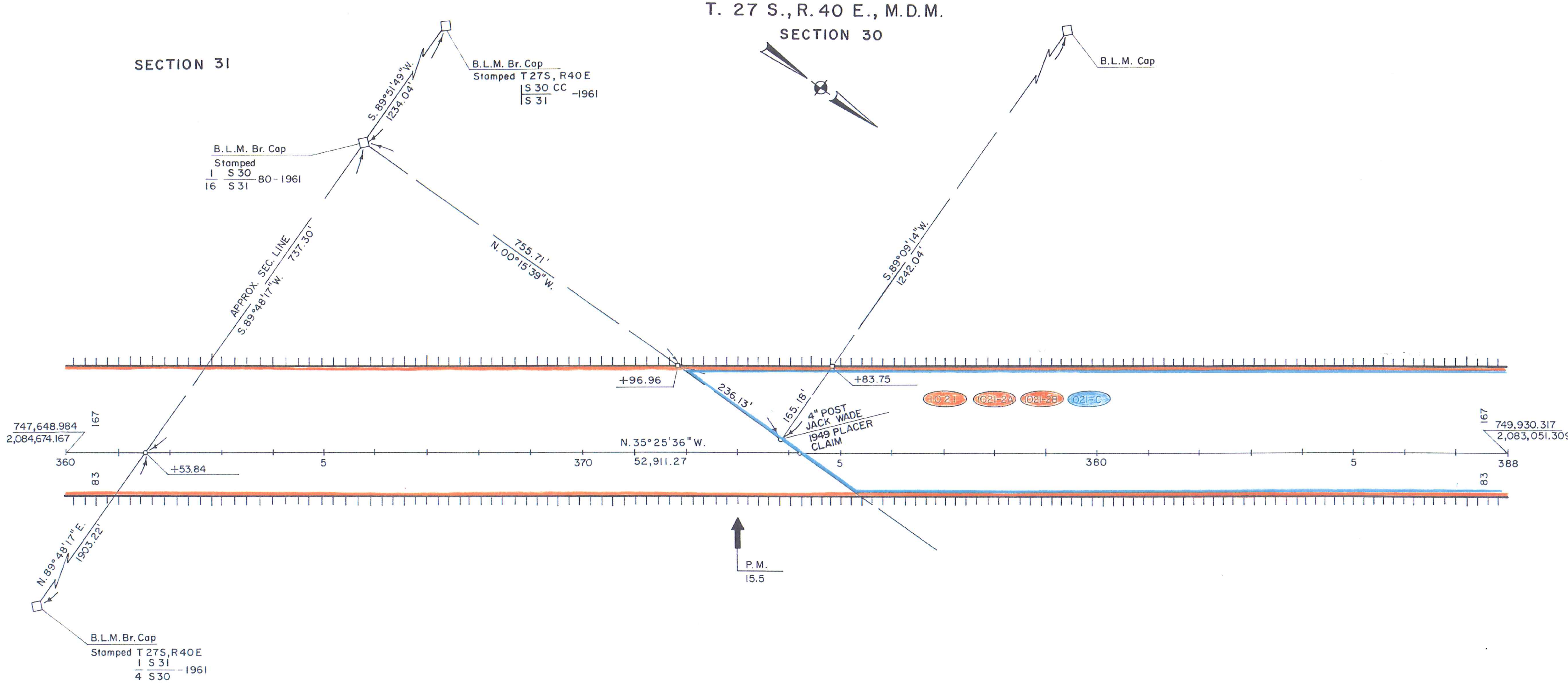
NO 4

MD Mer
T. 27 S
R. 40 E

Attachment DR-TRAFFIC-267

Figures

T. 27 S., R. 40 E., M.D.M.



1966 ASBUILTS INDICATE PROJECT IS MONUMENTED WITH TYPE B ℄ MONUMENTS

PARCEL	GRANTOR	INST.	RECORD	DATE	REMARKS	AREAS REQUIRED	AREAS UND. FEE	AREAS REMAINDER
1021	U.S.A.-B.L.M.	MAP	S.H.M.B. 2, Pg. 381, 2	1-19-65	Decision Dated 12-30-64			
1021-2B	MANFORD A. PEEPELS et ux	Q.C.	O.R. 3804-75	1-13-65				
1021-2A	CLAUD A. MATTOX et ux	Q.C.	O.R. 3816-395	2-23-65				
1021-C	PAUL R. SPLANE	Q.C.	O.R. 4651-348	3-13-72	PAR. 1A - Relinquishment of Mineral Rts.			

ACCESS PROHIBITED

CALIFORNIA COORDINATE SYSTEM (27) - ZONE 5

GRID BEARINGS - GROUND DISTANCES - GROUND STATIONING

GRID FACTOR = 0.999882

TO OBTAIN A GRID DISTANCE, MULTIPLY THE GROUND DISTANCE BY THE GRID FACTOR.

SCALE IN FEET

0 100 200

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

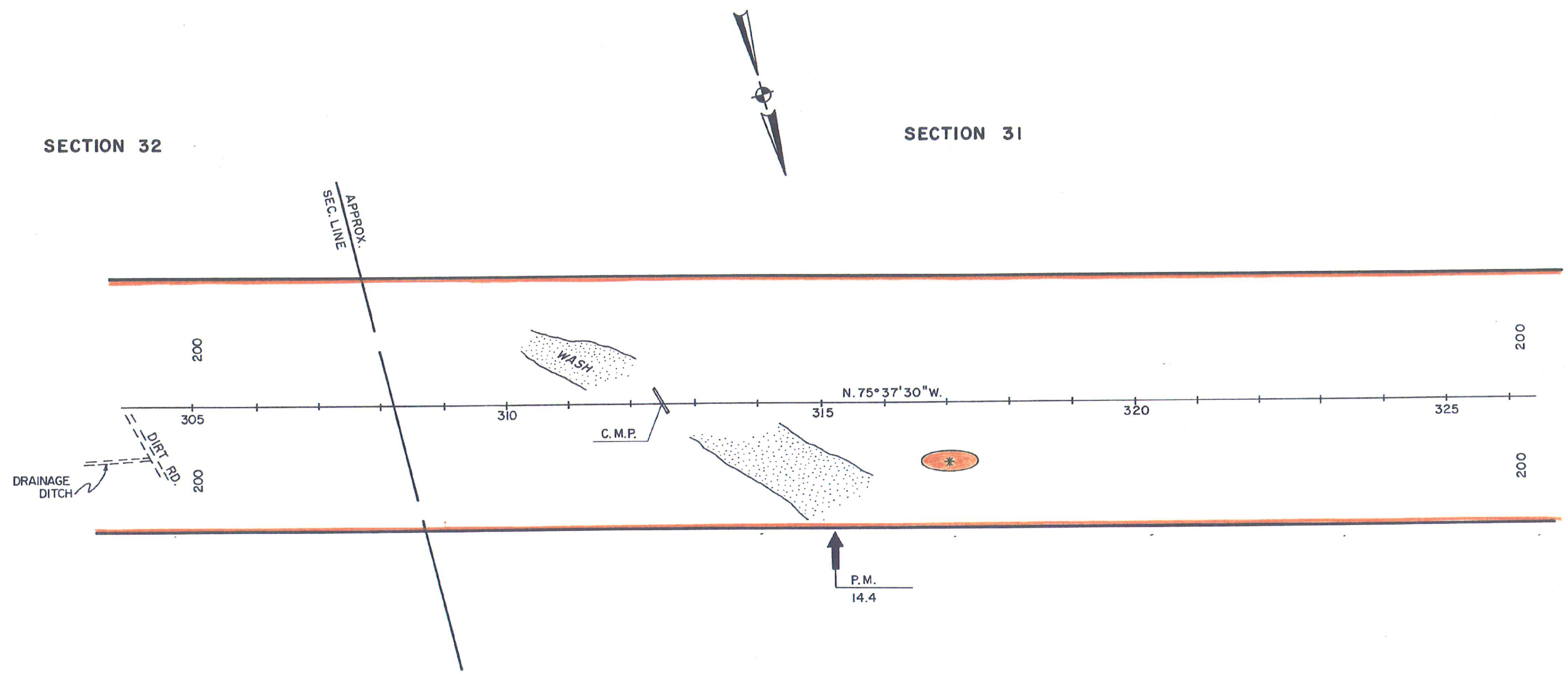
R/W RECORD MAP

DISTRICT	COUNTY	ROUTE	POST MILE
09	KER	395	15.5

DATE	REMARKS
7-96	C. ANDRUS - ENGR. P. RICHARD - DRAFT.

FORM A

T. 27 S., R.40 E., M.D.M.



PARCEL	GRANTOR	INST.	RECORD	DATE	REMARKS	AREAS REQUIRED	AREAS UND. FEE	AREAS REMAINDER
*	U.S.A. - G.L.O.	R.S.2477	S.H.M.B. 1/80	6-1-37	IN PAR. FOLD. 1021 (1 of 2)			

1937 CONST. PLANS INDICATE "C" MONUMENTS WERE SET UP TO STA. 315.

ASSUMED COORDINATE SYSTEM

SCALE IN FEET
0 100 200

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

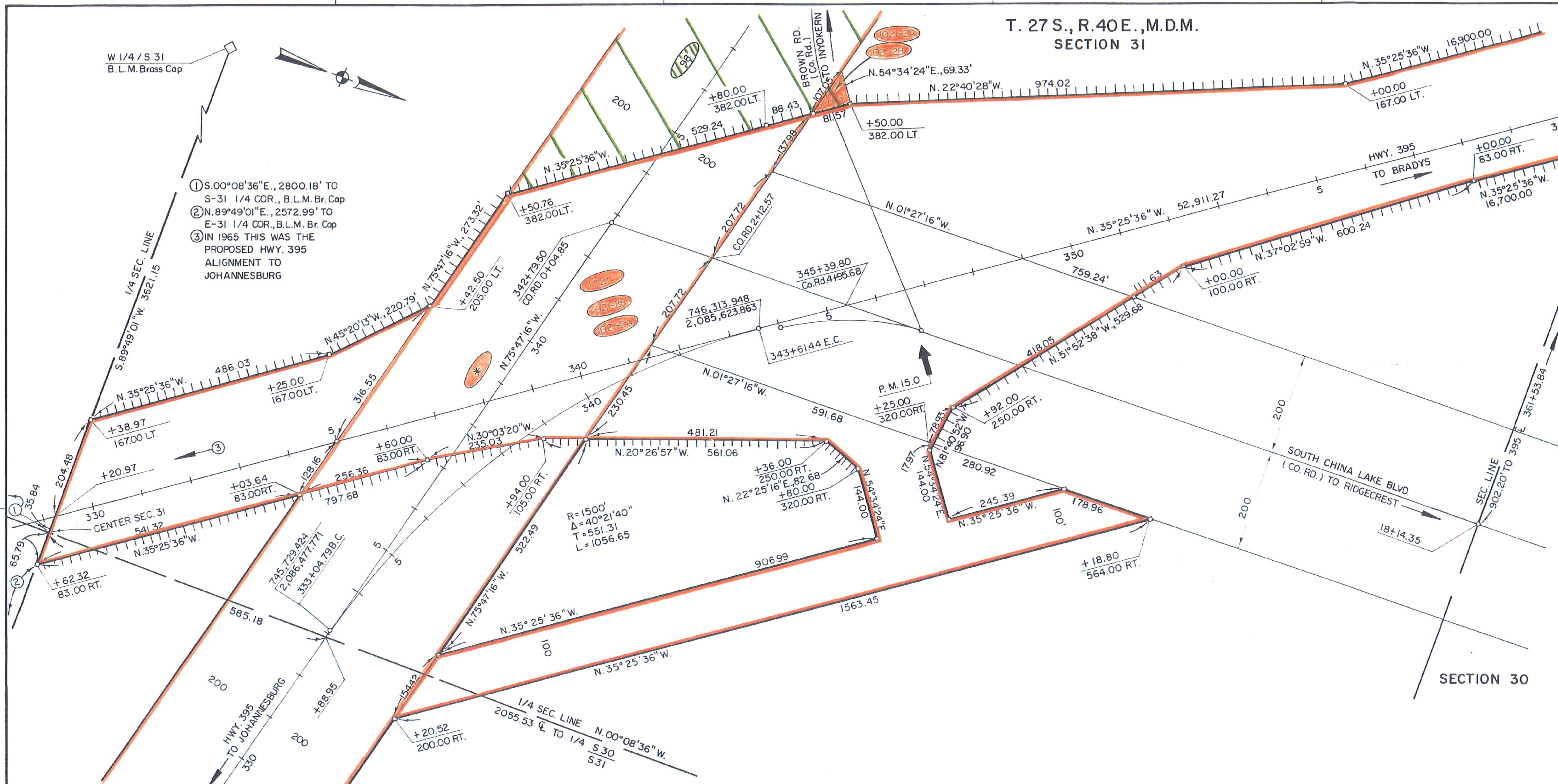
R/W RECORD MAP

DISTRICT	COUNTY	ROUTE	POST MILE
09	KER	395	14.4

DATE	REMARKS
6-96	C. ANDRUS - ENGR. P. RICHARD - DRAFT.

BASICALLY REDRAWN FROM 1937 CONST. PLANS
& S.H.M.B. 1/80

FORM 8



PARCEL	GRANTOR	INST.	RECORD	DATE	REMARKS	AREAS REQUIRED	AREAS UND. FEE	AREAS REMAINDER
*	U.S.A. – G.L.O.	R.S.2477	S.H.M.B. 1/80	6-1-37	IN PAR. FOLD. 1021 (1 of 2)			
98	STATE OF CALIFORNIA	REL.	O.R. 3999/425	11-30-66	PARCEL 1 TO KERN CO.			
1021	U.S.A. – B.L.M.	MAP	S.H.M.B. 2-381	1-19-65				
1021-2B	MANFORD A. PEEPELS et ux	QC	O.R. 3804-75	1-13-65				
1021-2A	CLAUD A. MATTOX et ux	QC	O.R. 3816-395	2-23-65				

1966 ASBUILTS INDICATE PROJECT IS MONUMENTED WITH TYPE-B ℄ MONUMENTS.

IIIII ACCESS PROHIBITED

CALIFORNIA COORDINATE SYSTEM (27) - ZONE 5
GRID BEARINGS - GROUND DISTANCES - GROUND STATIONING
GRID FACTOR = 0.999882
TO OBTAIN A GRID DISTANCE, MULTIPLY THE GROUND DISTANCE BY THE GRID FACTOR.

SCALE IN FEET: 0 100 200

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

R/W RECORD MAP

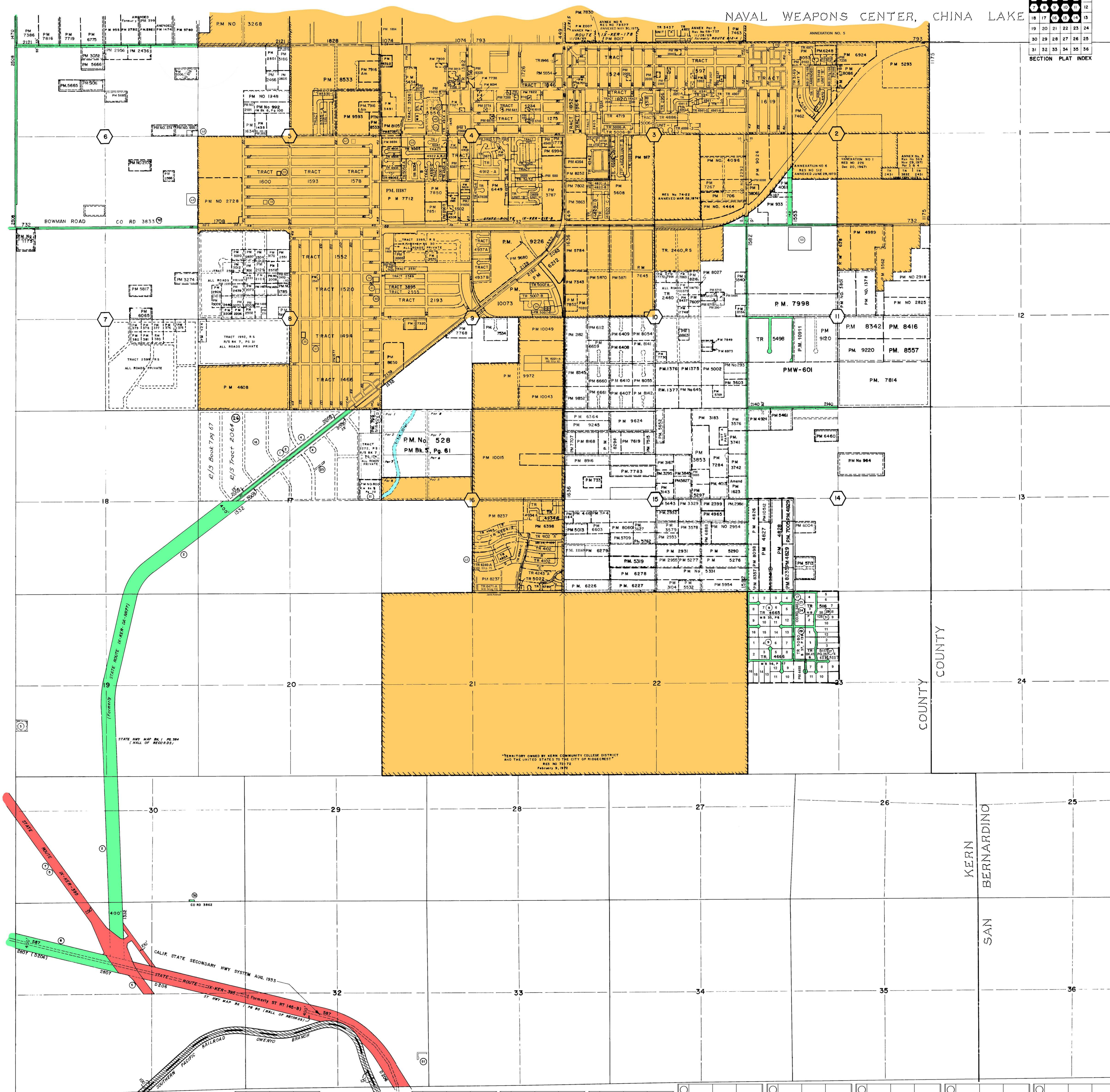
DISTRICT	COUNTY	ROUTE	POST MILE
09	KER	395	15.0

DATE		REMARKS	
7-96	C. ANDRUS - ENGR.	REDRAWN	P. RICHARD - DRAFT.

FORM A

T. 27 S., R. 40 E., M.D.M.

SCALE: 1"=1000'



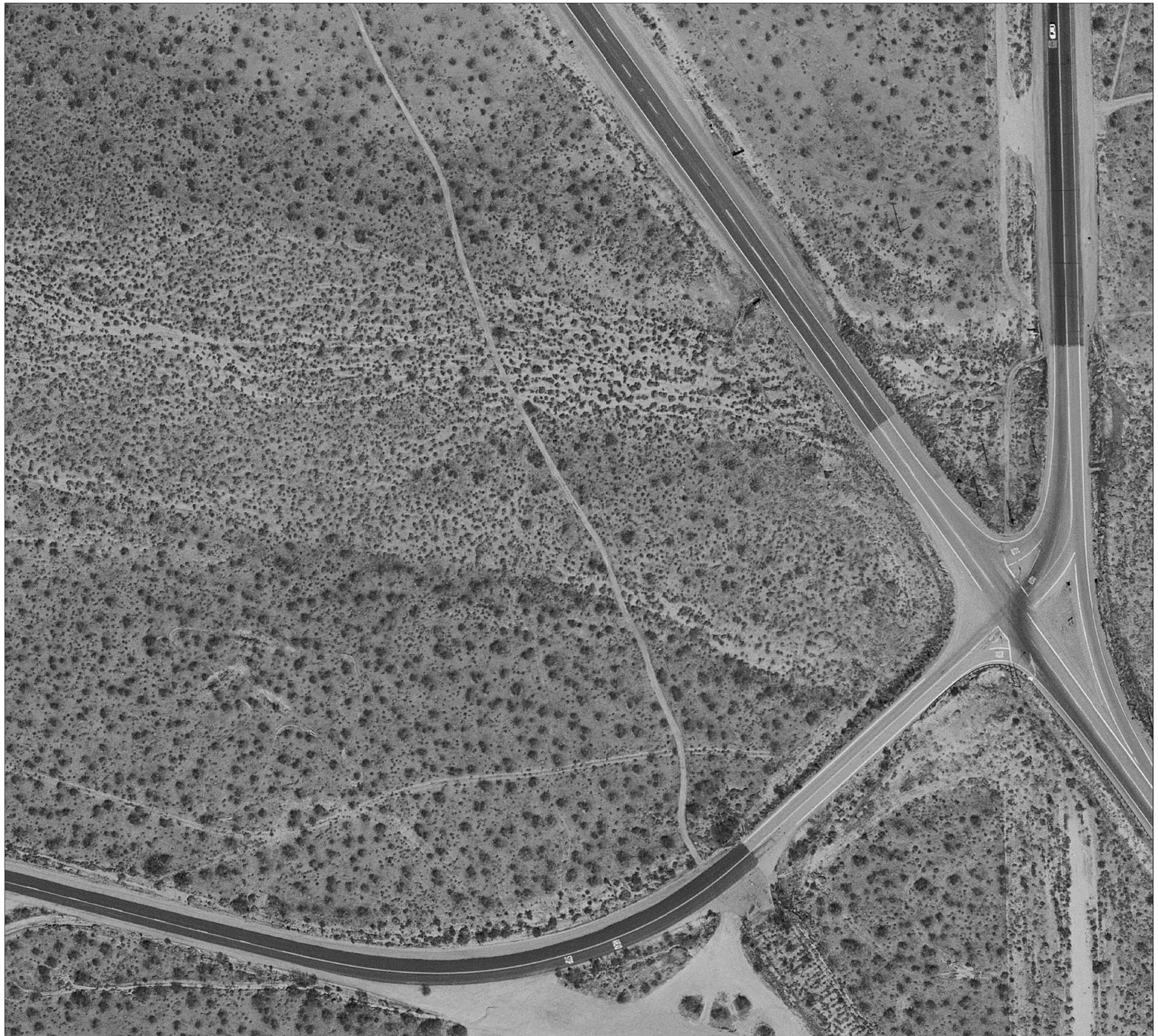
REF. NO.	SURVEYORS D. B. / PAGE	OFFICIAL BOOK / PAGE	BOARD Min. Bk. / Page
1	34/153	1131/292	STATE HWY
2	36/17	1131/456	CO. RD. 1332 (RELINQ.)
3	535/115	6071/2053	Q.C. By USA
4	83/190	3001/319	CO. RD. 2005
5	188/66 190/37	3804/75 3816/395	STATE HWY (Q.C. DEEDS)
6	245/11	3999/425	CO. RD. 2807 (RELINQ.)
7	336/66	4651/348	STATE HWY (Q.C. DEED)
8	537/113	6088/1244	CTF CORR
9	537/115	6088/1246	CTF CORR
10	349/181	4768/2426	P.M. 799 (PUB ACC)
11	351/52 351/56 351/60 351/125 351/126	4773/1349 4773/1353 4773/1357 4774/1667 4774/1668	P.M. 800 (PUB ACC) ↓
12	351/66	4773/1363	E-316 (P.M. 528)
13	356/147	4787/1327	P.M. 799 (PUB ACC)
14			
15			
16	STREET NAMES CHANGED		TR. 2064 (80-566)
17	430/51 430/125	5198/696 5200/1390	P.M. 4488 (OFFER) (PUB ACC)
18			
19			
20			
21	444/163	5315/2019	NON-ACCESS (1' STRIP)
22			
23	450/111	5378/584	PUB. ACC.
24	501/55	5771/2289	CO. RD. 3481
25	582/164	6457/1320	VACATE OFFER
26	596/48	6582/514	L L A
27	624/74	7007/1016	CORRECTION
28	624/43	7004/195	COUNTY RD
29	624/45	7004/197	COUNTY RD
30	648/8995	198-094916,7	ST.QC. TO KC
31	656/123	199-072167	LLA 23-99
32	710/1	202-202022	CO.RD.3862
33	736 / 114	204-212258	LOT MERGER
34	736 / 118	204-212259	CERTIFICATE OF COMP.
35	736 / 122	204-212260	LOT MERGER
36	743 / 102	205-059159	L.L.A. 04-25
37	743 / 098	205-059158	L.L.A. 05-03
38	743 / 106	205-059160	L.L.A. 05-01
39	741 / 025	204-316461	L.L.A. 04-23
40	741 / 033	204-316463	C.O.C.
41	741 / 029	204-316462	L.L.A. 04-25
42	748 / 063	205-158748	COMPLIANCE
43	750 / 110	205-186105	COMPLIANCE
44	750 / 113	205-186107	COMPLIANCE
45	751 / 057	205-204398	GRANT OF EASEMENT
46	754 / 060	205-254335	EASEMENT DEED
47	754 / 001	205-249687	COMPLIANCE
48	755 / 112	205-270073	GRANT DEED
49	755 / 109	205-270072	GRANT DEED
50	760 / 086	205-346807	COMPLIANCE
51	788 / 174	208-047372	Grant of Esmt.

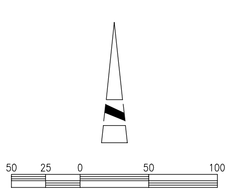
Map prepared by:
OFFICE of the COUNTY SURVEYOR
COUNTY of KERN, STATE of CALIFORNIA
Map to date: January 2005 (Deed Book 729)

T. 27 S., R. 36 E., M.D.B. & M.

plotted:

70





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AECOM

AECOM
5001 E. Commercenter Dr.
Bakersfield, Ca 93309
Phone 661.325.7253

www.aecom.com

REGISTERED PROFESSIONAL ENGINEER
WILLIAM CHARLES BLACK
No. C31465
EXP. 12-31-10
CIVIL
STATE OF CALIFORNIA

Designed: W. BLACK
Checked: W. BLACK
Drawn: K. S. BEDFORD
Record Drawing by/date:

Revisions:

#	DATE	DESCRIPTION

Prepared for:

Solar Millennium LLC

Ridgecrest Solar Power Project

Kern County, California

FIGURE DR-TRAFFIC-267

Date: 03/01/10
Sheet: 1 of 1

DR-CULT-89

Information Required:

Please submit for staff review and approval a research plan to locate and identify the configuration of the Gold Hill #1, Gold Hill #2, and Jumbo mines in section 35, T27S R39E (or, alternatively, in section 35, T27S R40E), and to recommend whether nearby historic-period archaeological sites are associated with these mines (and, if so, which ones), and whether the sites together possibly constitute an archaeological district.

Response:

Introduction

Archaeological surveys for the Ridgecrest Solar Power Project (RSPP) conducted to date have not identified the remnants of any operating mines within the RSPP Project area. However, a review of the 1904 State Mining Bureau map accompanying *the Register of Mines and Minerals: Kern County, California* (Aubury 1904) on file at the Shields Library Map Room, University of California, Davis indicates that two mines were located at that time within the boundaries of the RSPP southern solar field in Section 35, Township 27 South, Range 39 East (Figures DR-CULT-89-1 and DR-CULT-89-2 provided at the end of this section). These mines are recorded as the Gold Hill #1 mine (mine #123), in the northeast ¼ of the section, and the Jumbo mine (mine #171), in the southwest ¼ of the section. Both mines were listed as yielding quartz, sulphurets and hematite. Notes from Aubury 1904 taken by Glenn Farris, CEC Staff Archaeologist, on November 12, 2009 suggest that ownership of the Gold Hill Mine was in litigation and that the Jumbo mine was owned by mining machinery inventor Frank A. Huntington (Aubury 1904:11-12).

However, the 1904 register provides additional information that contradicts the mapped location of the mines. The elevation of both mines is stated in narrative descriptions as 4,200 feet, while the actual elevation in these areas of section 35 ranges from approximately 2,700 to 2,800 feet. Further, Troxel and Morton's 1962 volume, *Mines and Mineral Resources of Kern County, California*, mentions Gold Hill #1 as a mine "claim," a location to which an individual has asserted a right of possession, as opposed to an operating mine. Troxel and Morton note that Gold Hill #1 as well as Gold Hill #2 (mine #124), located outside of the RSPP, were likely associated with the Bellflower mine and reference Aubury 1904 as the source of their information (Troxel and Morton 1962; Glenn Farris, personal communication). Troxel and Morton (1962) also place the Jumbo mine in "sec. 35, T27S, R40E [?], MDM, Rademacher dist." and not in Range 39 East as shown on the 1904 map.

To aid in clarifying the location of the Gold Hill #1 and Jumbo mines and to recommend further action, a research program will be undertaken to yield further information on the siting, status and use history of the mines.

Research Issues

The primary question which this archival research program seeks to clarify is:

- Whether the Gold Hill #1 and Jumbo mines were located within the RSPP Project area, and, if so, to determine to the extent possible;
- Whether these were operating mines or claims;
- Ownership of the claims/mines over time;
- Duration and intensity of use if these constituted open mines; and

- Whether any features or subsurface elements remain.

Archival Methods

In order to clarify the locations of the Gold Hill #1 and Jumbo mines and to understand their ownership and use histories should they be located within the RSPP Project area, the Applicant will have a qualified historian conduct primary and secondary archival research at the Kern County Assessor-Recorder's Office, which holds historic grant and deed documents, and at the Kern County Library's Geology, Mining and Petroleum Collection, which includes historical books, government documents, and maps that may shed light on the location and history of the two mines in question. Relevant archival and secondary materials will be copied, or transcribed if unavailable for copying, and provided to Staff as attachments to the historical research report outlining methods and findings of the archival research. In addition, online sources such as the Online Archives of California and the Bancroft Library at the University of California, Berkeley will be consulted for documents and other files related to the mines and to Frank A. Huntington's involvement in this area of the Indian Wells Valley.

Archival Report

A technical report documenting the method of the archival investigations, including institutions visited and collections examined, and findings of the research with respect to mine location, ownership and use history will be prepared. The report will address, to the extent possible, the likelihood of the mines' location within the RSPP and present any additional evidence as to the intensity of use and potential for mine-related archaeological residues.

Proposed Field Approach

Should the findings of the archival research not conclusively locate the mines outside of the RSPP, field review of the approximate locations of the mines will be conducted during supplementary cultural resources surveys of the unsurveyed northern area of the redesigned RSPP footprint. If observed within the RSPP during supplementary field review, the mine locations will be recorded on DPR 523 Primary forms and Location Maps and added to the cultural resources inventory for RSPP to be submitted to Staff at the conclusion of Class III intensive pedestrian survey efforts.

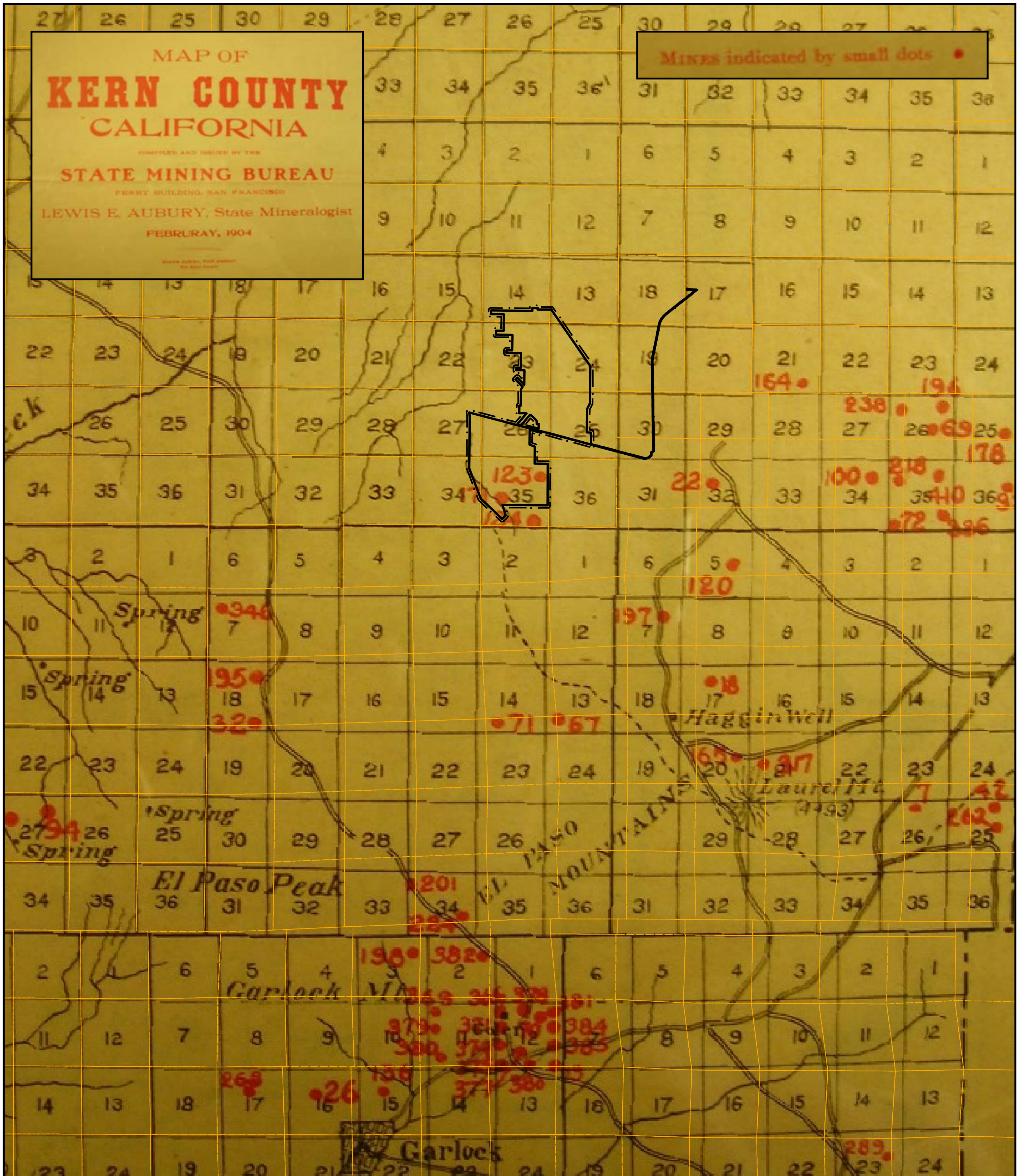
Should the mine locations be confirmed within the RSPP boundaries, Applicant's cultural resources consultant will formulate a brief discussion of the benefits and drawbacks of different geophysical methods given the geology and structure of the valley floor in this area, and coordinate with Staff to determine which, if any, method of geophysical analysis is appropriate to identify subsurface mine elements.

While historic period sites in the RSPP consist primarily of very sparse surface scatters and evidence of alluvial and Aeolian action in site deposition and redeposition is evident, should the Gold Hill #1 and Jumbo mines prove to be located and presently observable within the RSPP, historic period sites in section 35 will be re-examined by a Secretary of the Interior Standards qualified historical archaeologist in order to assess the integrity of each site, determine any reliable association with mining activities, and discuss whether such sites together constitute a district eligible to the CRHR or NRHP.

References

Aubury, Lewis E. 1904. Register of Mines and Minerals: Kern County, California. Issued by the State Mining Bureau, San Francisco, CA.

Morton, Paul K. and Bennie W. Troxel. 1962. Mines and Mineral Resources of Kern County, California: County Report 1. California Division of Mines and Geology.



Map Location

Legend

- Disturbance Area
- CEC Buffer
- Section Lines

1 inch = 2 miles

0 2 4 Miles

Ridgecrest Solar Power Project

DR-CULT-89-1

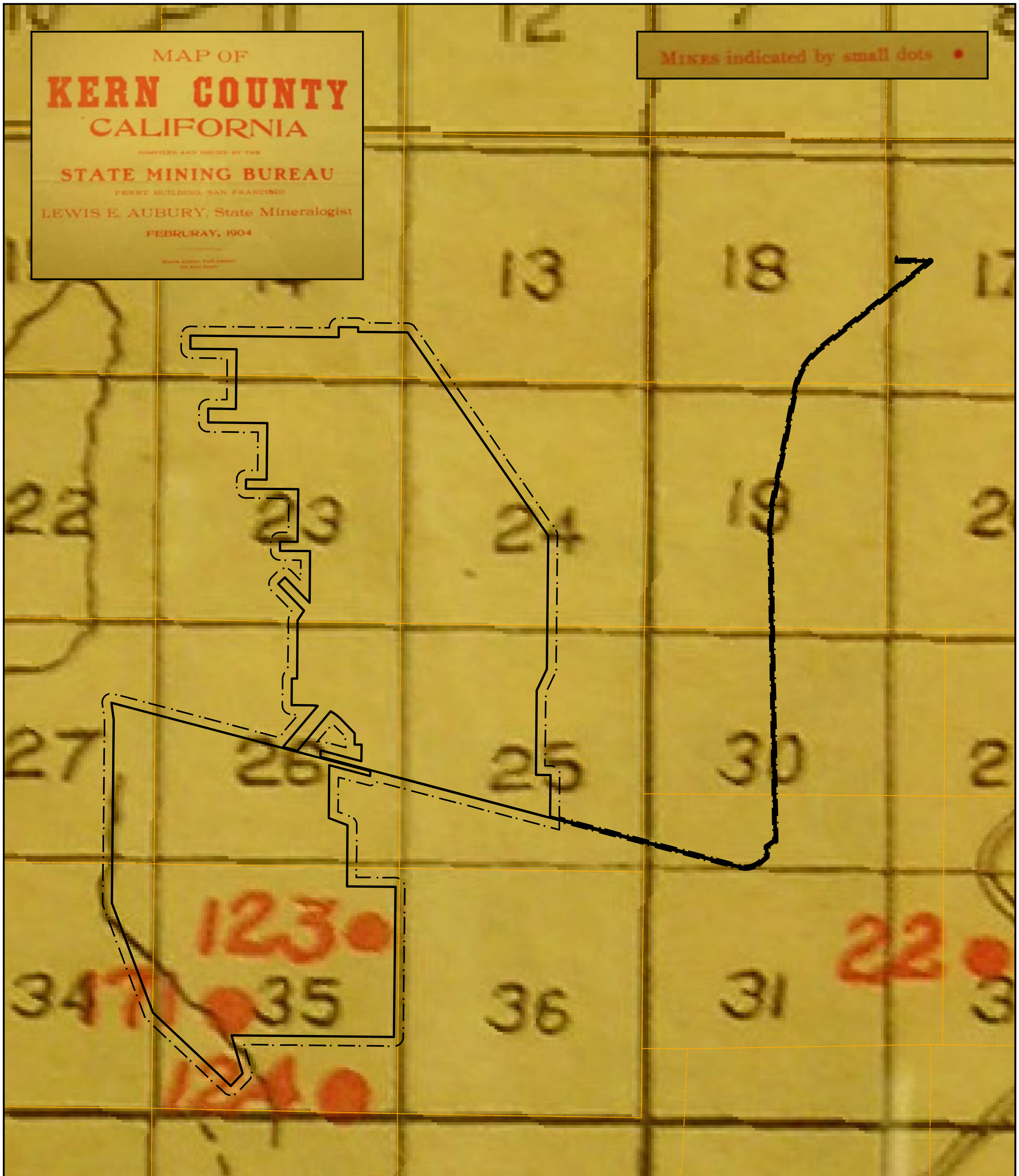
Source: State Mining Bureau 1904

Solar Millennium

AECOM

February 2010

Y:\Projects\Solar_Millennium\Figure_Templates\85x11P.mxt



Map Location

Legend

- Disturbance Area
- CEC Buffer
- Section Lines

1 inch = 3,000 feet

0 | 3,000 | 6,000 Feet

Ridgecrest Solar Power Project

DR-CULT-89-2

Source: State Mining Bureau 1904

Solar Millennium

AECOM

February 2010

Y:\Projects\Solar_Millennium\Figure_Templates\85x11P.mxt

DECLARATION OF SERVICE

I, Elizabeth Copley, declare that on March 8, 2010, I served and filed copies of the attached Ridgecrest Solar Power Project (Docket No. 09-AFC-9) Responses to CEC Data Requests for Cultural Resources (DR 89) and Traffic (DR 265-267) and City of Ridgecrest Master Drainage Report. The original documents, filed with the Docket Unit, are accompanied by a copy of the most recent Proof of Service list, located on the web page for this project at:

[http://www.energy.ca.gov/sitingcases/solar_millennium_ridgecrest].

The documents have been sent to both the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit, in the following manner:

(C*heck all that Apply*)

For service to all other parties:

__ sent electronically to all email addresses on the Proof of Service list;

X by personal delivery or by overnight delivery service or depositing in the United States mail at Oakland, California with postage or fees thereon fully prepaid and addressed as provided on the Proof of Service list above to those addresses **NOT** marked "email preferred."

AND

For filing with the Energy Commission:

X sending an original paper copy and one electronic copy, mailed and emailed Respectively, to the address below (preferred method);

OR

__ depositing in the mail an original and 12 paper copies, as follows:

CALIFORNIA ENERGY COMMISSION
Attn: Docket No. 09-AFC-9
1516 Ninth Street, MS-4
Sacramento, CA 95814-5512
docket@energy.state.ca.us

I declare under penalty of perjury that the foregoing is true and correct.

[signature]

BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION OF THE STATE OF CALIFORNIA
1516 NINTH STREET, SACRAMENTO, CA 95814
1-800-822-6228 – WWW.ENERGY.CA.GOV

APPLICATION FOR CERTIFICATION For the *RIDGECREST SOLAR POWER PROJECT*

Docket No. 09-AFC-9

PROOF OF SERVICE (Revised 3/2/2010)

APPLICANT
***Billy Owens**
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***Alice Harron**
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City of Ridgecrest

Final Report

Master Drainage Plan

May 1989

JMM James M. Montgomery
Consulting Engineers, Inc.

CITY OF RIDGECREST

MASTER DRAINAGE PLAN

MAY 1989

JAMES M. MONTGOMERY, CONSULTING ENGINEERS, INC.

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CITY OF RIDGECREST

MASTER DRAINAGE PLAN

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Chapter 1

These criteria are intended to result in 100-year protection for all structures. They are consistent with the current policies of Kern County.

Storm Characteristics

After reviewing all available information, it was decided to use the design storm methodology outlined in the San Bernardino County Hydrology Manual. This was considered to be more applicable to the desert study area than the methods presented in the Kern County Subdivision Standards. Storm characteristics were derived as follows.

Rainfall Depth - The NOAA Precipitation-Frequency Atlas for the State of California was used to estimate storm depths for durations of 1 to 24 hours. A graphical approach in the San Bernardino County Hydrology Manual was used to extrapolate rainfall depths for durations of 5 minutes to 1 hour.

Temporal Distribution - A synthetic "nested" storm pattern was used to distribute total storm rainfall over time. The nested storm is a combination of peak intensities for all durations assembled into a single storm event. That is, the 100-year, 24-hour nested storm contains 100-year, 1-hour intensity, the 100-year, 6-hour intensity, etc. Furthermore, the intensities are stacked such that the peak 10-minute intensity contains the peak 5-minute intensity, the peak 15-minute intensity contains the peak 10-minute intensity, and so forth. This approach provides critical design discharges for small watersheds as well as large watersheds, regardless of the time of concentration.

Areal Extent - The entire 112 square mile study area is comprised of ten drainage basins varying in size from 0.5 to 49.0 square miles. To be conservative for planning purposes, it was assumed that local storms could be centered over any of the individual drainage basins. The drainage basin planning areas were small enough that depth-area-reduction adjustments were not made to NOAA Atlas point precipitation values.

Land Use

Existing land use characteristics were determined using the Ridgecrest General Plan and recent aerial photographs. The General Plan was used to project ultimate land uses. Master Plan land use classifications are consistent with General Plan classifications. For hydrologic modeling purposes, values of "percent imperviousness" were assigned to each land use category based on values documented for similar study areas.

Soils

Soil Conservation Service (SCS) hydrologic soil group classifications (A, B, C or D) were determined for the study watersheds using a map provided by Kern County Department of Public Works. The map was based on soil survey reports of the SCS. In areas consisting primarily of alluvial materials (i.e., most of the developed and developing areas), the predominant soil type is B. In the mountainous areas, the main soil type is C.

Loss Rates

Loss rate parameters were estimated using the commonly accepted approach of the Soil Conservation Service. In this approach, hydrologic subareas are characterized by a Curve Number, which relates all of the various loss processes to soil type (or hydrologic soil group), vegetation cover (type and density), and land use. Curve Numbers are documented in the San Bernardino County Hydrology Manual, which contains a special section on desert conditions.

1.3 HYDROLOGY

The overall objective of the hydrologic analysis was to develop peak discharges and hydrograph volumes for use in design of drainage facilities. In order to quantify present drainage problems, existing condition discharges were estimated. For facility planning, ultimate condition hydrology was formulated. Hydrologic data was derived for 10-year, 25-year and 100-year events.

Hydrologic computations were performed using the HEC-1 Flood Hydrograph Package computer program developed by the Hydrologic Engineering Center of the U.S. Army Corps of Engineers. This is a rainfall-runoff simulation program with several options for performing the various hydrograph computation steps.

Existing Conditions

There are few major drainage improvements in the Ridgecrest study area. In particular, there are no major drains serving the urban core. Rather, runoff is conveyed primarily in streets, open swales and channels. The only improved (unlined) channel reach in Ridgecrest begins at the intersection of French Avenue and China Lake Blvd, and runs northeasterly toward Satellite Lake. There are a number of graded swales along roadways which act to intercept and convey runoff. The most common drainage facilities in the study area are culvert crossings of roadways (e.g., Highway 395, China Lake Blvd, Ridgecrest Blvd, Inyokern Rd).

Hydrologic Methods

The Ridgecrest study area and its tributary watershed were divided into a total of 138 reasonably homogeneous hydrologic subareas. These varied in size from 0.041 square miles (26 acres) to 21.7 square miles, with the smaller subareas used in the urban core area.

Subareas were grouped into ten drainage basins, each having a single outfall point. These drainage basins are defined below.

Drainage Basin	Identifier	Area (sq mi)	Description
El Paso Wash	EPW	49.02	Area tributary to the El Paso Wash culvert in Inyokern Rd, including the area south of Hwy 395
Ridgecrest Wash	RCW	10.44	Area tributary to Inyokern Rd and Downs St
Inyokern Road	IK	0.89	Area tributary to Inyokern Rd, between Downs St and China Lake Blvd
Drummond Ave Wash	DAW	0.46	Area tributary to Drummond Ave and its outfall channel, between Norma St and Knox Rd
West China Lake Wash	WCL	2.19	Area tributary to West China Lake Channel (parallel to Sunland St), from Downs St to Pilot Plant Rd
Church Street	CH	1.13	Area tributary to Ridgecrest Blvd, generally centered on Church Street
Upjohn Avenue	UJ	1.34	Area tributary to Ridgecrest Blvd and Richmond Rd, generally centered on Upjohn Ave
College Heights Wash	CHW	10.46	Area tributary to China Lake Blvd and College Heights Blvd, draining the mountains to the south
East China Lake Wash	ECL	19.73	Area tributary to Ridgecrest Blvd from Richmond Rd to the County Line, draining the alluvial apron to the southeast
Bowman Wash	BW	48.13*	Area tributary to Bowman Rd and Gateway Blvd, plus the outfall flowpath northeast to Mirror Lake

* Includes area of tributary drainage basins CH, UJ, CHW and ECL

The SCS unit hydrograph method was used to convert rainfall to runoff in the HEC-1 program. Lag times were computed using subarea lengths and slopes measured from the Ridgecrest 200-scale base maps and USGS quadrangles. Channel routing computations were performed using the normal depth method; street and pipe flow routing was computed using the kinematic routing method. Storage routing in natural and man-made ponding areas was performed using the Modified Puls method.

Preliminary model results were calibrated to a regional flood-frequency relationship developed from nine gages from the southeastern California desert region. Based on the calibration effort, dry antecedent moisture conditions were adopted for 10-year and 25-year storm simulations, and normal antecedent moisture conditions were adopted for the 100-year storm.

Results

Computed peak discharges and hydrograph volumes at several key locations in the study area are presented in Table 1-1. Results indicate that the largest peak discharges are generated on Bowman Wash, Ridgecrest Wash, and El Paso Wash. All of these drainage basins are comprised primarily of areas which are outside the City of Ridgecrest boundaries, and are under the jurisdiction of either Kern County or the Bureau of Land Management. As a result, the main flooding problems in Ridgecrest are attributed to "offsite" flows, rather than to runoff generated within the city limits.

Peak discharge estimates were found to compare reasonably well with previous studies by the Corps of Engineers. The Master Plan methodology yields results which are 5-10 percent higher than the Rational Method for small urban drainage areas. Thus Master Plan facilities should be large enough to accommodate flows from local subdivision facilities sized using the Rational Method.

1.4 RECOMMENDED ALTERNATIVE

Drainage improvement alternatives were formulated for each of the drainage basins in the Ridgecrest study area. A minimum of two alternatives were developed for each area. The first alternative is referred to as the All Conveyance Alternative, and consists exclusively of channels, drains, and other conveyance facilities. The second alternative is referred to as the Detention Alternative, and incorporates as many detention/retention sites in the plan as possible. In some cases variations of the two basic approaches were evaluated.

Cost estimates were developed for each alternative using unit cost data derived from local experience, projects in other parts of the Southwest United States, and standards developed by Montgomery Engineers. A 50 percent contingency was added to capital cost estimates to incorporate construction contingencies and engineering and administrative costs. The resulting project costs are considered appropriate for master planning purposes only (i.e., + 50 percent, - 30 percent).

TABLE 1-1

ULTIMATE CONDITION HYDROLOGY FOR SELECTED LOCATIONS IN THE RIDGECREST STUDY AREA

Location	Subarea	Drainage Area (sq mi)	Return Period (yr)	Peak Discharge (cfs)	Hydrograph Volume (acre-ft)
Ridgecrest Wash					
At Mahan/Drummond	RCW140	11.7	100	2,240	780
At Mahan/Felspar	RCW220	0.89	25	56	19
At Downs/Inyokern	RCW300	15.1	100	2,400	997
West China Lake Wash					
Inflow to Sump Area	WCL060	0.76	10	240	27
Upjohn Avenue					
At Ridgecrest Blvd	UJ050	1.34	25	150	41
Church Avenue					
At Ridgecrest Blvd	CH060	1.13	25	410	67
College Heights Wash					
At Bowman Rd	CHW210	10.5	100	5,270	879
Bowman Wash					
At Brady St	BW020	1.76	25	150	29
At China Lake Blvd	BW130	15.4	100	6,910	1,203
At Ridgecrest Blvd	BW180	27.6	100	10,900	2,106
El Paso Wash					
At Inyokern Rd	EPW260	49.0	100	13,100	N/A

The recommended alternative was selected on the basis of the following general criteria: least capital construction cost; lowest operation and maintenance cost; least design and construction obstacles; least institutional barriers; and greatest potential to avoid liability. Based on these criteria, Alternative 2, the Detention Alternative, was selected as the recommended alternative for each drainage basin with the exception of East China Lake Wash; in the latter case Alternative 1 was selected because a cost-effective detention approach could not be identified.

Elements of the recommended alternative are shown in Figure 1-1 and summarized in Table 1-2. Detailed cost estimates for individual facilities may be found in Chapter 6. The total cost of implementing the ultimate drainage plan is $49 million.

A phased implementation schedule was developed to assist the City in allocating limited drainage improvement funds in the most efficient manner. The program is based on the present perception of existing flood problems, pending development, and cost-sharing opportunities. The following eight priority levels were established.

Priority 1: Solutions to immediate flooding problems where risks to health and safety are involved. Establishment of the backbone of a system to isolate the City from damaging offsite flows from major watersheds.

Priority 2: Acquisition of land and right-of-way for key detention basin sites and channel alignments in and near the present urban area.

Priority 3: Construction of trunk storm drains in the urban core.

Priority 4: Completion of the channels to isolate the City from tributary flows, and acquisition of right-of-way for facilities south of Bowman Rd.

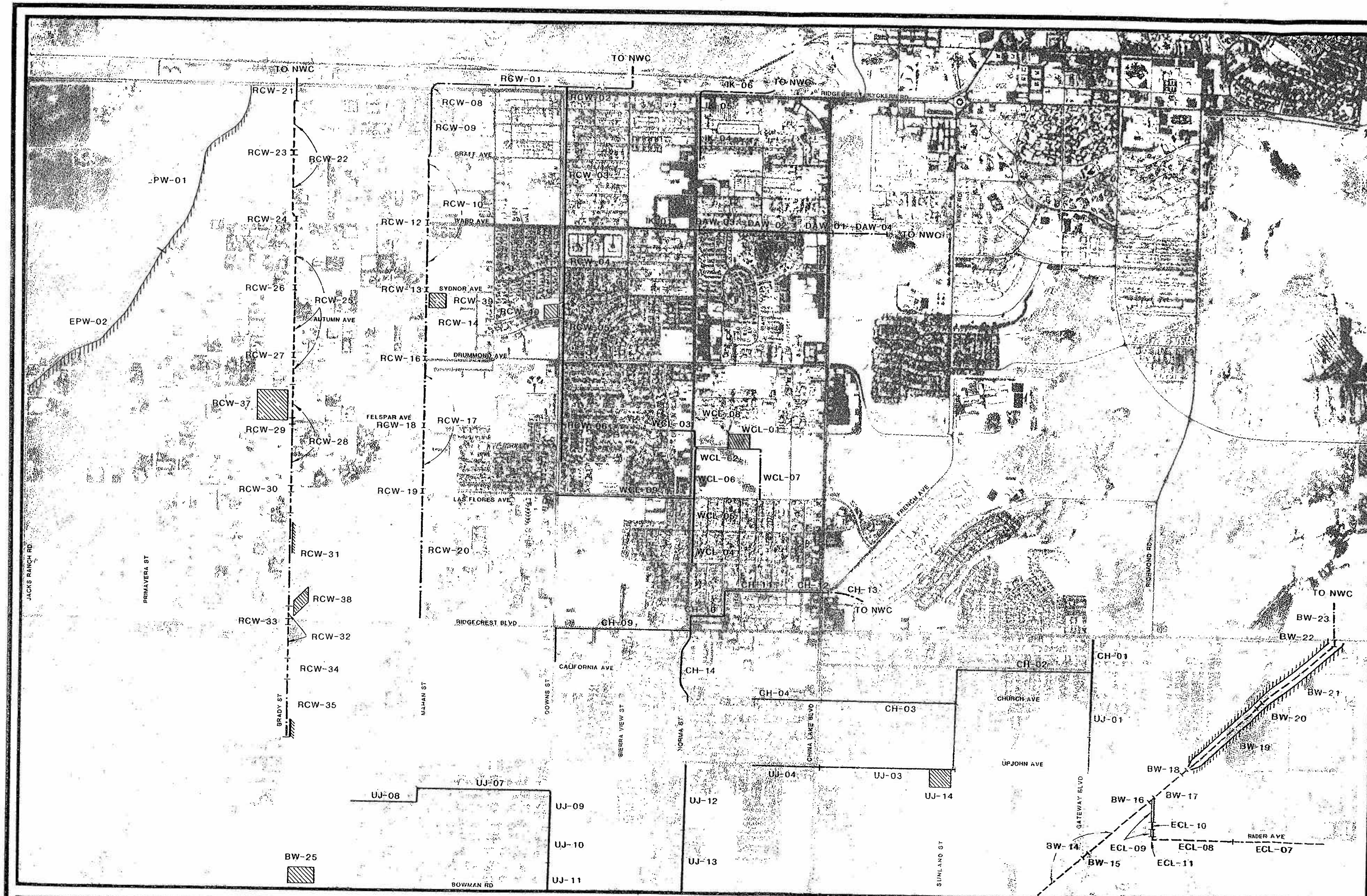
Priority 5: Completion of the urban core drainage system.

Priority 6: Construction of the "first level of defense" (detention basins, training dikes and channels) against flows from the upper College Heights watershed.

Priority 7: Construction of facilities in the urban fringe area.

Priority 8: Construction of facilities in outlying areas.

Projects and associated costs assigned to each priority level are listed in Table 1-3. The phased implementation schedule should be viewed as a flexible program, subject to change as development strategies, community priorities, and funding levels change.



