



Republican River Ground Water Model Analyses

Photo courtesy USGS 2001

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Purposes of Model Analyses

- Evaluate historical effects of pumping on baseflow/RRCA accounting
- Predict future effects of pumping on baseflow/RRCA accounting
- Evaluate pumping strategies that will facilitate compliance with the RR Compact

Figure 1

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Specific Model Analyses

- Baseline of effects of current pumping (2000) on future conditions
- Analysis of effects of changes in pumping on future compliance
- Effect of changes in pumping in wells adjacent to the Republican River and its tributaries (quick response wells)

Figure 2

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Baseline Scenario

- Historic 1918-2000
- Future 2001-2040
- As above, but with pumping off in each NRD (Upper, Lower, Middle, Tri-Basin, and Others)

Figure 3

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Natural Resource Districts

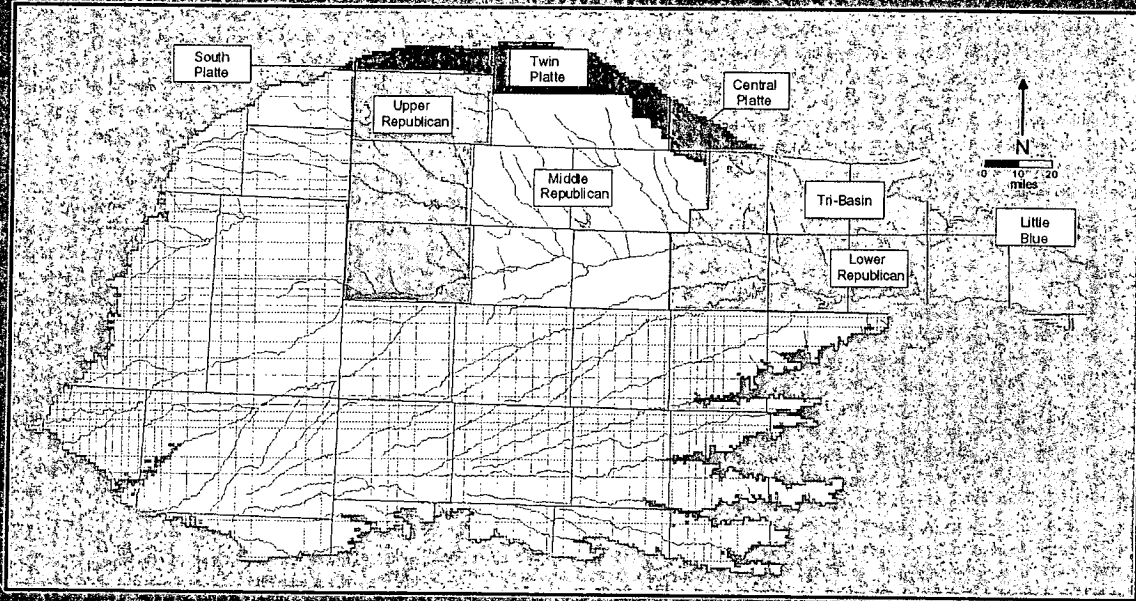


Figure 4

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Baseline Scenario

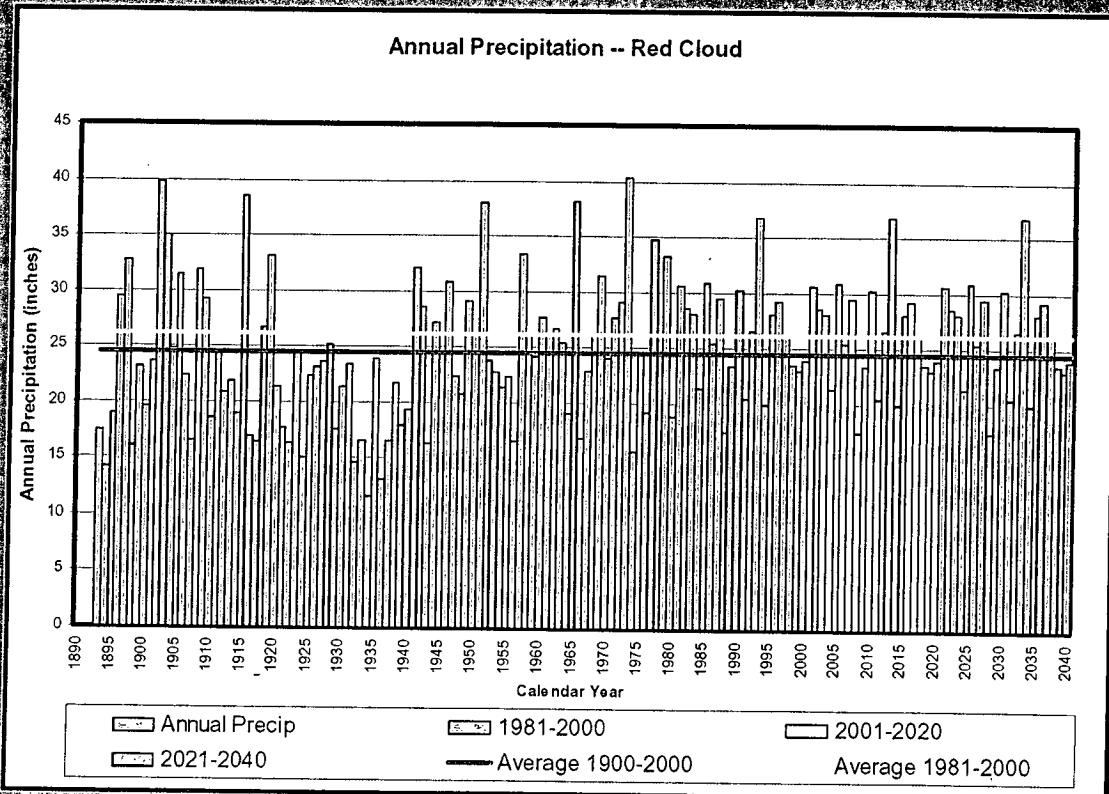


Figure 5

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Baseline Scenario

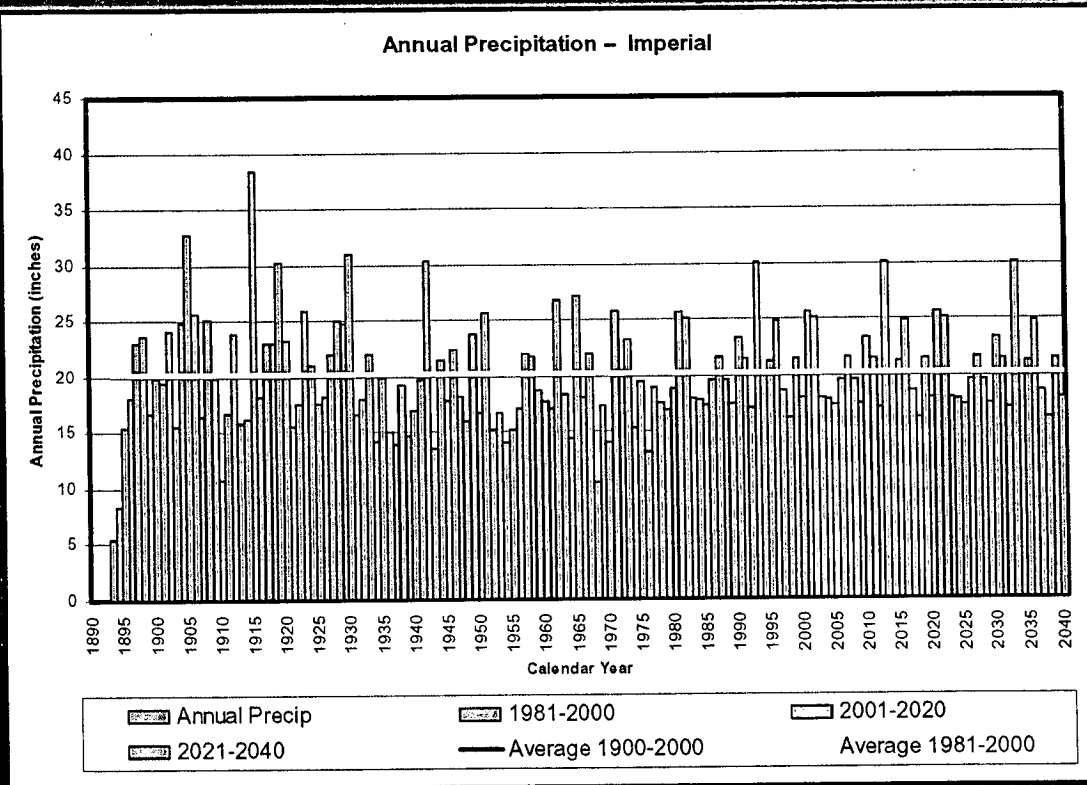


Figure 6

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Baseline Scenario

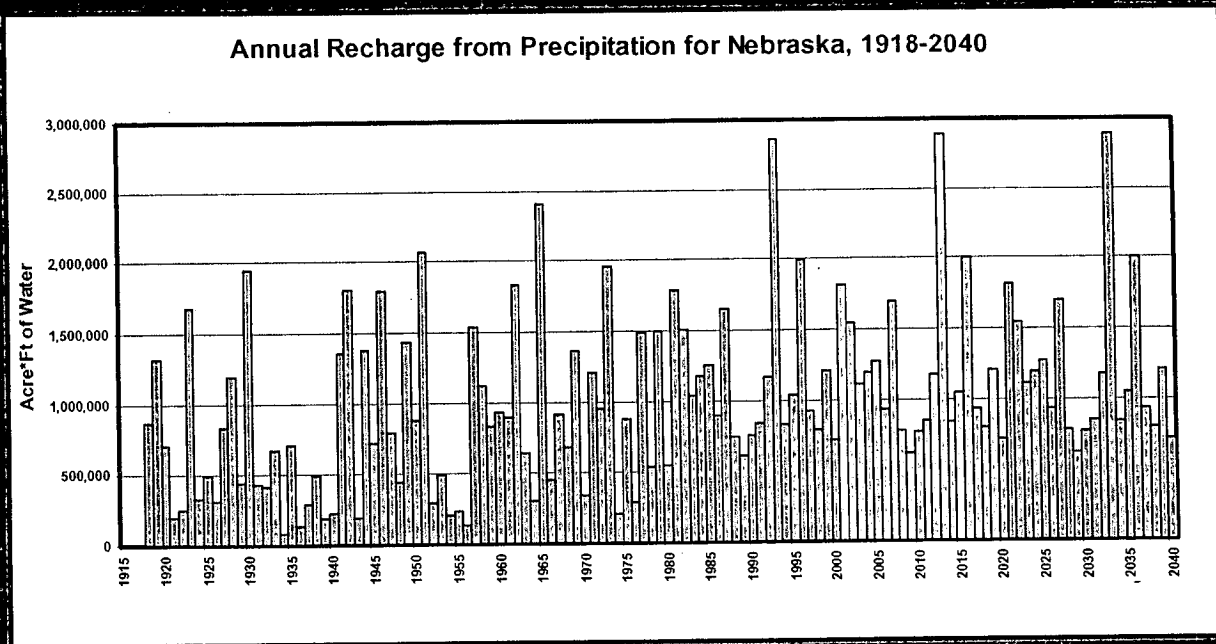


Figure 7

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Baseline Scenario

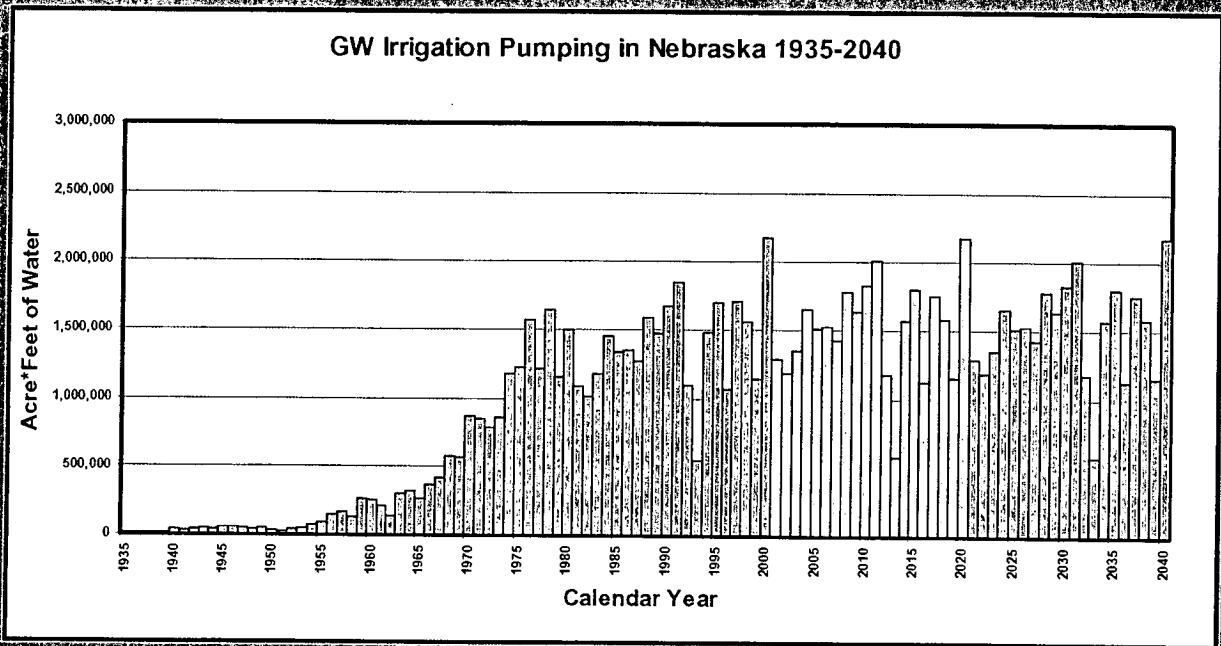


Figure 8

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Baseline Scenario - Pumping by NRD

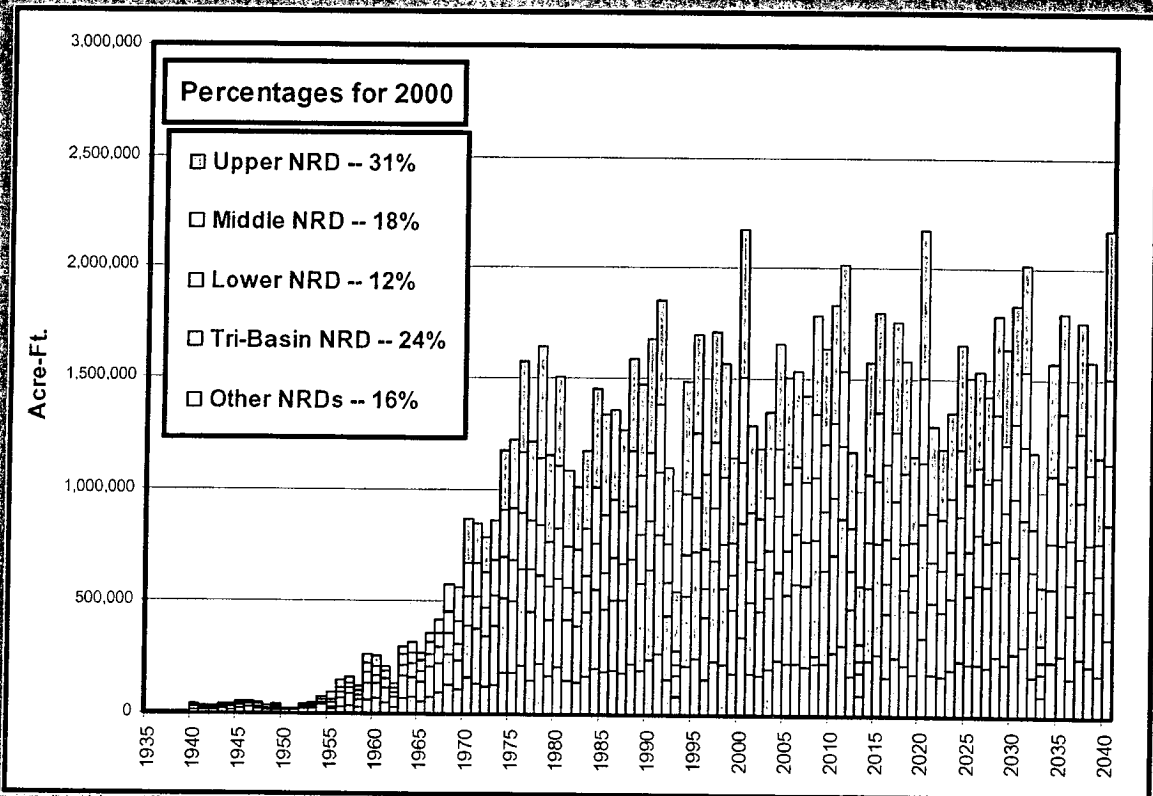
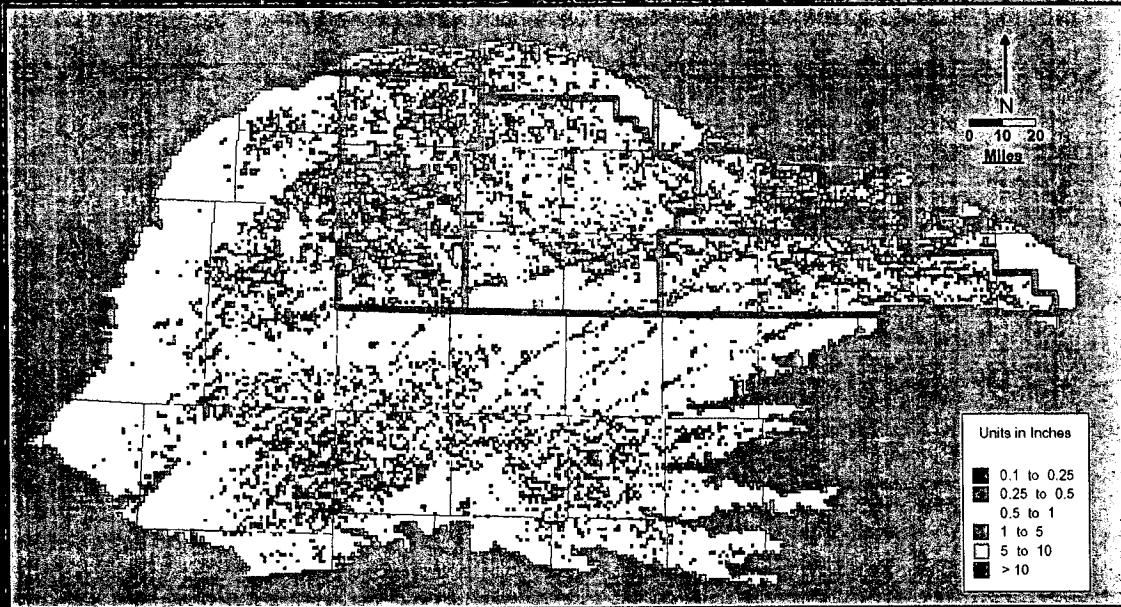


