Groundwater Contamination in Wafra Agricultural Area by the Produced Water of the Evaporative Pond

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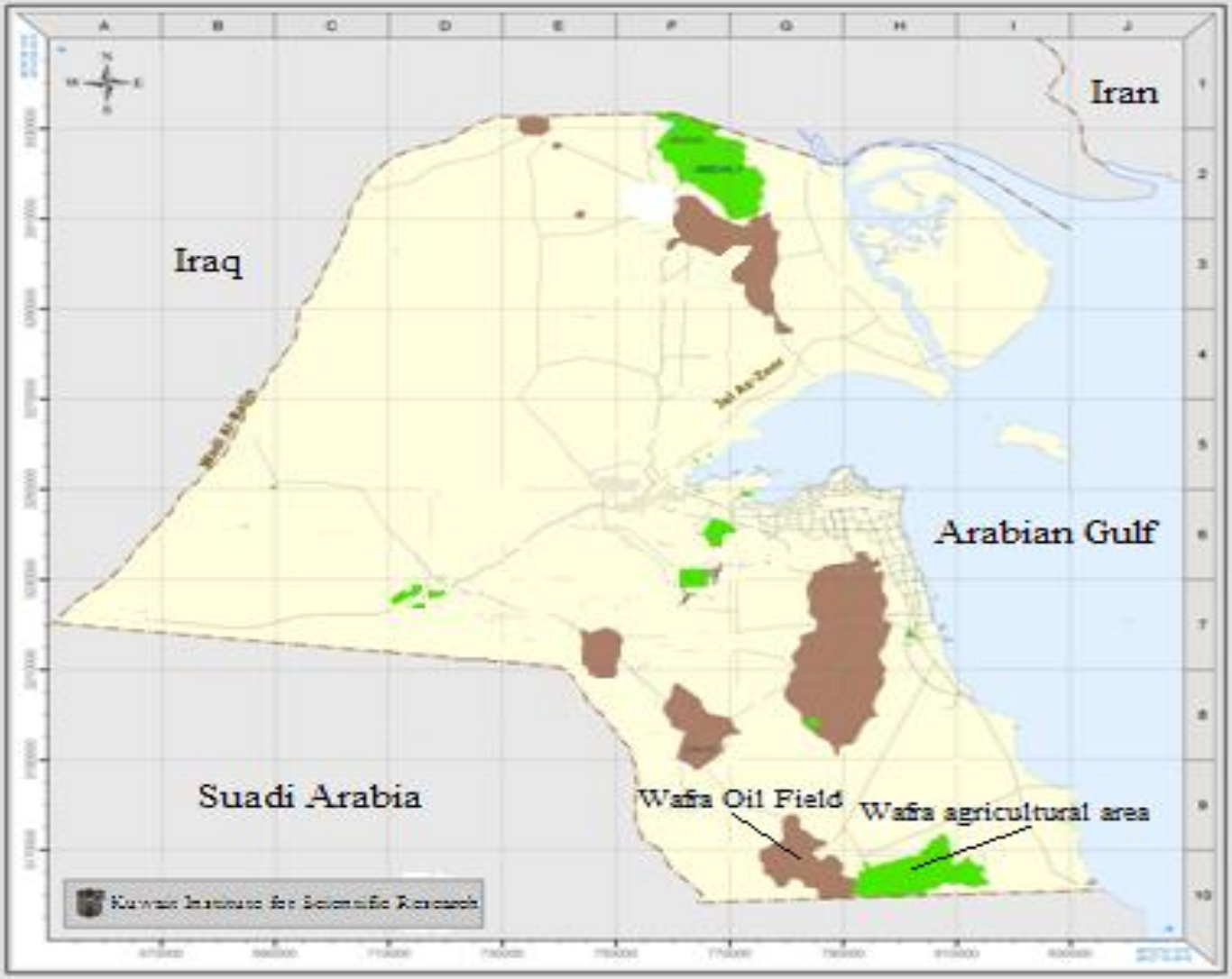
Location of the Wafra Agricultural Area and Oil Field