LEGEND

- BURIED CONDUIT (PIPE/BOX)
- UNLINED CHANNEL
- RIP RAP LINED CHANNEL
- CONCRETE LINED CHANNEL
- DIKE/LEVEE
- DETENTION/RETENTION BASIN
- DEBRIS BASIN
- CULVERT/BRIDGE
- BW-06 FACILITY NUMBER

0 1 2 3 4000'

PHOTO DATE: 12-03-87

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CITY OF RIDGECREST
MASTER DRAINAGE PLAN

RECOMMENDED DRAINAGE IMPROVEMENTS

FIGURE 1-1A

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CITY OF RIDGECREST
MASTER DRAINAGE PLAN

RECOMMENDED DRAINAGE IMPROVEMENTS

FIGURE 1-1B

TABLE 1-2

RECOMMENDED DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Ridgecrest Wash Drainage Basin					
RCW-01	CHANNEL - 8'w x 8'd x 3:1 unlined R/W = 0'	4,350	N/A	N/A	Inyokern Rd Channel Deepening
RCW-02	RCB - 6.5'w x 5'd	400	300	10	Downs - Under Inyokern
RCW-03	RCP - 66"	2,350	150	10	Downs - Inyokern to Ward
RCW-04	RCP - 36"	1,700	40	10	Downs - Ward to Sydnor
RCW-05	RCP - 54"	1,000	100	10	Downs - Sydnor to Drummond
RCW-06	RCP - 42"	2,000	64	10	Downs - Drummond to El Sereno
RCW-07	N/A				
RCW-08	RCB - 5'w x 4'd	600	300	25	Mahan - Under Inyokern
RCW-09	RCP - 42"	800	77	10	Mahan - Inyokern to Graaf
RCW-10	CHANNEL - 8'w x 4'd x 3:1 unlined R/W = 37'	2,600	77	10	Mahan - Graaf to Sydnor
RCW-11	N/A				
RCW-12	RCB - 2 - 4'w x 2'd	80	77	10	Ward Culvert
RCW-13	RCB - 2 - 4'w x 2'd	60	77	10	Sydnor Culvert
RCW-14	CHANNEL - 8'w x 6'd x 3:1 unlined R/W = 49'	1,300	260	10	Mahan - Sydnor to Drummond
RCW-15	N/A				
RCW-16	RCB - 2 - 4.5'w x 3'd	80	260	10	Drummond Culvert
RCW-17	CHANNEL - 8'w x 4.5'd x 3:1 unlined R/W = 40'	2,600	100	10	Mahan - Drummond to Las Flores
RCW-18	RCB - 2 - 3.5'w x 3'd	50	100	10	Felspar Culvert

TABLE 1-2 (cont'd)

RECOMMENDED DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Ridgecrest Wash Drainage Basin (cont'd)					
RCW-19	RCP - 2 - 27"	80	100	10	Las Flores Culvert
RCW-20	CHANNEL - 0'w x 4'd x 4:1 unlined R/W = 37'	2,600	34	10	Mahan - Las Flores to Ridgecrest V-ditch
RCW-21	RCB - 6 - 6'w x 4'd	440	1,500	100	Brady - Reach 7
RCW-22	CHANNEL - 25'w x 8'd x 2:1 Rip rap sides 1 - 3' drop structure R/W = 54'	2,300	1,500	100	Brady - Reach 6 (to Ward)
RCW-23	RCP - 3 - 42"	60	220	10	Graaf Culvert
RCW-24	RCB - 2 - 9'w x 6'd	80	1,500	100	Ward Culvert
RCW-25	CHANNEL - 12'w x 10'd x 2:1 Rip rap sides 2 - 3' drop structures R/W = 57'	3,750	1,500	100	Brady - Reach 5 (Ward to RCW140)
RCW-26	RCP - 3 - 42"	60	220	10	Sydnor Culvert
RCW-27	RCB - 2 - 9'w x 6'd	80	1,500	100	Drummond Culvert
RCW-28	CHANNEL - 8'w x 5'd x 2:1 Rip rap sides 4 - 3' drop structures R/W = 33'	1,950	140	100	Brady - Reach 4 (RCW140 to 170)
RCW-29	RCP - 2 - 33"	60	76	10	Felspar Culvert
RCW-30	RCB - 6'w x 3'd	80	140	100	Las Flores Culvert
RCW-31	CHANNEL - 8'w x 3'd x 2:1 unlined R/W = 25'	600	100	100	Brady - Reach 3 (RCW170 - 180)
	Levee - 6' high unlined R/W = 48'	450			

TABLE 1-2 (cont'd)

RECOMMENDED DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Ridgecrest Wash Drainage Basin (cont'd)					
RCW-32	CHANNEL - 10'w x 6'd x 2:1 Rip rap sides 1 - 4' drop structure R/W = 39'	900	390	100	Brady - Reach 2 (RCW180 - 190)
RCW-33	RCB - 10'w x 4'd	80	390	100	Ridgecrest Culvert
RCW-34	CHANNEL - 8'w x 4'd x 2:1 Rip rap perimeter R/W = 29'	400	130	100	Brady - Reach 1b
RCW-35	CHANNEL - 10'w x 5'd x 2:1 unlined	800	130	100	Brady - Reach 1a
	Levee - 3' high Rip rap lined side	400	130	100	
RCW-36	N/A				
RCW-37	Detention Basin - 105 AF 8.2 acres 15' deep, 2 ft levees 36" RCP outlet	-	Inflow = 2,240 Outflow = 1,500	100 100	Brady/Felspar Basin
	Inlet Channel - 17'w x 8'd x 2:1 Rip rap sides R/W = 54' 90' concrete overflow weir	700	1450	100	
	Inlet Dike - 4' high Rip rap lining	600	-	-	
RCW-38	Retention Basin - 30 AF 6.0 acres 8' deep 18" RCP outlet Spill to Brady Channel	-	Inflow = 560 Outflow = 0	100 100	Brady/RCW180
RCW-39	Detention Basin - 11.9 AF 2.1 acres 7' deep 21' concrete overflow weir 18" RCP outlet	-	Inflow = 260 Outflow = 77	10 10	Mahan/Sydnor Basin

TABLE 1-2 (cont'd)

RECOMMENDED DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Ridgecrest Wash Drainage Basin (cont'd)					
RCW-40	Detention Basin - 4.2 AF 1.7 acres 7' deep (3' ponding) 27' concrete overflow weir 36" inlet pipe 18" outlet pipe Park landscaping	-	Inflow = 100 Outflow = 20	10 10	Downs/Pearson Park Basin

Abbreviations:

Channel dimensions: bottom width x depth x side slope (horiz:vert)
RCB - reinforced concrete box
dimensions: no. of barrels - width x depth of each barrel
RCP - reinforced concrete pipe
dimensions: diameter
Detention/Retention dimensions: total volume in acre-feet
total surface area in acres
R/W - right-of-way

TABLE 1-2 (cont'd)

RECOMMENDED DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
West China Lake Drainage Basin					
WCL-01	RETENTION BASIN - 55 AF 5 acres, 14' deep no outlet or spillway	-	460 inflow 0 outflow	25	At Norma and Felspar; expand present sump area
WCL-02	CHANNEL - 8'w x 7'd x 1.35:1 gunite sides no new R/W	650	300	25	Norma Inlet Channel
WCL-03	RCP - 54"	800	96	10	Norma North Drain
WCL-04	RCP - 42"	700	71	10	Norma South Drain - Argus to Coso
WCL-05	RCP - 48"	650	95	10	Norma South Drain - Coso to Las Flores
WCL-06	RCP - 72"	1,000	250	10	Norma South Drain - Las Flores to Outfall
WCL-07	CHANNEL - 8'w x 3.5'd x 3:1 unlined R/W = 37'	1,200	63	25	Las Flores Inlet Channel
WCL-08	RCP - 30"	200	23	10	Felspar Inlet Drain
WCL-09	RCP - 54"	2,750	150	10	Las Flores Drain
WCL-10	see CH-12				
WCL-11	see CH-13				

TABLE 1-2 (cont'd)

RECOMMENDED DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Inyokern and Drummond Avenue Wash Drainage Basins					
IK-01	RCP - 48"	1,320	89	10	Ward Drain
IK-02	N/A				
IK-03	N/A				
IK-04	RCP - 60"	1,110	90	10	Norma Drain
IK-05	RCP - 66"	400	130	10	Inyokern Culvert
IK-06	Channel 20'w x 6.5'd x 3:1 unlined R/W = 0'	1,450	-	-	Deepen existing NWC Channel to accomodate Norma Drain
DAW-01	RCP - 66"	650	150	10	Ward Drain
DAW-02	RCP - 78"	1,380	80	10	Ward Drain
DAW-03	RCP - 66"	650	280	10	Ward Drain
DAW-04	CHANNEL - 7'w x 6'd x 3:1 unlined R/W = 68'	1,060	290	10	Channel to daylight Ward Drain

TABLE 1-2 (cont'd)

RECOMMENDED DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Church Ave and Upjohn Ave Drainage Basins					
CH-01	RCP - 66"	700	170	10	Gateway - California to Ridgecrest
CH-02	RCP - 54"	3,300	140	10	California - Sunland to Gateway
CH-03	RCP - 60"	2,660	170	10	Church - China Lake to Sunland
CH-04	RCP - 42"	1,310	105	10	Church - Norma to China Lake
CH-05	N/A				Church - Sierra View to Norma
CH-06	N/A				Sierra View - California to Church
CH-07	N/A				California - Downs to Sierra View
CH-08	N/A				Downs - Ridgecrest to California
CH-09	RCP - 54"	3,100	130	10	Ridgecrest - Downs to Norma
CH-10	RCP - 72"	930	280	10	Jean and Helena
CH-11	RCP - 78"	2,100	340	10	French - Helena to Balsam
CH-12	RCB - 9.5'w x 6'd	570	400	10	French - Balsam to Channel
CH-13	Channel - 8'w x 9'd x 2:1 to 8'w x 8'd x 2:1 unlined, R/W = 69'	820	-	-	French Channel Deepening; lower invert
CH-14	RCP - 66"	1,540	180	10	Norma - Church to Ridgecrest
CH-15	Channel -8'w x 8.5'd x 2:1 unlined R/W = 49'	2,000	440	25	Daylight Channel - depth reduces to 0 at outfall
UJ-01	RCP - 48"	2,000	43	10	Gateway - Upjohn to California
UJ-02	RCP - 33"	1,600	20	10	Sunland - Basin to Church
UJ-03	RCP - 60"	2,300	190	10	Upjohn - China Lake to Basin
UJ-04	RCP - 36"	1,320	62	10	Upjohn - Warner to China Lake
UJ-05	N/A				

TABLE 1-2 (cont'd)

RECOMMENDED DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Church Ave and Upjohn Ave Drainage Basins (cont'd)					
UJ-06	N/A				
UJ-07	RCP - 36"	2,640	46	10	Langley - Mahan to Downs
UJ-08	RCP - 30"	1,620	38	10	St. George - Guam to Mahan
UJ-09	RCB - 6.5'w x 4'd	700	55	10	Downs - Langley to Rader
UJ-10	RCB - 8'w x 4'd	1,000	88	10	Downs - Rader to Willow
UJ-11	RCP - 72"	630	120	10	Downs - Willow to Bowman
UJ-12	RCP - 66"	1,360	90	10	Norma - Upjohn to Rader
UJ-13	RCP - 54"	1,360	140	10	Norma - Rader to Bowman
UJ-14	Detention Basin - 13.8 AF 2.21 acres 7' deep (2' ponding) 49' overflow inlet 18" RCP outlet drain Turf landscaping	-	Inflow = 190 Outflow = 20	10	Future park site - Upjohn/Sunland

TABLE 1-2 (cont'd)

RECOMMENDED DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
College Heights Wash Drainage Basin					
CHW-01	CHANNEL - 8'w x 4.5'd x 2:1 rip rap lined 10 - 3' drops R/W = 50'	5,700	300	100	Detention Site 2 Outlet Channel
CHW-02	CHANNEL - 8'w x 5'd x 2:1 rip rap sides 7 - 3' drops R/W = 52'	3,200	300	100	Detention Site 1 Outlet Channel
CHW-03	N/A				
CHW-04	RCB - 2 - 5'w x 4'd	50	600	100	Springer culvert
CHW-05	CHANNEL -10'w x 6.5'd x 2:1 rip rap lined R/W = 61'	1,300	600	100	Norma Channel - Reach 1
CHW-06	CHANNEL - 5'w x 6'd x 1.5:1 concrete lined R/W = 48'	1,300	600	100	Norma Channel - Reach 2
CHW-07	RCB - 2 - 5.5'w x 4'd	100	600	100	Dolphin culvert
CHW-08	CHANNEL - 8'w x 4'd x 2:1 rip rap lined R/W = 29'	2,600	75	10	College Heights Blvd Channel - Reach 2
CHW-09	RCB - 2 - 4'w x 2'h	50	75	10	Springer culvert
CHW-10	CHANNEL - 8'w x 4'd x 2:1 rip rap lined R/W = 29'	2,600	130	10	College Heights Blvd Channel - Reach 3
CHW-11	RCB - 2 - 4'w x 2'd	50	130	10	Dolphin culvert
CHW-12	CHANNEL - 7'w x 5'd x 1.5:1 concrete lined R/W = 37'	2,300	360	25	College Heights Blvd Channel - Reach 4
CHW-13	RCB - 2 - 6'w x 3'd	100	360	25	College Heights Blvd culvert
CHW-14	CHANNEL - 5'w x 5'd x 1.5:1 concrete lined R/W = 25'	3,450	650	100	China Lake Blvd Channel

TABLE 1-2 (cont'd)

RECOMMENDED DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
College Heights Wash Drainage Basin (cont'd)					
CHW-15	RCB - 2 - 6'w x 5'd	100	650	100	College Heights Blvd (new)
CHW-16	RCB - 2 - 7'w x 5'd	200	1,900	100	College Heights Blvd (old)
CHW-17	Detention Basin - 220 AF	-	Inflow = 2,300 Outlflow = 300	100	Site 1 - West College Heights
	balanced cut/fill excavation				
	surface area = 13 acres				
	20' deep				
	1 - 54" RCP outlet	200			
	5,900 cfs PMF spillway				
	R/W = 0' (BLM)				
	dike - 5' high, rip rap	2,700			
CHW-18	Detention Basin - 250 AF	-	Inflow = 2,950 Outlflow = 300	100	Site 2 - Central College Heights Includes diversion from CHW160/170
	balanced cut/fill excavation				
	surface area = 12 acres				
	24' deep				
	2 - 36" RCP outlet	100			
	6,400 cfs PMF spillway				
	R/W = 0' (BLM)				
	dikes - 6' high, rip rap	2,700			
	4' high, rip rap	1,000			
CHW-20	RCP - 42"	1,200	50	10	Dolphin Drain - West
CHW-21	RCP - 48"	1,450	45	10	Dolphin Drain - East
CHW-22	RCB - 6'w x 4'd	1,200	71	10	Springer Drain - West
CHW-23	Diversion Facility				Diversion of CHW160/170 to Site 2 Basin
	Dike - 6' high, rip rap	2,400	1,370	100	
	RCB - 7'w x 5'd	60			

TABLE 1-2 (cont'd)

RECOMMENDED DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
East China Lake Drainage Basin					
ECL-01	Dike - 5' high	800	1,280	100	
	RCB - 10'w x 8'd	60	1,280	100	Gateway Culvert
ECL-02	CHANNEL - 24'w x 10'd x 2:1 Rip rap sides R/W = 89' 3 - 3' rock drops	2,600	2,550	100	Franklin Channel
ECL-03	RCB - 2 - 9'w x 8'd	60	2,550	100	Sunland Culvert
ECL-04	CHANNEL - 9'w x 9'd x 2:1 Rip rap lining 12 - 3' rock drops R/W = 49'	3,900	1,330	100	Sunland Channel
ECL-05	RCB - 10'w x 7'd	60	1,330	100	Dolphin Culvert
ECL-06	RCB - 10'w x 7'd	70	1,330	100	Bowman Culvert
ECL-07	CHANNEL - 15'w x 7'd x 2:1 Rip rap sides R/W = 49'	2,000	300 1,440	25 100	Rader Channel - Reach 1
ECL-08	CHANNEL - 15'w x 10'd x 2:1 Rip rap lining R/W = 60'	1,600	2,730	100	Rader Ave Channel - Reach 2
ECL-09	CHANNEL - 10'w x 6'd x 1.5:1 Gunite lining R/W = 39'	700	2,730	100	Richmond Road Channel
ECL-10	RCB - 2 - 9'w x 6'd	40	2,730	100	Fairgrounds Entrance culvert
ECL-11	RCB - 2 - 9'w x 6'd	60	2,730	100	Rader Ave culvert
ECL-12	DETENTION BASIN - 51 AF 5.74 acres (500' x 500') 10' deep + 2' berm 160' diversion weir 30" RCP outlet 5:1 side slopes	-	Inflow = 2,550 Outflow = 1,330	100 100	Sunland Basin

TABLE 1-2 (cont'd)

RECOMMENDED DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Bowman Wash Drainage Basin					
BW-01	DIKE - 6' high	400	820	100	Inlet Structure/training dike
BW-02	RCB - 4 - 4.5'w x 3'd	80	820	100	Brady culvert
BW-03	CHANNEL - 10'w x 6'd x 5:1 Unlined 7 - 3' drop structures R/W = 0' (in street)	2,640	500	100	Bowman Channel - Brady to Mahan
BW-04	RCB - 2 - 8'w x 4'd	80	500	100	Mahan culvert
BW-05	CHANNEL - 10'w x 6'd x 5:1 Unlined 8 - 3' drop structures R/W = 0' (in street)	2,600	500	100	Bowman Channel -
BW-06	RCB - 2 - 8'w x 4'd	80	500	100	Downs culvert
BW-07	CHANNEL - 8'w x 10'd x 2:1 Unlined 9 - 3' drop structures R/W = 0' (in street)	2,600	610	100	Bowman Channel - Downs to Norma
BW-08	RCB - 10.5'w x 8'd	80	610	100	Norma culvert
BW-09	CHANNEL - 8'w x 10'd x 2:1 Rip rap lining 2 - 3' drop structures R/W = 0' (in street)	2,600	1,600	100	Bowman Channel - Norma to China Lake
BW-10	RCB - 10.5'w x 8'd	250	1,600	100	China Lake Blvd culvert
BW-11	CHANNEL - 45'w x 10'd x 2:1 Rip rap sides R/W = 0' (in street)	2,600	3,470	100	Bowman Channel - China Lake to Sunland
BW-12	RCB - 4 - 10'w x 8'd	80	3,470	100	Sunland culvert
BW-13	CHANNEL - 46'w x 13'd x 2:1 Rip rap sides R/W = 0' (in street)	1,700	4,940	100	Bowman Channel - Sunland to Fwy Cutoff

TABLE 1-2 (cont'd)

RECOMMENDED DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Bowman Wash Drainage Basin (cont'd)					
BW-14	CHANNEL - 46'w x 13'd x 2:1 Rip rap sides R/W = 0' (in street)	2,900	4,940	100	Bowman Channel - Fwy Cutoff to Richmond
BW-15	RCB - 3 - 15'w x 11'd	115	4,940	100	Gateway culvert
BW-16	RCB - 3 - 15'w x 11'd	60	4,940	100	Richmond culvert
BW-17	CHANNEL - 120'w x 9.5'd x 2:1 Rip rap sides R/W = 200 (exist.)	750	6,550	100	Bowman Channel - Richmond to Upjohn
BW-18	RCB - 6 - 4'w x 3'd	60	350	2	Upjohn culvert
BW-19	CHANNEL - 120'w x 10'd x 2:1 Rip rap sides R/W = 200' (exist.) 0' - 5' levees	1,800	7,460	100	Bowman Channel - Upjohn to Church
BW-20	RCB - 6 - 4'w x 3'd	60	350	2	Church culvert
BW-21	CHANNEL - 110'w x 11'd x 2:1 Grouted rock sides R/W = 200' (exist.) 6' - 6.5' levees	1,900	8,420	100	Bowman Channel - Church to Ridgecrest
BW-22	BRIDGE - 110' span	80	8,420	100	Ridgecrest Blvd bridge
BW-23	CHANNEL - 110'w x 0'-4.5'd x 2:1 unlined	750	8,420	100	Outlet channel to daylight
BW-24	CHANNEL - 13'w x 8'd x 3:1 unlined 10 - 3' drop structures	2600	760	100	Brady Channel
BW-25	DETENTION BASIN - 43 AF 8.0 acres (park site) 6' deep 120' inflow weir no spillway 30" RCP outlet drain	-	Inflow = 1,510 Outflow = 500	100 100	Brady/Bowman Basin proposed park site

TABLE 1-2 (cont'd)

RECOMMENDED DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Bowman Wash Drainage Basin (cont'd)					
BW-30	RCP - 36"	1,500	51	10	Mahan Drain - Reach 1
BW-31	N/A				
BW-32	RCP - 48"	1,500	130	10	Downs Drain - Reach 1
BW-33	N/A				
BW-34	RCP - 42"	1,700	72	10	Norma Drain
BW-35	RCP - 54"	1,100	180	25	Mahan Drain - Reach 2
BW-36	RCB - 7'w x 4'd	360	200	10	Downs Inlet
BW-37	RCB - 6'w x 4'd	740	170	10	Downs Drain - Reach 2

TABLE 1-2 (cont'd)

RECOMMENDED DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
El Paso Wash Drainage Basin					
EPW-01	LEVEE - 5' high (average) Rip rap lined, one side R/W = 48'	4,060	13,100	100	Extend south from Inyokern Rd
EPW-02	LEVEE - 4' high (average) Rip rap lined, one side R/W = 42'	3,940	13,100	100	
EPW-03	LEVEE - 3' high (average) Rip rap lined, one side R/W = 36'	9,700	13,100	100	

TABLE 1-3

RECOMMENDED PROJECT PRIORITIES

Priority	Project Description	Facility Numbers	Project Cost ($1,000)
Priority 1	1.1 Bowman Rd Channel from Downs St to Outfall	BW-07 to BW-23	7,174
	1.2 Brady Channel from Felspar Ave to Outfall	RCW-21 to RCW-27	3,538
	Priority 1 Subtotal		10,712
Priority 2	2.1 Site Acquisition for Norma/ Felspar Retention Basin	WCL-01	1,013
	2.2 Site Acquisition for Brady/ Felspar Detention Basin	RCW-37	492
	2.3 Site Acquisition for Mahan/ Sydnor Detention Basin	RCW-39	125
	2.4 Site Acquisition for Brady/ Ridgecrest Detention Basin	RCW-38	360
	2.5 Right-of-Way Acquisition for Mahan Channel	RCW-10, RCW-14, RCW-17, RCW-20	496
	2.6 Right-of-Way Acquisition for Brady Channel from Felspar to Upjohn	RCW-28, RCW-31, RCW-32, RCW-34, RCW-35	231
	2.7 Site Acquisition for two College Heights Detention Basins	CHW-17, CHW-18	0
	Priority 2 Subtotal		2,717
Priority 3	3.1 Downs Storm Drain and Pearson Park Detention Basin	RCW-01 to RCW-06, RCW-40	2,013
	3.2 French Ave Storm Drain	CH-10 to CH-13	1,728
	3.3 Church Ave Storm Drain	CH-01 to CH-04, CH-15	2,224
	Priority 3 Subtotal		5,965

Table 1-3
Recommended Project Priorities
Page 2.

Priority	Project Description		Facility Numbers	Project Cost ($1,000)
Priority 4	4.1	Bowman Rd Channel from Brady St to Downs St	BW-01 to BW-06	616
	4.2	Bowman Detention Basin and Brady Inlet Channel	BW-25, BW-24	1,209
	4.3	Brady Channel from Felspar to Upjohn	RCW-28 to RCW-35	546
	4.4	Brady Detention Basins	RCW-37, RCW-38	926
	4.5	Right-of-Way Acquisition for College Heights Channel	CHW-08, CHW-10, CHW-12	637
	4.6	Right-of-Way Acquisition for China Lake Channel	CHW-14	446
	4.7	Right-of-Way Acquisition for Norma Channel	CHW-05, CHW-06	24
	Priority 4 Subtotal			4,404
Priority 5	5.1	Norma/Felspar Retention Basin and all tributary drains	WCL-01 to WCL-09	2,259
	5.2	Ward Ave Storm Drain	DAW-01 to DAW-04	1,093
	5.3	Norma St Storm Drain	IK-01, IK-04 to IK-06	760
	5.4	Drains Tributary to French Ave Storm Drain	CH-09, CH-14	1,269
	5.5	Drains Tributary to Church Ave Storm Drain	UJ-01 to UJ-04	1,507
	5.6	Upjohn Detention Basin	UJ-14	171
	Priority 5 Subtotal			7,059
Priority 6	6.1	College Heights Detention Basin Site 1	CHW-17	1,476
	6.2	College Heights Detention Basin Site 2	CHW-18, CHW-23	2,078
	6.3	Franklin and Sunland Channels	ECL-01 to ECL-06	2,257
	Priority 6 Subtotal			5,811

Table 1-3
Recommended Project Priorities
Page 3.

Priority	Project Description		Facility Numbers	Project Cost ($1,000)
Priority 7	7.1	Mahan Channel	RCW-08 to RCW-20	985
	7.2	Mahan Detention Basin	RCW-39	117
	7.3	Upjohn Diversion Drains to Bowman Rd Channel	UJ-07 to UJ-13	2,386
	7.4	Southern Drains to Bowman Rd Channel	BW-30 to BW-37	1,460
	Priority 7 Subtotal			4,948
Priority 8	8.1	College Heights Channel	CHW-08 to CHW-13	1,026
	8.2	China Lake Channel	CHW-14 to CHW-16	752
	8.3	Norma Channel	CHW-04 to CHW-07	520
	8.4	College Heights Detention Basin Outlet Channels	CHW-01 to CHW-02	1,134
	8.5	Radar/Richmond Channels	ECL-07 to ECL-11	1,314
	8.6	El Paso Wash Levees	EPW-01 to EPW-03	2,224
	8.7	College Heights Drains	CHW-20 to CHW-22	749
	Priority 8 Subtotal			7,719
			GRAND TOTAL	49,335

1.5 FINANCIAL ALTERNATIVES

The City does not have the economic resources available to implement the Master Plan. For this reason, a number of potential financial alternatives were investigated for funding stormwater improvements in the City of Ridgecrest. This investigation was preliminary in nature, and was intended to identify funding mechanisms which should be studied more closely by the City.

It was concluded that the "contribution to the problem" approach is more practical than the "receipt of benefits" approach from the standpoint of identifying the measures and units used to allocate costs and assess residents. The City should investigate further the feasibility of using various measures of runoff contribution to assess residents. These could include total property area, impervious area, or some other measurable factor. Coupled with this, a means of assessing benefits of regional protection from "offsite" runoff should be investigated. The Ridgecrest Redevelopment Agency is a potential source of these funds.

The City should consider the following financial alternatives for further investigation:

1. Fees for recovering the costs of providing specific services to individuals.

2. Service Charges as a better method than property taxes of assessing residents for stormwater control services. Service charges can be more equitably administered than taxes.

3. System Development Charges for ensuring that future developments pay their fair share of oversized storm drainage improvements. A more detailed analysis will be required to determine the optimal balance of service charges and system development charges to ensure equity and sufficient dependable revenue for debt service coverage requirements.

4. Ridgecrest Redevelopment Agency as a source of funds for constructing regional and local projects, and for acquiring required right-of-way.

5. Revenue Bonds as a method for raising debt capital while preserving the City's debt capacity for non-revenue producing facilities.

6. Cooperative Agreements with other agencies as a means of supplementing local funds. Agencies to be considered would include CALTRANS, Kern County, and China Lake NWC. Cost sharing potential would have to be investigated on a project-by-project basis.

Chapter 2

CHAPTER 2

INTRODUCTION

2.1 STUDY PURPOSE

The primary purpose of the Comprehensive Master Drainage Study for the City of Ridgecrest is to formulate a plan for controlling stormwater runoff which impacts areas within the City's jurisdiction. The plan consists of a flexible, implementable, cost-effective approach to managing runoff from ultimate development conditions in the entire watershed area tributary to the City of Ridgecrest. Proper management includes identifying and rectifying existing drainage problems, in addition to planning for future growth in the Ridgecrest Sphere of Influence.

The Master Drainage Plan presents a conceptual approach for drainage and flood control. Alternatives include combinations of storm drains, open channels, detention and retention basins, culverts, and levees. Sizes and locations of recommended facilities are approximate, consistent with a master plan level of detail. Additional detailed planning, preliminary design and refined cost estimates should all be undertaken before any of the recommended facilities are scheduled for design and construction.

Once the Master Drainage Plan has been adopted, it will facilitate orderly development within the community with regard to impacts on drainage systems. It will also establish annual expenditures required to implement the plan on a sequential priority basis, in order to promote the efficient use of City and community resources in addressing stormwater needs.

2.2 AUTHORIZATION

The Comprehensive Master Drainage Study was performed by James M. Montgomery, Consulting Engineers, Inc., under contract to the City of Ridgecrest dated October 8, 1987.

2.3 SCOPE OF WORK

The main elements of the overall project scope of work are outlined below.

Task 1. Basic Data Collection and Generation

- 1.1 Collect precipitation, streamflow, land use, and drainage design criteria.
- 1.2 Obtain aerial photogrammetric mapping for the City of Ridgecrest at a scale of 1"=200'.
- 1.3 Conduct field reconnaissance to document drainage, geomorphic, and land use conditions.
- 1.4 Prepare Technical Memorandum No. 1 to summarize the results of Task 1.

Task 2. Drainage Planning Criteria

2.1 Establish planning goals and objectives.
2.2 Determine design storm criteria.
2.3 Determine land use criteria.
2.4 Determine soils criteria.
2.5 Select hydrologic methods and model.
2.6 Prepare Technical Memorandum No. 2 to summarize the results of Task 2.

Task 3. Hydrologic Analysis

3.1 Prepare hydrologic model of Ridgecrest watershed area.
3.2 Compute peak discharges and hydrographs for existing land use conditions.
3.3 Compute peak discharges and hydrographs for ultimate land use conditions.
3.4 Evaluate hydrologic model results.
3.5 Prepare Technical Memorandum No. 3 to summarize the results of Task 3.

Task 4. Drainage Alternatives

4.1 Identify existing and potential future drainage problems.
4.2 Develop drainage alternatives.
4.3 Prepare facility cost estimates.
4.4 Assess non-hydrologic impacts and benefits of alternatives.
4.5 Prepare Technical Memorandum No. 4 to summarize the results of Task 4.

Task 5. Recommended Plan and Implementation Program

5.1 Select recommended drainage plan.
5.2 Develop preliminary financing plan for drainage improvements.
5.3 Formulate a phased implementation schedule for the recommended alternative.
5.4 Prepare Technical Memorandum No. 5 to summarize the results of Task 5.

Task 6. Corps of Engineers Coordination

Coordinate study data, methods and results with the Corps of Engineers.

Task 7. Master Plan Report

Prepare draft and final master plan reports.

Task 8. Project Management

8.1 Conduct regular progress meeting with City staff.
8.2 Conduct in-house technical review meetings.

Task 9. Training Program

Outline and conduct a program to train City staff and local engineers in the methods of analysis used in the master plan.

Task 10. Drainage Design Manual

Prepare draft and final drainage design manuals.

2.4 REPORT ORGANIZATION

This Master Drainage Plan Report contains eight chapters, organized as follows:

Chapter 1. Executive Summary
Chapter 2. Introduction
Chapter 3. Planning Criteria
Chapter 4. Hydrology
Chapter 5. Drainage Alternatives
Chapter 6. Cost Estimates
Chapter 7. Recommended Alternative
Chapter 8. Financial Alternatives

A separately bound technical appendix contains printouts of the computer model used to estimate peak discharges in the Ridgecrest study area. A Drainage Design Manual was prepared to assist the City in standardizing future local drainage studies and design projects.

2.5 COORDINATION

The data, assumptions and results of the Master Plan were coordinated with the Public Works Director of the City of Ridgecrest. This was accomplished through progress meetings and through preparation of Technical Memoranda. The Technical Memoranda presented detailed discussions of major project milestones (existing facilities, planning criteria, hydrology, and alternatives) during the course of the project to allow opportunity for City input at these milestones.

Initial study phases were coordinated with the Los Angeles District of the U.S. Army Corps of Engineers (COE). The COE was in the final stages of a Reconnaissance Study for Bowman Wash. The City of Ridgecrest was interested in obtaining as much in-lieu credit as possible with the COE for preparation of the Master Plan. However, the Reconnaissance Study found a benefit/cost ratio for a Bowman Wash flood control project of only approximately 0.3, and the COE involvement in Ridgecrest flooding problems was suspended.

The following agencies and individuals were contacted in the course of preparing the Ridgecrest Master Plan of Drainage.

Agency	Person	Subject
Corps of Engineers	Jim Conley, Mark Williams, Bill Lewis	Coordination for in-kind services, review of past Corps studies, Corps Reconnaissance Study
Corps of Engineers	Dennis Marfice	Corps hydrology studies in Ridgecrest
Corps of Engineers	John Pedersen	Hydrologic criteria for potential future Corps studies in Ridgecrest
Corps of Engineers	Rachael Korkos	Hydraulic analysis of Bowman Wash
L.A. Department of Water and Power	LeVal Lund	Precipitation data collected by LADWP
Kern Co. Department of Public Works	Mark Dawson	Soils and precipitation data
Kern County Water Agency	George Ribble	Basic data available, appropriate study methods for Ridgecrest
Kern County Planning and Zoning	Evan Edgar, Jim Hogg	Subdivision standards and County design criteria
Department of Water Resources	Unknown	Recent short-duration precipitation records for Ridgecrest vicinity
China Lake NWC	Dick Furstenburg, Lloyd Corbett	Precipitation data available for NWC
China Lake NWC	Rodney Kanagawa	Hydrologic data and drainage conditions for NWC
San Bernardino County Flood Control District	Bob Corchero	Recommended hydrologic methods and available data in desert areas

2.6 EXISTING STUDIES AND NEW DATA

Several existing reports and other data were collected and reviewed in the course of preparing the drainage plan. Those which provided information useful to the study are listed below in the form of an annotated bibliography.

1. Flood Plain Information, Ridgecrest and Vicinity, U.S. Army Corps of Engineers, June 1976.

   Flood history, flooding areas, peak discharges, limited hydrographs, and channel cross sections.

2. Ridgecrest Wash Channel Detailed Project Report, U.S. Army Corps of Engineers, November 1979.

   Alternative flood control solution for Ridgecrest Wash and El Paso Wash.

3. Ridgecrest and El Paso Wash Initial Appraisal Report, U.S. Army Corps of Engineers, November 1985.

   Background data, peak flows, and potential feasible alternatives for Ridgecrest Wash and El Paso Wash.

4. Bowman Wash Initial Appraisal Report, U.S. Army Corps of Engineers, November 1985.

   Background data, peak flows, and potential feasible alternatives for Bowman Wash.

5. City of Ridgecrest General Plan 1981-1995, EDAW, Inc., 1981.

   Community description, existing and ultimate land uses, description of development types.

6. Drainage System Restoration Design Drawings, China Lake Naval Weapons Center, 1986.

   Channel characteristics for receiving channel for drainage from a portion of Ridgecrest.

7. Flood Control and Water Conservation in Indian Wells and Searles Valleys, Open-File material from City of Ridgecrest.

   Groundwater recharge potential for detained storm flows.

8. County of San Bernardino Hydrology Manual, Williamson and Schmid, August 1986.

   Synthetic storm procedure, soil loss data, desert hydrology background.

9. Flood Insurance Study, City of Ridgecrest, Federal Insurance Administration, July 1981.

Peak discharges, flooding areas, flood water-surface elevation profiles.

10. Kern County Subdivision Standards, Kern County Planning Department.

County design standards, soil group maps.

11. Precipitation-Frequency Atlas of the Western United States, Volume XI - California, NOAA Atlas 2, National Oceanic and Atmospheric Administration, 1973.

Precipitation depths for various durations and frequencies, depth-area reduction curve.

12. Rainfall Depth-Duration-Frequency for California, California Department of Water Resources, November 1982.

Short-duration rainfall data and statistical analyses for gages in Randsburg and Inyokern.

13. Cooperative Stream Gaging Program, A Compilation of Peak Discharge Data on Selected Streams 1958-1985, Kern County Water Agency, August 1985.

Peak discharge records for non-recording stream gages in the vicinity of Ridgecrest.

14. Report on August 1984 Flood Discharges, Kern County Water Agency, December 1984.

Estimates of peak discharges in Ridgecrest for August 1984 flood.

15. Hydrologic Analysis for Feasibility Study of Las Vegas Wash and Tributaries, Clark County, Nevada, U.S. Army Corps of Engineers, Open-File Material, 1987.

Regional flood-frequency analysis and supporting data for southeastern California and southern Nevada streams.

16. Unpublished Precipitation Data, Los Angeles Department of Water and Power.

Daily precipitation data for Freeman, CA.

17. Weather at NWC, Climatological Data for 1946-1985, China Lake Naval Weapon Center, March 1986.

Precipitation and other meteorological data for NWC.

The only new data to be generated for the drainage plan study was topographic mapping. Prior to the study, the only topographic mapping available for the study area was the USGS 7.5-minute quadrangle maps. An aerial survey subcontract was established to prepare new planimetric topographic mapping for the City of Ridgecrest at a scale of 1"=200' with 4-foot contours. The area of coverage included all of the presently incorporated City area, exclusive of China Lake NWC, plus some fringe areas which may eventually be annexed.

Mapping was prepared on 28 sheets, using the AUTOCAD data base format. Separate digital overlays were prepared for topography (contours and spot elevations) and roadways. AUTOCAD files were delivered to the City on floppy disks. The City plans to use the AUTOCAD topographic and street data bases to prepare utility inventories and perform other mapping functions.

Chapter 3

JMM James M. Montgomery
Consulting Engineers, Inc.

CHAPTER 3

PLANNING CRITERIA

3.1 INTRODUCTION

This Chapter presents the planning and hydrologic design criteria to be used in analyzing drainage conditions for the Ridgecrest Master Drainage Plan. These criteria are the foundation for the hydrologic analysis and the formulation of drainage alternatives. Information in this Chapter was previously submitted for review and approval as Technical Memorandum No. 2.

The following topics are covered in this Chapter:

- o Study Area
- o Goals and Objectives
- o Level of Protection
- o Storm Characteristics
- o Land Use
- o Soils
- o Loss Rates
- o Hydrologic Model

3.2 STUDY AREA

Ridgecrest is located in the northeast corner of Kern County, at the northern edge of the Mojave Desert. Prior to the establishment of the Naval Ordinance Test Station (NOTS) at China Lake in 1943, Ridgecrest, then "Crumville", consisted of a few scattered farms and homesteads. Ridgecrest evolved during the 1950's and 1960's as a support community, vital to the mission of NOTS, by providing housing and services for Federal employees and contractors. The community incorporated in 1963.

Ridgecrest is located in the southern end of the Indian Wells Valley, surrounded by four mountain ranges: the Sierra Nevada on the west, the Cosos on the north, the Argus Range on the east, and the El Paso Mountains on the south. It is approximately 125 miles from both Bakersfield and San Bernardino, the two nearest major urban areas. Though often described as isolated, a characteristic that favors the City is its proximity to two major highways, an airport, and national rail service.

Ridgecrest is the only incorporated community in the Indian Wells Valley. The City's incorporated area includes approximately 14,000 acres, including over 6,600 acres of the China Lake Naval Weapons Center (NWC).

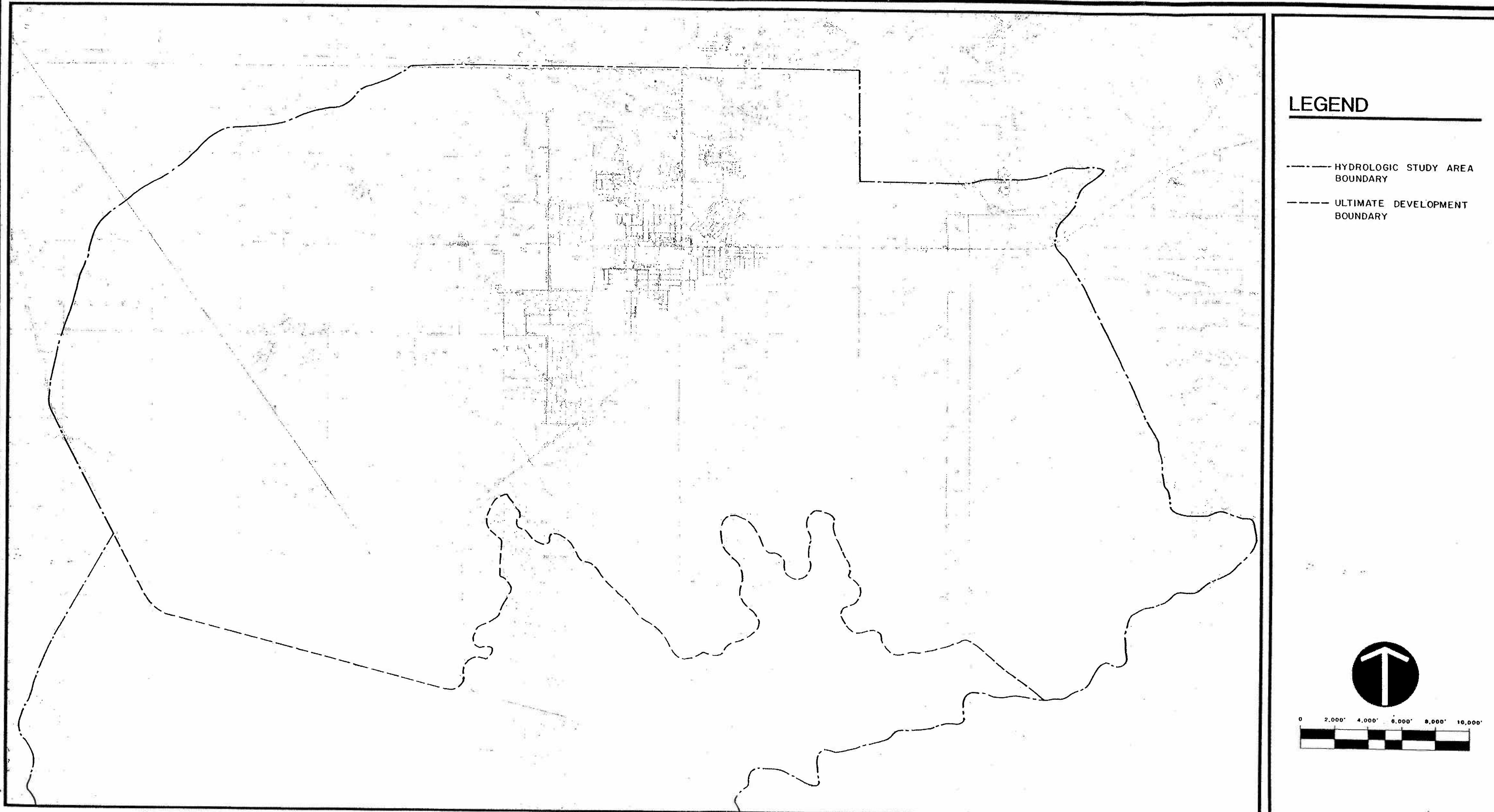
While the Indian Wells Valley has experienced a fairly steady growth rate over the last decade, Ridgecrest's population has changed dramatically since the early 1970's and has resulted in Ridgecrest becoming the second largest city in population in Kern County. The rapid increase in Ridgecrest's population between 1970 and 1980 is primarily attributable to population shifts from the NWC to the City. Population figures for the area have increased from 5,506 in 1960 to 24,828 in 1987.

The Indian Wells Valley forms a natural basin with the major runoff received from the El Paso Mountains to the south. The runoff forms three principal streams: Ridgecrest Wash, Bowman Wash and El Paso Wash. The streams flow through the basin in a north-easterly direction until eventually emptying into one of the three dry lakes in the area: Satellite Lake, Mirror Lake, and China Lake.

The average annual precipitation in the study area over the period 1946-1985 was 3.69 inches. The meteorologist at the China Lake NWC has recently adopted a 30-year average annual rainfall value of 4.37 inches, based on the period 1958-1987. Sixty percent of annual rainfall occurs in the winter. The area receives an average of 19 days of measurable precipitation per year. Three types of storms produce precipitation: general winter storms, gentle summer storms, and local thunderstorms. Historically, floods in the study area have usually resulted from local storms. Local storms can occur at any time and produce high intensity rainfall for peak durations of approximately 6 hours or less.

The hydrologic analysis associated with the Master Plan included all of the watershed area tributary to the City. This included the northern slopes of the El Paso Mountains which are beyond the southern City boundary. El Paso Wash and Little Dixie Wash are relatively large watersheds which drain toward the western side of Ridgecrest from the southwest. Previous field reconnaissance by the Corps of Engineers suggested that Highway 395 and the Southern Pacific Railroad grade effectively cut off the portion of these drainages southwest of the Highway, limiting discharges across the highway and railroad to the capacities of several small culverts. However, to assure use of proper design flows, all of the tributary area beyond the highway and railroad embankments was included in the hydrologic model.

One of the important study area considerations is the assumed extent of urban development for design conditions. The extent and density of urbanization is a critical factor affecting the magnitude of design discharges. For purposes of this study, the ultimate urban development boundary is assumed to be as shown in Figure 3-1. This is based on the assumption that all areas in the tributary area without excessively steep or unstable slopes will eventually be built-out in some form of urban development. It is stressed that this is a decision made for hydrologic modeling purposes only, and is not necessarily consistent with current planning policies of City or County agencies. Nonetheless, for the purpose of planning drainage facilities which will be capable of handling ultimate watershed conditions, it is necessary to make the most conservative, reasonable assumption regarding potential ultimate growth and development.



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CITY OF RIDGECREST
MASTER DRAINAGE PLAN

STUDY AREA
AND
ULTIMATE DEVELOPMENT BOUNDARY

FIGURE 3-1

3.3 GOALS AND OBJECTIVES

Based upon the express desires of the City of Ridgecrest and the experience of the project team, the following goals and objectives were established for this Master Drainage Plan.

1. To prevent inundation of all present and future inhabitable structures by an event with a return period of up to 100 years.

2. To control sheet flooding originating in the mountains to the south of the City.

3. To control sheet flooding due to runoff within the urban area.

4. To alleviate problems associated with nuisance urban water.

5. To develop a drainage system which does not rely extensively on streets and unimproved open swales for stormwater conveyance.

6. To develop regional detention sites, if feasibile, as opposed to many local detention basins.

7. To preserve remaining floodplain open space by utilizing dual-use stormwater management concepts (e.g., parks, floodways).

8. To prevent erosion and sediment deposition problems.

9. To develop a drainage system which is consistent with facilities at China Lake Naval Weapons Center.

10. To develop a stormwater management plan which combines both structural and nonstructural methods, if practical.

11. To coordinate data, methods and results with the Corps of Engineers, in order to arrive at a common solution for Bowman Wash.

12. To develop new base topographic mapping for the City of Ridgecrest.

13. To develop a plan which can be understood and modified, as necessary, by local engineers.

14. To develop a plan which, as a potential secondary benefit, provides opportunities for increased groundwater recharge.

3.4 LEVEL OF PROTECTION

Introduction

Planning and design of storm drainage facilities requires selection of the level of protection which those facilities are to afford. The level of protection is often expressed in terms of the frequency, or return period, of the storm for which the facilities are to prevent damage. This storm is referred to as the "design storm". Design storms for drainage facilities commonly have return periods varying anywhere from 2 years to over 100 years.

Selection of the design storm can have a significant impact on the size (and therefore on the cost) of required drainage facilities. As a result, the ideal selection process would include a typical engineering economic analysis to determine the level of protection providing the greatest net benefit, i.e. having the largest ratio of the total value of the damages prevented and benefits provided divided by the total project cost. Unfortunately, local drainage systems are rarely cost-effective by this criterion because of the relatively low value of the damages prevented on a frequent basis. Nonetheless, drainage facilities must still be provided by local agencies as an integral part of the infrastructure system. As a result, selection of a design storm is often a policy decision based on a number of non-technical factors including past design policies, recent flooding experience, public perceptions and desires, and practices of surrounding agencies.

This Section provides the City of Ridgecrest with the design storm criteria to be used in the storm drainage master plan and in future planning within the City. It includes background on present City design storm policies, comparisons with other flood control agencies and communities, and recommendations for the City of Ridgecrest.

It is noted that a design storm is comprised of several other characteristics in addition to return period, including precipitation depth, temporal distribution, and areal coverage. This Section only considers design storm level of protection. Other sections present a detailed discussion of recommended storm total rainfall, time distribution assumptions, and other design storm aspects required for hydrologic modeling.

Present Local Policy

The City of Ridgecrest does not currently have a formalized level of protection policy for new development. In general, drainage is handled in above-ground facilities including streets, swales or ditches. These facilities are normally sized to prevent damage to adjacent structures at a 50-year to 100-year level. Although drainage plans for new developments must be submitted to the City for review and approval, there are no standardized criteria by which these plans are evaluated, other than the desire to protect public safety and property.

The lack of drainage criteria and policies has arisen in part from the relative paucity of reliable hydrologic data in the Ridgecrest area. The City staff has been cautious about establishing strict drainage design guidelines when the basic data required to implement those guidelines (e.g., precipitation intensity-duration-frequency curves) is either not available or of questionable accuracy. This has been one of the driving forces behind the need to develop a drainage master plan for the community.

The City of Ridgecrest lies in the northeast corner of Kern County. Thus development occurring outside but adjacent to the City would have to comply with County drainage standards. These standards are outlined in a manual entitled "Kern County Subdivision Standards,"[1] which states the following level of protection policies:

1. Storm flows shall be carried and disposed of in such a manner that adjacent improvements will be free from 50-year or 100-year flooding, whichever is applicable.

2. Major waterways (drainage area over four square miles) shall provide 100-year capacity with freeboard.

3. Secondary waterways (drainage area between one and four square miles) shall provide 25-year capacity with freeboard, and shall provide 100-year capacity in the facility without freeboard or in alternate surface routes.

4. Local waterways (drainage area less than one square mile) shall provide 10-year capacity with freeboard, and shall provide 50-year capacity in the facility without freeboard or in alternate surface routes.

The above policies are generally consistent with the intent of current drainage planning in Ridgecrest, although they go a step further in establishing capacity requirements for specific categories of facilities. The aforementioned manual also provides approximate, generalized procedures by which design discharges should be computed. It is noted that the Kern County policies and procedures have been developed primarily for the valley area west of the Sierra Nevada Mountains, and thus may be less appropriate for use in the Ridgecrest area.

Purpose of Drainage Facilities

It is often convenient to identify four purposes for drainage facilities within a typical service area. Listed in order of descending priority, these are:

(a) Protection of life and safety
(b) Protection of residential and commercial property
(c) Prevention of nuisance conditions
(d) Enhancement of aesthetic conditions

These purposes are also listed in ascending order of acceptable risk with regard to failure. That is, society is willing to accept very little risk that a drainage facility will fail to protect life and public safety, but is willing to accept considerably more risk that a facility will occasionally not be able to mitigate nuisance problems or enhance aesthetic values. This leads to the condition in which a different design storm could be selected for each drainage purpose, with the design storm frequency increasing with increasing acceptability of the risk of failure. For example, facilities designed to protect life and safety could be designed with a 100-year level of protection (failure on average of once in 100 years), whereas facilities with the purpose of preventing nuisance conditions (e.g. closure of minor street intersections) could be designed with a 10-year level of protection (failure on average of once every 10 years).

Protection of life, safety, and property generally become planning concerns only after drainage areas have become large enough to generate significant runoff. Drainage within subdivisions does not usually meet this criterion due to the small areas involved; thus these localized areas are usually protected only for nuisance conditions. Major collection facilities (e.g. trunk storm drains) usually protect residential and commercial property from flooding, whereas facilities in the major natural drainage ways (e.g. channel improvements, dams) have the potential to affect life and safety.

Consider a small local area in a single subdivision. The area would commonly be served by an underground storm drain designed to carry the 10-year peak flow. The storm drain would operate with water surfaces below street grade and would discharge to a larger collection system. The occurrence of a large storm, say a 100-year storm, over this area would generate runoff in amounts exceeding the storm drain capacity. However, surplus runoff could be accomodated by flow in streets, surcharge capacity in the storm drain operating above the design head, and temporary surface storage, such that no significant threat to life or property would exist even for the 100-year event. Conversely, the surplus 100-year runoff associated with a large regional facility designed for 10-year capacity could be capable of inundating hundreds or thousands of acres, with substantial threat to life and property. Thus, use of a higher return period design storm is justified for the larger facility, in order to provide the same overall level of protection to all life and property within the service area.

Comparison with Other Agencies

Because selection of level of protection criteria is largely a policy decision, there is considerable variability among flood control and other jurisdictional agencies regarding design storm standards. However, most attempt to distingish between criteria applicable to regional versus local drainage systems; this is commonly done on the basis of drainage area.

The American Public Works Association publication "Urban Stormwater Management"[(2)] contains a brief discussion of design storm considerations. It indicates that the need to conform to the requirements of the National Flood Insurance Program has caused most communities to require that all inhabited structures be protected from the 100-year flood. Further, it has led most communities to delineate floodplains and design flood control facilities for major streams using the 100-year flood. There is less consistency in criteria for stormwater conveyance and storage facilities in residential, commercial and industrial areas. In 1980, APWA conducted a survey of 325 local public agencies, and found that "the design rainstorm most often specified for local drainage systems is the 10-year storm. This is followed in popularity by the 5-year, then the 2-year and 25-year rainstorms. For detention basins sizing, the 100-year design rainstorm is most used, followed by the 10-year and 25-year events." When facilities are designed for less than 100-year capacity, it is assumed that streets or other easement areas are capable of carrying enough flow to prevent damage to structures during the 100-year flood.

JMM has conducted its own design storm survey of public works agencies in California and the Southwest United States. The results are generally consistent with those reported above. Table 3-1 summarizes the results of the survey and shows recommended design storm recurrence interval as a function of drainage basin area. The table presents design storm criteria for up to three different levels of protection; none of the agencies researched had more than three categories. In cases where only one category is used, it is described under Level I; where two categories are used they are described under Levels I and II. It is noted that the definitions of "Level I," "Level II," or "Level III" may vary from community to community, so direct comparison of criteria on the basis of Table 3-1 alone should be avoided. Nonetheless, this table does allow for a quick review of design storm standards currently in use in other parts of the southwest and California.

In comparing current Ridgecrest level of protection criteria to the "common engineering practice" reflected in Table 3-1, two conclusions can be drawn. First, the performance standard of protecting all structures from 50-year to 100-year flooding is consistent with the general consensus of all communities. Second, most (but not all) agencies do establish facility capacity requirements in order to assure that the desired performance standards are met (e.g., storm drains for less than one square mile areas should have a 10-year capacity to prevent 50-year flooding of structures). It is noted that the Kern County standards are very much in line with the practices of other communities in the Southwest United States.

Recommended Design Storm Criteria

General design storm guidelines were formulated and presented to the City in Technical Memorandum No. 2. This resulted in adoption of the following specific design storm criteria.

1. All structures should be protected from flooding by the 100-year event. This is consistent with the requirements of the National Flood Insurance Program, and is more conservative than the Kern County standards for small local areas of less than one square mile.

2. Storm drains and channels serving individual subdivisions and local areas with tributary areas less than one square mile (640 acres) should be designed for the 10-year storm. Flows greater than the 10-year event should be carried safely in streets or other alternate flow paths.

3. Storm drains and channels serving intermediate areas with tributary areas between one and four square miles (640 and 2560 acres) should be designed for the 25-year storm. Flows greater than the 25-year storm should be carried safely in streets or other alternate flow paths.

4. Channels serving major areas with tributary areas greater than four square miles (2560 acres) should be designed for the 100-year storm.

TABLE 3-1

COMPARISON OF DESIGN STORM CRITERIA

Community	Level I		Level II		Level III	
	Area	Return Period	Area	Return Period	Area	Return Period
Kern County, CA	l.t.[a] 640 ac	10-yr	640-2560 ac	25-yr	g.t.[b] 2560 ac	100-yr
Ventura County, CA	Local	10-yr	Regional	50-yr		
Orange County, CA	l.t. 500 ac	10-yr	500-4000 ac	25-yr	g.t. 4000 ac	100-yr
Los Angeles Co., CA	All Regional	50-yr				
San Bernardino Co., CA	All Regional	100-yr				
Solano County, CA	l.t. 640 ac	10-yr	640-3200 ac	25-yr	g.t. 3200 ac	100-yr
Contra Costa Co., CA	l.t. 640 ac	10-yr	640-2560 ac	25-yr	g.t. 2560 ac Reg. Channels	50-yr 100-yr
Clark County, NV	Local	10-yr	Regional	100-yr		
North Las Vegas, NV	All Storm Drains	10-yr	All Channels	100-yr		
Peoria, AZ	All Storm Drains	2-yr	Retention Basins	10-yr		
Phoenix, AZ	Local	10-yr	All Channels	50-100-yr	Retention Basins	100-yr, 2-hr
Scottsdale, AZ	All Storm Drains	10-yr	All Channels	100-yr		
Albuquerque, NM	l.t. 320 ac	10-yr	g.t. 320 ac	100-yr		

[a] l.t. = less than
[b] [illegible] = gr[illegible]r th[illegible]

5. The design storm for diversions and for downstream facilities accepting diverted flows should be the 100-year event.

6. The design storm for sizing spillways for lakes and detention basins located on a main watercourse, where a threat of loss of life exists in the event of dam overtopping or failure, should be the probable maximum flood (PMF). Where only a threat of property damage exists, the 100-year design storm may be used. This policy would lead to a preference for designing off-channel rather than in-channel detention basins. All storage facilities should be sized for at least a 24-hour storm.

7. Facilities for major watercourses regulated by FEMA floodplain management policies should be designed for the 100-year event, regardless of the tributary drainage area.

During the hydrologic analysis, an evaluation of the number of potential facilities falling in each of the three "area" categories (local, intermediate and major) was conducted. At that time, the viability of the "intermediate" category was confirmed. It was found that several important facilities fall into this grouping, and that the drainage criteria should not be simplified by reducing the number of categories from three to two.

The recommended criteria are summarized below:

	Drainage Area	Design Storm Return Period
Small local areas	less than 640 acres	10 years
Intermediate facilities	640 to 2,560 acres	25 years
Major facilities, diversions, off-channel basin spillways	over 2,560 acres	100 years (24-hr for basins)
In-channel basin spillways	N/A	Probable Maximum

These criteria are intended to result in 100-year protection for all structures. They are consistent with the current policies of Kern County.

3.5 STORM CHARACTERISTICS

This section discusses the rationale for establishing the physical characteristics of the design storm to be used in the Ridgecrest Drainage Master Plan. These characteristics include rainfall depth, temporal distribution, areal distribution, and movement.

There are at least three commonly used approaches to determining appropriate design storm characteristics:

1. Select a specific, well-documented historical event.

2. Select standard depths and distributions developed by a water resources agency (e.g., NOAA, SCS).

3. Develop synthetic characteristics based either on local storm history or local agency design policies.

Due to the lack of local storm data, this Master Plan will make use of Approaches 2 and 3. These have the additional benefit of allowing development of storm data for a variety of return periods.

Past reports were reviewed to determine if there were standard, accepted storm characteristics developed previously for the Ridgecrest area. The City currently has no policy relating to this issue, and would refer engineers to the Kern County Subdivision Standards for hydrologic design data. This document does not provide storm characteristics for the desert areas of the County, but rather uses an approximate regional approach for estimating design discharges in the desert areas.

Previous Corps of Engineers reports were likewise not helpful in this regard. The original Detailed Project Report for Ridgecrest Wash (1969)[3] used the storm of September 30, 1932, in Tehachapi, California as a Standard Project Storm, and calibrated it to discharge-frequency relationship developed for gages in the Palm Springs area. The 1976 COE Floodplain Information Report[4] made no mention of a design storm, and developed design flows using a regional flood-frequency analysis based on gage records from Southeastern California. The COE Initial Appraisals of Ridgecrest Wash, El Paso Wash and Bowman Wash (1985, 1987)[5,6] used the FPI hydrology, so presented no new storm information.

After reviewing the available information, it was decided to use the design storm methodology outlined in the San Bernardino County Hydrology Manual[7]. This manual presents methodologies and data for developing synthetic design storm characteristics specifically for the desert areas of San Bernardino County. Because these desert areas are hydrologically similar to the Ridgecrest study area, it is believed that these methods are appropriate for use in this Master Drainage Plan. Following the procedures of the San Bernardino County Hydrology Manual as they relate to desert areas, design storm characteristics for Ridgecrest are derived in the following paragraphs.

Rainfall Depth

Precipitation depth-duration-frequency data was taken from the Precipitation-Frequency Atlas for the State of California prepared by the National Oceanic and Atmospheric Administration (NOAA)[8]. This atlas provides maps of precipitation depths for a variety of storm durations and frequencies. When using the NOAA Atlas to determine rainfall depths, it is appropriate to check the Atlas values against specific local raingage data, if available. This is particularly true since the Atlas was prepared in the early 1970's, and additional rainfall data is now available which could affect the rainfall depth-frequency relationship.

The California Department of Water Resources publication Rainfall Depth-Duration-Frequency for California[9] provides the most recent depth-duration-frequency data for gages in the State. The two recording rain gages closest to Ridgecrest are at Inyokern and Randsburg. Table 3-2 compares NOAA Atlas values to the actual gage data at these locations. This table shows that there is excellent agreement between the two sources for 6-hour depths, but the NOAA Atlas is consistently higher for 1-hour depths (27-32%) and for 24-hour depths (5-20%). Despite this consistent trend, the record lengths for these two gages are too short (8 years and 6 years) to be used as a basis for adjusting the NOAA regional rainfall analysis. It is concluded that the NOAA Atlas yields values which may tend to be conservative, but not overly conservative for design purposes.

As an additional test, NOAA Atlas data was checked against the long-term daily rainfall data collected by Los Angeles Department of Water and Power (LADWP) along the Los Angeles Aqueduct. The LADWP station closest to the Ridgecrest study area is located at Freeman, California. This gage has 58 years of daily rainfall data, but has not been analyzed statistically for depth-duration-frequency. An annual series of peak 24-hour rainfall depths was extracted from the record, and plotted to determine a graphical frequency relationship. The results are shown in Table 3-3, which also gives a comparision to NOAA Atlas values. The results are similar to those for the comparison to recording gages summarized in Table 3-2, in that the NOAA Atlas values are slightly higher (4-21%) than the actual rainfall data.

Using the figures and procedures from the NOAA Atlas, precipitation depths for a range of durations and frequencies were computed for the Ridgecrest study area. Values were selected to apply to the centroid of the tributary watershed. These results are shown in Table 3-4 for durations of 1 hour to 24 hours.

The NOAA Atlas does not provide a method for estimating rainfall depths for durations less than 1 hour. For this, the San Bernardino County Hydrology Manual was used. This manual provides a graphical approach for extrapolating the 1-hour rainfall depth to durations as short as 5 minutes and provides a specific modification for desert watersheds. This data is necessary to formulate the storm temporal distribution, and to apply the rational method to small subareas. Results of applying the San Bernardino County method are shown in Table 3-4 for durations of 5 minutes to 60 minutes.

Temporal Distribution

Because of the lack of local storm data, it was decided to develop a synthetic storm distribution using the "nested" storm approach described in the San Bernardino County Hydrology Manual and developed originally by the Corps of Engineers. The nested storm is a combination of peak intensities for all durations assembled into a single storm event. That is, the 100-year nested 24-hour storm distribution contains the 100-year, 5-minute intensity, the 100-year, 1-hour intensity, the 100-year, 6-hour intensity, etc. Furthermore, the intensities are stacked such that the peak

10-minute intensity contains the peak 5-minute intensity, the peak 15-minute intensity contains the peak 10-minute intensity, and so forth. The particular approach to combining these intensities is based on a standard SCS distribution, modified to fit local conditions. The strength of this method is that it will provide critical design discharges for small watersheds and large watersheds, regardless of the time of concentration.