Figure 9

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Baseline Scenario Map Showing Ground Water Irrigation Pumping in July 2000 (Inches*)



*Rate represents per cell rate, not rate per irrigated area

Figure 10

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Baseline Scenario – Graph Showing Percent of GW Irrigated Return Flow for Nebraska 1918-2040

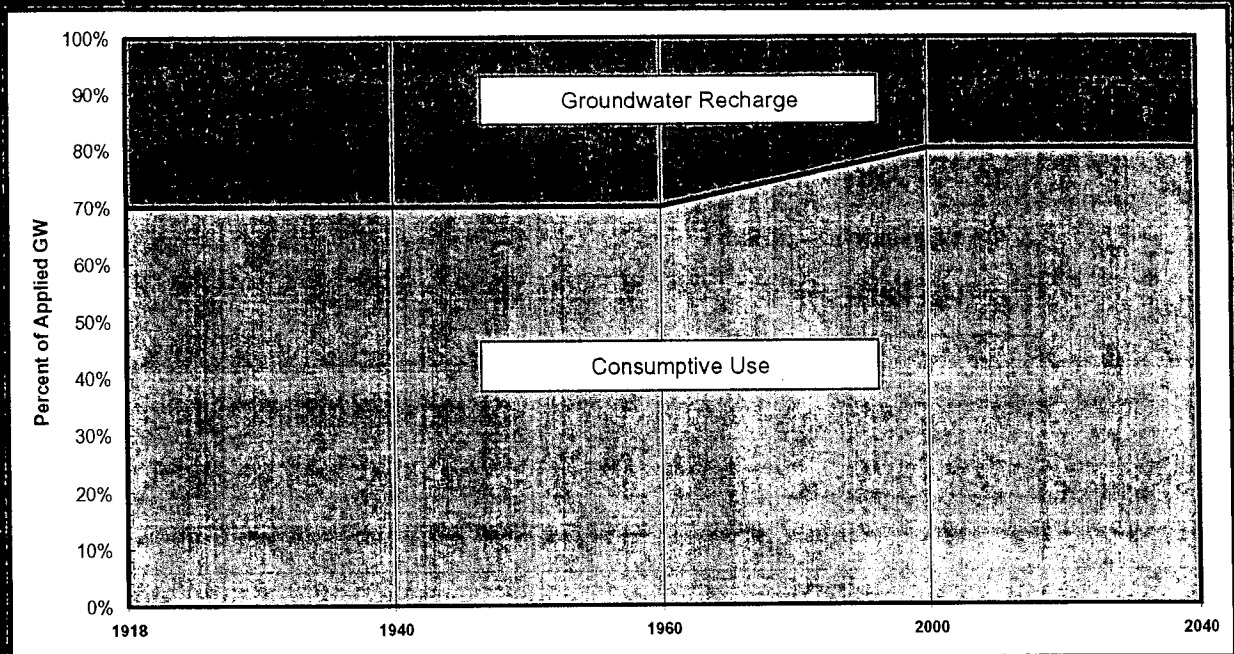


Figure 11

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Baseline Scenario

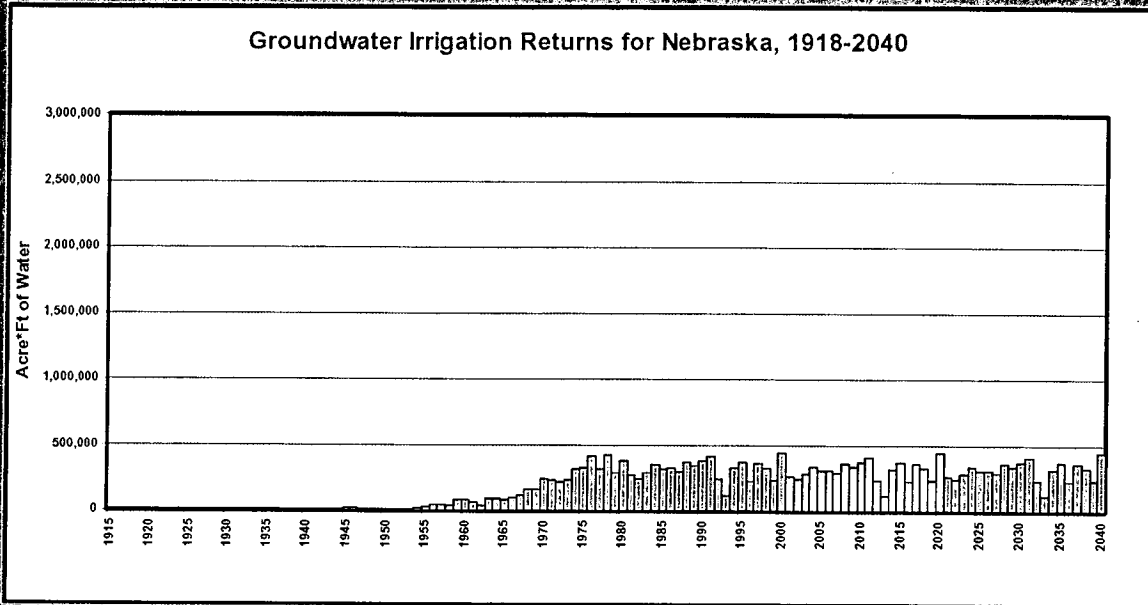
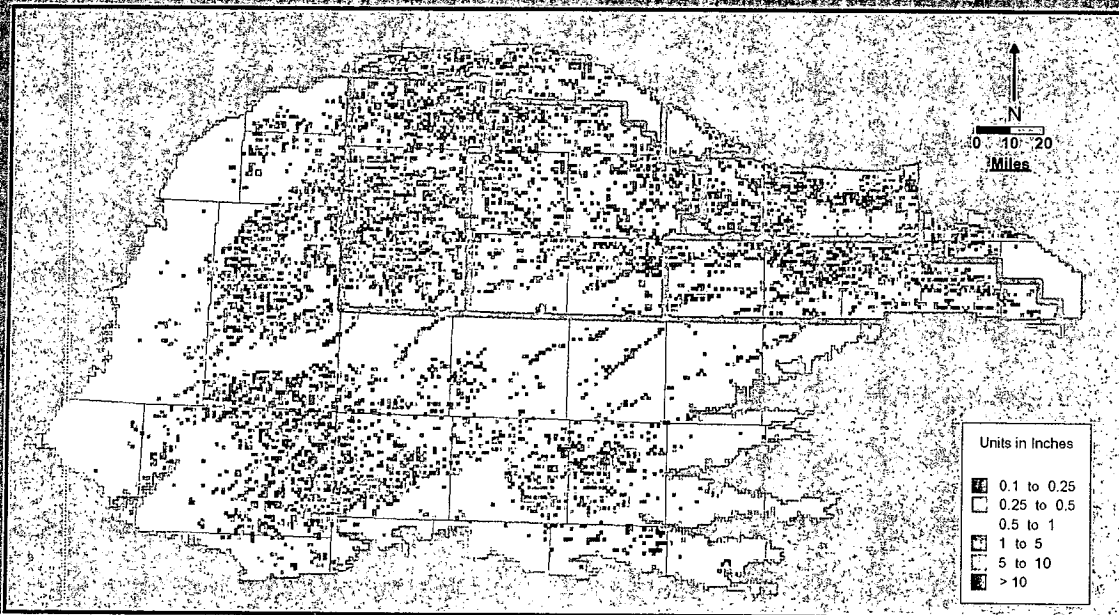


Figure 12

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Baseline Scenario Map Showing Ground Water Irrigation Returns in July 2000 (Inches²)



Rate represents per cell rate, not rate per irrigated area

Figure 13

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Baseline Scenario

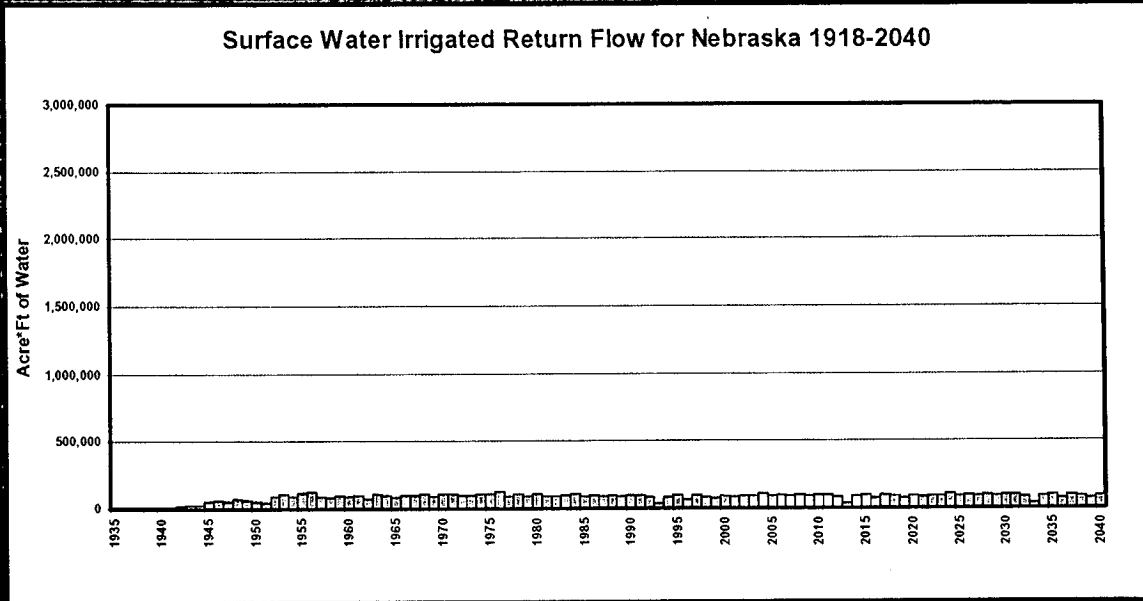


Figure 14

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Baseline Scenario

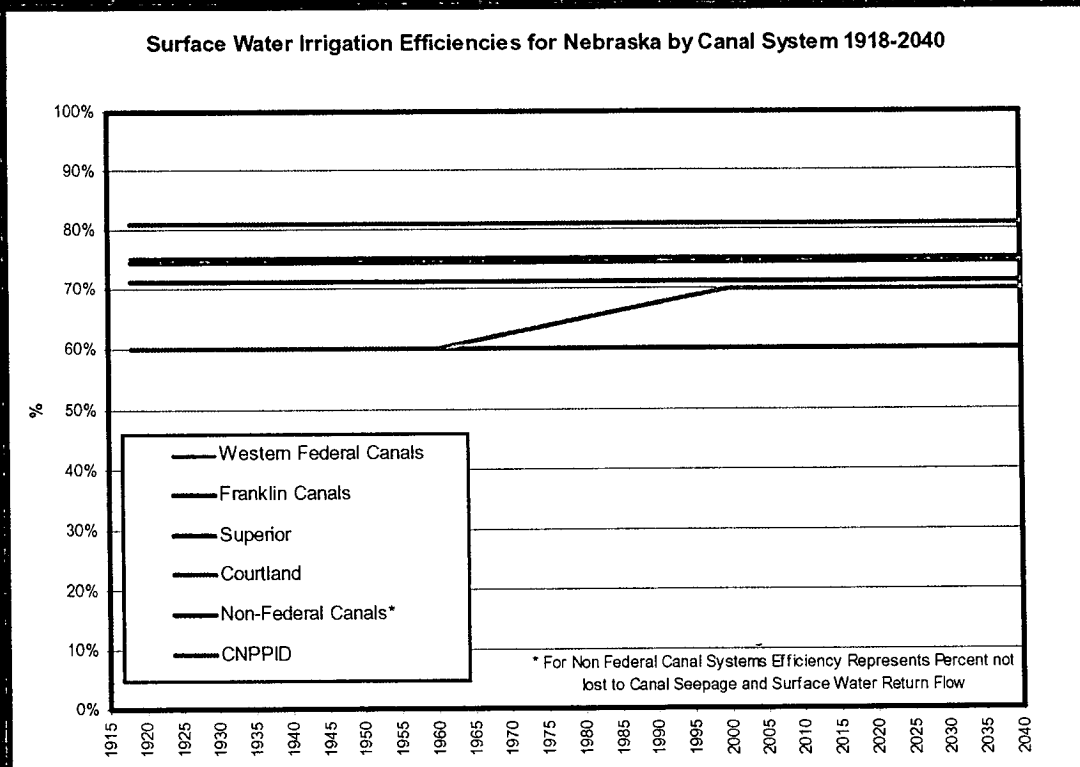
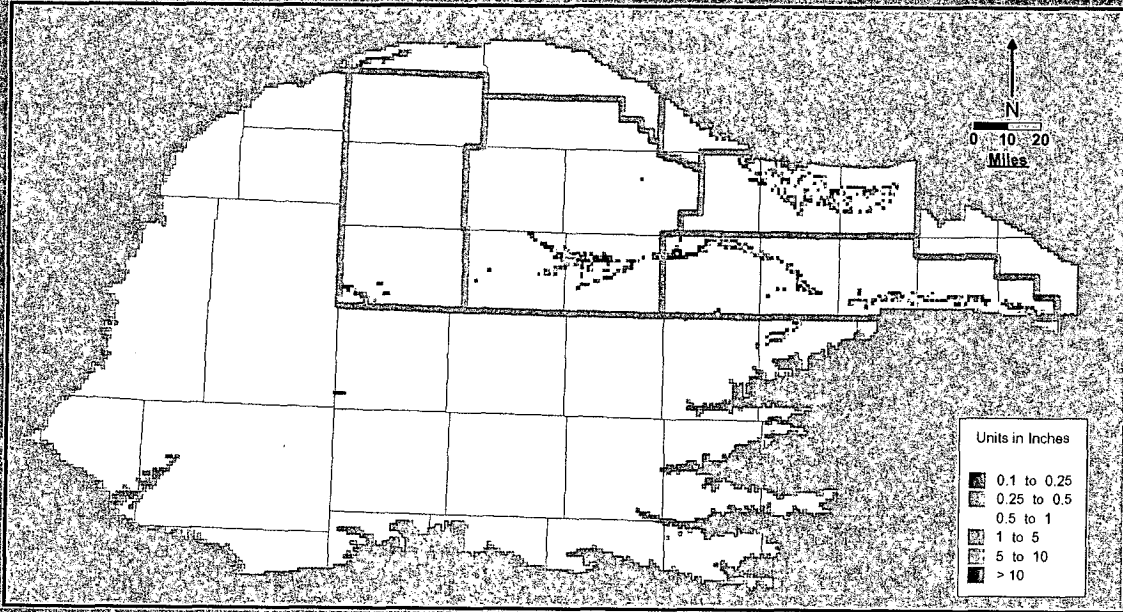


Figure 15

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**Baseline Scenario
Map Showing Annual Recharge from Excess Irrigation by
SW in July 2000 (Inches²)**



