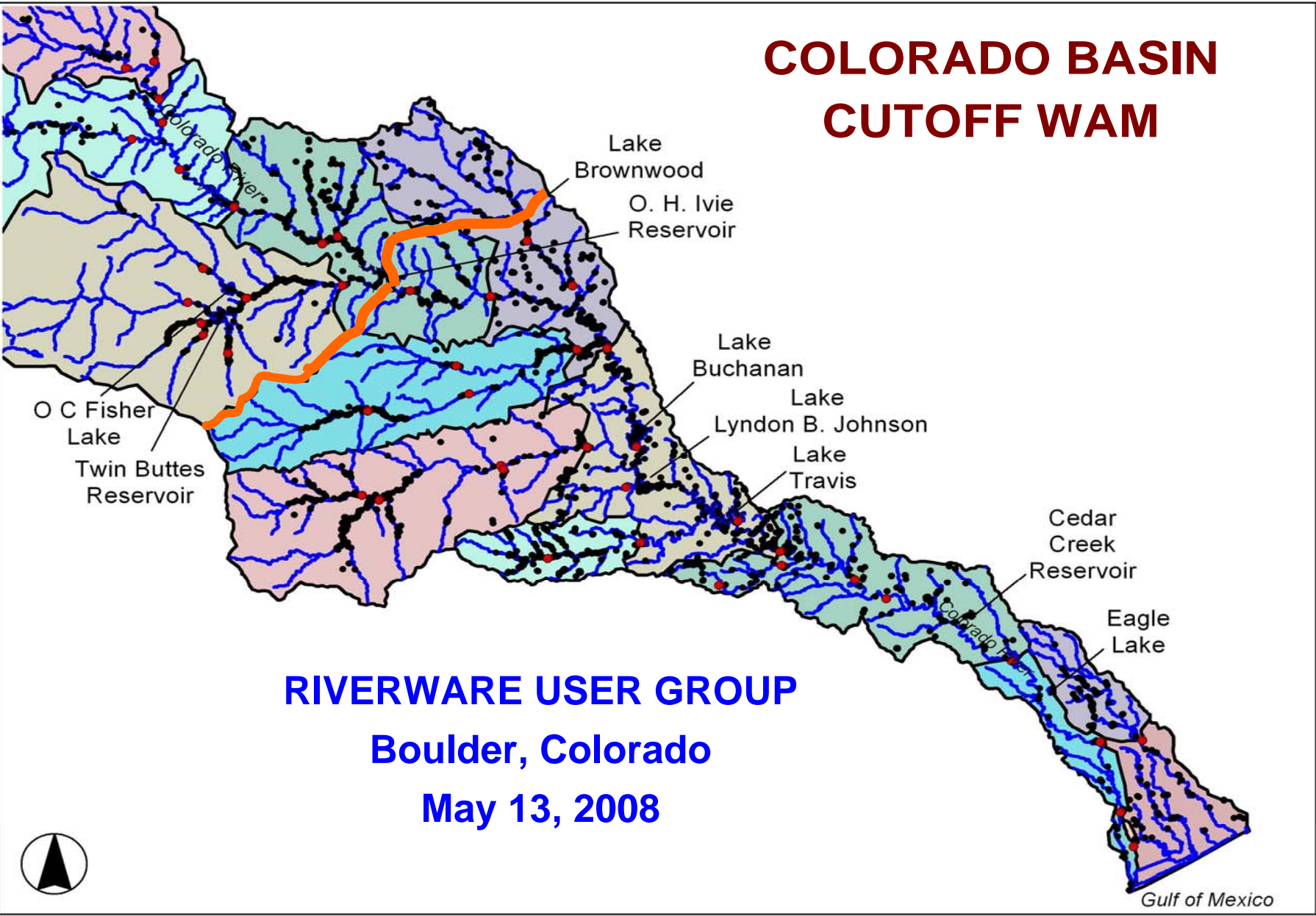


Lower Colorado River Authority's RiverWare Modeling Activities in the Lower Colorado River Basin in Texas

