BIG STONE LAKE 319

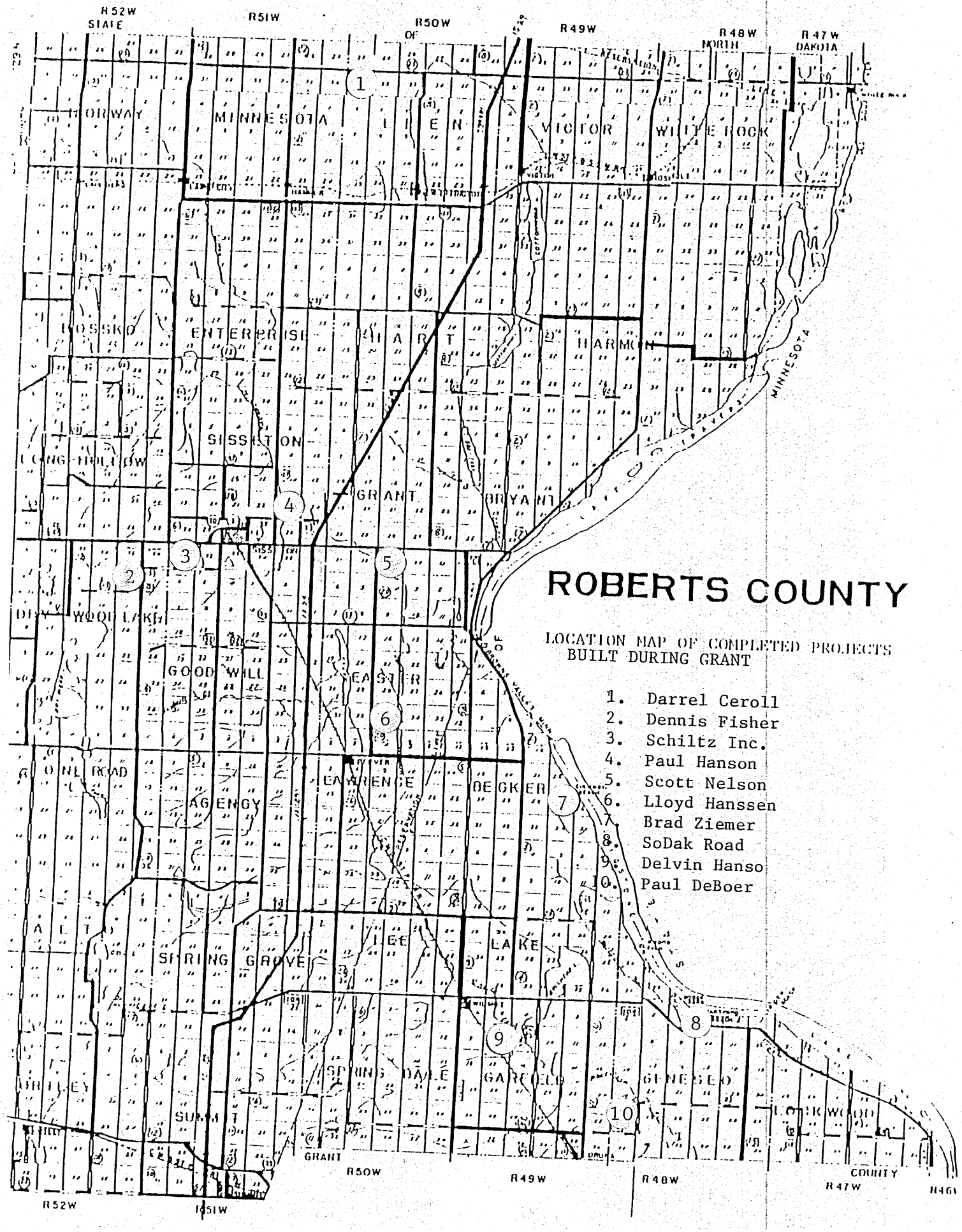
FINAL REPORT

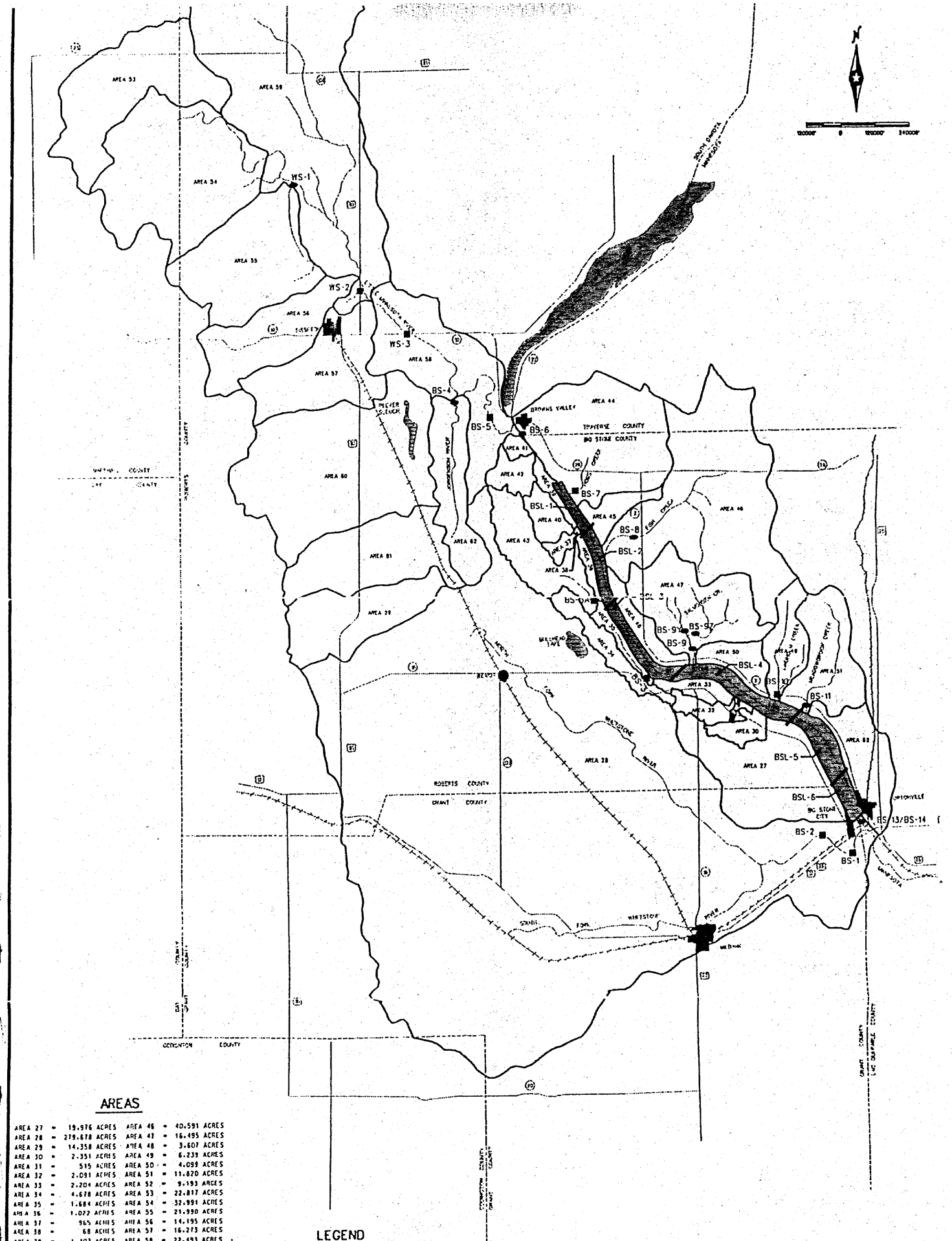
#C9008522-89

START-UP SEPTEMBER 5, 1989

END DECEMBER 30, 1992

Prepared by: Roberts County
&
SD Department of Environment &
Natural Resources


R52W
STATE
R51W
R50W
OF
R49W
R48W
NORTH
R47W
DAKOTA
MINNESOTA
ROBERTS COUNTY
LOCATION MAP OF COMPLETED PROJECTS
BUILT DURING GRANT
1. Darrel Ceroll
2. Dennis Fisher
3. Schiltz Inc.
4. Paul Hanson
5. Scott Nelson
6. Lloyd Hanssen
7. Brad Ziemer
8. SoDak Road
9. Delvin Hanso
10. Paul DeBoer
GRANT
R50W
R49W
R48W
R47W
COUNTY
R52W
R51W



AREAS

AREA 27 =	19,976 ACRES	AREA 46 =	40,591 ACRES
AREA 28 =	279,678 ACRES	AREA 47 =	16,495 ACRES
AREA 29 =	14,358 ACRES	AREA 48 =	3,607 ACRES
AREA 30 =	2,351 ACRES	AREA 49 =	6,239 ACRES
AREA 31 =	515 ACRES	AREA 50 =	4,099 ACRES
AREA 32 =	2,091 ACRES	AREA 51 =	11,820 ACRES
AREA 33 =	2,204 ACRES	AREA 52 =	9,193 ACRES
AREA 34 =	4,678 ACRES	AREA 53 =	22,817 ACRES
AREA 35 =	1,684 ACRES	AREA 54 =	32,991 ACRES
AREA 36 =	1,022 ACRES	AREA 55 =	21,990 ACRES
AREA 37 =	965 ACRES	AREA 56 =	14,195 ACRES
AREA 38 =	68 ACRES	AREA 57 =	16,273 ACRES
AREA 39 =	1,303 ACRES	AREA 58 =	22,493 ACRES
AREA 40 =	2,949 ACRES	AREA 59 =	69,941 ACRES
AREA 41 =	911 ACRES	AREA 60 =	42,045 ACRES
AREA 42 =	2,864 ACRES	AREA 61 =	11,212 ACRES
AREA 43 =	9,595 ACRES	AREA 62 =	11,599 ACRES
AREA 44 =	25,608 ACRES		
AREA 45 =	3237 ACRES	TOTAL =	790,151 ACRES