Rate represents per cell rate, not rate per irrigated area

Figure 16

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**Baseline Scenario
Map Showing Canal Systems in
RRCA Model**

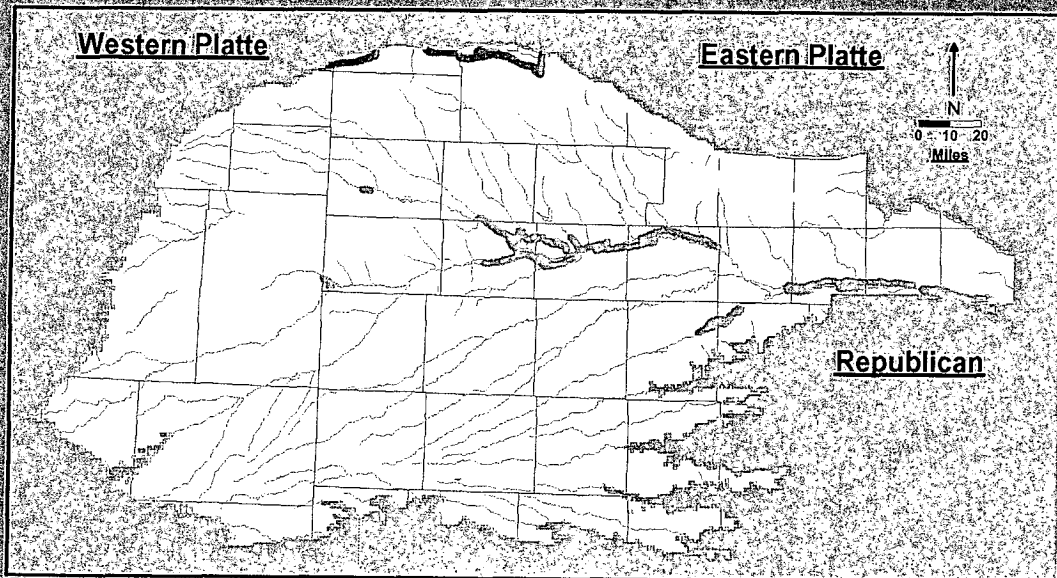


Figure 17

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Baseline Scenario

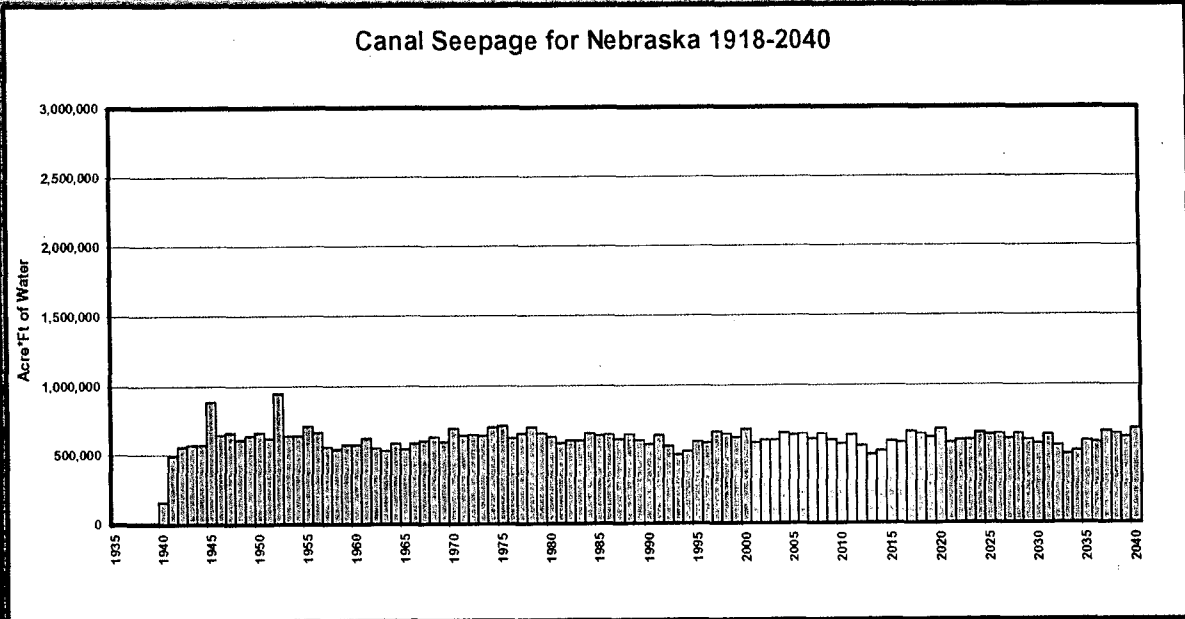
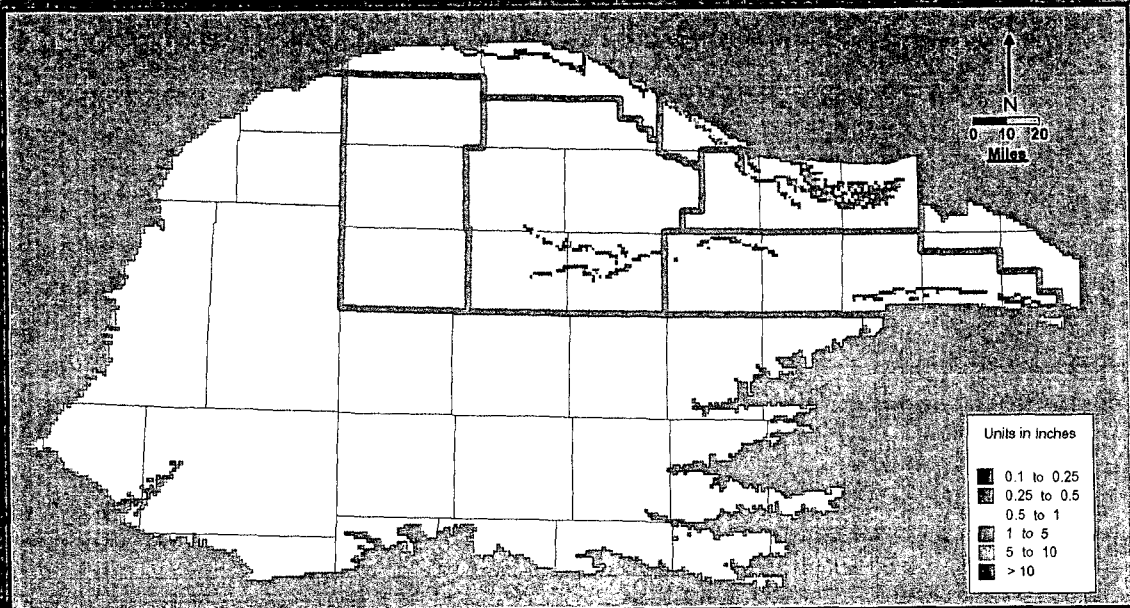


Figure 18

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Map Showing Annual Recharge from Canal Seepage in July 2000 (Inches*)



*Rate represents per cell rate, not rate per irrigated area

Figure 19

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Graph of Model Calculated ET Volume 1918-2040

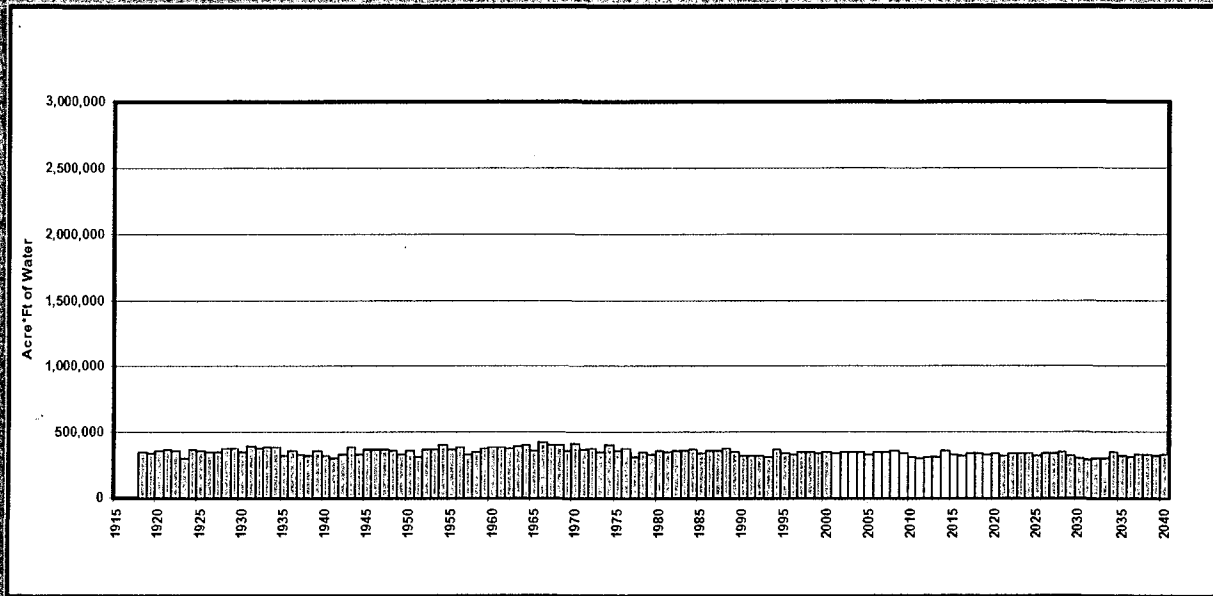


Figure 20

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Map Showing Distribution of Cells from which Water was Discharged to Phreatophyte ET in July 2000

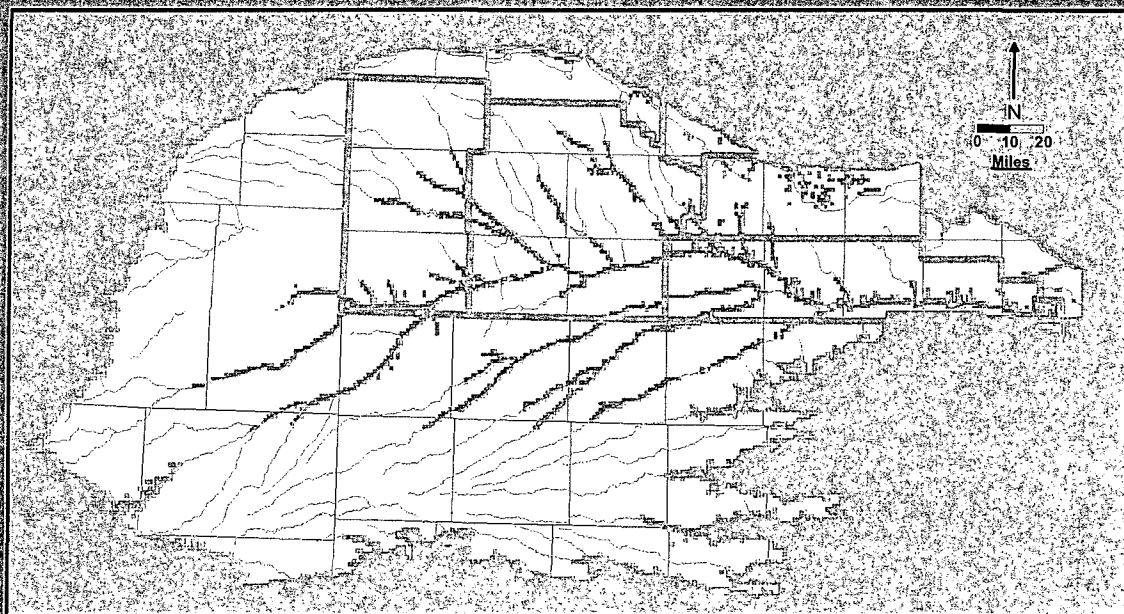


Figure 21

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Map showing constant heads, streams, reservoirs, drains and estimated 2000 water levels

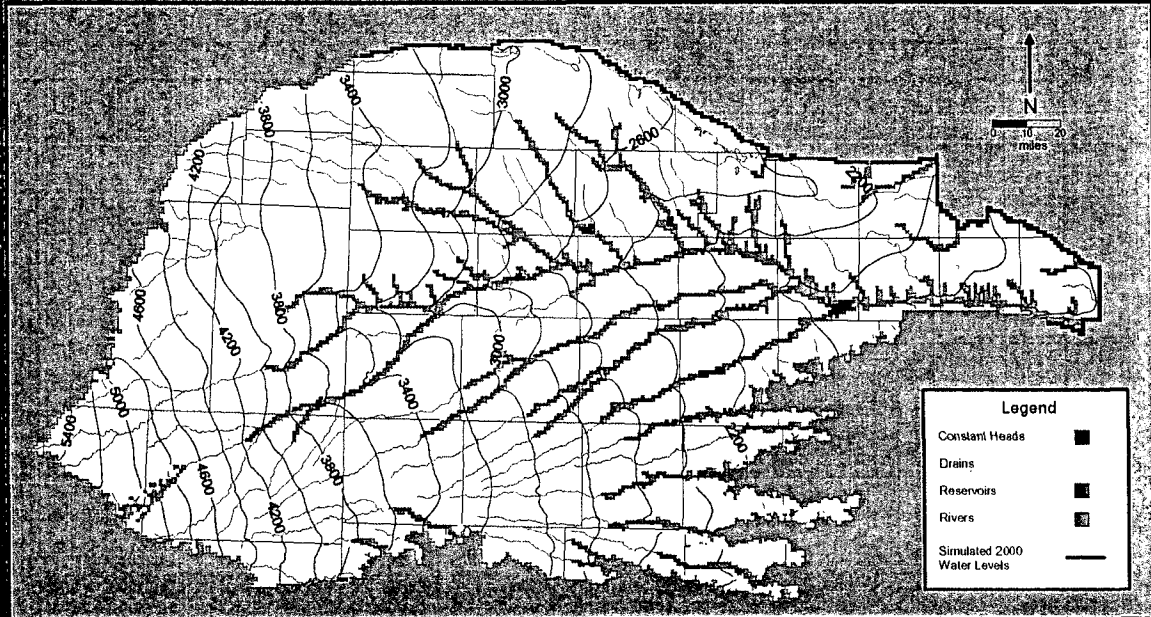


Figure 22

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Table of major ins/outs pumping/recharge for Nebraska 2000

	Recharge from Precipitation	Recharge from Excess GW Irrigation	Recharge from Excess SW Irrigation	Recharge from Canal Seepage	Recharge from Rivers	Decrease in Storage
Inflow	714,	441,5	88,1	678,	204,6	1,892,654
	Discharge to ET	Discharge to Rivers	Discharge to Wells	Increase in Storage		
Outflows	344,082	861,847	2,175,155	729,979		

Figure 23

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Nebraska Inflows for 2000 in Acre - Ft

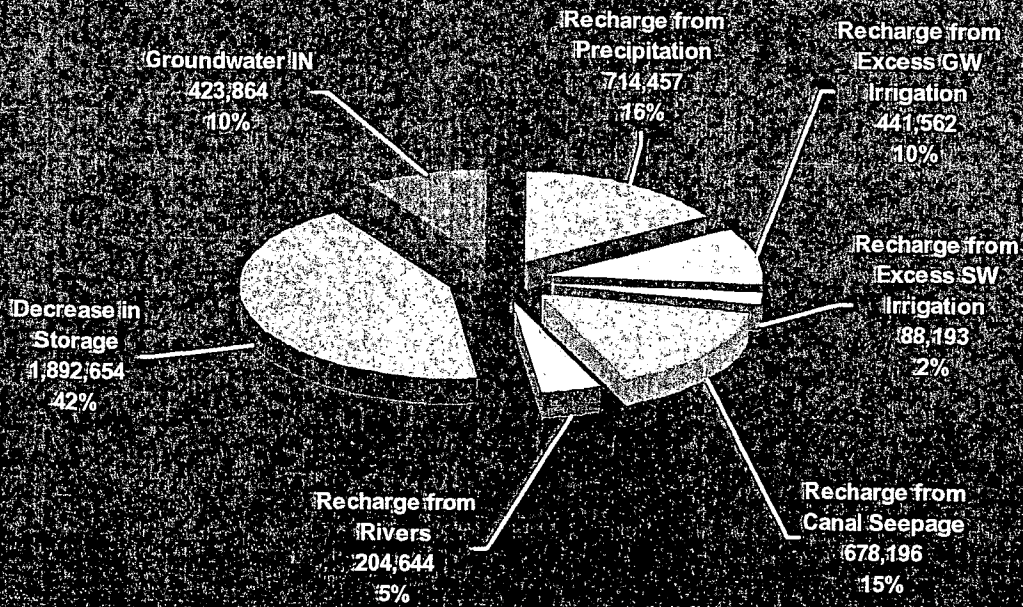


Figure 24

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Nebraska Outflows for 2000 in Acre - Ft

