RECONNAISSANCE REPORT:

POTENTIAL WATER SUPPLY RESERVOIRS

CITY OF OSCEOLA & RURAL USERS

CLARKE COUNTY, IOWA

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

1991

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INTRODUCTION

In March 1988, the Soil Conservation Service (SCS) was requested by the soil and water conservation district commissioners from six districts to identify and present information concerning water and related land resource problems in the drainage area of Lake Red Rock. Consequently, a study of the Lake Red Rock Basin (LRRB) was initiated to provide a concentrated investigation of the uncontrolled drainage area upstream of Red Rock dam and reservoir. Particular concerns are flood damage, soil erosion, lack of water supply, inferior water quality, and sedimentation problems. Lack of adequate water supplies are primarily a result of uniformly poor quality aquifers, leaving much of the study area reliant upon impounding surface reservoirs. These reservoirs have been the major supply source for many communities over the past 50 years. Design of several of the impoundments underestimated sedimentation rates and did not fully consider effects of drought years. Inadequate supplies are anticipated for some rural municipalities, especially where water supply needs are increasing. 1/

One of these communities is the City of Osceola, Iowa. West Lake Reservoir, which currently supplies the City of Osceola and a small rural water district with agricultural, municipal, and industrial water, was originally constructed in the 1930s. The reservoir has a water supply withdrawal capacity of approximately 1,513 acre-feet (AF)/year based on two years of data during an extreme drought period, 1988-1989. Current water supply storage capacity of West Lake is 3,820 AF or about 2-1/2 years of water demand. This indicates that West Lake is just adequate in serving the supply demands of the Osceola area at the present time. Osceola's population, however, has been growing steadily over the past 20 years and the city has been successful in attracting new industry to the area. Future industrial development would greatly increase total water demand, especially wet process industries requiring large volumes of water. Osceola has requested the Soil Conservation Service, Water Resources Planning Staff, to investigate surface water impoundments for future municipal, industrial, and agricultural water storage. This reconnaissance report responds to this request by discussing opportunities at several structure sites in terms of water supply capabilities, structure design, and installation costs.

1/ LRRB - Draft Plan of Work, May 1, 1990, USDA, SCS & FS

SUMMARY

A preliminary engineering report entitled "Water Treatment Plan Improvements, Osceola, Iowa, 1990," by Howard R. Green Company, consulting engineers, provides projected water supply demands for Osceola and a rural water system in Clarke County. The current water supply is West Lake Reservoir, a 306 acre lake located one mile west of Osceola. Estimated volume of storage is 3,820 AF. The report also shows that West Lake's current water supply and withdrawal capacity cannot adequately serve the demands of the Osceola area in the year 2030. The Green report's projected water demand was used in this study to evaluate six alternative structure sites for their ability to supplement West Lake Reservoir. Four of the six sites were analyzed for total water supply capabilities should West Lake become unavailable as a water supply source. Categories of preliminary study SCS performed during this review were: hydrology/hydraulics, geology, cultural resources, engineering design, and cost estimates.

In order to project water demand for the design year of 2030, the current domestic and commercial use is calculated on a per capita basis and multiplied by the estimated population for Osceola in 2030. Future water demand for rural users is calculated based on all current potential rural users. Industrial usage is estimated to be about twice the current demand. Total future commercial, industrial, municipal, and rural demands are approximately 2,087 AF/year. Present available supply from West Lake of 1,513 AF/year shows a 574 AF/year deficit for the year 2030.

This SCS reconnaissance report includes data showing proposed earth dam design. Installation and maintenance costs were estimated for one design at four structure sites and for two designs at each of two other structure sites.

SITE DESCRIPTIONS

Six potential structure sites in Clarke County were studied. Three sites are located within the White Breast Creek Watershed and three sites are within the Squaw Creek Watershed. (See Exhibit #1). Other sites not studied may also be suitable.
+ larger sites

Site WB-1 is located in the SW1/4, Section 25, T72N, R26W, approximately 2 miles southwest of Osceola. Site WB-6 is located on North Hoosier Creek in the SE1/4 of Section 3, T71N, R25W. Site WB-7 is on Hoosier Creek in the SE1/4, Section 9, T71N, R25W. Both sites 6 and 7 are approximately five miles SE of Osceola.