LEGEND

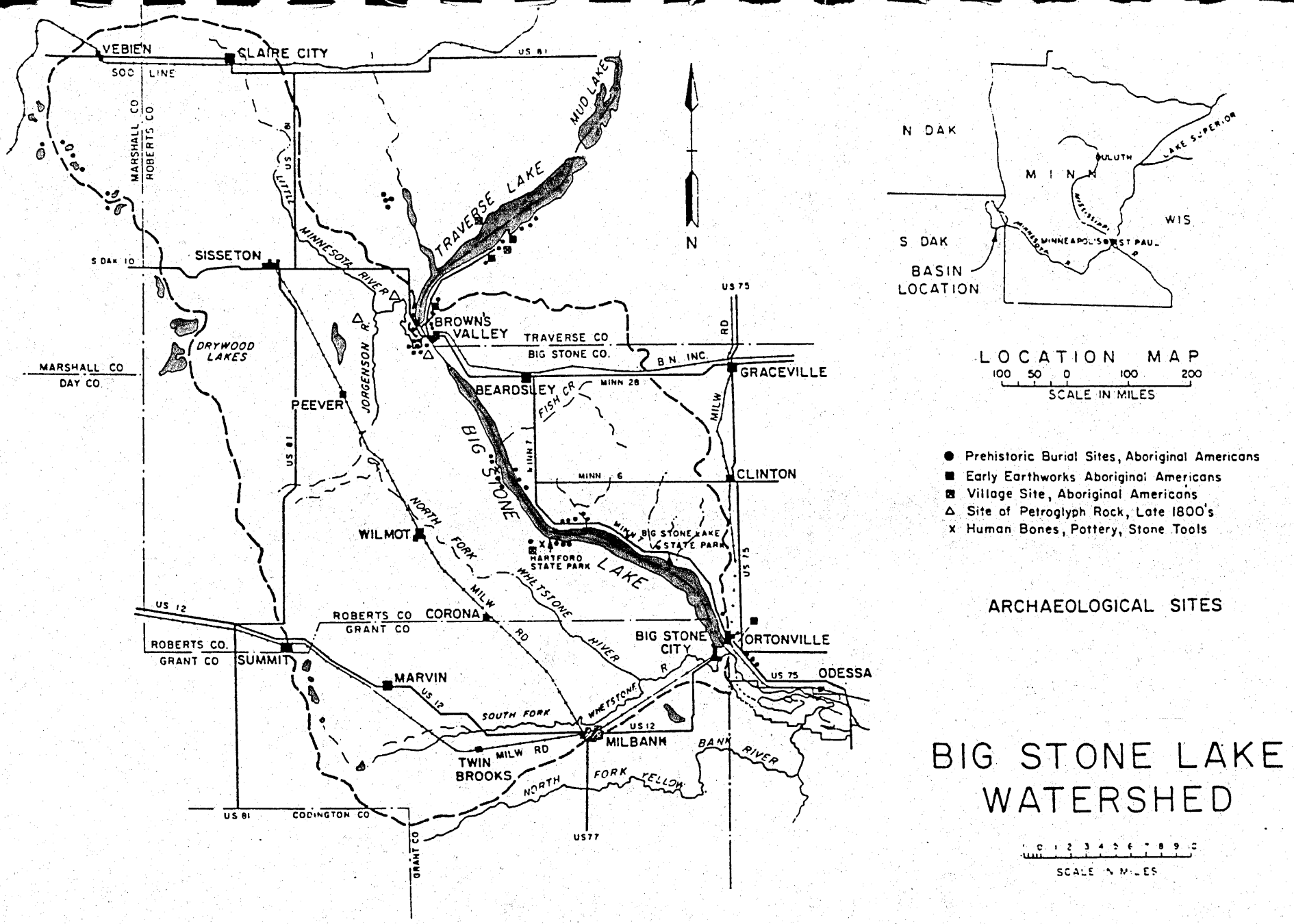
- PAST OR INACTIVE STREAM MONITORING LOCATION
- PRESENT STREAM MONITORING LOCATION
- LAKE MONITORING LOCATION

BIG STONE LAKE WATERSHED AND MONITORING LOCATIONS

Date 5/92

Figure F-1

Table of Contents



Big Stone Lake Watershed - Archaeological Sites

INTRODUCTION:

Big Stone Lake is an 12,610 acre interstate body of water bordering Minnesota and South Dakota (Figure 1a). Its 740,157 acre watershed includes portions of Roberts, Grant and Marshall Counties in South Dakota, and Big Stone and Traverse Counties in Minnesota. The principal tributaries to Big Stone Lake include the Whetstone River which enters the lake from the southwest near the lake's outlet and the Little Minnesota River which lies northwest of the lake and empties into its upper end.

Physical Lake Characteristics Are:

Lake length, miles	25.8
Maximum width, miles	1.3
Surface area, acres	12,610
Volume, acre-feet	98,880
Maximum depth, feet	16
Mean depth, feet	8
Shoreline length, miles	59.9
Watershed area, acres	740,157

GEOLOGIC HISTORY AND ORIGIN OF THE LAKE:

Big Stone Lake lies in the valley of a former glacial river which drained Lake Agassiz. Lake Agassiz was a large glacial lake which covered most of eastern North Dakota, northwestern Minnesota and a small part of northeastern South Dakota during the ice-age that

ended about 8000 years ago. During an early stage of development, the melt-water from glacial ice was ponded in Lake Agassiz by a ridge of ice and rock materials (a moraine) located along the lower end of the present Lake Traverse. As the ice in the ridge melted, the ponded melt-waters began to drain southward from Lake Agassiz, eroding a channel through the glacial sand and gravel deposits. The drainage waters increased in flow and eventually a large river, glacial River Warren, formed a wide deep valley which extended from the foot of what is now Lake Traverse through much of south-central Minnesota. Eventually, the direction of flow from glacial Lake Agassiz reversed, and the lake was drained northward along the present Red River. Following the glacial drainage, the Whetstone River carried large amounts of sediments in the valley of the Minnesota River near the present site of Big Stone City, South Dakota and Ortonville, Minnesota. The sediments formed a delta and a natural dam which retarded the flows of streams and runoff from lands above the delta and created Big Stone Lake in the valley above the mouth of the Whetstone River.

PROJECT OBJECTIVE:

Big Stone Lake is a hypereutrophic lake which experiences excessive algal blooms, over abundance of rooted vegetation and excessive sedimentation. The Big Stone Lake Restoration Project is a multifaceted implementation effort designed to control sources of pollution to the lake and reduce existing levels of pollution in the lake. The overall objective of the restoration

effort was to increase the recreation potential and lifespan of Big Stone Lake. Major goals included a reduction of both density and duration of algae blooms, limitation of aquatic macrophytes, and a reduction of sedimentation and phosphorus loadings.

PROJECT HISTORY:

Restoration activities which were implemented before the 319 Grant period included a Phase I Diagnostic/Feasibility Study and a Phase II. Step I Work Plan. Both Phase I and Phase II past activities were funded in part by Section 314 Clean Lakes grants. A major component of the Phase I study was water quality sampling of the lake and tributaries flowing into the lake. Another major component was the compilation of historical information on lake water quality and lake usage. The results of these evaluations concluded that both water quality and usage of the lake were declining. The Phase I study also determined that the factor having the most detrimental effect on lake water quality was runoff from agricultural land in the watershed. This included contributions from livestock feedlots as well as other general agricultural runoff.

Due to the enormity of problems experienced by Big Stone Lake and limitations imposed on the restoration project by funding constraints, the project was developed to proceed in a step-wise manner. The following program elements were recommended based on the Phase I Diagnostic/Feasibility Study:

1. Whetstone River Flow Management

2. Lake Level Management
3. Feedlot Management
4. Watershed Management
5. Phase II Monitoring Program
6. Public Involvement

IMPLEMENTATION OF GRANT #C9008522-89:

Implementation of the Phase II Step II Big Stone Lake 319 Workplan #C9008522-89 began September 5, 1989. This funding allowed for the continued restoration of the Big Stone Lake Restoration Project. Funds were exhausted December 30, 1992. Significant progress has been achieved during this grant period. An update of past accomplishments and progress during this period will be discussed in detail in the following report.

WATERSHED PROJECT TEAM:

On February 5, 1990, Roberts County Commissioners entered into an agreement with South Dakota Department of Environment and Natural Resources (DENR) by which the county became the official local sponsor of the Big Stone Lake Restoration Project. The Roberts County Commissioners have further delegated the project's responsibilities to the Roberts Conservation District. South Dakota's Watershed Team consisted of four positions:

1. South Dakota Co-Director
2. Water Quality Analyst
3. Secretary
4. SCS Technician

The office for the watershed team was located in the Federal Building in Sisseton, South Dakota. All team members carried out their responsibilities as set forth in the 319 Workplan. On January of 1992, the position of the Water Quality Analyst was terminated and the position's responsibilities were assumed by the Co-Director. This was done in an effort to improve staff efficiency and extend the present available funds until other funds could be obtained to continue the Big Stone Lake Restoration Project. Total personnel expenses incurred during the 319 Grant period, including salary and benefits, were $127,288. For further break-down on personnel expenses and other related administration project expenses, refer to Appendix A.

WHETSTONE RIVER FLOW MANAGEMENT:

During the first four years of the Phase II implementation of the project (1985-1988), a new control structure was constructed at the south end of the lake where the Whetstone River enters Big Stone Lake. Although this project was funded by a combination of funds other than 319 Grant funds, recommendations to implement this project were based on the US Army Corps of Engineers Feasibility Report, 1975 and South Dakota Department of Environment and Natural Resource Phase I Diagnostic/Feasibility Study, 1983.

The objective of Whetstone River Flow Management was reduction in the loadings of sediment and nutrients to Big Stone Lake from the Whetstone River. The Whetstone River has a 279,678 acre watershed

that flows into the lower end of the lake. Water quality monitoring data from the Phase I Study (DENR, 1983) indicated that the water quality in the Whetstone River was the poorest in the Big Stone Lake watershed. Both sediment and nutrient loads in the Whetstone River were excessive. One of the purposes of the control structure was to divert 80 percent of the flow of the Whetstone River away from the lake into the Minnesota River. This was done in an attempt to keep the large loads of sediment and nutrients out of Big Stone Lake. In addition to the new control structure, a silt barrier located where the Whetstone River enters the lake was raised by one foot, and a debris barrier was constructed just upstream from the new control structure to prevent debris from entering the lake or plugging the control structure. The completion of these projects have allowed for improved control of Whetstone River flows and thus nutrient and sediment loadings into Big Stone Lake.

The Whetstone River flow management was a continued ongoing activity during the period of the 319 Workplan. The South Dakota watershed team provided technical assistance as needed. The actual operation of the control structure was the delegated responsibility of the Minnesota Co-Director under the guidance of the Upper Minnesota River Watershed District.

Lake Farley:

Lake Farley is a small man-made lake on the South Fork of the Whetstone River near Milbank, South Dakota. Lake Farley receives

runoff from a 75 square mile watershed and serves as a sediment basin for the Whetstone River and ultimately Big Stone Lake. Over the years, Lake Farley filled in with silt and became ineffective. In the spring of 1985, because of unsafe dam conditions, the control structure for Lake Farley was breached. Local and state efforts to reestablish Lake Farley before this grant period included 100,000 cubic yards of sediment removal from the basin with land-based equipment and strengthening of the earthen dam structure. A feasibility study conducted during this grant period by the Milbank's city consultant concluded that the existing spillway was not repairable. Two spillways alternatives were evaluated. The first alternative was a chute spillway, similar to the existing spillway, with a cost estimate of $494,000. The second alternative was a free overfall spillway estimated to cost $287,000. Based on cost, the City's consultant has recommended that the existing spillway should be replaced with a free overfall spillway. Replacement and construction of the free overfall spillway depends on the success of obtaining further funding assistance. During this grant period, the watershed team provided technical assistance.

LAKE LEVEL MANAGEMENT:

The objective of lake level management was to decrease bank erosion and increase the export of in-lake nutrients for improved water quality within Big Stone Lake. The level of Big Stone Lake has been set by the Minnesota and South Dakota legislatures at 964.6 ft. mean sea level. This level is regulated by the

Minnesota/South Dakota Boundary Waters Commission, which granted the Minnesota Department of Natural Resources (DNR) the authority to issue operational instructions for the control structure. Minnesota Department of Natural Resources has further delegated the actual operation of the control structure to Minnesota's Big Stone Lake Restoration Project Co-director under the guidance of the Upper Minnesota River Watershed District. Lake level management continued to be an ongoing activity during the period of the proposed 319 Workplan. South Dakota's watershed team provided technical assistance in the form of monitoring the Big Stone Lake's watersheds and all major tributaries flowing into the lake.