*KIRK KENNEDY
TRC/BRANDES
AUSTIN TEXAS
AUGUST 13, 2008*



COLORADO BASIN CUTOFF WAM



RIVERWARE USER GROUP
Boulder, Colorado
May 13, 2008

Gulf of Mexico

OVERVIEW OF WRAP MODEL

- **INFLOW - NATURALIZED FLOWS**
- **OUTFLOW – REGULATED FLOW; UNAPPROPRIATED FLOW**
 - **REGULATED FLOW – NATURALIZED FLOW LESS DEPLETIONS BY UPSTREAM WATER RIGHT ACTIVITIES.**
 - **UNAPPROPRIATED FLOW – NATURALIZED FLOW LESS DEPLETIONS BY UPSTREAM WATER RIGHT ACTIVITIES AND LESS PASS THROUGHs REQUIRED BY DOWNSTREAM WATER RIGHT ACTIVITIES.**
- **MAINTAINED BY TEXAS COMMISSION ON ENVIRONMENTAL QUALITY (TCEQ)**
- **TCEQ'S RUN3 - LEGAL REPRESENTATION OF ALL WATER RIGHTS OF RECORD**

OVERVIEW OF WRAP MODEL (cont'd)

- **SIZE OF WAM MODEL**
 - **~1250 WATER RIGHTS**
 - **~ 31 MAJOR RESERVOIRS**
 - **WATERSHED AREA**
 - **~31,000 SQUARE MILES**
 - **~600 MILES LONG**
 - **MONTHLY TIMESTEP**
 - **FORTRAN BASED**
 - **RUN TIME ~ 3 MINUTES**

GENERAL APPROACH USED TO DEVELOP LCRA RIVERWARE MODELS

- **USE WAM MODEL AS BASIS FOR INFLOW**
- **SELECT SET OF CONTROL POINTS USED AS INFLOW LOCATIONS**
- **BASIN DIVIDED INTO 2 GEOGRAPHIC AREAS**
 - **UPSTREAM OF HIGHLAND LAKES (LCRA)**
 - **AT AND DOWNSTREAM OF HIGHLAND LAKES**
- **REGULATED FLOWS USED AS INFLOWS TO RIVERWARE FOR UPSTREAM AREA**
- **INCREMENTAL REGULATED FLOWS USED AS INFLOWS FOR DOWNSTREAM AREA**

GENERAL APPROACH USED TO DEVELOP LCRA RIVERWARE MODELS (cont'd)

- **RESULT:**
 - **DEPLETIONS BY ALL WATER RIGHTS UPSTREAM OF LCRA'S HIGHLAND LAKES ACCOUNTED FOR IN INFLOWS**
 - **DEPLETIONS BY LCRA'S WATER RIGHTS AS WELL AS ALL WATER USE ACTIVITIES ON THE MAINSTEM DOWNSTREAM OF THE HIGHLAND LAKES NOT ACCOUNTED FOR IN INFLOWS BUT THEIR EXISTENCE IS ACCOUNTED FOR.**
 - **RIVERWARE MODEL STRUCTURED TO SIMULATE ONLY WATER RIGHT ACTIVITIES AT LCRA'S HIGHLAND LAKES AND DOWNSTREAM**

GENERAL APPROACH USED TO DEVELOP LCRA RIVERWARE MODELS (cont'd)

- **RUN RIVERWARE AND COMPARE OUTPUT TO WAM**
 - **SIMULATED DIVERSIONS**
 - **RESERVOIR STORAGE AND EVAPORATION**
 - **REGULATED STREAMFLOWS**
 - **RELEASES FROM HIGHLAND LAKES FOR VARIOUS ACTIVITIES**
- **MAKE APPROPRIATE CHANGES TO RIVERWARE**
- **APPROACH ENABLES “TIE” TO TCEQ’S WAM MODEL**
 - **PERMITTING / PLANNING ANALYSIS**
 - **OPERATION ANALYSIS**

RULES BASED - LCRA RIVERWARE MODEL

- **2003 LCRA WATER MANAGEMENT PLAN (PENDING)**
- **USED CUTOFF VERSION OF TCEQ WAM MODEL AS BASE**
 - **ALL WATER RIGHTS UPSTREAM OF IVIE AND BROWNWOOD TREATED AS SENIOR TO ALL WATER RIGHTS DOWNSTREAM OF IVIE AND BROWNWOOD.**
- **SIMULATION CONDITIONS MADE TO APPROXIMATE 2060 CONDITIONS**
 - **REGION K ESTIMATES USED FOR LCRA RELATED DEMANDS AND AUSTIN RETURN FLOWS**
 - **NON-LCRA RELATED WATER RIGHTS USED FULL AUTHORIZED AMOUNTS**
 - **WEATHER VARIABLE IRRIGATION DEMANDS FOR LCRA IRRIGATION RIGHTS**
 - **ALL MAJOR RESERVOIRS ADJUSTED TO REFLECT 2060 SEDIMENTATION CONDITIONS**