Three sites on Squaw Creek are all in T73N, R26W. Site SQW-1 is located in SW 1/4, Section 32; Site SQW-2 is in SE 1/4, Section 20; and site SQW-3 is NW 1/4, Section 27. These sites are located west of Interstate 35 about seven miles NW of Osceola.

The sites are partially to heavily wooded and will require moderate to extensive clearing and grubbing in the construction area (which will increase construction costs). The abutments consist mostly of Pre-Illinioan glacial till which is suitable for fill material in the earth dams. The Alluvial soils of the valley floor will require foundation drains and relief wells to control seepage and piping.

Highway US 34 and Burlington Northern Railroad are located in the upper drainage area of site WB-1. Potential for hazardous material contamination resulting from accidental spills is quite high for this site. Highway US 69 is located in the upper drainage area of site WB-6. Both Interstate 35 and Highway US 69 pass through the drainage to WB-7. Potential for accidental contamination is not as great for WB-6 and WB-7 but is still present. The Burlington Northern railroad and the town of Murray are located on the watershed boundary of the Squaw Creek sites SQW-1, SQW-2, and SQW-3. Potential for accidental contamination at these three sites is present, but is less than for the other three sites. The sewage treatment facilities for Murray do not outlet into Squaw Creek.

DESIGN CONSIDERATIONS

a. Hydrology and Hydraulics

Each structure site's hydrologic characteristics were determined and used in this review. These include: drainage area, stage-area-volume data, soils classification and land use for computation of runoff curve numbers, channel slope and velocity of flow for determination of time of concentration, precipitation amounts as defined by procedures beginning on page 2-1 of Technical Release (TR) #60 and by data taken from Engineering Field Manual (EFM) Chapter 2. Sediment volume delivered to the sites for the design period was also determined.

Generally, hydrologic soil groups were similar for all six structure sites and were determined to have a large percentage of group D with some B's and C's indicating internal drainage characteristics are moderate to slow and runoff potential moderate to high. Projected future land use and treatment was estimated to be 35 percent contoured row crops, 25 percent contoured small grain, 25 percent contoured legumes or rotation meadow, 10 percent pasture and meadow, and 5 percent farmsteads. The runoff curve number for all six sites was computed to be 81 using EFM Chapter 2 procedures. Chapter 2 of the EFM was also used to estimate times of concentration for all sites which ranged from 1.9 to 3.6 hours. Drainage areas ranged from 4.3 square miles at WB-6 to 19.4 square miles at SQW-3.

Each site was assigned a hazard class based on potential consequences of dam failure. The SCS dam class and Iowa Department of Natural Resources (IDNR) hazard class are compared below:

SCS Dam Class	IDNR Hazard Class
a	Low
b	Moderate
c	High

All structure sites were assigned class "b" with the exception of WB-1, which was given a "c" classification largely due to the close proximity of Interstate Route 35 downstream.

Design rainfall was taken from EFM Chapter 2. The SCS TR-60 and IDNR TB16 Structure Hydrology criteria are met with the following design rainfall amounts:

Dam Class	Principal 1-Day	Principal 10-Day	Emergency 6-Hour	Freeboard 6-Hour
b	6.3	11.4	7.9	14.9
c	7.0	12.0	10.9	26.8

Two computer programs were used to analyze the hydrology of the structure sites. The first program was Structure Site Analysis, DAMS 2 from TR-48. This program develops inflow hydrographs and uses the stage-discharge-storage relationship at the structure site to flood route hydrographs through spillways. A few examples of the output generated by DAMS 2 are: drawdown time in days, the elevations of the emergency spillway crest, permanent pool, freeboard hydrograph, and the discharge at peak outflow in cfs. Output from DAMS2 is part of the input for the second computer program Reservoir Operation, RESOP, as described in TR-19. The RESOP used historic hydrologic data for the years 1950-1959 and 1966-1989 and computed a monthly water balance based on inflow, outflow, and reservoir storage. Inflow can be described as the runoff from the uncontrolled watershed plus rainfall on the reservoir water surface, plus spillage (if any) from upstream reservoirs. Outflow includes: seepage, evaporation, water supply demand, and spill. In this case "demand" is 574 AF per year for supplemental use, or 2,087 AF for total need, and is distributed by month as shown below. "Spill" is the volume passing through structure spillways to keep total volume in the reservoir from exceeding the storage at principal spillway elevation.