FEEDLOT POLLUTION CONTROL:

The Phase I study determined that 88% of the phosphorus having the most detrimental effect on lake water quality was runoff from agricultural land in the watershed. This included contributions from livestock feedlots as well as other general agricultural runoff. It was also determined that 20 percent of this phosphorus was derived from feedlot operations. To identify and prioritize potential problem feedlots, a "Feedlot Rating Model" developed by Young, Otterby and Roos (1982) was used. If a feedlot operation received a index number greater than 50, the operator was advised of the potential pollution problem, and what steps were needed to rectify the problem. During this grant period, $320,009 was spent to correct non-conforming feedlot operations. A summary of allocated project monies and location of completed projects is

located in Appendix B. Further discussions on feedlot pollution control progress will be covered by sub-watersheds.

Whetstone Watershed:

The Whetstone Watershed drains a watershed of 279,678 acres. Water quality monitoring data from the Phase I Study (DENR, 1983) indicated that the water quality in the Whetstone River is the poorest in the Big Stone Lake watershed. For this reason the Whetstone watershed had been the focus of most of the animal waste management systems (AWMS's) and best management practices (BMP's) implementations at the beginning of the project, 1985-1988. As of 1988, twelve animal waste management systems (AWMS's) had been constructed in the Whetstone River watershed. During the Phase II Step II Workplan, two additional AWMS's were constructed.

Delvin Hanson's AWMS project is located in Roberts County adjacent to the North Fork of the Whetstone River. This system was designed to contain the sediment and nutrients of a 910-head hog, 20-head sheep and 80-head fat cattle operation. The project's "Feedlot Rating", using Feedlot Rating Model developed by Young, Oterby, and Roos (1982), was 57. This operation produced 2905 tons of waste per year. Based on this production, an estimated 27,298 lbs. of phosphorus was contained to the feedlot yard and AWMS. Total project costs upon completion were $48,392.

Paul DeBoer's AWMS was also located in Roberts County adjacent to the North Fork of the Whetstone River. The Deboer's project

contained the sediment and nutrients of 150-dairy cows, 240-dairy yearlings and 140-dairy calves. Using the "Feedlot Rating Model", this feedlot rated an 84. This operation produced 5417 tons of waste per year. Based on this production, an estimated 21,668 lbs of phosphorus is contained to the feedlot yard and AWMS. Total project costs were $46,416.

Although a number of problem feedlots still remained in the Whetstone Watershed, because of the work completed, the diversion of 80 percent of peak flows of the Whetstone River by a new control structure in particular, focus of the project was shifted during the Phase II Step II Workplan to the Little Minnesota River watershed.

Little Minnesota & Adjacent Lake Shore Watershed:
The Little Minnesota drains the largest subwatershed area of any tributary in the Big Stone Lake watershed (286,414 acres). Because of completion of the new control structure which diverted 80 percent of the Whetstone River, the Little Minnesota River remains the largest pollution source to Big Stone Lake. Water quality monitoring data from the Phase I Study (DENR, 1983) and HDR Engineering Inc. report (1992) indicated that the Little Minnesota River contributes 48.9 percent of Big Stone Lake's phosphorus budget during normal years. The nutrients and sediment discharged from the Little Minnesota River watershed have maximum detrimental effects since they are the largest in quantity, and also have the potential to flow through the total length of the

lake. For this reason, the Little Minnesota watershed was the focus of the Phase II Step II Workplan. During the Phase II workplan, the staff identified 135 feedlots in the Little Minnesota & Adjacent Lake Shore watershed and rated them using the Feedlot Rating Model developed by Young, Oterby, and Roos (1982). Each feedlot was assigned a numerical index number with a number of 100 being the worst problem down to 0 or no problems. Sixty-three feedlots in the watershed indexed greater than 50. Project goals were to address all feedlots which have a problematic number greater than 50. As of 1988, five animal waste management systems (AWMS's) had been constructed in the Little Minnesota & adjacent watershed. During the Phase II Step II Workplan, seven additional AWMS's were completed. The seven completed AWMS's during the Phase II Step II Workplan contain the feedlot nutrient and sediment runoff of an estimated 2085 animal units from entering tributaries of Big Stone Lake. Sizes of the projects varied from a 40,000-flock goose farm, to a 130-sow herd which was located on the shore of Big Stone Lake. A cost-analysis of these projects is located in Appendix B. A brief narrative will follow on the seven completed AWMS's in the Little Minnesota watershed:

Darrell Ceroll's Animal Waste Management System (AWMS) was designed to contain the sediment and nutrients of 80-1050 pound dairy cows, 80-500 pound calves and 45-1150 pound stock cows. Total construction costs for this project were $28,146.

Dennis Fisher's project is located adjacent to a tributary of the Little Minnesota River. The Fisher's project had a "Feed Lot Rating" index number of 56. This project was designed to control lot runoff and collect wastes from 75-1100 pound beef cows and 100-500 pound calves. Waste production storage is designed for 984 tons. Total construction costs were $36,814.

The Brad Ziemer's project had a "Feedlot Rating" potential index number of 83. Due to the location of the feedlot, on the shore of Big Stone Lake, and its high index number, the project had been designated a priority project. The Animal Waste Management System (AWMS) is designed to contain the waste of 136-bred sows. Due to the location of the lake and high water tables, this project was designed as a concrete holding tank. All animals on this farm are now in total confinement. Total project costs were $18,137.

The Schiltz's Goose Farm had a "Feedlot Rating" potential index number of 83. Due the size of this operation, 40,000 Geese, and its location adjacent to a tributary of the Little Minnesota River, this feedlot was also designated a priority project. The feedlot operation is now totally contained. Total project costs were $102,478.

Scott Nelson's project had a "Feedlot Rating" index number of 70. This project was designed to contain the nutrients of 125-900 pound beef cows, and 125-400 pound calves. The Nelson's project was located adjacent to the Little Minnesota River. Total project

construction costs were $13,942. No 319 Grant funds were used to cost-share this project. This project was cost-shared by using a Long Term Agreement (LTA) ASCS fund. The watershed staff provided technical help for this project.

Lloyd Hanssen's project had a "Feedlot Rating" index of 69. The project was located near the Jorgenson River which is a tributary of the Little Minnesota River. This project contained the nutrients of 100-1300 pound dairy cows, 25-800 pound dairy yearlings, and 25-400 pound dairy calves. The Hanssen's project was cost-shared by 319 Grant and LTA funds. Total project costs were $23,681.

Paul Hanson's project is located with a tributary of the Little Minnesota River flowing through the feedlot. The "Feedlot Rating" index was 67. The project contains the nutrients of 125-1,400 pound dairy cows and 16-dairy calves with an average weight of 115 pounds. Total project costs were $32,641. It should be noted that during this project, 319 Grant funds were exhausted. It is for this reason that only $2002 of the total costs, $32,641 were cost-shared.

During this Grant Period, $320,009 was spent in both watersheds for construction of nine Animal Waste Management Systems. Fifty-one feedlots in the Little Minnesota and adjacent watershed remain with potential pollution problems. These remaining feedlots will be addressed as cost-share funds become available.

WATERSHED MANAGEMENT:

The implementation of Best Management Practices (BMP's) were encouraged and promoted by the watershed team of the Big Stone Lake Restoration Project. Cost-share funding was made available for BMP implementation mainly through the Agricultural Conservation Program (ACP). Technical assistance and support were provided to SCS for BMP implementation. The following BMP's were promoted in the Big Stone Watershed:

1. Conservation Reserve Program
2. No-till farming practices
3. Conservation tillage
4. Crop residue management
5. Grass waterways
6. Stream channel & road erosion control

Conservation Reserve Program:

The most popular and widely accepted best management practice (BMP) in the Big Stone Lake watershed was the Conservation Reserve Program (CRP). A total of 21,722 acres were enrolled in the watershed. Of this total, 15,853 acres were located in the Little Minnesota River watershed. Many of the CRP acres were located adjacent to tributaries or drainage areas of the Big Stone Lake and act to reduce soil erosion and filter runoff from surrounding watershed acres. A map showing the location of Conservation Reserve Program acres within Roberts County's Big Stone Lake watershed is located in Appendix C.

No-Till Farming Practices:

The Corps of Engineers 1975 Big Stone Lake Feasibility Report concluded that 55% of the phosphorus entering the Big Stone Lake was derived from land runoff. In an effort to address this problem, a "Cost-Share Project" to promote the practices of No-Till and Minimum Tillage was promoted from 1982-1987. During that time, 63 operators No-Tilled 4,578 acres in Big Stone Lake's watershed. This project was funded by Special ACP funds and discontinued when these funds became exhausted.

In the fall of 1992, due to improvements made in available No-Till equipment and changes in the present economic climate of farming, a No-Till project was again promoted in the Big Stone Lake watershed. Roberts Conservation District, entered into an agreement with John Deere & Company to sub-lease two No-Till drills to area operators. In an effort to ensure better success and to promote acceptance of reduced tillage, a "Residue Tillage Plot Project" will be used for education and information during 1993 and 1994. This plot will compare conventional tillage, minimum tillage, and no-till practices. The plot will also demonstrate the different tillage practices and their effect on residue management. Project staff have provided technical and educational assistance as needed to implement this project.

Multi-Purpose Dams:

The multi-purpose dam project is a inter-agency cooperative effort consisting of US Fish & Wildlife, Ducks Unlimited, Robert

Conservation District, ASCS, SCS, Citizens for Big Stone Lake, and the Big Stone Lake Restoration Project. The multi-purpose dam projects are located in selected areas for the purpose of decreasing the amount of sediment and nutrients entering tributaries which enter the Big Stone Lake, improving range land management by better water distribution, and providing better habitat for wildlife. Twenty multi-purpose dam projects, which cost $60,001, were completed in the Big Stone Lake watershed during this Grant Period. Although no 319 Project Grant funds were committed to this project, the watershed team provided technical and educational assistance as needed to insure adequate participation.

Complimentary Projects:

Access Road Erosion Control:

The objective of access road erosion control was to reduce or eliminate roadside erosion to Big Stone Lake. The specific goal of the Access Road Erosion Control Project was to identify the most severe sediment hazards created by inadequate drainage along lake access roads. Because of the close proximity of the problem areas to the lake, they sometimes had a greater affect on water quality than areas of erosion further away from the lake. These problem sites appeared mostly in road ditches with slopes greater than 6 percent. Four access roads in Roberts County were identified in 1986 as having significant sediment hazards to the Big Stone Lake.

The Minnehaha Cove and Hiawatha Beach projects were completed during the Phase II Step I Workplan. The Minnehaha Cove road had severe erosion in a down-hill ditch. Project staff, SCS engineers, and Lake Township officers installed a low dike within the ditch and a 15" culvert so flows were diverted into a ravine with heavy vegetation.

The Hiawatha Beach road also had a severely eroded ditch on the right down hill side of the road. Again project staff, SCS engineers, and Lake Township officers implemented a project of placing Class 2 riprap in the ditch. No further visible erosion has occurred to date.

The SoDak Park Road project was completed during this Grant Period. The original SoDak Park road, had a slope of greater than 6 percent. This resulted in significant sediments and nutrients being deposited in Big Stone Lake. In 1991, the project staff, and Lake Township officers implemented a project to abandon the original road and constructed a new road with diversion barriers and culverts to divert rain water. The new road also had measures taken in which to decrease the slope of the road. The SoDak Park Road project was funded with a combination of Phase II Step II Grant, County, and local funds. Total project costs were $31,054, Appendix B.