The synthetic design storm distributions for 10-year, 25-year and 100-year events are given in Table 3-5. A graphical representation of the temporal 24-hour storm distribution is shown in dimensionless form in Figure 3-2.

Areal Extent

In addition to depth and distribution, it is necessary to specify the area covered by the design storms, and the variation of rainfall throughout the study area. The total cumulative watershed area tributary to all portions of the City of Ridgecrest is about 112 square miles. However, this overall area is comprised of ten essentially independent drainage basins varying in size from 0.5 square miles to 49.0 square miles. To be conservative for planning purposes, it was assumed that the design storm could be centered over and completely cover any of the drainage basins.

It is also necessary to compute average precipitation depths over the watershed area. This requires reducing the point-precipitation values in the NOAA Atlas based on the drainage area covered by the design storm. In general, the average precipitation depth decreases as the drainage area increases. This is defined by a depth-area relationship. Because of the lack of historical local storm data, the standard NOAA Atlas depth-area curve was used. The 24-hour depth-area reduction curve gives a reduction factor of 0.96 for the largest drainage basin watershed area of 49 square miles. Most of the major drainages within the study area are less than 10 square miles; the depth-area reduction factor for this size drainage area is about 0.99.

Because the reduction factors are minimal, and because most of the drainages of study are small, no depth-area reduction was applied to the point-precipitation depths derived previously. These factors are not significant when compared to the level of accuracy with which point values can be read from the maps and charts in the NOAA Atlas. Thus the rainfall depths in Table 3-5 were not adjusted.

Storm Movement

Typical summer thunderstorm movement generally follows tracks from the south or southeast, as the storms are generated in Baja California or the Gulf of Mexico. However, there is insufficient information available to determine rates of movement over the Ridgecrest study area. In light of this, it was assumed that the design storm is stationary over the watershed areas, and occurs over the entire area concurrently.

TABLE 3-2

COMPARISON OF DEPTH-DURATION-FREQUENCY DATA FOR NOAA ATLAS vs. ACTUAL GAGES

Duration (hr)	Return Period (yr)	Precipitation Depth (inches) Inyokern Gage	Inyokern NOAA	Randsburg Gage	Randsburg NOAA
1	100	0.84	1.11	0.96	1.22
6	10	1.19	1.13	1.34	1.30
6	25	1.45	1.36	1.63	1.60
6	100	1.83	1.70	2.05	2.00
24	10	1.54	1.77	1.89	2.00
24	25	1.91	2.38	2.31	2.75
24	100	2.40	2.90	2.91	3.50

TABLE 3-3

COMPARISON OF DAILY PRECIPITATION-FREQUENCY DATA AT FREEMAN, CA

Return Period (yr)	Precipitation Depth (inches) Gage	NOAA
10	1.85	2.25
25	2.52	2.80
50	2.94	3.05
100	3.40	3.55

TABLE 3-4

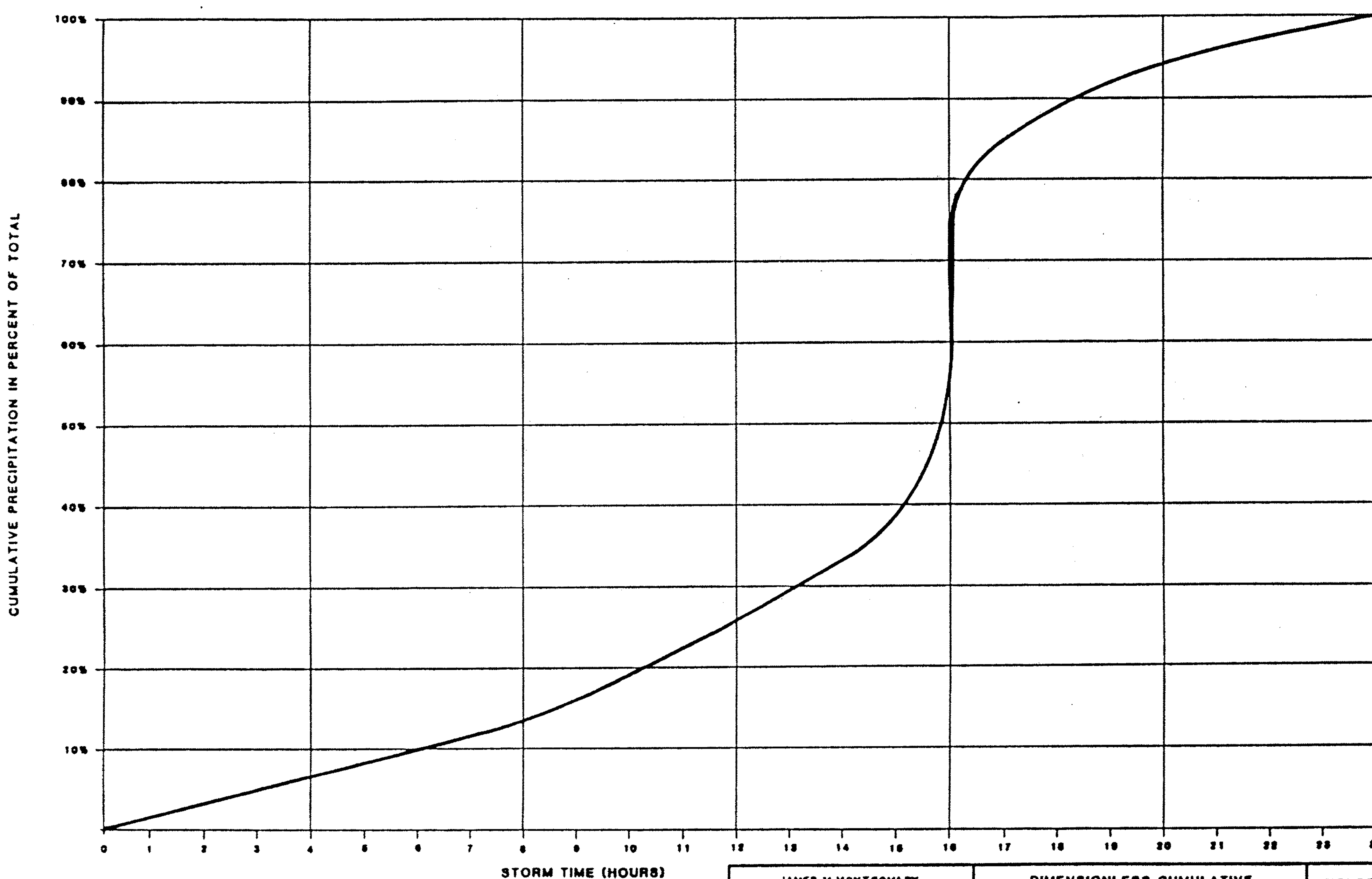
PRECIPITATION-DURATION-FREQUENCY DATA FOR RIDGECREST

Duration	Peak Precipitation Depth (inches) 10-year	25-year	100-year
5-min	0.36	0.42	0.55
10-min	0.44	0.52	0.68
15-min	0.50	0.59	0.76
30-min	0.62	0.73	0.95
45-min	0.93	0.82	1.07
60-min	0.76	0.89	1.17
2-hr	0.89	1.08	1.35
3-hr	1.00	1.18	1.53
6-hr	1.15	1.40	1.80
12-hr	1.50	1.90	2.45
24-hr	1.85	2.40	3.00

Table 3 - 5

SYNTHETIC STORM DISTRIBUTIONS
FOR RIDGECREST

Duration Hours	Duration Minutes	Incremental Precipitation (inches) 10-yr	25-yr	100-yr	
1	60	0.03	0.04	0.05	
2	120	0.03	0.04	0.05	
3	180	0.03	0.04	0.05	
4	240	0.03	0.04	0.05	
5	300	0.03	0.04	0.05	
6	360	0.03	0.04	0.05	
7	420	0.03	0.04	0.05	
8	480	0.03	0.04	0.05	
9	540	0.05	0.07	0.09	
10	600	0.05	0.07	0.09	
11	660	0.06	0.08	0.10	
12	720	0.06	0.08	0.10	
13	780	0.06	0.09	0.11	
14	840	0.06	0.09	0.11	
15	900	0.09	0.13	0.17	
	920	0.04	0.06	0.06	
	925	0.02	0.03	0.04	
	930	0.02	0.03	0.04	
	935	0.03	0.03	0.04	
	940	0.03	0.03	0.04	
	945	0.04	0.04	0.05	
	950	0.04	0.05	0.06	Peak one hou
	955	0.06	0.07	0.08	
16	960	0.08	0.10	0.13	
	965	0.36	0.42	0.55	
	970	0.04	0.06	0.08	
	975	0.02	0.03	0.04	
	980	0.02	0.03	0.04	
17	1020	0.09	0.10	0.11	
18	1080	0.06	0.08	0.11	
19	1140	0.06	0.08	0.11	
20	1200	0.05	0.07	0.09	
21	1260	0.03	0.04	0.04	
22	1320	0.03	0.04	0.04	
23	1380	0.03	0.04	0.04	
24	1440	0.03	0.04	0.04	
Total		1.85	2.40	3.00	



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DIMENSIONLESS CUMULATIVE DESIGN STORM DISTRIBUTION

FIGURE 3-2

3.6 LAND USE

One of the most important parameters required to develop the hydrologic model for the City of Ridgecrest study area is land use. Both existing and future land use must be identified to estimate the current and future quantities and rates of runoff generated by precipitation.

The following information was utilized to identify existing and ultimate land use in the City:

- New aerial photographs at a scale of 1" = 1,000'[10].
- Ridgecrest General Plan - Land Use Plan[11].
- Ridgecrest General Plan - Existing Land Uses, 1979.

Figure 3-3, Existing Land Use, and Figure 3-4, Ultimate Land Use, were developed from these sources. The various land use classifications are defined as follows:

Rural Residential - Includes areas with 0 - 0.4 dwelling units per acre (du/ac), which corresponds to one unit on a minimum of 2.5 acres and maximum of 20 acres. Also included in this classification is uninhabited land which has been cultivated or otherwise altered from its natural state.

Estate Density Residential - Single family housing with 0.4 - 1 du/ac.

Low Density Residential - Constitutes areas with 1 - 6 du/ac and includes duplexes and mobile homes.

Medium Density Residential - Includes areas with 6 - 25 du/ac.

Commercial - Designates all types of retail stores, offices, and apartments.

Civic and Institutional - Includes government and public agencies, health and welfare facilities, and the civic center site.

Industrial - Comprised of industrial and warehousing uses along with research and development activities involving hazardous materials.

Parks and Schools - This classification designates public parks, recreational facilities, and school areas.

Open Space - Includes any area which has been left in its natural state.

Several sites are currently under construction within the study area, requiring special land classification considerations for the Existing Land Use Plan. Because the areas had been significantly altered, they could no longer be classified as Open Space. However, very little or no structural improvements had been made. It was decided to classify these area according to the type of development being constructed, under the assumption that the projects would be completed as planned. This will result in conservative runoff estimates for these areas prior to completion of the developments.

Percent Impervious

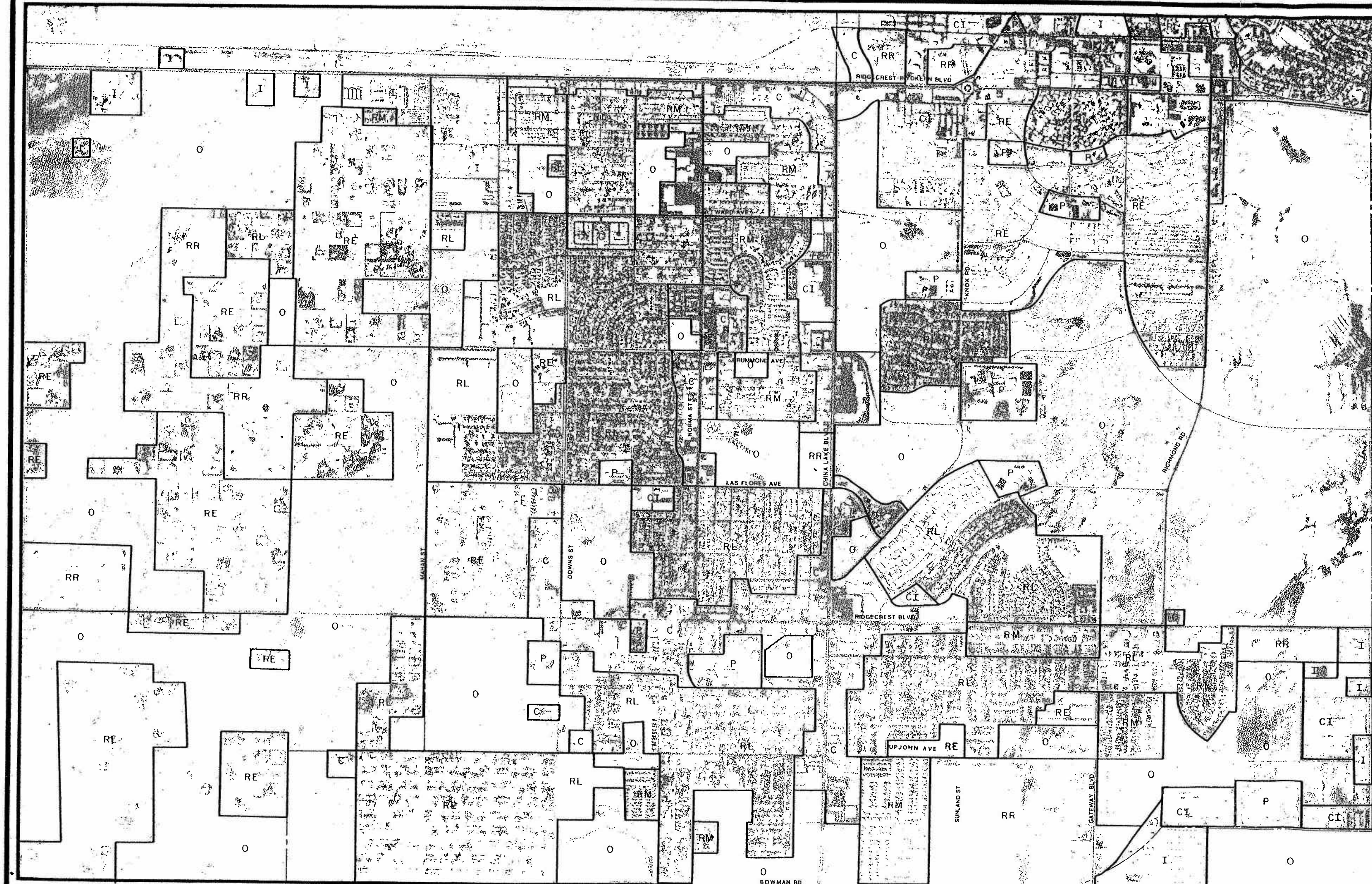
For stormwater modeling, the key factor which relates to land use is a parameter called "percent impervious". The portion of impervious area is important since all of the precipitation falling on impervious ground is converted directly to runoff. Since it is neither practical nor cost-effective to directly measure all impervious areas within the study area, a relationship was derived between the City of Ridgecrest land use classifications and typical percent impervious values.

The land use-percent impervious relationship was derived for the residential areas by assuming a typical size house for each classification including sidewalk and driveway, and dividing the resulting impervious area by the unit acreage for that classification. The fact that higher density housing normally contains smaller units than lower density housing was considered in this approach. A similar method of estimation was used to derive the non-residential classifications.

Table 3-6 presents the ranges of percent impervious values for use in the City of Ridgecrest Master Drainage Plan. It should be noted that the percent impervious values found in Table 3-6 reflect "directly connected impervious area" rather than "gross impervious area". Gross impervious area includes all impervious surfaces in the drainage area, while the directly connected impervious area includes only those impervious surfaces which drain directly to the stormwater collection system (gutters, drains, channels) without first passing over any pervious surfaces. For example, this factor excludes the portion of rooftops which drain to backyard lawns. The percent impervious values used in the hydrologic model reflect directly connected impervious area. Directly connected impervious area may represent as little as 50 percent of the gross impervious area for low density residential land uses, and as much as 100 percent for commercial and industrial areas.

A survey of water resources literature and previous JMM stormwater master planning projects was conducted to check the validity of the method used in determining the land use-percent impervious relationship. This survey is summarized in Table 3-7. A direct comparison between different communities can not be made due to differences in land use definitions and in development styles. However, a general comparison of percent impervious values based on similar densities and development styles showed that the relationship used for this study is typical for similar communities in the Western United States.

In certain cases, values outside the recommended range were adopted if warranted by unusual site-specific conditions. For example, an area of commercial land use which has a large amount of open space and landscaping would not be accurately represented by an impervious value of 80-90 percent as indicated in Table 3-6. In this case, a lower percent impervious value would be appropriate.



LEGEND

RR – RURAL DENSITY RESIDENTIAL (0-0.4 du/ac)
RE – ESTATE DENSITY RESIDENTIAL (0.4-1 du/ac)
RL – LOW DENSITY RESIDENTIAL (1-6 du/ac)
RM – MEDIUM DENSITY RESIDENTIAL (6-25 du/ac)
C – COMMERCIAL / OFFICE / APARTMENTS
I – INDUSTRIAL
CI – CIVIC AND INSTITUTIONAL
P – PARKS AND SCHOOLS
O – OPEN SPACE
—— - —— CORPORATE LIMIT

0 1 2 3 4000'

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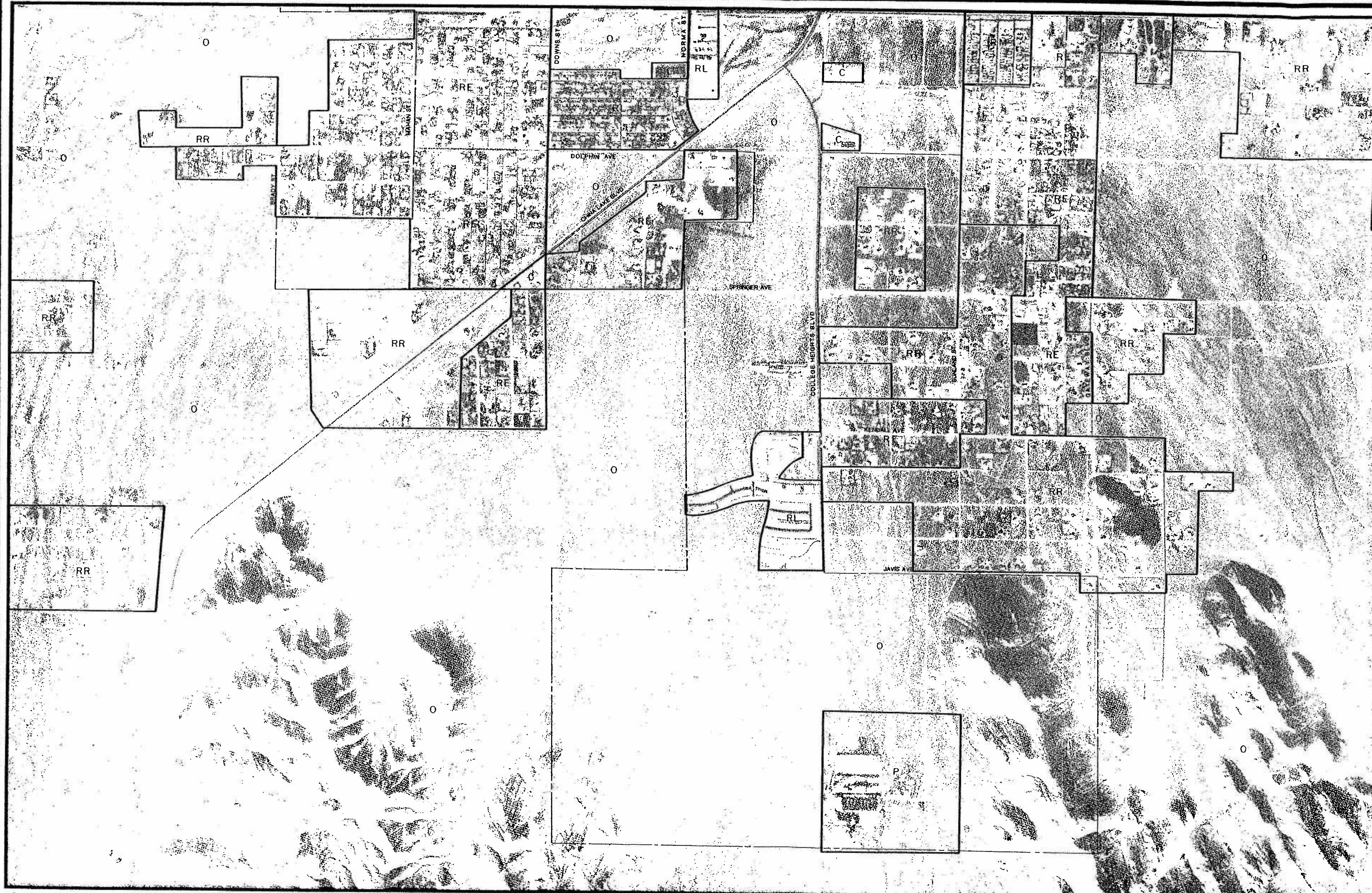
CITY OF RIDGECREST
MASTER DRAINAGE PLAN

EXISTING LAND USE

FIGURE 3-3A



LEGEND

RR – RURAL DENSITY RESIDENTIAL (0–0.4 du/ac)
RE – ESTATE DENSITY RESIDENTIAL (0.4–1 du/ac)
RL – LOW DENSITY RESIDENTIAL (1–6 du/ac)
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0 1 2 3 4000'

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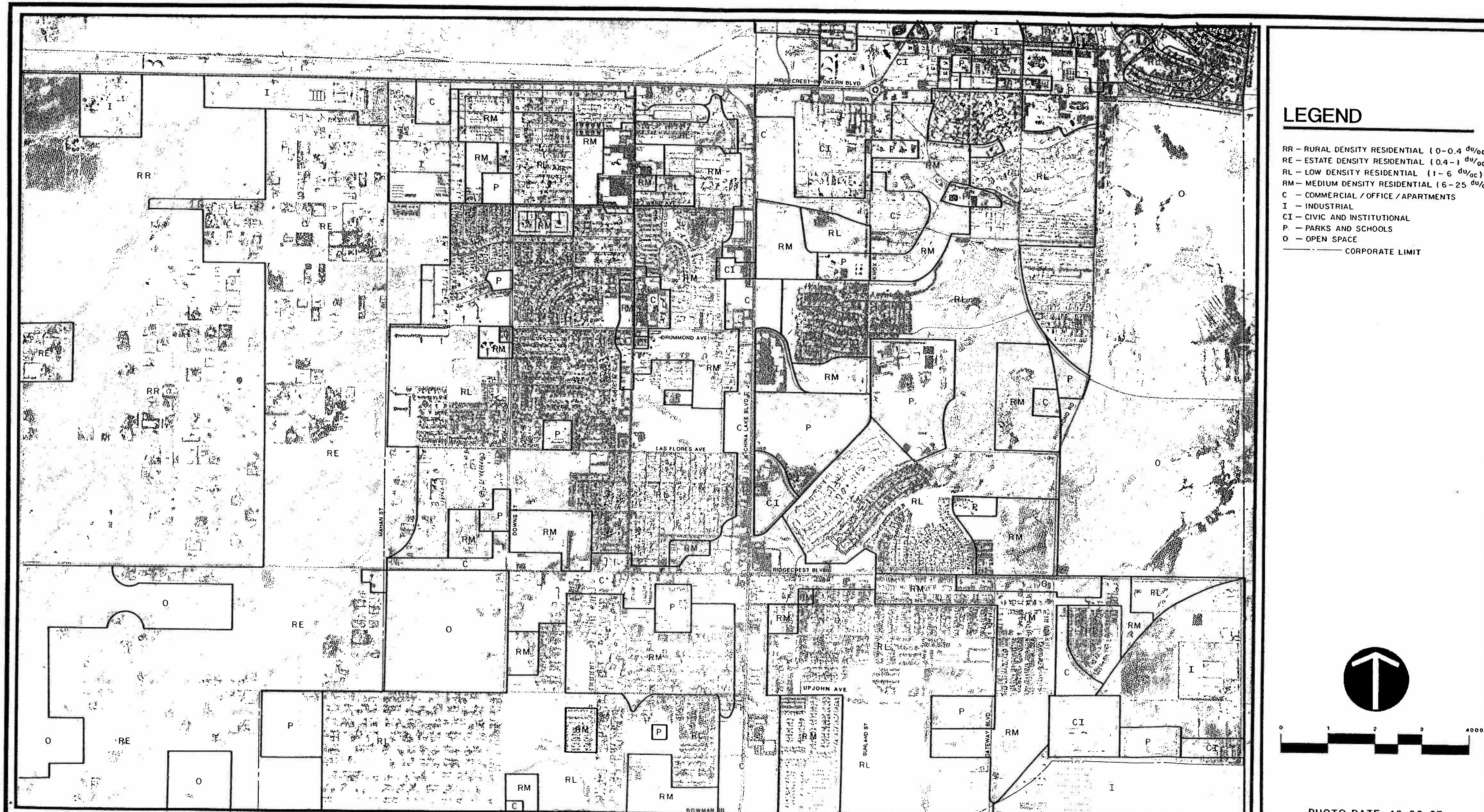
CITY OF RIDGECREST
MASTER DRAINAGE PLAN

EXISTING LAND USE

FIGURE 3-3B



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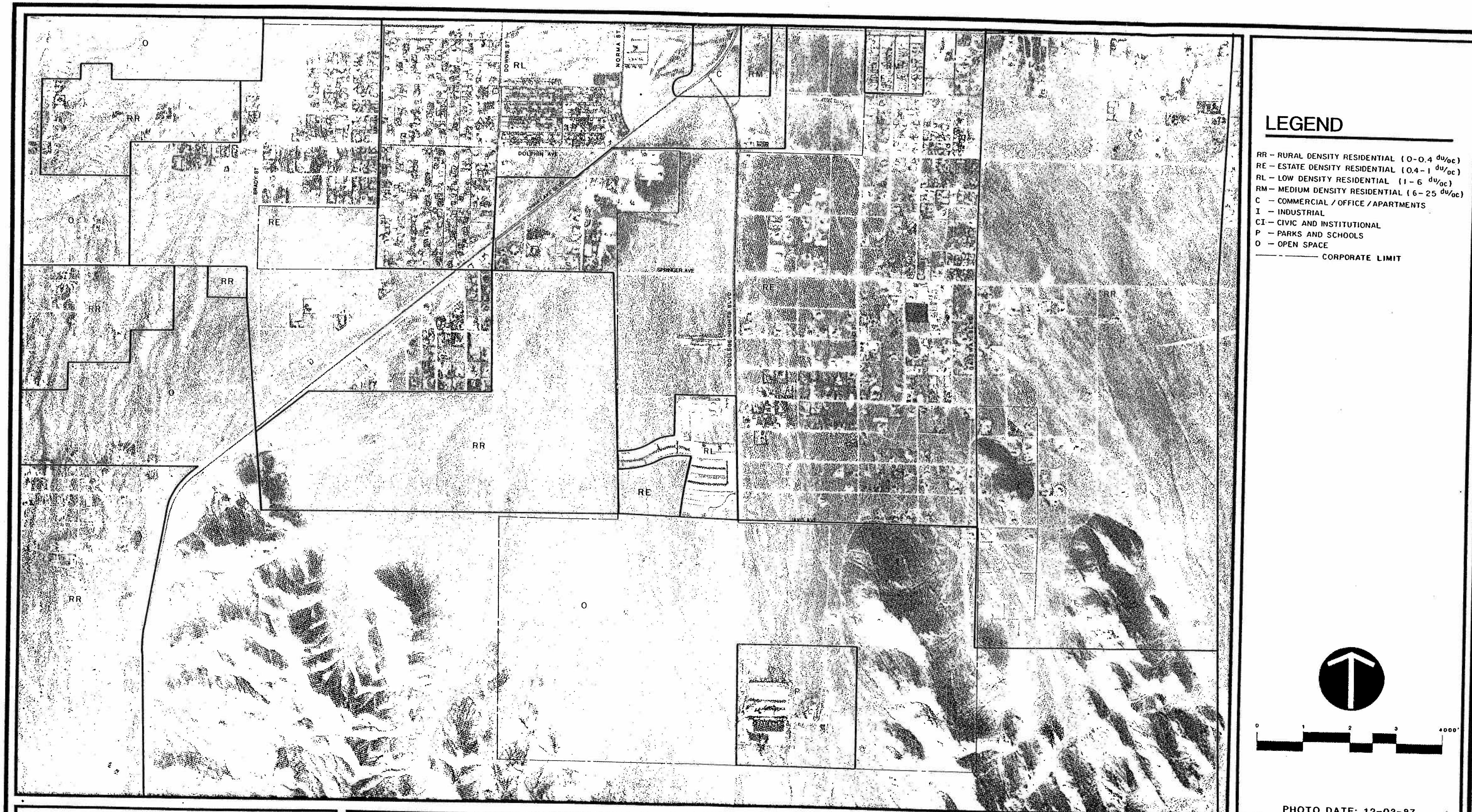
CITY OF RIDGECREST MASTER DRAINAGE PLAN

ULTIMATE LAND USE

FIGURE 3-4A



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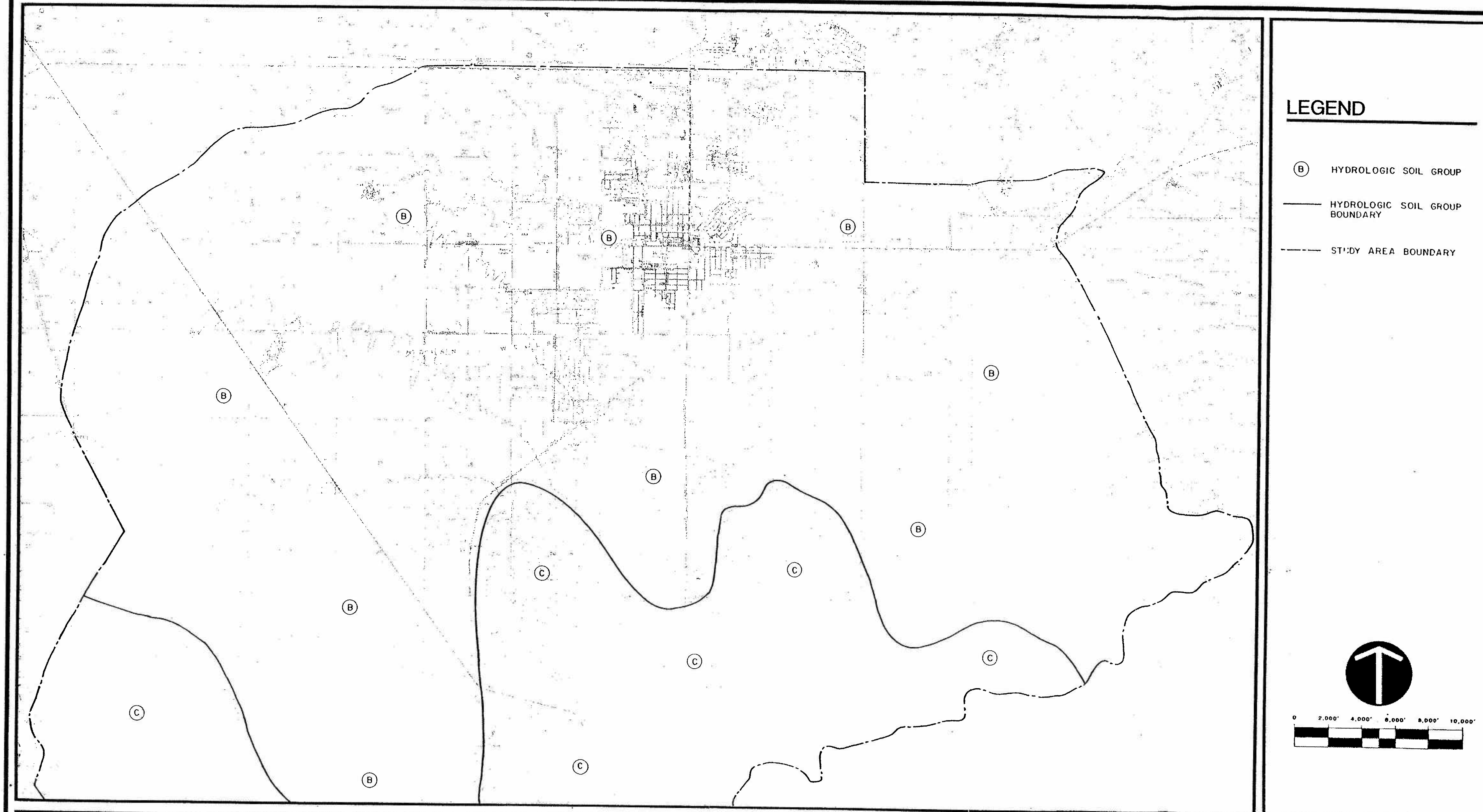
CITY OF RIDGECREST
MASTER DRAINAGE PLAN

ULTIMATE LAND USE

FIGURE 3-4B



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CITY OF RIDGECREST
MASTER DRAINAGE PLAN

HYDROLOGIC SOIL GROUP

FIGURE 3-5

TABLE 3-6

PERCENT IMPERVIOUS VALUES

Land Use	Percent Impervious
Rural Density Residential	5 - 10
Estate Density Residential	10 - 15
Low Density Residential	15 - 30
Medium Density Residential	30 - 50
Commercial	80 - 90
Industrial	80 - 90
Civic and Institutional	60 - 90
Parks and Schools	20 - 60
Open Space	0 - 5

TABLE 3-7

PERCENT IMPERVIOUS VALUES FOR VARIOUS LAND USE CLASSIFICATIONS

Study/Report	Source	Low Density Residential	Med. Density Residential	High Density Residential	Commercial	Intensive Use	Open Area
TR-55 Urban Hydrology	SCS	20-40	65	N/A	85	75	0
N. Las Vegas, NV M.P.	JMM	10-30	30-40	N/A	60	70-80	5
Clark County, NV M.P.	JMM	5-30	30-50	65-70	85	75	0
Peoria, AZ M.P.	JMM	22-47	47-65	N/A	85	72	0
Glendale, AZ M.P.	CDM	20-55	55-65	65	90	95	6
W. Valley City, UT M.P.	JMM	20-30	40	N/A	60-70	80	5
Orange County, CA Hydro Man.	OCFCD	15-36	70	70	75-95	95	0
Metro Denver	USGS	11-32	33-52	33-52	51-98	46	0

Explanation:
JMM = James M. Montgomery, Consulting Engineers, Inc.
SCS = Soil Conservation Service
CDM = Camp Dresser & McKee
USGS = U.S. Geological Survey
OCFCD = Orange County Flood Control District

3.7 SOILS

It is necessary for preparation of the hydrologic model to determine general soil types for hydrologic subareas. Soil types are a primary factor, along with land use and vegetative cover, in determining loss rate functions.

For purposes of hydrologic analysis, the wide variety of soil types is typically divided into four hydrologic soil groups as per the classic definition of the Soil Conservation Service (SCS). These soil groups are labeled A, B, C, and D, and have the following characteristics:

- Type "A" Soils: Have the lowest runoff potential and consist chiefly of deep, well to excessively drained sands or gravels.
- Type "B" Soils: Have a moderate rate of transmission or infiltration. They consist primarily of moderately deep to deep, moderately well to well-drained soils of moderately fine to moderately coarse textures.
- Type "C" Soils: Have a lower rate of infiltration by transmission, consisting mainly of soils with a layer which impedes the downward movement of water, or soil with moderately fine to fine texture.
- Type "D" Soils: Have the slowest infiltration rate. They are comprised primarily of clay soils with a high "swelling" potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material.

The primary source of soils information is the soil survey reports of the SCS. This information has been converted into a hydrologic soil group map by Kern County Department of Public Works, for use in hydrologic studies throughout the County[12].

Soils maps depicting the location of hydrologic soil groups (A,B,C, and D) in the master plan study area are presented in Figure 3-5. In areas consisting primarily of alluvial materials (i.e., most of the developed and developing areas), the predominant soil type is B. In the mountainous watersheds, the predominant soil type is C. The scale of the Kern County soil group map was not adequate to provide detailed information throughout the study area. Based on the available information, it was assumed that all alluvial soils in the study are group B, and all the mountainous areas are group C.

3.8 LOSS RATES

A key aspect of developing a rainfall-runoff model is the estimation of parameters describing the loss potential of the various subareas. Losses refer to the portion of the storm precipitation volume which is not available for producing runoff; i.e., they are instrumental in determining the "rainfall excess". Processes in the hydrologic cycle which contribute to precipitation losses include interception, soil infiltration, depression storage, initial wetting, and evapotranspiration. Estimation of representative loss rate parameters is often difficult due to the lack of actual data available. Thus, loss parameters are frequently estimated by referring to general relationships with soil type, vegetative cover, and land use. They are also a typical model calibration parameter.

In this study, loss rate parameters have been estimated using the commonly accepted approach of the Soil Conservation Service. In this approach, soils are characterized by a Curve Number (CN), which relates all of the various loss processes to soil type (or hydrologic soil group), vegetation cover (type and density), and land use. As a result, CN can be easily estimated by an experienced hydrologist, whereas derivation of individual loss rates may be more difficult. CN values for various soil types are documented in a variety of hydrologic references, including the San Bernardino County Hydrology Manual which contains a special section on desert conditions.

To estimate CN, it is necessary to know the soil group, cover, and conditions (generally the cover density) of each subarea. Soil groups are either B or C, as discussed in the previous section. In the undeveloped areas, cover was assumed to consist of desert brush (mesquite, creosote, etc.), with fair conditions (50% vegetation cover) in the alluvial areas and poor conditions (25% vegetation cover) in the mountainous areas. In the developed portions of the study area, cover was assumed to consist of urban landscaping (lawns, plantings, etc.). Cover conditions were estimated for each subarea by inspection of recent aerial photographs, and in general were determined to be fair (50% - 75% vegetation cover) in the higher density residential and commercial areas, and poor (25% - 50% vegetation cover) in the rural residential areas. Based on these criteria, the CN values listed in Table 3-8 were selected.

Table 3-8

CURVE NUMBERS

Hydrologic Soil Group	Vegetation Cover	Condition	Curve Number
B	Desert Brush	Fair	80
C	Desert Brush	Poor	88
B	Urban Landscape	Good	56
B	Urban Landscape	Fair	63

3.9 HYDROLOGIC MODEL

Introduction

The primary design information required for evaluation and sizing of drainage facilities consists of peak discharges and flood hydrographs; that is, hydrologic data. Thus it is important that a proper method be selected for computing flows and hydrographs. This method should yield accurate results, be consistent with currently accepted hydrologic practice, and should be capable of being duplicated. Further, because the method may be used by the City of Ridgecrest staff and local engineers to perform future planning and design studies, the method should be readily understood by and available to the engineering community.

Previous drainage planning studies in the City have utilized the familiar "Rational Method" to compute peak discharges. In its simplest form, this method is represented by the expression $Q = CiA$, where Q is the peak flow in cfs, C is a runoff coefficient related primarily to land use, i is the rainfall intensity in inches/hour for a storm duration approximately equal to the time of concentration of the drainage basin, and A is the drainage area in acres. The rational method is well-suited for use with hand-calculation applications, although there are also computer programs available which allow for simultaneous analysis of a network of subareas. The primary drawback of the rational method is that it generates a peak flow only, and does not predict the entire flood hydrograph (shape and volume) required for analysis of storage facilities. However, there are "modified rational methods" used by certain agencies which attempt to generate a synthetic hydrograph shape (e.g., triangular) to augment the calculated peak flow and allow for approximate analyses of storage facilities. The rational method is generally considered to be an adequate analytical method only for small areas (e.g., less than one square mile).

In contrast, there are several commonly used approaches for performing hydrologic analyses which simulate the rainfall-runoff process in considerably more detail than the rational method. These methods have gained greater popularity with the expanding availability of computer services. They are all similar in that they are composed of five basic components:

1. Division of the total drainage area into reasonably homogeneous subareas or subbasins
2. Definition of the depth, temporal distribution, and areal extent of design storm precipitation
3. Determination of watershed losses
4. Transformation of rainfall into runoff
5. Routing of runoff through the drainage network

The methods differ in the level of complexity with which they treat the various model components. They all have the advantage, compared to the rational method, of computing full flood hydrographs and of being applicable to larger study areas.

Based upon the level of detail required by this master plan study, the size of the study area, and the desire to evaluate storage alternatives, it is considered necessary to adopt a rainfall-runoff approach rather than a rational method approach. A complete discussion of all the currently available hydrologic methods in this category is beyond the scope of this report. All of the common methods have been incorporated into one or more computer programs to facilitate their application. Thus, selection of a hydrologic methodology is equivalent to selection of a stormwater modeling program.

Selection of Computer Model

There are several good computer packages currently available to perform stormwater management computations. Many are generalized programs which are designed to be applied to a broad range of conditions; others have been developed specifically for certain study areas (e.g., particular counties or cities).

Utilizing JMM's previous experience in stormwater planning studies, the following programs were "short-listed" for further consideration:

HEC-1 (Flood Hydrograph Package) - developed and supported by the Hydrologic Engineering Center of the U.S. Army Corps of Engineers

SWMM (Storm Water Management Model) - developed by Water Resources Engineers and supported by the Environmental Protection Agency

ILLUDAS (Illinois Urban Drainage Area Simulator) - developed by the Illinois State Water Survey

TR-20 (Project Formulation - Hydrology) - developed and supported by the U.S. Soil Conservation Service (SCS)

FLOODSB - developed and supported by Advanced Engineering Software (AES) specifically for San Bernardino County, California

These five programs were evaluated on the basis of 11 criteria. Six criteria were related to technical factors (hydrograph generation method, ability to model urban areas, data requirements, ability to size facilities, input/output format, and flexibility in modeling). Five other criteria reflected administrative concerns (cost of application, ease of training City staff, quality of documentation, availability of program support, and PC compatibility). The results of the program comparison are summarized in Technical Memorandum No. 2.

Based on a subjective evaluation, it appeared that HEC-1 and FLOODSB are the two programs best suited to the modeling needs of the Ridgecrest Master Drainage Plan. SWMM was not recommended due to its high cost of implementation and difficulty of interpretation by non-hydrologists. There are no real advantages to using TR-20 because the recent versions of HEC-1 have incorporated the SCS hydrologic methods as subroutines, and HEC-1 is easier to use and better supported than TR-20. ILLUDAS was rejected primarily because of its reliance on the rational method for all watershed sizes and its relative lack of documentation and support.

Considering the relative comparisons, HEC-1 was selected for the hydrologic analyses for the Ridgecrest Master Drainage Plan. This decision was made primarily because of the large number of subareas to be modeled (over 100). Initial data preparation efforts demonstrated that the FLOODSB program was too inefficient to manipulate for such a large data set. HEC-1 input parameters were selected to simulate the desert area routine of the FLOODSB program as closely as possible.

Chapter 4

CHAPTER 4

HYDROLOGY

4.1 INTRODUCTION

This chapter describes the methods used in the hydrologic analysis for the Ridgecrest Drainage Master Plan. Efforts to calibrate the hydrologic model results to local peak discharge data are described. Finally, results of the hydrologic analysis are summarized.

The overall objective of the hydrologic analysis was to develop peak discharges and hydrograph volumes for use in design of drainage facilities. In order to quantify present drainage problems, existing discharges were estimated. For facility planning, ultimate development hydrology was formulated. Hydrologic information has been prepared for 10-year, 25-year, and 100-year events.

Prior to describing the hydrologic approaches utilized, the existing drainage system will be defined in order to place the computed design flows in proper context.

4.2 EXISTING FACILITIES INVENTORY

An inventory of existing drainage facilities in the Ridgecrest study area was prepared in order to document the extent and effectiveness of the current drainage system. This inventory was prepared through field reconnaissance and through inspection of the new 1"=200' topographic maps. All drainage facilities -- bridges, culverts, catch basins, and channels -- were verified in the field.

The existing facilities inventory was prepared for two reasons:

1. To determine the impact of these facilities on hydrologic drainage patterns (e.g., through ponding or diversions).

2. To evaluate the ability of the existing drainage system to handle design flows.

Because of these objectives, facilities were documented in the watershed upstream of Ridgecrest as well as within the City itself. In particular, culvert crossings in Highway 395, Old Highway 395, and the Southern Pacific Railroad southwest of Ridgecrest were evaluated in order to determine the effective drainage area and the contributing flows from the upstream watershed.

The locations, types and sizes of drainage facilities, as determined by field inspection, are shown in Figures 4-1 and 4-2, and in Table 4-1. Most of the culvert drains and other minor facilities were documented in the field by City of Ridgecrest personnel. It can be seen that there are few major drainage improvements in the study area; in particular, there are no major storm drains serving the urban area. Rather, runoff is conveyed primarily in

TABLE 4-1

EXISTING FACILITIES INVENTORY

Facility ID(1)	Location	Type(2)	Approx. Length (ft)	Capacity (cfs)
1	SPRR	68' w x 4.3' h Supported Bridge	20	1,550
2	SPRR	14.5' w x 4.0' h Bridge	20	620
3	Old Hwy 395	24" CMP Culvert	40	25
4	Hwy 395	24" CMP Culvert	100	30
5	Hwy 395	54" CMP Culvert	100	215
6	Hwy 395	54" CMP Culvert	100	240
7	Hwy 395	2-42" CMP Culvert	80	150
8	Hwy 395	3-60" CMP Culvert	100	920
9	Hwy 395	3-42" CMP Culvert	80	225
10	Hwy 395	42" CMP Culvert	100	105
11	Hwy 395	10' w x 8' h RCB Culvert	100	1,270
12	Hwy 395	42" CMP Culvert	100	105
13	Hwy 395	48" CMP Culvert	100	130
14	Hwy 395	48" CMP Culvert	80	105
15	Hwy 395	2-24" CMP Culvert	80	45
16	China Lake Blvd.	24" RCP Culvert	60	35
17	China Lake Blvd.	24" CMP Culvert	60	23
18	Norma St.	2-24" CMP Culvert	50	35
19	China Lake Blvd.	3-24" CMP Culvert	60	70
20	China Lake Blvd.	2-30" CMP Culvert	60	65
21	Ridgecrest Blvd.	36" CIP, 18" CMP Culvert	50	110
22	Ridgecrest Blvd.	15" CMP Culvert	50	11
23	Ridgecrest Blvd.	12" CMP Culvert	50	5
24	Ridgecrest Blvd.	15" CMP Culvert	50	9
25	Ridgecrest Blvd.	12" CMP Culvert	50	4
26	Ridgecrest Blvd.	18" CMP Culvert	50	17

Table 4-1
Existing Facilities Inventory
(Cont'd.)

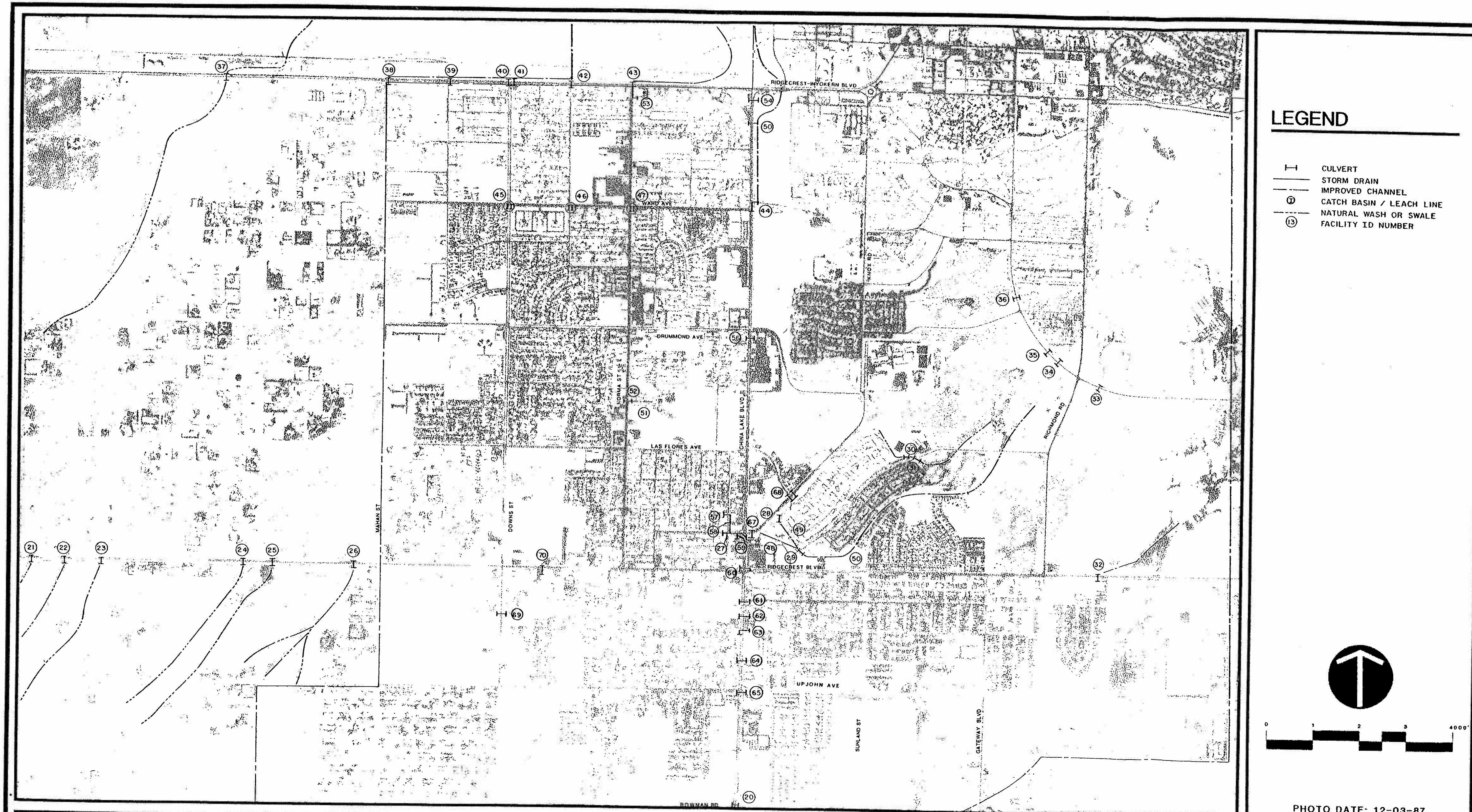
Facility ID(1)	Location	Type(2)	Approx. Length (ft)	Capacity (cfs)
27	French Ave.	30" CMP Drain	500	N/A
28	Unpaved Road	36" CMP Culvert	20	90
29	Gold Canyon Rd	3-84" CMP Arch Culvert	40	450
30	Footpath	36" CMP Culvert	20	25
31	Gold Canyon Rd	30" CMP Culvert	60	35
32	Ridgecrest Blvd.	2-30" CMP Culvert	60	75
33	Pilot Plant Rd	2-24" CMP Culvert	50	50
34	Lauristen Rd	24" CMP Culvert	50	30
35	Lauristen Rd	24" CMP Culvert	50	30
36	Lauristen Rd	24" CMP Culvert	50	30
37	Inyokern Rd	5-36" RCP Culvert	80	310
38	Inyokern Rd	24" x 36" CMP Drain	80	35
39	Inyokern Rd	36" x 48" CMP Drain	80	70
40	Inyokern Rd	2-24" x 30" CMP Drain	80	165
41	Inyokern Rd	24" x 30" CMP Drain	80	30
42	Inyokern Rd	36" x 48" CMP Drain	80	70
43	Inyokern Rd	18" CMP Drain	80	12
44	China Lake Blvd.	18" RCP Drain	192	N/A
45	Ward/Downs	2 Leach Lines	80	N/A
46	Ward/Sierra View	2 Leach Lines	60	N/A
47	Ward/Norma	2 Leach Lines	80	N/A
48	French Ave.	20'w x 5'd x 2:1 ss Channel	850	1,620
49	French Ave.	10'w x 5'd x 2:1 ss Channel	1,250	860
50	Varies	20'w x 7'd x 3:1 ss Channel	1,800	4,570
51	Norma Street	15'w x 2'd x 3:1 ss Channel	550	90
52	Norma Street	3-12" CMP Drain	80	N/A
53	Norma Street	2-16" CMP Drain	80	N/A
54	China Lake Blvd.	12" CMP Drain	100	N/A

Table 4-1
Existing Facilities Inventory
(Cont'd.)

Facility ID(1)	Location	Type(2)	Approx. Length (ft)	Capacity (cfs)
55	China Lake Blvd.	12" CMP Drain	100	N/A
56	China Lake Blvd.	24" x 40" CMP Drain	100	N/A
57	Balsam Street	24" x 36" CMP Drain	500	N/A
58	Balsam Street	24" x 36" CMP Drain	80	N/A
59	French Avenue	24" x 36" CMP Drain	50	N/A
60	China Lake Blvd.	12" RCP Drain	250	N/A
61	China Lake Blvd.	22" x 6" RCB Drain	200	N/A
62	China Lake Blvd.	22" x 6" RCB Drain	200	N/A
63	China Lake Blvd.	22" x 6" RCB Drain	200	N/A
64	China Lake Blvd.	22" x 6" RCB Drain	200	N/A
65	China Lake Blvd.	Unknown Drain	200	N/A
66	College Heights Blvd.	4-24" x 40" CMP Culvert (3 plugged)	50	140 (Unobstructed)
67	French Avenue	12" CMP Drain	100	N/A
68	French Avenue	2-12" CMP Drain	100	N/A
69	Downs Street	24" CMP Drain	60	N/A
70	Ridgecrest Blvd.	Unknown Drain	50	N/A

(1) Refers to ID number on Figures 4-1 and 4-2

(2) CMP Culvert = corrugated metal pipe
RCP = reinforced concrete pipe
CIP = cast iron pipe
RCB = reinforced concrete box
w = bottom width; d = depth; ss = side slope



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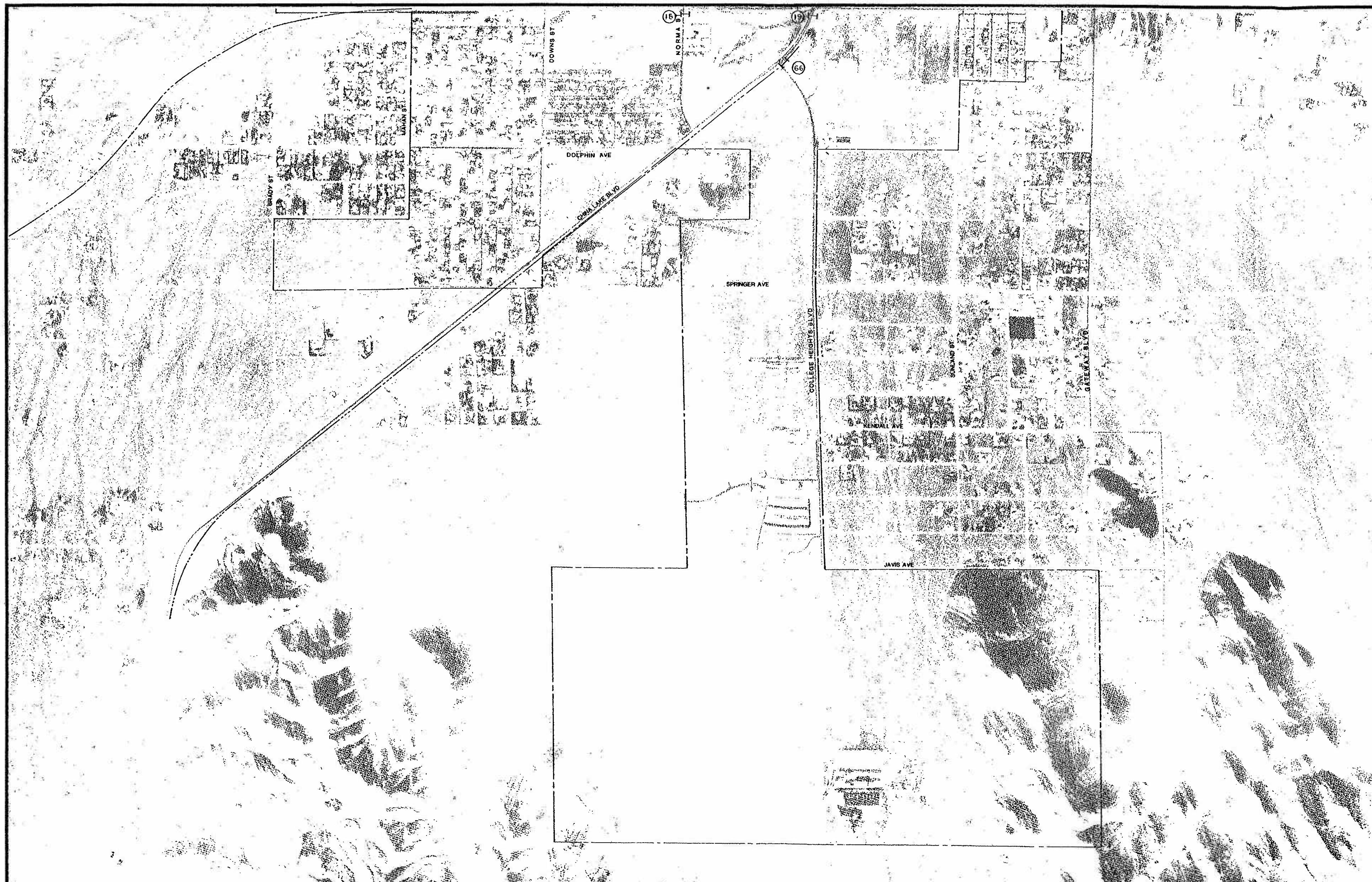
CITY OF RIDGECREST
MASTER DRAINAGE PLAN

EXISTING DRAINAGE FACILITIES

FIGURE 4-1A



LEGEND

- CULVERT
- STORM DRAIN
- IMPROVED CHANNEL
- CATCH BASIN / LEACH LINE
- NATURAL WASH OR SWALE
- FACILITY ID NUMBER

0 1 2 3 4000'

PHOTO DATE: 12-03-87

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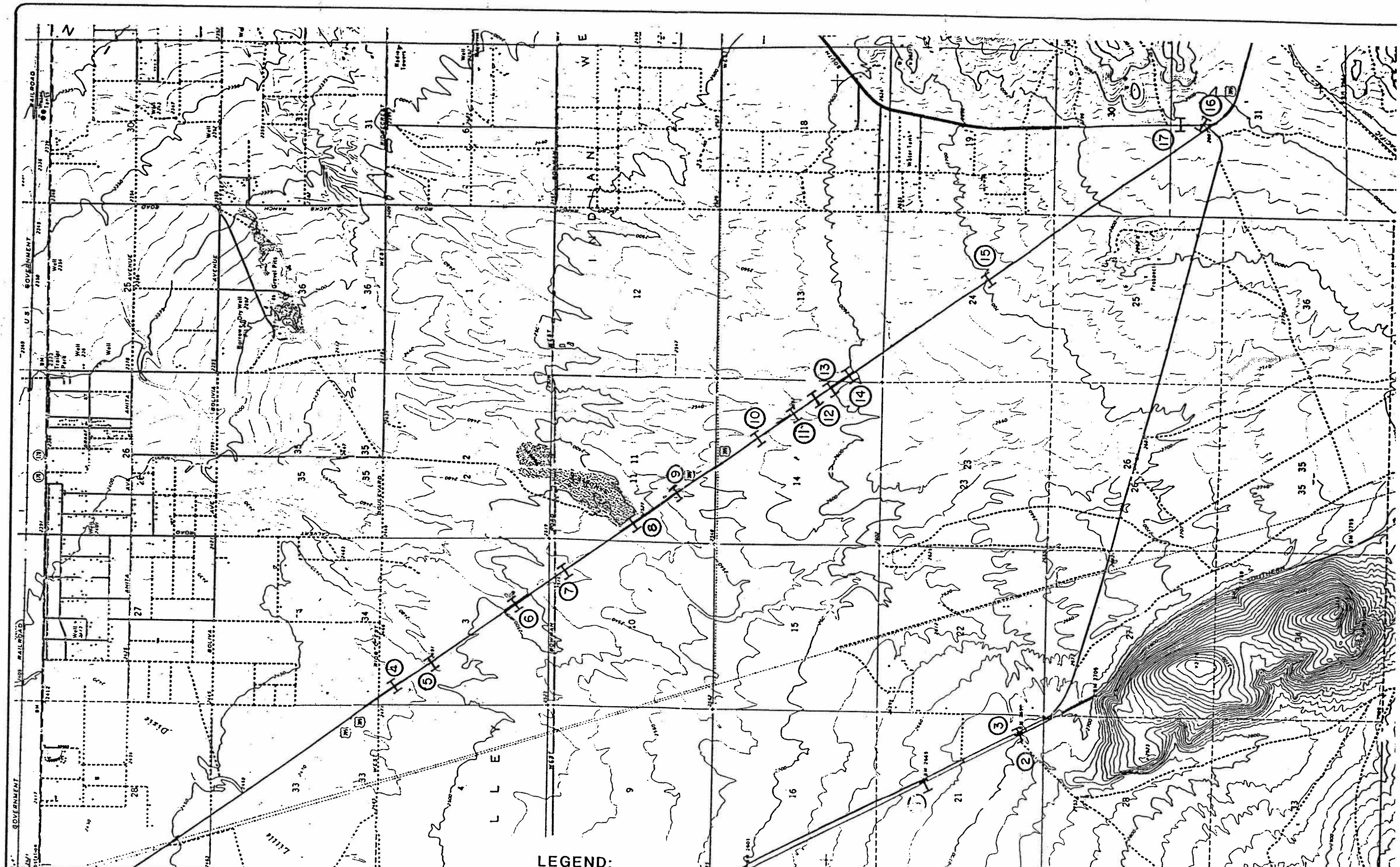
CITY OF RIDGECREST
MASTER DRAINAGE PLAN

EXISTING DRAINAGE FACILITIES

FIGURE 4-1B



LEGEND:

⊢⊣ — CULVERT

①-FACILITY I.D. NUMBER

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EXISTING DRAINAGE FACILITIES
IN TRIBUTARY WATERSHED

FIGURE 4-2

streets and open swales and channels. The main drainage facilities are culvert crossings of roadways (e.g., in Highway 395, China Lake Blvd., Ridgecrest Blvd., and Inyokern Road).