Legend
Oil fields
Agriculture

0 5 10 20 30 40 50 km

1973

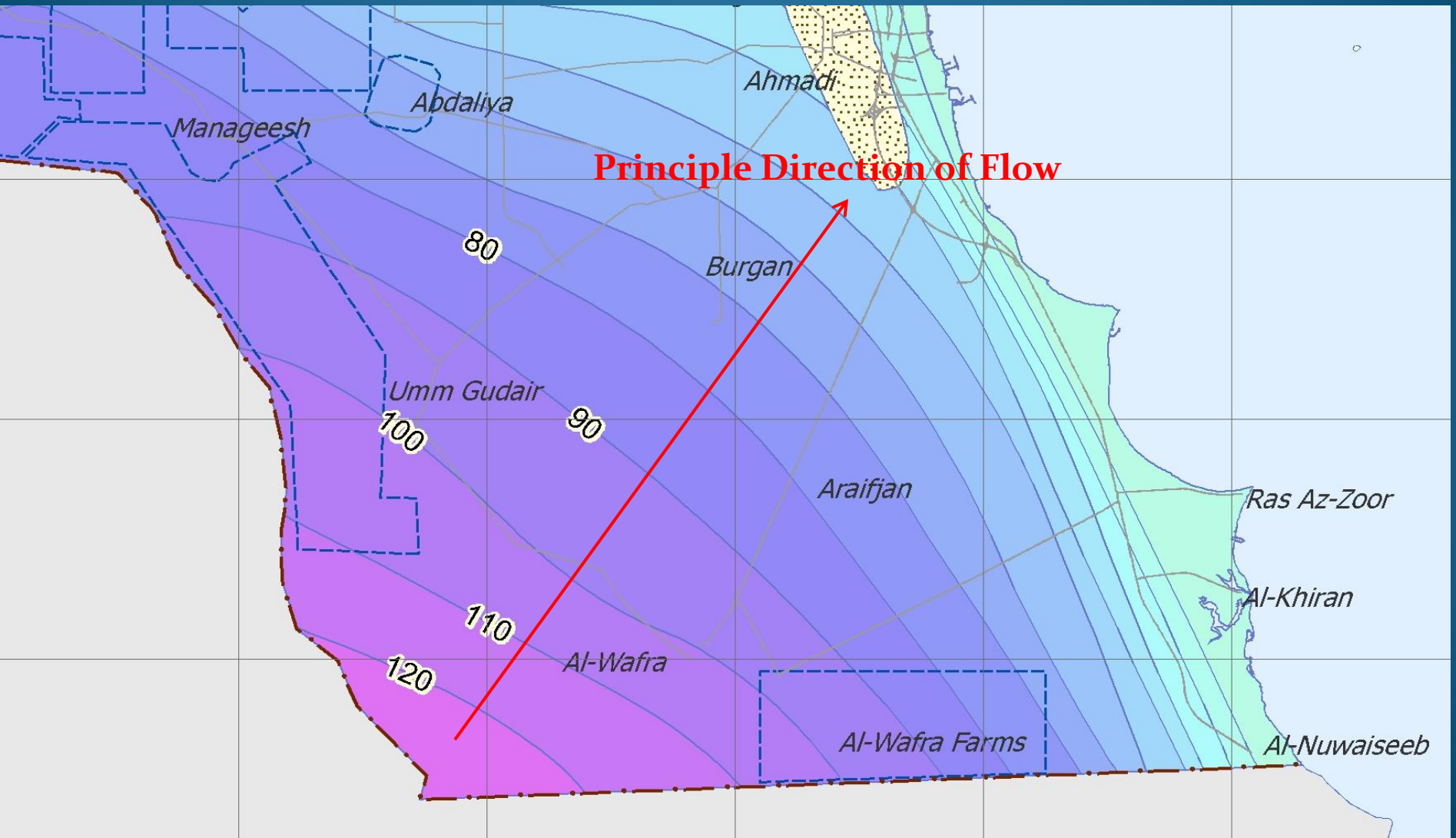
Number of Farms and Wells in Wafra Agricultural Area