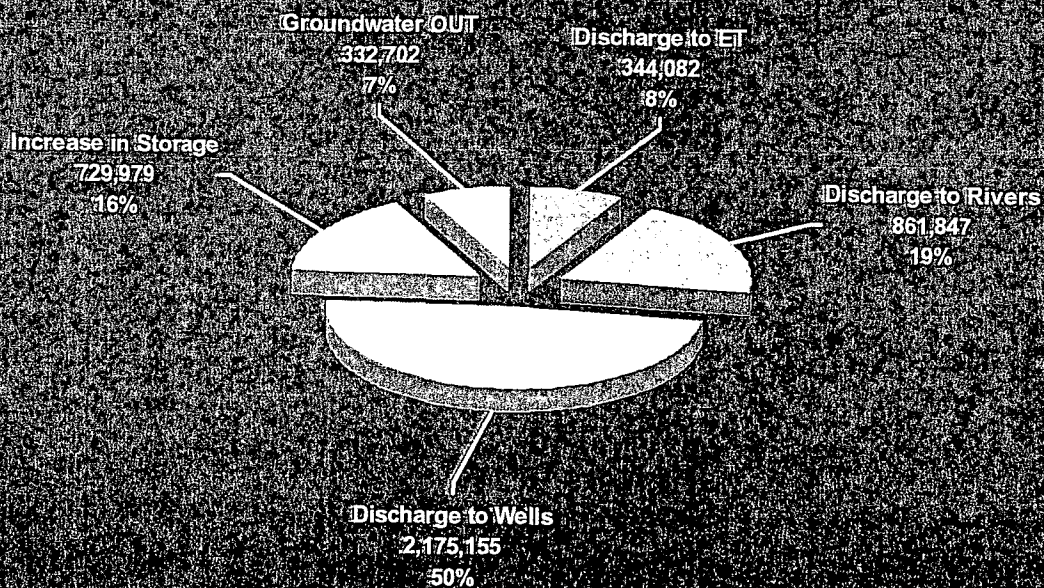


Figure 25

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Table of major ins/outs pumping/recharge for Upper NRD 2000

	<i>Recharge from Precipitation</i>	<i>Recharge from Excess GW Irrigation</i>	<i>Recharge from Excess SW Irrigation</i>	<i>Recharge from Canal Seepage</i>	<i>Recharge from Rivers</i>	<i>Decrease in Storage</i>
<i>Inflow</i>	112,484	133,014	2,580	0	46,846	610,915
	<i>Discharge to ET</i>	<i>Discharge to Rivers</i>	<i>Discharge to Wells</i>	<i>Increase in Storage</i>		
<i>Outflows</i>	61,285	60,098	666,396	125,051		

Figure 26

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Upper NRD Inflows for 2000 in Acre - Ft

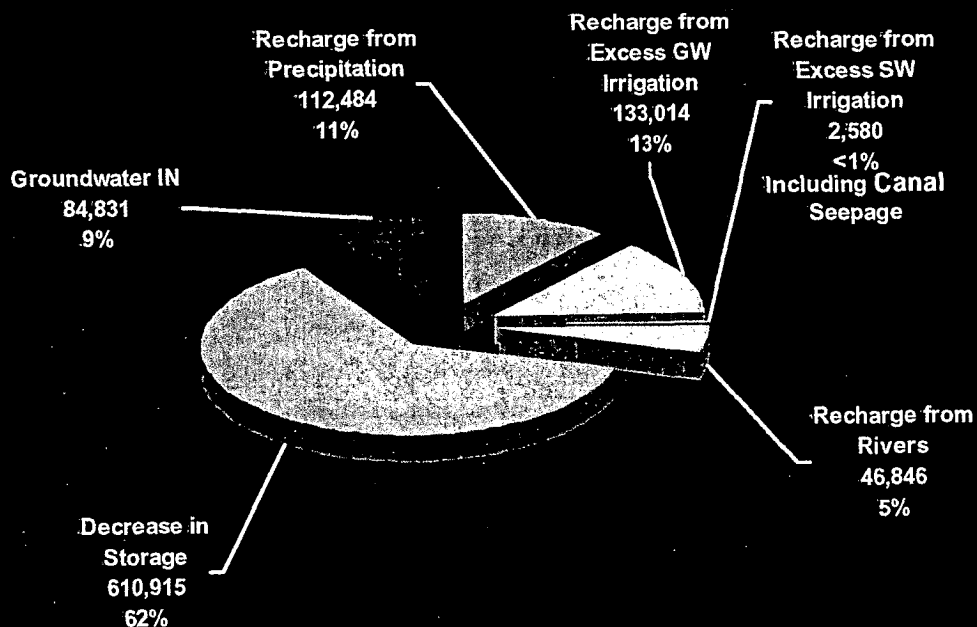


Figure 27

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Upper NRD Outflows for 2000 in Acre - Ft

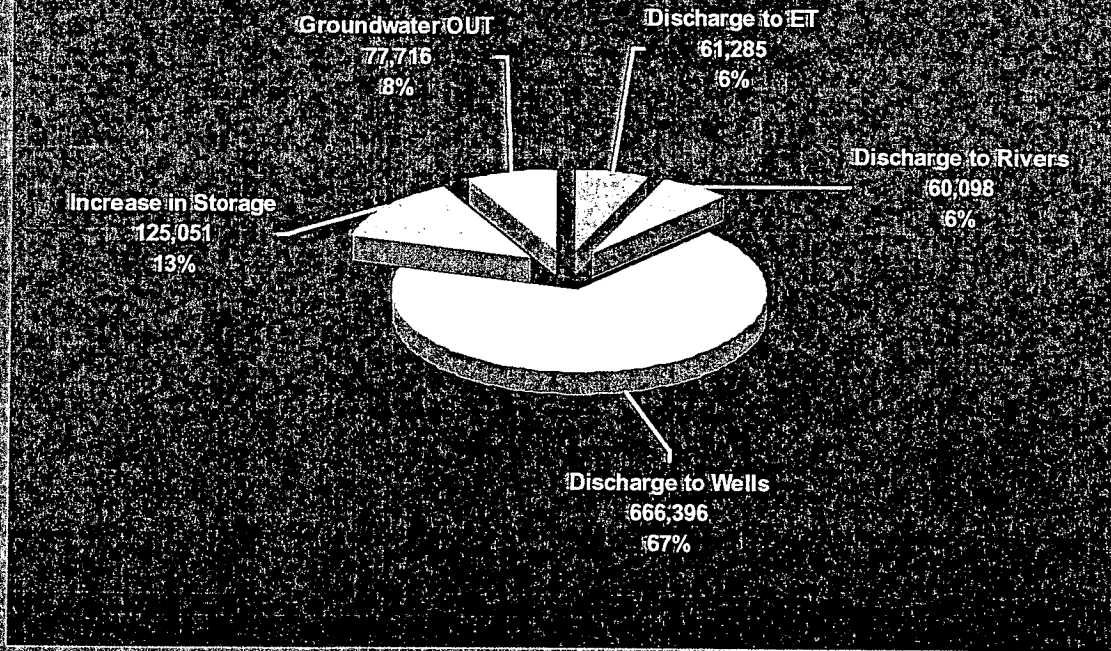


Figure 28

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Table of major ins/outs pumping/recharge for Middle NRD 2000

	Recharge from Precipitation	Recharge from Excess GW Irrigation	Recharge from Excess SW Irrigation	Recharge from Canal Seepage	Recharge from Rivers	Decrease in Storage
						353,141
		Discharge to ET	Discharge to Rivers	Discharge to Wells	Increase in Storage	
Outflows	116,314	76,769	384,439	126,043		

Figure 29

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Middle NRD Inflows for 2000 in Acre - Ft

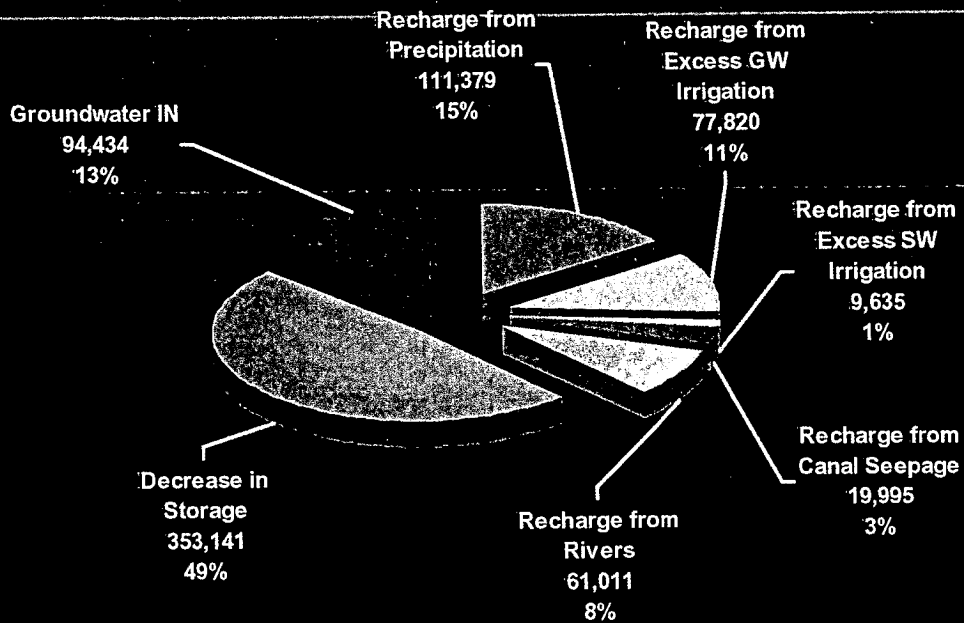


Figure 30

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Middle NRD Outflows for 2000 in Acre - Ft

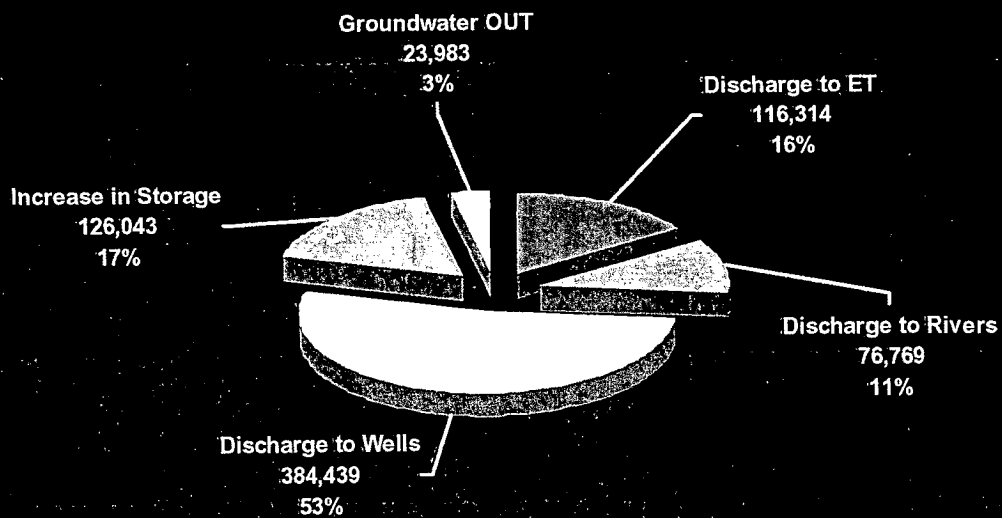


Figure 31

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Table of major ins/outs pumping/recharge for Lower NRD
2000

	Recharge from Precipitation	Recharge from Excess GW Irrigation	Recharge from Excess SW Irrigation	Recharge from Canal Seepage	Recharge from Rivers	Decrease in Storage
Inflow	120,815	53,442	16,246	49,142	49,942	259,655
	Discharge to ET	Discharge to Rivers	Discharge to Wells	Increase in Storage		
Outflows	137,181	83,512	267,215	113,958		

Figure 32

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Lower NRD Inflows for 2000 in Acre - Ft

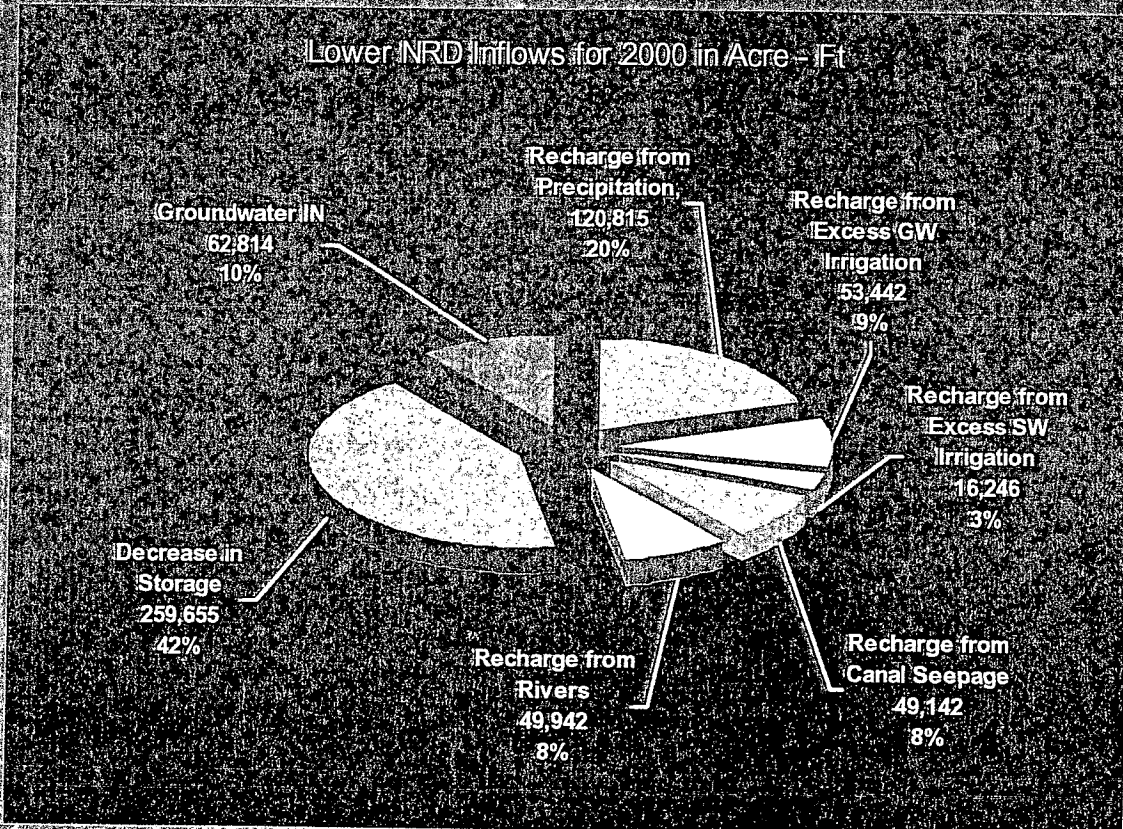


Figure 33

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Lower NRD Outflows for 2000 in Acre - Ft

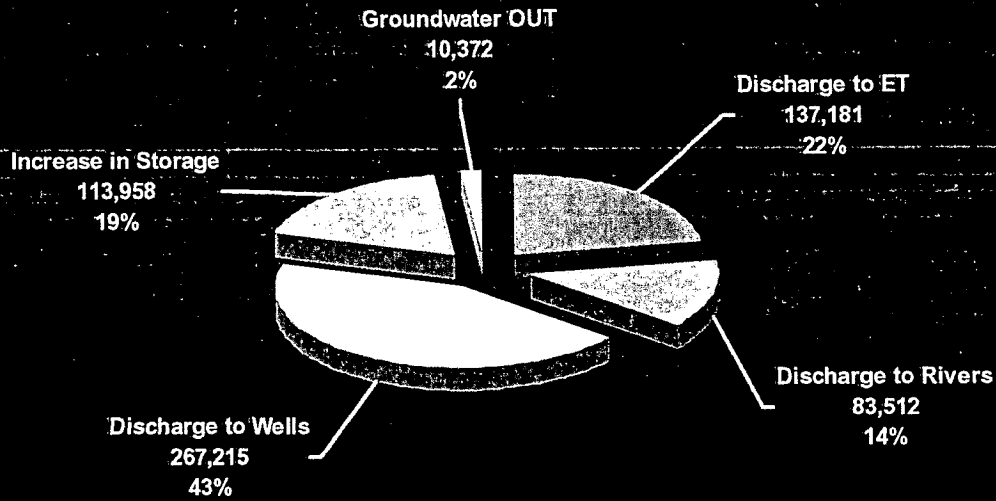


Figure 34

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Table of major ins/outs pumping/recharge for Tri-Basin NRD 2000

	Recharge from Precipitation	Recharge from Excess GW Irrigation	Recharge from Excess SW Irrigation	Recharge from Canal Seepage	Recharge from Rivers	Decrease in Storage
Inflows	248,552	104,420	35,585	215,595	20,075	379,252
	Discharge to ET	Discharge to Rivers	Discharge to Wells	Increase in Storage		
Outflows	14,096	134,915	512,757	192,641		