Ridgecrest has recently experimented with a system of catch basins and leach lines to manage nuisance flows. In a pilot project, bubble-up catch basins were installed at three intersections on Ward Avenue. These catch basins were connected to leach lines (a gravel trench approximately 4 feet wide and 10 feet deep, surrounded by filter fabric), designed to percolate nuisance urban runoff and minor storm flows. Although their primary function is not storm drainage mitigation, the Corps of Engineers has estimated that this system provides approximately 25-year capacity for stormwater retention(14). The pilot project on Ward Avenue has proven successful, and the City plans to expand the catch basin/leach line system to Las Flores Avenue when funds become available.

The only improved channel reach in Ridgecrest begins at the intersection of French Avenue and China Lake Blvd., and runs northeasterly toward Satellite Lake. The channel is an excavated, graded facility which is unlined. There are a number of graded swales along roadways which act to intercept and convey stormwater. Because these are in areas without curb and gutter improvements and thus are probably not permanent improvements, they have not been included in this inventory.

Capacities of existing facilities have been computed using the Texas Hydraulic Systems (THYSYS) program(15), assuming normal depth flow in channels and inlet control for culverts in elevated roadways and railroad embankments. Channel capacities include no freeboard allowance (i.e., bank-full capacity). Catch basins have not been inventoried or analyzed. They are considered to be beyond the master plan level of detail. Facility capacities are tabulated in Table 4-1. Capacities have not been estimated for minor culvert drains or cross drains which primarily handle nuisance flows.

Detailed descriptions of minor culvert drains prepared by City personnel are included as Appendix B for reference.

4.3 HYDROLOGIC METHODS

This section presents the data and methods used to compute peak discharges and flood hydrographs for the planning of drainage facilities. As discussed in Chapter 3, Planning Criteria, the HEC-1 Flood Hydrograph Package(13) computer program was used to simulate the rainfall-runoff process. The primary inputs to this program are described below. Much of this information is summarized from Chapter 3.

Hydrologic Subareas

The Ridgecrest study area and its tributary watershed were subdivided into reasonably homogeneous hydrologic subareas. A total of 138 subareas were used, varying in size from 0.041 square miles (26 acres) to 21.7 square miles. The larger subareas were used in the outlying, mountainous drainage area which is beyond the ultimate urban development boundary (See Figure 3-1). The smaller subareas were used in the presently developed urban area.

Subarea boundaries and flow directions are shown in Figure 4-3. Subarea concentration points were selected so as to provide discharges at key points for design of drainage facilities, as well as points of natural flow concentration. The best available mapping (1"=200' topography in the incorporated area, 1"=2,000' topography in the outlying area) was used to define subarea boundaries, and was the basis for measuring subarea areas.

Subareas were grouped into ten drainage basins, each having a single outfall point. These drainage basins are defined below.

Drainage Basin	Identifier	Area (sq mi)	Description
El Paso Wash	EPW	49.02	Area tributary to the El Paso Wash culvert in Inyokern Rd, including the area south of Hwy 395
Ridgecrest Wash	RCW	10.44	Area tributary to Inyokern Rd and Downs St
Inyokern Road	IK	0.89	Area tributary to Inyokern Rd, between Downs St and China Lake Blvd
Drummond Ave Wash	DAW	0.46	Area tributary to Drummond Ave and its outfall channel, between Norma St and Knox Rd
West China Lake Wash	WCL	2.19	Area tributary to West China Lake Channel (parallel to Sunland St), from Downs St to Pilot Plant Rd
Church Street	CH	1.13	Area tributary to Ridgecrest Blvd, generally centered on Church Street
Upjohn Avenue	UJ	1.34	Area tributary to Ridgecrest Blvd and Richmond Rd, generally centered on Upjohn Ave
College Heights Wash	CHW	10.46	Area tributary to China Lake Blvd and College Heights Blvd, draining the mountains to the south

Drainage Basin	Identifier	Area (sq mi)	Description
East China Lake Wash	ECL	19.73	Area tributary to Ridgecrest Blvd from Richmond Rd to the County Line, draining the alluvial apron to the southeast
Bowman Wash	BW	48.13*	Area tributary to Bowman Rd and Gateway Blvd, plus the outfall flowpath northeast to Mirror Lake

* Includes area of tributary drainage basins CH, UJ, CHW, and ECL

Within each drainage basin, subareas were numbered in an upstream to downstream sequence using a three-digit numeral. Increments of 10 were used in subarea numbering to allow for future subdivision of subareas if desired. The full subarea identifier consists of a combination of the drainage basin code and the subarea number. Thus subarea RCW050 is the fifth subarea in the computation sequence for the Ridgecrest Wash drainage basin.

Storm Characteristics

The design storm is a 24-hour event with a sharp peak intensity typical of desert thunderstorms. The precipitation-duration-frequency data (rainfall depths for various storm durations and frequencies) was taken from the NOAA Atlas for California (Table 3-4). The temporal distribution of rainfall was adopted from the San Bernardino County Hydrology Manual. This is a nested distribution in which the 24-hour event contains the 5-minute peak intensity, the 30-minute peak intensity, the 1-hour peak intensity, etc. The distribution is presented in Figure 3-2 and Table 3-5. A uniform storm depth with no depth-area adjustment was applied concurrently to the entire 111 square mile watershed. Isolated local storm events and storm movement were not modeled. This approach produced critical events for each of the individual drainage basins, all of which are less than 50 square miles. Storms with recurrence intervals of 10, 25, and 100 years were simulated in order to generate hydrographs with the same return periods.

Loss Rates

Watershed losses were computed using the SCS Curve Number method, adjusted for percent imperviousness. Curve Numbers for each soil type occurring in the watershed were estimated using Figure 3-5 and Table 3-8; these Curve Numbers were input directly to HEC-1 for each subarea. Table 3-6 was then used to estimate a percent imperviousness factor for each subarea as a function of land use. Figures 3-3 and 3-4 were used to determine a weighted average land use and percent imperviousness value for each subarea under both existing and ultimate development conditions. The Curve Number was adjusted between existing and ultimate development conditions for subareas which converted from open land to urban development, based on the data in Table 3-8.

The impact of antecedent moisture condition assumptions on loss rates and runoff is discussed in Section 4.4 Model Calibration.

Unit Hydrograph

The unit hydrograph concept was used to convert rainfall to runoff in the HEC-1 model. HEC-1 contains several methods of performing unit hydrograph computations (SCS Method, Clark Method, etc.). Based largely on ease of application, the SCS Method was selected for use in this study. This method requires computation of a single parameter for model input - lag time. Using the approach outlined in the San Bernardino County Hydrology Manual, lag times for each subarea were computed using the expression:

$$Lag = 24\, n\, ((L x L_{ca})/S^{0.5})^{0.38}$$

where Lag = lag time in hours
n = basin roughness factor
L = length of longest watercourse (miles)
L_{ca} = length along longest watercourse to a point opposite the basin centroid (miles)
S = overall slope of drainage area between headwaters and concentration point (feet/mile)

Values for n are given in Figure 4-4.

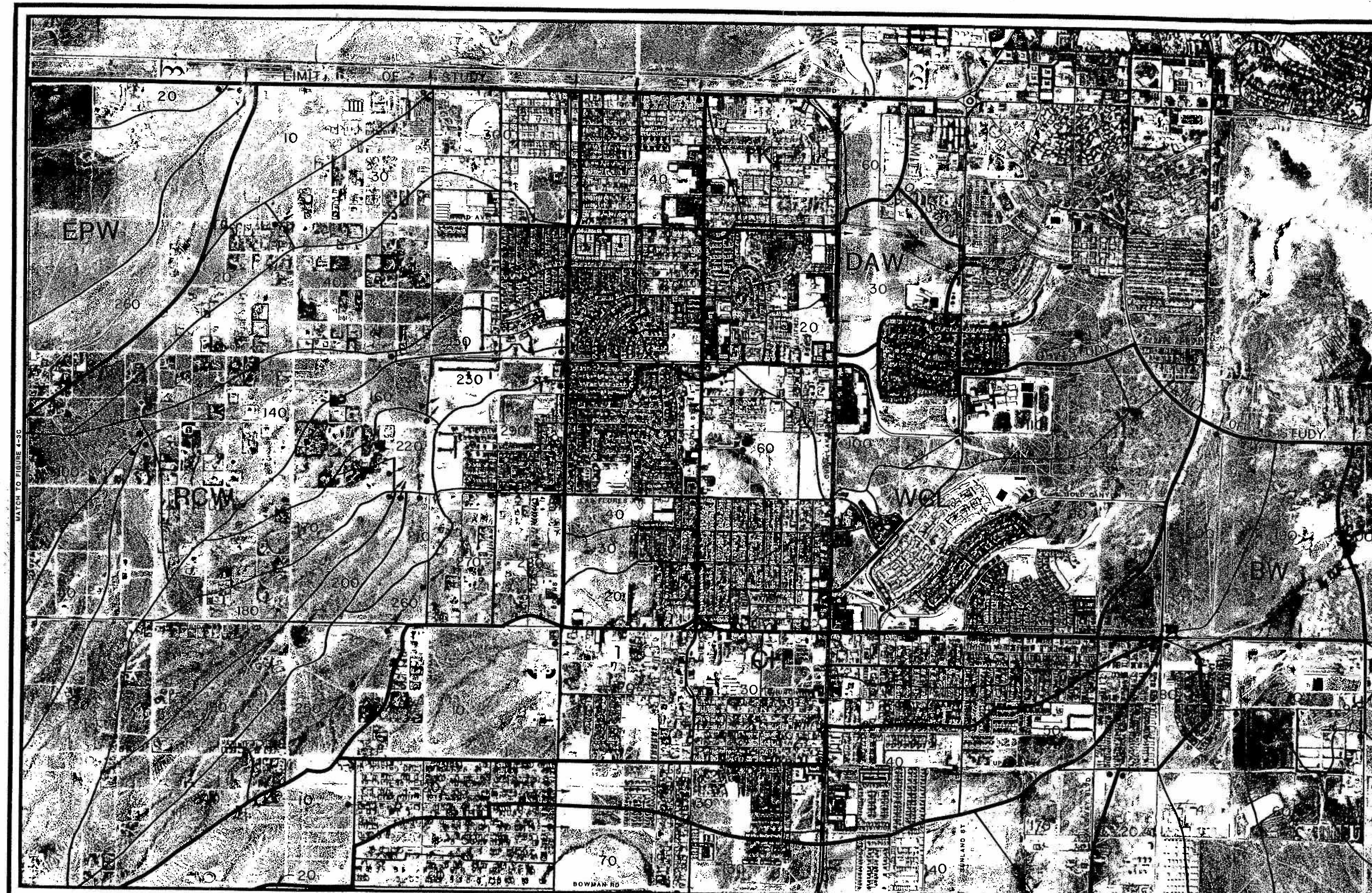
The unit hydrograph lag was selected as a model calibration parameter, and is discussed in more detail in Section 4.4 Model Calibration.

Hydrograph Routing

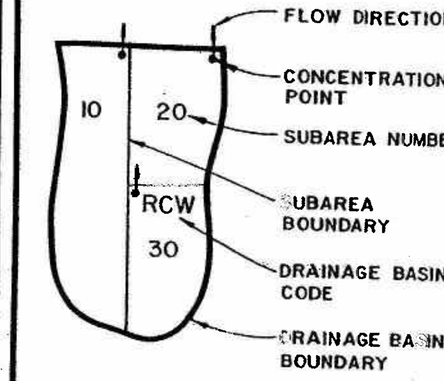
The HEC-1 program allows hydrographs to be routed through downstream subareas. Routing consists of two processes: (1) translation in time due to hydrograph travel times (flow velocities); and (2) attenuation of the peak flow due to floodplain storage, ponding, or other factors. HEC-1 allows for use of several different routing methods, depending on the physical processes involved and the amount of data available. The methods selected for use in four different routing conditions are described below.

Street Flow. For flow carried primarily in paved streets, the kinematic routing method was used. This method essentially involves only hydrograph translation, since storage effects for street flow are minimal. Data required includes routing length, slope, cross section (typically a 50-ft wide rectangular section), and roughness (0.020).

Channel Flow. For flow carried in improved channels, the kinematic routing method was used, with the same data requirements listed above.



LEGEND



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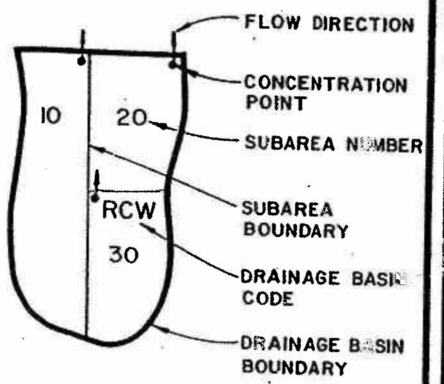
CITY OF RIDGECREST
MASTER DRAINAGE PLAN

HYDROLOGIC SUBAREA MAP

FIGURE 4-3 A

LEGEND



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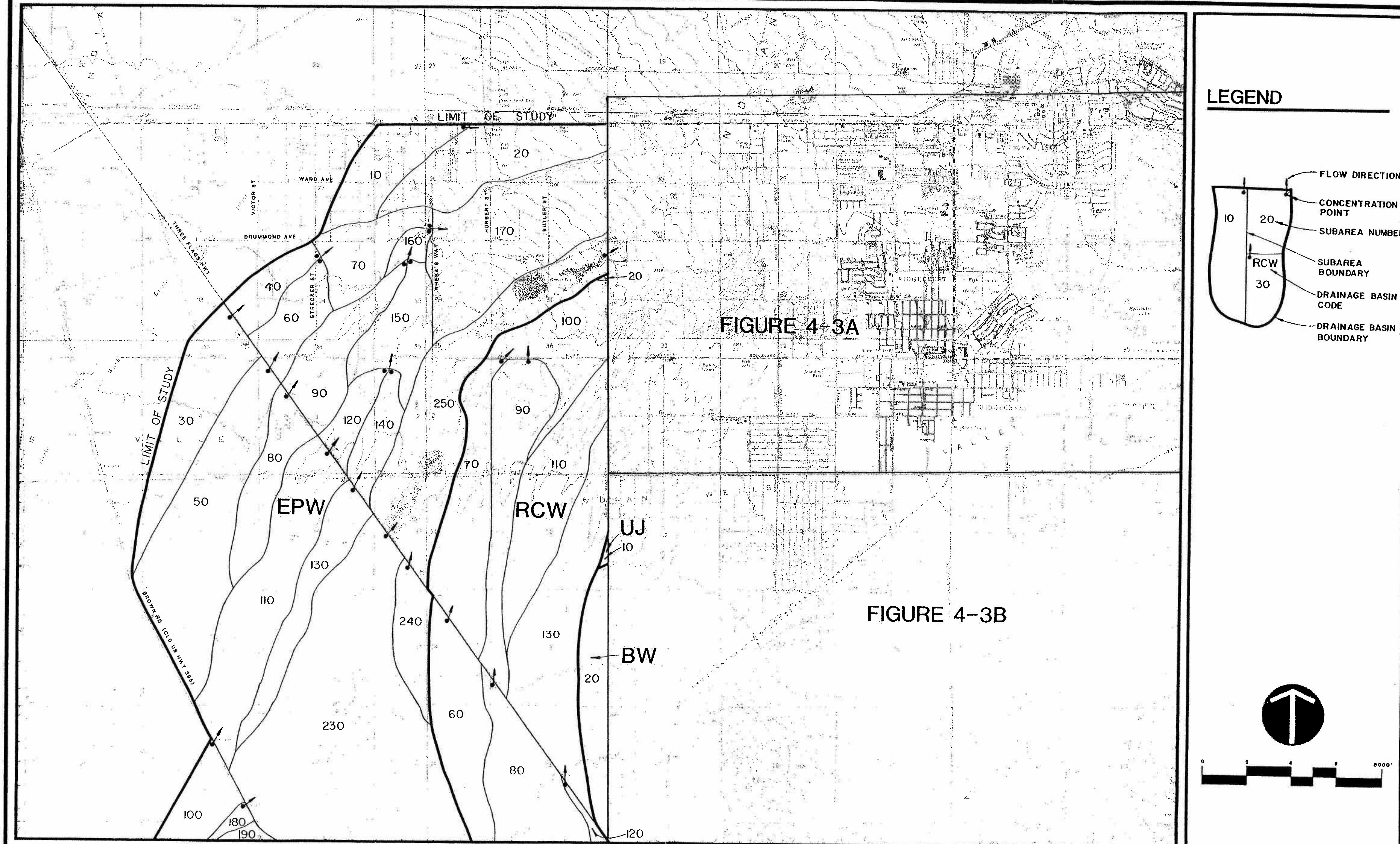
CITY OF RIDGECREST
MASTER DRAINAGE PLAN

HYDROLOGIC SUBAREA MAP

FIGURE 4-3B



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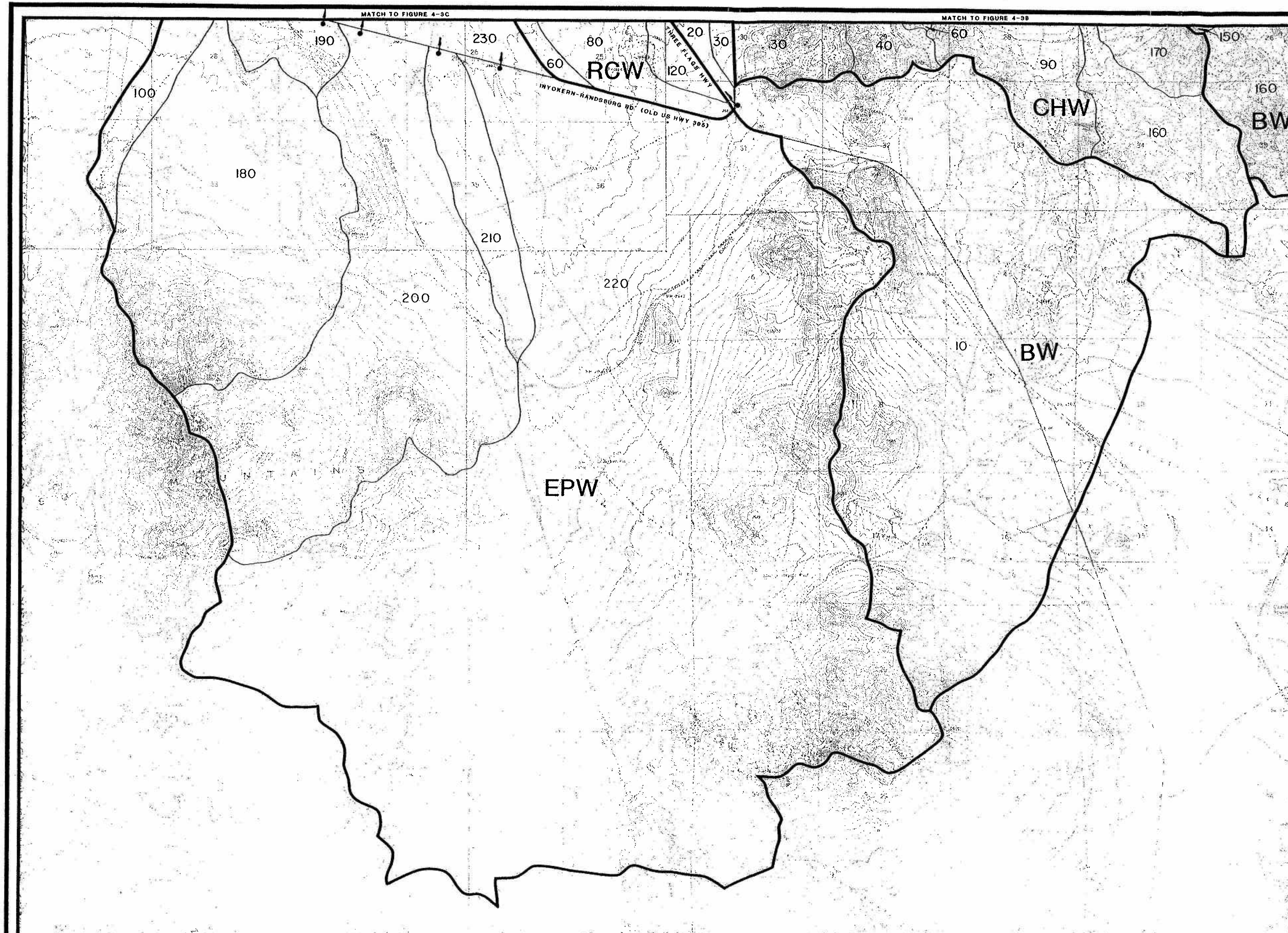
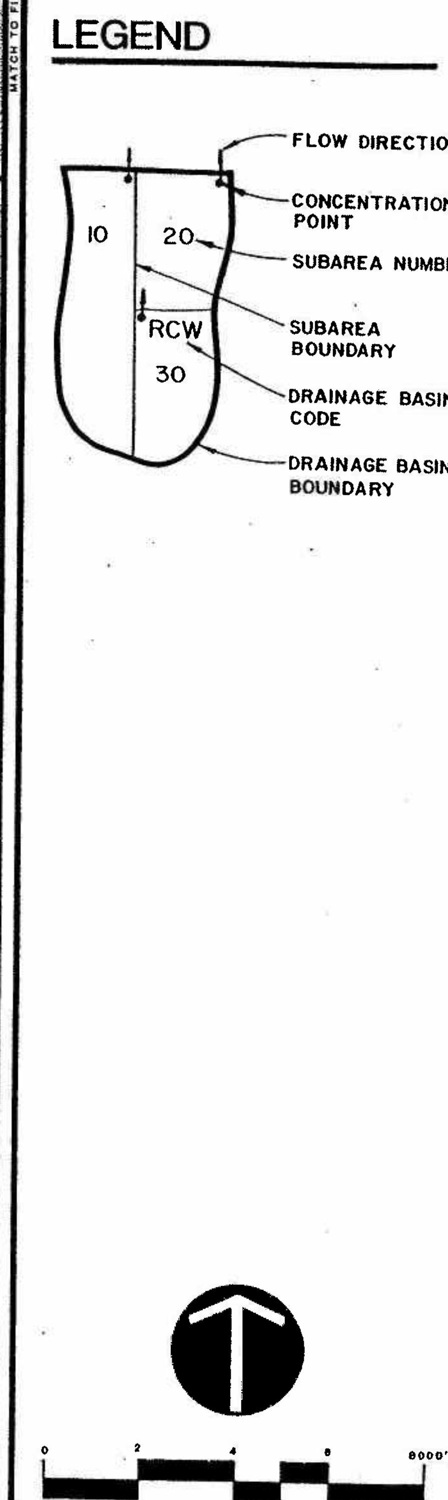
CITY OF RIDGECREST
MASTER DRAINAGE PLAN

HYDROLOGIC SUBAREA MAP

FIGURE 4-3C





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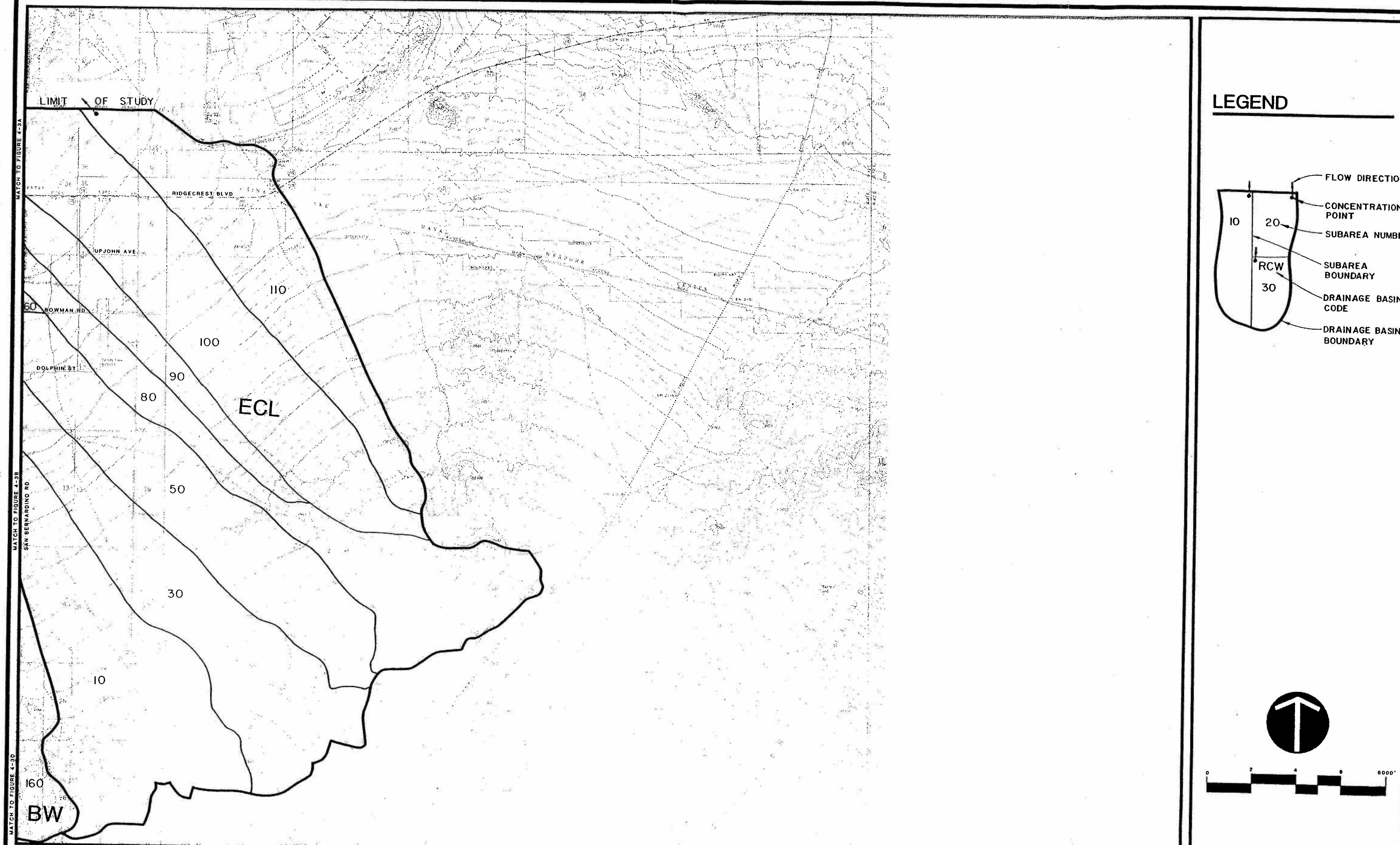
CITY OF RIDGECREST
MASTER DRAINAGE PLAN

HYDROLOGIC SUBAREA MAP

FIGURE 4-3D



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CITY OF RIDGECREST
MASTER DRAINAGE PLAN

HYDROLOGIC SUBAREA MAP

FIGURE 4-3E

$\bar{n}$ = 0.015

1. Drainage area has fairly uniform, gentle slopes
2. Most watercourses either improved or along paved streets
3. Groundcover consists of some grasses - large % of area impervious
4. Main water course improved channel or conduit

$\bar{n}$ = 0.020

1. Drainage area has some graded and non-uniform, gentle slopes
2. Over half of the area watercourses are improved or paved streets
3. Groundcover consists of equal amount of grasses and impervious area
4. Main watercourse is partly improved channel or conduit and partly greenbelt (see n = 0.025)

$\bar{n}$ = 0.025

1. Drainage area is generally rolling with gentle side slopes
2. Some drainage improvements in the area - streets and canals
3. Groundcover consists mostly of scattered brush and grass and small % impervious
4. Main watercourse is straight channels which are turfed or with stony beds and weeds on earth bank (greenbelt type)

$\bar{n}$ = 0.030

1. Drainage area is generally rolling with rounded ridges and moderate side slopes
2. No drainage improvements exist in the area
3. Groundcover includes scattered brush and grasses
4. Watercourses meander in fairly straight, unimproved channels with some boulders and lodged debris

$\bar{n}$ = 0.040

1. Drainage area is composed of steep upper canyons with moderate slopes in lower canyons
2. No drainage improvements exist in the area
3. Groundcover is mixed brush and trees with grasses in lower canyons
4. Watercourses have moderate bends and are moderately impeded by boulders and debris with meandering courses

$\bar{n}$ = 0.050

1. Drainage area is quite rugged with sharp ridges and steep canyons
2. No drainage improvements exist in the area
3. Groundcover, excluding small areas of rock outcrops, includes many trees and considerable underbrush
4. Watercourses meander around sharp bends, over large boulders and considerable debris obstruction

$\bar{n}$ = 0.200

1. Drainage area has comparatively uniform slopes
2. No drainage improvements exist in the area
3. Groundcover consists of cultivated crops or substantial growths of grass and fairly dense small shrubs, cacti, or similar vegetation
4. Surface characteristics are such that channelization does not occur

FIGURE 4-4

BASIN FACTOR DESCRIPTIONS

Sheet Flow. This condition occurs when discharges greatly exceed the capacity of minor channels or streets and is characterized by shallow flow depths covering broad areas. It is common on the alluvial apron to the south of Ridgecrest, as well as in the urban area. The normal depth method was used to simulate hydrograph routing through sheet flow reaches. This method accounts for the impact of floodplain storage on hydrograph attenuation. Input data requirements consist of routing length, slope, floodplain roughness, and elevation/station data for a typical cross section.

Ponding. Hydrograph routing through natural or man-made ponding areas was performed using the Modified Puls method. Under existing conditions, these areas occur primarily along Highway 395 where the roadway is elevated on a fill embankment several feet above the natural flowline. This method was also used in the analysis of proposed detention or retention basins. Data requirements consist of a relationship between storage volume in the pond, water surface elevation, and outflow capacity (including low-level outlets and weir flow). The storage-elevation relationships were developed using the best available topographic mapping for each ponding area.

4.4 MODEL CALIBRATION

Rainfall input to the hydrologic model is in the form of storm precipitation data of a specified return period. It is assumed that this storm data will produce peak flood flows of the same return period. In order to verify this assumption, a model calibration study was performed. The objective of the calibration study was to assure that the results produced by the hydrologic model are consistent with the regional flood-frequency characteristics of the study area.

The preferred calibration data is concurrent rainfall and runoff records from recording gages in the study area, preferably for a severe historical storm. This allows simulated flood hydrographs to be compared to actual flood hydrographs, and allows model parameters to be adjusted so there is reasonably good agreement between hydrograph magnitudes and volumes. Unfortunately, there are no such rain gages or stream gages in the Ridgecrest study area. The August 1984 storm would be the best candidate for a calibration event. However, a search for data for that event turned up only peak discharge estimates at several locations (staff gage readings or slope-area estimates), and a 24-hour rainfall recording at China Lake NWC. Because most of the rainfall during this event fell over the El Paso Mountains, the China Lake reading was not considered a valid representation of the total storm depth. In addition, no time-history or areal extent information is available for this event. There is a similar lack of data for other flood events, and hence it was concluded that the local model could not be calibrated to a particular local storm event.

In order to relate the simulated discharges from the hydrologic model to actual local experience in runoff frequency, a regional flood-frequency relationship was investigated. Due to the lack of a long-term streamflow gage in or near the Ridgecrest study area, it was necessary to use data from several shorter-term gages in the southwest desert area of California. This is a similar approach to that utilized by the Corps of Engineers in their recent hydrologic analysis for Las Vegas Valley, Nevada[16]. In this study, 14 gage records from California, Nevada and Arizona were used to develop relationships between drainage area and mean peak discharge, and between drainage area and standard deviation of peak flows. These records all met the requirement of having at least 10 years of record, not more than 25 percent zero flow years, no significant snowpack or upstream ponding or diversions, and general statistical consistency with the other gages in the region.

For purposes of this master plan study, six of the gages used in the Corps analysis (those closest to the study area) were supplemented with three additional gages from the study region. Frequency statistics (mean, standard deviation, skew) for the "Corps" gages were taken directly from the Corps report; statistics for the new gages (Crust Creek near Westend, Sand Creek near Inyokern, Salt Wells Creek near Westend) were computed from records provided by Kern County Water Agency[17]. This data is summarized in Table 4-2.

Assuming that the sample of annual peak discharges fits a log-Pearson distribution, the frequency relationship can be described according to:

$$Q = m + ks$$

where Q = log of peak discharge for desired return period

m = mean of log of annual peak flows

s = standard deviation of log of annual peak flows

k = frequency factor, function of return period to be calculated and adopted skewness

The average of the skew values for the nine station records was about 0.1. This compares to the regional or "generalized" skew value given in Water Resources Council Bulletin 17B[18] as 0.2. Due to the closeness of these values, a skew of 0.1 was adopted for this study. Values of k for different skew values can be found in Bulletin 17B, and are given below for a skew of 0.1:

Return Period (years)	k
10	1.29178
25	1.78462
100	2.39961

Using the 9 gage records in Table 4-2, regional relationships were developed between m and drainage area, and s and drainage area. These relationships are shown graphically in Figures 4-5 and 4-6. These figures show that data for gages with drainage areas under 1.0 square mile does not fit well with that of the other gages. This is undoubtedly due to sampling problems associated with very small watersheds in desert areas subject to localized thunderstorm flooding.

TABLE 4-2

STATISTICS FOR REGIONAL FREQUENCY ANALYSIS

No.	Agency	Gage ID	Description	Area (sq. mi.)	Log Mean	Log St. Dev	Computed Skew	No. of Years	No. of Zeros
1	KCWA	D-8-26-43	Crust Cr. nr Westend	0.13	0.3412	0.6485	-0.0272	27	4
2	KCWA	Q-33-26-38	Sand Cr. nr Inyokern	1.02	-0.4991	0.8474	0.9662	27	5
3	KCWA	G-23-26-42	Salt Wells Cr. nr Westend	65	1.8526	0.6943	0.1335	27	4
4	COE	10255885	San Felipe Cr. nr Westmoreland	1693	3.4799	0.6027	0.5293	22	0
5	COE	10254050	Salt Cr. nr Mecca	265	2.5203	0.6320	0.0466	22	0
6	COE	10252550	Caruthers Cr. nr Ivanpah	1.13	1.4791	0.9900	-0.2659	19	0
7	COE	10251220	Amargosa R at Tecopa	3090	2.4001	0.6801	0.1677	21	0
8	COE	10251271	Amargosa R Tr #1 nr Johnnie	2.21	1.1143	1.0266	-0.6578	16	3
9	COE	10264878	Ninemile Cr. nr Brown	10.4	1.2837	0.8589	-0.0195	15	0

KCWA = Kern County Water Agency

COE = Corps of Engineers

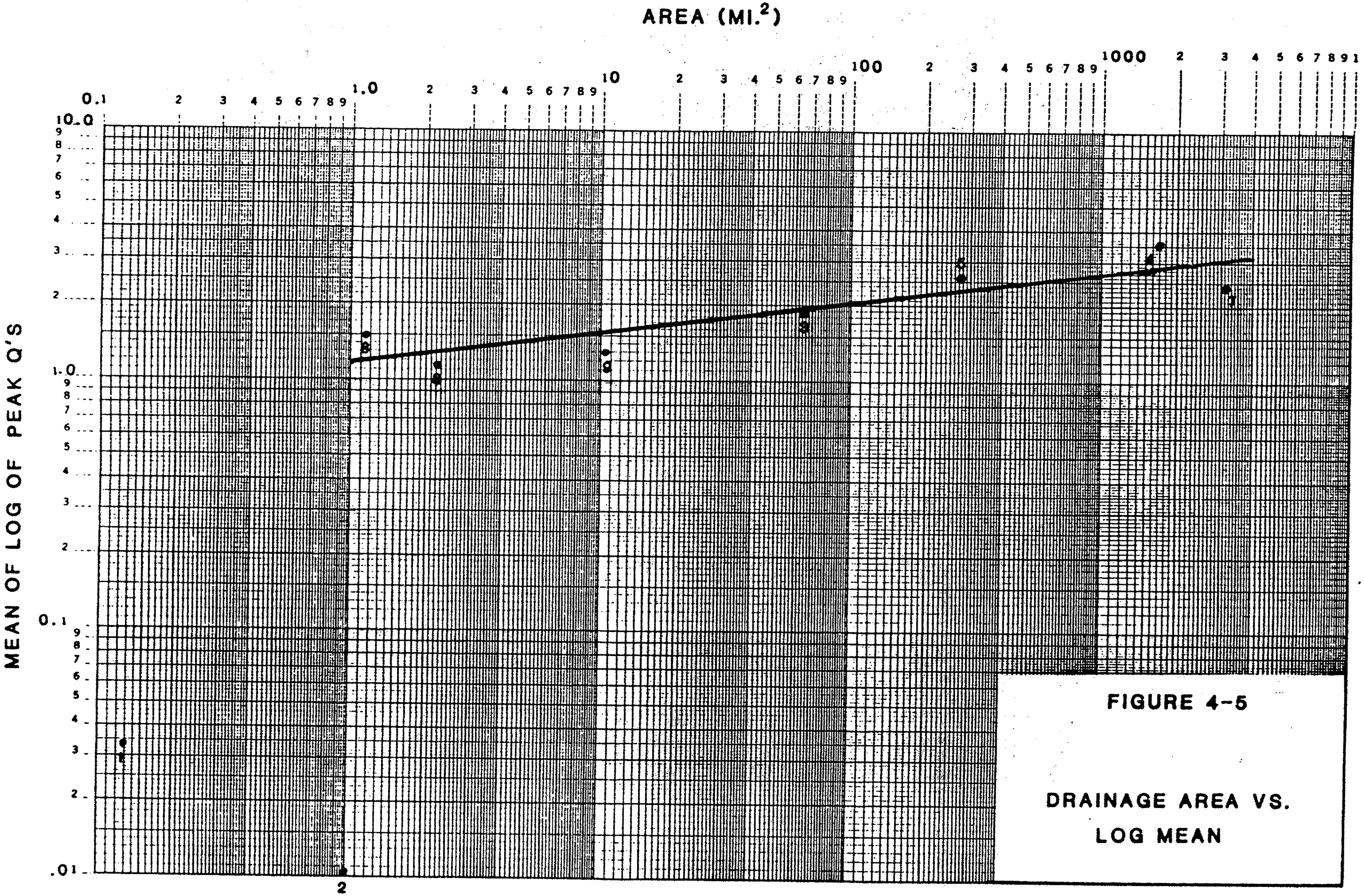


FIGURE 4-5

DRAINAGE AREA VS.
LOG MEAN

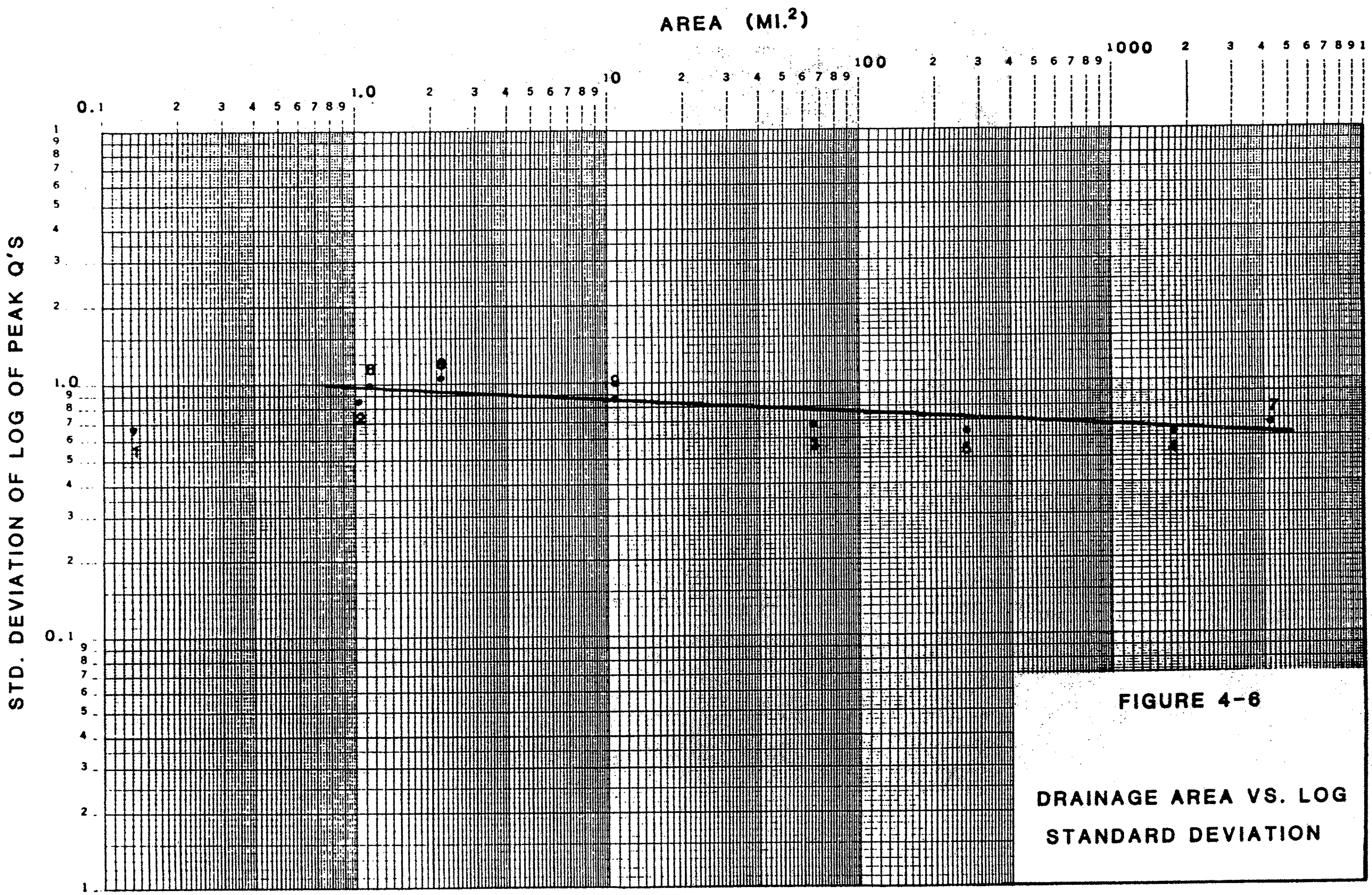


FIGURE 4-6

DRAINAGE AREA VS. LOG STANDARD DEVIATION

Three subareas were selected for model calibration investigations - EPW180, EPW220, and CH40. The EPW subareas are larger undeveloped subareas southwest of the main urban area; CH40 is a typical small urban subarea. The regional mean and standard deviation values for each calibration subarea were read from Figures 4-5 and 4-6. These values and the computed regional discharges based on the log-Pearson III distribution are given in Table 4-3.

The four subareas were modeled using both the HEC-1 program and the FLOODSB software for comparison. The two primary parameters which were investigated for potential modification through calibration were the lag time and the antecedent moisture conditions. The lag time can be defined in numerous ways, but is generally related to the travel time through the subarea. In the FLOODSB program developed for the San Bernardino County Hydrology Manual, lag is defined as the period between the beginning of unit effective rainfall and the time when the outflow reaches 50 percent of the ultimate peak discharge; it is related to time of concentration by the empirical formula lag = 0.8 Tc. This lag time will be referred to as the San Bernardino (SB) lag. In HEC-1, the SCS unit hydrograph method was selected, in which the lag is defined as the time between the center of mass of rainfall excess and the peak of the unit hydrograph; the SCS lag is empirically related to time of concentration through the formula lag = 0.6 Tc. The two lags are thus related by

$$lag_{SCS} = 0.75\ lag_{SB}.$$

Because the FLOODSB program includes desert runoff routines which are not directly incorporated in HEC-1, it was considered important to determine whether the HEC-1 parameters could be selected so as to "simulate" the results of FLOODSB.

Antecedent moisture condition was selected as a calibration parameter because it is a straightforward approach to adjusting watershed losses (initial and uniform). This can be done by adjusting Curve Numbers (used to automatically calculate losses in the HEC-1/SCS method) to reflect unusually dry preceeding conditions (AMC I) or unusually wet preceeding conditions (AMC III). The "normal" condition is referred to as AMC II. Curve Numbers for the three AMC conditions are summarized below.

Curve Numbers For AMC Conditions

II	I	III
90	78	98
85	70	97
80	63	94
75	57	91
70	51	87
65	45	83
60	40	79
55	35	75
50	31	70

TABLE 4-3

COMPUTED REGIONAL PEAK DISCHARGES FOR CALIBRATION SUBAREAS

Subarea	Area (sq mi)	Mean	Standard Deviation	Peak Discharges (cfs) 10-Year	25-Year	100-Year
EW180	4.06	1.37	0.92	360	1,030	3,780
EPW220	21.7	1.69	0.84	600	1,550	5,080
CH40(1)	0.11	0.10	1.00	25	75	320

(1) Potential inaccuracy due to small drainage area.

The three calibration watersheds were simulated using HEC-1 with various combinations of lag methods and AMC conditions. Table 4-4 presents the results of the simulations, and compares peak flows to the regional flood-frequency results of Table 4-3, the results of running the FLOODSB program for the same subareas, and the results of the City of Ridgecrest Flood Insurance Study(19) hydrologic analysis. The latter hydrology was performed using regional flood-frequency methods similar to those developed by the Corps of Engineers for the Flood Plain Information Report(4).

Several conclusions are drawn from the data in Table 4-4.

1. The various methods of analysis and parameter options yield widely varying results. The regional flood-frequency estimates and flood insurance study flows are reasonably consistent because both are based on the limited local streamflow data. However, the rainfall-runoff models produce a wide range of results depending on the parameters selected.

2. The FLOODSB desert routines yield generally higher results than indicated by the local data, particularly for the more frequent events (i.e., 10-year). Thus, the FLOODSB model does not appear to be well calibrated to the Ridgecrest study area for watershed losses (or AMC values) for common events.

3. Because of the difference between the regional flood-frequency data and the FLOODSB results, it is not possible to calibrate the HEC-1 parameters to both approaches concurrently. Therefore, it will be assumed that FLOODSB is producing results which are too conservative for the lower floods, and the regional flood-frequency data will be used to calibrate the HEC-1 parameters.

The parameter options for HEC-1 were ranked according to their ability to reproduce the regional flood-frequency discharge estimates. This ranking accounted for the fact that the larger watersheds (over 4.0 square miles) will have facilities designed for the 100-year event, whereas watersheds under 1.0 square mile will have facilities designed for the 10-year event.

Frequency	First Choice	Second Choice
10-Year	SCS lag, AMC I	SB lag, AMC I
25-Year	SCS lag, AMC I	SB lag, AMC II
100-Year	SB lag, AMC II	SCS lag, AMC II

To simplify the modeling effort, only one lag method should be used. Based on the above comparison, the SCS lag method was selected. This has the additional advantage of being theoretically consistent with the SCS unit hydrograph method being employed in the HEC-1 simulations. Thus, if lag times are calculated using the SB approach, they should be adjusted to the SCS lag times using the expression $\text{lag}_{SCS} = 0.75\ \text{lag}_{SB}$.

The calibration results show that AMC I conditions should be used for 10-year and 25-year storm simulations, and AMC II should be used for the 100-year storm. Thus, the standard Curve Numbers for AMC II conditions were adjusted for simulating the smaller events using the table presented earlier.

TABLE 4-4

COMPARISON OF SIMULATED PEAK DISCHARGES

Modeling Method	Subarea EPW180 Q10	Subarea EPW180 Q25	Subarea EPW180 Q100	Subarea EPW220 Q10	Subarea EPW220 Q25	Subarea EPW220 Q100	Subarea CH040 Q10	Subarea CH040 Q25	Subarea CH040 Q100
Regional Flood-Frequency	360	1030	3780	600	1550	5080	25 (2)	76 (2)	320 (2)
FLOODSB (AMC II)	1300	—	2240	3690	—	6890	101	—	167
Flood Insurance Study (1)	110	—	1310	520	—	6230	— (3)	— (3)	— (3)
HEC-1 - SB lag, AMC II	1020	1590	2240	3660	5640	7900	45	60	84
SB lag, AMC I	250	610	1080	1070	2380	4070	45	59	73
SB lag, AMC III	1870	2470	3120	6420	8500	10,800	65	95	130
SCS lag, AMC II	1250	1940	2730	4530	6960	9740	55	74	102
SCS lag, AMC I	310	750	1330	1340	2970	5080	55	72	90
SCS lag, AMC III	2260	2990	3780	7980	10,400	13,200	79	116	160

(1) Discharges interpolated from limited number of concentration points listed in FIS report.

(2) Potential inaccuracy due to small drainage aea.

(3) Could not estimate. FIS did not report results for small drainage areas.

It was found that finer adjustments of Curve Numbers to gain better agreement with the regional flood-frequency estimates were not warranted.

It is noted that this result differs from the San Bernardino County Hydrology Manual, which recommends use of AMC II for 10-year and 25-year events, and AMC III for 100-year events. It is felt that the use of AMC I and AMC II are more appropriate for desert study areas.

4.5 ULTIMATE CONDITIONS MODELING

Peak discharges and runoff hydrographs for ultimate development conditions throughout Ridgecrest and the tributary drainage area were estimated using the HEC-1 program. The model of existing conditions discussed previously was modified to represent ultimate development by adjusting certain parameters. These parameters are described below. Subarea boundaries were assumed to be unchanged between existing and ultimate conditions. Although future development could alter local drainage patterns (e.g. through street improvements), such changes are not predictable at present, and are expected to be minor relative to overall City-wide drainage planning.

Percent Imperviousness

Percent impervious values for each subarea in the central portion of the study area were estimated from the Ultimate Land Use Map (Figure 3-4) and Table 3-6 which relates land use type to typical percent imperviousness. In areas outside of the main urban boundary but within the Ultimate Development Boundary (Figure 3-1), no ultimate land use information is available. It was assumed that these outlying areas would buildout in a combination of rural residential and estate residential, with an average percent imperviousness of 10 percent.

Curve Number

The Curve Number is a function of soil type and vegetation cover. The latter characteristic can be altered through development, for example in the conversion of open desert lands to urban landscaping including lawns, shrubs, etc. Thus in subareas where significant changes from desert to urban land use are expected, Curve Numbers were adjusted for ultimate conditions according to the values in Table 3-8. In the outlying areas (i.e., those between the primary development area and the ultimate development boundary), it was assumed that low density development would have only a minor impact on vegetation cover, since most lots would remain in desert landscaping. Thus in these areas the Curve Number was assumed to decrease from 80 (Soil B, poor cover) to 76.

Lag Time

Travel time for subarea runoff generally decreases with urbanization due to the paving of flow paths (i.e., streets) and the enhanced concentration of flow. In this study, lag time has been calculated according to the expression:

$$\text{Lag} = 24\, n\, ((L x L_{ca})/S^{0.5})^{0.38}$$

In conversion from open to urban land on alluvial aprons, flow path lengths (L and L_{ca}) typically increase, while the average slope typically decreases. Thus it can be assumed that the term in parentheses in the lag formula will remain unchanged, and lag time modifications will only be a function of changes in n. In developing the existing conditions HEC-1 model, an n factor of 0.030 was used for open desert on mild to moderate slopes, and 0.020 was used in urban areas. To model ultimate conditions, lag times were adjusted in subareas where significant portions of the subarea changed from open to developed land. In the case where a subarea would convert from entirely open to entirely urbanized, the ultimate lag would be calculated as 0.67 times the existing lag (0.020/0.030). In outlying development areas where densities are assumed to remain low (RR and RE), an ultimate n factor of 0.025 was assumed, so the conversion factor from existing to ultimate lag was 0.83.

Hydrograph Routing

Routing parameters for ultimate development conditions were not modified from the existing conditions model. Channel areas were assumed to remain in a semi-natural state, so hydraulic characteristics would be similar to those at present. In cases of urban or sheet flow routing, typical routing cross sections were adopted for the existing conditions model. Although specific development patterns could affect these parameters, there is considerable uncertainty in impacts to particular areas. The approximate nature of these routing techniques did not warrant modifications in converting from existing to ultimate conditions. Routing parameters may be modified as necessary in the evaluation of alternatives in which channelization, channel lining, or detention storage are involved.

4.6 RESULTS

Results of the HEC-1 hydrologic analysis for "without project" conditions are summarized in Table 4-5. This table presents peak discharges under existing and ultimate development conditions, for recurrence intervals appropriate for the corresponding drainage areas, (10-year for less than 1.0 square mile, 25-year for 1.0 to 4.0 square miles, and 100-year for over 4.0 square miles). These results apply to present drainage network and facility conditions.

Hydrograph volumes at key locations in the study area are tabulated in Table 4-6. Typical hydrographs are plotted in Figures 4-7 to 4-10.

Table 4-5 includes several instances where peak flows are decreasing in a downstream direction, (e.g., EPW240 to EPW250). This is common in the sheet flow areas where significant floodplain storage is available and considerable hydrograph routing occurs. For alternatives which include channelization or improvements to existing channels, the HEC-1 model will be modified to account for the loss of floodplain storage and the reduced travel time through subareas.

Table 4-5 also contains a few instances of peak discharges which are slightly lower for ultimate conditions development than for existing conditions. This occurs primarily in the watershed areas beyond the urban development core.

TABLE 4-5

WITHOUT PROJECT PEAK DISCHARGES

Subarea	Cumulative Area (sq mi)	Recurrence Interval (yr)	Existing Peak Flow (cfs)	Ultimate Peak Flow (cfs)
El Paso Wash Drainage Basin				
EPW010	0.54	10	20	44
EPW020	1.44	25	77	140
EPW030	0.86	10	1	68
EPW040	1.16	25	28	79
EPW050	1.54	25	6	9
EPW060	3.06	25	70	125
EPW070	3.49	25	36	94
EPW080	0.49	10	2	7
EPW090	1.04	25	50	77
EPW100	0.82	10	20	20
EPW110	2.06	25	20	26
EPW120	2.29	25	32	47
EPW130	0.52	10	9	36
EPW140	3.10	25	71	110
EPW150	4.63	100	1,120	1,150
EPW160	8.16	100	1,620	1,650
EPW170	11.32	100	2,510	2,500
EPW180	4.06	100	2,730	2,730
EPW190	0.45	10	87	87
EPW200	5.04	100	3,070	3,070
EPW210	0.81	10	14	14
EPW220	21.69	100	9,720	9,720
EPW230	35.68	100	13,000	12,800
EPW240	35.98	100	13,000	12,900
EPW250	37.43	100	12,700	12,500
EPW260	49.02	100	13,400	13,100
Ridgecrest Wash Drainage Basin				
RCW010	0.21	10	41	80
RCW020	0.19	10	12	20
RCW030	0.57	10	80	130
RCW040	0.41	10	31	51
RCW050	0.62	10	110	120
RCW060	0.29	10	3	8
RCW070	1.14	25	79	110
RCW080	1.25	25	53	75
RCW090	3.17	25	150	220
RCW100	3.91	25	110	180
RCW110	4.91	100	1,580	1,540
RCW120	4.89	100	1,900	1,890
RCW130	11.42	100	2,470	2,480
RCW140	11.74	100	2,260	2,240

Table 4-5 (Cont'd.)

Subarea	Cumulative Area (sq mi)	Recurrence Interval (yr)	Existing Peak Flow (cfs)	Ultimate Peak Flow (cfs)
Ridgecrest Wash Drainage Basin (Contd.)				
RCW150	11.82	100	2,160	2,120
RCW160	0.15	10	12	21
RCW170	0.15	10	12	19
RCW180	0.43	10	25	40
RCW190	0.27	10	11	33
RCW200	0.33	10	7	20
RCW210	0.39	10	2	12
RCW220	0.89	10	26	56
RCW230	1.12	25	63	100
RCW240	0.11	10	4	15
RCW250	0.32	10	11	50
RCW260	0.37	10	9	43
RCW270	0.48	10	17	53
RCW280	0.60	10	57	120
RCW290	0.76	10	100	150
RCW300	15.09	100	2,430	2,400
Drummond Avenue Wash Drainage Basin				
DAW010	0.20	10	150	150
DAW020	0.06	10	65	65
DAW030	0.46	10	140	180
Inyokern Road Drainage Basin				
IK010	0.06	10	40	41
IK020	0.17	10	89	89
IK030	0.30	10	120	130
IK040	0.51	10	190	230
IK050	0.22	10	150	160
IK060	1.35	25	550	660
West China Lake Drainage Basin				
WCL010	0.22	10	120	120
WCL020	0.11	10	34	71
WCL030	0.19	10	40	95
WCL040	0.25	10	53	110
WCL050	0.36	10	87	130
WCL060	0.76	10	89	240
WCL070	0.91	10	120	120
WCL080	1.00	10	160	180
WCL090	2.19	25	290	490
WCL100	0.23	10	91	150
WCL110	0.44	10	51	140

Table 4-5 (Cont'd.)