To date, no projects have been implemented on the Hartford Beach Park road. The road is no longer being used and has started to

revegetate. Unless use of the road is resumed, project staff consider the problem solved.

POINT SOURCES OF POLLUTION IN THE LITTLE MINNESOTA RIVER:

Historic water quality data indicated that city wastewater treatment facilities contributed an estimated 20 percent of the total phosphorus budget in the Little Minnesota River. A number of municipal wastewater treatment facilities were completed since implementation of the Big Stone Lake Restoration Project. These new wastewater treatment facilities are located on the Little Minnesota River and were designed for zero discharge. Although no 319 Grant funds were used directly in these projects, technical help was provided as needed. The construction of the following wastewater treatment facilities have reduce the loadings of phosphorus in the Little Minnesota River and thus Big Stone Lake.

Browns Valley Wastewater Treatment Facility:
The Browns Valley Wastewater Treatment Facility was completed during the fourth quarter of 1989. The new facility consists of improved wastewater lagoons which were incorporated with a crop irrigation system. With the completion of this system, wastewater is no longer being discharged into the Little Minnesota River and Big Stone Lake.

Sisseton Wastewater Treatment Facility:

Improvements to the Sisseton Wastewater Treatment Facility were also completed during the fourth quarter of 1989. Additional lagoon capacity consisting of twelve ponds covering 248.3 acres was added to the system. The new system will utilize treatment in the lagoons followed by evapotranspiration in the newly created wetland area. Consequently there are no discharges of wastewater from the City of Sisseton entering the Little Minnesota River and Big Stone Lake.

Veblen Wastewater Treatment Facility:

Improvements to the Veblen Wastewater Treatment Facility were completed during the fourth quarter of 1992. The old treatment site was abandoned and a new enlarged wastewater treatment facility was constructed. The new treatment facility was designed to allow for more evapotranspiration and thus eliminate or minimize the need for future discharges into the Little Minnesota River and Big Stone Lake. Due to the completion date of this project, the impact of this project on phosphorus loadings are not reflected in 1992 Little Minnesota River data.

Peever Wastewater Treatment Facility:

A bid has been approved for the improvement of Peever's Wastewater Treatment Facility. However, due to the inclement weather experienced during 1992, construction was not started. This project is located on the Jorgenson River, a tributary of the Little Minnesota River. Construction should be realized in 1993.

This project was designed so that the City of Peever should have zero discharges in the future.

No other point sources of pollution have been identified in the Little Minnesota watershed at this time.

PUBLIC INVOLVEMENT:

In order to keep the various agencies and public informed of project progress, an Information and Education program was conducted by the Watershed Team. One of the functions of the project was to educate farm and ranch operators in the watershed of the various BMP's needed and available cost-share funds to implement those BMP's. To accomplish this, the following activities were completed by the Watershed Team:

Quarterly reports were distributed to local governments and private groups involved in the project. These reports assessed progress or lack of progress of the many different projects and summarized the monitoring project data. At the end of the year, a summary of the years activities was distributed as a annual report to all interested individuals.

The Watershed Team in cooperation with the Citizens for Big Stone Lake Association produced a newsletter for distribution to landowners and individuals interested in the Big Stone Lake Restoration Project. The newsletters generally summarized the

quarterly reports and included other information which was pertinent to the lake's watershed.

The Watershed Team participated in radio talk shows at KDIO, KBWS and KMSD radio stations. These shows were used to inform area listeners of watershed regulations and Big Stone Lake Restoration Project's progress.

An estimated 150 articles on the Big Stone Lake and its watershed have been published in area newspapers and magazines. Some articles were written by project staff, with the remaining written by reporters from interviews with project staff. These interviews were given for the purpose of informing the public of events of interest concerning the project.

Each year three Farm Shows were held in the Big Stone Lake's watershed. Project staff were present at these events for public exposure, to answer pertinent watershed questions, and distribute maps of the Big Stone Lake and other related information.

The staff have also been involved in providing technical assistance and support to other agencies for BMP promotion and implementation. Due to SCS's BMP watershed goals and Big Stone Lake Restoration Project's BMP goals for the improvement of the lake are similar, a close working relationship has developed. The staff have also worked closely with the Dept. of Agriculture Stabilization Conservation Service (ASCS). ASCS has provided

supplemental cost-share funds for many of the BMP practices carried out by the project.

In an effort to disseminate information between the many involved agencies and individuals, an "inter-agency meeting" was held annually for the purpose of reviewing past project progress, establish future project goals, and to foster good working relationships. These meetings were attended by both South Dakota and Minnesota departments, agencies, and individuals.

These public information activities were conducted on a continuing basis and participated in by all staff members of the Watershed Team. This has resulted in an improved awareness of the project and its goals during the Phase II Step II Workplan.

PHASE II MONITORING PROGRAM:

The objective of the water quality monitoring program was to document and quantify reductions in pollutant loadings and water quality improvements that result from implementation of BMP's in the Big Stone Lake Watershed. The monitoring program for the Phase II Big Stone Lake 319 Workplan was patterned after the existing plan for Phase II of the project. It should be noted, that in 1992 chemical analysis of tributaries and in-lake for "Ortho-Phosphorus" was replaced by "Total Dissolved Phosphorus" chemical analysis. This was necessitated because the South Dakota's State Health Laboratory and project staff were unable to

meet the recommended EPA holding times for "Ortho-Phosphorus". Water sample collection, preservation and field analysis were conducted in accordance with the Quality Assurance Program of the Division of Water Resource Management. Chemical analysis of samples were conducted by the South Dakota State Health Laboratory in accordance with their approved Quality Assurance Project Plan. Care was taken to ensure that the data was compatible with existing historical data. All monitoring data and all hydrologic data was entered into a computer file. This data was analyzed by the Water Quality Analyst. A comprehensive report of all water quality and hydrologic data was collected and reported in the project's "Annual Reports". During this Grant Period, $6,591 was spent for monitoring, refer to Appendix A.

Tributary Monitoring:

The purpose of tributary monitoring was to determine nutrient and sediment budgets for the Big Stone Lake hydrologic system. Nine tributary sites were monitored for the funding period. The chemical parameters analyzed by the SD State Health Laboratory included:

Total Phosphorus	Ortho Phosphorus	Nitrate + Nitrite,
Ammonia	Kjeldahl Nitrogen	Total Solids
Suspended Solids	Total Alkalinity	Fecal Coliform
Dis. Phosphorus		

Field parameters analyzed by the Water Quality Analyst include the following:

Air Temperature	Water Temperature	Field PH
Visual Observation	Water Velocity	Date and Time

In Lake Monitoring:

The purpose of in-lake monitoring was to determine water quality trends in Big Stone Lake, to estimate productivity and changes in the tropic state of the lake, and to develop in-lake hydrologic and nutrient budgets. The in-lake sampling sites remained the same as in the original Phase II Workplan. The following parameters were measured on each of the composite samples collected for in-lake samples:

Total Phosphorus	Ortho Phosphorus	Nitrate + Nitrite,
Ammonia	Kjeldahl Nitrogen	PH
Total Solids	Suspended Solids	Total Alkalinity
Specific Conductivity	Fecal Coliform	Dissolved Oxygen
Water Temperature	Secchi Disc	Dis. Phosphorus

Conclusions extrapolated from the above mentioned monitoring need to be made cautiously. Due to weather variability, size of Big Stone Lake's watershed (740,157 acres), size of the Big Stone Lake (12,610 acres), frequency of sampling and other factors, interpretation of the data becomes very complex. A summary of data used to support the following conclusions is located in Appendix D & E.

PROJECT CONCLUSION:

The overall objective of the restoration effort was to increase the recreation potential and lifespan of Big Stone Lake. Major goals included a reduction of both density and duration of algae blooms, limitation of aquatic macrophytes, and a reduction of sedimentation and phosphorus loadings.

Projects which were implemented for the purpose of achieving the project's objectives with Phase II Step II Big Stone Lake 319 Workplan #C9008522-89 Grant funds include nine animal waste management systems and one road project. These efforts along with other accomplishments have had the following affects on the water quality of Big Stone Lake.

Public Perception:

The public, in general, perceive "lake water quality" in terms of algae bloom density and duration. The public have perceived an improvement in the quality of the lake water since restoration efforts were implemented. This perception is reflected in lake usage data which was collected at Hartford Beach State Park, (refer to Appendix D). The Hartford Beach State Park is centrally located on the Big Stone Lake. During this Grant Period, lake visitations have shown an increased of 48 percent, campground use 122 percent and collected receipts 176 percent.

Although water quality was a factor in the lake's increased use, factors other than water quality need to be acknowledged.

Increased fish population and lake promotion were two factors which had a positive influence.

Gill net sampling done by the South Dakota Department of Game Fish and Parks and Minnesota Department of Natural Resources (1991) saw walleye numbers in the Big Stone Lake increase to almost 16 times their normal population for a similar lake. This factor, increased fish population, resulted in an increased number of people fishing at Big Stone Lake, especially in 1992. Efforts to explain this phenomenon have been unsuccessful.

Another factor which has increased lake use was the promotion of the lake by area Cities. With the improved water appearance and increased fish population, the cities of Graceville Minnesota, Big Stone City and Milbank South Dakota have promoted the lake through fishing tournaments, sport magazines, and boat shows. This effort has resulted in many individuals returning to enjoy the lake.

Monitoring Data Conclusions:

Monitoring of the lake and its tributaries was carried out as recommended which allowed for continued continuity of collected data with previous historical data.

Big Stone Lake contains excessive amounts of nutrients which produce nuisance growths of algae. Nutrients are present in both the aqueous and sediment phases. Phosphorus and nitrogen are the two substances generally limiting plant growth in lakes. In

reality, it is difficult to control the amount of nitrogen entering a lake. For this reason, the Big Stone Lake management strategy is to concentrate on controlling the amount of phosphorus entering the lake.

In 1992 the tributaries and in-lake "Ortho-Phosphorus" chemical analysis was replaced by "Total Dissolved Phosphorus" chemical analysis. This was done since EPA holding times for "Ortho-Phosphorus" could not be met. Although the two lab analysis are similar, the parameters are not the same or equal. For the purpose to evaluate trends of phosphorus in the Big Stone Lake, 1989-1992, "Total Phosphorus" chemical analysis will be used. It should also be noted that all trend changes noted in the conclusion of this report were derived at by using "Analytical Graphing-Linear Regression". Three sampling stations will be considered: BSL-1 located at the North end of the lake, BSL-3 centrally located, and BSL-6 located at the South end of the lake.

BSL-1:

The BSL-1 station which is located at the North end of Big Stone Lake, showed a 27 percent decrease in the concentration of "Total Phosphorus", (refer to Appendix E). Also during this grant period, secchi disc readings have shown a 35 percent improvement, (refer to Appendix E). A secchi disc is a weighted white disc which when lowered into the water disappears at a depth related to the amount of dissolved and particulate organic matter in the water. This measurement of transparency is an estimate of the

density of phytoplankton (algae) populations, in other words the nutrient richness or trophic state of the lake.

These improvements can be attributed to the following factors: In the fall of 1989 the Sisseton and Browns Valley wastewater treatment facilities were put into operation. Also, the project has constructed twelve animal waste management systems in the Little Minnesota's watershed which enters the North end of the lake. One system completed, Schiltz's Goose farm which was located adjacent to a tributary of the Little Minnesota River, contained the sediment and nutrients of 40,000 geese. This particular feedlot had a rating of 83 using the Feedlot Rating Model developed by Young, Oterby, and Roos (1982). The Conservation Reserve Program (CRP) was a very popular Best Management Practice (BMP) in the Little Minnesota watershed. A total of 15,853 acres of CRP are presently enrolled.