Year	Total No. of Farms	No. of Farms Utilized	No. of Wells
1979	190		369
2001	1205		
2002	1277		
2003	1343	1222	1076
2004	1369		
2005	1410		1500
2006	1504	1480	1475
2007	1633	1621	1678
2008	1675	1637	2063

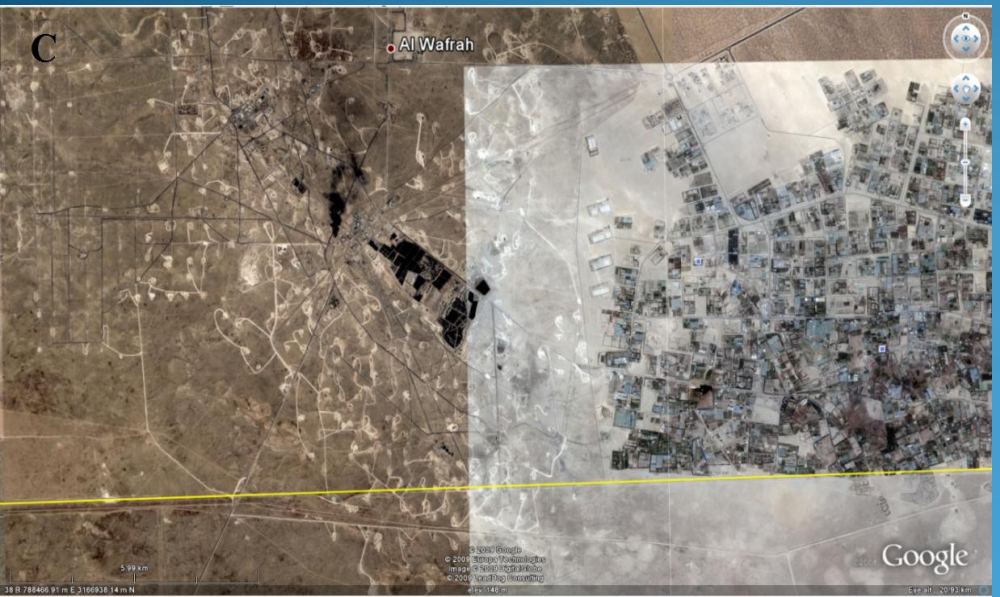
TERTIARY STRATIGRAPHY OF KUWAIT

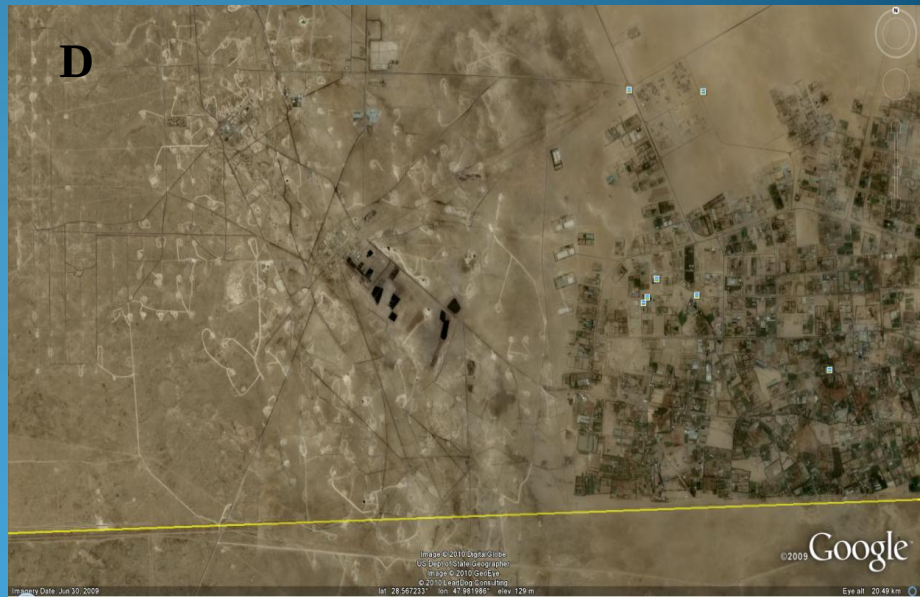
AGE	GROUP	FORMATION	LITHOLOG	LITHOLOGY	GROUND WATER
PLEISTO.-RECENT				SAND, GRAVEL, SILT & CLAY	MOSTLY DRY
PLIO-CENE	KUWAIT GROUP	DIBDIBBA		SAND & GRAVEL (CONGLOMERATIC)	LOCALLY FRESH, MOSTLY BRACKISH
MIOCENE	KUWAIT GROUP	FARS		CALCAREOUS SANDSTONES & SHALES	BRACKISH
MIOCENE	KUWAIT GROUP	GHAR		QUARTZOSE SANDSTONE, SHALY AT BASE	BRACKISH
EOCENE	HASA GROUP	DAMMAM		LIMESTONE & DOLOMITE, CHERTY AT TOP	BRACKISH
EOCENE	HASA GROUP	RUS		ANHYDRITE, MARL, LIMESTONE	BRACKISH\ SALINE
EOCENE	HASA GROUP	UMM AR-RADHUMA		MARL, DOLOMITE ANHYDRITE	BRACKISH\ SALINE

