I Introduction

This Engineering Appendix has been compiled from various authors and members of the Red River Valley Study Team. This appendix contains information and data developed and used to provide the estimates of water supply quantities and costs of various features described in the main report. Not all of the data for these features is contained within this appendix. Some additional data and information , particularly on the water supply projections and modeling, is provided in the Hydrology Appendix.

The purpose of this appendix is to provide the information and data that was used, at this appraisal level, for the limited design and layouts of the physical features. The designs presented here are not to be considered for actual construction but are for the purposes of determining the physical quantities involved for the cost estimate. These designs do provide a sufficient level of detail on each feature so evaluations and comparisons between features can be made.

Sketches and drawings are provided here to convey the physical concepts of the features to the reader. These drawings and sketches are not necessarily drawn to scale nor do they represent all of the local site characteristics.

Cost estimates developed for these features contains individual costs for major items only. Other items not listed at this level of detail are considered to be a part of the 20% unlisted items category. As design levels progress to high detail, more individual items are included with the designs and the percentage of unlisted items is reduced.

The Hydrology Appendix contains the details and results of the HYROSS simulation computer model runs. These model runs were used to identify shortages that existing in the year 2050, given predicted growth in population and industrial development. As a summary of the various water supply “features” investigated for cost and supply, the follow table is included for comparison of various supply shortages remaining. The remaining shortages occur predominantly during the 1930's drought event. Water supplies that are capable of meeting the shortages of the 1930's are also capable of meeting any other shortage during the 54 year model simulation time. Generally, the single year of 1934 contains the worst conditions for water supplies in the Red and Sheyenne rivers.

SHORTAGE SUMMARY (IN KAF)

	Water Supplied			REMAINING SHORTAGES - KAF				
				Composite Red Rive		Composite Shevenne		54-Yrs
	1934	1930's	54-Yrs	1934	1930's	1934	1930's	Total
Year 2050 Baseline Conditions	**0**	**0**	**0**	**23.37**	**157.03**	**30.20**	**149.49**	**361.43**
FEATURE 1: Enlarge Lake Ashtabula								
190,000 ac-ft size, starting full	31.5	152.18	179.33	21.87	151.72	0.18	2.62	**182.10**
190,000 ac-ft size, starting empty	3.1	35.79	35.99	23.37	157.03	27.10	113.70	**325.44**
FEATURE 2: Build Kindred Dam & Reservoir								
180,000 ac-ft reservoir starting full	31.5	152.57	179.45	21.87	151.33	0.18	2.62	**181.98**
50,000 ac-ft reservoir starting empty	26.0	117.27	116.92	23.37	157.03	4.16	32.22	**244.51**
FEATURE 3: Build Maple River Dam and Reservoir								
40,000 ac-ft reservoir starting full	27.5	75.58	75.85	21.87	151.96	4.16	78.98	**285.58**
22,000 ac-ft reservoir starting empty	16.2	57.61	57.87	21.87	151.96	15.54	96.95	**303.56**
FEATURE 4: Connecting Pipeline to move water to Upper Red River								
4A Kindred Dam to Wahpeton								
4B Maple River to Wahpeton								
4C Kindred to Wahpeton & Abercrombie								
FEATURE 5: Construct Ring Dike(s) for additional surface storage								
22,000 ac-ft ring dike regulating pipeline import	44.0	239.38	259.36	5.95	40.55	3.63	26.59	**102.07**
22,000 ac-ft ring dike for high spring flows storage	10.2	154.01	163.78	38.07	110.92	5.34	41.59	**197.65**
FEATURE 6: Purchase Surface Water from Irrigation								
Purchase and transfer all surface water irrigation	3.3	20.06	26.28	21.87	153.91	28.37	132.55	**335.15**
FEATURE 7: Develop Unappropriated Ground Water Supply								
Spiritwood Aq	6.66	66.60	359.64					
FEATURE 8: Purchase Existing Irrigation and Re-Appropriate Ground Water								
Sheyenne Delta	2.58	25.80	139.32					
Page/Galesburg	3.33	33.30	179.82					
Elk Valley	2.78	27.80	150.12					
FEATURE 9: Develop Aquifer Storage and Recovery								
West Fargo North Aquifer space available under water table conditions, ac-ft								
Use 10 KAF available space to be recharged from ring dike supply								
FEATURE 10: Utilize new Desalinization Plant								
1 MGD	1.10	11.00	59.40					
2 MGD	2.20	22.00	118.80					
FEATURE 11: Develop Reuse from major municipalities wastewater supplies								
Grand Forks, Fargo wastewater reuse for irrigation	0.4	2.90	3.86	23.23	156.98	29.96	146.64	**357.57**
FEATURE 12: Municipal and Industrial Conservation measures								
Apply uniform conservation measuress (15%reduce demanc	14.2	88.33	103.08	19.15	125.65	20.22	92.54	**258.35**