Figure 35

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Tri-Basin NRD Inflows for 2000 in Acre - Ft

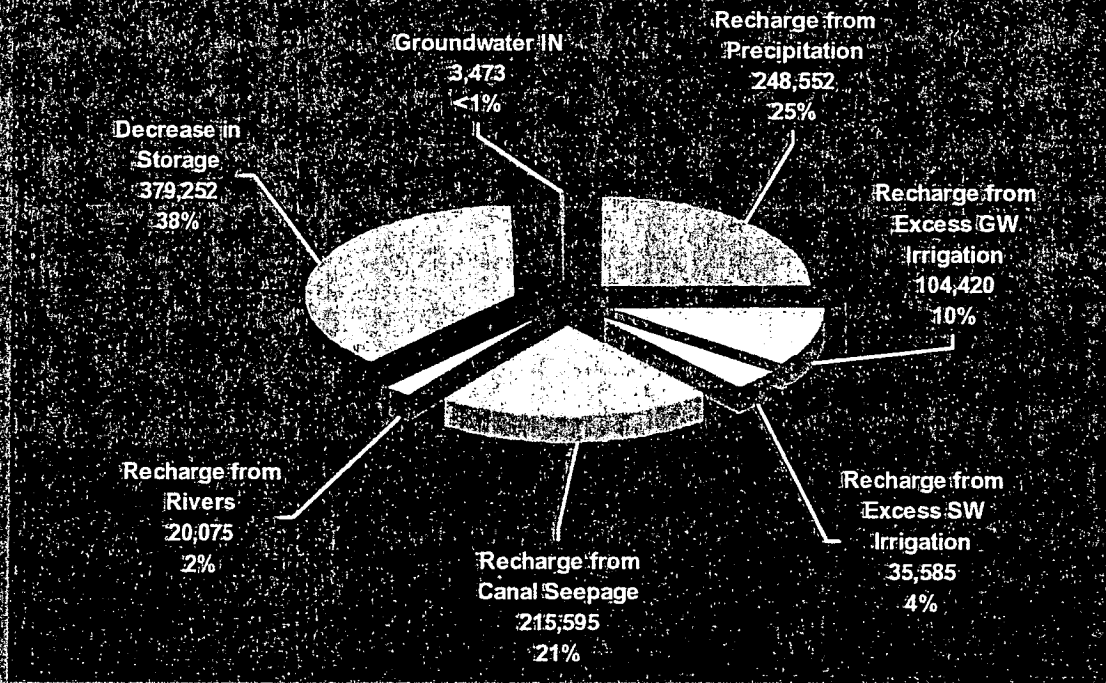


Figure 36

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Tri-Basin NRD Outflows for 2000 in Acre - Ft

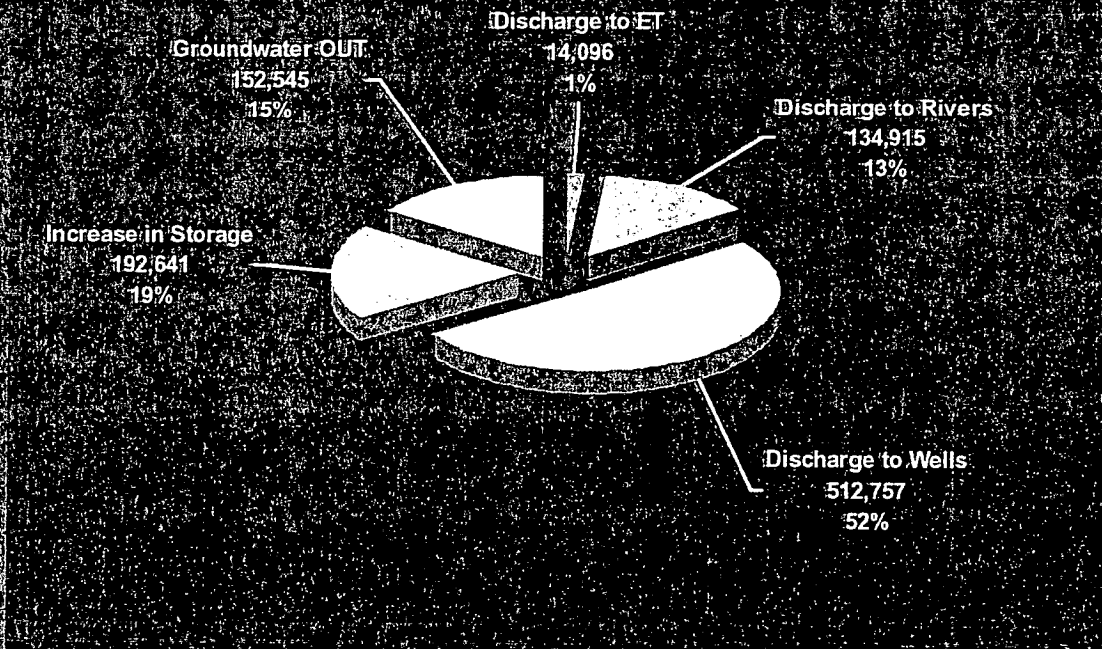


Figure 37

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Table of major ins/outs pumping/recharge for Other NRD 2000

	Recharge from Precipitation	Recharge from Excess GW Irrigation	Recharge from Excess SW Irrigation	Recharge from Canal Seepage	Recharge from Rivers	Decrease in Storage
<i>inflow</i>	121,	72,	24,1	393,	26,7	289,690
	Discharge to ET	Discharge to Rivers	Discharge to Wells	Increase in Storage		
<i>Outflows</i>	15,206	506,552	344,348	172,286		

Figure 38

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Other NRD Inflows for 2000 in Acre - Ft

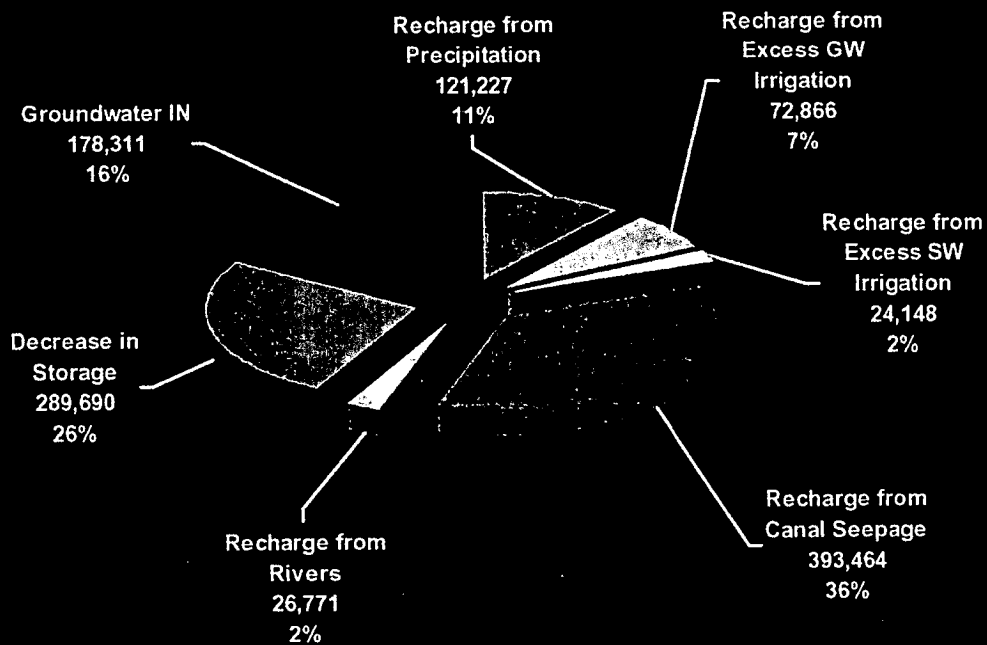


Figure 39

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Other NRD Outflows for 2000 in Acre - Ft

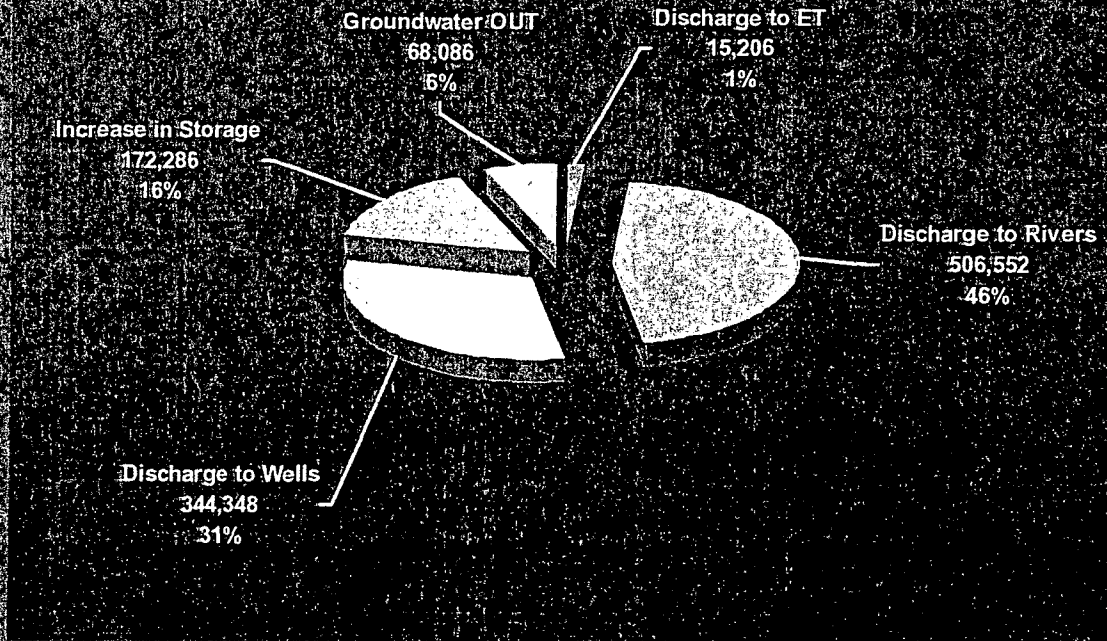


Figure 40

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Baseline Impacts

- Impacts of historical and future pumping for Nebraska
- Impacts of historical and future pumping by NRD

Figure 41

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Model Calculated Water Level Change, 1940 to 2000

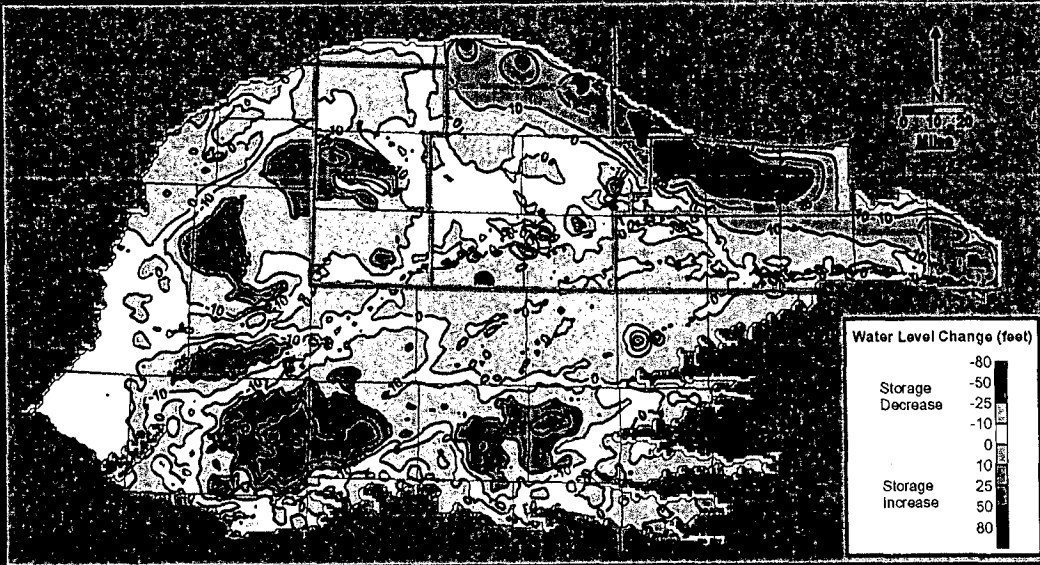


Figure 42

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Model Calculated Water Level Change, 2000 to 2040

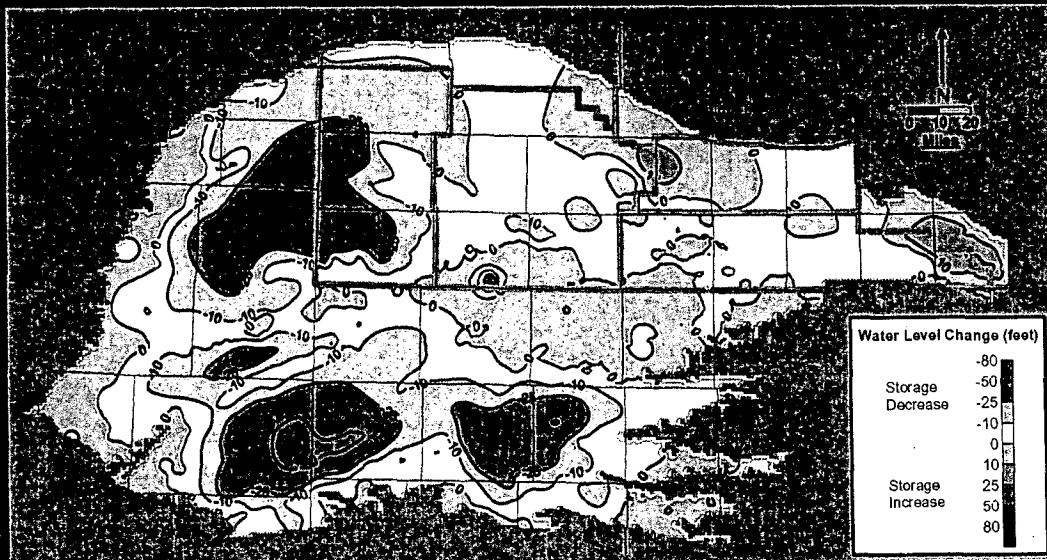


Figure 43

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Baseflow for Frenchman Creek at Imperial

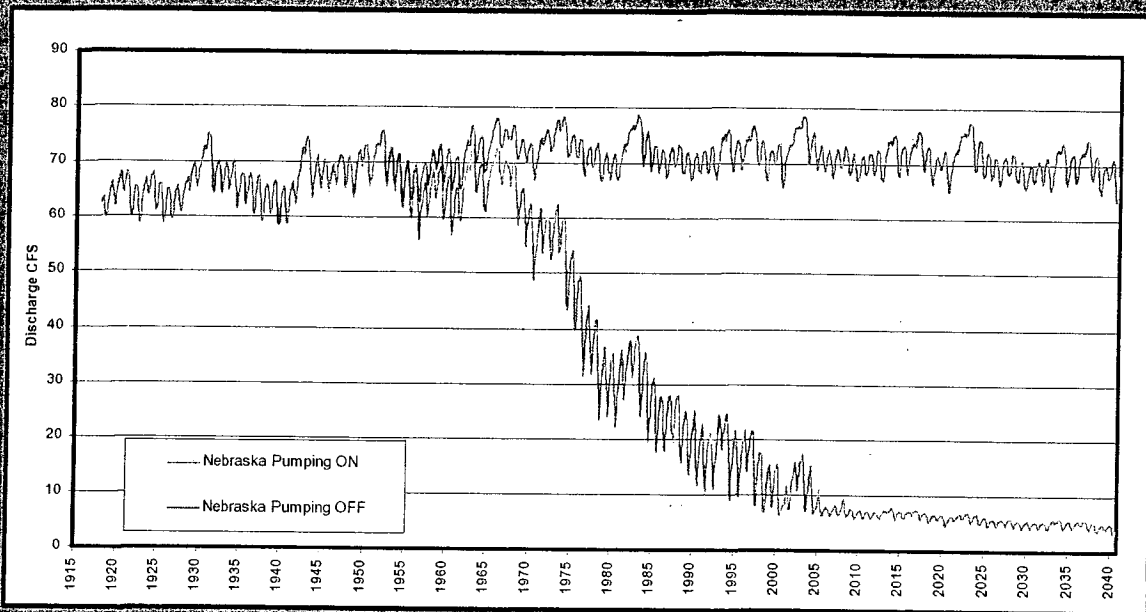


Figure 44

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Baseflow for Medicine Creek above Harry Strunk

