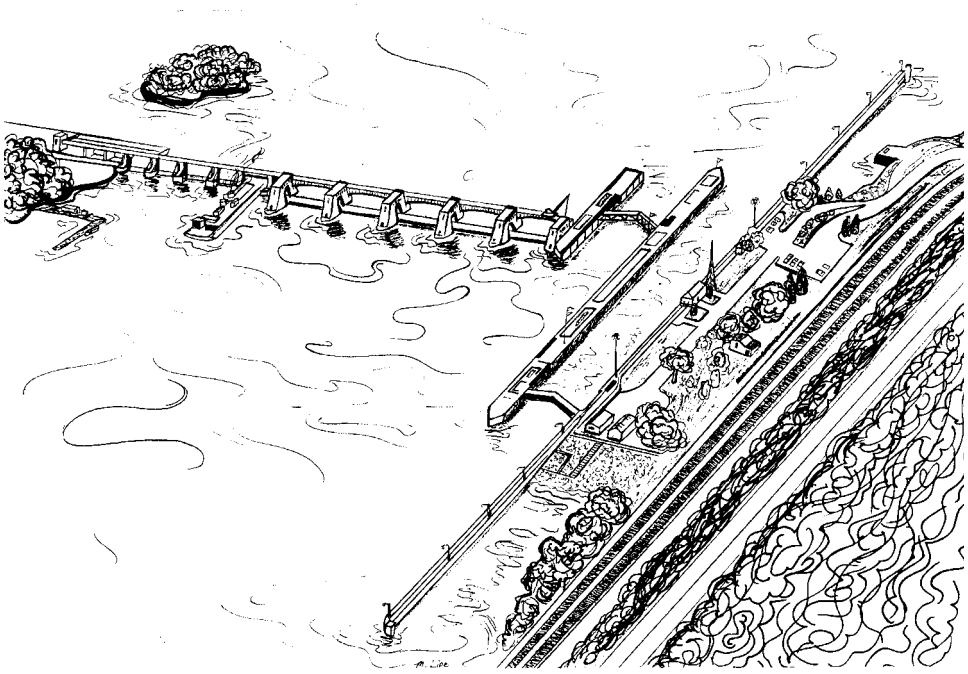
Long Term Resource Monitoring Program

Technical Report

96-T004

Pool 25: Water Levels Management Alternatives and Their Effects on Habitat



This PDF file may appear different from the printed report because of slight variations incurred by electronic transmission. The substance of the report remains unchanged.

October 1996

LTRMP Technical Reports provide Long Term Resource Monitoring Program partners with scientific and technical support.

All reports in this series receive anonymous peer review.

Cover graphic by Mi Ae Lipe-Butterbrodt

Printed on recycled paper

Pool 25: Water Level Management Alternatives and Their Effects on Habitat

by

Joseph H. Wlosinski and James T. Rogala
U.S. Geological Survey
Environmental Management Technical Center
575 Lester Avenue
Onalaska, Wisconsin 54650

October 1996

Additional copies of this report may be obtained from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161 (1-800-553-6847 or 703-487-4650).

This report may be cited:

Wlosinski, J. H., and J. Rogala. 1996. Pool 25: Water level management alternatives and their effects on habitat. National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, October 1996. LTRMP 96-T004. 85 pp. + Appendixes A–D.

Contents

Tables

Figures

Preface

The Long Term Resource Monitoring Program (LTRMP) was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U.S. Army Corps of Engineers' Environmental Management Program. The LTRMP is being implemented by the Environmental Management Technical Center, a U.S. Geological Survey science center, in cooperation with the five Upper Mississippi River System (UMRS) States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The U.S. Army Corps of Engineers provides guidance and has overall Program responsibility. The mode of operation and respective roles of the agencies are outlined in a 1988 Memorandum of Agreement.

The UMRS encompasses the commercially navigable reaches of the Upper Mississippi River, as well as the Illinois River and navigable portions of the Kaskaskia, Black, St. Croix, and Minnesota Rivers. Congress has declared the UMRS to be both a nationally significant ecosystem and a nationally significant commercial navigation system. The mission of the LTRMP is to provide decision makers with information for maintaining the UMRS as a sustainable large river ecosystem given its multiple-use character. The long-term goals of the Program are to understand the system, determine resource trends and effects, develop management alternatives, manage information, and develop useful products.