RULES BASED - LCRA RIVERWARE MODEL

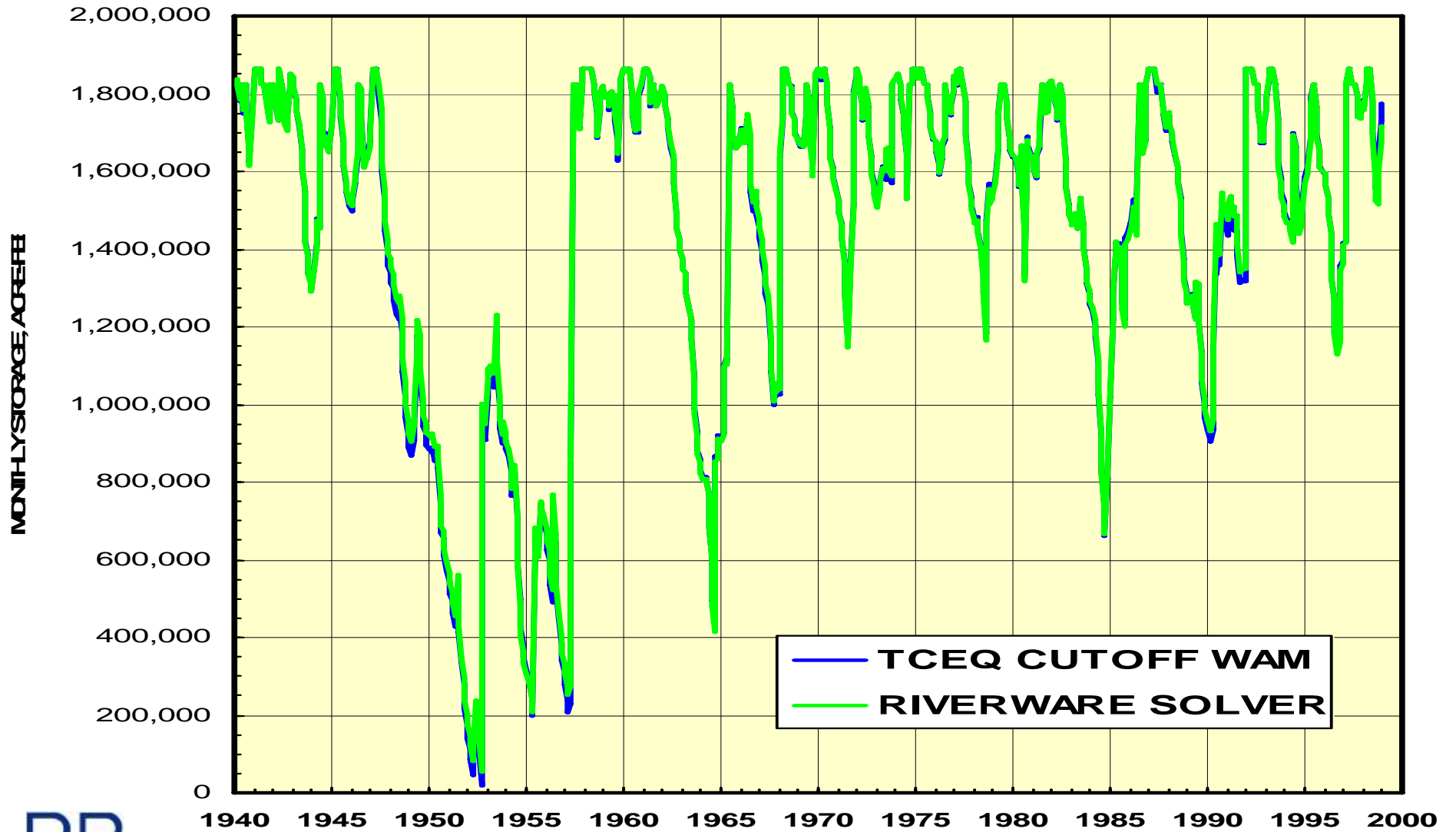
(cont)

- **MONTHLY TIMESTEP**
- **COMPLEX ENVIRONMENTAL FLOW REQUIREMENTS**
- **CITY OF AUSTIN MUNICIPAL RETURN FLOWS INCLUDED WITH COMPLEX REUSE SPECIFICATIONS**
- **RULES BASED, 1821 RULES, 85 MINUTE RUN TIME.**