BSL-3:

The BSL-3 sampling station is centrally located on the lake in the Hartford Beach State Park vicinity. Analytical graphing of the "Total Phosphorus" data, showed a decrease of 18 percent. Secchi disc readings have also shown an improvement of 32 percent (refer to Appendix E).

Due to BSL-3's location, it is directly influenced by BSL-1 and the Little Minnesota Watershed loadings. As continued project progress is realized at BSL-1, improvements will by reflected at BSL-3.

BSL-6:

The BSL-6 station is located at the South end of Big Stone Lake. This station was affected not only by what nutrients and sediment flow from the North end but also the Whetstone River flows which enter the South end of the lake. With the completion of the control structure which diverts 80 percent of the Whetstone River, and other Best Management Practices in the Whetstone Watershed, a decrease of 38 percent in total phosphorus has been noted. Secchi Disc readings have improved 27 percent.

Due to the size and distance of the completed projects in the Little Minnesota watershed in relation to the lake's location and hydraulic residence time of 1.2-3.0 years in Big Stone Lake, the full effects of the completed projects will not be known for sometime.

Monitoring data from within the lake does support the perception which the public have of the lake. The Big Stone Lake has shown a short term improvement. The Watershed Team feels based on current data that further improvements will be noted as restoration efforts continue in the lake's watershed.

Intentions of Roberts County, the project's sponsor, is to continue the restoration effort. Due to the size of Big Stone Lake's watershed and the number of remaining problems which still need to be addressed in the Little Minnesota River watershed, a long term source of cost-share funding is being pursued. At the

present time, Roberts County, is pursuing a PL566 Grant. If this effort is successful, many of the remaining nutrient and sediment problems in the Little Minnesota watershed will be addressed.

PROJECT PITFALLS:

As the project has progressed, a number of project pitfalls have been noted. The degree of design difficulty of the remaining feedlot projects has increased. Project engineers are finding it more difficult to create designs which not only contain the problem of sediment and nutrient pollution but are also acceptable and economically feasible for the feedlot operators. The increased difficulty of these projects has increased the estimated time to design and cost to construct. Even with the present cost-share incentives, area operators are finding it difficult to finance their share of the project.

Another limiting factor on project progress has been the number of local contractors interested in constructing Animal Waste Management Systems. Contractors are presently using the Big Stone Lake's projects to supplement their work schedule for the year.

END

APPENDIX A

1. ADMINISTRATION EXPENSE

2. MONITORING EXPENSE

319 GRANT #C9008522-89
ADMINISTRATION EXPENSES
(incurred @ Roberts County)

	EXPENSE	EPA	STATE	LOCAL	TOTAL
	WAGES				
1990	Director	$11,193.52	$371.20	$862.96	$12,427.68
1991	"	15,552.67	4613.85	5041.66	25,208.18
1992	"	18,575.59		4643.80	23,219.39
1990	Water A.	8,272.26	274.75	646.77	9,193.78
1991	"	11,559.59	3355.25	3728.71	18,643.55
1990	Secretary	2,165.29	74.71	211.75	2,451.75
1991	"	2,160.88	677.23	709.52	3,547.63
1992	"	2,846.78		711.68	3,558.46
1990	SCS Tech	5,378.82		5378.82	10,757.64
1991	"	10,141.15			10,141.15
1992	"	6,511.00		1627.75	8,138.75
Sub Total		94,357.55	9,366.99	23563.42	127,287.96
1990	RENT	1,090.85	174.53	261.81	1,527.19
1991	"	1,570.80	523.68	523.56	2,618.04
Sub Total		2,661.65	698.21	785.37	4,145.23
1990	TELEPHONE	1,089.32	66.25	156.93	1,312.50
1991	"	1,164.15	355.90	380.02	1,900.07
1992	"	724.57		181.14	905.71
Sub Total		2,978.04	422.15	718.09	4,118.28
1990	OFFICE EXP.	1,417.66	89.66	221.22	1,728.54
1991	"	1,471.09	443.77	478.71	2,393.57
1992	"	2,616.39		654.10	3,270.49
Sub Total		5,505.14	533.43	1354.03	7,392.62
TOTAL EXPENSES		$105,502.38	$11,020.78	$26,420.91	$142,944.07

319 GRANT #C9008522-89
MONITORING EXPENSES
(incurred @ Roberts County)

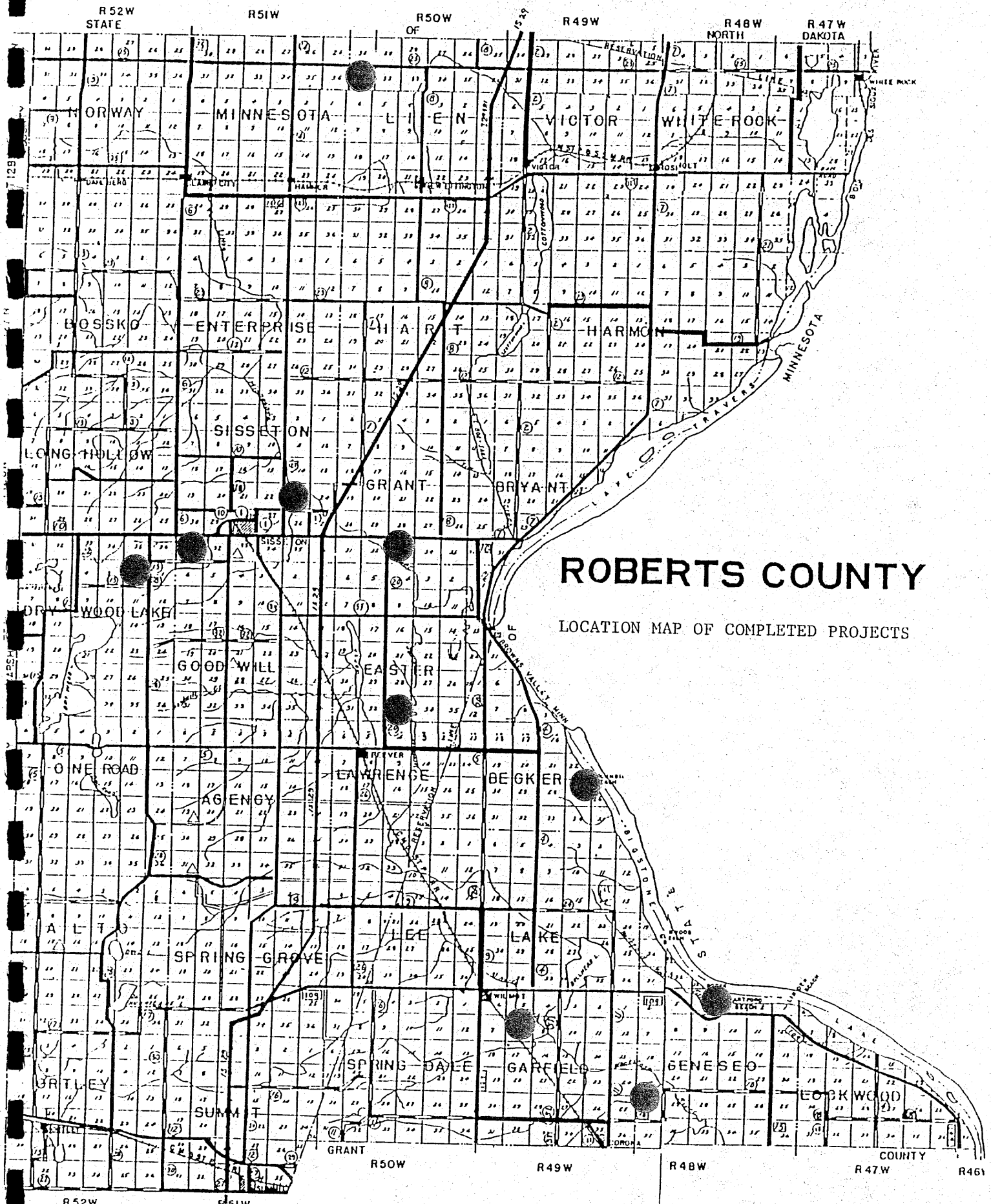
	EXPENSE	EPA	STATE	LOCAL	TOTAL
	MONITORING				
1990	"	$1,364.90	$75.60	$174.70	$1,615.20
1991	"	$2,171.14	$720.12	$722.81	$3,614.07
1992	"	$1,089.71		$272.42	$1,362.13
TOTAL	EXPENSE	$4,625.75	$795.72	$1,169.93	$6,591.40

APPENDIX B

1. PROJECT'S EXPENSE BREAKDOWN
2. PROJECT'S LOCATION MAP

319 GRANT #C9008522-89
PROJECT EXPENSES

PROJECT	EPA	STATE	LOCAL & (ACP)	TOTAL
Animal Waste Systems				
DARRELL CEROLL	$14,571.47	$4,857.16	$8,717.48	$28,146.11
DELVIN HANSON	$27,108.85	$9,036.28	$12,246.83	$48,391.96
PAUL DeBOER	$27,849.71	$9,283.24	$9,283.23	$46,416.18
DENNIS FISHER	$22,088.65	$7,362.88	$7,362.88	$36,814.41
BRAD ZIEMER	$10,882.21	$3,627.40	$3,627.40	$18,137.01
SCHILTZ'S	$63,646.96	$18,335.64	$20,495.86	$102,478.46
LLOYD HANSSEN	$6,672.86		$17,007.85	$23,680.71
SCOTT NELSON			$13,941.66	$13,941.66
PAUL HANSON	$1,601.70		$400.43	$2,002.13
Sub Total	$174,422.41	$52,502.60	$93,083.63	$320,008.64
Road Project SoDak Road	$5,140.00		$25,913.98	$31,053.98
TOTAL PROJECT EXPENSE	$179,562.41	$52,502.60	$118,997.61	$351,062.62