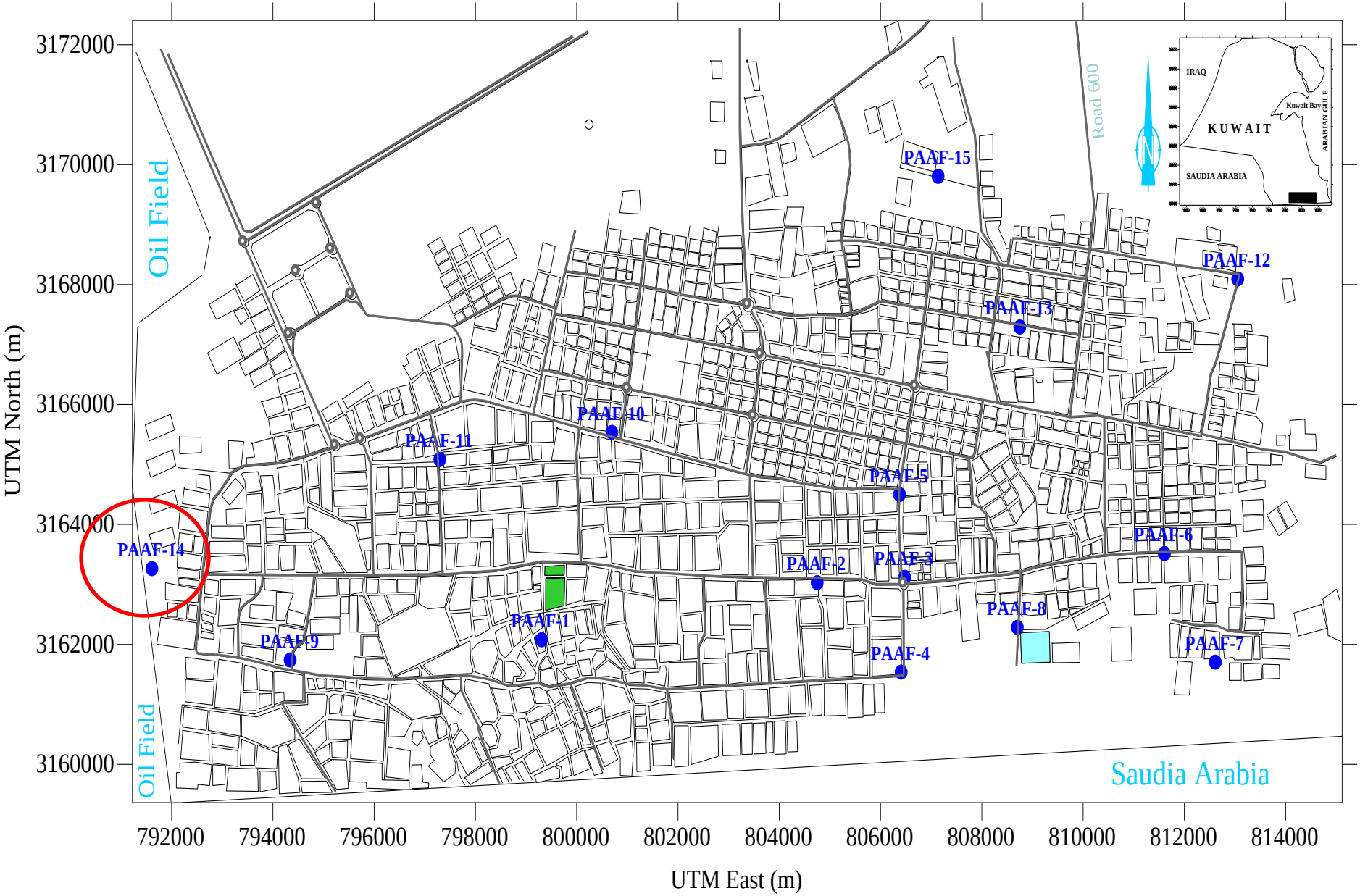
Initial Potentiometric Head, 1960



A (1985), (B) 2003, (C, D)2009






UTM North (m)
3172000
3170000
3168000
3166000
3164000
3162000
3160000
UTM East (m)
792000
794000
796000
798000
800000
802000
804000
806000
808000
810000
812000
814000
Oil Field
Oil Field
Road 600
Saudia Arabia
PAAF-1
PAAF-2
PAAF-3
PAAF-4
PAAF-5
PAAF-6
PAAF-7
PAAF-8
PAAF-9
PAAF-10
PAAF-11
PAAF-12
PAAF-13
PAAF-14
PAAF-15
IRAQ
KUWAIT
SAUDIA ARABIA
Kuwait Bay
ARABIAN GULF