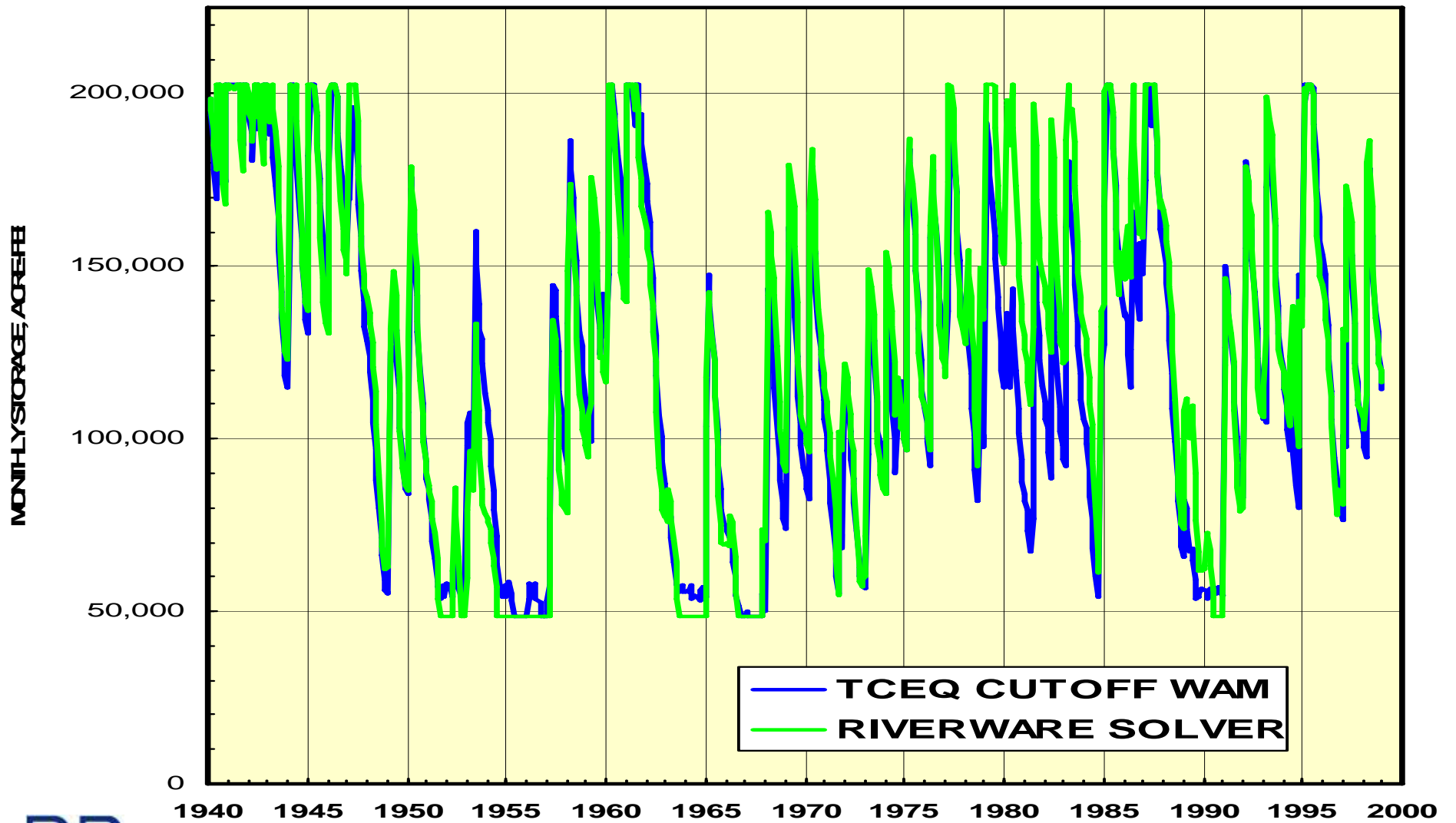
SOLVER BASED - LCRA RIVERWARE MODEL

- **MODELING ASSUMPTIONS SAME AS PREVIOUS MODEL**
 - **249 RULES, 40 MINUTE RUN TIME.**
- **PROBLEM AREAS FOR VALIDATION**
 - **ENVIRONMENTAL FLOW REQUIREMENTS**
 - **REUSE OF RETURN FLOW**
- **COMPARISON BETWEEN WAM AND SOLVER BASED MODEL**
 - **LCRA SYSTEM STORAGE**
 - **STP'S COOLING RESERVOIR**
 - **FLOW TO MATAGORDA BAY**
 - **ENVIRONMENTAL PASS THRU AND RELEASES**