Demand Distribution by Month

Month	Percent	Supplement (AF)	Total (AF)
January	7.0	40.0	146.0
February	6.5	37.0	136.0
March	7.5	43.0	157.0
April	8.0	46.0	167.0
May	9.0	52.0	187.0
June	9.5	55.0	198.0
July	10.5	60.0	219.0
August	10.0	57.0	209.0
September	9.0	52.0	187.0
October	8.0	46.0	167.0
November	7.5	43.0	157.0
December	7.5	43.0	157.0
	100.0	574.0	2087.0

b. Geology

White Breast and Squaw Creek Watersheds are located in the Iowan Drift Plain region of Iowa. This area is characterized by incised valleys in Pre-Illinioan glacial till. Thin caps of loess may be present on the ridges or sideslopes. Till loess derived alluvium is present in the valleys and drainageways. Depth to bedrock varies widely in the watershed and in a few locations may outcrop at the surface. Bedrock consists of Pennsylvanian (Kansas City Group) formations. These formations include shale and limestone.

Preliminary investigation drilling in the watershed was done in 1976. Typical site materials consisted of glacial till in the abutments and alluvium on the floodplain. The till is generally a dense CL material, but may contain lenses of sand. These lenses are usually relatively small and/or discontinuous. Alluvial deposits contain a variety of materials including CL, CH, SC, and SM. Investigation of Site WB-1 encountered all of these materials. Bedrock (shale/limestone) was also located at approximately 6' - 7' below the channel bottom.

Although geologic conditions and materials in the watershed are generally favorable for the construction of structures, detailed investigation for specific sites will need to be done. Items that need to be addressed include specific foundation materials, depth to bedrock, the need for foundation drains, and potential borrow material. Foundation materials are important in determinations of settlement and slope stability. If bedrock is located near or at the surface, special considerations will need to be given in design. Foundation drains may be required if permeable material is encountered in the investigation. Glacial till on nearby ridges and alluvium from the pool area should provide adequate fill material. Amount and sources of sediment supplied to the site will also need to be addressed.

c. Cultural Resources

The state archeological files were examined to see if any cultural resources were known to exist in the vicinity of any of the planned reservoirs. One archeological site, 13CL23, is located near the structure site, WB-1. This archeological site may be high enough on the landscape so that it would not be affected by a reservoir, but this needs to be checked out before construction. None of the other structure sites had archeological sites recorded in their vicinity. The structure sites checked were WB-1, WB-6, WB-7, SQW-1, SQW-2, and SQW-3.

Should these reservoirs be constructed with federal involvement, the lead federal agency will be responsible for complying with federal cultural resource law. It is probable that more than this search of the state archeological files will be necessary for compliance with federal law.

d. Engineering

1. Earth Fill

The six sites studied will each have fill heights of approximately 50 feet. The cross sectional template (see exhibit #2) of the proposed fills will have 20 foot top widths, 3:1 side slopes (upstream and downstream), 30 foot rip-rapped wave protection berm at normal pool elevation, and 12 foot slope stability berm (20-25" below top of fill) on the downstream slope.

The valley abutments which are composed of glacial till will provide an adequate supply of fill material. The alluvial soils in the pool area will provide top dressing material for the earth dam and other areas disturbed by construction.

2. Foundation Drainage

The extent of foundation drainage will be determined from a detailed geologic investigation at each site. The preliminary geologic information available at this time indicates the alluvial deposits contain a variety of CL, CH, SC, and SM materials. The management of seepage and piping in these materials can be accomplished using trench drains and relief wells. Since bedrock was located 6-7 feet below the channel bottom at site WB-1, special geologic investigations will be required to determine the seepage problems through fractures in the limestone.