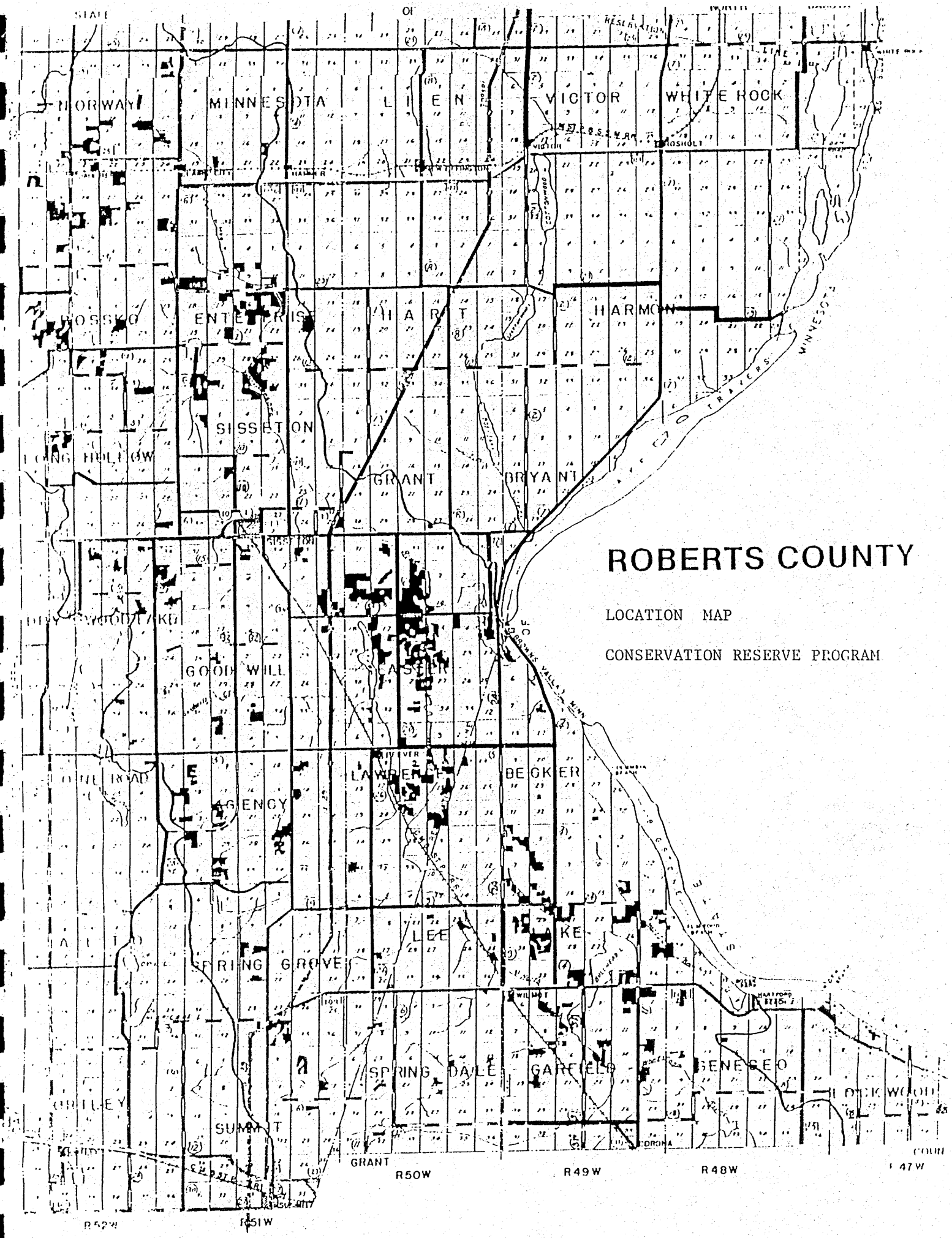


ROBERTS COUNTY

LOCATION MAP OF COMPLETED PROJECTS

APPENDIX C

1. CONSERVATION RESERVE PROGRAM MAP



ROBERTS COUNTY

LOCATION MAP

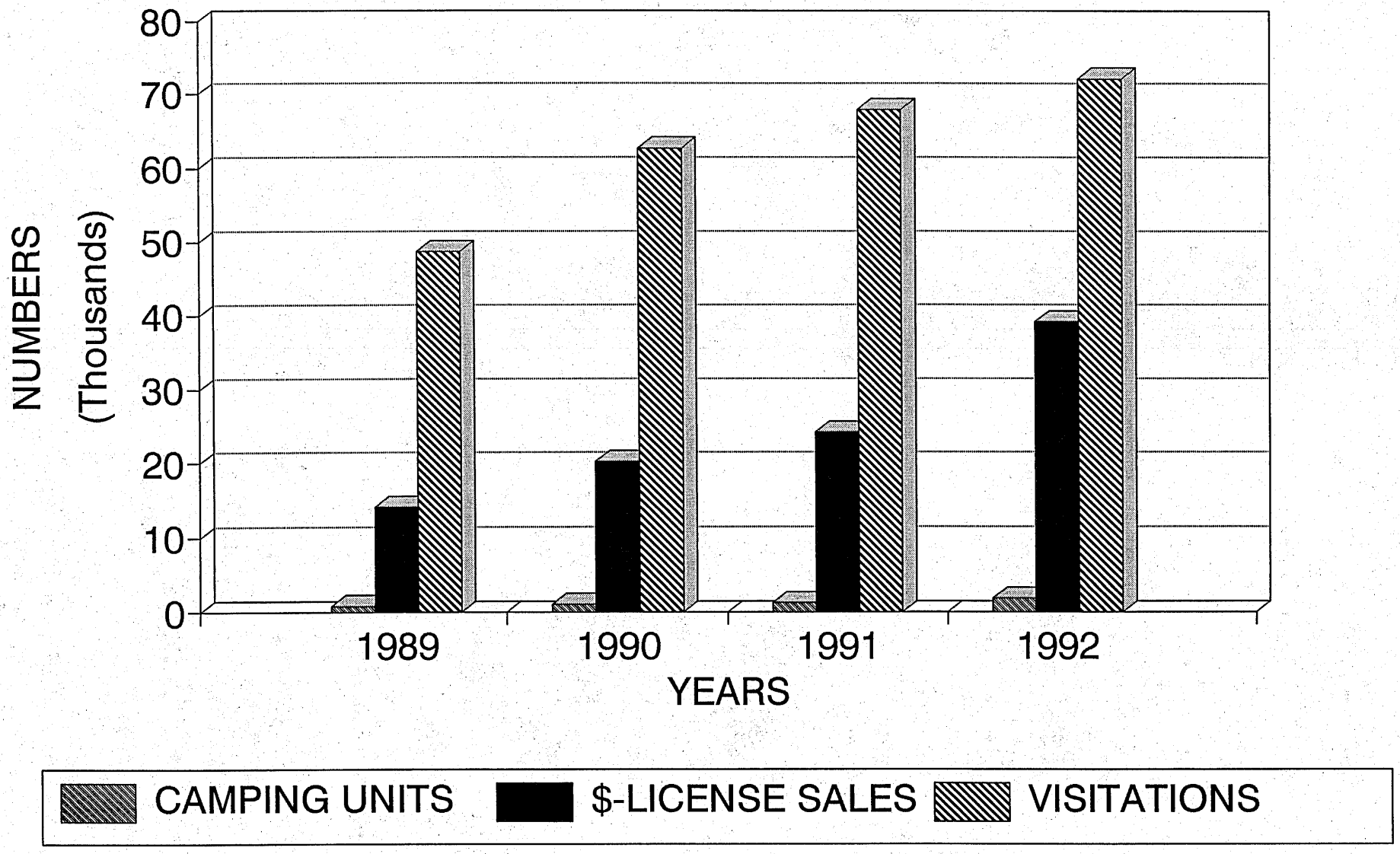
CONSERVATION RESERVE PROGRAM

APPENDIX D

1. HARTFORD BEACH STATE PARK DATA

HARTFORD STATE PARK

DATA