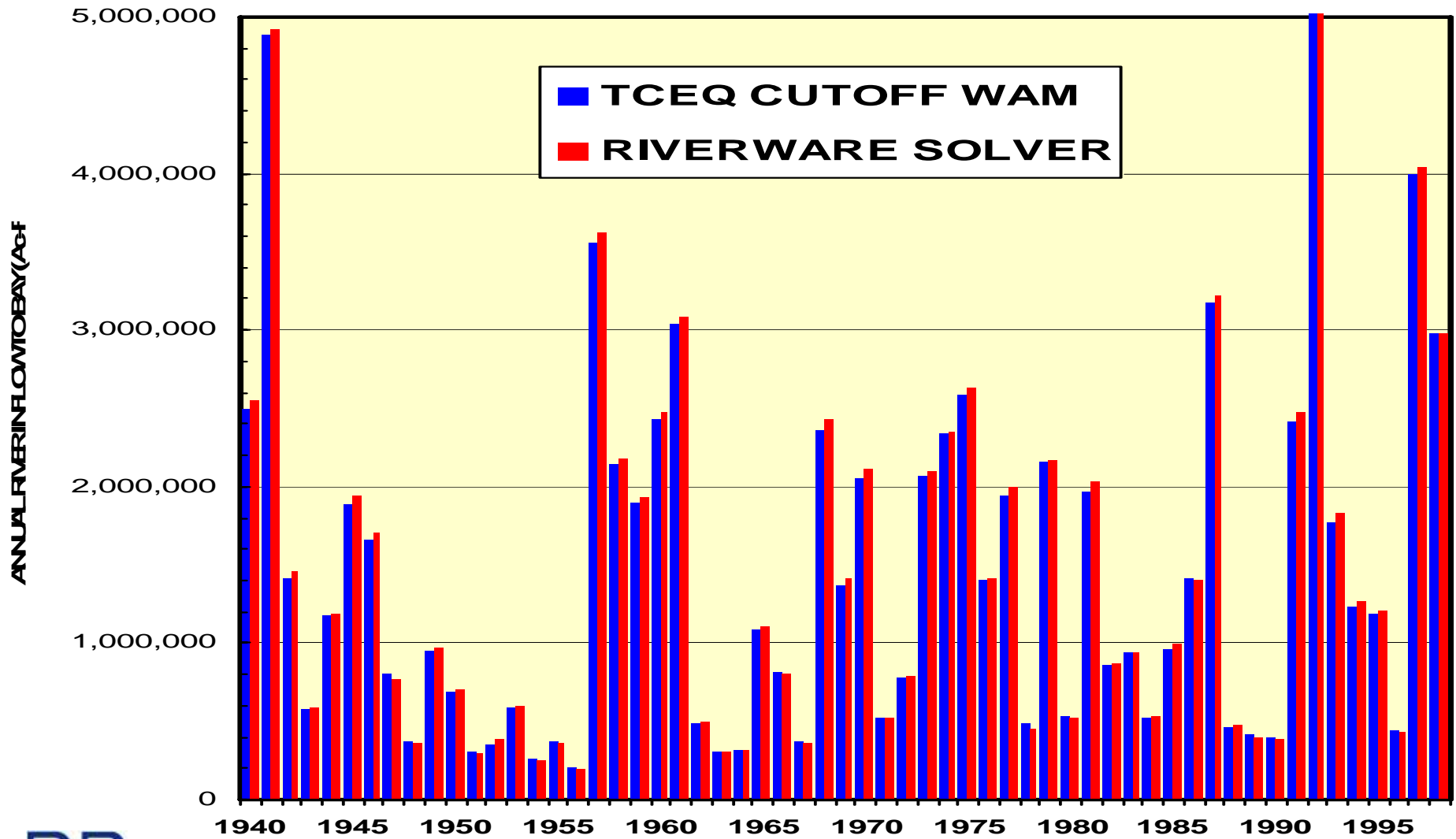
LCRA SYSTEM STORAGE



STP'S COOLING RESERVOIR



FLOW TO MATAGORDA BAY



ENVIRONMENTAL PASS THROUGH AND RELEASES (AF)

	TCEQ CUTOFF WAM		RIVERWARE SOLVER MODEL	
	ANNUAL DRT	ANNUAL POR	ANNUAL DRT	ANNUAL POR
	AVG	AVG	AVG	AVG
PASS-THRUS FOR INSTREAM FLOW	22,555	50,002	18,843	49,892
RELEASES FOR INSTREAM FLOW	5,039	1,926	10,382	2,756
TOTAL (INFLOW + STORAGE)	27,594	51,928	29,225	52,647
PASS-THRUS FOR BAY	49,034	94,172	52,931	94,692
TOTAL ENVIRONMENT	76,628	146,100	82,156	147,339
ACTUAL FLOW TO BAY	490,124	1,525,456	498,373	1,545,985