Subarea	Cumulative Area (sq mi)	Recurrence Interval (yr)	Existing Peak Flow (cfs)	Ultimate Peak Flow (cfs)
East China Lake Drainage Basin				
ECL010	4.00	100	1,880	2,240
ECL020	4.15	100	1,870	2,220
ECL030	2.97	25	200	270
ECL040	3.18	25	190	320
ECL050	2.62	25	210	290
ECL060	6.02	100	2,600	2,730
ECL070	6.23	100	2,410	2,480
ECL080	2.57	25	160	280
ECL090	3.48	25	190	330
ECL100	13.12	100	3,120	3,130
ECL110	2.47	25	200	260
ECL110	15.58	100	3,540	3,660
Upjohn Road Drainage Basin				
UJ010	0.55	10	11	48
UJ020	0.71	10	25	51
UJ030	0.94	10	51	99
UJ040	1.13	25	150	200
UJ050	1.34	25	97	150
Church Road Drainage Basin				
CH010	0.33	10	26	130
CH020	0.58	10	150	200
CH030	0.84	10	220	300
CH040	0.95	10	240	320
CH050	1.08	25	430	570
CH060	1.13	25	320	410
College Heights Wash Drainage Basin				
CHW010	0.26	10	32	45
CHW020	0.34	10	23	40
CHW030	2.51	25	430	600
CHW040	3.50	25	630	870
CHW050	3.57	25	620	860
CHW060	0.47	10	50	80
CHW070	4.23	100	2,380	2,660
CHW080	4.77	100	2,330	2,590
CHW090	1.38	25	420	480
CHW100	1.66	25	360	420
CHW110	1.95	25	310	380
CHW120	2.05	25	270	330
CHW130	0.27	10	17	47
CHW140	0.48	10	54	93

Table 4-5 (Cont'd.)

Subarea	Cumulative Area (sq mi)	Recurrence Interval (yr)	Existing Peak Flow (cfs)	Ultimate Peak Flow (cfs)
College Heights Wash Drainage Basin (Contd.)				
CHW150	0.64	10	52	92
CHW160	1.25	25	170	290
CHW170	2.31	25	300	480
CHW180	2.47	25	290	440
CHW190	3.30	25	300	460
CHW200	5.65	100	2,650	2,790
CHW210	10.46	100	4,880	5,270
Bowman Wash Drainage Basin				
BW010	4.65	100	1,900	1,900
BW020	1.76	25	110	150
BW030	2.92	25	190	300
BW040	3.01	25	190	300
BW050	0.11	10	18	33
BW060	0.20	10	33	60
BW070	3.40	25	140	240
BW080	0.58	10	20	51
BW090	0.72	10	34	68
BW100	4.19	100	1,430	1,540
BW110	0.33	10	40	130
BW120	4.76	100	1,530	1,630
BW130	15.44	100	6,410	6,910
BW140	15.78	100	6,420	6,920
BW150	18.18	100	7,320	7,820
BW160	20.69	100	8,370	9,090
BW170	25.01	100	10,100	11,000
BW180	27.60	100	9,990	10,900
BW190	43.49	100	10,200	10,700
BW200	0.21	10	5	22

TABLE 4-6

HYDROGRAPH VOLUMES IN THE RIDGECREST STUDY AREA

Location	Subarea	Drainage Area (sq mi)	Return Period (yr)	Hydrograph Volume (acre-feet)
Ridgecrest Wash				
At Mahan/Drummond	RCW140	11.7	100	780
At Mahan/Felspar	RCW220	0.89	25	19
At Downs/Inyokern	RCW300	15.1	100	997
West China Lake Wash				
Inflow to Sump Area	WCL060	0.76	10	27
Upjohn Avenue				
At Ridgecrest Blvd	UJ050	1.34	25	41
Church Avenue				
At Ridgecrest Blvd	CH060	1.13	25	67
College Heights Wash				
At Bowman Rd	CHW210	10.5	100	879
Bowman Wash				
At Brady St	BW020	1.76	25	29
At China Lake Blvd	BW130	15.4	100	1,203
At Ridgecrest Blvd	BW180	27.6	100	2,106

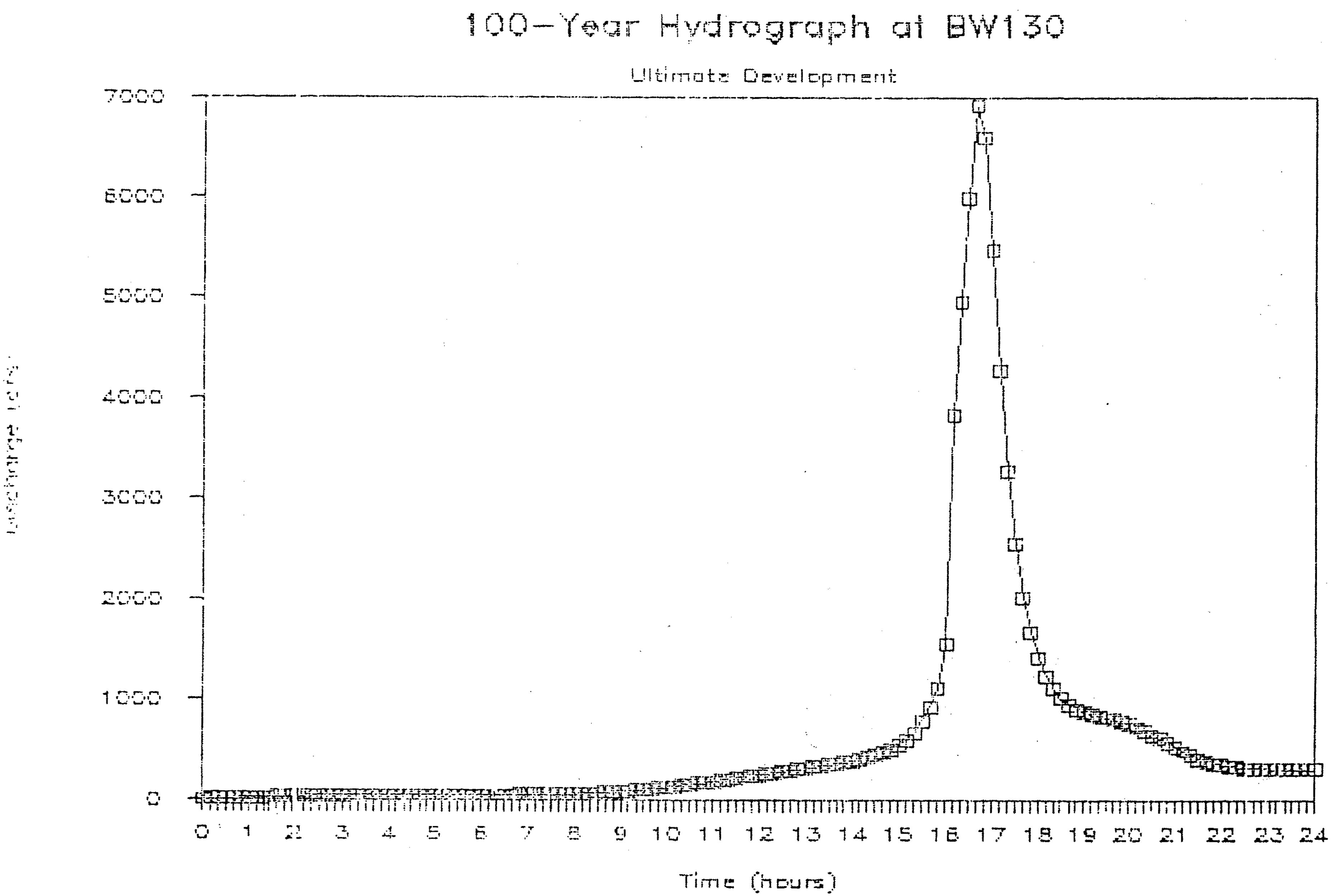
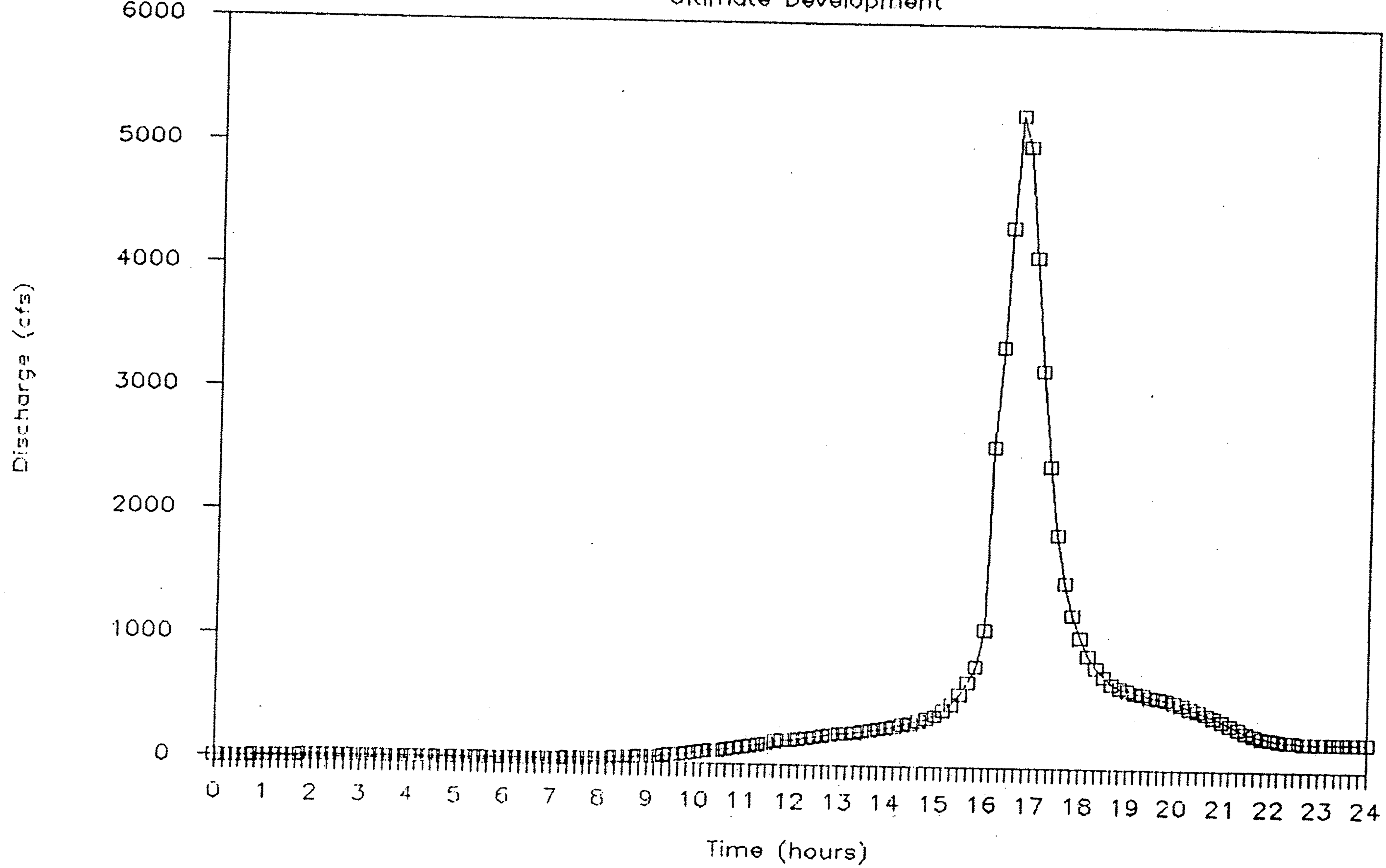

100-Year Hydrograph at BW130
Ultimate Development
Discharge (cfs)
7000
6000
5000
4000
3000
2000
1000
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time (hours)

FIGURE 4-7

100–Year Hydrograph at CHW210

Ultimate Development



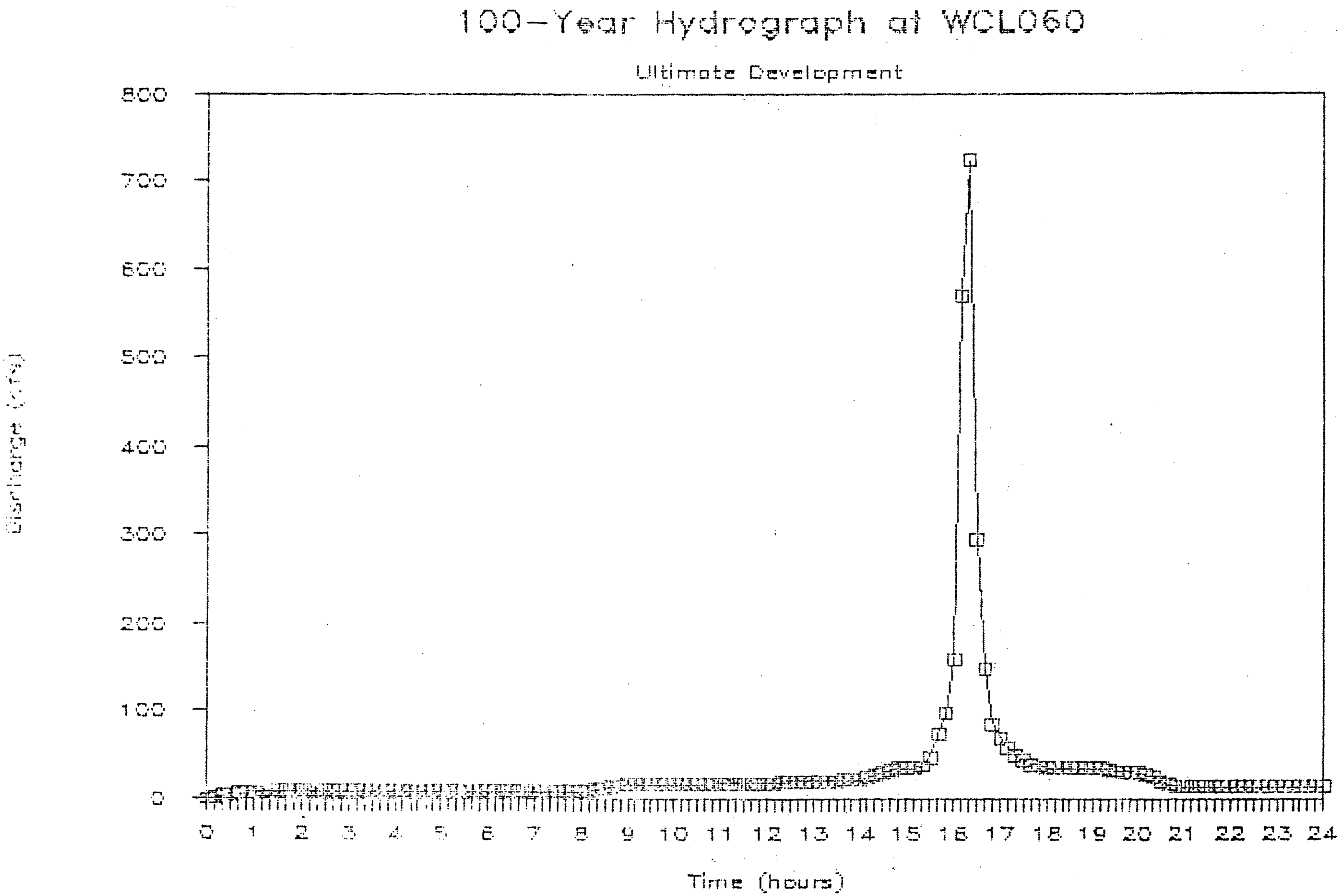
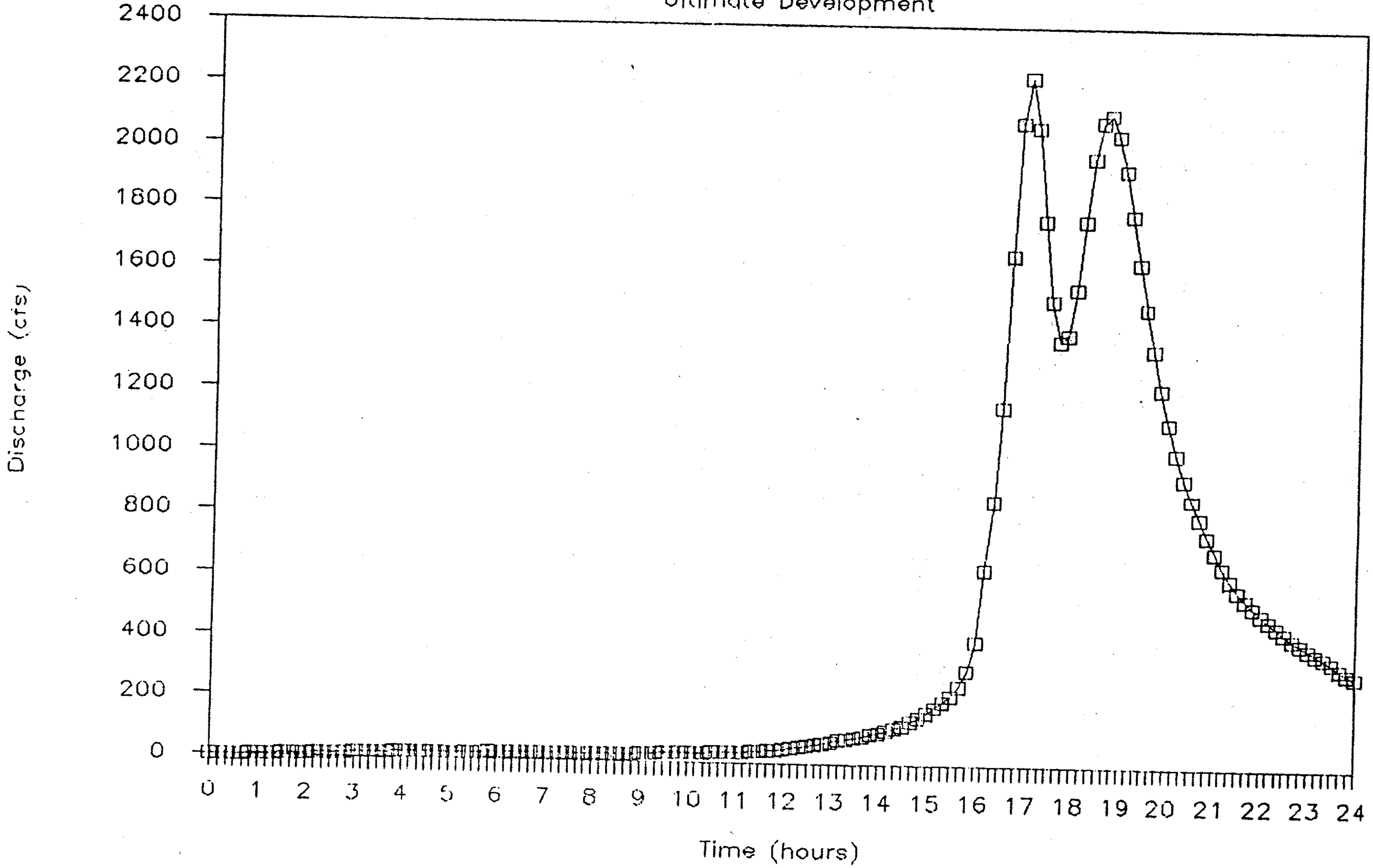

100-Year Hydrograph at WCL060
Ultimate Development
800
700
600
500
400
300
200
100
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time (hours)

FIGURE 4-9

100—Year Hydrograph at RCW140

Ultimate Development



It is believed that the decrease in lag time associated with urbanization causes downstream subareas to peak more rapidly, thereby affecting the combination with upstream routed hydrographs. Although urbanization is generally considered to increase peak flows, the above process is reasonable for desert areas. When drainage improvements are introduced to the HEC-1 model for urban conditions (e.g., channelization of sheet flows), there is expected to be a clear increase in ultimate flows over existing flows.

Based upon the results of the hydrologic analysis, many of the major drainage facilities in Ridgecrest are found to be undersized. Table 4-7 lists the primary drainage facilities which have capacities exceeded by the ultimate conditions design discharge. There are several locations where Highway 395 is overtopped by the design flood (EPW230, RCW080, BW010), despite the significant ponding volumes created behind the highway embankment. Problems also occur along Ridgecrest Blvd and Inyokern Road. Individual cross culvert drains have not been included in this evaluation due to their undocumented capacities.

It is noted that the unlined channel east of China Lake Blvd running parallel to Sunland Street (facilities 48-50) has adequate capacity for the ultimate development flow under the present drainage patterns. In addition, the sump in the broad open area northeast of the intersection of Norma Street and Las Flores Ave fills to a maximum depth of about 3.2 feet, but does not inundate surrounding developed property. This is based on the assumption that all flow in RCW280 is directed north along Downs Street rather than east along Las Flores Ave. A flow split at this location would increase computed ponding elevations in the sump, but would not lead to hazardous conditions.

Table 4-8 presents a comparison of Master Plan flows developed by the Corps of Engineers for use in their past planning studies and the Flood Insurance Study for the City of Ridgecrest. For all the drainage basins except El Paso Wash, the Master Plan 100-year peak discharges are very close to the Corps of Engineers 100-year peak discharges, and fall between the Corps 100-year and Standard Project Flood discharges. The large difference in El Paso Wash flows occurs due to the assumed impact of Highway 395. In the Corps study, it was assumed that all flood waters would pond behind Highway 395 in the El Paso Wash watershed, and flows downstream of the highway would be limited to the capacity of the small highway culverts. However, the more detailed Master Plan model shows that for the 100-year flood, the ponding areas will fill up and spill over the roadway; this creates higher downstream discharges than were assumed by the Corps. Despite this difference, on all other drainage basins there is good agreement between the previous Corps of Engineers hydrology and the new Master Plan hydrology.

Table 4-5 indicates that the drainage basins which produce the largest peak discharges are El Paso Wash, Ridgecrest Wash, and Bowman Wash (which includes College Heights Wash and East China Lake Wash). This is significant because all of these drainage basins are comprised primarily of areas which are outside the current City of Ridgecrest boundaries. Most of the area in these basins is either in unincorporated Kern County or is public land under the jurisdiction of the Bureau of Land Management. As a result,

TABLE 4-7

UNDERSIZED PRIMARY FACILITIES

Facility ID[1]	Subarea	Return Period (yr)[2]	Ultimate Discharge (cfs)	Capacity (cfs)[3]
2	EPW180	100	2,730	620
3	EPW180	100	2,730	25
8	EPW230	100	12,800	920[4]
14	RCW080	100	810	105[4]
16/17	BW010	100	1,900	58[4]
19/20	BW130	100	1,640	135
23	RCW130	25	150	5[4]
32	ECL070	100	2,480	75
34/35	WCL090	25	490	60
37	EPW260	100	13,100	310
38	RCW030	10	130	35
40/41	RCW300	100	2,400	195
43	IK040	10	230	12
66	CHW080	100	2,590	140

(1) See Figures 4-1 and 4-2

(2) Based on tributary drainage area

(3) See Table 4-1

(4) Ponding occurs behind roadway embankment and overtops the road

TABLE 4-8

COMPARISON OF MASTER PLAN "WITHOUT PROJECT" PEAK FLOWS TO CORPS OF ENGINEERS PEAK FLOWS

Location	Master Plan Q100 Existing	Master Plan Q100 Ultimate	Corps of Engineers[1] Q100	Corps of Engineers[1] SPF
El Paso Wash at Inyokern Rd	13,400	13,100	3,000[4]	4,700[4]
Ridgecrest Wash at Downs St	2,430	2,400	2,300	3,900
West China Lake Wash[2] at China Lake Blvd	870	940	860	1,400
College Heights Wash at China Lake Blvd	2,650	2,790	2,500	4,200
East China Lake Wash[3] at Bowman Rd	4,400	4,900	3,000	5,400
Bowman Wash at Mahan Ave	1,340	1,510	900	1,500
Bowman Wash at Ridgecrest Blvd	9,990	10,900	7,800	12,700

(1) Flows were used in Corps Reconnaissance Studies for Ridgecrest Wash and Bowman Wash (1985), and in the Flood Insurance Study

(2) WCL060 + WCL070

(3) ECL010 + ECL030 + ECL050

(4) Corps incorrectly restricts flow below Highway 395 to capacity at existing culverts; JMM model shows weir flow occurs over roadway in addition to culvert flow.

the main flooding problems in Ridgecrest are attributed to "offsite" flows, rather than to flows which are generated within the city limits and which may be impacted by development or drainage projects in the City. This is an important concept to consider when evaluating the drainage alternatives presented in Chapter 5.

Results of the hydrologic analysis based on the HEC-1 program and the SCS unit hydrograph method were compared with peak flow calculations using the Rational Method. The Rational Method procedures in the Kern County Subdivision Manual Standards were used to compute peak flows for subareas IK010 and CH040 under existing development conditions. Results are summarized below.

		Peak Discharge (cfs)	
Subarea	Return Period	HEC-1/SCS	Rational Method
IK010	10-yr	40	36
	25-yr	51	50
CH040	10-yr	55	48
	25-yr	72	68

It is concluded that the Master Plan methodology yields results which are 5-10 percent higher than the Rational Method. This indicates that Master Plan facilities should be large enough to accommodate flows from local subdivision facilities sized using the Rational Method.

Chapter 5

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CHAPTER 5

DRAINAGE ALTERNATIVES

5.1 INTRODUCTION

Drainage alternatives have been developed for each of the major drainage basins in the City of Ridgecrest study area. At least two alternatives have been formulated for each area. In some cases alternatives consist of different facility alignments or sizes; in other cases alternatives include detention basins in upstream watersheds in order to allow for down-sizing of downstream facilities.

Alternatives formulated for each of the drainage basins are described in Sections 5.3 through 5.10. Figures 5-1A, 5-1B, 5-2A, and 5-2B, found at the end of this chapter, depict the schematic location and orientation of each major drainage element. Each drainage element has been assigned a facility identification number in order to facilitate use of the report text, tables, and maps. The facility number consists of a 2- or 3-letter code which identifies the drainage basin in which the facility is located, followed by a 2-digit numeral. For example, BW-06 is the sixth facility in the Bowman Wash Drainage Basin.

Alternatives have been formulated for ultimate development conditions in each watershed area. Facility alignments and sizes have been determined on a conceptual level only; additional more detailed design studies must be performed before facility characteristics are finalized prior to construction. The criteria used to compute facility sizes and parameters are presented in Section 5.2. It is noted that all aspects of the alternatives necessary to assure proper functioning under ultimate conditions are included (e.g., culverts at minor road crossings), although all are not necessary immediately and could be replaced with less expensive options (e.g., dip sections) as temporary solutions.

During development of alternatives, it has been assumed that upstream drainage patterns beyond the Ridgecrest city limits will not be modified by future development or stormwater improvements. Certain critical facilities have been shown in the plan in unincorporated areas where they are necessary for the proper functioning of downstream facilities in the City.

5.2 CRITERIA FOR DESIGN OF DRAINAGE FACILITIES

This section presents the basic criteria used in the planning and design of drainage facilities in the Ridgecrest area. Included are hydraulic design requirements, right-of-way requirements, slope protection requirements, and other factors affecting the size, location, and characteristics of alternative drainage facilities.

In the following discussion, local washes and facilities are those having tributary drainage areas of less than 1.0 square mile; secondary washes and facilities are those having tributary drainage areas of between 1.0 and 4.0 square miles; and major washes and facilities are those having tributary drainage areas of over 4.0 square miles.

Planning and design criteria have been primarily based on the Kern County Subdivision Standards. Where appropriate, these standards have been modified or expanded to be more applicable to desert areas using the criteria of Clark County, Nevada and Pima County, Arizona. Other modifications were made based on review by the Ridgecrest Public Works Director.

Open Channels

a. Wherever possible, existing watercourses will be maintained in their natural condition.

b. Local channels will be designed to carry the 10-year discharge with freeboard, and the 25-year discharge without freeboard. They will be designed to operate against the 10-year water surface elevation in the outfall facility.

c. Secondary channels will be designed to carry the 25-year discharge with freeboard and the 100-year discharge without freeboard.

d. Major channels will be designed to carry the 100-year discharge with freeboard.

e. Minimum freeboard requirements are as follows:

Natural watercourses	-	20 percent of specific energy head
Local channels	-	1 foot
Secondary channels	-	2 feet
Major channels	-	2 feet or 20 percent of specific energy head, whichever is greater.

Additional freeboard will be required when channel slopes are within 20 percent of critical slope.

f. Manning's roughness coefficients for open channels are:

Concrete	-	0.015
Soil cement	-	0.020
Sack concrete rip rap	-	0.030
Grouted rock rip rap	-	0.030
Dumped rock rip rap	-	0.035
Rip rap sides only	-	0.031
Grassed	-	0.035
Unlined earthen	-	0.028

g. Minimum bottom width is 5 feet for lined channels without maintenance roads, and 8 feet for unlined or rock protected channels. Triangular channels are acceptable with side slopes of 4:1 or flatter.

h. Side slopes for unlined channels will be 3:1 or flatter. Side slopes for grassed or rock protected channels will be 2:1 or flatter. Side slopes for concrete lined channels will be 1.5:1 or flatter, unless provided with sufficient reinforcement. Preferred side slopes for soil cement channels are 6:1, although slopes of up to 3:1 can be designed if special equipment is used.

i. The following limiting velocities will be used for various slope protection measures:

Slope Condition	Allowable Velocity
Unlined	less than 4 ft/sec
Grassed	3-5 ft/sec
Dumped rock	5-12 ft/sec
Concrete or soil cement	over 12 ft/sec

Slope protection will be required on channel banks steeper than 3:1 regardless of the design velocity.

Closed Conduits

a. Conduits will generally be reinforced concrete pipes or boxes. For short culverts designed for 10- or 25-year frequencies, corrugated metal pipe may be used. In relatively straight reaches with no utility interferences, cast-in-place concrete pipe may be used.

b. Manning's n value for concrete closed conduits is 0.013, and for corrugated metal pipes is 0.024.

c. The minimum pipe size is 18 inches, and the general minimum cover requirement is 2 feet. Cover may be reduced if special class concrete and/or additional reinforcement are used.

d. Local conduits can be designed for full-flow capacity, or may be designed to operate under pressure with the hydraulic gradeline a minimum of 1.0 foot below the gutter flowline.

e. Secondary and major conduits will be designed with a maximum depth of 0.8 times the diameter for pipes, or a clearance of 1.0 foot between the water level and the soffitt in a box.

f. To maintain self-cleaning conditions, closed conduit velocities will be greater than 2.5 ft/sec.

Storage Basins

a. Basins may provide either stormwater detention (limited release during and after storm event) or retention (storage of full runoff volume).

b. Off-channel or flow-by basins are preferred to in-channel or flow-through basins due to their smaller storage requirement.

c. Below grade basins are preferred to above grade basins.

d. In-channel above grade basins will be required to safely pass the probable maximum flood over the spillway.

e. Detention basins will be drained in less than 24 hours. Retention basins will be drained in less than 7 days.

f. When incorporated into school facilities, retention basins will have a maximum ponding depth of 3.0 feet.

g. Freeboard requirements are generally 2 feet for detention and retention basins. For basins with ponding depths of 5.0 feet or less, only 1 foot of freeboard is required.

h. Basins will be passive, self-regulating facilities (i.e., no electrically or manually operated controls).

i. All basins will have spillways and low-level outlets.

j. Basins will be located on sites with multi-use potential to the extent possible.

k. Basins will be designed to capture and retain sediment from upstream watersheds.

l. Maximum basin side slopes are 4:1.

m. Debris basins will be required at all upstream channel or pipeline headworks to focus sediment and debris deposition in manageable locations. They are sized with a storage volume of 5,000 cubic yards per square mile, and include a spillway to pass the 100-year design discharge.

Floodways

a. Floodways are defined as broad areas of natural sheet flow which are to be reserved as a drainage easement area.

b. The minimum floodway width will be 500 feet. This provides sufficient setback for erosion protection, and also establishes a wide enough area to have open space benefits.

c. Floodways will be flanked by confining levees with a height of 3 feet and slope protection at critical locations to prevent erosion.

d. If necessary, concrete or rip rap flow spreading slabs will be placed across the entire floodway width to prevent excessive flow concentration leading to invert erosion and headcutting.

Dikes/Levees

a. Dikes or levees may be used to direct sheet flows to a desired outfall location (e.g., channel inlet).

b. The minimum dike height is 3 feet.

c. The standard dike cross section has a 12-foot top width and 3:1 side slopes to allow for access and maintenance.

d. Dike lining is required based on the same slope protection criteria for open channels. Lining will include a 5-foot deep cut-off wall at the toe of the dike.

Bridges and Culverts

a. Culverts or bridges will be provided for all crossings of proposed open channels by existing streets, whether they are presently paved or unpaved. Dip sections or low flow crossings are considered temporary measures and are not considered in the Master Plan.

b. New bridge or culvert structures will not encroach below the defined channel freeboard.

c. A debris allowance of 2 feet will be required for capacity calculations of bridges and culverts with vertical piers. If sloping piers are used, the debris allowance will be applied to the upper 25 percent of the flow depth only.

Right-of-Way

a. For natural watercourses, a drainage easement is required for the full waterway including freeboard, modified as necessary to account for a maximum side slope of 2:1. A setback of 50 feet is required for local and secondary watercourses; a setback of 100 feet is required for major watercourses.

b. For channels with side slopes steeper than 4:1, the following right-of-way requirements apply.

Top Width	Right-of-Way
Over 50 feet	Top width plus 20 feet on both sides
Under 50 feet	Top width plus 20 feet on one side and 5 feet on other side

These right-of-way requirements need not apply when a channel is parallel and adjacent to a public roadway.

c. For channels with side slopes flatter than 4:1, right-of-way is the top width plus 5 feet on both sides.

d. For concrete channels with no maintenance roads, right-of-way is the top width plus 0.5 feet on both sides. Access to the channel must be provided at intervals of not more than 2,000 feet.

e. For closed conduits, right-of-way is the conduit width plus 2 feet on both sides, with a minimum of 10 feet.

f. Basins will require 5 feet of additional right-of-way beyond the top of the banks around the entire site.

g. Fencing is not required for natural watercourses or for channels with side slopes flatter than 4:1. Otherwise, 5-foot chain link fences are required on both sides of the channel. Basins must be fenced if the design depth is greater than 18 inches and the slopes are steeper than 4:1.

h. Levees will require 5 feet of additional right-of-way beyond the toe of the slope on both sides of the embankment.

5.3 RIDGECREST WASH DRAINAGE BASIN

Flooding from Ridgecrest Wash affects areas throughout the northwest portion of the City. Runoff originates in the watershed to the south and southwest; local runoff is a relatively minor problem in this basin. Thus the strategy in developing drainage alternatives was to intercept and divert runoff before it enters the developed portion of the study area. All alternatives include a storm drain in Downs St, a channel/drain in Mahan St, and a major cutoff channel along Brady St. Alternative 1 is an all-conveyance alternative which includes only channels and storm drains; Alternative 2 incorporates detention/retention basins in order to reduce the size of downstream facilities.

Elements of each alternative for the Ridgecrest Wash Drainage Basin are summarized in Table 5-1.

Alternative 1

In this alternative, the main cutoff channel for all west-to-east flows is located along Brady St, which is one-half mile west of the current City boundary. There is no protection provided for properties west of Brady St.

The Brady Channel (RCW-21 to RCW-35) begins just north of Upjohn Ave, and terminates in the El Paso Wash channel north of Inyokern Rd. Due to its critical importance to flood protection, the entire facility has been sized for the 100-year event, even though portions of the channel south of Las Flores Ave pick up runoff from less than 1 square mile. In general the channel has rock side slopes and an unlined bottom. Exceptions are in the most upstream reach where the channel is unlined, and in the most downstream reach where a 6 - 9'w x 4'd RCB must be used to cross Inyokern Rd with a minimum of vertical clearance. Where necessary, rock drop structures have been incorporated to maintain an invert slope consistent with design velocities less than 8 ft/sec.

In the reach between Ward Ave and Inyokern Rd, the Brady Channel is on the west side of the street and a wider, shallower channel cross section is adopted (42'w x 8'd) in order to transition from the deeper upstream reach (24'w x 10'd) to the Inyokern Rd culvert; also, there are no existing surface improvements to contend with in this area. The remainder of the channel is on the east side of Brady St. Between Upjohn Ave and Las Flores Ave, the channel crosses swales up to 10 feet deep which are part of the Ridgecrest Wash floodplain. In these locations (subareas RCW170, RCW180, and

TABLE 5-1

RIDGECREST WASH DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Alternative 1 - All Conveyance					
RCW-01	CHANNEL - 8'w x 8'd x 3:1 unlined R/W = 0'	4,350	N/A	N/A	Inyokern Rd Channel Deepening
RCW-02	RCB - 7'w x 6'd	400	380	10	Downs - Under Inyokern
RCW-03	RCP - 78"	2,350	230	10	Downs - Inyokern to Ward
RCW-04	RCP - 60"	1,350	120	10	Downs - Ward to Sydnor
RCW-05	RCP - 54"	1,350	100	10	Downs - Sydnor to Drummond
RCW-06	RCP - 42"	2,000	64	10	Downs - Drummond to El Sereno
RCW-07	N/A				
RCW-08	RCB - 2 - 5.5'w x 4'd	600	650	25	Mahan - Under Inyokern
RCW-09	RCP - 60"	800	280	10	Mahan - Inyokern to Graaf
RCW-10	CHANNEL - 8'w x 6'd x 3:1 unlined 1 - 3' drop structure R/W = 49'	2,600	280	10	Mahan - Graaf to Sydnor
RCW-11	N/A				
RCW-12	RCB - 2 - 6.5'w x 4'd	80	280	10	Ward Culvert
RCW-13	RCB - 2 - 6.5'w x 4'd	60	280	10	Sydnor Culvert
RCW-14	CHANNEL - 8'w x 6'd x 3:1 unlined R/W = 49'	1,300	260	10	Mahan - Sydnor to Drummond
RCW-15	N/A				
RCW-16	RCB - 2 - 4.5'w x 3'd	80	260	10	Drummond Culvert
RCW-17	CHANNEL - 8'w x 4.5'd x 3:1 unlined R/W = 40'	2,600	100	10	Mahan - Drummond to Las Flores
RCW-18	RCB - 2 - 3.5'w x 3'd	50	100	10	Felspar Culvert

TABLE 5-1 (cont'd)

RIDGECREST WASH DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Alternative 1 - All Conveyance					
RCW-19	RCP - 2 - 27"	80	100	10	Las Flores Culvert
RCW-20	CHANNEL - 0'w x 4'd x 4:1 unlined R/W = 37'	2,600	34	10	Mahan - Las Flores to Ridgecrest V-ditch
RCW-21	RCB - 6 - 9'w x 4'd	440	2,400	100	Brady - Reach 7
RCW-22	CHANNEL - 42'w x 8'd x 2:1 Rip rap sides 1 - 3' drop structure R/W = 79'	2,300	2,400	100	Brady - Reach 6 (to Ward)
RCW-23	RCP - 3 - 42"	60	220	10	Graaf Culvert
RCW-24	RCB - 2 - 14'w x 8'd	80	2,400	100	Ward Culvert
RCW-25	CHANNEL - 24'w x 10'd x 2:1 Rip rap sides 2 - 3' drop structures R/W = 69'	3,750	2,350	100	Brady - Reach 5 (Ward to RCW140)
RCW-26	RCP - 3 - 42"	60	220	10	Sydnor Culvert
RCW-27	RCB - 3 - 9.5'w x 8'd	80	2,350	100	Drummond Culvert
RCW-28	CHANNEL - 10'w x 7'd x 2:1 Rip rap sides 4 - 3' drop structures R/W = 43'	1,950	630	100	Brady - Reach 4 (RCW140 to 170)
RCW-29	RCP - 2 - 33"	60	76	10	Felspar Culvert
RCW-30	RCB - 10'w x 5'd	80	630	100	Las Flores Culvert
RCW-31	CHANNEL - 12'w x 7'd x 2:1 Rip rap sides R/W = 45'	650	560	100	Brady - Reach 3 (RCW170 - 180)
	Levee - 9'high Rip rap side R/W = 90'	1,350			

TABLE 5-1 (cont'd)

RIDGECREST WASH DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Alternative 2 - Detention					
RCW-19	RCP - 2 - 27"	80	100	10	Las Flores Culvert
RCW-20	CHANNEL - 0'w x 4'd x 4:1 unlined R/W = 37'	2,600	34	10	Mahan - Las Flores to Ridgecrest V-ditch
RCW-21	RCB - 6 - 6'w x 4'd	440	1,500	100	Brady - Reach 7
RCW-22	CHANNEL - 25'w x 8'd x 2:1 Rip rap sides 1 - 3' drop structure R/W = 54'	2,300	1,500	100	Brady - Reach 6 (to Ward)
RCW-23	RCP - 3 - 42"	60	220	10	Graaf Culvert
RCW-24	RCB - 2 - 9'w x 6'd	80	1,500	100	Ward Culvert
RCW-25	CHANNEL - 12'w x 10'd x 2:1 Rip rap sides 2 - 3' drop structures R/W = 57'	3,750	1,500	100	Brady - Reach 5 (Ward to RCW140)
RCW-26	RCP - 3 - 42"	60	220	10	Sydnor Culvert
RCW-27	RCB - 2 - 9'w x 6'd	80	1,500	100	Drummond Culvert
RCW-28	CHANNEL - 8'w x 5'd x 2:1 Rip rap sides 4 - 3' drop structures R/W = 33'	1,950	140	100	Brady - Reach 4 (RCW140 to 170)
RCW-29	RCP - 2 - 33"	60	76	10	Felspar Culvert
RCW-30	RCB - 6'w x 3'd	80	140	100	Las Flores Culvert
RCW-31	CHANNEL - 8'w x 3'd x 2:1 unlined R/W = 25'	600	100	100	Brady - Reach 3 (RCW170 - 180)
	Levee - 6' high unlined R/W = 48'	450			

TABLE 5-1 (cont'd)

RIDGECREST WASH DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Alternative 2 - Detention					
RCW-32	CHANNEL - 10'w x 6'd x 2:1 Rip rap sides 1 - 4' drop structure R/W = 39'	900	390	100	Brady - Reach 2 (RCW180 - 190)
RCW-33	RCB - 10'w x 4'd	80	390	100	Ridgecrest Culvert
RCW-34	CHANNEL - 8'w x 4'd x 2:1 Rip rap perimeter R/W = 29'	400	130	100	Brady - Reach 1b
RCW-35	CHANNEL - 10'w x 5'd x 2:1 unlined	800	130	100	Brady - Reach 1a
	Levee - 3' high Rip rap lined side	400	130	100	
RCW-36	N/A				
RCW-37	Detention Basin - 105 AF 8.2 acres 15' deep, 2 ft levees 36" RCP outlet	-	Inflow = 2,240 Outflow = 1,500	100 100	Brady/Felspar Basin
	Inlet Channel - 17'w x 8'd x 2:1 Rip rap sides R/W = 54' 90' concrete overflow weir	700	1450	100	
	Inlet Dike - 4' high Rip rap lining	600	-	-	
RCW-38	Retention Basin - 30 AF 6.0 acres 8' deep 18" RCP outlet Spill to Brady Channel	-	Inflow = 560 Outflow = 0	100 100	Brady/RCW180
RCW-39	Detention Basin - 11.9 AF 2.1 acres 7' deep 21' concrete overflow weir 18" RCP outlet	-	Inflow = 260 Outflow = 77	10 10	Mahan/Sydnor Basin

TABLE 5-1 (cont'd)

RIDGECREST WASH DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Alternative 1 - All Conveyance					
RCW-32	CHANNEL - 10'w x 6'd x 2:1 Rip rap sides 1 - 4' drop structure R/W = 39'	900	390	100	Brady - Reach 2 (RCW180 - 190)
RCW-33	RCB - 10'w x 4'd	80	390	100	Ridgecrest Culvert
RCW-34	CHANNEL - 8'w x 4'd x 2:1 Rip rap sides + bottom R/W = 29'	400	130	100	Brady - Reach 1b
RCW-35	CHANNEL - 10'w x 5'd x 2:1 unlined	800	130	100	Brady - Reach 1a
	Levee - 3' high Rip rap side	400	130	100	
RCW-36	DEBRIS BASIN - 36 AF Concrete spillway R/W = 4.5 acres 10' deep	-	2,240	100	Brady and Drummond

TABLE 5-1 (cont'd)

RIDGECREST WASH DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Alternative 2 - Detention					
RCW-01	CHANNEL - 8'w x 8'd x 3:1 unlined R/W = 0'	4,350	N/A	N/A	Inyokern Rd Channel Deepening
RCW-02	RCB - 6.5'w x 5'd	400	300	10	Downs - Under Inyokern
RCW-03	RCP - 66"	2,350	150	10	Downs - Inyokern to Ward
RCW-04	RCP - 36"	1,700	40	10	Downs - Ward to Sydnor
RCW-05	RCP - 54"	1,000	100	10	Downs - Sydnor to Drummond
RCW-06	RCP - 42"	2,000	64	10	Downs - Drummond to El Sereno
RCW-07	N/A				
RCW-08	RCB - 5'w x 4'd	600	300	25	Mahan - Under Inyokern
RCW-09	RCP - 42"	800	77	10	Mahan - Inyokern to Graaf
RCW-10	CHANNEL - 8'w x 4'd x 3:1 unlined R/W = 37'	2,600	77	10	Mahan - Graaf to Sydnor
RCW-11	N/A				
RCW-12	RCB - 2 - 4'w x 2'd	80	77	10	Ward Culvert
RCW-13	RCB - 2 - 4'w x 2'd	60	77	10	Sydnor Culvert
RCW-14	CHANNEL - 8'w x 6'd x 3:1 unlined R/W = 49'	1,300	260	10	Mahan - Sydnor to Drummond
RCW-15	N/A				
RCW-16	RCB - 2 - 4.5'w x 3'd	80	260	10	Drummond Culvert
RCW-17	CHANNEL - 8'w x 4.5'd x 3:1 unlined R/W = 40'	2,600	100	10	Mahan - Drummond to Las Flores
RCW-18	RCB - 2 - 3.5'w x 3'd	50	100	10	Felspar Culvert

TABLE 5-1 (cont'd)

RIDGECREST WASH DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Alternative 2 - Detention					
RCW-40	Detention Basin - 4.2 AF 1.7 acres 7' deep (3' ponding) 27' concrete overflow weir 36" inlet pipe 18" outlet pipe Park landscaping	-	Inflow = 100 Outflow = 20	10 10	Downs/Pearson Park Basin

Abbreviations:

- Channel dimensions: bottom width x depth x side slope (horiz:vert)
- RCB - reinforced concrete box
- RCP - reinforced concrete pipe
  - dimensions: diameter
- Detention/Retention dimensions: total volume in acre-feet; total surface area in acres
- R/W - right-of-way

RCW240), the channel is leveed on the east side in order to intercept the surface flow. The design channel invert in these areas would be above the invert of the existing swale. Rather than filling these areas in, the depressions can be preserved so they can act as informal debris control areas. A 36 acre-foot debris basin (RCW-36) is located near Drummond Ave in subarea RCW140, which is the main branch of Ridgecrest Wash, in order to intercept debris before it enters the Brady Channel.

Culverts with full 100-year capacity were provided at major street crossings of the channel (Ward Ave, Drummond Ave, Las Flores Ave, and Ridgecrest Blvd) where emergency access should be provided. Other crossings were sized for 10-year flows so they would remain passable in all but the more severe flooding conditions; alternate routes are available in these cases.

The Mahan Channel (RCW-08 to RCW-20) begins at Ridgecrest Blvd and discharges to the NWC channel on the north side of Inyokern Rd. It collects all runoff between Brady St and Mahan St. The Mahan Channel has a 10-year capacity for all reaches except the crossing of Inyokern Rd, where the drainage area exceeds 1.0 square mile and a 25-year capacity is adopted. The facility is an unlined channel from Ridgecrest Blvd to Graaf Ave, with a cross section varying from a 4-ft deep V-ditch at the upstream end to an 8'w x 6'd trapezoidal channel between Sydnor Ave and Graaf Ave. In the latter reach a 3-ft rock drop structure is required to maintain a safe velocity. At Graaf Ave the channel transitions to a 60" RCP to avoid displacing existing surface improvements.

The facility outlets to the existing NWC unlined channel running east-west between Inyokern Rd and the U.S Government Railroad tracks. This channel is currently only 4 feet deep at Mahan St; this shallow depth severely restricts the height of a concrete box required to convey the Mahan Channel flow under Inyokern Rd. To improve the hydraulics at this location, Alternative 1 includes deepening the NWC channel by 4 feet while maintaining a bottom width of 8 feet and side slopes of 3:1 (RCW-01). The conduit under Inyokern Rd is a 6'w x 4'd RCB.

Culverts are provided at road crossings of the Mahan Channel at quarter mile intervals. Thus 10-year culverts are included at Ward Ave, Sydnor Ave, Drummond Ave, Felspar Ave, and Las Flores Ave. Any other minor road crossings are dip sections only. No debris basins are provided for Mahan Channel due to the small drainage area.

This alternative includes a major storm drain in Downs St between El Sereno Ave and Inyokern Rd (RCW-02 to RCW-06). The purpose of the drain is to collect and convey runoff from the area between Mahan St and Downs St. From El Sereno Ave to Inyokern Rd the drain is a pipe varying in diameter from 42 to 78 inches. At Inyokern Rd the drain transitions to a box in order to get under Inyokern Rd with adequate vertical clearance.

This alternative assumes that there is a diversion of runoff from subareas RCW270 and RCW280 into the West China Lake Drainage Basin, via a storm drain in Las Flores Ave. This allows the Downs Storm Drain to be downsized by an average of 18 inches in diameter. Although the West China Lake facilities must be enlarged to accommodate the diverted flow, the diversion scenario is preferred because: (1) it is about 6 percent less expensive than the direct conveyance approach where RCW270 and RCW280 flows would be taken down Downs St; and (2) it reduces potential constructability problems associated with constructing a very large, shallow box under Inyokern Rd.

Alternative 2

Alternative 2 is the Detention Alternative for the Ridgecrest Wash Drainage Basin. It incorporates the alignment of conveyance facilities described for Alternative 1, but adds detention/retention basins at key locations to reduce the size of these conveyance facilities.

Two storage sites were identified for the Brady Channel. Site 1 (RCW- 38) is in the natural depression at the confluence of the swale in subarea RCW180. The basin is located east of the channel, and is constructed by a combination of diking around the present depression and excavating a 6-acre area to the natural invert elevation. The total basin volume is 30 acre-feet, which will allow for full retention of the 100-year hydrograph. Because of the natural storage at the site, an excavation volume of only 14 acre-feet is required. The maximum basin depth is 8 feet, which includes 2 feet of freeboard. An overflow channel with 100 cfs capacity is provided along Brady St to handle flows in excess of the design volume. The basin will be drained via an 18-inch pipe outletting to the RCW180 swale; this flow will eventually be picked up by the Mahan Channel.

Site 2 (RCW-37) is located near the intersection of Brady St and Felspar Ave. It is designed to intercept and detain runoff at subarea RCW140 (the main branch of Ridgecrest Wash) before it enters the Brady Channel. The site is the open parcel of 8.2 acres (600 ft by 600 ft) at the northwest corner of Brady St and Felspar Ave. The basin is conceived as an off-channel facility which will receive overflows from the main RCW140 flow. This will require construction of a collection dike along the westward extension of the north rim of the basin, as well as channelization of the flow past the basin and into the Brady Channel.

The tributary area at this location is large (11.7 square miles), contributing to a large hydrograph volume. In addition, the long extent of the watershed area results in a bi-modal hydrograph peak which increases the storage required to reduce the non-detained discharge to any specified level. The recommended basin size is 105 acre-feet, which will allow the 100-year peak flow in Brady Channel to be reduced from 2,350 cfs to 1,500 cfs. The maximum basin depth is 15 feet, with a 2-foot dike included to provide freeboard.

Flows will enter the basin via a concrete-lined overflow weir in the proposed channel adjacent to the basin. The weir length is 90 feet for 2 feet of overflow depth. The slope of the basin will also be lined at the overflow weir to provide erosion protection. In order to obtain enough storage at this site to make a significant impact on downstream facilities, while maintaining minimal land acquisition needs, the basin bottom must be about 5 feet lower than the adjacent invert of the Brady Channel. The shallow longitudinal slope of the Brady Channel would result in the need for a very long outlet pipe to drain the entire basin by gravity to the channel. Thus the recommended approach is to drain the upper 10 feet of the basin by gravity to the Brady Channel, and designate the lower 5 feet as a retention area. The upper portion will be drained in 24 hours using a 36-inch RCP extending north from the basin a distance of 1,000 feet; the lower portion will be drained only through percolation and evaporation.

Construction of detention/retention basins at Sites 1 and 2 allow for a reduction in the size of the required Brady Channel facilities. Channel widths are reduced by 2 to 17 feet; depths are reduced by 0 to 4 feet.

Alternative 2 also includes a detention basin on the Mahan Channel (RCW-39). There are several potential basin locations near the intersection of Sydnor Ave and Mahan St which are hydrologically effective. This report shows the basin on the southeast corner of the intersection, although sites on the northeast and southwest corners could also be developed. The off-channel detention basin covers 2.1 acres (300 ft by 300 ft), and has a maximum depth of 7 feet. Allowing for 2 feet of freeboard, the active storage volume is 8.5 acre-feet. This volume is capable of reducing the 10-year peak flow from 260 cfs to 77 cfs. An overflow weir in the Mahan Channel (21 feet long, 2 feet deep) allows flows in excess of 77 cfs to enter the basin. A 12-inch RCP outlet pipe is provided to drain the basin in 24 hours by gravity back to the Mahan Channel. Although not presently identified as a potential park site, this detention basin could be designed as a multi-use facility.

The reduced downstream flows allow for a reduction in the size of the Mahan Channel below the basin. The channel from Sydnor Ave to Graaf Ave is 2 feet shallower (it was already the minimum width of 8 feet) than in the all-conveyance alternative; the drain between Graaf Ave and Inyokern Rd is 18 inches smaller; and the 25-year RCB culvert crossing of Inyokern Rd is less than half as wide.

Alternative 2 incorporates a detention basin in Pearson Park, located on the west side of Downs St north of Vicki Ave. This is an existing City park which has recently been graded to act as a sump area with dry wells. The proposed basin facility is an off-channel basin; flows are diverted into the basin from the Downs Storm Drain via a 27-foot long overflow structure and a 36-inch pipe. With 4.2 acre-feet of active storage, the 10-year flow in the Downs Storm Drain can be reduced from 100 cfs to 20 cfs. In order to improve the hydraulics of the inflow system, the basin depth must be about 7 feet; however, the allowable ponding depth in an urban, multi-use detention facility is only 3 feet. To accommodate the required overexcavation and a minimum 5:1 side slope, a surface area of 1.7 acres must be set aside for the basin. The park site is a total of 3.93 acres, so this represents about 40 percent of the park area. The basin is drained by a 12-inch RCP which returns flows to the Downs Storm Drain after the storm has passed.

The Pearson Park detention basin area will be relandscaped with turf after excavation to allow use as a ballfield, playground, picnic area, or any other use which does not include permanent structures which could be damaged by occasional inundation (e.g., restrooms). This is consistent with the proposed recreational use plan for Pearson Park.

Construction of the Pearson Park detention basin will reduce the diameter of downstream conveyance facilities in Downs St by 12 to 24 inches.

Other Alternatives

In addition to Alternatives 1 and 2 described above, three other alternatives were investigated for Ridgecrest Wash. Primarily these included other locations for the main north-south cutoff channel, which in the above alternatives is shown along Brady St. Other alternatives are briefly described below.

Alternative 3 is similar to Alternative 1, but with the main cutoff channel moved from Brady St to Primavera St. The Primavera Channel would extend from north of Las Flores Ave to approximately Sydnor Ave, where it would outfall to El Paso Wash. The peak flow intercepted at this location is slightly less than that collected at Brady St (2,310 cfs vs 2,350 cfs).

The Primavera St alignment has several advantages over the Brady St alignment. First, the channel is shorter (3,100 feet compared to 6,500 feet). Second, the channel outfalls to El Paso Wash, and as such does not have to convey flow under Inyokern Rd. (El Paso Wash Alternative 1 does not include improvements to Inyokern Rd.) Finally, there is less existing development in the vicinity of the Primavera Channel alignment, which could make the right-of-way acquisition process easier.

The Mahan Channel serves essentially the same purpose in Alternative 3 as in Alternative 1 - that is, to intercept south branch Ridgecrest Wash flows and local flows between Primavera St and Mahan St. Because the local tributary area is larger in Alternative 3, the Mahan Channel bottom width is increased by 3 to 8 feet over Alternative 1. It remains unlined with drop structures north of Drummond Ave and has rip rapped banks south of Drummond Ave. The Downs Storm Drain would be the same in this alternative as in the other alternatives.

Based on a preliminary cost estimate, Alternative 3 is about 11 percent less expensive than Alternative 1. However, locating the primary cutoff channel this far west into unincorporated Kern County was not satisfactory to the City, due to potential problems with land acquisition and ongoing maintenance.

Alternative 4 assumes that the primary cutoff channel would be located along Mahan St in order to keep this critical facility entirely in the present incorporated area of the City. The channel would extend from Ridgecrest Blvd to Inyokern Rd. In this scenario a lined channel is used in order to minimize right-of-way requirements. Rip rap lining is used from Ridgecrest Blvd to Las Flores Ave, and gunite lining is used from Las Flores Ave to Graaf Ave. The channel geometry would vary from 5'w x 4'd at the upstream end to 17'w x 10'd at Graaf Ave. At Graaf Ave the facility would transition to a 4-barrel 7.5'w x 4'd RCB to get under Inyokern Rd.

A preliminary cost estimate indicated that Alternative 4 is about 8 percent more expensive than Alternative 1, due primarily to the decision to line the channel and maintain a minimum top width.

Alternative 4 requires construction of large and expensive box culverts in Mahan St to convey flow between Graaf Ave and Inyokern Rd. As an option to the use of the Mahan St alignment, Alternative 5 includes a detention basin for the Mahan Channel. There are two potential sites on the northeast and southeast corners of the intersection of Mahan St and Sydnor Ave. Each site is about 8.2 acres (600 ft by 600 ft). The total volume of the Ridgecrest Wash 100-year hydrograph at this location is about 860 acre-feet, with a peak of 2,380 cfs. Providing retention storage of 101 acre-feet will reduce the peak flow downstream to about 1,500 cfs. This can be accomplished with a maximum retention basin depth of 17 feet (including 2 feet of freeboard), and will significantly reduce the required size of the downstream channel and storm drain.

A preliminary cost estimate showed that including the detention basin in Alternative 5 provides about a 19 percent savings over the all-conveyance Mahan Channel option in Alternative 4. However, it is still slightly more expensive than the detention option for the Brady Channel in Alternative 2, due to the channel lining for the Mahan Channel which is still used upstream of the detention basin.

5.4 WEST CHINA LAKE DRAINAGE BASIN

Alternatives in the West China Lake Drainage Basin rely on two primary facilities: the French Avenue Channel and the Norma/Felspar sump area. The former is an existing facility with more than adequate capacity for the naturally tributary ultimate condition flows; the latter is a small existing sump area which will be expanded in Alternative 2 to accommodate Master Plan flows.

Facilities in the West China Lake Drainage Basin alternatives are summarized in Table 5-2.