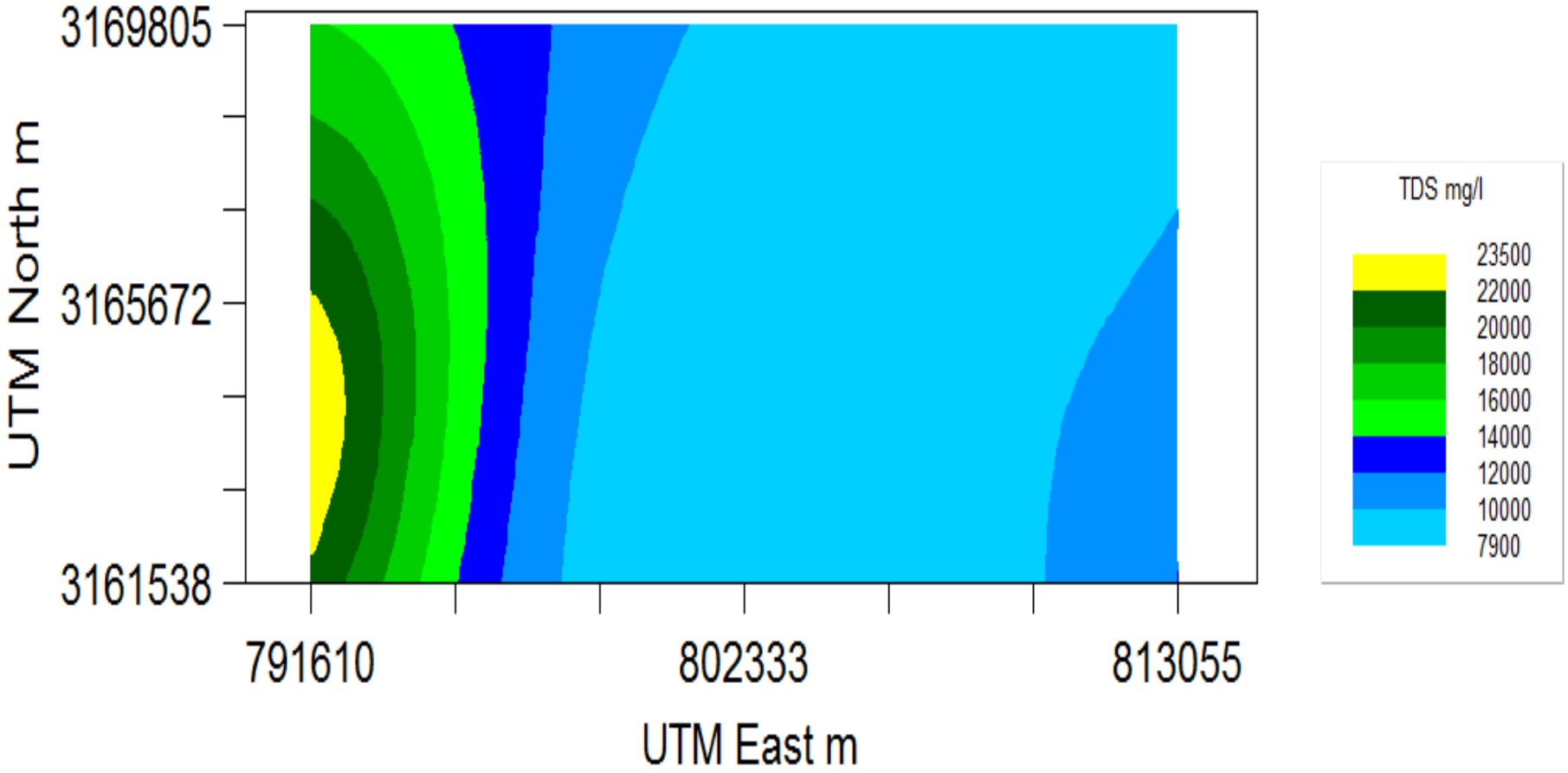
Multi-level Well (CMT Solnist)