This report was prepared under Strategy 1.2.3, *Determine Effects of Water Levels and Discharges on the Upper Mississippi River Ecosystem*, and Goal 3, *Develop Alternatives to Better Manage the Upper Mississippi River System*, as specified in the Operating Plan of the LTRMP for the Upper Mississippi River System (USFWS 1993). The purpose of this report is to provide requested information to the Pool 25 Natural Resources Management Committee concerning the effects of water level management alternatives on floodplain habitat. This report was developed with funding provided by the Long Term Resource Monitoring Program.

Pool 25: Water Level Management Alternatives and Their Effects on Habitat

By Joseph H. Wlosinski and James T. Rogala

Abstract

The effects of changing levee and water level management practices on present habitat types and amounts on the Upper Mississippi River floodplain at Pool 25 were predicted. The intent of the study was to investigate a broad range of plans that would provide coarse resolution information and the tools needed to study specific plans in the future. Two conditions were investigated for levees: the present levee system and all levees removed. Five water level management plans were studied: the present plan, two plans that would increase water levels, and two plans that would decrease water levels. The levee and water level management variables resulted in a total of ten unique management alternatives. Each was studied at four discharge regimes for a total of 40 scenarios. A geographic information system (GIS) was used to investigate the amounts and types of habitat that would be affected for each scenario. Tools developed for the study were a discharge elevation relation for the tailwater of Pool 25; estimates of water levels throughout Pool 25 for each scenario; GIS coverages of water levels, floodplain elevations, levees, and habitat types; and a technique to compare alternative scenarios. All GIS analyses were performed in a raster environment.

Introduction

Conservation agencies in Illinois and Missouri requested assistance from the Environmental Management Technical Center (EMTC) in developing water regulation alternatives at Lock and Dam 25 on the Upper Mississippi River (UMR). The objective of this multiyear study is to evaluate water regulation alternatives that will minimize negative effects and increase ecological benefits of dam operation. The purpose of this report is to provide requested information to the Pool 25 Natural Resources Management Committee concerning the effects of water level management and levee alternatives on floodplain habitat. The Pool 25 Natural Resources Management Committee is composed primarily of members of the Upper Mississippi River Conservation Committee who are making long-term plans to manage the River floodplain using ecosystem principles. The Committee selected the management scenario options investigated in this study. Defining constraints associated with changing water level management plans, such as the need to purchase additional lands or easements, was not part of this study.

A companion report (Wlosinski 1996) contains information on historical discharges and water level management practices in Pool 25. An annotated bibliography of the effects of water levels on ecosystem components is also available (Wlosinski and Koljord in press). Engineering, legal, and administrative constraints must be resolved before alternative plans are implemented. Information concerning constraints on water level management can be found in reports by the U.S. Army Corps of Engineers (USACOE 1991) and Wilcox and Willis (1993).

The intent of the Natural Resources Management Committee for Pool 25 was to investigate a limited number of plans covering a broad range of management alternatives and to develop the tools needed to study more specific plans in the future. A recommended future plan may actually be a suite of plans that changes from one year to the next, between seasons, or as a function of certain predefined conditions.

Some terminology in this report may not be common but is used routinely for water level management or analysis using geographic information systems (GIS). These terms are defined in Table 1.

Management Scenarios

We investigated two management variables for this study: levees and water level management plans. Two conditions were investigated for levees: the present levee system and all levees removed. Five water level management plans were studied: (1) the present plan (Fig. 1), where water levels are held between 434 and 435.75 ft at Mosier Landing when discharges are under 95,000 cfs and are held at 429.7 ft at Lock and Dam 25 when discharges are above 95,000 cfs until open river conditions exist (about 135,000 cfs); (2) a plan that maintains a water level of 434 ft at Lock and Dam 25 at all discharges until open river conditions exist (about 190,000 cfs); (3) a plan that maintains a water level of 437 ft at Lock and Dam 25 at all discharges until open river conditions exist; (4) a plan that maintains a water level of 429.7 ft at Lock and Dam 25 at all discharges until open river conditions exist; and (5) a plan that always leaves the gates of Lock and Dam 25 in the raised position so that the only control of water levels would be from Dam 26. The two management variables, levee and water level management plans, result in a total of ten unique management alternatives (two levee conditions times five water level management plans).

Four different steady-state discharge regimes were investigated for each of the ten management alternatives: 19,000, 56,000, 95,000, and 135,000 cfs. We chose a regime of 19,000 cfs because it represents conditions at nearly flat pool, and it was the estimated discharge when aerial photography was taken for this study. A regime of 56,000 cfs represents a moderate discharge, and it was the lowest discharge represented on the graph (USACOE 1980) showing the relation of discharge and water levels in the tailwater of Pool 25. The two higher discharges, 95,000 and 135,000 cfs, represent the maximum and minimum discharge at maximum drawdown under the present plan (Fig. 1).