Alternative 1

This is the All Conveyance Alternative. In this alternative, drainage to the Norma/Felspar sump area is collected in main storm drains in Norma St both north and south of the basin inlet off of Norma Street (WCL-02 to WCL-03) and from a small portion of the Ridgecrest Wash Drainage Basin (subareas RCW270 and RCW280). Drains vary in diameter from 42 to 72 inches. To convey the drainage from RCW270 and RCW280 to the sump area site, a storm drain must be constructed in Las Flores Ave from Downs St to Norma St (WCL-09). The inlet channel off of Norma St (presently 16 feet wide and 3-4 feet deep) must be deepened to 7 feet in order to accept the storm drains. The existing fenced right-of-way for this channel is about 30 feet wide. If this is maintained with a 7-foot channel depth and the minimum unlined channel bottom width of 8 feet, then the side slopes of the channel must be steepened to 1.35:1. Under the proposed design criteria, this requires concrete or gunite lining for slope stability. Gunite is used for cost estimating purposes. Inlets to the sump area are also provided off of Las Flores Ave and Felspar Ave (WCL-07 and WCL-08). The inlet from Las Flores Ave is an unlined 8'w x 3.5'd channel with 3:1 side slopes; it traverses the currently open land between Las Flores and Felspar, but will require

TABLE 5-2

WEST CHINA LAKE DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Alternative 1 - All Conveyance					
WCL-01	N/A				
WCL-02	CHANNEL - 8'w x 7'd x 1.35:1 gunite sides no new R/W	1,300	300	25	Norma Inlet Channel
WCL-03	RCP - 54"	800	96	10	Norma North Drain
WCL-04	RCP - 42"	700	71	10	Norma South Drain - Argus to Coso
WCL-05	RCP - 48"	650	95	10	Norma South Drain - Coso to Las Flores
WCL-06	RCP - 72"	1,000	250	10	Norma South Drain - Las Flores to Outfall
WCL-07	CHANNEL - 8'w x 3.5'd x 3:1 unlined R/W = 37'	1,100	63	25	Las Flores Inlet Channel
WCL-08	RCP - 30"	200	23	10	Felspar Inlet Drain
WCL-09	RCP - 54"	2,750	150	10	Las Flores Drain
WCL-10	RCP - 66"	670	120	10	French Drain
WCL-11	CHANNEL - 8'w x 5.5'd x 2:1 unlined no new R/W	600	-	-	French Channel Deepening; lower inlet
WCL-12	RCP - 84" R/W = 12'	3,900	350	10	Sump area outfall
WCL-13	CHANNEL - 8.5'w x 8.5'd x 2:1 unlined 1 - 3' drop structure	1,320	350	10	Sump area outfall; maximum channel size shown; daylights to natural grade

TABLE 5-2 (cont'd)

WEST CHINA LAKE DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Alternative 2 - Detention					
WCL-01	RETENTION BASIN - 55 AF 5 acres, 14' deep no outlet or spillway	-	460 inflow 0 outflow	25	At Norma and Felspar; expand present sump area
WCL-02	CHANNEL - 8'w x 7'd x 1.35:1 gunite sides no new R/W	650	300	25	Norma Inlet Channel
WCL-03	RCP - 54"	800	96	10	Norma North Drain
WCL-04	RCP - 42"	700	71	10	Norma South Drain - Argus to Coso
WCL-05	RCP - 48"	650	95	10	Norma South Drain - Coso to Las Flores
WCL-06	RCP - 72"	1,000	250	10	Norma South Drain - Las Flores to Outfall
WCL-07	CHANNEL - 8'w x 3.5'd x 3:1 unlined R/W = 37'	1,200	63	25	Las Flores Inlet Channel
WCL-08	RCP - 30"	200	23	10	Felspar Inlet Drain
WCL-09	RCP - 54"	2,750	150	10	Las Flores Drain
WCL-10	see CH-12				
WCL-11	see CH-13				

acquisition of a 37 foot wide strip of right-of-way including an 8-foot wide access road. The Felspar inlet will be a 30-inch storm drain.

All the inflow to the Norma/Felspar sump area will be conveyed to the east via conduits or channels. The Felspar inlet ties into the Norma inlet which, in turn, ties into the Las Flores inlet just before it joins the Felspar outfall, an 84" RCP (WCL-12). The Felspar outfall continues due east across China Lake Blvd to French Ave, where it becomes an 8.5'w x 8.5'd channel with 2:1 side slopes. An unlined open channel option was investigated in place of the 84" RCP. However, because the headworks of the pipe is in the sump area, there is high ground between the pipe inlet and outlet. This would require a maximum channel depth of 23 feet, which with 3:1 side slopes would necessitate a channel right-of-way width of up to 171 feet. This was not considered to be a reasonable alternative for this area. Nonetheless, due to the lack of surface improvements along the proposed pipeline alignment, cast-in-place concrete pipe can be used to minimize the cost of this facility.

The southern portion of the West China Lake Drainage Basin drains to the French Avenue Channel. This alternative includes a storm drain in French Ave between Balsam Ave and the channel in order to convey the flow under China Lake Blvd (WCL-10). This facility is a 66-inch RCP, and replaces a 30-inch CMP. To accept a drain of this larger size, the French Avenue Channel invert must be lowered by up to 4 feet over a length of 600 feet.

Alternative 2

In this alternative, drainage to the Norma/Felspar Retention Basin is collected in the same manner as drainage was collected at the sump area in Alternative 1. These facilities include the main storm drains in Norma St both north and south of the basin inlet off of Norma St (WCL-02 to WCL-03) and the storm drain in Las Flores Ave from Downs St to Norma St (WCL-09). An option was considered in which the runoff from subareas RCW270 and RCW280 was directed to the Downs storm drain in the Ridgecrest Wash Drainage Basin, and the West China Lake Drainage Basin facilities were sized to handle only local runoff. However, preliminary cost estimates indicated that it is more cost-effective to accommodate the RCW270 and RCW280 flows in the West China Lake drainage system and allow the Downs storm drain to be reduced in size.

As with Alternative 1, the inlet channel off of Norma St (WCL-02) must be deepened to 7 feet in order to accept the storm drain, and the sides must be lined with concrete due to the steep side slopes required to keep the channel in the existing right-of-way. The inlets to the retention basin off of Las Flores Ave and Felspar Ave (WCL-07 and WCL-08) from Alternative 1 are also used for Alternative 2. It is noted that the lengths of some of the inlet facilities to the retention basin are slightly different than those for Alternative 1, due to the configuration of the basin.

The retention basin (WCL-01) is located in a 5-acre parcel which is expected to be acquired by the City, at the site of the existing Norma/Felspar sump area. To accommodate the full 25-year inflow (including diversions from subareas RCW270 and RCW280) with 2 feet of freeboard, the existing basin volume must be increased to 55 acre-feet. With 5 acres of surface area and 4:1 side slopes, this requires a depth of 14 feet. The basin will function as a retention facility; that is, it will be emptied only through percolation and evaporation. There are no nearby storm drains which could act as an outfall either by gravity or through pumping. A retention basin with these characteristics will be capable of accepting the 100-year hydrograph volume and keeping ponding depths in areas adjacent to the basin at 1.0 foot or less.

In the southern portion of the West China Lake Drainage Basin, Alternative 2 consists of storm drains required to convey flow diverted from the Church Street Drainage Basin as well as the local flows. These facilities have been incorporated into the Church St system rather than the West China Lake system (CH-11 to CH-13).

5.5 INYOKERN AND DRUMMOND AVENUE WASH DRAINAGE BASINS

The Inyokern Drainage Basin and the Drummond Avenue Wash Drainage Basin are located in the northeast corner of the City, and are influenced only by local drainage. The major drainage facilities formulated for this area are storm drains in Norma St and in Ward Ave.

Elements of the alternative drainage facilities developed for the Inyokern and Drummond Avenue Wash Drainage Basins are summarized in Table 5-3.

Alternative 1

This is the most straightforward approach to handling drainage in this area. It consists of a major storm drain in Norma St from Ward Ave to Inyokern Rd, and two reaches of storm drain in Ward Ave (Sierra View St to Norma St and Mountain View Place to China Lake Blvd). Pipe sizes vary from 48 to 84 inches (IK-01 to IK-06, DAW-01 to DAW-04).

The Norma St drain crossing of Inyokern Rd is complicated by the need to outlet to a shallow channel (4 feet deep) on the north side of the road. If the existing channel invert is maintained, a box culvert 2 feet deep and 20 feet wide is required to cross under the roadway. If the channel invert is lowered by 4 feet, then the crossing can be accomplished with an 84-inch RCP. Because the costs of the two options are within 6 percent of each other, the option with the lower channel invert is adopted in order to minimize potential utility conflicts in Norma St and Inyokern Rd.

There is no channel on the east side of China Lake Blvd to which the Ward Ave storm drain could discharge. Thus this alternative must include excavation of a channel capable of daylighting this flow. The selected alternative is an 8-foot wide unlined channel with a maximum depth of 5 feet and length of 350 feet. If necessary, this channel could be extended to tie into drainage facilities on the NWC base.

Alternative 2

This alternative places the main storm drain in Ward Ave rather than in Norma St. Flows from subareas IK020 and IK030 are diverted into the

TABLE 5-3

INYOKERN AND DRUMMOND AVENUE WASH DRAINAGE BASINS

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Alternative 1 - Conveyance/No IK Diversion					
IK-01	RCP - 48"	1,320	89	10	Ward Drain
IK-02	RCP - 54"	660	130	10	Norma Drain
IK-03	RCP - 72"	670	160	10	Norma Drain
IK-04	RCP - 84"	1,335	230	10	Norma Drain
IK-05	RCB - 2 - 10'w x 2'd	175	230	10	Inyokern Culvert
IK-06	N/A				
DAW-01	RCP - 54"	650	150	10	Ward Drain
DAW-02	RCP - 54"	1,380	80	10	Ward Drain
DAW-03	N/A				
DAW-04	CHANNEL - 7'w x 5'd x 3:1 unlined R/W = 62'	350	150	10	Channel to daylight Ward Drain
Alternative 2 - Conveyance/With IK Diversion					
IK-01	RCP - 48"	1,320	89	10	Ward Drain
IK-02	N/A				
IK-03	N/A				
IK-04	RCP - 60"	1,110	90	10	Norma Drain
IK-05	RCP - 66"	400	130	10	Inyokern Culvert
IK-06	Channel 20'w x 6.5'd x 3:1 unlined R/W = 0'	1,450	-	-	Deepen existing NWC Channel to accomodate Norma Drain
DAW-01	RCP - 66"	650	150	10	Ward Drain
DAW-02	RCP - 78"	1,380	80	10	Ward Drain
DAW-03	RCP - 66"	650	280	10	Ward Drain
DAW-04	CHANNEL - 7'w x 6'd x 3:1 unlined R/W = 68'	1,060	290	10	Channel to daylight Ward Drain

Drummond Avenue Wash Drainage Basin by connecting the two reaches of storm drain in Ward Ave described in Alternative 1. This allows the Norma St drain to be 12 to 18 inches smaller, but requires the Ward Ave drain to be 12 to 24 inches larger.

Because the Norma St storm drain is smaller in this alternative than in Alternative 2, the outfall channel invert only needs to be lowered by at most 2.5 feet to daylight the proposed drain. By contrast, the channel required at the outfall of the Ward storm drain must be deeper (6 feet maximum) and longer (1,060 feet) than under Alternative 1.

5.6 CHURCH AVENUE AND UPJOHN AVENUE DRAINAGE BASINS

Church Avenue and Upjohn Avenue are two parallel drainage basins located between Ridgecrest Blvd and Bowman Rd. They are only influenced by local runoff. Because the drainage basins have a common outfall at Ridgecrest Blvd and are interrelated in other ways, discussion of their alternatives has been combined into a single section.

The present drainage pattern in these drainage basins consists of some street flow, but is primarily sheet flow in an urbanizing area. If storm drain improvements are made in this area, flow velocities could increase considerably. Because of the long length of the drainage basins, reduced travel time could significantly affect the timing of hydrograph combinations, and result in higher downstream flows than modeled for "without project" conditions as presented in Chapter 4. Therefore, a new HEC-1 run was made for 10-year and 25-year storms with routing parameters modified to model pipe flow conditions. Discharges from this run were used to size storm drains in the Church Avenue and Upjohn Avenue Drainage Basins.

Characteristics of alternative facilities for the Church Avenue and Upjohn Avenue Drainage Basins are summarized in Table 5-4.

Alternative 1

This alternative diverts as much of the Upjohn Avenue Basin runoff to Bowman Road Channel as possible, and diverts the upper portion of the Church Avenue Basin to the French Avenue Channel. The primary east-west facility is a storm drain in Church Ave and California Ave which outlets at Ridgecrest Blvd and Gateway Blvd.

The upper portion of the Church Avenue system (subareas CH010 and CH020) is diverted north into the West China Lake Drainage Basin at Norma St. This is done in order to try to maximize the use of the French Avenue Channel, which has unused capacity even under ultimate development conditions. In addition, it avoids the need for a long east-west storm drain which would parallel other facilities.

Several locations were investigated for diverting runoff from Church Ave directly to the French Avenue Channel. These included Gold Canyon Dr, Fire Opal St, Sunland St, and China Lake Blvd. However, in all these locations there was insufficient gradient for gravity flow in a storm drain

TABLE 5-4

CHURCH AVE AND UPJOHN AVE DRAINAGE BASINS

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Alternative 1 - All Conveyance					
CH-01	RCB - 7.5'w x 6'd	700	390	10	Gateway - California to Ridgecrest
CH-02	RCP - 84"	3,300	350	10	California - Sunland to Gateway
CH-03	RCP - 60"	2,660	170	10	Church - China Lake to Sunland
CH-04	RCP - 42"	1,310	105	10	Church - Norma to China Lake
CH-05	N/A				Church - Sierra View to Norma
CH-06	N/A				Sierra View - California to Church
CH-07	N/A				California - Downs to Sierra View
CH-08	N/A				Downs - Ridgecrest to California
CH-09	RCP - 54"	3,100	130	10	Ridgecrest - Downs to Norma
CH-10	RCP - 72"	930	280	10	Jean and Helena
CH-11	RCP - 78"	2,100	340	10	French - Helena to Balsam
CH-12	RCB - 9.5'w x 6'd	570	400	10	French - Balsam to Channel
CH-13	Channel - 8'w x 9'd x 2:1 to 8'w x 8'd x 2:1 unlined, R/W = 69'	820	-	-	French Channel Deepening; lower invert
CH-14	RCP - 66"	1,540	180	10	Norma - Church to Ridgecrest
CH-15	Channel - 8'w x 9'd x 2:1 unlined R/W = 49'	2,000	440	25	Daylight Channel; depth reduces to 0 at outfall
UJ-01	RCP - 48"	2,000	43	10	Gateway - Upjohn to California
UJ-02	RCP - 66"	1,300	130	10	Sunland - Upjohn to Church
UJ-03	RCP - 42"	2,600	56	10	China Lake - Rader to Church
UJ-04	RCP - 36"	1,320	62	10	Upjohn - Warner to China Lake
UJ-05	N/A				
UJ-06	N/A				

TABLE 5-4 (cont'd)

CHURCH AVE AND UPJOHN AVE DRAINAGE BASINS

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
UJ-07	RCP - 36"	2,640	46	10	Langley - Mahan to Downs
UJ-08	RCP - 30"	1,620	38	10	St. George - Guam to Mahan
UJ-09	RCB - 6.5'w x 4'd	700	55	10	Downs - Langley to Rader
UJ-10	RCB - 8'w x 4'd	1,000	88	10	Downs - Rader to Willow
UJ-11	RCP - 72"	630	120	10	Downs - Willow to Bowman
UJ-12	RCP - 66"	1,360	90	10	Norma - Upjohn to Rader
UJ-13	RCP - 54"	1,360	140	10	Norma - Rader to Bowman

TABLE 5-4 (cont'd)

CHURCH AVE AND UPJOHN AVE DRAINAGE BASINS

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Alternative 2 - Detention					
CH-01	RCP - 66"	700	170	10	Gateway - California to Ridgecrest
CH-02	RCP - 54"	3,300	140	10	California - Sunland to Gateway
CH-03	RCP - 60"	2,660	170	10	Church - China Lake to Sunland
CH-04	RCP - 42"	1,310	105	10	Church - Norma to China Lake
CH-05	N/A				Church - Sierra View to Norma
CH-06	N/A				Sierra View - California to Church
CH-07	N/A				California - Downs to Sierra View
CH-08	N/A				Downs - Ridgecrest to California
CH-09	RCP - 54"	3,100	130	10	Ridgecrest - Downs to Norma
CH-10	RCP - 72"	930	280	10	Jean and Helena
CH-11	RCP - 78"	2,100	340	10	French - Helena to Balsam
CH-12	RCB - 9.5'w x 6'd	570	400	10	French - Balsam to Channel
CH-13	Channel - 8'w x 9'd x 2:1 to 8'w x 8'd x 2:1 unlined, R/W = 69'	820	-	-	French Channel Deepening; lower invert
CH-14	RCP - 66"	1,540	180	10	Norma - Church to Ridgecrest
CH-15	Channel -8'w x 8.5'd x 2:1 unlined R/W = 49'	2,000	440	25	Daylight Channel - depth reduces to 0 at outfall
UJ-01	RCP - 48"	2,000	43	10	Gateway - Upjohn to California
UJ-02	RCP - 33"	1,600	20	10	Sunland - Basin to Church
UJ-03	RCP - 60"	2,300	190	10	Upjohn - China Lake to Basin
UJ-04	RCP - 36"	1,320	62	10	Upjohn - Warner to China Lake
UJ-05	N/A				

TABLE 5-4 (cont'd)

CHURCH AVE AND UPJOHN AVE DRAINAGE BASINS

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
UJ-06	N/A				
UJ-07	RCP - 36"	2,640	46	10	Langley - Mahan to Downs
UJ-08	RCP - 30"	1,620	38	10	St. George - Guam to Mahan
UJ-09	RCB - 6.5'w x 4'd	700	55	10	Downs - Langley to Rader
UJ-10	RCB - 8'w x 4'd	1,000	88	10	Downs - Rader to Willow
UJ-11	RCP - 72"	630	120	10	Downs - Willow to Bowman
UJ-12	RCP - 66"	1,360	90	10	Norma - Upjohn to Rader
UJ-13	RCP - 54"	1,360	140	10	Norma - Rader to Bowman
UJ-14	Detention Basin - 13.8 AF 2.21 acres 7' deep (2' ponding) 49' overflow inlet 18" RCP outlet drain Turf landscaping	-	Inflow = 190 Outflow = 20	10	Future park site - Upjohn/ Sunland

between Church Ave and the channel. As a result, it was necessary to pick up flows at Downs St and Norma St and divert them to the upstream end of the French Avenue Channel via a storm drain in Ridgecrest Blvd and French Ave (CH-09 to CH-14). The diversion drains vary in diameter from 54 to 78 inches, with the last reach under China Lake Blvd requiring a 9.5'w x 6'd box section. This also requires a deepening of the French Avenue Channel by up to 5.5 feet, over a length of 820 feet. The reach of storm drain in French Ave from Balsam St to the channel inlet serves to replace an improvement which would otherwise be required in the West China Lake Drainage Basin.

Runoff from the lower portion of the Church Avenue Drainage Basin is collected in a storm drain in Church Ave and California Ave (CH-01 to CH-04). This alignment essentially follows the natural drainage pattern. The conduit varies from 42-inch pipe to 7.5'w x 6'd box. The drain crosses under Ridgecrest Blvd, after which an unlined channel conveys the flow to the French Avenue Channel. This daylighting channel has the minimum 8-foot width, and varies in depth from 0.0 foot at the outfall to 9.0 feet at Ridgecrest Blvd. The maximum depth is required to accommodate the incoming storm drain; a flow depth of only 6 feet is needed to convey the 25-year design flow. Flows would gradually leave the channel near the downstream end and run harmlessly to the northeast. A 0 to 3 foot dike on the west side of the channel will prevent inundation of Gateway Blvd at the downstream end of the channel.

The Upjohn Avenue system is characterized by cutoff drains which divert flows out of the Upjohn Avenue Drainage Basin to either the Bowman Road Channel or to the Church Storm Drain (UJ-01 to UJ-13). Two cutoff drains in Downs St and Norma St serve to divert runoff from the Upjohn Avenue basin into the Bowman Road Channel. In order to have enough gradient for the diversion in the Downs St and Norma St drains, the Bowman Road Channel must be at least 10 feet deep. This is about 4 feet deeper than would be required to simply carry the design flow in the Bowman Road Channel. The Downs St cutoff drain varies from 72-inch pipe to 8'w x 4'd box; the Norma St cutoff drain varies from 54- to 66-inch pipe.

Three drains carry flows northward to the storm drain in Church and California Ave. These drains are located in China Lake Blvd (42" RCP), Sunland Blvd (66" RCP) and Gateway Blvd (48" RCP). The alignment of this system avoids the need for a long storm drain in Upjohn Ave which would parallel the Church Ave storm drain.

Alternative 2

This is the detention alternative for the Church/Upjohn Ave area. An investigation of potential detention sites in this drainage basin resulted in selection of only one site. This is located at the proposed City park on the southwest corner of the intersection of Sunland Blvd and Upjohn Ave. The park is a 5-acre parcel which could be used as an off-channel storage basin for Upjohn Avenue Drainage Basin runoff.

In this alternative the China Lake Blvd cutoff drain is replaced by a drain in Upjohn Ave from China Lake Blvd to Sunland Ave; this allows as much of the drainage area as possible to be directed to the basin site. Providing 3.5 acre-feet of active storage at this location will allow the 10-year peak flow to be reduced from 190 cfs to 20 cfs. All flows in excess of 20 cfs will be diverted to the basin via a 49-foot overflow weir in the Upjohn Avenue storm drain. To improve the hydraulics of the diversion from the Upjohn Avenue drain, the invert of the basin must be about 7 feet below the ground surface. With a side slope of 5:1 and a ponding depth of 2 feet, a bottom area of 1.74 acres is needed. The requirement of a total depth of 7 feet leads to a surface area of 2.21 acres. This represents slightly less than one-half of the park site. A minimum 18-inch RCP outlet pipe is capable of draining the basin back to the Upjohn Avenue storm drain in less than 24 hours.

Development of stormwater storage at this site in this manner is consistent with use of the parcel as a playground, ballfield, etc. No formal plans for recreational amenities to be provided at this location have been developed by the City to date, and the City does not currently own the land.

The hydrologic benefits of storage at this location are significant. The reduction in peak flows leads to about a 30-inch reduction in the diameter of downstream storm drains, and allows a RCP to be used under Ridgecrest Blvd rather than a RCB.

The alignments and sizes of the Church Ave storm drains west of Sunland Ave are the same in Alternative 2 as they were in Alternative 1.

Other Alternatives

Several other alternatives were investigated for the Church Avenue and Upjohn Avenue Drainage Basins.

a. No Diversions / Sunland Alignment. Church Ave and Upjohn Ave flows were kept in their natural drainage areas, with primary storm drains in Church Ave and Upjohn Ave. Flows from the two areas were combined for a common outfall at Sunland St.

b. No Diversions / Gateway Alignment. Same as (a), but with the flows from the two areas kept separate until Gateway Blvd. This essentially establishes two independent and parallel storm drain systems which are separated by only 1,300 feet; this approach was considered to contain certain redundancies which would not be cost-effective.

c. Gateway Alignment with Retention. Same as (b) as far as alignment, but includes development of a retention site in each of the drainage basins. In the Church Avenue basin, the retention site is the existing playground at Monroe Junior High School at the intersection of Church Ave and Warner St. In the Upjohn Avenue basin, the retention site is at the proposed park site discussed above in Alternative 2. In each location, a retention basin with an area of 2 acres and a maximum depth of ponding of 3 feet was considered.

d. Diversions to Bowman Road Channel Only. This option includes diversion of flows from the upper portion of the Upjohn Avenue Drainage Basin into the Bowman Road Channel as in Alternative 1, but does not include diversions from lower Upjohn Ave to the Church Avenue storm drain or from the upper portion of the Church Avenue Drainage Basin to the French Avenue Channel. Upjohn Ave and Church Ave storm drain alignments are the same as in option (b).

Preliminary cost estimates were developed for all of the above alternatives. It was found that although all the options were fairly close in cost, only (c) was competitive with Alternatives 1 and 2. It has not been presented as one of the primary alternatives due to potential safety and public relations problems associated with use of school yards for temporary stormwater storage.

5.7 COLLEGE HEIGHTS WASH DRAINAGE BASIN

The College Heights Wash Drainage Basin contributes to runoff in the southern portion of Ridgecrest, approximately between China Lake Blvd and College Heights Blvd. Several flow paths exit the El Paso Mountains south of the City, creating a broad alluvial apron. This portion of the Master Plan study area is characterized by unconfined sheet flows which are tributary to Bowman Wash.

Two alternative approaches were formulated for controlling runoff from the College Heights watershed. Alternative 1 is the "All Conveyance" approach, which relies strictly on channelization to convey stormwater through the watershed to a safe disposal point. Alternative 2 is the "Detention" approach, in which strategically located detention basins are used to reduce the peak flows to levels which can be more adequately carried by downstream channels. Because there is essentially no existing channel system in this watershed, each of the alternatives involve considerable channel improvements.

Much of the College Heights Wash Drainage Basin is out of the Ridgecrest city limits, even though it is developed. These areas (e.g. south of China Lake Blvd and west of Norma St, and east of College Heights Blvd), are currently in unincorporated Kern County. Although significant drainage problems may exist in these areas, they are not addressed in this Master Plan. Improvements are shown in these County areas only when they are necessary to the protection of the incorporated City of Ridgecrest.

Facility descriptions for each of the alternatives are summarized in Table 5-5.

Alternative 1

This All Conveyance alternative is comprised of three primary channel facilities: the Norma Street Channel, the College Heights Blvd Channel, and the China Lake Blvd Channel. The function of the first two facilities is to prevent stormwater which originates in watersheds beyond the city limits from entering the City. The function of the third facility is to convey this runoff safely to the Bowman Road Channel. In addition to these channels,

TABLE 5-5

COLLEGE HEIGHTS WASH WASH DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
ALTERNATIVE 1 - All Conveyance					
CHW-01	Dike - 6' high rock lined R/W = 0' (BLM)	1,400	790	100	East Training Dike
	Dike - 4' high rock lined R/W = 0' (BLM)	1,400	540	100	West Training Dike
	Floodway 300' wide 3' dikes, unlined	5,100	1,900	100	Central Floodway
CHW-02	Dike - 5' high rock lined R/W = 0 (BLM)	2,000	2,360	100	Kendall Training Dike
	Floodway 300' wide 3' dikes, unlined	3,600	2,300	100	Western Floodway
CHW-03	DEBRIS BASIN - 9.0 AF 20' deep average 0.5 acres 1790 cfs spillway	-	1,790	100	Norma Debris Basin
CHW-04	RCB - 3 - 9'w x 8'd	50	4,060	100	Springer culvert
CHW-05	CHANNEL - 27'w x 10'd x 2:1 rip rap lined 4 - 3' drops R/W = 92'	1,300	4,060	100	Norma Channel - Reach 1
CHW-06	CHANNEL -11'w x 9'd x 1.5:1 concrete lined R/W = 63'	1,300	4,060	100	Norma Channel - Reach 2
CHW-07	RCB - 2 - 10.5'w x 7'd	100	4,060	100	Dolphin culvert
CHW-08	CHANNEL - 8'w x 6'd x 2:1 rip rap lined R/W = 37'	2,600	470	25	College Heights Blvd Channel - Reach 2
CHW-09	RCB (2 - 4'w x 3.5'h)	50	470	25	Springer culvert

TABLE 5-5 (cont'd)

COLLEGE HEIGHTS WASH WASH DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
ALTERNATIVE 1 - All Conveyance					
CHW-10	CHANNEL - 8'w x 6'd x 2:1 rip rap lined R/W = 37'	2,600	500	25	College Heights Blvd Channel - Reach 3
CHW-11	RCB - 2 - 4'w x 4'd	50	500	25	Dolphin culvert
CHW-12	CHANNEL - 5'w x 9'd x 1.5:1 concrete lined R/W = 37'	2,300	1,900	100	College Heights Blvd Channel - Reach 4
CHW-13	RCB - 2 - 7.5'w x 7'd	100	1,900	100	College Heights Blvd culvert
CHW-14	CHANNEL - 9'w x 9'd.x 1.5:1 concrete lined R/W = 41'	3,450	4,100	100	China Lake Blvd Channel
CHW-15	RCB - 2 - 10'w x 7'd	100	4,100	100	College Heights Blvd (new)
CHW-16	RCB - 3 - 8.5'w x 7'd	200	5,270	100	College Heights Blvd (old)
CHW-20	RCP - 42"	1,200	50	10	Dolphin Drain - West
CHW-21	RCP - 48"	1,450	45	10	Dolphin Drain - East
CHW-22	RCB - 6'w x 4'd	1,200	71	10	Springer Drain - West
CHW-23	Dike - 6' high rock lined	2,350	440	25	Training Dike
CHW-24	RCB - 7'w x 4'd	40	440	25	Javis culvert
CHW-25	CHANNEL - 5'w x 4.5'd x 2:1 gunite lining 8 - 3' concrete drops R/W = 28'	2,600	440	25	College Heights Channel - Reach 1
CHW-26	RCB - 7'w x 4'd	100	440	25	College Heights Culvert

TABLE 5-5 (cont'd)

COLLEGE HEIGHTS WASH WASH DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
ALTERNATIVE 2 - Detention					
CHW-01	CHANNEL - 8'w x 4.5'd x 2:1 rip rap lined 10 - 3' drops R/W = 50'	5,700	300	100	Detention Site 2 Outlet Channel
CHW-02	CHANNEL - 8'w x 5'd x 2:1 rip rap sides 7 - 3' drops R/W = 52'	3,200	300	100	Detention Site 1 Outlet Channel
CHW-03	N/A				
CHW-04	RCB - 2 - 5'w x 4'd	50	600	100	Springer culvert
CHW-05	CHANNEL -10'w x 6.5'd x 2:1 rip rap lined R/W = 61'	1,300	600	100	Norma Channel - Reach 1
CHW-06	CHANNEL - 5'w x 6'd x 1.5:1 concrete lined R/W = 48'	1,300	600	100	Norma Channel - Reach 2
CHW-07	RCB - 2 - 5.5'w x 4'd	100	600	100	Dolphin culvert
CHW-08	CHANNEL - 8'w x 4'd x 2:1 rip rap lined R/W = 29'	2,600	75	10	College Heights Blvd Channel - Reach 2
CHW-09	RCB - 2 - 4'w x 2'h	50	75	10	Springer culvert
CHW-10	CHANNEL - 8'w x 4'd x 2:1 rip rap lined R/W = 29'	2,600	130	10	College Heights Blvd Channel - Reach 3
CHW-11	RCB - 2 - 4'w x 2'd	50	130	10	Dolphin culvert
CHW-12	CHANNEL - 7'w x 5'd x 1.5:1 concrete lined R/W = 37'	2,300	360	25	College Heights Blvd Channel - Reach 4
CHW-13	RCB - 2 - 6'w x 3'd	100	360	25	College Heights Blvd culvert
CHW-14	CHANNEL - 5'w x 5'd x 1.5:1 concrete lined R/W = 25'	3,450	650	100	China Lake Blvd Channel

TABLE 5-5 (cont'd)

COLLEGE HEIGHTS WASH WASH DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
ALTERNATIVE 2 - Detention					
CHW-15	RCB - 2 - 6'w x 5'd	100	650	100	College Heights Blvd (new)
CHW-16	RCB - 2 - 7'w x 5'd	200	1,900	100	College Heights Blvd (old)
CHW-17	Detention Basin - 220 AF	-	Inflow = 2,300	100	Site 1 - West College Heights
	balanced cut/fill excavation		Outlflow = 300		
	surface area = 13 acres				
	20' deep				
	1 - 54" RCP outlet	200			
	5,900 cfs PMF spillway				
	R/W = 0' (BLM)				
	dike - 5' high, rip rap	2,700			
CHW-18	Detention Basin - 250 AF	-	Inflow = 2,950	100	Site 2 - Central College Heights
	balanced cut/fill excavation		Outlflow = 300		Includes diversion from
	surface area = 12 acres				CHW160/170
	24' deep				
	2 - 36" RCP outlet	100			
	6,400 cfs PMF spillway				
	R/W = 0' (BLM)				
	dikes - 6' high, rip rap	2,700			
	4' high, rip rap	1,000			
CHW-20	RCP - 42"	1,200	50	10	Dolphin Drain - West
CHW-21	RCP - 48"	1,450	45	10	Dolphin Drain - East
CHW-22	RCB - 6'w x 4'd	1,200	71	10	Springer Drain - West
CHW-23	Diversion Facility				Diversion of CHW160/170
	Dike - 6' high, rip rap	2,400	1,370	100	to Site 2 Basin
	RCB - 7'w x 5'd	60			

training dikes and floodways are shown in the upper portion of the drainage area to establish defined flows paths on the alluvial apron.

Flows from the western portion of the drainage basin are collected by a dike along Kendall Ave (CHW-02). This dike directs runoff to a floodway which runs diagonally from Kendall Ave to Springer Ave at Norma St. The floodway is 300 feet wide and is confined by 3-foot dikes. The purpose of the floodway is to establish a well-defined flow path on the alluvial fan which will be preserved after ultimate development. The width is wide enough to allow the area to have open space benefits (e.g., as a linear park). The diversion dike is on BLM land, but the floodway is in unincorporated Kern County.

Flows from the central portion of the College Heights Wash Drainage Basin are collected by a training dike system (CHW-01) and directed to a floodway which runs along the Norma St alignment. As described above, this floodway is 300 feet wide with 3-foot dikes, and could serve as a linear open space area. The dikes are on BLM land and the floodway is in unincorporated Kern County.

The Norma Street Channel runs from Springer Ave to Dolphin Ave (CHW-03 to CHW-07). It is lined with rip rap in the upstream reach, and is lined with gunite in the downstream reach to minimize right-of-way requirements. The Norma Street Channel may be difficult to construct due to potential interferences with surface improvements on private property. If this becomes prohibitive to the project, an alternate channel could be constructed along the property line 1,300 feet to the west. This alignment has fewer interferences, but is not recommended at this time because it requires a longer and more expensive channel along China Lake Blvd. A debris basin is located at the Norma Street Channel headworks; it collects flows from the two floodways.

The College Heights Blvd Channel runs along College Heights Blvd from Javis Ave to Bowman Rd (CHW-08 to CHW-13; CHW-23 to CHW-26). A training dike extending southeast from the channel headworks directs runoff to the channel from the southeast portion of the College Heights Wash Drainage Basin (subareas CHW160 and CHW170). The upper channel reach from Javis Ave to Kendall Ave is on the east side of the street, even though this side is in the County whereas the west side is in the City; this alignment is selected in order to avoid conflicts with the existing development on the west side of the street. This channel reach must be concrete-lined due to the steep natural slopes. Between Kendall Ave and Dolphin Ave, the channel is rip rap lined and is moved to the west side (City side) of the street. There are currently well-defined drainage swales on both sides of the street along the entire channel alignment, within the street right-of-way. This right-of-way could be used for the channel if desired. Between Dolphin Ave and Bowman Rd the channel is lined with gunite in order to minimize right-of-way requirements in an area zoned for commercial development. Storm drains have been included in Dolphin Ave and Springer Ave in order to collect sheet flow (and runoff from future development) and convey it to the College Heights Blvd Channel.

The China Lake Blvd Channel connects the Norma Street Channel to the College Heights Blvd Channel, and then deposits the combined flow into the Bowman Road Channel (CHW-14 to CHW-16). The China Lake Blvd Channel is gunite lined to minimize right-of-way requirements in a future commercial area, and could be located in a portion of the China Lake Blvd street right-of-way if desired.

Alternative 2

This is the detention alternative. It makes use of the same basic channel configuration as Alternative 1, but includes two large detention basins in the upstream watershed to allow the downstream channels to be smaller. Both basins are located on BLM land to minimize problems of land acquisition.

Basin 1 is located southeast of the intersection of Downs St and Kendall Ave (CHW-17). It has training dikes to allow it to collect runoff from all of the southwestern portion of the College Heights Wash watershed. The basin is designed to be a flow-through facility, with a total storage volume (including freeboard) of 220 acre-feet and a passive 54-inch RCP outlet structure. If an area of about 13 acres is employed, the maximum basin depth is 20 feet. Basin 1 is capable of reducing the 100-year inflow of 2,300 cfs to 300 cfs. Because it is located in the natural flow path, a spillway capable of passing the Probable Maximum Flood (PMF) is required.

Basin 2 is located south of the extensions of Javis Ave and Norma St (CHW-18). It collects runoff from the central and eastern portions of the upper College Heights Wash watershed. Training dikes are used to divert 100-year flows from subareas CHW060, CHW100, CHW130, CHW160, and CHW170 into the basin to maximize its regional effectiveness. The present plan shows the basin located to the west of Norma St; however, if desired, it could be relocated to the proposed City park area immediately east of Norma St. Both sites are on BLM land.

The flow-through basin has a total volume of 250 acre-feet, and an outlet of a twin 36-inch RCP. Assuming a basin surface area of about 12 acres, the maximum depth is 24 feet including 2 feet of freeboard. The basin reduces the 100-year peak flow from 2,950 cfs to 300 cfs. A PMF spillway is required, based on the naturally tributary area.

The effect of the above two detention basins is to reduce downstream channel dimensions in the College Heights Wash Drainage Basin by 1 to 5 feet in bottom width and 1 to 2 feet in depth. It also provides benefits in peak flow reduction to the Bowman Road Channel.

5.8 EAST CHINA LAKE WASH DRAINAGE BASIN

The East China Lake Wash Drainage Basin is tributary to Satellite Lake and Mirror Lake. Nearly all of the watershed area is south of the current City boundaries. Drainage improvements are formulated for locations where these offsite flows must be intercepted relatively near the city limits in order to prevent flooding in the City. These two locations are at Franklin Ave between Sunland St and Gateway Blvd (ECL-01 to ECL-06), and along Rader Ave east of Richmond Rd (ECL-07 to ECL-11).

Drainage improvements for the East China Lake Wash Drainage Basin are summarized in Table 5-6.

Alternative 1

This is an all-channel alternative. In order to cutoff flows from subareas BW150 and BW160 before they impact the City, a 100-year channel is proposed along the extension of Franklin Ave, between Sunland Blvd and Gateway Blvd. This location was selected because it is near the present City boundary (at Bataan) and has a minimum of potential development conflicts. The channel is 24 feet wide and 10 feet deep, with rip rap lining on the sides. A training dike extends east from Gateway Blvd to direct more flow to the channel. A rip rap channel then takes the flow northward along the west side of Sunland Blvd to the outfall at the Bowman Road Channel. Culverts with 100-year capacity are provided at Gateway Blvd, Sunland Blvd, Dolphin Blvd, and Bowman Rd.

Along Rader Ave, a rip rap channel extends from near the County Line to Richmond Rd. A concrete lined channel then conveys this flow along Richmond Rd to the Bowman Road Channel. Both of these reaches have adequate right-of-way available adjacent to the current roadways.

Alternative 2

This is the detention alternative. There are minimal detention opportunities in the East China Lake Wash Drainage Basin because of the lack of concentration areas; most flow remains as sheet flow until it reaches Mirror Lake. In addition, there are no parcels of BLM land which are in hydrologically beneficial locations.

In the Gateway/Sunland portion of the study area, a detention site was selected on the northwest corner of the intersection of Sunland Blvd and Franklin Ave. Sites further to the east were rejected because of potential surface development conflicts; also, this is the first point at which the cutoff channel has collected all the flow from subareas BW150 and BW160.

The proposed detention basin is an off-channel facility with an active storage volume of 51 acre-feet. This can be developed on a 5.74-acre parcel (500 ft by 500 ft), with a maximum ponding depth of 10 feet. The side slopes are assumed to be 5:1 in case any recreational uses could be combined with the stormwater retention use. Flows enter the basin from the Sunland Channel via a 160-foot long concrete overflow weir. The gravity outlet is a 30-inch RCP which drains back to the Sunland Channel. A 2-foot dike around the storage area provides the necessary freeboard. Development of this detention basin reduces the width and depth of the downstream channel by 8 feet and 1 foot, respectively. It also reduces the peak flow tributary to the lower Bowman Road Channel.

No detention basin sites were selected in the Radar Ave/Richmond Rd portion of the study area. Alternative 2 in this area is the same as Alternative 1. An option which would replace the proposed channels by closed condiuts (pipes and boxes) was investigated, but a preliminary cost estimate indicated that this option was over 3 times more expensive than the open channel option.

TABLE 5-6

EAST CHINA LAKE DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Alternative 1 - All Conveyance					
ECL-01	Dike - 5' high	800	1,280	100	
	RCB - 10'w x 8'd	60	1,280	100	Gateway Culvert
ECL-02	CHANNEL - 24'w x 10'd x 2:1 Rip rap sides R/W = 89' 3 - 3' rock drops	2,600	2,550	100	Franklin Channel
ECL-03	RCB - 2 - 9'w x 8'd	60	2,550	100	Sunland culvert
ECL-04	CHANNEL - 17'w x 10'd x 2:1 Rip rap lining R/W = 67' 12 - 3' rock drops	3,900	2,550	100	Sunland Channel
ECL-05	RCB - 2 - 9'w x 8'd	60	2,550	100	Dolphin culvert
ECL-06	RCB - 2 - 9'w x 8'd	70	2,550	100	Bowman culvert
ECL-07	CHANNEL - 15'w x 7'd x 2:1 Rip rap sides R/W = 49'	2,000	300 1,440	25 100	Rader Ave Channel - Reach 1
ECL-08	CHANNEL - 15'w x 10'd x 2:1 Rip rap lining R/W = 60'	1,600	2,730	100	Rader Ave Channel - Reach 2
ECL-09	CHANNEL - 10'w x 6'd x 1.5:1 Gunite lining R/W = 39'	700	2,730	100	Richmond Road Channel
ECL-10	RCB - 2 - 9'w x 6'd	40	2,730	100	Fairgrounds Entrance culvert
ECL-11	RCB - 2 - 9'w x 6'd	60	2,730	100	Rader Ave culvert

TABLE 5-6 (cont'd)

EAST CHINA LAKE DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Alternative 2 - Detention					
ECL-01	Dike - 5' high RCB - 10'w x 8'd	800 60	1,280 1,280	100 100	Gateway Culvert
ECL-02	CHANNEL - 24'w x 10'd x 2:1 Rip rap sides R/W = 89' 3 - 3' rock drops	2,600	2,550	100	Franklin Channel
ECL-03	RCB - 2 - 9'w x 8'd	60	2,550	100	Sunland Culvert
ECL-04	CHANNEL - 9'w x 9'd x 2:1 Rip rap lining 12 - 3' rock drops R/W = 49'	3,900	1,330	100	Sunland Channel
ECL-05	RCB - 10'w x 7'd	60	1,330	100	Dolphin Culvert
ECL-06	RCB - 10'w x 7'd	70	1,330	100	Bowman Culvert
ECL-07	CHANNEL - 15'w x 7'd x 2:1 Rip rap sides R/W = 49'	2,000	300 1,440	25 100	Rader Channel - Reach 1
ECL-08	CHANNEL - 15'w x 10'd x 2:1 Rip rap lining R/W = 60'	1,600	2,730	100	Rader Ave Channel - Reach 2
ECL-09	CHANNEL - 10'w x 6'd x 1.5:1 Gunite lining R/W = 39'	700	2,730	100	Richmond Road Channel
ECL-10	RCB - 2 - 9'w x 6'd	40	2,730	100	Fairgrounds Entrance culvert
ECL-11	RCB - 2 - 9'w x 6'd	60	2,730	100	Rader Ave culvert
ECL-12	DETENTION BASIN - 51 AF 5.74 acres (500' x 500') 10' deep + 2' berm 160' diversion weir 30" RCP outlet 5:1 side slopes	-	Inflow = 2,550 Outflow = 1,330	100 100	Sunland Basin

5.9 BOWMAN WASH DRAINAGE BASIN

The main part of the Bowman Wash Drainage Basin consists of the area between China Lake Blvd and Upjohn Ave. However, this drainage area also extends along Bowman Rd all the way east to Satellite Lake.

The area along Bowman Wash, which roughly follows the alignment of Bowman Rd east of Brady St, has historically been subject to flooding problems. This is largely due to the fact that it acts as the concentration point for all flows from the mountains to the south of Ridgecrest, and thus can be impacted by stormwater from the Bowman Wash, College Heights Wash, or East China Lake Wash Drainage Basins.

The key drainage improvement in this area is the Bowman Road Channel. This facility has been previously identified by City staff and by the U.S. Army Corps of Engineers as the backbone of drainage solutions for the southern portion of the City of Ridgecrest. There are also other secondary channels and drains required in this drainage area to convey stormwater to the Bowman Road Channel.

Facilities included in the Bowman Wash Drainage Basin alternatives are summarized in Table 5-7.

Alternative 1

This is an All Conveyance alternative, and it is compatible with Alternative 1 for College Heights Wash and East China Lake Wash.

The Bowman Road Channel has been designed to run down the center of the Bowman Rd right-of-way (BW-01 to BW-22). The entire right-of-way is 200 ft wide, and 100 ft has been reserved for the channel. The channel starts at Brady St, with an inlet training dike and debris basin. In the reaches between Brady St and Downs St, the channel is wide (30 to 31 foot bottom), and shallow (5 to 6.5 feet). In the reach between Downs St and China Lake Blvd, the depth must be increased to 10 feet in order to accommodate the tributary storm drains diverting flow from the Upjohn Avenue Drainage Basin along Downs St and Norma St. The width is reduced to 8 feet in this reach to minimize the required overexcavation. The channel width must be increased to 56 feet below China Lake Blvd to carry the flows entering from the College Heights Wash Drainage Basin. Between Sunland St and Richmond Rd the channel must be lined with gunite in order to gain sufficient capacity within the allowable existing right-of-way.

Beyond Richmond Rd, the right-of-way increases to a full 200 feet because it is now proposed to take the freeway alignment down Richmond Rd to Ridgecrest Blvd. In the next downstream reaches the channel bottom is made very wide (76 to 99 feet) and levees are used to reduce problems daylighting into Satellite Lake. Between Richmond Rd and Ridgecrest Blvd, a combination of excavation and levees are used to create a total channel depth of 12 to 14.5 feet. The depth was determined by fixing the topwidth and levee base width within the 200-foot available right-of-way. The depth of excavation varies from 12 feet at Richmond Rd to 7.5 feet at Ridgecrest Blvd; the levees confine flow on both sides of the channel, beginning about

TABLE 5-7

BOWMAN WASH DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Alternative 1 - All Conveyance					
BW-01	DEBRIS BASIN - 5.5 AF 1 acre 7' deep	-	820	100	Brady/Bowman
	6' dike, rock lined	400			training dike
BW-02	RCB - 4 - 4.5'w x 3'd	80	820	100	Brady culvert
BW-03	CHANNEL - 30'w x 5'd x 3:1 Rip rap sides 3 - 4' drop structures R/W = 0' (in street)	2,640	820	100	Bowman Channel - Brady to Mahan
BW-04	RCB - 4 - 4.5'w x 3'd	80	820	100	Mahan culvert
BW-05	CHANNEL - 31'w x 6.5'd x 3:1 Rip rap sides 3 - 4' drop structures R/W = 0' (in street)	2,600	1,330	100	Bowman Channel - Mahan to Downs
BW-06	RCB - 5 - 6'w x 4.5'd	80	1,330	100	Downs culvert
BW-07	CHANNEL - 8'w x 10'd x 2:1 Rip rap lining 3 - 4' drop structures R/W = 0' (in street)	2,600	1,510	100	Bowman Channel - Downs to Norma
BW-08	RCB - 12'w x 8'd	80	1,510	100	Norma culvert
BW-09	CHANNEL - 8'w x 10'd x 2:1 Rip rap lining 2 - 3' drop structures R/W = 0' (in street)	2,600	1,630	100	Bowman Channel - Norma to China Lake
BW-10	RCB - 12'w x 8'd	250	1,630	100	China Lake Blvd culvert
BW-11	CHANNEL - 56'w x 10.5'd x 2:1 Rip rap lining R/W = 0' (in street)	2,600	6,920	100	Bowman Channel - China Lake to Sunland
BW-12	RCB - 5 - 11'w x 8.5'd	80	6,920	100	Sunland culvert

TABLE 5-7 (cont'd)

BOWMAN WASH DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
BW-13	CHANNEL - 30'w x 13.5'd x 2:1 Gunite lined R/W = 0' (in street)	1,700	7,810	100	Bowman Channel - Sunland to Fwy Cutoff
BW-14	CHANNEL - 45'w x 11'd x 1.5:1 Gunite lined R/W = 0' (in street)	2,900	10,900	100	Bowman Channel - Fwy Cutoff to Richmond
BW-15	RCB - 5 - 11.5'w x 9'd	115	10,900	100	Gateway culvert
BW-16	RCB - 5 - 11.5'w x 9'd	60	10,900	100	Richmond culvert
BW-17	CHANNEL - 115'w x 12'd x 2:1 Rip rap sides R/W = 200 (exist.)	750	10,900	100	Bowman Channel - Richmond to Upjohn
BW-18	RCB - 6 - 4'w x 3'd	60	350	2	Upjohn culvert
BW-19	CHANNEL - 99'w x 13'd x 2:1 Grouted rock sides R/W = 200' (exist.) 0' - 5.5' levees	1,800	11,600	100	Bowman Channel - Upjohn to Church
BW-20	RCB - 6 - 4'w x 3'd	60	350	2	Church culvert
BW-21	CHANNEL - 76'w x 14.5'd x 2:1 Grouted rock sides R/W = 200' (exist.) 6' - 7' levees	1,900	12,300	100	Bowman Channel - Church to Ridgecrest
BW-22	BRIDGE - 76' span	80	12,300	100	Ridgecrest Blvd bridge
BW-23	CHANNEL - 76'w x 0'-7.5'd x 2:1 unlined	2,500	12,300	100	Outlet channel to daylight
BW-30	RCP - 36"	1,500	51	10	Mahan Drain - Reach 1
BW-31	N/A				
BW-32	RCP - 48"	1,500	130	10	Downs Drain - Reach 1

TABLE 5-7 (cont'd)

BOWMAN WASH DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
BW-33	N/A				
BW-34	RCP - 42"	1,700	72	10	Norma Drain
BW-35	RCP - 54"	1,100	180	25	Mahan Drain - Reach 2
BW-36	RCB - 7'w x 4'd	360	200	10	Downs Inlet
BW-37	RCB - 6'w x 4'd	740	170	10	Downs Drain - Reach 2

TABLE 5-7 (cont'd)

BOWMAN WASH DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Alternative 2 - Detention					
BW-01	DIKE - 6' high	400	820	100	Inlet Structure/training dike
BW-02	RCB - 4 - 4.5'w x 3'd	80	820	100	Brady culvert
BW-03	CHANNEL - 10'w x 6'd x 5:1 Unlined 7 - 3' drop structures R/W = 0' (in street)	2,640	500	100	Bowman Channel - Brady to Mahan
BW-04	RCB - 2 - 8'w x 4'd	80	500	100	Mahan culvert
BW-05	CHANNEL - 10'w x 6'd x 5:1 Unlined 8 - 3' drop structures R/W = 0' (in street)	2,600	500	100	Bowman Channel- Mahan to Downs
BW-06	RCB - 2 - 8'w x 4'd	80	500	100	Downs culvert
BW-07	CHANNEL - 8'w x 10'd x 2:1 Unlined 9 - 3' drop structures R/W = 0' (in street)	2,600	610	100	Bowman Channel - Downs to Norma
BW-08	RCB - 10.5'w x 8'd	80	610	100	Norma culvert
BW-09	CHANNEL - 8'w x 10'd x 2:1 Rip rap lining 2 - 3' drop structures R/W = 0' (in street)	2,600	1,600	100	Bowman Channel - Norma to China Lake
BW-10	RCB - 10.5'w x 8'd	250	1,600	100	China Lake Blvd culvert
BW-11	CHANNEL - 45'w x 10'd x 2:1 Rip rap sides R/W = 0' (in street)	2,600	3,470	100	Bowman Channel - China Lake to Sunland
BW-12	RCB - 4 - 10'w x 8'd	80	3,470	100	Sunland culvert
BW-13	CHANNEL - 46'w x 13'd x 2:1 Rip rap sides R/W = 0' (in street)	1,700	4,940	100	Bowman Channel - Sunland to Fwy Cutoff

TABLE 5-7 (cont'd)

BOWMAN WASH DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
BW-14	CHANNEL - 46'w x 13'd x 2:1 Rip rap sides R/W = 0' (in street)	2,900	4,940	100	Bowman Channel - Fwy Cutoff to Richmond
BW-15	RCB - 3 - 15'w x 11'd	115	4,940	100	Gateway culvert
BW-16	RCB - 3 - 15'w x 11'd	60	4,940	100	Richmond culvert
BW-17	CHANNEL - 120'w x 9.5'd x 2:1 Rip rap sides R/W = 200 (exist.)	750	6,550	100	Bowman Channel - Richmond to Upjohn
BW-18	RCB - 6 - 4'w x 3'd	60	350	2	Upjohn culvert
BW-19	CHANNEL - 120'w x 10'd x 2:1 Rip rap sides R/W = 200' (exist.) 0' - 5' levees	1,800	7,460	100	Bowman Channel - Upjohn to Church
BW-20	RCB - 6 - 4'w x 3'd	60	350	2	Church culvert
BW-21	CHANNEL - 110'w x 11'd x 2:1 Grouted rock sides R/W = 200' (exist.) 6' - 6.5' levees	1,900	8,420	100	Bowman Channel - Church to Ridgecrest
BW-22	BRIDGE - 110' span	80	8,420	100	Ridgecrest Blvd bridge
BW-23	CHANNEL - 110'w x 0'-4.5'd x 2:1 unlined	750	8,420	100	Outlet channel to daylight
BW-24	CHANNEL - 13'w x 8'd x 3:1 unlined 10 - 3' drop structures	2600	760	100	Brady Channel
BW-25	DETENTION BASIN - 43 AF 8.0 acres (park site) 6' deep 120' inflow weir no spillway 30" RCP outlet drain	-	Inflow = 1,510 Outflow = 500	100 100	Brady/Bowman Basin proposed park site

TABLE 5-7 (cont'd)

BOWMAN WASH DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
BW-30	RCP - 36"	1,500	51	10	Mahan Drain - Reach 1
BW-31	N/A				
BW-32	RCP - 48"	1,500	130	10	Downs Drain - Reach 1
BW-33	N/A				
BW-34	RCP - 42"	1,700	72	10	Norma Drain
BW-35	RCP - 54"	1,100	180	25	Mahan Drain - Reach 2
BW-36	RCB - 7'w x 4'd	360	200	10	Downs Inlet
BW-37	RCB - 6'w x 4'd	740	170	10	Downs Drain - Reach 2

TABLE 5-8

EL PASO WASH DRAINAGE BASIN

ALTERNATIVE DRAINAGE IMPROVEMENTS

FACILITY NUMBER	DESCRIPTION	LENGTH (ft)	DESIGN FLOW (cfs)	DESIGN FREQUENCY (yr)	COMMENTS
Alternative 1					
EPW-01	LEVEE - 5′ high (average) Rip rap lined, one side R/W = 48′	4,060	13,100	100	Extend south from Inyokern Rd
EPW-02	LEVEE - 4′ high (average) Rip rap lined, one side R/W = 42′	3,940	13,100	100	
EPW-03	LEVEE - 3′ high (average) Rip rap lined, one side R/W = 36′	9,700	13,100	100	
Alternative 2					
EPW-01	N/A	see RCW-21 to RCW-31 Alternative 2			
EPW-02	N/A				
EPW-03	N/A				

County area presently in the El Paso Wash floodplain, and thus by itself does not represent an ultimate solution to regional problems from this flooding source.

It is noted that this alternative does not include improvements to the Inyokern Rd crossing, which is presently severely undersized (310 cfs capacity versus 13,100 cfs 100-year peak flow). This crossing is a Caltrans facility, and is outside of the city limits. In addition, this alternative does not include improvements to the portion of the channel north of Inyokern Rd, which is on the NWC. Flooding from this reach will not adversely impact the City, and the channel is the responsibility of the NWC.

In the future this levee alternative could be incorporated into a permanent solution for El Paso Wash. This solution could involve either: (1) levees on the west side as well as the east side of the floodplain; (2) channelization in the main floodplain; and/or (3) detention storage in the upstream watershed.

Alternative 2

This alternative omits the El Paso Wash levee, and instead collects any overflows in a channel along Brady St (RCW-21 to RCW-31). This channel is part of Alternative 2 for the Ridgecrest Wash Drainage Basin, in which it would serve to convey Ridgecrest Wash flows from Felspar Ave to the El Paso Wash channel north of Inyokern Rd.

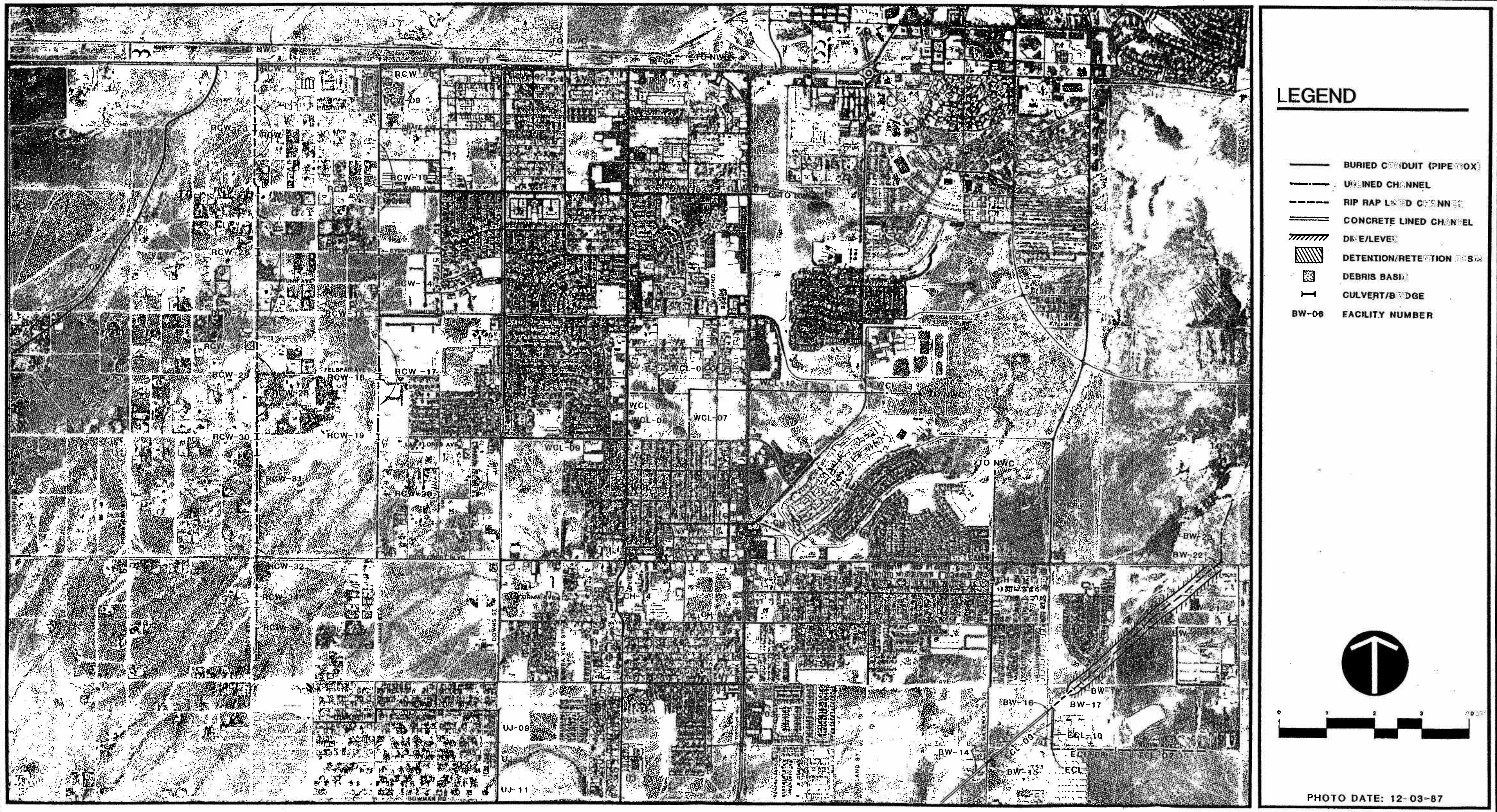
In order to accept El Paso Wash overflows, the channel would have to be oversized to account for the possibility that flooding on El Paso Wash and Ridgecrest Wash could occur simultaneously. A detailed analysis of the joint probability of this occurrence is beyond the scope of this Master Plan analysis. Assuming the worst case scenario - storms occurring over both watersheds simultaneously - the Ridgecrest Wash peak would occur about 1.5 hours earlier than the El Paso Wash peak. Considering the flow regulation provided by the natural storage at Highway 395, it is assumed that the El Paso Wash flow will be at 75 percent of the peak at the time the Ridgecrest Wash peak occurs. The concurrent peak is thus 9,800 cfs on El Paso Wash.