Environmental Well
Water Supply Well

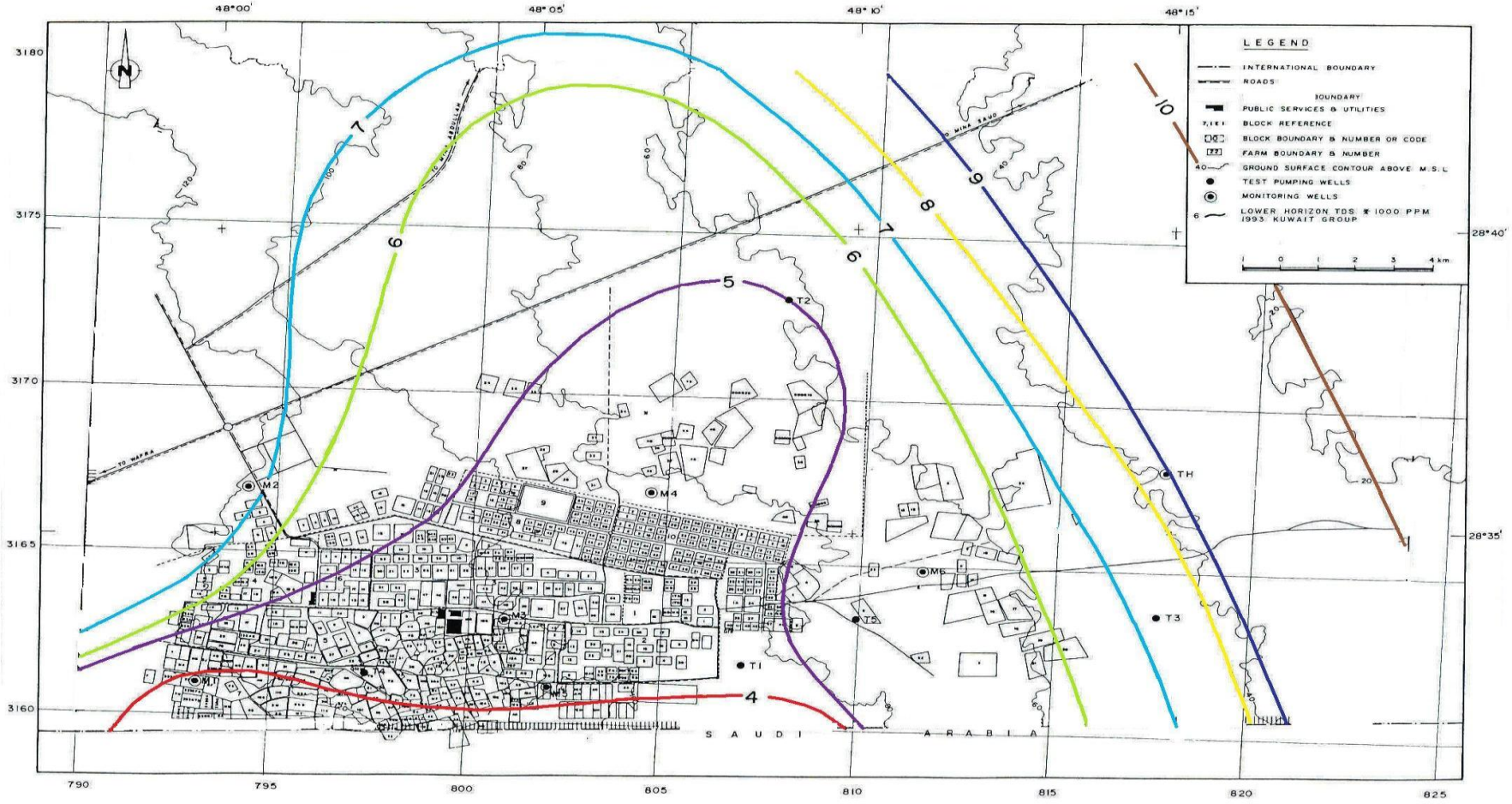
Vertical Distribution of the TDS in Well No. PAAAFR-14

Depth below ground surface (m)	pH	EC (µS/cm)	TDS mg/l
27.0	6.88	27100	15,280
28.0	6.71	51800	36,831
29.0	6.59	65300	49,707
30.0	6.52	71100	54,791
31.0	*6.46*	*75500*	*58,175*
40.0	6.54	73600	56,664
45.0	6.69	73100	56,,183