3. Principal Spillway

The principal spillway conduit will be Reinforced Concrete Pipe (RCP) placed on a cambered Reinforced Concrete (R/C) cradle with filter diaphragm and drain collar (See Exhibit #3). The inlet will be R/C flat top riser with a gate valve for controlling the drawdown conduit. A R/C impact basin is recommended for the conduit outlet. The RCP principal spillway has these advantages.

a. Simple design
b. Ease of construction
c. Less maintenance
d. Excellent flood control
e. Meets IDNR requirements.

4. Emergency Spillway

The emergency spillway will be a designed vegetated, open channel constructed around one end of the earth fill and will outlet at a distance downstream so that no damage will occur to the earthern dam. This design allows large runoff events to be safely conveyed downstream. Since this spillway will not be used frequently it can be protected by grass vegetation. Advantages are:

a. Hydraulic capacity
b. Efficient construction - generally the excavated earth can be used for embankment fill material.
c. Can accommodate roadways on top of fill.
d. Little or no armor necessary.

5. Drawdown facility

Fishery management and maintenance activities may require lowering the water surface of the reservoir. The drawdown conduit will be an RCP on an R/C cradle placed near the bottom of the pool and outlet into the flat top riser through a gate valve. Each site will have a conduit sized to fit the riser and principal spillway dimensions and will equal or exceed the IDNR drawdown criteria. The design life should be equal to the principal spillway.

e. Environmental Effects

Construction of any of the alternative sites will result in environmental changes. The site area will eliminate terrestrial wildlife habitat. All pool areas contain moderate to extensive areas of woody and grassy habitat that provides habitat for many species of wildlife, both game and non-game species.

The pool will also replace a minor stream fishery with a potentially good flatwater fishery.

The project may affect wetlands, both within and downstream of the pool area.

Should the city choose to construct one of these alternative sites with any federal assistance, either technical or financial, then the lead federal agency would be responsible for ensuring the project complies with all provision of the National Environmental Policy Act to minimize any adverse effects of the project.

ALTERNATIVES

a. Supplemental Water Supply

Osceola's current water supply source, West Lake Reservoir, has a withdrawal capacity of 1,513 AF/yr. Based on the projected demand for Osceola and rural water system of 2,087 AF/yr, a deficit of 574 AF/yr would exist if West Lake continued to be the only water source. In order to determine additional water storage necessary to provide 574 AF/yr a safety factor of 2.52 was used to calculate a total water storage requirement of 1,500 AF (574 x 2.52). The factor 2.52 was taken from the Green Company report as the ratio of water supply storage to annual withdrawal capacity of the existing system. Therefore, a new reservoir would be required to have a water supply storage volume of 1,500 AF as a supplemental water supply to West Lake Reservoir.

A review of the computer output for all six structure sites shows that all sites would be adequate supplemental water sources. Only two of the six sites, WB-6 and WB-7, had difficulty supplying 574 AF/yr during the extreme drought periods simulated in the RESOP program for the years 1956-1959. It should be mentioned that no water conservation methods were incorporated into the program for the dry periods and, therefore, describe a situation which would be much more severe than a true circumstance which includes water rationing or some other methods of conservation. The remaining four sites, WB-1, SQW-1, SQW-2, and SQW-3 were all able to sufficiently supply 574 AF/yr through the drought periods and with no conservation methods.

b. Total Water Supply

Projected water supply demand of 2,087 AF/yr with a safety factor of 2.52 produces a total water storage requirement of 5,259 AF. The four structure sites which had no deficiencies when analyzed for supplemental capabilities, were evaluated as possible sites for total water supply sources. WB-1 was the only site of the four which would not store 5,259 AF because of physical restraints. It could, however, store 3,472 AF which is 1.7 times the total demand of 2,087 AF/yr. The other three sites, SQW-1, SQW-2, and SQW-3 could store 5,259 AF and would serve as adequate water supply sources for total future demands.

COSTS

a. <u>Material Unit</u>

Unit costs for components of these structures were developed from bid abstracts of Iowa structures contracted in 1988, 1989, and 1990.