In addition, the El Paso Wash floodplain drainage pattern is so poorly defined with the existing topography (USGS quadrangles at 1"=2,000', 5-foot contours) that an accurate estimate of the rate of overflow in the direction of the Brady Street Channel is very difficult. Based on an analysis of the floodplain hydraulics using the COE Water Surface Profiles computer program HEC-2, it is estimated that approximately 40 percent of the peak flow could break out of the main flow path and run as sheet flow to the Brady Channel. This indicates that the Brady Channel under this alternative should be sized to carry 3,900 cfs more than if it were to accept flows from Ridgecrest Wash only.

The All Conveyance Alternative for the Brady Channel is sized for a 100-year flow of 2,400 cfs; the Detention Alternative is sized for 1,500 cfs. In each case, substantial oversizing of the Brady Channel would be required to intercept the El Paso Wash sheet flows. For the conveyance alternative, the lower reaches of Brady Channel must be 16 to 30 feet wider and 1 to 2 feet deeper, or they must be concrete lined. A preliminary cost estimate showed that this option would be about 150 percent more expensive than the Alternative 1 levee option.

The primary operational drawback to this alternative is the uncertainty regarding the estimate of the magnitude of El Paso Wash overflows to be conveyed in the various reaches of the Brady Channel. If this estimate is significantly low, then adequate protection will not be provided for the northwestern corner of the City. In addition, this alternative provides no protection to the (County) area between the El Paso Wash channel and Brady St. It is not capable of being incorporated into a permanent solution for El Paso Wash in the same way as Alternative 1.

As a result of these issues, the above alternative has not been incorporated into an overall plan for the northwest corner of the City. In particular, Alternative 2 for Brady Channel in the Ridgecrest Wash Drainage Basin has not been sized to accommodate the El Paso Wash overflows. The 2 feet of freeboard in the Brady Channel will allow the channel to accept about 1,300 cfs over the design flow at bank-full conditions; this probably represents about a 25-year overflow from El Paso Wash.



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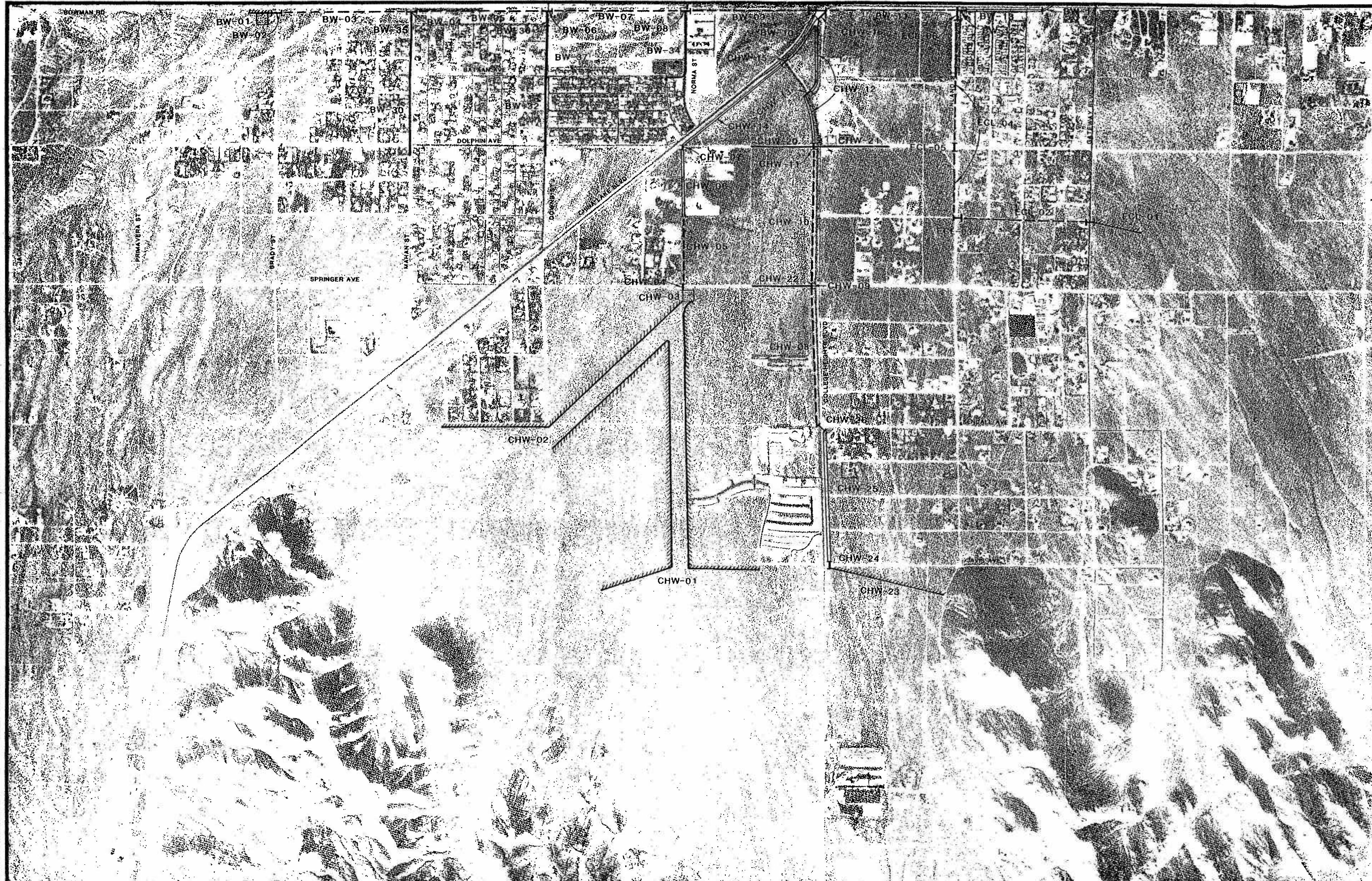
CITY OF RIDGECREST
MASTER DRAINAGE PLAN

DRAINAGE IMPROVEMENTS
ALTERNATIVE 1 - ALL CONVEYANCE

FIGURE 5-1A



LEGEND

- BURIED CONDUIT (PIPE/BOX)
- UNLINED CHANNEL
- RIP RAP LINED CHANNEL
- CONCRETE LINED CHANNEL
- DIKE/LEVEE
- DETENTION/RETENTION BASIN
- DEBRIS BASIN
- CULVERT/BRIDGE
- BW-06 FACILITY NUMBER

0 1 2 3 4000'

PHOTO DATE: 12-03-87

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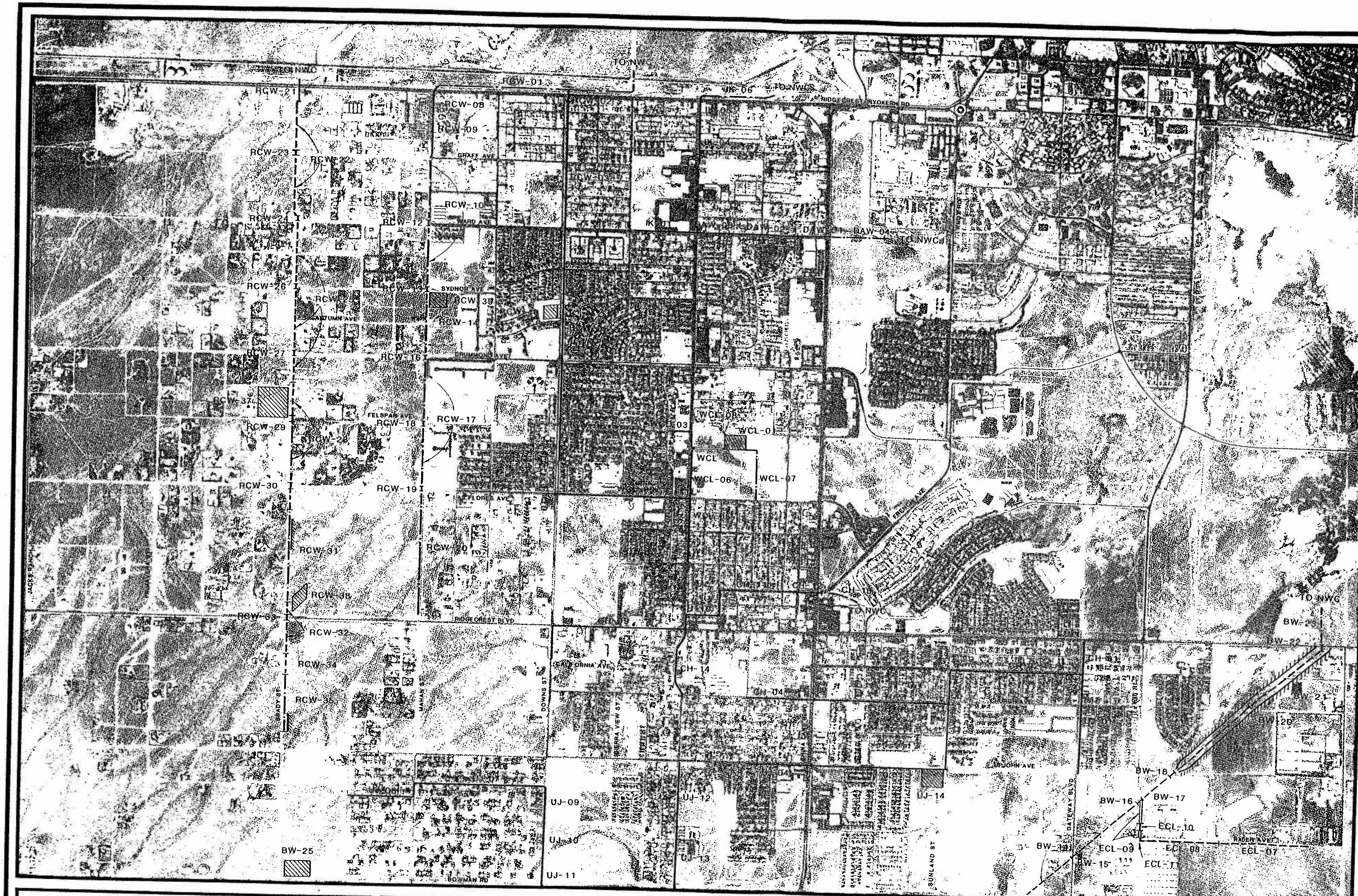
CITY OF RIDGECREST
MASTER DRAINAGE PLAN

DRAINAGE IMPROVEMENTS
ALTERNATIVE 1 - ALL CONVEYANCE

FIGURE 5-1B



LEGEND

- BURIED CONDUIT (PIPE/BOX)
- UNLINED CHANNEL
- RIP RAP LINED CHANNEL
- CONCRETE LINED CHANNEL
- DIKE/LEVEE
- DETENTION/RETENTION BASIN
- DEBRIS BASIN
- CULVERT/BRIDGE
- BW-06 FACILITY NUMBER

0 1 2 3 4000'

PHOTO DATE: 12-03-87

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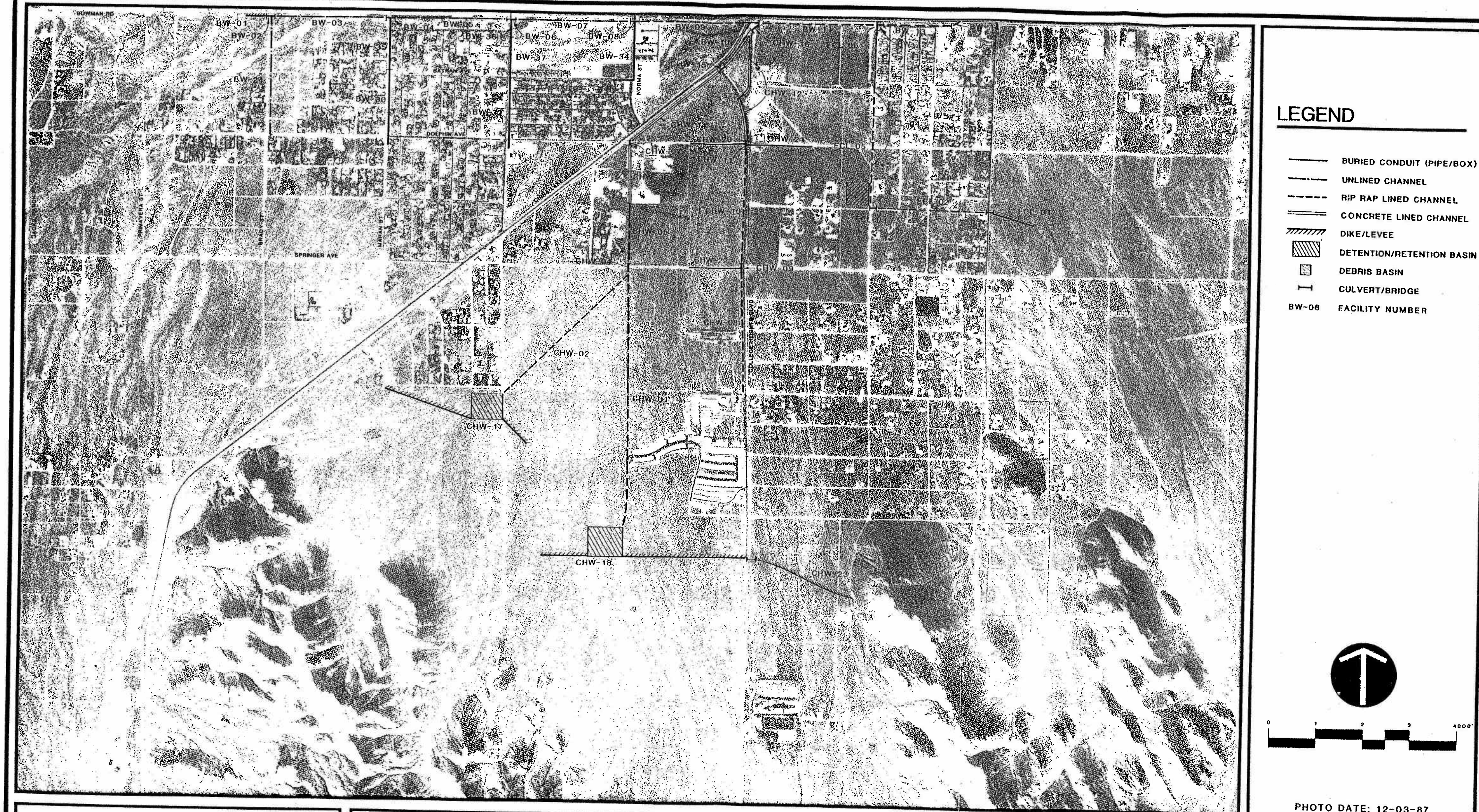
CITY OF RIDGECREST
MASTER DRAINAGE PLAN

DRAINAGE IMPROVEMENTS
ALTERNATIVE 2 – DETENTION

FIGURE 5–2A



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CITY OF RIDGECREST
MASTER DRAINAGE PLAN

DRAINAGE IMPROVEMENTS
ALTERNATIVE 2 - DETENTION

FIGURE 5-2B

Chapter 6

CHAPTER 6

COST ESTIMATES

6.1 INTRODUCTION

The overall objective of this chapter is to present the detailed preliminary cost estimates that have been developed for the various flood control improvement alternatives described in Chapter 5. The costs that have been developed are construction costs for each of the projects defined in the alternatives. A composite contingency factor of 50 percent has been added to these construction costs to take into account such things as:

- o Construction contingencies,
- o Engineering and Administration costs.

This chapter is divided into sections discussing unit cost data, cost estimate contingencies, and a summary of the alternative cost estimates for each of the major drainage basins.

It should be noted that the cost estimates presented in this report are approximate and have been made without detailed engineering data. The definition of the costs for this project have been estimated for master planning purposes only (i.e., +50 percent, -30 percent). Care should be taken when attempting to utilize these costs for purposes other than those defined for this report.

6.2 UNIT COST DATA

This section presents a brief discussion on the derivation of the unit costs for reinforced concrete pipe (RCP), reinforced concrete boxes (RCB), unlined and lined channels, dikes or levees, detention/retention facilities, bridge construction, and land or easement acquisition. These unit costs provide the basis upon which cost estimates were calculated for the various elements of the improvement alternatives.

Reinforced Concrete Pipe

To estimate the cost of reinforced concrete pipelines, a relationship was developed between pipeline diameter and cost in dollars per lineal foot of pipe installed. Unit cost information was derived from recent cost estimates performed by JMM for pipeline construction projects in the desert southwest. To verify and further quantify the pipeline costs, two cost estimating manuals were utilized (the Los Angeles County Flood Control District Cost Estimation Manual[20] and Means 1986 Building Construction Cost Data).

Table 6-1 presents the unit cost for estimating RCP pipeline construction cost. Values in this table represent the base unit costs for the construction of pipes including costs for material, installation, appurtenances,

TABLE 6-1

REINFORCED CONCRETE PIPE CONSTRUCTION COSTS ($/LINEAL FOOT)

RCP Diameter (in)	Stable Soil	Stable Soil + Utilities	Stable Soil + utilities & traffic
18	32	59	71
24	39	64	76
30	50	74	86
33	57	82	94
36	63	87	101
42	77	104	121
48	92	122	142
54	111	144	166
60	130	165	190
66	149	186	215
72	170	208	241
78	192	232	270
84	214	255	293
90	246	289	330

excavation, labor, bedding and backfill, and contractors overhead and profit. The unit costs presented in Table 6-1 are exclusive of any contingencies.

The unit costs have been developed for two construction conditions, utility interference and traffic control, to allow for more flexibility in cost estimating.

The uncertainty in the depth of placement and difficulty of installation which may or may not be encountered at the time of construction, as well as other factors, are major drawbacks to the usage of these unit costs. However, these unit costs are adequate in general for the purposes of comparing alternatives.

Reinforced Concrete Boxes (RCB)

To estimate the cost of reinforced concrete box structures, internal JMM cost data were used. A relationship was developed between wetted perimeter and cost in dollars per lineal foot of box installed. Costs were developed for both cast-in-place and precast box culverts and for unpaved and paved streets. The box culvert costs were based on a unit cost of $15 per foot of perimeter per lineal foot for cast-in-place boxes, and $8 per foot of perimeter per lineal foot for precast boxes. The following unit cost table includes material, delivery, installation, excavation, backfill, and paving if specified.

	Unit Cost ($/foot of perimeter/lineal ft)	
Type	Unpaved	Paved
Precast RCB	11.40	13.30
Cast-in-place RCB	18.75	20.00

Channels

The following discussion presents the unit costs and the procedure by which construction cost estimates were calculated for both unlined and lined channels.

Unlined Channels. For this type of improvement, the unit cost for normal excavation was $3.50 per cubic yard which includes: equipment, labor, installation, and contractors overhead and profit. Excavated material was assumed to be wasted on-site.

Lined Channels. Channel lining was assumed to consist of reinforced concrete, gunite, gabions, or rock rip rap. Unit costs were based on the area of coverage in conjunction with internal JMM cost data. For reinforced concrete, a thickness of 6 to 8 inches was assumed. Gunite lining was assumed to be 4 inches thick, with wire. Gabions were assumed to be 12 inches thick, and rip rap lining was assumed to be 2 feet thick. The cost of rip rap lining was based on a recent Corps of Engineers estimate of $15/ton, taken from the Bowman Wash Reconnaissance Study[6]. The resulting unit costs are given below.

Flow Rate (cfs)	Cost ($)
1,000	300,000
131,000	3,400,000

The flow into the basin defines the spillway capacity (either 100-year or Probable Maximum Flood); a total cost amount is then selected by interpolating from the above table.

Any costs related to the liability associated with urban multi-use detention basins have not been included in either the capital or O&M cost estimates for these facilities.

Bridge Structures

Bridges, in this Master Plan, were assumed to be structures which pass the 100-year design flow with a free water surface and were, therefore, free-span structures with minimal supports. Moreover, bridges were visualized as large, flat structures with paved surfaces, and were used when culverts would not provide sufficient hydraulic capacity. The unit cost for estimating bridge construction was $55 per square foot of bridge surface. This figure is the unit cost used by the Bridge Department of the California Department of Transportation (CALTRANS) for estimating the construction cost of flat surface, free-span bridges.

Land Acquisition Costs

For alternatives involving detention/retention facilities, channel enlargements, or dikes/levees, it could be necessary for the City to acquire additional easements or purchase land. Where project sites are located on public lands such as school grounds, parks, or BLM reserves, it was assumed that a stormwater flowage easement could be acquired at no significant cost. In the case of privately held land, it was assumed that the City would have to purchase the land outright. Although the City could invoke its right of condemnation to acquire a critical site, this method of land acquisition was not considered for cost estimating purposes.

Based on discussions with a local realtor, residential land values in Ridgecrest vary between $300 per acre and $200,000 per acre, depending on factors such as location, lot size, accessibility, zoning, and changing economic factors. Commercial land values range between $65,000 per acre to $650,000 per acre. For estimating purposes, three categories of residential areas were assumed: parcels less than 1 acre within the City (R1); parcels greater than 1 acre within the City (R2); and parcels outside the incorporated areas of the City (R3). Commercial areas were all grouped together (C1). Average unit costs for land acquisition are presented below.

Type	$/acre
R1	150,000
R2	40,000
R3	5,000
C1	200,000

Landscaping

The cost of establishing or replacing existing turf landscaping in park areas was assumed to be $10.35/sq ft ($15,300/acre). This is based on experience in other California communities. Costs for permanent irrigation systems ($0.30/sq ft) are not included in this estimate.

COST ESTIMATE CONTINGENCIES

The development of the cost estimates thus far has focused on the estimation of total construction costs rather than total project costs. The construction cost estimates do not include allowances for engineering, legal, administration, or construction contingency costs. To define total project costs these extras, or contingencies, must be estimated. The most efficient method to do this would be to include these contingencies as a percentage of the total construction cost. Hence, the following sections discuss the development of these percentages for two major contingency items:

Construction Contingency. This cost is added to cover unforeseen problems with the construction of the facilities as defined in this Master Plan. These costs also include contractor mobilization and planning. For this Master Plan, these costs have been estimated as 20 percent of the total construction costs.

Engineering and Administration Costs. This contingency is estimated to be 25 percent of the sum of the total construction cost and the construction contingency. It is composed of two parts; engineering and administration. The engineering portion is 15 percent and is intended to cover all costs associated with engineering the project. These costs include project level engineering studies, reports, preparation of final plans, specifications, contract documents, and engineering services during project construction. To cover those activities associated with the construction of the project that are not directly related to engineering, an adminstration/legal contingency of 10 percent has been included.

Thus, total project costs are computed by calculating the total construction costs and multiplying by a composite contingency factor of 1.50.

6.3 ALTERNATIVE COST ESTIMATES

The total project costs have been developed for all of the alternatives discussed in Chapter 5 for each of the major drainage areas defined in this Master Plan. The total project costs for each of the major drainage areas are summarized in Table 6-2 to Table 6-9. These tables present the total project costs for the various facilities comprising elements of each drainage alternative, with a brief description of each facility.

TABLE 6-2

COST ESTIMATES FOR IMPROVEMENT ALTERNATIVES

Description: RIDGECREST WASH

**** ALTERNATIVE 1 - BRADY CHANNEL ALL CONVEYANCE ****

FACILITY NUMBER	ITEM	TYPE	QUANTITY	UNIT COST	TOTAL	PROJECT TOTAL w/ CONTINGENCIES	COMMENTS
RCW-01	CHANNEL (8'w x 8'd x 3:1)						Inyokern Rd Channel Deepening
	Land Acquisition						
	Excavation	N/A	32,200	3.50	112,700		
	Lining						
	Drop Structures						
	Subtotal				112,700	169,050	
RCW-02	RCB (1 - 7'w x 6'd)	26	400	20.00	208,000	312,000	Downs - Under Inyokern
RCW-03	RCP	78	2,350	192	451,200	676,800	Downs - Inyokern to Ward
RCW-04	RCP	60	1,350	190	256,500	384,750	Downs - Ward to Sydnor
RCW-05	RCP	54	1,350	166	224,100	336,150	Downs - Sydnor to Drummond
RCW-06	RCP	42	2,000	121	242,000	363,000	Downs - Drummond to El Sereno
RCW-07	N/A						
	SUBTOTAL					$2,241,750	
RCW-08	RCB (2 - 5.5'w x 4'd)	38	600	20.00	456,000	684,000	Mahan - Under Inyokern
RCW-09	RCP	60	800	190	152,000	228,000	Mahan - Inyokern to Graaf
RCW-10	CHANNEL (8'w x 6'd x 3:1)						Mahan - Graaf to Sydnor
	Land Acquisition	R2	2.92	40,000	116,800		
	Excavation	N/A	15,000	3.50	52,500		
	Lining						
	Drop Structures	3	18	222.00	3,996		1 - 3' rock drop
	Subtotal				173,296	259,944	
RCW-11	N/A						
RCW-12	RCB (2 - 6.5'w x 4'd)	42	80	11.40	38,304	57,456	Ward Culvert
RCW-13	RCB (2 - 6.5'w x 4'd)	42	60	11.40	28,728	43,092	Sydnor Culvert

RCW-14	CHANNEL (8'w x 6'd x 3:1)						Mahan - Sydnor to Drummond
	Land Acquisition	R2	1.46	40,000	58,400		
	Excavation	N/A	7,500	3.50	26,250		
	Lining						
	Drop Structures						
	Subtotal				84,650	126,975	
RCW-15	N/A						
RCW-16	RCB (2 - 4.5'w x 3'd)	30	80	11.40	27,360	41,040	Drummond Culvert
RCW-17	CHANNEL (8'w x 4.5'd x 3:1)						Mahan - Drummond to Las Flores
	Land Acquisition	R2	2.39	40,000	95,600		
	Excavation	N/A	9,300	3.50	32,550		
	Lining						
	Drop Structures						
	Subtotal				128,150	192,225	
RCW-18	RCB (2 - 3.5'w x 3'd)	26	50	11.40	14,820	22,230	Felspar Culvert
RCW-19	RCP	27	160	39	6,240	9,360	Las Flores Culvert (2 - 27")
RCW-20	CHANNEL (0'w x 4'd x 4:1)						Mahan - Las Flores to Ridgecrest
	Land Acquisition	R2	2.21	40,000	88,400		V-ditch
	Excavation	N/A	6,200	3.50	21,700		
	Lining						
	Drop Structures						
	Subtotal				110,100	165,150	
	SUBTOTAL					$1,829,472	
RCW-21	RCB (6 - 9'w x 4'd)	156	440	20.00	1,372,800	2,059,200	Brady - Reach 7 (under Inyokern)
RCW-22	CHANNEL (42'w x 8'd x 2:1)						Brady - Reach 6 (to Ward)
	Land Acquisition	R2	4.20	40,000	168,000		
	Excavation	N/A	39,500	3.50	138,250		
	Lining	Rip Rap	9,140	21.00	191,940		sides only
	Drop Structures	3	52	222.00	11,544		1 drop
	Subtotal				509,734	764,601	
RCW-23	RCP	42	180	77	13,860	20,790	Graaf Culvert (3 - 42")
RCW-24	RCB (2 - 14'w x 8'd)	88	80	11.40	80,256	120,384	Ward Culvert
RCW-25	CHANNEL (24'w x 10'd x 2:1)						Brady - Reach 5 (Ward to RCW140)
	Land Acquisition	R2	5.94	40,000	237,600		
	Excavation	N/A	61,100	3.50	213,850		
	Lining	Rip Rap	18,600	21.00	390,600		sides only
	Drop Structures	3	68	222.00	15,096		2 - 34'-long drops
	Subtotal				857,146	1,285,719	

TABLE 6-2 (cont'd)

COST ESTIMATES FOR IMPROVEMENT ALTERNATIVES

Description: RIDGECREST WASH

******* ALTERNATIVE 2 - BRADY CHANNEL DETENTION *******

FACILITY NUMBER	ITEM	TYPE	QUANTITY	UNIT COST	TOTAL	PROJECT TOTAL w/ CONTINGENCIES	COMMENTS
RCW-01	CHANNEL (8'w x 8'd x 3:1)						Inyokern Rd Channel Deepening
	Land Acquisition						
	Excavation	N/A	32,200	3.50	112,700		
	Lining						
	Drop Structures						
	Subtotal				112,700	169,050	
RCW-02	RCB (1 - 6.5'w x 5'd)	23	400	20.00	184,000	276,000	Downs - Under Inyokern
RCW-03	RCP	66	2,350	149	350,150	525,225	Downs - Inyokern to Ward
RCW-04	RCP	36	1,700	101	171,700	257,550	Downs - Ward to Sydnor
RCW-05	RCP	54	1,000	166	166,000	249,000	Downs - Sydnor to Drummond
RCW-06	RCP	42	2,000	121	242,000	363,000	Downs - Drummond to El Sereno
RCW-07	N/A						
RCW-40	DETENTION BASIN (4.2 AF)						Downs Basin at Pearson Park overexcavated for hydraulics
	Excavation	N/A	16,600	3.64	60,424		
	Dikes						
	RCP	36	100	63	6,300		inlet pipe
	RCP	18	100	32	3,200		drain pipe
	Spillway	N/A					
	Land Acquisition						
	Landscaping	N/A	1.67	15,300	25,551		park turf
	Diversion Weir	N/A			20,000		lump sum
	Subtotal				115,475	173,213	
	SUBTOTAL					$2,013,038	
RCW-08	RCB (5'w x 4'd)	28	600	20.00	336,000	504,000	Mahan - Under Inyokern
RCW-09	RCP	42	800	121	96,800	145,200	Mahan - Inyokern to Graaf

RCW-10	CHANNEL (8'w x 4'd x 3:1)						Mahan - Graaf to Sydnor
	Land Acquisition	R2	2.21	40,000	88,400		
	Excavation	N/A	15,000	3.50	52,500		
	Lining						
	Drop Structures	3	18	222.00	3,996		1 - 3' rock drop
	Subtotal				144,896	217,344	
RCW-11	N/A						
RCW-12	RCB (2 - 4'w x 2'd)	24	80	11.40	21,888	32,832	Ward Culvert
RCW-13	RCB (2 - 4'w x 2'd)	24	60	11.40	16,416	24,624	Sydnor Culvert
RCW-14	CHANNEL (8'w x 6'd x 3:1)						Mahan - Sydnor to Drummond
	Land Acquisition	R2	1.46	40,000	58,400		
	Excavation	N/A	7,500	3.50	26,250		
	Lining						
	Drop Structures						
	Subtotal				84,650	126,975	
RCW-15	N/A						
RCW-16	RCB (2 - 4.5'w x 3'd)	30	80	11.40	27,360	41,040	Drummond Culvert
RCW-17	CHANNEL (8'w x 4.5'd x 3:1)						Mahan - Drummond to Las Flores
	Land Acquisition	R2	2.39	40,000	95,600		
	Excavation	N/A	9,300	3.50	32,550		
	Lining						
	Drop Structures						
	Subtotal				128,150	192,225	
RCW-18	RCB (2 - 3.5'w x 3'd)	26	50	11.40	14,820	22,230	Felspar Culvert
RCW-19	RCP	27	160	39	6,240	9,360	Las Flores Culvert (2 - 27")
RCW-20	CHANNEL (0'w x 4'd x 4:1)						Mahan - Las Flores to Ridgecrest
	Land Acquisition	R2	2.21	40,000	88,400		
	Excavation	N/A	6,200	3.50	21,700		V-ditch
	Lining						
	Drop Structures						
	Subtotal				110,100	165,150	
RCW-39	DETENTION BASIN (11.9 AF)						Mahan Basin at Sydnor
	Excavation	N/A	19,200	3.64	69,888		
	Dikes						
	RCP	18	100	32	3,200		outlet drain
	Spillway	N/A					
	Land Acquisition	R2	2.07	40,000	82,800		
	Landscaping	N/A					
	Channel Lining	Gunite	131	36.00	4,716		overflow weir
	Subtotal				160,604	240,906	
	SUBTOTAL					$1,721,886	

RCW-34	CHANNEL (8'w x 4'd x 2:1)						Brady - Reach 1b
	Land Acquisition	R2	0.27	40,000	10,800		
	Excavation	N/A	950	3.50	3,325		full perimeter
	Lining	Rip Rap	1,150	21.00	24,150		
	Drop Structures						
	Subtotal				38,275	57,413	
RCW-35	CHANNEL (10'w x 5'd x 2:1)						Brady - Reach 1a
	Land Acquisition	R2	0.46	40,000	18,400		
	Excavation	N/A	3,000	3.50	10,500		
	Lining	Rip Rap					
	Drop Structures						lined levee
	Dike/Levee	3	400	36.10	14,440		
	Subtotal				43,340	65,010	
RCW-36	N/A						Brady/Drummond Debris Basin
RCW-37	DETENTION BASIN (105 AF)						Brady/Felspar - Site 2 all below ground
	Excavation	N/A	169,400	2.03	343,882		
	Dikes						
	Conveyance	36	200	63	12,600		
	Spillway	N/A					
	Land Acquisition	R2	8.20	40,000	328,000		
	Landscaping	N/A					
	Inlet Channel (17'w x 8'd x 2:1)						channel + dike
	Land Acquisition	R2	1.43	40,000	57,200		
	Excavation	N/A	6,800	3.50	23,800		
	Lining	Rip Rap	2,800	21.00	58,800		for slopes
	Lining	Gunite	830	36.00	29,880		for spill weir
	Drop Structures						
	Dike/Levee	4	600	51.50	30,900		
	Subtotal				885,062	1,327,593	
RCW-38	DETENTION BASIN (30 AF)						
	Excavation	N/A	22,600	2.56	57,856		
	Dikes						
	RCP	18	80	32	2,560		spill to Reach 3
	Spillway	N/A					24-hr drain
	Land Acquisition	R2	6	40,000	240,000		
	Landscaping	N/A					
	Subtotal				300,416	450,624	
	SUBTOTAL					$6,093,447	
TOTAL COST						$9,828,371	

WCL-12	CIPP	84	3,900	135	526,500	
	Land Acquisition	R1	1.07	150,000	160,500	
	Subtotal				530,315	795,473
WCL-13	CHANNEL (8.5'w x 8.5'd x 2:1)					
	Land Acquisition	R1	1.77	150,000	265,500	
	Excavation	N/A	5,299	3.50	18,547	
	Lining					
	Drop Structures	3	19.0	222.00	4,218	
	Subtotal				288,265	432,397
TOTAL COST						$3,412,139

TABLE 6-4

COST ESTIMATES FOR IMPROVEMENT ALTERNATIVES

Description: DRUMMOND AVENUE WASH

******** ALTERNATIVE 1 - NO DIVERSIONS FROM IK ********

FACILITY NUMBER	ITEM	TYPE	QUANTITY	UNIT COST	TOTAL	PROJECT TOTAL w/ CONTINGENCIES	COMMENTS
DAW-01	RCP	54	650	166	107,900	161,850	Ward Avenue Drain
DAW-02	RCP	54	1,380	166	229,080	343,620	Ward Avenue Drain
DAW-03	N/A						
DAW-04	CHANNEL						Daylight channel
	Land Acquisition	R1	0.50	150,000	75,000		
	Excavation	N/A	622	3.50	2,177		
	Lining						
	Drop Structures						
	Subtotal				77,177	115,766	
TOTAL COST						$621,236	

Description: INYOKERN BASIN

*** ALTERNATIVE 1 - ALL CONVEYANCE (W/ CHANNEL MOD.) ***

FACILITY NUMBER	ITEM	TYPE	QUANTITY	UNIT COST	TOTAL	PROJECT TOTAL w/ CONTINGENCIES	COMMENTS
IK-01	RCP	48	1,320	142	187,440	281,160	Ward Ave Drain
IK-02	RCP	54	660	166	109,560	164,340	Norma Drain - Reach 1
IK-03	RCP	72	670	241	161,470	242,205	Norma Drain - Reach 2
IK-04	RCP	84	1,510	293	442,430	663,645	Norma Drain - Reach 3
IK-05	N/A						
IK-06	Channel Excavation	N/A	7,100	3.50	24,850	37,275	
TOTAL COST						$1,388,625	

TABLE 6-4 (cont'd)

COST ESTIMATES FOR IMPROVEMENT ALTERNATIVES

Description: DRUMMOND AVENUE WASH

********** ALTERNATIVE 2 - DIVERSION FROM IK **********

FACILITY NUMBER	ITEM	TYPE	QUANTITY	UNIT COST	TOTAL	PROJECT TOTAL w/ CONTINGENCIES	COMMENTS
DAW-01	RCP	66	650	215	139,750	209,625	Ward Avenue Drain
DAW-02	RCP	78	1,380	270	372,600	558,900	Ward Avenue Drain
DAW-03	RCP	66	650	215	139,750	209,625	Ward Avenue Drain
DAW-04	CHANNEL						
	Land Acquisition	R2	1.65	40,000	66,000		Daylight channel
	Excavation	N/A	2,984	3.50	10,444		
	Lining						
	Drop Structures						
	Subtotal				76,444	114,666	
TOTAL COST						$1,092,816	

Description: INYOKERN BASIN

*********** ALTERNATIVE 2 - DIVERSION TO DAW ***********

FACILITY NUMBER	ITEM	TYPE	QUANTITY	UNIT COST	TOTAL	PROJECT TOTAL w/ CONTINGENCIES	COMMENTS
IK-01	RCP	48	1,320	142	187,440	281,160	Ward Ave Drain
IK-02	N/A						
IK-03	N/A						
IK-04	RCP	60	1,110	190	210,900	316,350	Norma Drain - Reach 3
IK-05	RCP	66	400	215	86,000	129,000	
IK-06	CHANNEL (20'w x 6.5'd x3:1)						NWC Inyokern Channel
	Land Acquisition						
	Excavation	N/A	6,300	3.50	22,050		
	Lining						
	Drop Structures						
	Subtotal				22,050	33,075	
TOTAL COST						$759,585	

TABLE 6-5

COST ESTIMATES FOR IMPROVEMENT ALTERNATIVES

Description: CHURCH AVENUE BASIN

* ALTERNATIVE 1 ALL CONVEYANCE - DIVERT TO FRENCH CHANNEL *

FACILITY NUMBER	ITEM	TYPE	QUANTITY	UNIT COST	TOTAL	PROJECT TOTAL w/ CONTINGENCIES	COMMENTS
CH-01	RCB (7.5'w x 6'd)	27	700	13.30	251,370	377,055	Gateway - California to Ridgecrest
CH-02	RCP	84	3,300	293	966,900	1,450,350	California - Sunland to Gateway
CH-03	RCP	60	2,660	190	505,400	758,100	Church - China Lake to Sunland
CH-04	RCP	42	1,310	121	158,510	237,765	Church - Warner to China Lake
CH-05	N/A						
CH-06	N/A						
CH-07	N/A						
CH-08	N/A						
CH-09	RCP	54	3,100	166	514,600	771,900	Ridgecrest - Downs to Norma
CH-10	RCP	72	930	241	224,130	336,195	Jean and Helena
CH-11	RCP	78	2,100	270	567,000	850,500	French - Helena to Balsam
CH-12	RCB (9.5'w x 6'd)	31	570	20.00	353,400	530,100	French - Balsam to Channel
CH-13	CHANNEL						
	Land Acquisition						
	Excavation	N/A	2,160	3.50	7,560		French Channel Deepening
	Lining						
	Drop Structures						
	Subtotal				7,560	11,340	
CH-14	RCP	66	1,540	215	331,100	496,650	Norma - Church to Ridgecrest
CH-15	CHANNEL (8'w x 9'd x 2:1)						Daylight channel for Church Drain
	Land Acquisition	R2	2.25	40,000	90,000		
	Excavation	N/A	8,000	3.50	28,000		
	Lining						
	Drop Structures						
	Dike	3	300	14.00	4,200		est. for 600' at 1.5' avg height
	Subtotal				122,200	183,300	
TOTAL COST						$6,003,255	

TABLE 6-5 (cont'd)

COST ESTIMATES FOR IMPROVEMENT ALTERNATIVES

Description: CHURCH AVENUE BASIN

** ALTERNATIVE 2 DETENTION - DIVERT TO FRENCH CHANNEL **

FACILITY NUMBER	ITEM	TYPE	QUANTITY	UNIT COST	TOTAL	PROJECT TOTAL w/ CONTINGENCIES	COMMENTS
CH-01	RCP	66	700	215	150,500	225,750	Gateway - California to Ridgecres
CH-02	RCP	54	3,300	166	547,800	821,700	California - Sunland to Gateway
CH-03	RCP	60	2,660	190	505,400	758,100	Church - China Lake to Sunland
CH-04	RCP	42	1,310	121	158,510	237,765	Church - Warner to China Lake
CH-05	N/A						
CH-06	N/A						
CH-07	N/A						
CH-08	N/A						
CH-09	RCP	54	3,100	166	514,600	771,900	Ridgecrest - Downs to Norma
CH-10	RCP	72	930	241	224,130	336,195	Jean and Helena
CH-11	RCP	78	2,100	270	567,000	850,500	French - Helena to Balsam
CH-12	RCB (9.5'w x 6'd)	31	570	20.00	353,400	530,100	French - Balsam to Channel
CH-13	CHANNEL						
	Land Acquisition						
	Excavation	N/A	2,160	3.50	7,560		French Channel Deepening
	Lining						
	Drop Structures						
	Subtotal				7,560	11,340	
CH-14	RCP	66	1,540	215	331,100	496,650	Norma - Church to Ridgecrest
CH-15	CHANNEL (8'w x 8.5'd x 2:1)						Daylight channel for Church Drai
	Land Acquisition	R2	2.25	40,000	90,000		
	Excavation	N/A	7,500	3.50	26,250		
	Lining						
	Drop Structures						
	Dike	3	300	14.00	4,200		est. for 600' at 1.5 avg heigh
	Subtotal				120,450	180,675	
TOTAL COST						$5,220,675	

TABLE 6-5

COST ESTIMATES FOR IMPROVEMENT ALTERNATIVES

Description: UPJOHN AVENUE BASIN

* ALTERNATIVE 1 ALL CONVEYANCE - DIVERT TO BOWMAN CHANNEL & CHURCH DRAIN *

FACILITY NUMBER	ITEM	TYPE	QUANTITY	UNIT COST	TOTAL	PROJECT TOTAL w/ CONTINGENCIES	COMMENTS
UJ-01	RCP	48	2,000	142	284,000	426,000	Gateway - Upjohn to California
UJ-02	RCP	66	1,300	215	279,500	419,250	Sunland - Upjohn to Church
UJ-03	RCP	42	2,600	121	314,600	471,900	China Lake - Rader to Church
UJ-04	RCP	36	1,320	101	133,320	199,980	Upjohn - Warner to China Lake
UJ-05	N/A						
UJ-06	N/A						
UJ-07	RCP	36	2,640	101	266,640	399,960	Langley - Mahan to Downs
UJ-08	RCP	30	1,620	86	139,320	208,980	St. George - Guam to Mahan
UJ-09	RCB (6.5'w x 4'd)	21	700	13.30	195,510	293,265	Downs - Langley to Rader
UJ-10	RCB (8'w x 4'd)	24	1,000	13.30	319,200	478,800	Downs - Rader to Willow
UJ-11	RCP	72	630	241	151,830	227,745	Downs - Willow to Bowman
UJ-12	RCP	66	1,360	215	292,400	438,600	Norma - Upjohn to Rader
UJ-13	RCP	54	1,360	166	225,760	338,640	Norma - Rader to Bowman
TOTAL COST						$3,903,120	

TABLE 6-5 (cont'd)

COST ESTIMATES FOR IMPROVEMENT ALTERNATIVES

Description: UPJOHN AVENUE BASIN

* ALTERNATIVE 2 DETENTION - DIVERT TO BOWMAN CHANNEL & CHURCH DRAIN *

FACILITY NUMBER	ITEM	TYPE	QUANTITY	UNIT COST	TOTAL	PROJECT TOTAL w/ CONTINGENCIES	COMMENTS
UJ-01	RCP	48	2,000	142	284,000	426,000	Gateway - Upjohn to California
UJ-02	RCP	33	1,600	94	150,400	225,600	Sunland - Upjohn to Church
UJ-03	RCP	60	2,300	190	437,000	655,500	Upjohn - China Lake to Basin
UJ-04	RCP	36	1,320	101	133,320	199,980	Upjohn - Warner to China Lake
UJ-05	N/A						
UJ-06	N/A						
UJ-07	RCP	36	2,640	101	266,640	399,960	Langley - Mahan to Downs
UJ-08	RCP	30	1,620	86	139,320	208,980	St. George - Guam to Mahan
UJ-09	RCB (6.5'w x 4'd)	21	700	13.30	195,510	293,265	Downs - Langley to Rader
UJ-10	RCB (8'w x 4'd)	24	1,000	13.30	319,200	478,800	Downs - Rader to Willow
UJ-11	RCP	72	630	241	151,830	227,745	Downs - Willow to Bowman
UJ-12	RCP	66	1,360	215	292,400	438,600	Norma - Upjohn to Rader
UJ-13	RCP	54	1,360	166	225,760	338,640	Norma - Rader to Bowman
UJ-14	DETENTION BASIN (13.8 AF)						Future park site
	Excavation	N/A	22,300	2.56	57,088		- overexcavate to 7' deep
	Dikes						
	RCP	18	100	32	3,200		- outlet pipe
	Spillway	N/A					
	Land Acquisition						
	Landscaping	N/A	2.21	15,300	33,813		
	Overflow Weir	N/A	1	20,000	20,000		- 49' inflow weir
	Subtotal				114,101	171,152	
TOTAL COST						$4,064,222	

TABLE 6-6

COST ESTIMATES FOR IMPROVEMENT ALTERNATIVES

Description: COLLEGE HEIGHTS WASH

*********** ALTERNATIVE 1 - ALL CONVEYANCE ***********

FACILITY NUMBER	ITEM	TYPE	QUANTITY	UNIT COST	TOTAL	PROJECT TOTAL w/ CONTINGENCIES	COMMENTS
CHW-01	DIKE	6	1,400	87.10	121,940		East Training Dike, rock lined
	DIKE	4	1,400	51.50	72,100		West Training Dike, rock lined
	DIKE	3	9,500	14.00	133,000		Floodway Dikes, unlined
	Land Acquisition	R3	35.10	5,000	175,500		Floodway - 300' wide
	Subtotal				502,540	753,810	
CHW-02	DIKE	5	2,000	68.50	137,000		Kendall Training Dike, rock lined
	DIKE	3	6,700	14.00	93,800		Floodway Dikes, unlined
	Land Acquisition	R3	27.80	5,000	139,000		Floodway - 300' wide
	Subtotal				369,800	554,700	
CHW-03	DEBRIS BASIN (9.0 AF)						Norma Debris Basin
	Excavation	N/A	14,500	3.64	52,780		
	Dikes						
	Conveyance						
	Spillway	N/A	1,790	N/A	318,834		
	Land Acquisition	R2	0.50	40,000	20,000		
	Landscaping	N/A					
	Subtotal				391,614	587,422	
CHW-04	RCB (3 - 9'w x 8'd)	102	50	11.40	58,140	87,210	Springer culvert
CHW-05	CHANNEL (27'w x 10'd x 2:1)						Norma Channel - Reach 1
	Land Acquisition	R3	2.75	5,000	13,750		
	Excavation	N/A	22,600	3.50	79,100		
	Lining	Rip Rap	10,400	21.00	218,400		
	Drop Structures	3	148	222.00	32,856		4 rock drops
	Subtotal				344,106	516,159	
CHW-06	CHANNEL (11'w x 9'd x 1.5:1)						Norma Channel - Reach 2
	Land Acquisition	R3	1.88	5,000	9,400		
	Excavation	N/A	10,620	3.50	37,170		
	Lining	Gunite	6,280	36.00	226,080		
	Drop Structures						
	Subtotal				272,650	408,975	
CHW-07	RCB (2 - 10.5'w x 7'd)	70	100	11.40	79,800	119,700	Dolphin culvert

CHW-08	CHANNEL (8'w x 5.5'd x 2:1)						College Heights Blvd Channel - Reach 2
	Land Acquisition	R2	2.09	40,000	83,600		
	Excavation	N/A	10,100	3.50	35,350		full perimeter
	Lining	Rip Rap	9,400	21.00	197,400		7 rock drops
	Drop Structures	3	126	222.00	27,972		
	Subtotal				344,322	516,483	
CHW-09	RCB (2 - 4'w x 3.5'd)	30	50	11.40	17,100	25,650	Springer culvert
CHW-10	CHANNEL (8'w x 6'd x 2:1)						College Heights Blvd Channel - Reach 2
	Land Acquisition	R2	2.21	40,000	88,400		
	Excavation	N/A	11,600	3.50	40,600		full perimeter
	Lining	Rip Rap	10,100	21.00	212,100		4 rock drops
	Drop Structures	3	72	222.00	15,984		
	Subtotal				357,084	535,626	
CHW-11	RCB (2 - 4'w x 4'd)	32	50	11.40	18,240	27,360	Dolphin culvert
CHW-12	CHANNEL (5'w x 9'd x 1.5:1)						College Heights Blvd Channel - Reach 4
	Land Acquisition	C1	1.95	200,000	390,000		
	Excavation	N/A	14,180	3.50	49,630		
	Lining	Gunite	9,570	36.00	344,520		
	Drop Structures						
	Subtotal				784,150	1,176,225	
CHW-13	RCB (2 - 7.5'w x 7'd)	58	100	13.30	77,140	115,710	College Heights Blvd culvert
CHW-14	CHANNEL (9'w x 9'd x 1.5:1)						China Lake Blvd Channel
	Land Acquisition	C1	3.25	200,000	650,000		
	Excavation	N/A	25,880	3.50	90,580		
	Lining	Gunite	15,890	36.00	572,040		
	Drop Structures						
	Subtotal				1,312,620	1,968,930	
CHW-15	RCB (2 - 10'w x 7'd)	68	100	13.30	90,440	135,660	College Heights Blvd (new) culvert
CHW-16	RCB (3 - 8.5'w x 7'd)	93	200	13.30	247,380	371,070	College Heights Blvd (old) culvert
CHW-20	RCP	42	1,200	77	92,400	138,600	Dolphin - West
CHW-21	RCP	48	1,450	92	133,400	200,100	Dolphin - East
CHW-22	RCB (6'w x 4'd)	20	1,200	11.40	273,600	410,400	Springer - West
CHW-23	DIKE	6	2,350	87.10	204,685	307,028	Training Dike, rock lined
CHW-24	RCB (7'w x 4'd)	22	40	11.40	10,032	15,048	Javis Culvert

CHW-25	CHANNEL (5'w x 4.5'd x 2:1)						College Heights Channel - Reach 1
	Land Acquisition	R1	1.67	150,000	250,500		
	Excavation	N/A	6,100	3.50	21,350		
	Lining	Gunite	5,300	36.00	190,800		8 concrete drops
	Drop Structures	3	120	168.00	20,160		
	Subtotal				482,810	724,215	
CHW-26	RCB (7'w x 4'd)	22	100	13.30	29,260	43,890	College Heights Culvert
TOTAL COST						$9,739,970	

TABLE 6-6 (cont'd)

COST ESTIMATES FOR IMPROVEMENT ALTERNATIVES

Description: COLLEGE HEIGHTS WASH

FACILITY NUMBER	ITEM	************* ALTERNATIVE 2 - DETENTION ************* TYPE	QUANTITY	UNIT COST	TOTAL	PROJECT TOTAL w/ CONTINGENCIES	COMMENTS
CHW-01	CHANNEL (8'w x 4.5'd x 2:1)						Detention Site 2 Outlet Channel
	Land Acquisition	R3	6.54	5,000	32,700		
	Excavation	N/A	16,200	3.50	56,700		
	Lining	Rip Rap	17,800	21.00	373,800		full perimeter
	Drop Structures	3	180	222.00	39,960		10 drops
	Subtotal				503,160	754,740	
CHW-02	CHANNEL (8'w x 5'd x 2:1)						Detention Site 1 Outlet Channel
	Land Acquisition	R3	3.82	5,000	19,100		
	Excavation	N/A	10,700	3.50	37,450		
	Lining	Rip Rap	8,000	21.00	168,000		sides only
	Drop Structures	3	126	222.00	27,972		7 rock drops
	Subtotal				252,522	378,783	
CHW-03	N/A						
CHW-04	RCB (2 - 5'w x 4'd)	36	50	11.40	20,520	30,780	Springer culvert
CHW-05	CHANNEL (10'w x 6.5'd x 2:1)						Norma Channel - Reach 1
	Land Acquisition	R3	1.82	5,000	9,100		
	Excavation	N/A	7,200	3.50	25,200		
	Lining	Rip Rap	4,200	21.00	88,200		
	Drop Structures	3	80	222.00	17,760		4 rock drops
	Subtotal				140,260	210,390	
CHW-06	CHANNEL (5'w x 6'd x 1.5:1)						Norma Channel - Reach 2
	Land Acquisition	R3	1.43	5,000	7,150		
	Excavation	N/A	4,100	3.50	14,350		
	Lining	Gunite	3,800	36.00	136,800		
	Drop Structures						
	Subtotal				158,300	237,450	
CHW-07	RCB (2 - 5.5'w x 4'd)	38	100	11.40	43,320	64,980	Dolphin culvert
CHW-08	CHANNEL (8'w x 4'd x 2:1)						College Heights Blvd Channel - Reach 2
	Land Acquisition	R2	1.73	40,000	69,200		
	Excavation	N/A	6,160	3.50	21,560		
	Lining	Rip Rap	7,480	21.00	157,080		
	Drop Structures						
	Subtotal				247,840	371,760	

CHW-09	RCB (2 - 4'w x 2'd)	24	50	11.40	13,680	20,520	Springer culvert
CHW-10	CHANNEL (8'w x 4'd x 2:1)						College Heights Blvd Channel - Reach 3
	Land Acquisition	R2	1.73	40,000	69,200		
	Excavation	N/A	6,160	3.50	21,560		
	Lining	Rip Rap	7,480	21.00	157,080		
	Drop Structures						
	Subtotal				247,840	371,760	
CHW-11	RCB (2 - 4'w x 2'd)	24	50	11.40	13,680	20,520	Dolphin culvert
CHW-12	CHANNEL (7'w x 5'd x 1.5:1)						College Heights Blvd Channel - Reach 4
	Land Acquisition	C1	1.43	200,000	286,000		
	Excavation	N/A	6,180	3.50	21,630		
	Lining	Gunite	6,400	36.00	230,400		
	Drop Structures						
	Subtotal				538,030	807,045	
CHW-13	RCB (2 - 6'w x 3'd)	36	100	13.30	47,880	71,820	College Heights Blvd culvert
CHW-14	CHANNEL (5'w x 5'd x 1.5:1)						China Lake Blvd Channel
	Land Acquisition	R1	1.98	150,000	297,000		
	Excavation	N/A	8,000	3.50	28,000		
	Lining	Gunite	8,800	36.00	316,800		
	Drop Structures						
	Subtotal				641,800	962,700	
CHW-15	RCB (6'w x 5'd)	22	100	13.30	29,260	43,890	College Heights Blvd (new) culvert
CHW-16	RCB (2 - 7'w x 5'd)	48	200	13.30	127,680	191,520	College Heights Blvd (old) culvert + Bowman culvert
CHW-17	DET. BASIN (220 AF)						Site 1 Basin
	Excavation	N/A	177,500	2.03	360,325		cut/fill
	Dikes	5	2,000	68.50	137,000		Kendall
	Dikes	5	700	68.50	47,950		Downs
	Conveyance (RCP)	54	200	111	22,200		outlet
	Spillway	N/A	5,900	N/A	416,841		PMF
	Land Acquisition						BLM
	Landscaping						
	Subtotal				984,316	1,476,475	
CHW-18	DET. BASIN (250 AF)						Site 2 Basin
	Excavation	N/A	202,000	2.03	410,060		cut/fill
	Dikes	6	2,700	87.10	235,170		east side
	Dikes	4	1,000	51.50	51,500		west side
	Conveyance (RCP)	36	200	63	12,600		2 - 36" RCP outlet
	Spillway	N/A	6,400	N/A	428,764		PMF
	Land Acquisition						BLM
	Landscaping	N/A					
	Subtotal				1,138,094	1,707,142	

CHW-20	RCP	42	1,200	77	92,400	138,600	Dolphin - West
CHW-21	RCP	48	1,450	92	133,400	200,100	Dolphin - East
CHW-22	RCB (6'w x 4'h)	20	1,200	11.40	273,600	410,400	Springer - West
CHW-23	Dike	6	2,400	87.10	209,040	313,560	Diversion Dike
	RCB (2 - 7'w x 5'd)	48	60	13.30	38,304	57,456	College Heights Blvd culvert
						----------	
TOTAL COST						$8,842,390	

TABLE 6-7

COST ESTIMATES FOR IMPROVEMENT ALTERNATIVES

Description: EAST CHINA LAKE BASIN

********** ALTERNATIVE 1 - ALL CONVEYANCE **********

FACILITY NUMBER	ITEM	TYPE	QUANTITY	UNIT COST	TOTAL	PROJECT TOTAL w/ CONTINGENCIES	COMMENTS
ECL-01	DIKE	5	800	68.50	54,800		
	RCB (10'w x 8'd)	36	60	13.30	28,728		Gateway Culvert
	Subtotal				83,528	125,292	
ECL-02	CHANNEL (24'w x 10'd x 2:1)						Franklin Channel
	Land Acquisition	R3	5.31	5,000	26,550		
	Excavation	N/A	42,400	3.50	148,400		
	Lining	Rip Rap	13,000	21.00	273,000		sides only
	Drop Structures	3	102	222.00	22,644		3 rock drops
	Subtotal				470,594	705,891	
ECL-03	RCB (2 - 9'w x 8'd)	68	60	13.30	54,264	81,396	Sunland culvert
ECL-04	CHANNEL (17'w x 10'd x 2:1)						Sunland Channel
	Land Acquisition	R3	5.55	5,000	27,750		
	Excavation	N/A	53,400	3.50	186,900		
	Lining	Rip Rap	22,800	21.00	478,800		full perimeter
	Drop Structures	3	324	222.00	71,928		12 rock drops
	Subtotal				765,378	1,148,067	
ECL-05	RCB (2 - 9'w x 8'd)	68	60	18.75	76,500	114,750	Dolphin culvert
ECL-06	RCB (2 - 9'w x 8'd)	68	70	11.40	54,264	81,396	Bowman culvert
ECL-07	CHANNEL (15'w x 7'd x 2:1)						Rader Channel - Reach 1
	Land Acquisition	R2	2.25	40,000	90,000		
	Excavation	N/A	15,040	3.50	52,640		
	Lining	Rip Rap	6,960	21.00	146,160		sides only
	Drop Structures						
	Subtotal				288,800	433,200	
ECL-08	CHANNEL (15'w x 10'd x 2:1)						Rader Channel - Reach 2
	Land Acquisition	R2	2.20	40,000	88,000		
	Excavation	N/A	20,740	3.50	72,590		
	Lining	Rip Rap	10,620	21.00	223,020		full perimeter
	Drop Structures						
	Subtotal				383,610	575,415	

ECL-09	CHANNEL (10'w x 6'd x 1.5:1)						Richmond Channel
	Land Acquisition	R2	0.63	40,000	25,200		
	Excavation	N/A	2,960	3.50	10,360		
	Lining	Gunite	2,460	36.00	88,560		
	Drop Structures						
	Subtotal				124,120	186,180	
ECL-10	RCB (2 - 9'w x 6'd)	60	40	13.30	31,920	47,880	Fairgrounds Entrance culvert
ECL-11	RCB (2 - 9'w x 6'd)	60	60	13.30	47,880	71,820	Rader culvert
TOTAL COST						$3,571,287	

TABLE 6-7 (cont'd)