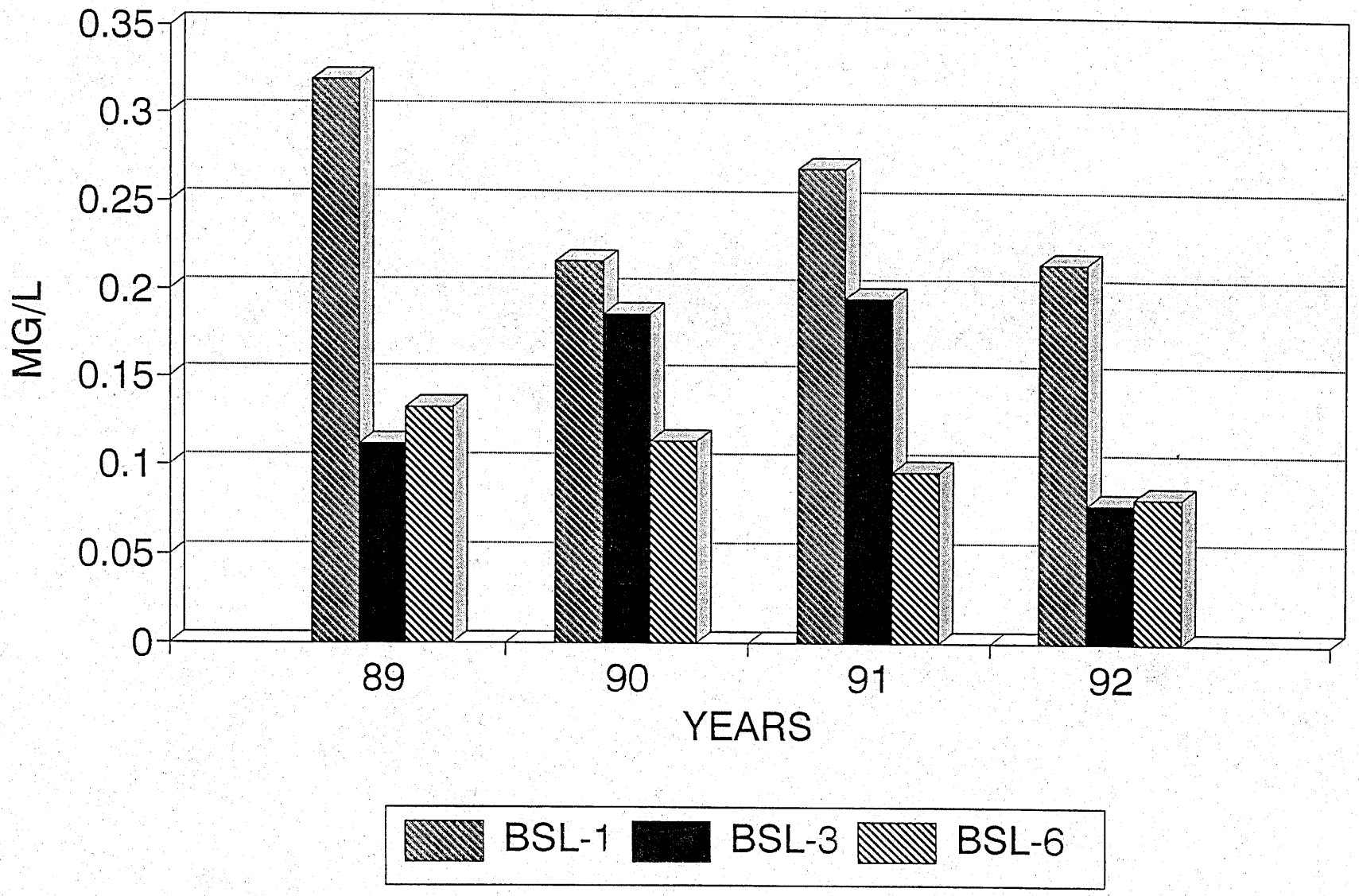


APPENDIX E

1. BIG STONE LAKE PHOSPHORUS & SECCI DATA

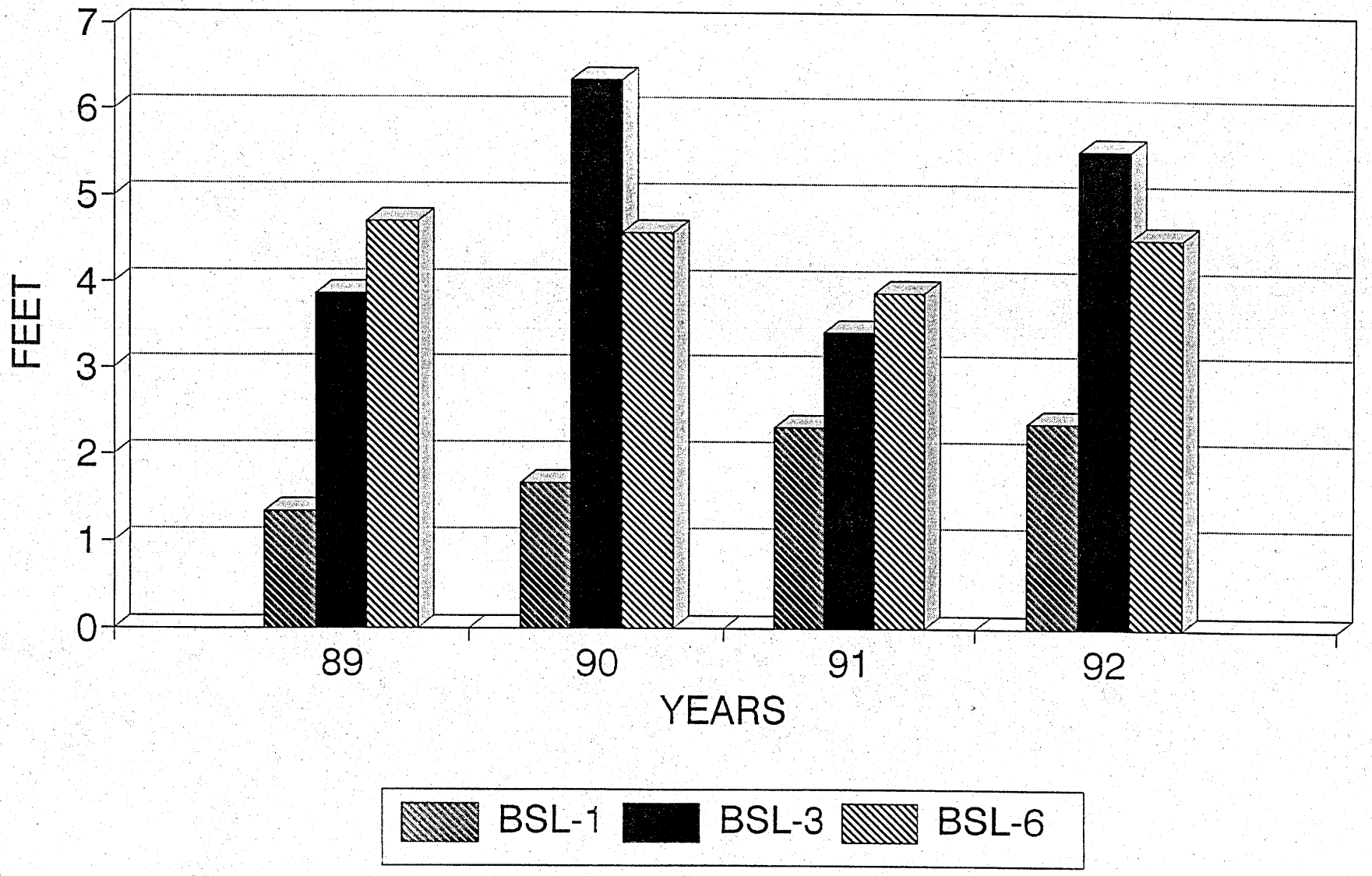
   A. BSL-1
   B. BSL-3
   C. BSL-6

BIG STONE LAKE'S
"TOTAL PHOSPHORUS" (MAY-SEPT)



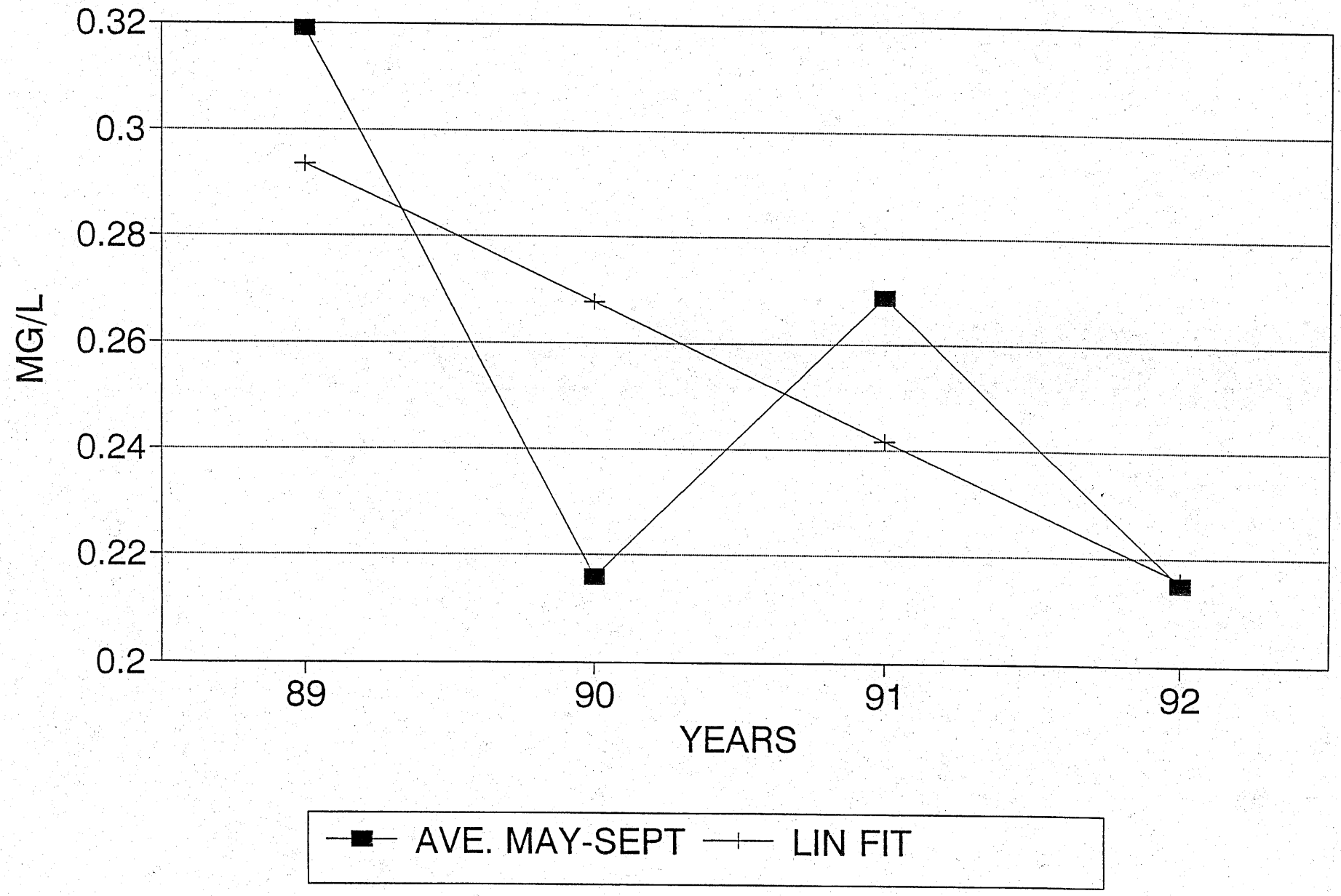
BIG STONE LAKE SECCHI READINGS

MAY THRU SEPT.