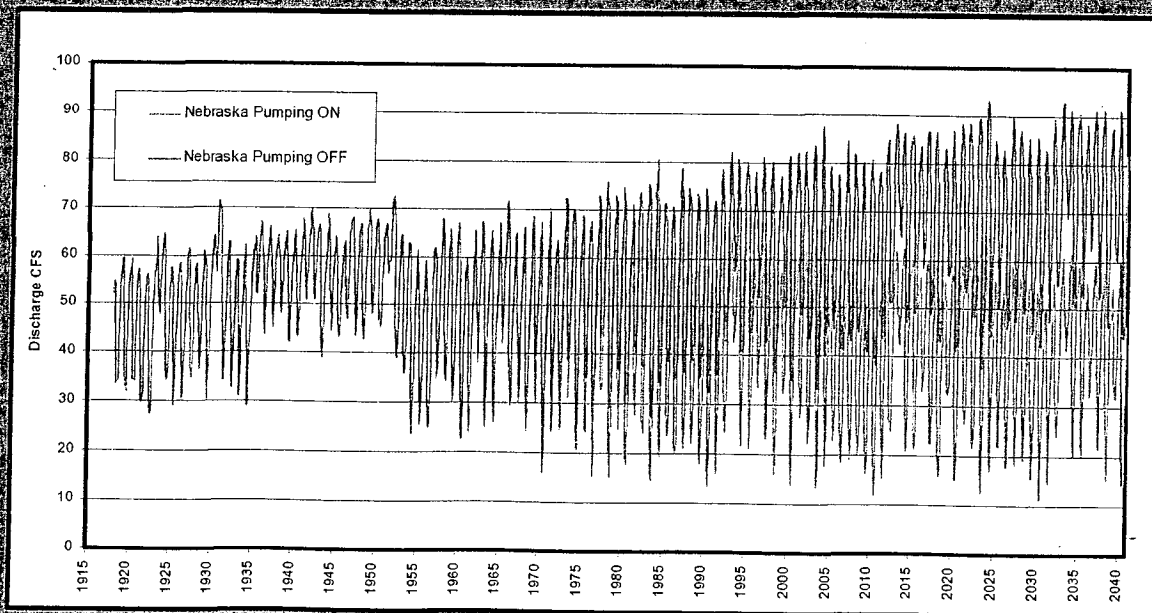


Figure 45

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Baseflow for Republican River between Harlan and Guide Rock

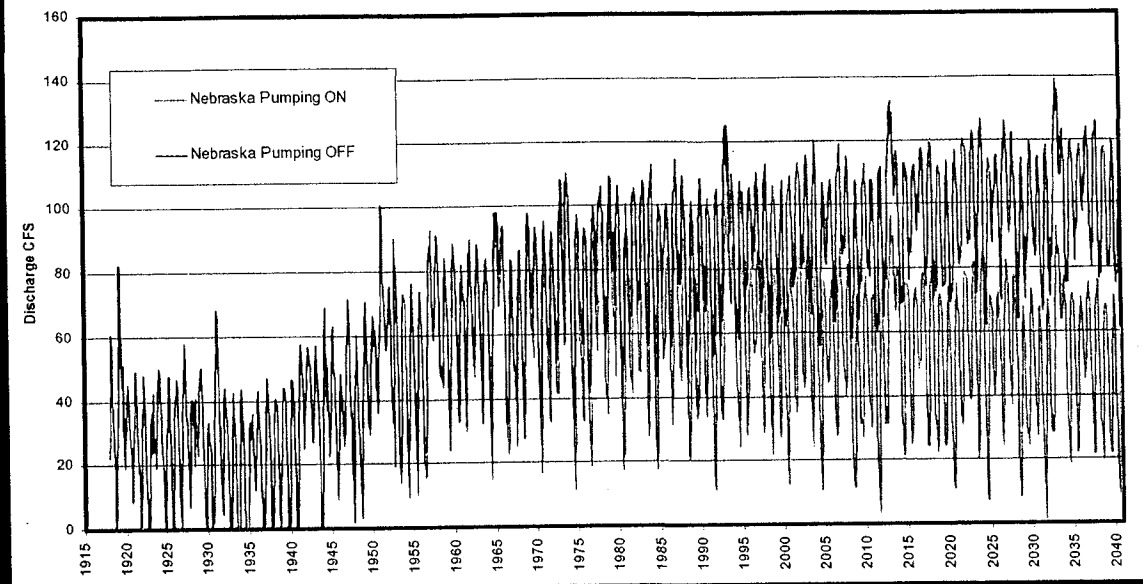


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Impacts of Historic and Future Pumping on Baseflow in Nebraska

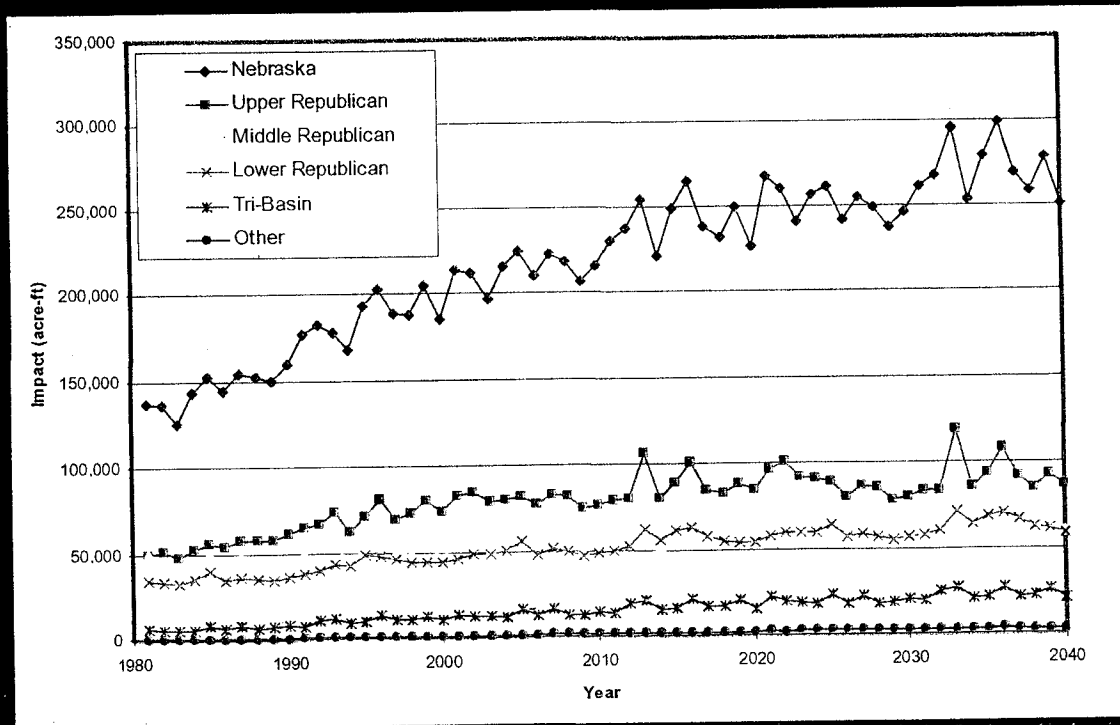


Figure 47

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Change in Storage (1918-2040)

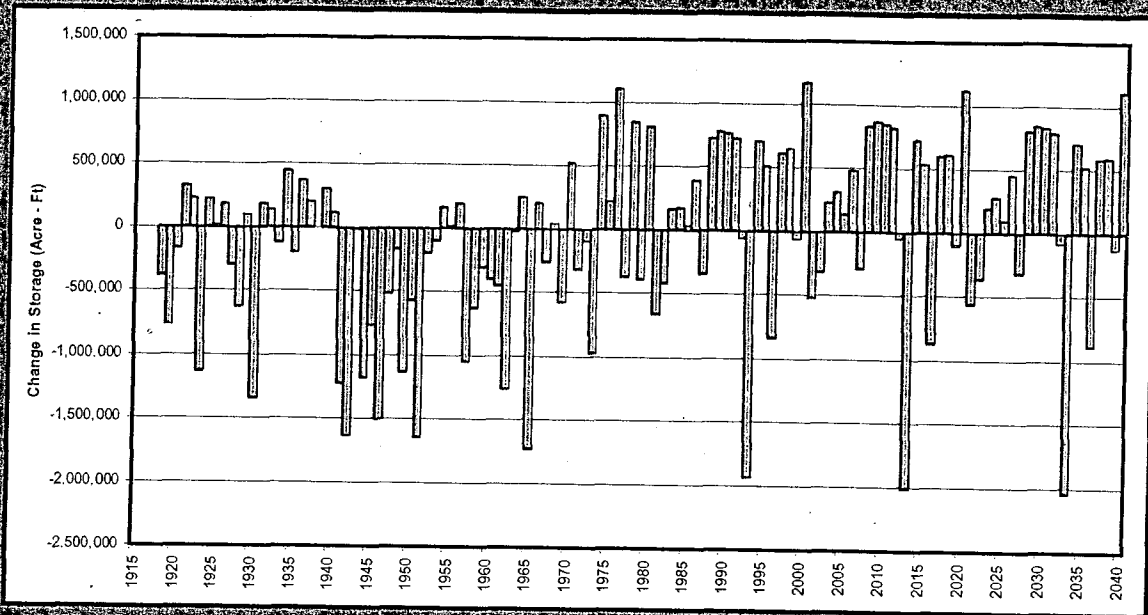


Figure 48

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NRD Impacts as a Percentage

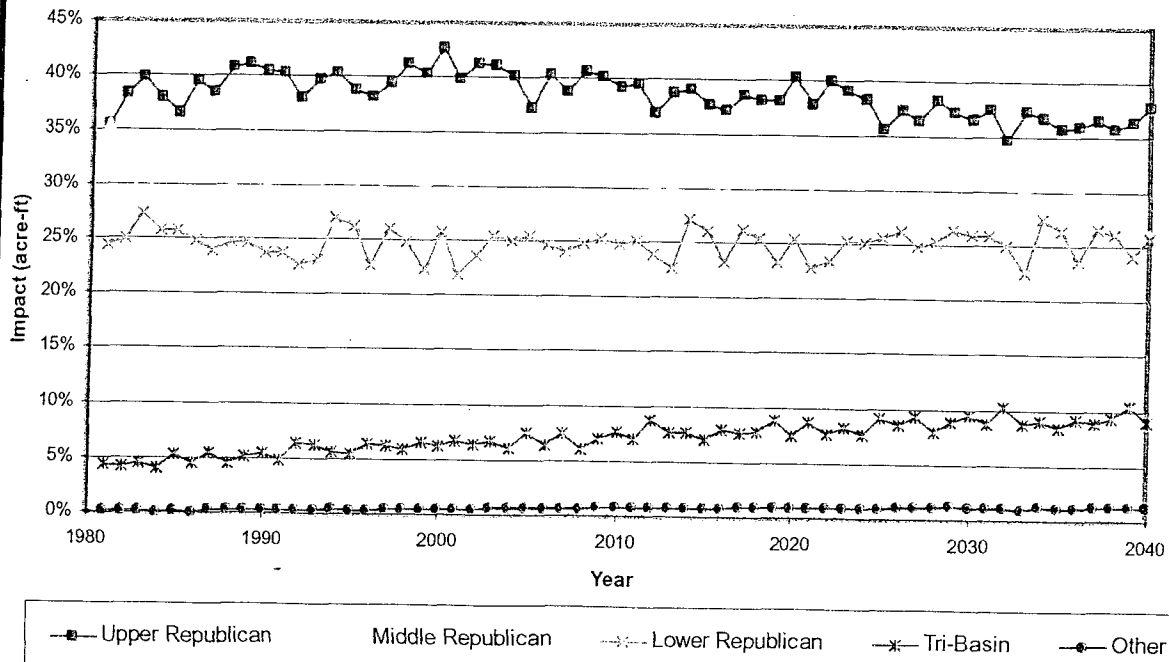


Figure 49

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Analyses of Effects of Changes in Pumping on Future Compliance

- 20%, 40%, 50%, and 100% reductions in pumping throughout Nebraska
- As above, but with reduction in pumping in each NRD (Upper, Lower, and Middle)
- 10% increase in pumping throughout Nebraska
- As above, but with increase in pumping in each NRD (Upper, Lower, and Middle)

Figure 50

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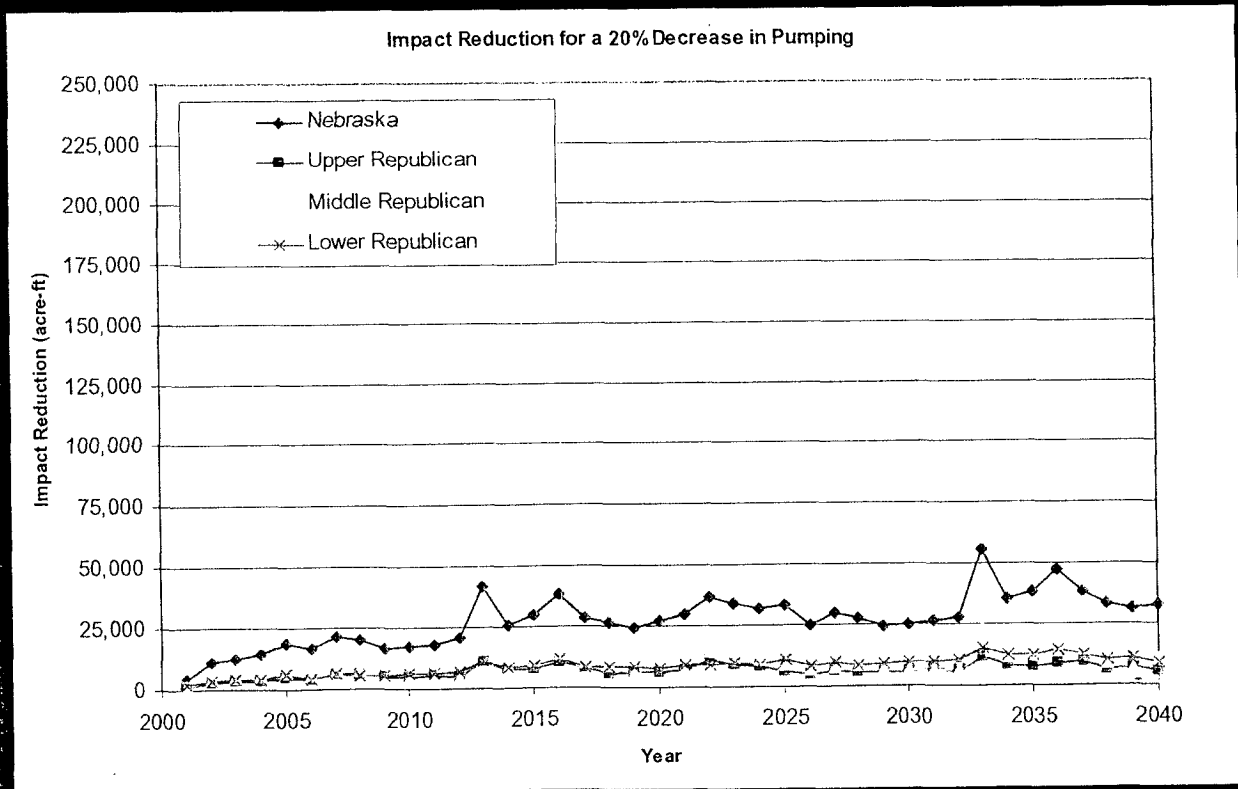


Figure 51

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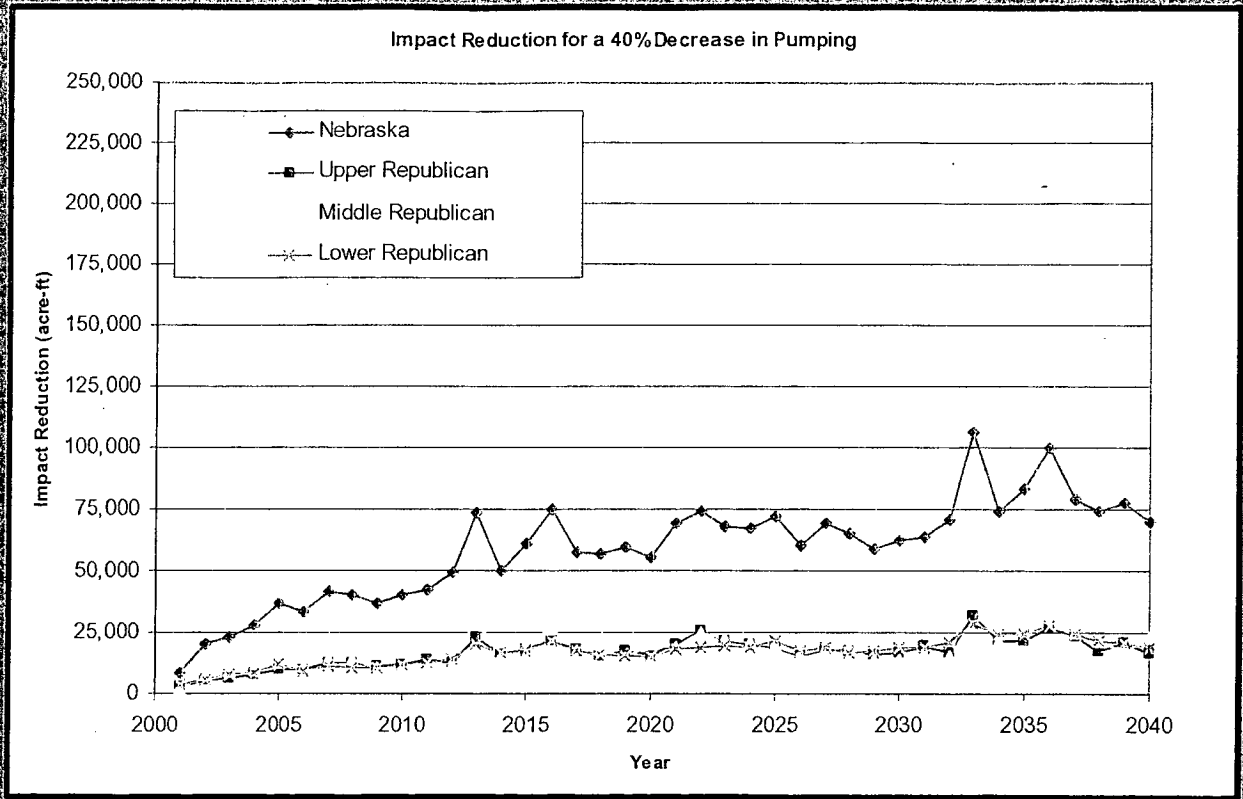