Kriged Total Dissolved Solids, 2009

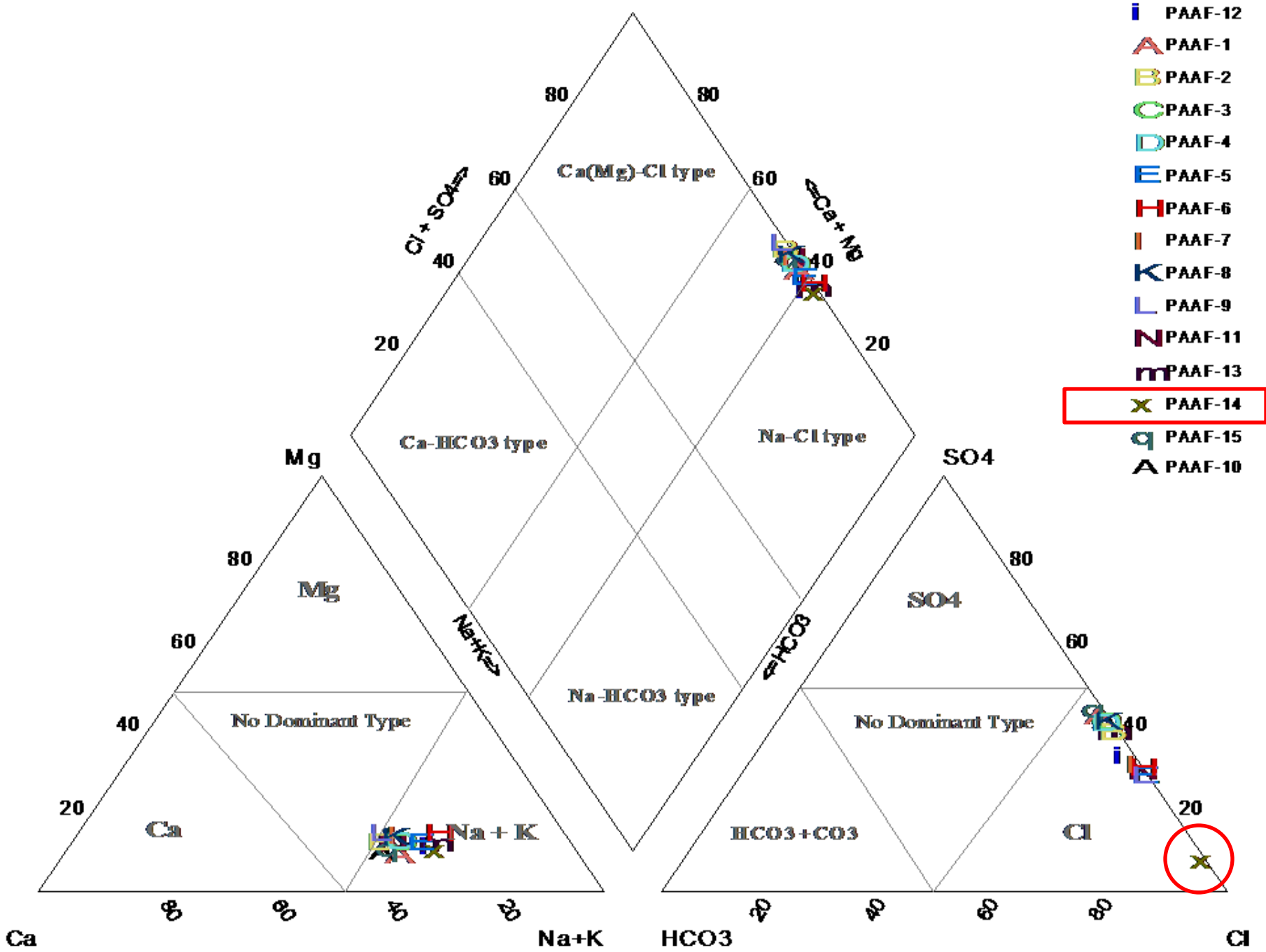


TDS Distribution in 1993



The Impacts of the Contamination

- The Groundwater
- The Soil
- The Agricultural Activities: Plants & Fish
- Health


PAAF-12
PAAF-1
PAAF-2
PAAF-3
PAAF-4
PAAF-5
PAAF-6
PAAF-7
PAAF-8
PAAF-9
PAAF-11
PAAF-13
PAAF-14
PAAF-15
PAAF-10
Ca(Mg)-Cl type
Ca-HCO3 type
Na-Cl type
Na-HCO3 type
Cl + SO4
Ca + Mg
Na+K
HCO3
Mg
SO4
No Dominant Type
No Dominant Type
Ca
Na + K
HCO3+CO3
Cl
Ca
Na+K
HCO3
Cl

Conclusion

- Water Resources Management in the Wafra Area.
- Characterizing the Plume.
- Remediation Program.

Thank You