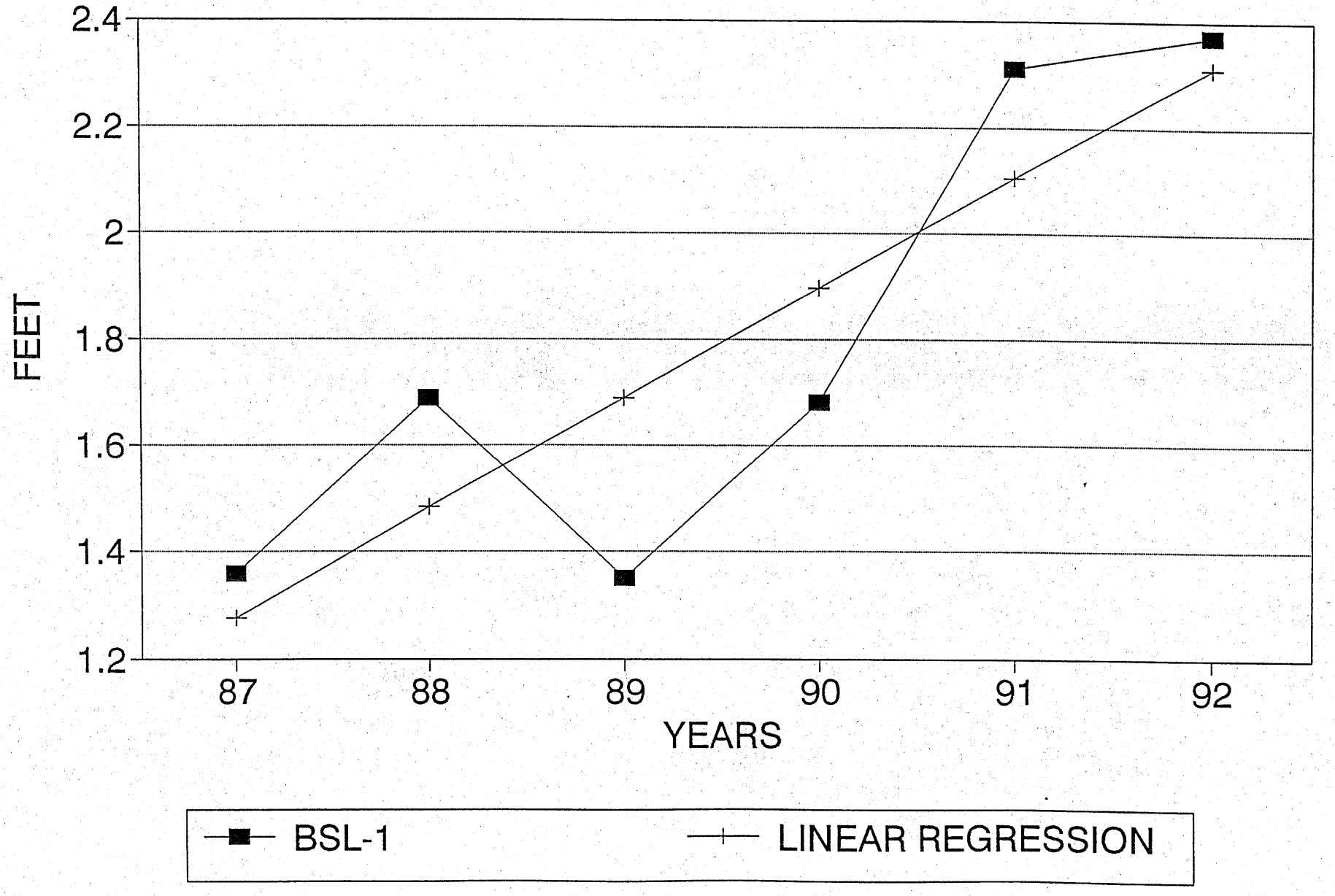
BIG STONE LAKE BSL-1

"TOTAL PHOSPHORUS" CONCENTRATION/YEAR



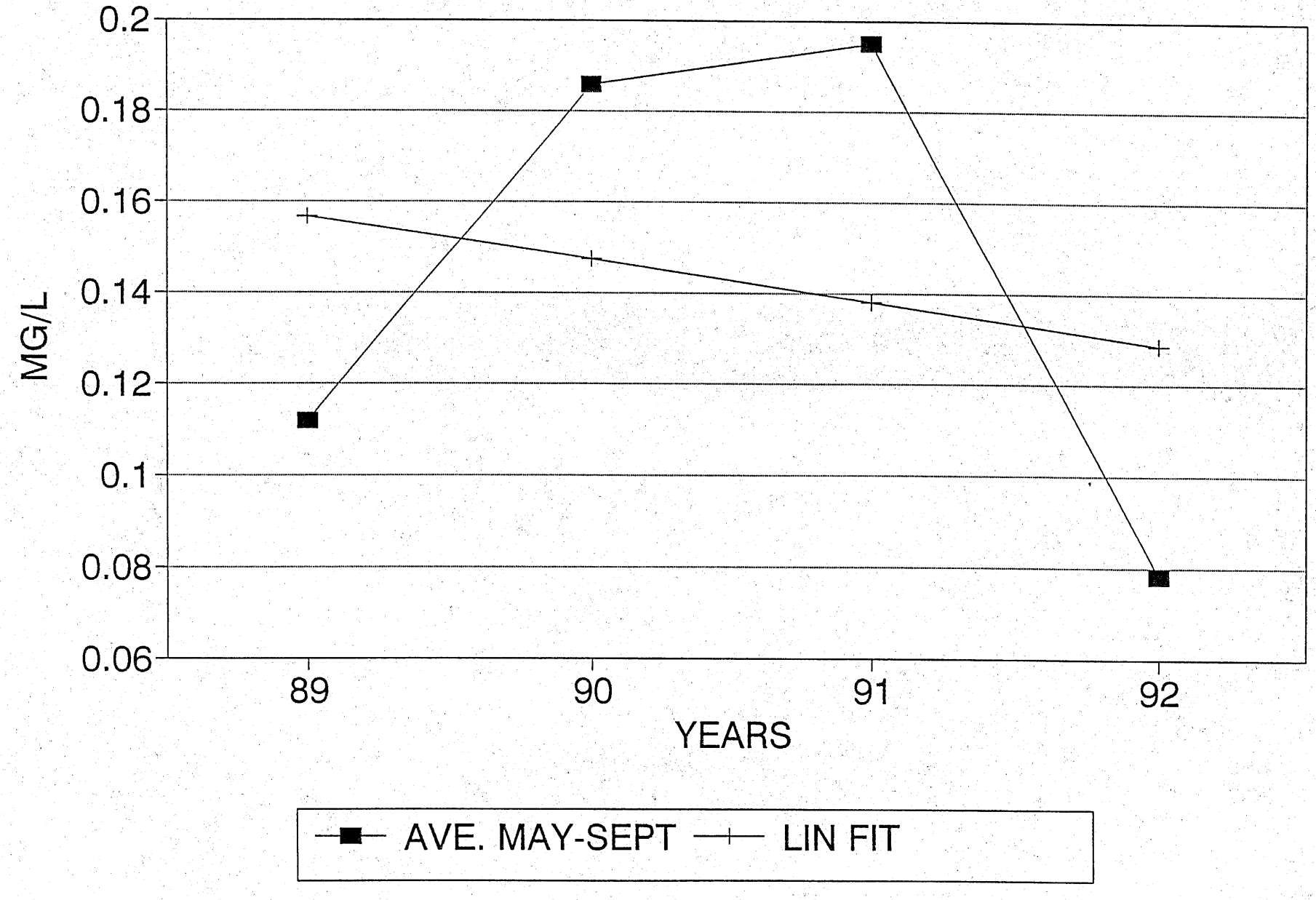
BIG STONE LAKE SECCI READINGS

BSL-1 MAY THRU SEPT.



BIG STONE LAKE BSL-3

"TOTAL PHOSPHORUS" CONCENTRATION/YEAR



BIG STONE LAKE SECCI READINGS

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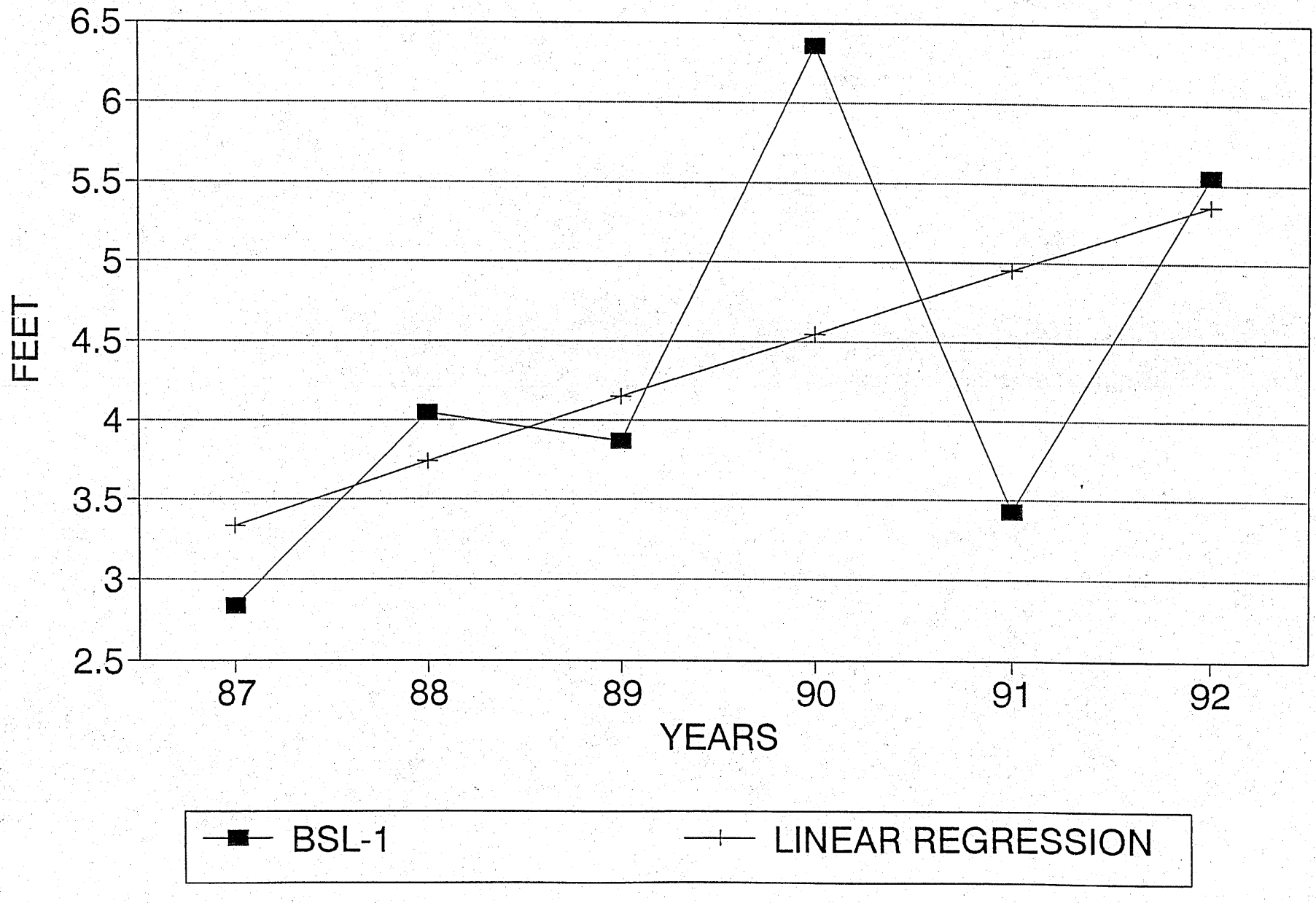
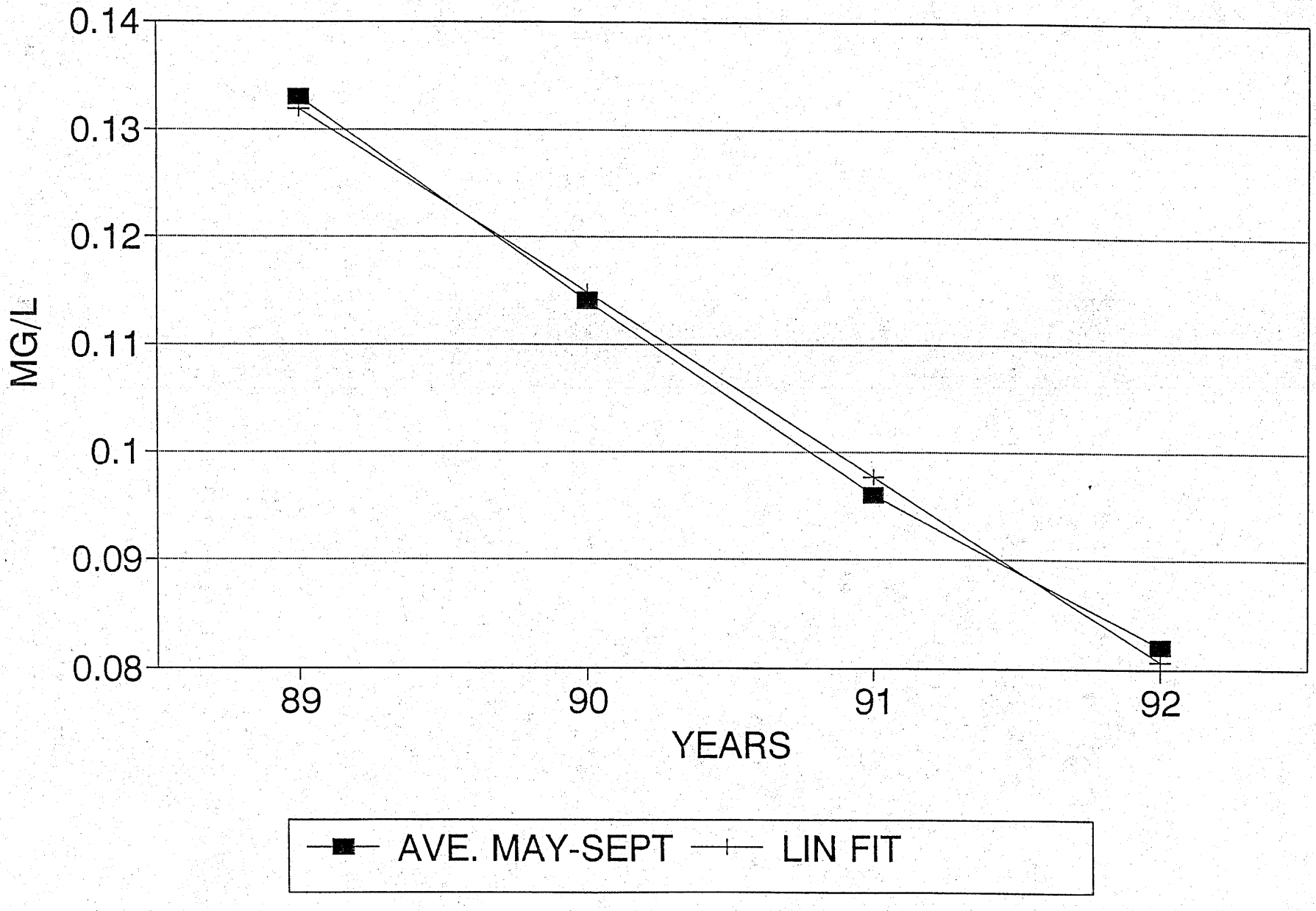


BIG STONE LAKE BSL-6

"TOTAL PHOSPHORUS" CONCENTRATION/YEAR



BIG STONE LAKE SECCI READINGS

BSL-6 MAY THRU SEPT.