Figure 52

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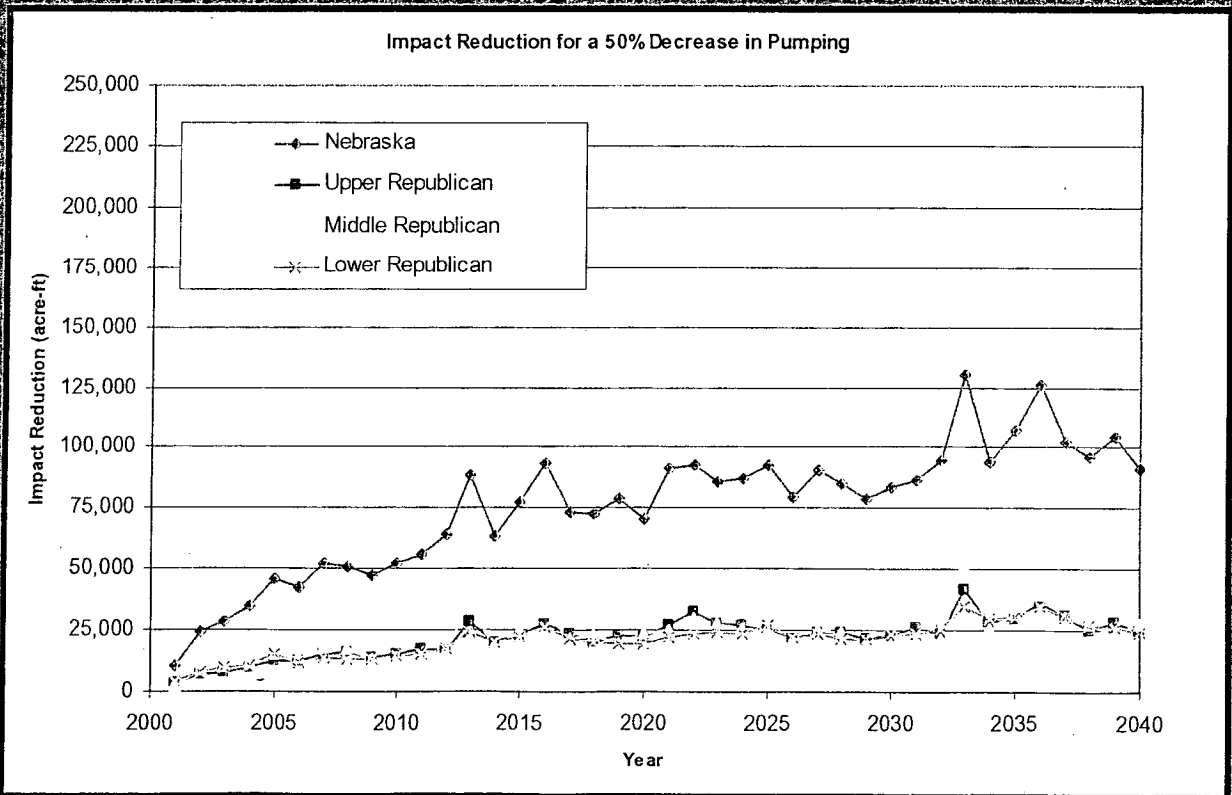


Figure 53

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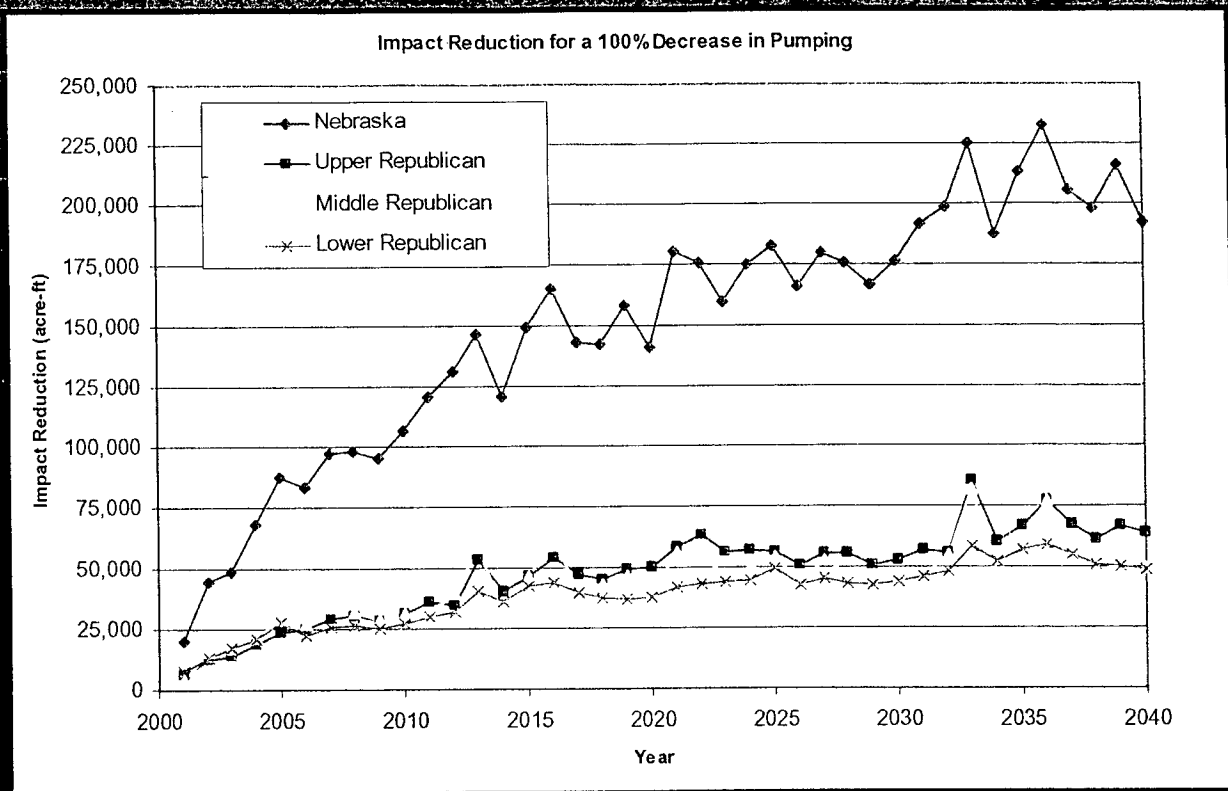


Figure 54

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Increase in Pumping???

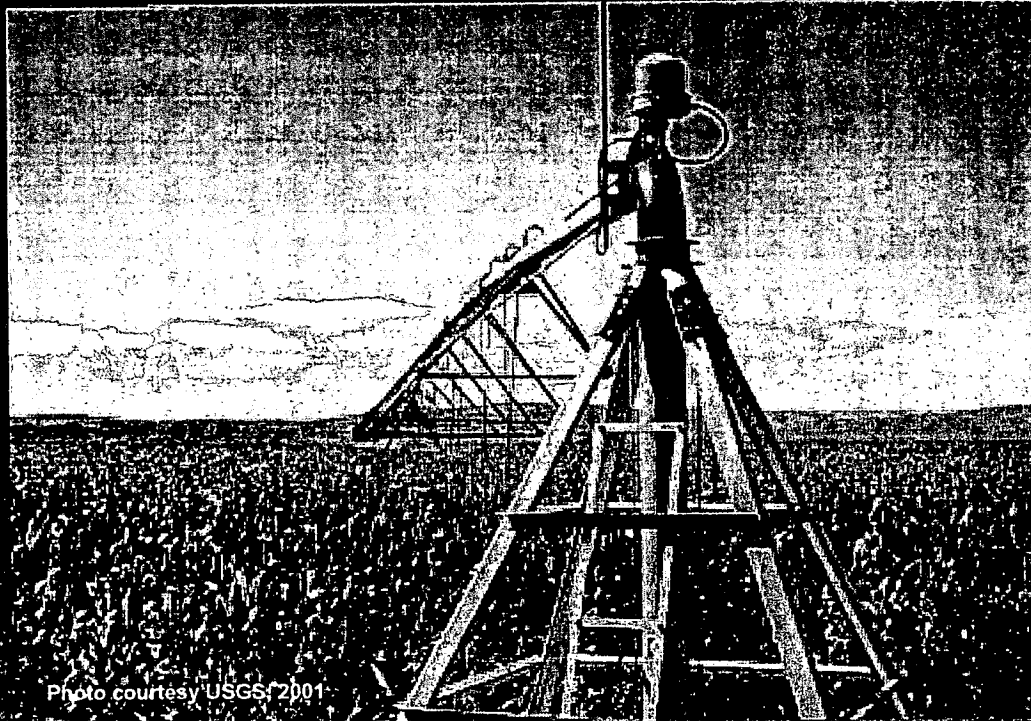


Photo courtesy USGS, 2001

Figure 55

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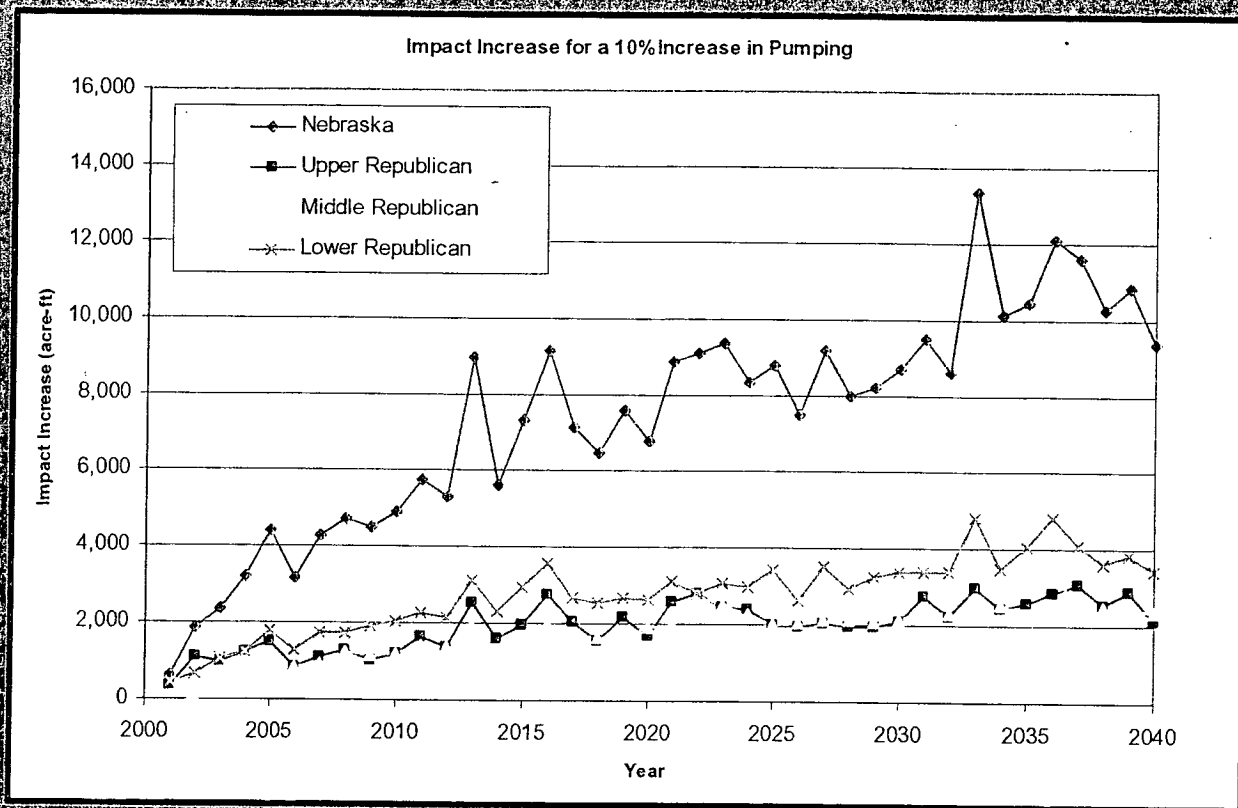


Figure 56

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Delineation of Quick Response Wells

- Turn off pumping in stream cells.
- Turn off pumping within 1 mile of any stream cell.
- Turn off pumping within 2 miles of any stream cell.

Figure 57

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Location of Stream Cells

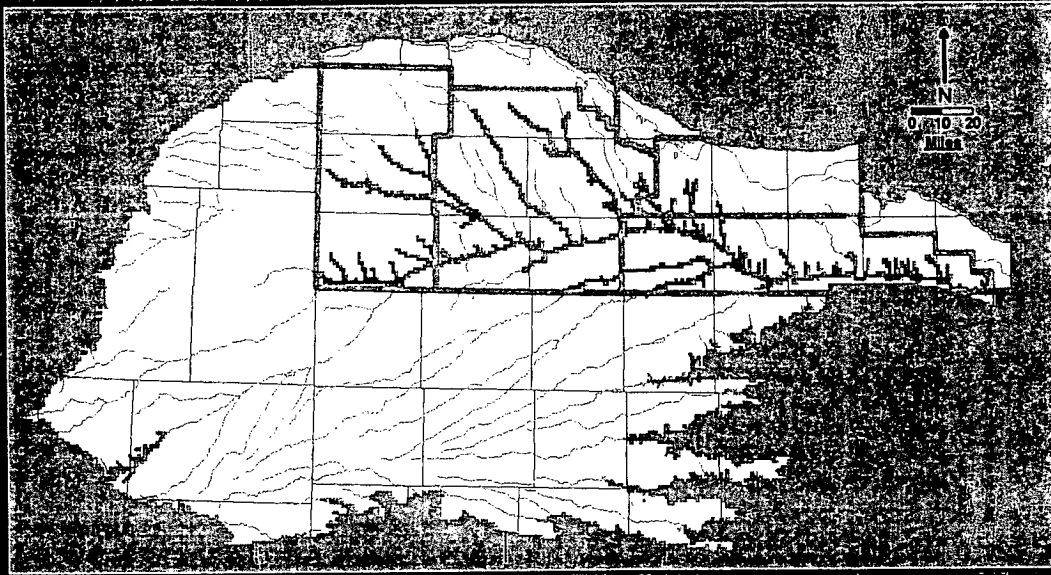


Figure 58

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Pumping in Stream Cells

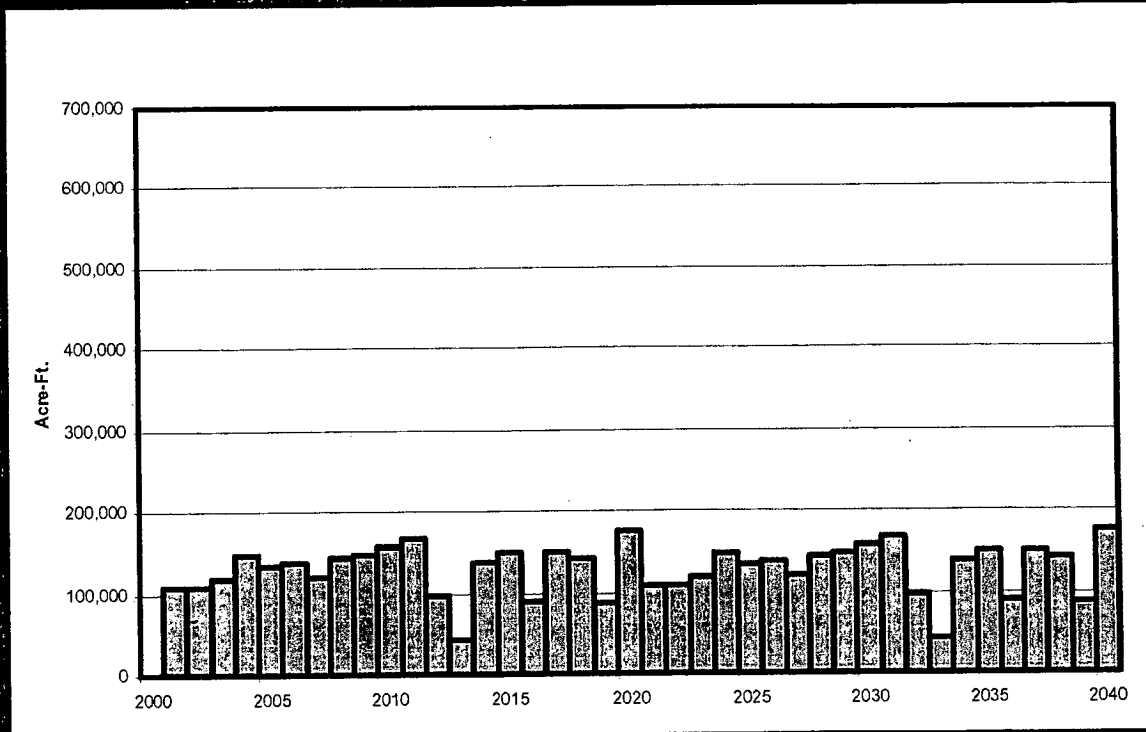


Figure 59

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Location of Cells Within 1 Mile of Stream Cells