SHORTAGE SUMMARY (IN KAF)

	Water Supplied			REMAINING SHORTAGES - KAF				
				Composite Red Rive		Composite Shevenne		54-Yrs
	1934	1930's	54-Yrs	1934	1930's	1934	1930's	Total
Year 2050 Baseline Conditions	**0**	**0**	**0**	**23.37**	**157.03**	**30.20**	**149.49**	**0.00**
FEATURE 13: Implement Drought Contingency Plans								
Use Ashtabula minimum pool	3.5	39.78	36.10	23.37	153.07	26.66	113.67	**325.33**
Apply uniform conservation measuress (reduced demand)	14.2	88.33	103.08	19.15	125.65	20.22	92.54	**258.35**
Use Ashtabula minimum pool with conservation measures	23.8	104.58	118.25	19.15	126.17	10.63	75.77	**243.18**
FEATURE 14: Import Missouri River Water to the Upper Sheyenne River								
Pipeline import to upper Sheyenne River	31.5	152.49	179.65	21.87	151.41	0.18	2.62	**181.78**
Pipeline import to upper Sheyenne River, reregulated in Lake Ashtabula	41.99	419.90	2267.46	0.00	0.00	0.00	0.00	**5.53**
FEATURE 15: Import via the Wild Rice River								
Import to Upper Red River only	49.3	275.16	315.68	0.00	0.00	4.24	31.36	**45.75**
W.Fargo storage shrtge remainig and New Industry5								
FEATURE 16: Import Missouri River water to the Upper Red River								
Import to Upper Red River only	49.3	275.16	315.68	0.00	0.00	4.24	31.36	**45.75**
W.Fargo storage shrtge remainig and New Industry5								
FEATURE 17: Provide Surface Water Connection for Rural Water Systems								
Surface water diversion for rural water systems	0.0	-6.88	-0.09	23.37	163.90	30.21	149.50	**361.52**
FEATURE 18: Import Missouri River water via Bismarck to Fargo Pipeline								
Pipeline from Bismarck to Fargo (83 cfs)	41.8	218.69	227.78	7.09	51.37	4.67	36.46	**133.65**
W.Fargo storage shrtge remainig and New Industry3,4,5								
Bismarck-Fargo pipeline with conservation demands (53.4 cf	39.7	220.89	240.36	9.88	57.88	4.00	27.75	**121.07**
Need to change to INCLUDE Moorhead								
FEATURE 19: Import Missouri River from McClusky Canal to Hillsboro area and re-distribute								
Pipeline import with tee near Hillsboro	53.4	303.58	355.90	0.00	0.14	0.19	2.80	**5.53**
(99.3 Shey Import, 30.3 Red Import)								
FEATURE 20: Import Missouri River water via Jamestown to Fargo pipeline								
Pipeline from Bismarck to Fargo (83 cfs)	41.8	218.69	227.78	7.09	51.37	4.67	36.46	**133.65**
FEATURE 21: Western Red River Valley Pipeline Distribution System for all Shortages								
Import to both Upper Red and Sheyenne Rivers	53.4	303.58	355.90	0.00	0.14	0.19	2.80	**5.53**