COST ESTIMATES FOR IMPROVEMENT ALTERNATIVES

Description: EAST CHINA LAKE BASIN

FACILITY NUMBER	ITEM	************* ALTERNATIVE 2 - DETENTION ************* TYPE	QUANTITY	UNIT COST	TOTAL	PROJECT TOTAL w/ CONTINGENCIES	COMMENTS
ECL-01	Dike	5	800	68.50	54,800		
	RCB (10'w x 8'd)	36	60	13.30	28,728		Gateway Culvert
	Subtotal				83,528	125,292	
ECL-02	CHANNEL (24'w x 10'd x 2:1)						Franklin Channel
	Land Acquisition	R3	5.31	5,000	26,550		
	Excavation	N/A	42,400	3.50	148,400		
	Lining	Rip Rap	13,000	21.00	273,000		sides only
	Drop Structures	3	102	222.00	22,644		3 rock drops
	Subtotal				470,594	705,891	
ECL-03	RCB (2 - 9'w x 8'd)	68	60	13.30	54,264	81,396	Sunland Culvert
ECL-04	CHANNEL (9'w x 9'd x 2:1)						Sunland Channel
	Land Acquisition	R3	4.39	5,000	21,950		
	Excavation	N/A	35,100	3.50	122,850		
	Lining	Rip Rap	21,000	21.00	441,000		full perimeter
	Drop Structures	3	228	222.00	50,616		12 rock drops
	Subtotal				636,416	954,624	
ECL-05	RCB (10'w x 7'd)	34	60	13.30	27,132	40,698	Dolphin Culvert
ECL-06	RCB (10'w x 7'd)	34	70	13.30	31,654	47,481	Bowman Culvert
ECL-07	CHANNEL (15'w x 7'd x 2:1)						Rader Channel - Reach 1
	Land Acquisition	R2	2.25	40,000	90,000		
	Excavation	N/A	15,040	3.50	52,640		
	Lining	Rip Rap	6,960	21.00	146,160		
	Drop Structures						
	Subtotal				288,800	433,200	
ECL-08	CHANNEL (15'w x 10'd x 2:1)						Rader Channel - Reach 2
	Land Acquisition	R2	2.20	40,000	88,000		
	Excavation	N/A	20,740	3.50	72,590		
	Lining	Rip Rap	10,620	21.00	223,020		full perimeter
	Drop Structures						
	Subtotal				383,610	575,415	

ECL-09	CHANNEL (10'w x 6'd x 1.5:1)						Richmond Channel
	Land Acquisition	R2	0.63	40,000	25,200		
	Excavation	N/A	2,960	3.50	10,360		
	Lining	Gunite	2,460	36.00	88,560		
	Drop Structures						
	Subtotal				124,120	186,180	
ECL-10	RCB (2 - 9'w x 6'd)	60	40	13.30	31,920	47,880	Fairgrounds Entrance culvert
ECL-11	RCB (2 - 9'w x 6'd)	60	60	13.30	47,880	71,820	
ECL-12	DETENTION BASIN (51 AF)						Sunland Basin
	Excavation	N/A	81,000	2.03	164,430		
	Dikes						
	RCP	30	100	50	5,000		outlet pipe
	Lining	Gunite	960	36.00	34,560		diversion weir
	Spillway	N/A					
	Land Acquisition	R2	5.74	40,000	229,600		500' x 500'
	Landscaping	N/A					
	Subtotal				433,590	650,385	
TOTAL COST						$3,920,262	

TABLE 6-8

COST ESTIMATES FOR IMPROVEMENT ALTERNATIVES

Description: BOWMAN WASH

FACILITY NUMBER	ITEM	********** ALTERNATIVE 1 - ALL CONVEYANCE ***********					COMMENTS
		TYPE	QUANTITY	UNIT COST	TOTAL	PROJECT TOTAL w/ CONTINGENCIES	
BW-01	DEBRIS BASIN (5.5 AF)						Inlet structure, debris basin
	Excavation	N/A	8,800	3.64	32,032		
	Dikes	6	400	87.10	34,840		
	Conveyance						
	Spillway	N/A	815	N/A	295,584		
	Land Acquisition	R2	1.00	40,000	40,000		
	Landscaping						
	Subtotal				402,456	603,685	
BW-02	RCB (4 - 4.5'w x 3'd)	60	80	11.40	54,720	82,080	Brady culvert
BW-03	CHANNEL (30'w x 5'd x 3:1)						Reach 1 - Brady to Mahan
	Land Acquisition						
	Excavation	N/A	22,000	3.50	77,000		
	Lining	Rip Rap	9,280	21.00	194,880		sides only
	Drop Structures	4	120	252.00	30,240		3 drops at 40' each
	Subtotal				302,120	453,180	
BW-04	RCB (4 - 4.5'w x 3'd)	60	80	13.30	63,840	95,760	Mahan culvert
BW-05	CHANNEL (31'w x 6.5'd x 3:1)						Reach 2 - Mahan to Downs
	Land Acquisition						
	Excavation	N/A	30,600	3.50	107,100		
	Lining	Rip Rap	11,900	21.00	249,900		sides only
	Drop Structures	4	135	252.00	34,020		3 drops at 45' each
	Subtotal				391,020	586,530	
BW-06	RCB (5 - 6'w x 4.5'd)	105	80	13.30	111,720	167,580	Downs culvert
BW-07	CHANNEL (8'w x 10'd x 2:1)						Reach 3 - Downs to Norma
	Land Acquisition						
	Excavation	N/A	27,000	3.50	94,500		
	Lining	Rip Rap	15,200	21.00	319,200		full perimeter
	Drop Structures	4	54	252.00	13,608		3 drops at 18' each
	Subtotal				427,308	640,962	
BW-08	RCB (1 - 12'w x 8'd)	40	80	13.30	42,560	63,840	Norma culvert

BW-09	CHANNEL (8'w x 10'd x 2:1)						
	Land Acquisition						Reach 4 - Norma to China Lake
	Excavation	N/A	27,000	3.50	94,500		
	Lining	Rip Rap	15,200	21.00	319,200		full perimeter
	Drop Structures	3	36	222.00	7,992		2 drops at 18' each
	Subtotal				421,692	632,538	
BW-10	RCB (1 - 12'w x 8'd)	40	250	20.00	200,000	300,000	China Lake Blvd culvert
BW-11	CHANNEL (56'w x 10.5'd x 2:1)						
	Land Acquisition						Reach 5 - China Lake to Sunland
	Excavation	N/A	77,860	3.50	272,510		
	Lining	Rip Rap	29,740	21.00	624,540		full perimeter
	Drop Structures						
	Subtotal				897,050	1,345,575	
BW-12	RCB (5 - 11'w x 8.5'd)	195	80	13.30	207,480	311,220	Sunland culvert
BW-13	CHANNEL (30'w x 13.5'd x 2:1)						
	Land Acquisition						Reach 6 - Sunland to Cutoff
	Excavation	N/A	48,450	3.50	169,575		
	Lining	Gunite	17,070	36.00	614,520		full perimeter
	Drop Structures						
	Subtotal				784,095	1,176,143	
BW-14	CHANNEL (45'w x 11'd x 1.5:1)						
	Land Acquisition						Reach 7 - Cutoff to Richmond
	Excavation	N/A	72,600	3.50	254,100		
	Lining	Gunite	27,300	36.00	982,800		full perimeter
	Drop Structures						
	Subtotal				1,236,900	1,855,350	
BW-15	RCB (5 - 11.5'w x 9'd)	205	115	13.30	313,548	470,321	Gateway culvert
BW-16	RCB (5 - 11.5'w x 9'd)	205	60	13.30	163,590	245,385	Richmond culvert
BW-17	CHANNEL (115'w x 12'd x 2:1)						
	Land Acquisition						Reach 8 - Richmond to Upjohn
	Excavation	N/A	46,300	3.50	162,050		
	Lining	Rip Rap	4,500	21.00	94,500		sides only
	Drop Structures						
	Subtotal				256,550	384,825	
BW-18	RCB (6 - 4'w x 3'd)	84	60	13.30	67,032	100,548	Upjohn culvert (2-yr)
BW-19	CHANNEL (99'w x13'd x 2:1)						
	Land Acquisition						Reach 9 - Upjohn to Church
	Excavation	N/A	70,200	3.50	245,700		
	Lining	Gabion	11,600	35.00	406,000		sides only
	Drop Structures						
	Excavation	N/A	9,700	3.50	33,950		levees
	Subtotal				685,650	1,028,475	

BW-20	RCB (6 - 4'w x 3'd)	84	60	13.30	67,032	100,548	Church culvert (2-yr)
BW-21	CHANNEL (76'w x 14.5'd x 2:1)						Reach 10 - Church to Ridgecrest
	Land Acquisition						
	Excavation	N/A	48,000	3.50	168,000		
	Lining	Gabion	13,700	35.00	479,500		sides only
	Drop Structures						
	Excavation	N/A	20,300	3.50	71,050		levees
	Subtotal				718,550	1,077,825	
BW-22	BRIDGE (76'w x 80'1)	Supported	6,080	55.00	334,400	501,600	Ridgecrest Blvd bridge
BW-23	EXCAVATION	N/A	20,300	3.50	71,050	106,575	Outlet transition
TOTAL COST						$12,330,544	

BW-30	RCP	36	1,500	87	130,500	195,750	Mahan Drain - Reach 1
BW-31	N/A						
BW-32	RCP	48	1,500	142	213,000	319,500	Downs Drain - Reach 1
BW-33	N/A						
BW-34	RCP	42	1,700	121	205,700	308,550	Norma Drain
BW-35	RCP	54	1,100	111	122,100	183,150	Mahan Drain - Reach 2
BW-36	RCB (1 - 7'w x 4'd)	22	360	13.30	105,336	158,004	Downs Inlet
BW-37	RCB (1 - 6'w x 4'd)	20	740	13.30	196,840	295,260	Downs Drain - Reach 2
TOTAL COST						$1,460,214	

TABLE 6-8 (cont'd)

COST ESTIMATES FOR IMPROVEMENT ALTERNATIVES

Description: BOWMAN WASH

FACILITY NUMBER	ITEM	************* ALTERNATIVE 2 - DETENTION ************* TYPE	QUANTITY	UNIT COST	TOTAL	PROJECT TOTAL w/ CONTINGENCIES	COMMENTS
BW-01	DIKE	6	400	87.10	34,840	52,260	Inlet Structure
BW-02	RCB (4 - 4.5'w x 3'd)	60	80	11.40	54,720	82,080	Brady culvert
BW-03	CHANNEL (10'w x 6'd x 5:1)						Reach 1 - Brady to Mahan
	Land Acquisition						
	Excavation	N/A	20,400	3.50	71,400		
	Lining						
	Drop Structures	3	140	222.00	31,080		7 drops at 20' each
	Subtotal				102,480	153,720	
BW-04	RCB (2 - 8'w x 4'd)	48	80	13.30	51,072	76,608	Mahan culvert
BW-05	CHANNEL (10'w x 6'd x 5:1)						Reach 2 - Mahan to Downs
	Land Acquisition						
	Excavation	N/A	23,100	3.50	80,850		
	Lining						
	Drop Structures	3	160	222.00	35,520		8 drops at 20' each
	Subtotal				116,370	174,555	
BW-06	RCB (2 - 8'w x 4'd)	48	80	13.30	51,072	76,608	Downs culvert
BW-07	CHANNEL (10'w x 10'd x 2:1)						Reach 3 - Downs to Norma
	Land Acquisition						
	Excavation	N/A	36,600	3.50	128,100		
	Lining						
	Drop Structures	3	162	222.00	35,964		9 drops at 18' each
	Subtotal				164,064	246,096	
BW-08	RCB (1 - 10.5'w x 8'd)	37	80	13.30	39,368	59,052	Norma culvert
BW-09	CHANNEL (8'w x 10'd x 2:1)						Reach 4 - Norma to China Lake
	Land Acquisition						
	Excavation	N/A	27,000	3.50	94,500		
	Lining	Rip Rap	15,200	21.00	319,200		full perimeter
	Drop Structures	3	36	222.00	7,992		2 drops at 18' each
	Subtotal				421,692	632,538	
BW-10	RCB (1 - 10.5'w x 8'd)	37	250	20.00	185,000	277,500	China Lake Blvd culvert

BW-11	CHANNEL (45'w x 10'd x 2:1)						Reach 5 - China Lake to Sunland
	Land Acquisition						
	Excavation	N/A	62,600	3.50	219,100		
	Lining	Rip Rap	12,900	21.00	270,900		sides only
	Drop Structures	3	165	222.00	36,630		3 drops at 55' each
	Subtotal				526,630	789,945	
BW-12	RCB (4 - 10'w x 8'd)	144	80	13.30	153,216	229,824	Sunland culvert
BW-13	CHANNEL (46'w x 13'd x 2:1)						Reach 6 - Sunland to Cutoff
	Land Acquisition						
	Excavation	N/A	58,900	3.50	206,150		
	Lining	Rip Rap	11,000	21.00	231,000		sides only
	Drop Structures						
	Subtotal				437,150	655,725	
BW-14	CHANNEL (46'w x 13'd x 2:1)						Reach 7 - Cutoff to Richmond
	Land Acquisition						
	Excavation	N/A	100,500	3.50	351,750		
	Lining	Rip Rap	18,700	21.00	392,700		sides only
	Drop Structures	3	168	222.00	37,296		3 drops at 56' each
	Subtotal				781,746	1,172,619	
BW-15	RCB (3 - 15'w x 11'd)	156	115	13.30	238,602	357,903	Gateway culvert
BW-16	RCB (3 - 15'w x 11'd)	156	60	13.30	124,488	186,732	Richmond culvert
BW-17	CHANNEL (120'w x 9.5'd x 2:1)						Reach 8 - Richmond to Upjohn
	Land Acquisition						
	Excavation	N/A	36,700	3.50	128,450		
	Lining	Rip Rap	3,500	21.00	73,500		sides only
	Drop Structures						
	Subtotal				201,950	302,925	
BW-18	RCB (6 - 4'w x 3'd)	84	60	13.30	67,032	100,548	Upjohn culvert (2-yr)
BW-19	CHANNEL (120'w x 10'd x 2:1)						Reach 9 - Upjohn to Church
	Land Acquisition						
	Excavation	N/A	52,800	3.50	184,800		
	Lining	Rip Rap	8,940	21.00	187,740		sides only
	Drop Structures						
	Excavation	N/A	11,700	3.50	40,950		levees
	Subtotal				413,490	620,235	
BW-20	RCB (6 - 4'w x 3'd)	84	60	13.30	67,032	100,548	Church culvert (2-yr)
BW-21	CHANNEL (110'w x 11'd x 2:1)						Reach 10 - Church to Ridgecrest
	Land Acquisition						
	Excavation	N/A	37,700	3.50	131,950		
	Lining	Rip Rap	10,400	21.00	218,400		sides only
	Drop Structures						
	Excavation	N/A	25,800	3.50	90,300		levees
	Subtotal				440,650	660,975	

BW-22	BRIDGE (110'w x 80'l)	Supported	8,800	55.00	484,000	726,000	Ridgecrest Blvd bridge
BW-23	EXCAVATION	N/A	10,000	3.50	35,000	52,500	Outlet transition
BW-24	CHANNEL (13'w x 8'd x 3:1)						Brady Channel
	Land Acquisition	R2	3.94	40,000	157,600		
	Excavation	N/A	30,000	3.50	105,000		
	Lining						
	Drop Structures	3	250	222.00	55,500		10 rock drops, 25' each
	Subtotal				318,100	477,150	
BW-25	DETENTION BASIN (43 AF)						Bowman/Brady Basin
	Excavation	N/A	69,400	2.03	140,882		below ground
	Dikes						
	RCP	30	200	50	10,000		outlet drain
	Spillway	N/A					
	Land Acquisition	R2	8.00	40,000	320,000		proposed park site
	Landscaping	N/A					
	Lining	Gunite	480	36.00	17,280		inflow weir
	Subtotal				488,162	732,243	

TOTAL COST						$8,996,889	

BW-30	RCP	36	1,500	87	130,500	195,750	Mahan Drain - Reach 1
BW-31	N/A						
BW-32	RCP	48	1,500	142	213,000	319,500	Downs Drain - Reach 1
BW-33	N/A						
BW-34	RCP	42	1,700	121	205,700	308,550	Norma Drain
BW-35	RCP	54	1,100	111	122,100	183,150	Mahan Drain - Reach 2
BW-36	RCB (1 - 7'w x 4'd)	22	360	13.30	105,336	158,004	Downs Inlet
BW-37	RCB (1 - 6'w x 4'd)	20	740	13.30	196,840	295,260	Downs Drain - Reach 2

TOTAL COST						$1,460,214	

TABLE 6-9

COST ESTIMATES FOR IMPROVEMENT ALTERNATIVES

Description: EL PASO WASH

FACILITY NUMBER	ITEM	TYPE	QUANTITY	UNIT COST	TOTAL	PROJECT TOTAL w/ CONTINGENCIES	COMMENTS
		*************** ALTERNATIVE 1 - LEVEES **************					
EPW-01	DIKE/LEVEE	5	4,060	68.50	278,110		Rip Rap Lined (one side only)
	Land Acquisition	R2	4.47	40,000	178,800		
	Subtotal				456,910	685,365	
EPW-02	DIKE/LEVEE	4	3,940	51.50	202,910		Rip Rap Lined (one side only)
	Land Acquisition	R2	3.80	40,000	152,000		
	Subtotal				354,910	532,365	
EPW-03	DIKE/LEVEE	3	9,700	36.10	350,170		Rip Rap Lined (one side only)
	Land Acquisition	R2	8.02	40,000	320,800		
	Subtotal				670,970	1,006,455	
TOTAL COST						$2,224,185	

Chapter 7

CHAPTER 7

RECOMMENDED PLAN

7.1 INTRODUCTION

This chapter presents a summary of the recommended improvements for the City of Ridgecrest drainage system. The selection of the recommended alternative or set of improvements for each drainage basin planning area relates to the alternative descriptions contained in Chapter 5 and the cost estimates for those alternatives contained in Chapter 6. This chapter also presents a phased implementation schedule developed by assigning priorities to each recommended project element.

The recommended alternative was selected based on the following general criteria.

a. Lowest capital construction cost

b. Lowest operation and maintenance (O&M) cost

c. Least design and construction obstacles

d. Least institutional barriers

e. Greatest potential to avoid liability

Different criteria were more important in different cases, depending on specific conditions in each watershed. In addition, there are tradeoffs between the criteria (e.g., alternatives with the lowest capital construction cost often have the highest O&M costs).

Cost comparisons between alternatives are strongly affected by the assumed unit costs. Relatively small changes in unit cost values can greatly impact the overall project costs. Because these values are estimates only (as opposed to actual bids), they have a significant degree of potential error (+50 percent, -30 percent). Thus care must be taken in selecting a preferred alternative only on the basis of construction cost. This is particularly true when substantial land acquisition is involved, because land costs have been generalized and no site-specific investigations have been made. Thus subsequent predesign studies should investigate all alternatives, not just the recommended alternative, in order to select the most cost-effective approach based on site-specific cost data.

The impact on O&M costs of comparing different facilities in different alternatives was evaluated based on commonly accepted O&M unit costs expressed as a function of initial construction costs. These are given below.

o Reinforced concrete pipe	0.5%
o Reinforced concrete box culvert	0.5%
o Channels (lined and unlined)	1.5%

- o Dikes/levees 2.0%
- o Detention basin/debris basins 1.0%
- o Pump stations 3.0%
- o Floodings 1.0%

These costs are appropriate for comparing various alternatives, but should not necessarily be used to develop projected O&M budgets.

7.2 RECOMMENDED ALTERNATIVE

A recommended alternative is selected for each drainage basin planning area. In general, these areas are independent of each other. Thus, the City-wide recommended alternative is the collection of recommended alternatives for each individual drainage basin. Reference is made to Tables 5-1 through 5-8 in Chapter 5 for facility descriptions, and to Tables 6-2 through 6-9 in Chapter 6 for facility cost estimates.

The key criterion in determining the recommended alternative is project cost. Table 7-1 was prepared to summarize total project costs for alternatives in each drainage basin. Other selection criteria are somewhat more subjective at this level of analysis.

Ridgecrest Wash Drainage Basin

The Detention Alternative (Alternative 2) is the recommended alternative for the Ridgecrest Wash Drainage Basin. Detention basins in this area are effective in reducing the overall cost of drainage improvements by $1,150,000. In addition, the cost of each individual major system component - the Downs Storm Drain, the Mahan Channel and the Brady Channel - is reduced by the use of detention basins. Although the four detention basins included in this plan will increase the O&M responsibilities of the City in this area, the reduced capital costs and the ability to use the detention sites for other purposes (e.g., parks) should offset the additional O&M expenses.

Several aspects of the recommended alternative for Ridgecrest Wash may present implementation problems. First, there are considerable land acquisition requirements associated with the Mahan Channel, the Brady Channel, the Mahan Detention Basin, and the two Brady Detention Basins. The channel alignments may be easier to acquire if a portion of existing street right-of-way can be used; this may also reduce the cost estimates for these project elements. However, the detention sites may only be developed if considerable private property can be acquired. The City should begin pursuing these sites immediately.

Second, the Brady Channel alignment lies entirely outside the City of Ridgecrest. Thus, the City will have to coordinate this critical project with Kern County Public Works and Planning Departments. In addition, right-of-way will have to be acquired outside of the City and Ridgecrest crews will have to maintain the facility beyond the city limits.

TABLE 7-1

SUMMARY OF PROJECT COST ESTIMATES

Drainage Basin/ Project Description	Facility Numbers	Project Costs ($1,000) Alternative 1	Alternative 2
Ridgecrest Wash			
Downs Drain	RCW-01 to 07,40	2,242	2,013
Mahan Channel	RCW-08 to 20,39	1,829	1,722
Brady Channel	RCW-21 to 38	6,908	6,093
		10,979	9,828
West China Lake			
All Facilities	WCL-01 to 13	3,412	3,271
Drummond/Inyokern			
Drummond Drainage Basin Drains	DAW-01 to 04	621	1,093
Inyokern Drainage Basin Drains	IK-01 to 06	1,389	760
		2,010	1,853
Church Ave/Upjohn Ave			
Church Ave Drains	CH-01 to 15	6,010	5,221
Upjohn Ave Drains	UJ-01 to 14	3,903	4,064
		9,913	9,285
College Heights Wash			
West Side Channels	CHW-01 to 07,17,18	3,028	4,861
College Heights Channel	CHW-08 to 13, 20 to 26	4,236	2,784
China Lake Channel	CHW-14 to 16	2,476	1,198
		9,740	8,843
East China Lake Wash			
Franklin/Sunland Channels	ECL-01 to 06,12	2,257	2,606
Rader/Richmond Channels	ECL-07 to 11	1,314	1,314
		3,571	3,920
Bowman Wash			
Bowman Rd Channel	BW-01 to 23	12,331	8,997
Side Drains	BW-30 to 37	1,460	1,460
		13,791	10,457
El Paso Wash			
Levees	EPW-01 to 03	2,224	2,224
City-wide Total		55,640	49,681

Third, the plan includes three major drains crossing Inyokern Rd, which is a State-maintained roadway. The drain crossings are a 6.5'w x 5'd RCB in Downs St, a 5'w x 4'd RCB in Mahan St, and a 6-6'w x 4'd RCB in Brady St. There may be utility conflicts associated with these crossings, and traffic conflicts will have to be resolved. In addition, the projects will have to be closely coordinated with CALTRANS. However, it is also possible that CALTRANS could participate in funding these projects. The recommended alternative (Alternative 2) has significantly smaller facilities crossing Inyokern Rd than Alternative 1.

West China Lake Drainage Basin

The recommended alternative for West China Lake Drainage Basin is Alternative 2, the Detention Alternative. This option utilizes a 55 acre-ft retention basin in the present sump area near Norma St and Felspar Ave, to collect runoff from most of the West China Lake watershed area. In addition, runoff from subareas RCW270 and RCW280 is diverted into the retention basin by a drain in Las Flores Avenue.

The detention alternative is about $140,000 less expensive than the all conveyance alternative. However, much of the recommended alternative cost is associated with land acquisition for the retention sump ($675,000). It is likely that this particular site can be acquired more cheaply because the City already owns a small sump basin in this location; in addition, the entire 5-acre parcel is under a single ownership and the City has been in contact with the owner about acquiring it.

It is expected that most of the drain and channel facilities in the recommended alternative can be constructed without major difficulties. However, specific utility conflicts have not been investigated.

Drummond Avenue Wash/Inyokern Drainage Basins

The recommended alternative for the Drummond Avenue Wash Drainage Basin and Inyokern Drainage Basin is Alternative 2. This is a conveyance alternative in which runoff from the upper portion of the Inyokern Drainage Basin is diverted easterly along Ward Ave. This option is about $160,000 less expensive than Alternative 1 in which flows are conveyed northerly along Norma St. No detention sites were identified in these two urban drainage basins.

The two recommended projects which may face major obstacles to construction are the drain crossings of Inyokern Rd in Norma St (66" RCP) and China Lake Blvd. in Ward Ave (66" RCP). It is expected that utility and traffic conflicts associated with these two crossings may be more difficult than usual. In addition, the Inyokern Rd crossing must be coordinated with CALTRANS, and the daylight channel for the Ward Ave drain must be coordinated with China Lake NWC. Alternative 1, which is not the recommended scenario, has a larger crossing of Inyokern Rd and a smaller crossing of China Lake Blvd.

Other project elements should be reasonably straightforward.

Church Avenue/Upjohn Avenue Drainage Basins

The recommended alternative for the Church Ave and Upjohn Ave Drainage Basins is Alternative 2. This is the Detention Alternative for this area. The recommended alternative includes diversion of flows from the upper Upjohn Ave watershed into the Bowman Rd Channel; diversion of flows from the upper Church Ave watershed into the French Ave Channel; and development of an off-channel detention basin in a proposed City park site at Upjohn Ave and Sunland St.

The Detention Alternative is $790,000 less expensive than the All Conveyance Alternative, primarily due to the reduced storm drain diameters resulting from the hydrologic benefits of the proposed detention basin. The cost of acquiring, developing and maintaining the detention site could be less than expected (or at least distributed among more than one City department) because of its dual-use designation as a City park site. No recreation plans have been proposed for the park, but the basin should be compatible with any uses which consist primarily of open spaces (e.g., park, playground, ball fields).

The major obstacles to implementing the recommended alternative are expected to be associated with the storm drain along French Ave in the downtown area, including a 9.5'w x 6'd RCB under China Lake Blvd. The utility and traffic conflicts involved with this project are expected to be significant, but have not yet been identified.

College Heights Wash Drainage Basin

The recommended alternative for this watershed is Alternative 2, the Detention Alternative. This alternative includes two large detention basins on BLM land in the upper portion of the watershed, as well as channels along College Heights Blvd, China Lake Blvd and the extension of Norma St. The Detention Alternative is $900,000 less expensive than the All Conveyance Alternative, a capital savings which will more than offset the additional O&M requirements of the relatively remote detention sites.

Implementation of this alternative will require negotiation with BLM for the two large detention sites (13 acres and 12 acres). More importantly, many of the recommended facilities required to protect the City of Ridgecrest are in unincorporated Kern County. This includes a portion of the College Heights Blvd Channel, the Norma Channel, and the two detention basin outlet channels. The outlet channels are particularly problematic because they require long drainage easements to be established. It is important to note that some approach to fixing a dependable drainage pattern through these areas is required in order to assure that the downstream conveyance facilities in the City will be effective.

Channels are recommended for alignments parallel to College Heights Blvd and China Lake Blvd. It is possible that land acquisition costs, and potential surface interferences, could be reduced from the estimates in Chapter 6 if existing street right-of-way could be utilized for portions of the channels. These land acquisition issues should be investigated and resolved by the City as soon as possible, as they are critical to the implementation of the recommended alternative. In addition, land acquisition for the Norma Channel should be evaluated more closely due to potential private property and surface improvement conflicts.

East China Lake Drainage Basin

The Detention Alternative (Alternative 2) is about $350,000 more expensive than the All Conveyance Alternative (Alternative 1), and will also have higher O&M expenses. However, the detention basin in Alternative 2 at Franklin Ave and Sunland St is partially responsible for the large reduction in lower Bowman Wash facilities. Thus, the Detention Alternative has benefits beyond the East China Lake Drainage Basin which should be considered in selecting the recommended alternative.

In this Master Plan, the All Conveyance Alternative will be presented as the recommended alternative. This option includes major channels along Franklin Ave and Sunland St. Both of these facilities are primarily in unincorporated Kern County and are located upstream of the City in order to provide protection to presently incorporated areas. Thus, land acquisition, construction and O&M issues must be resolved with the County, and must be addressed as soon as possible.

Further study of this watershed area should be conducted to attempt to find a cost-effective detention alternative. It is possible that site-specific land acquisition costs for a basin in a slightly different location could make the detention alternative viable. With the master plan basin orientation, the 100-year peak flow was not reduced sufficiently to make a dramatic difference in downstream channel dimensions.

Bowman Wash Drainage Basin

The recommended alternative for the Bowman Wash Drainage Basin is Alternative 2, the Detention Alternative. This alternative is consistent with the recommended alternatives in the tributary watersheds (College Heights Wash and East China Lake Wash), with the exception that facilities have been sized for lower Bowman Rd Channel assuming the Sunland Detention Basin is in place. This is not expected to present a capacity problem given the channel freeboard allowance and the conservativeness of the master plan design assumptions.

The recommended alternative includes an off-channel detention basin in a proposed City park site near the intersection of Brady St and Bowman Rd. This basin was sized so as to accommodate multiple uses.

The key element of the recommended alternative is the Bowman Rd Channel, which extends from Brady St to Ridgecrest Blvd. The channel is unlined with drop structures in the upper reaches, rip rap lined in the middle reaches, and leveed with rip rap sides in the lower reaches. West of Richmond Blvd, the channel is confined to the 100-ft right-of-way reserved for it in the 200-ft Bowman Rd easement. East of Richmond Blvd, the channel and levees encompass the full 200-ft right-of-way, because the roadway will be realigned down Richmond Blvd.

Major problems with implementing this alternative include the critical road crossings of China Lake Blvd and Ridgecrest Blvd. The recommended detention alternative significantly reduces the size of these crossings as compared to the All Conveyance Alternative.

El Paso Wash Drainage Basin

Alternative 1 is the recommended alternative for this watershed. This is the only alternative which was seriously presented in the Master Plan. It consists of a levee along the east side of the El Paso Wash floodplain to prevent overflows from impacting the City. No detention alternatives were presented, due to the large size of the tributary watershed (resulting in the need for very large detention basins) and to the remoteness from the City of feasible storage sites.

7.3 IMPLEMENTATION PROGRAM

The recommended Master Drainage Plan for the City of Ridgecrest has been formulated to address all existing and future drainage problems in the community. Due to the lack of existing drainage improvements, the plan calls for construction of numerous open channels, storm drains, culverts, and detention basins. Because of the high cost of the entire master plan program, all of the facilities will not be constructed in one year or even one decade. Thus it is important that priorities be assigned to each recommended facility, so drainage improvement expenditures can effectively alleviate the most critical drainage problems first.

Several general guidelines were established for assigning facility priorities. These are summarized below.

1. Existing problem areas should be handled before areas subject to flooding only under ultimate development.

2. Flooding problems associated with major washes carrying offsite flows should be given high priority. In general these create the most significant public safety hazards.

3. Upstream facilities should not be constructed without an adequate outfall.

4. High priority projects should address areas of legitimate public concern.

5. Project priority may be affected by the availability of funds (e.g., from developers or other cost-sharing agencies) for specific facility elements.

6. Relatively uniform protection should be provided for all areas of the community. Thus funds should be distributed geographically.

Based on the above criteria, a phased implementation program has been established for the Ridgecrest Master Drainage Plan. This program is presented in Table 7-2, and is based on the present perception of existing

TABLE 7-2

RECOMMENDED PROJECT PRIORITIES

Priority	Project Description	Facility Numbers	Project Cost ($1,000)
Priority 1	1.1 Bowman Rd Channel from Downs St to Outfall	BW-07 to BW-23	7,174
	1.2 Brady Channel from Felspar Ave to Outfall	RCW-21 to RCW-27	3,538
	Priority 1 Subtotal		10,712
Priority 2	2.1 Site Acquisition for Norma/ Felspar Retention Basin	WCL-01	1,013
	2.2 Site Acquisition for Brady/ Felspar Detention Basin	RCW-37	492
	2.3 Site Acquisition for Mahan/ Sydnor Detention Basin	RCW-39	125
	2.4 Site Acquisition for Brady/ Ridgecrest Detention Basin	RCW-38	360
	2.5 Right-of-Way Acquisition for Mahan Channel	RCW-10, RCW-14, RCW-17, RCW-20	496
	2.6 Right-of-Way Acquisition for Brady Channel from Felspar to Upjohn	RCW-28, RCW-31, RCW-32, RCW-34, RCW-35	231
	2.7 Site Acquisition for two College Heights Detention Basins	CHW-17, CHW-18	0
	Priority 2 Subtotal		2,717
Priority 3	3.1 Downs Storm Drain and Pearson Park Detention Basin	RCW-01 to RCW-06, RCW-40	2,013
	3.2 French Ave Storm Drain	CH-10 to CH-13	1,728
	3.3 Church Ave Storm Drain	CH-01 to CH-04, CH-15	2,224
	Priority 3 Subtotal		5,965

Table 7-2 (Cont'd)

Priority		Project Description	Facility Numbers	Project Cost ($1,000)
Priority 4	4.1	Bowman Rd Channel from Brady St to Downs St	BW-01 to BW-06	616
	4.2	Bowman Detention Basin and Brady Inlet Channel	BW-25, BW-24	1,209
	4.3	Brady Channel from Felspar to Upjohn	RCW-28 to RCW-35	546
	4.4	Brady Detention Basins	RCW-37, RCW-38	926
	4.5	Right-of-Way Acquisition for College Heights Channel	CHW-08, CHW-10, CHW-12	637
	4.6	Right-of-Way Acquisition for China Lake Channel	CHW-14	446
	4.7	Right-of-Way Acquisition for Norma Channel	CHW-05, CHW-06	24
	Priority 4 Subtotal			4,404
Priority 5	5.1	Norma/Felspar Retention Basin and all tributary drains	WCL-01 to WCL-09	2,259
	5.2	Ward Ave Storm Drain	DAW-01 to DAW-04	1,093
	5.3	Norma St Storm Drain	IK-01, IK-04 to IK-06	760
	5.4	Drains Tributary to French Ave Storm Drain	CH-09, CH-14	1,269
	5.5	Drains Tributary to Church Ave Storm Drain	UJ-01 to UJ-04	1,507
	5.6	Upjohn Detention Basin	UJ-14	171
	Priority 5 Subtotal			7,059
Priority 6	6.1	College Heights Detention Basin Site 1	CHW-17	1,476
	6.2	College Heights Detention Basin Site 2	CHW-18, CHW-23	2,078
	6.3	Franklin and Sunland Channels	ECL-01 to ECL-06	2,257
	Priority 6 Subtotal			5,811

Chapter 8

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CHAPTER 8

FINANCIAL ALTERNATIVES

8.1 INTRODUCTION

For many municipal officials, a financial analysis involves the examination of the following two problems:

1. Where can we find money to fund our capital and operating requirements?

2. Which financial alternatives will provide us with the needed funds at the lowest cost?

In order to find solutions to these two problems, a financial analysis must, however, also address a third, more fundamental problem:

3. How can the system capital, operating, and financial costs be equitably allocated to our residents?

This third problem must be addressed because all financial instruments, such as general obligations and revenue bonds, are ultimately secured and paid for by assesments to the residents and property owners, whether by taxes, user charges, or other fees. Too many municipal financial programs have floundered politically because residents perceived that the costs of service would not be fairly distributed among them. This consideration may be especially important for the City of Ridgecrest since the residents may be paying substantially more for drainage services as the master plan improvements are implemented.

In this chapter, financial alternatives will be presented in the following areas:

1. General philosophies for the allocation of system costs to city residents.

2. Methods for assessing residents.

3. Debt financing instruments.

Advantages and disadvantages will be discussed for the presented financial alternatives. Recommendations will be made concerning which alternatives should be evaluated in greater detail.

8.2 GENERAL PHILOSOPHIES FOR THE ALLOCATION OF SYSTEM COSTS

Two primary philosophies have been developed for assessing residents for storm drainage services. The first philosophy holds that residents should be charged based on the actual benefits received while the second holds that charges should be based on contribution to the stormwater problem.

Receipt of Benefits

Historically, public financing of drainage improvements has often been based on special benefits to the properties directly served by the improvements. The most obvious special benefit is the reduction or elimination of flood damages to specific private properties. Recently, general benefits have also been recognized as valid considerations in charging residents for drainage control services. General benefits could include the protection of public facilities and the reduction of nuisance flooding of streets which benefit all residents in a community. Cost allocations based on special benefits would be made in proportion to some measure of flood protection to residential properties. Costs associated with general benefits could be assessed equally to all city residents.

Charging residents according to benefits received makes sense conceptually because stormwater control can be envisioned as a municipal service similar to the water and sewer utilities. The biggest problem with this approach is in defining the measure of flood protection to use in allocating the system costs to residents. One could argue that the costs should be allocated and assessments made according to the assessed valuation of each property. This approach recognizes that the reduction of flood damage is a function of the value of the protected property. The approach is also very easy to implement since assessed valuation information is readily available from the tax roll. Unfortunately, assessed valuation is not a particularly good indicator of benefits received since it does not account for locational differences among properties. Properties close to drainage facilities receive more special benefits from such facilities than similarly valued properties on hilltops. A drainage analysis on the scale of a FEMA Flood Insurance Study would probably be required to develop an equitable measure of flood protection.

Contribution to the Problem

This approach is based on the notion that residents should be assessed stormwater control charges based on their imposition of costs on the stormwater control system. The approach has one clear advantage over the receipt of benefits approach. It is a comparatively straightforward process to identify measures of problem contribution. To the extent that drainage system costs in the City of Ridgecrest are a direct result of runoff within the City boundaries, these costs could be allocated and assessments made on the basis of some measure of runoff contribution. For example, residents could be assessed based on the total property areas as well as the areas of impervious surfaces on their properties. Total area information is available from the tax rolls. The accumulation of impervious information would require field work and review of development plans. The greater degree of equity obtained by using impervious areas would, therefore, need to be weighed against the cost of obtaining the required data. In general, perfect equity is not possible in light of the limited resources available for accounting and billing.

The relative ease of measuring runoff contribution has led some drainage agencies to define "benefit" as a service received for removing runoff from properties, thereby mixing the two assessment philosophies. This is also the situation with sewer agencies which bill their customers based on the flows and pollutant concentrations in the customers' wastes. Sewer customers receive the service of waste removal from their properties and are billed according to their imposition of costs on the sewer system.

Unfortunately, much of the runoff which contributes to drainage problems in Ridgecrest is generated in unincorporated Kern County or on government lands which are beyond the present and probable ultimate City boundaries. In this case the residents of the City do not contribute to the runoff problem, except to the extent that they develop in natural floodplain areas. It may be possible to treat those areas with a "receipt of benefits" philosophy described above.

Other Issues

Several other issues are also important in selecting a philosophy or mix of philosophies by which to allocate costs of stormwater improvements. Some of these are mentioned below.

Perceived Equity. Public acceptance of the financing strategy and the various methods it includes is absolutely essential for a drainage program to be successful. It must be recognized that some members of the community will not wish to pay anything, through any financing method, to fund drainage control. In most cases, a larger segment of the population will understand the need for an adequate stormwater management program, and the necessity of paying for it. To these citizens the critical issue is usually equity, where a reasonable correlation exists between those who would pay and those who would benefit from the improvements.

Flexibility. The drainage systems in Ridgecrest are varied and complex. The program needed to manage these systems also has a number of elements. The financing strategy should be responsive to the complexities of both the physical and management systems. It must provide a flexible approach which can grow incrementally with the program.

Capacity. The financing methods should be carefully evaluated before implementation to determine if they can generate sufficient revenue now and in the future to meet program needs. "Willingness to pay" may have thresholds beyond which the public will not support stormwater management. The percieved equity of the financing strategy is a component of this, and the public's willingness to pay can increase with their perception of equity.

Compatibility. Whenever possible, the financing strategy should be compatible with existing City systems. This simplifies implementation and acceptance within the staffs of other departments and agencies, and minimizes costs. In some cases, however, the needs of the stormwater management financing methods may require substantial improvements or changes in existing systems. An effort should be made to anticipate opportunities to improve, or provide for future enhancement of financing systems of other operations. For example, existing billing systems may not be adequate for the drainage financing methods desired. As an option to developing a new billing system only for drainage, upgrading billing systems generally may be a spin-off benefit to the City as a whole.

Cost. The bottom line to many of these consideration is cost. A "perfectly equitable" financing method might be desirable and achievable except for the cost of development and maintenance. Absolute compatibility with other City programs and practices may not be cost-effective in all cases. Financing flexibility may be limited to avoid the expense of too complicated a mix of financing methods in the financing strategy. The analytical process for the financing strategy itself must be oriented toward the most cost-effective solution for the City of Ridgecrest, within the context of all the considerations cited above.

8.3 METHODS FOR ASSESSING RESIDENTS

Specific methods for assessing residents may be evaluated once the general assessment philosophy and the assessment measure are determined. The sources of costs should be considered since different methods may be used to recover different costs.

Fees

Fees are widely used by local governments to finance specific services to individuals. Plan checking, inspection, provision of city topographic maps, and similar costs could be recovered.

Property Taxes

Property taxes are used in California to pay for government operating expenses as well as to pay debt service for general obligation bonds. By using taxes, costs would be allocated and residents assessed based on the assessed values of their properties. Assessed value is a poor indicator of runoff contribution and a mediocre indicator of flood protection benefits. Property taxes, therefore, provide less than ideal equity for either asessment philosophy. Therefore, the use of property tax revenues for drainage improvements should in theory, only be done in those cases where general benefit to the entire community can be shown. Where such revenues are limited in terms of improvements needed, they should be allocated first to paying for those improvements of greatest benefit to the community at large.

Another disadvantage of the use of property taxes is that many properties owned by public agencies or charitable organizations would not be assessed for flood control even though such properties would contribute runoff and receive benefits from the drainage system.

One advantage of the use of property taxes is that the tax system is already set up for immediate implementation. Property taxes could, therefore, be used on an interim basis while other more equitable methods are developed.

It must be recognized that utilization of property taxes for capital improvements can be a potentially politically sensitive issue. Consequently, it is likely that maximum use should be made of other available revenue sources prior to resorting to this source.

Sales and Use Taxes

The major advantage of the sales and use tax as a source of revenue is its broad taxing base. The burden of paying such a tax is borne by both residents and non-residents of the community. A second advantage is that such a tax allows the city to keep pace with the economic growth of the community. In addition, these taxes also reflect price increases. Thus, while prices the City must pay increase, the revenue collected from sales and use taxes also increases even if the volume of retail sales remains constant or even declines.

From an equity standpoint the sales tax is somewhat analogous to property taxes, in that they could rationally be used for drainage improvements of general benefit to the whole community.

The allocation of sales tax increases to finance the City's drainage program would without question raise significant revenues. However, voter acceptance and approval of such an increase could be expected to require significant public relations and community involvement efforts to be successful.

Service Charges

Service charges are distinguished from fees in that the charges are imposed periodically. Service charges are used extensively to fund water and wastewater agencies and sometimes also to fund flood control systems. One significant advantage of service charges as opposed to tax levies is that the charges could be flexible based on whatever assessment methods the City desires to ensure equity.

Service charges have an additional advantage in that they can be used as security for revenue bonds which have certain advantages over general obligations bonds as discussed below. Revenue bond covenants generally include coverage provisions which require that revenue from service charges less operating expenses be greater than stated proportions of the total debt service costs. The proportions are frequently in the 135 to 150 percent range.

The application of such a fee is based on the concept that all lands within the City contribute storm water runoff flows to the City's drainage system. The provision of a system to properly and safely convey those flows without damage to properties or others is thus considered a benefit to all properties. Furthermore, the use of the drainage system to convey drainage flows constitutes a service to each property served.

Determination of the service charge can be based on a number of factors including land area, type of zoning or land use, proportion of the area covered with paved surfaces, excessive slopes or other topographic factors, and others. Service charges can be defined on a drainage basin basis and adjusted for both anticipated capital and operating costs within the basin. In setting the charges described above, it is important to structure the fees on a premise that includes the initial installation of the system, its operation, and its ultimate replacement. This provides a legal basis for the charges to be levied in perpetuity; it also does not put the city in the position of having to provide all required drainage facilities for new developments.

Storm drainage services charges are considered a particularly equitable method for placing the burden of cost for drainage improvements on those who benefit from them proportionately to the amount of the benefit. It also provides a mechanism for a continuing source of revenue for such facilities.

One disadvantage of service charges is that the City would be required to establish and maintain a billing system. This could involve formulation of a separate drainage utility to manage the system. Costs associated with billing could be mitigated somewhat by including drainage service charges with residents' sewer or water bills. Alternatively, the City may be able to include the charges with the property tax roll similar to Assessment District charges. In that case, the City would annually submit a lien tape with the service charge for each parcel of property within the City. In any case, the City would be required to periodically calculate the charge for each resident or property.

System Development Charges

System development charges are similar to the connection fees commonly charged to new developments to hook up to water and wastewater systems. They are one-time fees charged to developers at the time of subdivision approval or building permit issuance. The charges for individual properties may be based on whatever assessment measures the City desires for equity.

The development fee is generally applied on a unit cost basis with the acre used as the most common unit. The charge must be based on a realistic definition of the scope, nature and estimated cost of major drainageway improvements planned for each basin in order to avoid arbitrariness in its application. The fees will also vary from basin to basin depending upon the needed improvements. Such fees have been found especially useful when the improvements include excess capacity to accommodate future growth.

Development in the City of Ridgecrest started in lower areas within drainage basins and will continue to progress upstream during the master plan planning period. Storm drain segments constructed initially will, therefore, likely be "oversized" for the runoff contributed by current development in anticipation of greater runoff from future development upstream. It would not be fair for the City to fund such oversized improvements on a pay-as-you-go basis since current residents would then be subsidizing future residents. A more equitable solution would be to fund at least a portion of the capital costs using debt measures, and then use system development charges to ensure that future developments pay a fair share of the oversized improvements as well as existing improvements financed by general obligation bonds. The charges could then be considered as the price for new developments to "buy into" the system which was originally designed with them in mind.

The extent of new real estate development in Ridgecrest is highly variable and depends on uncontrollable external factors such as the health of the general economy, mortgage interest rates, and activity at China Lake NWC. Future system development charges can, therefore, not be used to secure bonds or provide debt service coverage. The development charges must be used in conjunction with service charges if revenue bonds are used to finance major system facilities. Another factor limiting the size of system development charges is that excessive charges could hinder growth in the City by increasing the cost of real estate. It is important to recognize that the application of a drainage development fee would not provide the means of correcting existing drainage problems in already developed areas.

Special Assessments

Special assessment districts were originally established to provide low-cost, tax-exempt financing to developers for constructing street improvements associated with their developments. Special assessments have since been used to fund various types of improvements such as sidewalks, streetlights, and sewage collection systems. Property owners are assessed portions of the project costs based on some measure of the special benefits they receive. For example, they could be assessed the costs of installing sidewalks based on the front footage of their properties. The owners have the choice of paying their assessments immediately or periodically paying proportionate shares of the debt service for assessment bonds used to finance the unpaid project costs. Since special assessments constitute liens against the properties, they have a lower bad debt rate than service charges.

Special assessments are generally included with the tax roll, requiring preparation of an annual lien tape. The lien tape contains the parcel numbers of the assessed properties as well as the amounts of the required annual payments. The administrative costs associated with the special assessments are probably similar to the costs for service charges, but are greater than the costs for property taxes.

It is important to note that property owners may be assessed for special benefits, but not for general benefits. This would probably not be a problem for small assessment districts used to fund local drainage improvements since special benefits may be determined for each property.

Donated Assets

Local drainage improvements, such as detention basins and drainage channels, could be constructed by real estate developers as a condition for approval of their development plans. The improvements would be deeded to and maintained by the City upon completion of the developments. Responsibility for financing these improvements would in this way be shifted from the City to the developers. As an additional advantage, the costs of the drainage improvements may be reduced if the improvements are integrated into the development plans. It should be remembered, however, that such requirements will raise real estate costs.

8.4 DEBT FINANCING INSTRUMENTS

Debt financing will be required to allow for timely implementation of the Master Plan improvements. Debt will also be necessary to allow for an equitable distribution of capital costs between current and future residents, as discussed above.

General Obligation Bonds

General obligation (GO) bonds are used primarily for major capital improvements, and are backed by the full credit of the government agency issuing them. Property tax proceeds are usually pledged to the retirement of these bonds over a number of years to effectively extend the payment period as an alternative for pay-as-you-go financing. Voter approval of property tax levies for these bonds is required. General obligation bonding for drainage improvements distributes the costs city-wide, but only among properties which pay property taxes. Exempt properties, even heavily developed ones which significantly impact drainage, would pay nothing while private, undeveloped properties in rural areas would participate only minimally in the financing. GO bonds do, however, command the most favorable interest rates of all financing instruments available to local governments.

Revenue Bonds

Bonds repaid by revenues generated through means other than property taxes, usually user charges or systems development charges, are a realistc alternative for drainage programs. They are most appropriate for financing major and minor system capital improvements, land acquisition, and perhaps remedial maintenance. Revenue bonds are not backed by the full credit of the local government. As a result revenue bonds must pay a higher interest rate than GO bonds. In many cases a "coverage factor" to generate excess revenue is also included to ensure against a revenue short-fall which might endanger repayment commitments. Coverage factors may vary at the discretion of both the City and its bonding agents, and range from 135 to 150 percent of the amount needed solely for bond repayment.

One advantage of the use of revenue bonds is the preservation of the City's general obligation debt capacity for non-revenue producing improvements. Another advantage is the accompanying use of service charges which can be applied more equitably than property taxes.

Ridgecrest Redevelopment Agency

Virtually the entire City of Ridgecrest is included in the Ridgecrest Redevelopment Agency (RDA), which was formed in 1986 under the Community Redevelopment Law of the State of California (Health and Safety Code Section 33000, et. seq.). The RDA prepared a Redevelopment Plan to outline the powers, duties and obligations of the agency. Although it does not present a specific plan for redevelopment, rehabilitation, or revitalization of the Project Area, the Plan does establish a process and framework for their implementation.

The Redevelopment Plan Objectives include, among others:

- To eliminate health and safety hazards which impact the general welfare of the community.
- To improve inadequate public utilities, infrastructure, and facilities which impair and in some cases, prevent development allowed by the General Plan.

Included among proposed redevelopment actions are:

- The installation, construction, reconstruction, redesign or reuse of streets, utilities, curbs, gutters, sidewalks, traffic control devices, flood control facilities, and other public improvements.
- The acquisition and disposition of real property required for use in accordance with this plan.

The construction of storm drains, flood control facilities, and the acquisition of lands required for these improvements are all appropriate functions for the RDA.

The Ridgecrest Redevelopment Plan also outlines methods for financing projects. These include financial assistance from local sources, the State of California and/or the Federal Government, property tax increments, interest income, RDA bonds, or any other legally available source. The annual RDA revenue from taxes can not exceed $10 million, adjusted to the Consumer Price Index. In addition, the outstanding bonded indebtedness can not exceed $100 million, adjusted to the Consumer Price Index.

Finally, the Plan lists proposed redevelopment projects. Three drainage improvements are shown: French Avenue/Gold Canyon Drive Channel, Bowman Road Channel, and Ward Avenue/China Lake Blvd./Drummond Avenue/Norma Street Channel. The first and third projects (or similar alternatives) have been constructed; the Bowman Road Channel is a major element of this Master Plan.

Revenue from Cooperating Agencies

There are a number of State, County, and Federal agencies with which cost sharing agreements could be reached for construction of drainage facilities with common benefits.

State agencies which should be considered as potential funding sources include California Department of Transportation (CALTRANS) and California Department of Water Resources (CDWR). CALTRANS has constructed major transportation arteries in and around the City of Ridgecrest, including Hwy 395, Old Hwy 395, and Ridgecrest-Inyokern Rd. These roads impact drainage patterns, requiring CALTRANS to develop appropriate drainage solutions. Costs for facilities which address CALTRANS projects and are also included in the City drainage master plan could be funded by both agencies. Funding from this source would have to be investigated on a project-by-project basis.

County agencies which could provide shared funds for drainage improvements include the Kern County Flood Plain Management Division, Department of Public Works, and Kern County Water Agency. This is a particularly promising source of cost sharing because many regional flood control projects protecting Ridgecrest also provide protection to surrounding County areas. In addition, much of the damaging runoff in the study area is generated in unincorporated areas of the County.

Federal agencies which should be considered as potential funding sources include the U.S. Department of the Navy and the U.S. Army Corps of Engineers. A portion of the China Lake Naval Weapons Center will benefit from drainage facilities proposed in the Master Plan. The U.S. Army Corps of Engineers recently completed a Reconnaissance Study for the construction of the Bowman Wash Channel. Unfortunatley, at this time it looks as though no Corps project will result from this effort. However, lines of communication with this agency should be kept open in the future.

8.5 RECOMMENDATIONS

Of the two major assessment philosophies examined in this chapter, the "contribution to the problem" approach is the more practical from the standpoint of identifying the measures and units used to allocate costs and assess residents. The City should investigate further the feasibility of using various measures of runoff contribution to assess residents. These could include total property area, impervious area, or some other measurable factor. Coupled with this, a means of assessing benefits of regional protection from "offsite" runoff should be investigated. The RDA is a potential source of these funds.

The City should consider the following financial alternatives for further investigation:

1. Fees for recovering the costs of providing specific services to individuals.

2. Service Charges as a better method than property taxes of assessing residents for stormwater control services. Service charges can be more equitably administered than taxes.

3. System Development Charges for ensuring that future developments pay their fair share of oversized storm drainage improvements. A more detailed analysis will be required to determine the optimal balance of service charges and system development charges to ensure equity and sufficient dependable revenue for debt service coverage requirements.

4. Ridgecrest Redevelopment Agency as a source of funds for constructing regional and local projects, and for acquiring required right-of-way.

5. Revenue Bonds as a method for raising debt capital while preserving the City's debt capacity for non-revenue producing facilities.

6. Cooperative Agreements with other agencies as a means of supplementing local funds. Agencies to be considered would include CALTRANS, Kern County, and China Lake NWC. Cost sharing potential would have to be investigated on a project-by-project basis.

Appendix A

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APPENDIX A

REFERENCES

1. Kern County Planning Department, Kern County Subdivision Standards.

2. American Public Works Association, Urban Stormwater Management, 1981.

3. U.S. Army Corps of Engineers, Los Angeles District, Ridgecrest Wash Channel Detailed Project Report, November 1969.

4. U.S. Army Corps of Engineers, Los Angeles District, Floodplain Information, Ridgecrest and Vicinity, June 1976.

5. U.S. Army Corps of Engineers, Los Angeles District, Initial Appraisal Report for Ridgecrest and El Paso Wash, November 1985.

6. U.S. Army Corps of Engineers, Los Angeles District, Initial Appraisal Report for Bowman Wash, November 1985.

7. County of San Bernardino, Hydrology Manual, Williamson and Schmid, August 1986.

8. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Atlas 2, Precipitation-Frequency Atlas of the Western United States, Volume XI - California, 1973.

9. California Department of Water Resources, Rainfall Depth-Duration-Frequency for California, November 1982.

10. Airborne Systems, Inc., Aerial Photography, 1"=1000', December 3, 1987.

11. City of Ridgecrest, General Plan 1981-1985, EDAW Inc., 1981.

12. Kern County Department of Public Works, Hydrologic Soil Groups, 1971.

13. Hydrologic Engineering Center, U.S. Army Corps of Engineers, HEC-1 Flood Hydrograph Package Users Manual, January 1985.

14. U.S. Army Corps of Engineers, Los Angeles District, Personal Communications, Jim Connelly, April 1988.

15. Texas State Department of Highways and Public Transportation, THYSYS Texas Hydraulic System, March 1986.

16. U.S. Army Corps of Engineers, Los Angeles District, Hydrologic Analysis for Feasibility Study of Las Vegas Wash and Tributaries, Clark County, Nevada, Open-File Material, 1987.

17. Kern County Water Agency, Cooperative Stream Gaging Program, A Compilation of Peak Discharge Data on Selected Streams 1958-1985, August 1985.

APPENDIX A
REFERENCES (Continued)

18. U.S. Water Resources Council Bulletin 17B, Guidelines for Determining Flood Flow Frequency, September 1981.

19. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, City of Ridgecrest, California, July 1981.

20. Los Angeles County Flood Control District, Cost and Quantity Estimating Manual, January 1983.

Appendix B

CULVERT DRAINS

1. China Lake Boulevard - 50 feet ± south of Inyokern Road., drop inlet on west side, drains east.

2. China Lake Boulevard - At south end of Triangle Drive by Plumbing Shop, curb inlet on west side, drains east.

3. China Lake Boulevard - South of Drummond, curb inlet on west side, drains east through Towne Centre complex, outlet on Drummond.

4. China Lake Boulevard - Drop inlet at northwest corner of China Lake Boulevard & Ridgecrest Boulevard; north curb return, drains east, outlet on Ridgecrest Boulevard.

5. China Lake Boulevard - Curb inlet at northwest corner of China Lake Boulevard & California Avenue, drains east, outlet on California Avenue.

6. China Lake Boulevard - Inlets at southwest and northwest corners of China Lake Boulevard & Parkview Drive, southwest corner drains to northwest corner then drains east, outlet on Parkview Drive, north side.

7. China Lake Boulevard - Inlets at southwest and northwest corner of China Lake Boulevard & Church Avenue, southwest corner drains to northwest corner then drains east, outlet on Church Avenue, north side.

8. China Lake Boulevard - Inlet at northwest corner of China Lake Boulevard & Wilson Avenue, west return, drains east, outlet on Wilson Avenue, north side.

9. China Lake Boulevard - Inlet at northwest corner of China Lake Boulevard & Upjohn Avenue, west return (paved over), drained east, outlet on Upjohn Avenue, north side.

10. China Lake Boulevard - Culverts under College Heights Boulevard, south side of China Lake Boulevard, drains east.

11a. Balsam Street - South of Argus Avenue, curb inlet west side, drains east to manhole then south to junction box and curb inlet at northeast corner of Balsam Street & French Avenue.

11b. Balsam Street - North of French Avenue, curb inlet west side, drains east to junction box and curb inlet at northeast corner of Balsam Street & French Avenue, then drains east to junction box and curb inlet at northwest corner of French Avenue & China Lake Boulevard.

11c. French Avenue - West of China Lake Boulevard, drop inlet south side, drains north to junction box and curb inlet at northwest corner of French Avenue & China Lake Boulevard, then drains east to southeast corner of French Avenue & China Lake Boulevard, outlets into "V" channel, south side of French Avenue.

12. French Avenue - East of China Lake Boulevard, drop inlet at northeast corner drains south to drop inlet then outlets to "V" channel on south side of French Avenue.

13. French Avenue - At Las Flores Avenue, north corner and west corner, curb inlets, drain southeast to inlet boxes then to "V" channel on the southeast side of French Avenue.

14. Norma Street - North of Atkins Avenue, inlet on east side drains west to junction box and curb inlet, then drains north to outlet in channel north of Inyokern Road.

15. Norma Street - 350 feet ± south of Felspar Avenue, curb inlet west side, drains east to inlet box then drains into channel east of Norma Street.

16. Downs Street - 200 feet ± north of Church Avenue, culvert drains west to east under Downs Street.

17. Ridgecrest Boulevard - Inlet box south side of Ridgecrest Boulevard by Knights of Columbus Hall, drains to north side of Ridgecrest Boulevard.

MISCELLANEOUS ITEMS & COMMENTS

- Table 4-1, Facility ID 32 outlets into graded channel to Satellite Lake.
- Table 4-1, Facility ID 44 is an eighteen inch (18") RCP, 192 feet long beginning at a drop inlet box at the southwest corner of Ward Avenue & China Lake Boulevard and runs north to a junction box with drop inlet, then drains east under China Lake Boulevard to "V" swale draining east from China Lake Boulevard.
- Table 4-1, Facility ID's 45 and 46 have two leach lines like ID 47.

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