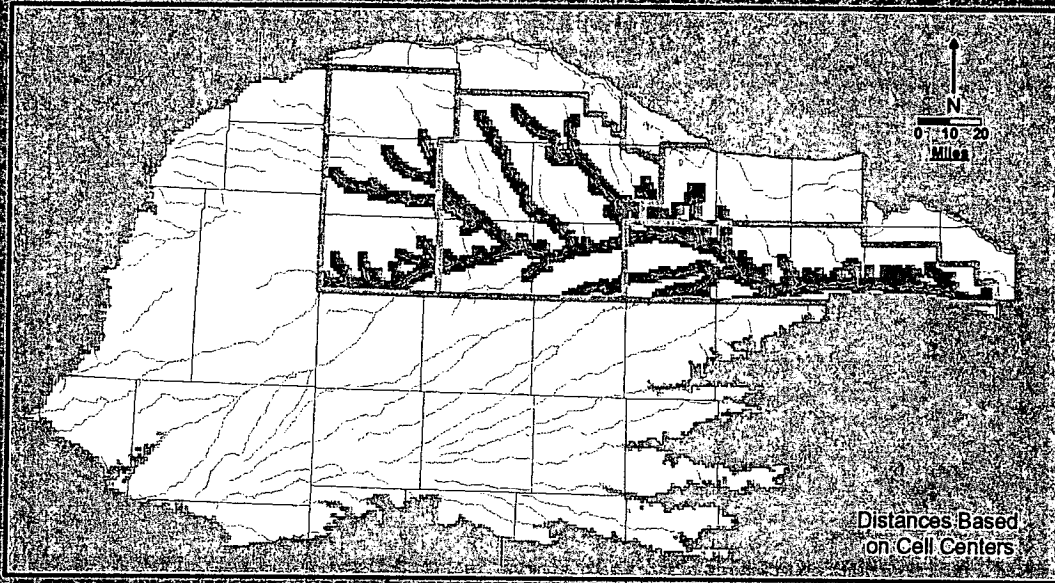


Figure 60

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Pumping in Cells Within 1 Mile of Stream Cells

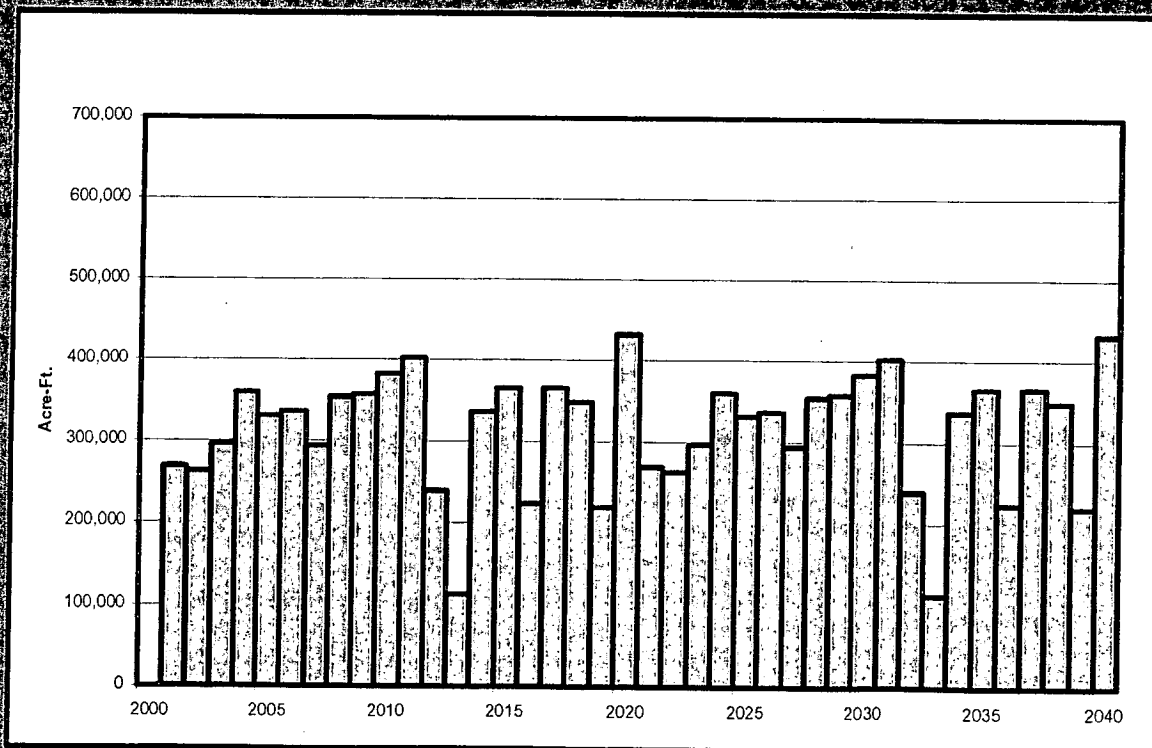


Figure 61

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Location of Cells Within 2 Miles of Stream Cells

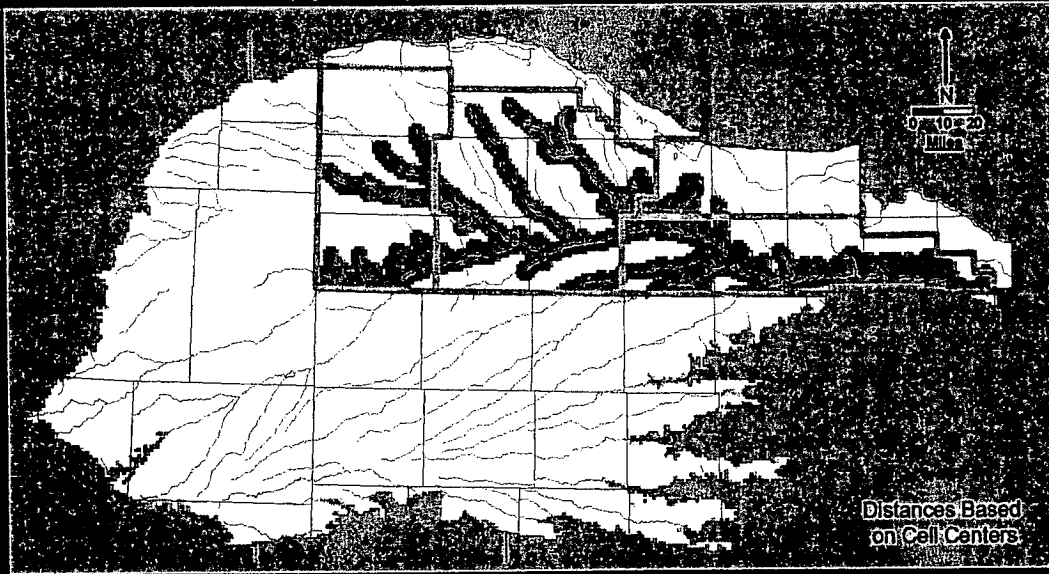


Figure 62

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Pumping in Cells Within 2 Miles of Stream Cells

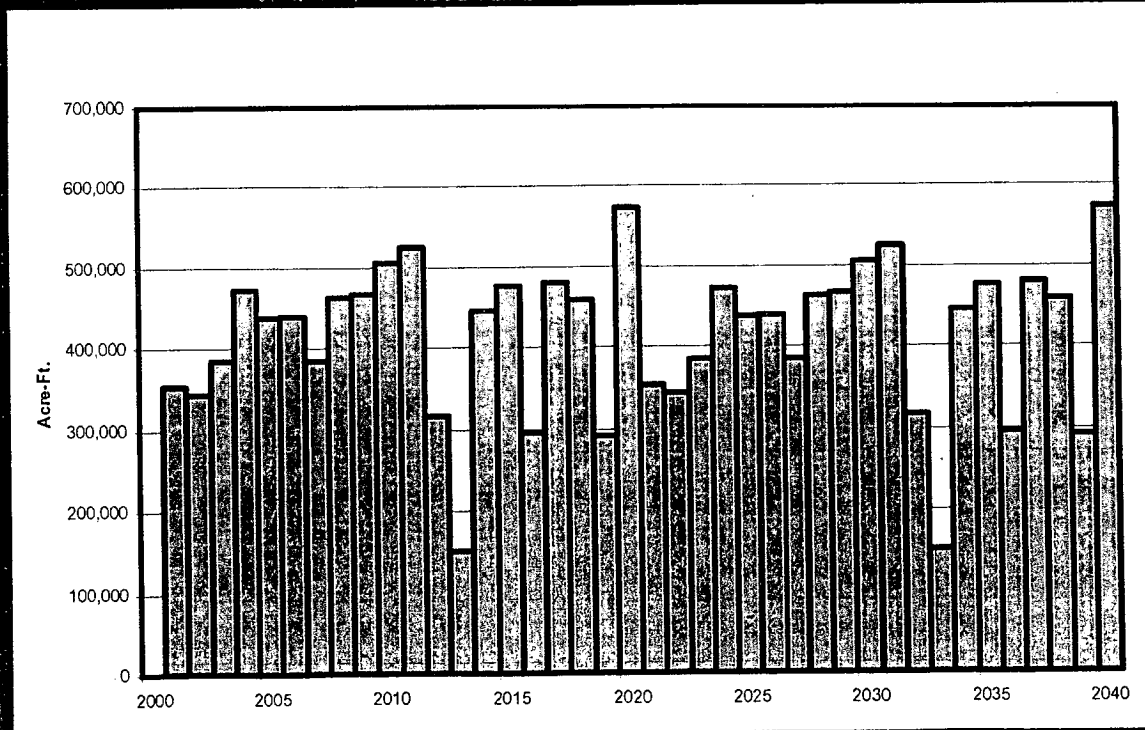


Figure 63

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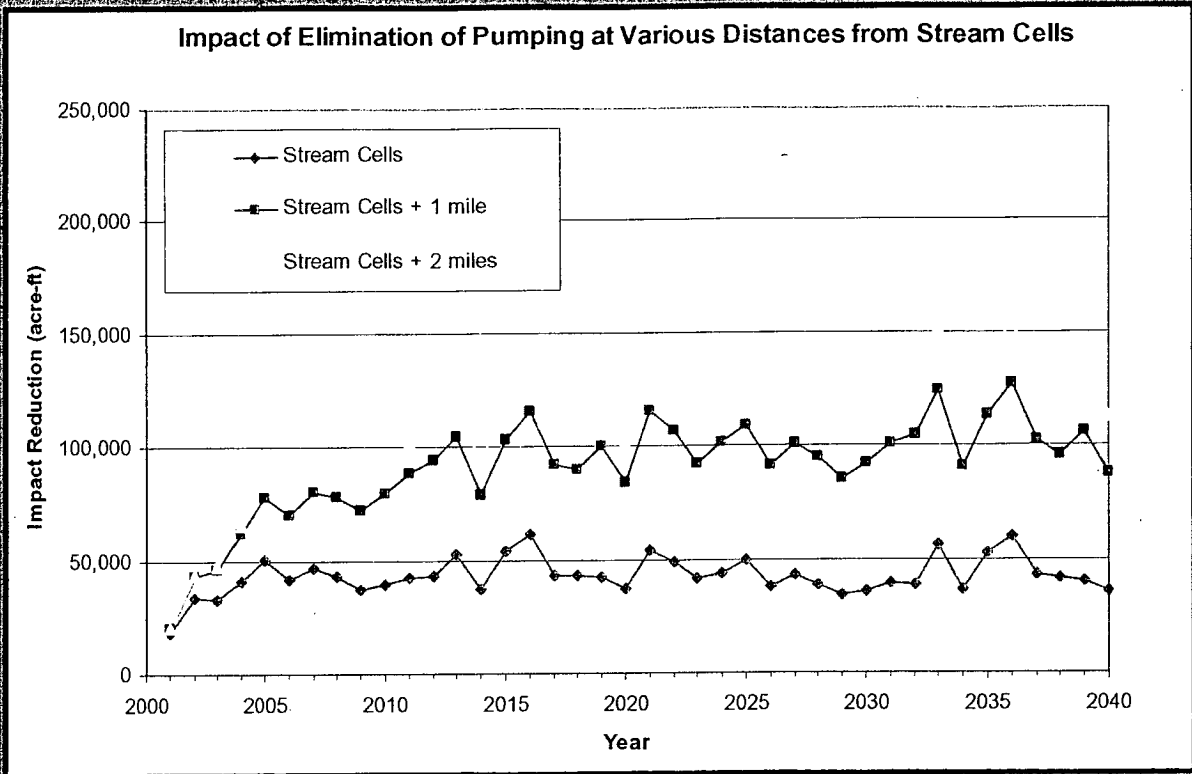


Figure 64

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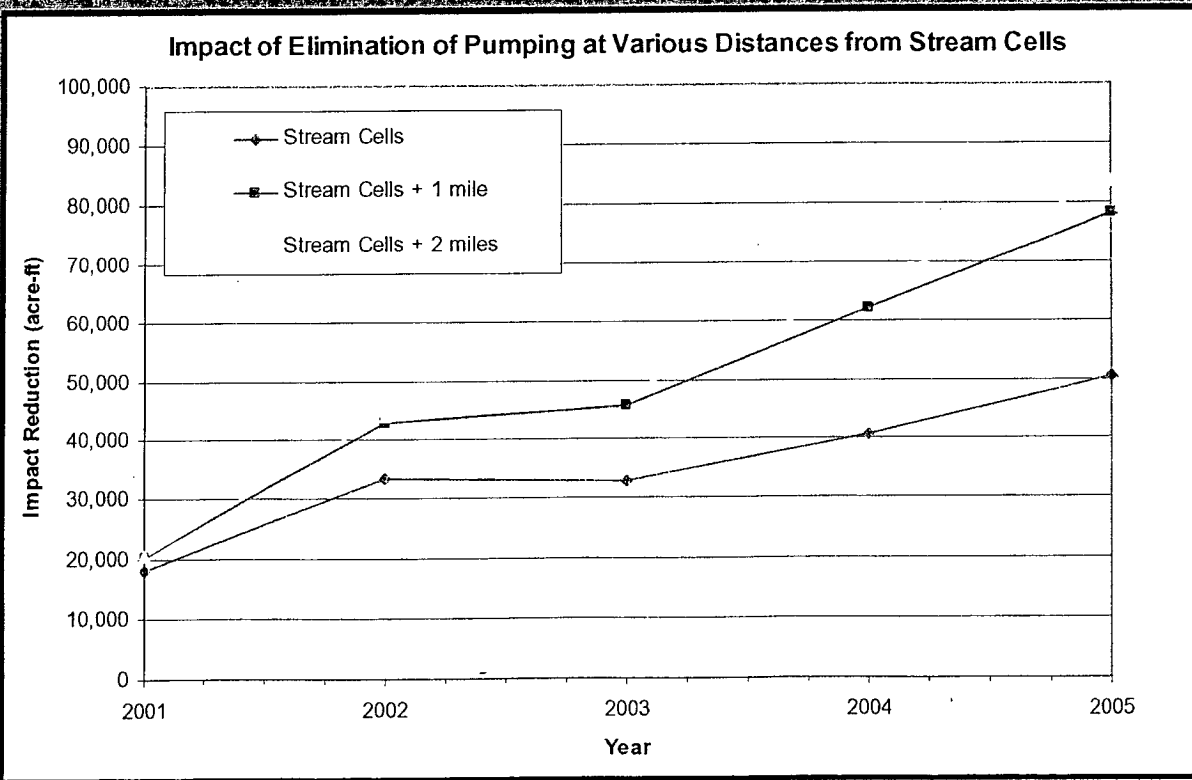


Figure 65

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