We determined the effects of each of the ten management alternatives at the four selected discharge regimes on selected habitat classes, resulting in 40 scenarios (ten management alternatives times four discharge regimes). Levee and water level management alternatives and the discharge regimes used in this study are presented in Table 2.

Methods

A GIS was used to quantify the aerial extent and types of habitat that would be affected for each of the 40 scenarios. Methods were needed to develop a discharge elevation relation for the tailwater of Pool 25; estimates of water levels throughout Pool 25 for each scenario; GIS coverages of water levels, floodplain elevations, levees, and habitat types; and a technique to compare alternative scenarios. All GIS analyses were performed in a raster environment using the ARC/INFO GIS software package.

Discharge–Elevation Relation

A mathematical relation between discharge and water level elevation at the tailwater of Lock and Dam 25 was developed by using a third-order polynomial regression. Water level data were obtained from the USACOE, St. Louis District. Discharges were estimated from U.S. Geological Survey (USGS) stations at Valley City and Grafton, Illinois, and Keokuk, Iowa (Wlosinski 1996). The regression was based on data collected from 1986 to 1993. The relation between discharge and water levels is presented in Figure 2.

Water Level Estimates

Water level estimates throughout the pool were needed for each scenario. These estimates were obtained by using HEC-2, a computer model intended for calculating water surface profiles for steady, gradually varied flow (Hydrologic Engineering Center 1990). Data for elevation transects for the model were obtained (1) from a

study performed on the main and secondary channels in fall 1993 by the USACOE, St. Louis District; (2) from data collected by the Alton Field Station of the Illinois Natural History Survey on backwaters in summer 1994; and (3) from USGS quadrangle maps at a resolution of 1:24,000. Elevation transects for the model occurred at about 0.5-mi intervals.

The model was calibrated by adjusting the Manning's *N* parameter for each transect. Calibration runs were made at 19,000, 56,000, 95,000, and 135,000 cfs. Predictions were compared to average elevation data collected by the USACOE, St. Louis District, from 1952 to 1993 at five stations (Table 3). Manning's *N* was adjusted until predicted values were within 0.3 ft of the observed values for all four discharge regimes.

An initial water level at Lock and Dam 25 was also needed for HEC-2 to predict pool water levels for each of the 20 scenarios. For the calibration simulations (Plan 1), the mean water level at the discharge of interest was calculated from elevation data collected by the USACOE, St. Louis District, from 1952 to 1993. The mean was 433.8 ft at discharges of 19,000 and 56,000 cfs, 431.7 ft at 95,000 cfs, and 429.9 ft at 135,000 cfs. Thus, Plan 1 is based on historical water level measurements. For the alternative management scenarios at all four discharges, the starting water level was 434.0 ft for Plan 2; 437.0 ft for Plan 3; and 429.7 ft for Plan 4. Water levels for Plan 5 were obtained from the water level discharge relation for the tailwater of Lock and Dam 25 (Fig. 3). The water surface used was 419.2, 422.0, 425.0, and 428.2 ft for discharges of 19,000, 56,000, 95,000, and 135,000 cfs, respectively. The HEC-2 model used for the final calibration simulation is in Appendix A.

The same water level predictions for the levee and no-levee options were used. We assumed that levees would not have a significant effect on water levels because the discharges of interest were less than flood flows. Thus, the model was used to obtain 20 different water level datasets (five water level management plans times four discharge regimes). Model transects only includeelevation information needed for this study and do not continue landward of levees, so the model is not suitable for predicting water levels during floods.

Water Level Coverage

A GIS coverage of water levels was created for each of the 20 scenarios from the HEC-2 predictions. A template of polygons for each river mile was created to produce a surface representing water levels. Most of the template cells were perpendicular to the direction of flow, with no lateral changes in water surface elevation. However, if off-channel areas are only contiguous with the main channel at a downstream location, the polygon would have an irregular pattern. The template also assumes that Lock and Dam 25 is continuous from bluff to bluff. The template was developed according to conditions determined from 1989 aerial photography. The polygon coverage was converted to a raster grid coverage with a cell size of 50 m. The large cell size was selected because of the low resolution of the river mile template. The GIS program for developing the water level coverage is in Appendix B.