The following conditions were considered:

1. Fill material would be readily available.
2. Reinforced concrete quantities would be greater than 50 cubic yards.
3. RCP costs obtained from manufactures.

b. <u>Installation</u>

Fifteen percent contingency was added to the construction cost to cover unforeseen expenses.

Thirty percent was added for engineering and administrative costs.

Land rights costs are based upon a land purchase area of twice the normal pool area (ac) times an estimated $500 per acre.

c. <u>Operation, Maintenance, and Replacement</u>

Operation, maintenance, and replacement (OMR) costs should be considered. These are the costs of materials, equipment, services and facilities needed to operate the dam and lake, make necessary repairs and replacements to maintain the structural measures in sound operating conditions during the life of project. Included are the costs for repairs, replacements, or additions, and an appropriate charge for inspection, engineering, supervision, and general overhead. These costs will be a continuing responsibility of the Osceola Water Board.

In Iowa the SCS estimates OMR to be 0.35 percent of construction cost plus a $200 lump-sum estimate for annual on-site inspection. In addition, periodic inspection by a professional engineer will be necessary.

The expected OMR costs for these alternatives would be $2350-$5500 per year. These funds should be placed in a sinking fund annually for use when needs arise.

COMPARISON DATA

Site	Drainage Area (ac)	Pool Surface Area (ac)	Available Water Supply	Annual Supplemental Demand	Total Annual Demand	Installation 3/ Cost ($1000)	Annual OM&R ($)
WB-1	9,220	235	2275 AF 1/ 742 mg 2/	1500 AF 489 mg		1,366	3250
WB-1	9,220	360	4250 AF 1385 mg		5259 AF 1714 mg	1,670	3700
WB-6	2,750	140	1986 AF 647 mg	1500 AF 489 mg		1,180	3000
WB-7	4,630	~~100~~ 60	2090 AF 681 mg	1500 AF 489 mg		955	2350
SQW-1	6,190	190	2202 AF 718 mg	1500 AF 489 mg		1,082	2650
SQW-2	8,900	400	2510 AF 818 mg	1500 AF 489 mg		1,636	3550
SQW-3	12,420	255	2908 AF 948 mg	1500 AF 489 mg		1,770	4200
SQW-3	12,420	650	10,000 AF 3259 mg		5,259 AF 1714 mg	2,610	5500

1/ AF = acre-feet
2/ mg = million gallons
3/ Does not include raw water intake or transmission lines

RECOMMENDATIONS

General

1. Use earthfill template similar to Exhibit #2.
2. For principal spillways use RCP on a cambered R/C cradle with filter diaphragm and drain collar.
3. For principal spillway outlet use R/C impact basin.
4. Use R/C flat top riser for the inlet of principal spillway equipped with a gate valve.
5. For drawdown conduit use RCP on a R/C cradle laid near the reservoir bottom and outlet through the gate valve into the riser.
6. For the emergency spillway use a designed vegetated earthen spillway.
7. A detailed geologic investigation should be made for the earth fill foundation and emergency spillway.
8. A detailed breach routing should be made downstream to define effects of a dam failure.
9. Develop a plan to prevent construction of new homes in the breach flood area.
10. A detailed estimate of sediment delivery to the lake should be made to determine sediment storage.
11. Develop an aggressive plan to identify and control erosion on the crop and pasture land in the watershed land area above the water supply pool.
12. Considerations must be given to the environmental and cultural resource areas.
13. Considerations must be given to potential sites having minimum exposure to contamination (railroads, highway accidents). Sites in Squaw Creek may have the lowest potential for contamination.
14. Site SQW-3 is most satisfactory for water storage to meet total future needs.
15. For supplemental water supply all six sites would be adequate.
16. Site WB-6 would be the most susceptable to shortage during extreme droughts.

LIST OF PREPARERS

This reconnaissance report was prepared by an interdisciplinary team composed of the following specialists, Soil Conservation Service, Iowa:

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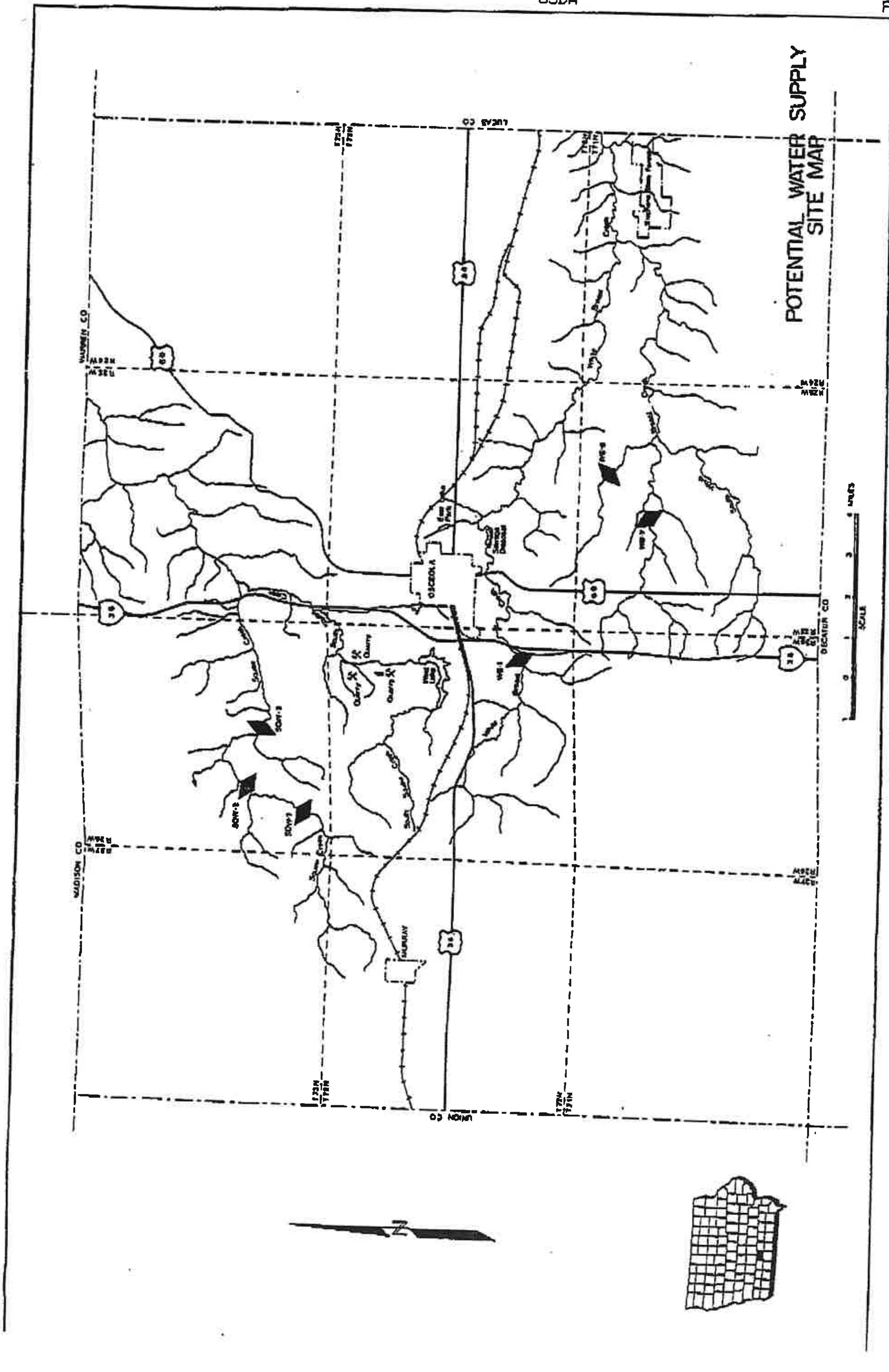
POTENTIAL WATER SUPPLY
SITE MAP
EXHIBIT I
LUCAS CO
UNION CO
WARREN CO
MADISON CO
DECATUR CO
OSCEOLA
MURRAY
SCALE