Floodplain Elevation Coverage

Data for a GIS coverage of floodplain elevations were obtained from five sources. The only source of data for terrestrial areas was 5-ft contour data obtained from USGS 1:24,000 quadrangle maps. The highest contour included in this coverage was based on predictions from HEC-2 of the highest elevation by river mile for the 20 scenarios investigated. For this reason, the total area of the coverage may be slightly smaller than the actual area of the floodplain.

Bathymetric data were obtained from USACOE, St. Louis District, surveys performed on the main and secondary channels in fall 1993 and LTRMP Alton Field Station surveys conducted on backwaters in summer 1994. For

the USACOE transect data, 5-ft contours were interpolated by computer and plotted on maps. In addition, 3-ft contours were drawn by hand from the USACOE transect data to supplement the computer-generated contours and 1- to 3-ft contours were drawn from bathymetric data collected in the backwaters. All bathymetric data were gaged to a constant water surface elevation (434.0 ft) throughout the pool, and bed elevations were then calculated from water depths.

Additional elevations along shorelines were derived from land cover data and SPOT satellite data taken at three different discharge regimes. Land cover data and SPOT imagery were classified into land and water classes, and the boundary was then treated as a shoreline. Shoreline elevations were estimated by using the HEC-2 model, elevation data at the Pool 25 headwater gage, and a discharge estimate obtained from the Pool 25 tailwater gage.

We combined all elevation data into one coverage. Interpolation methods were then used with these data to generate a continuous elevation surface. To assist the interpolation algorithm, additional data were created in an intermediate interpolation step. This interpolation was performed along selected lines, referred to as break lines, which were critical for retaining the integrity of the surface. Otherwise, errors might have been introduced into the coverage in areas of elevational change, which would be interpreted as distinct triangles of equal elevation. We used a linear interpolation of a grid from a triangulated irregular network (TIN).

Levee Coverage

The levee coverage was, for the most part, provided by the Scientific Assessment and Strategy Team (SAST), who digitized interpreted aerial photography. Data used from SAST included levee center lines and areas protected by levees. Modifications to their coverage were made by adding areas that were isolated from the main river and were not designated as such. Polygons of the protected areas were then created. The polygon data were converted into a raster dataset at a 5-m cell size, and areas (polygons) protected by levees were assigned a "nodata" value. The levee coverage was then used to mask floodplain areas for the scenarios representing the present levees condition. Thus, the total habitat acreage for the two levee conditions was different. We assumed that levees would not be overtopped under any combination of discharges and water level management plans used for the study.

Habitat Coverages

Two classification schemes were used as surrogates for habitat types: land cover/land use and aquatic areas. For both schemes, we used data obtained from aerial photography taken in September 1989. LTRMP's 13-Class Generalized Classification Scheme was used for reporting the effects on land cover/land use (Table 4). However, this classification system is a subset of a classification system with finer resolution, and either scheme can be used for future studies. One class, the submergents rooted floating aquatics emergents, did not occur anywhere and was excluded from the analyses. Six classes were designated as aquatic (ending with emergents, Table 4) and the rest as terrestrial. Additional information on the finer resolution scheme is provided (Appendix C).

Wilcox (1993) presented an aquatic areas classification scheme for the Upper Mississippi River System (Fig. 4). We followed his scheme in this study, except that the main and secondary channels were not further subdivided. Nonaquatic areas were considered terrestrial.

Comparison of Scenarios

A three-digit numbering scheme was created for comparing different management scenarios (Table 5). The first digit represents the levee

conditions, the second the water level management plan, and the third the discharge. Scenario "111" represents the present levee system and present water level management plan at 19,000 cfs. These were the conditions that were in place when the photography was obtained for land cover/land use and aquatic areas in 1989.

Changes in habitat types can occur as a function of discharge and of water level management plan. We dealt with both changes by adding two general classes, "flooded terrestrial" and "dewatered aquatics." Thus, we did not predict the type of habitat that would occur if an area that was designated as terrestrial was flooded or an aquatic area was dewatered, only the type of present habitat that was affected. We also did not predict whether existing classes would change because of changes in water depth or changes in elevation above the water surface.

Changes that would occur as a result of each of the management alternatives were determined by overlay of GIS databases using the software package ARC/INFO GRID. The initial overlay was the water surface elevation grid and the elevation database. The product of that overlay was a land water grid, which was used to determine inundation or exposure of habitat present in the Plan 1 scenario for each of the four discharges. Each of the other plans was then compared to the present plan (Plan 1) for each discharge. This led to 16 comparisons for each of the two levee conditions. The change due to the presence or absence of levees was generated by using the levee mask (present levee condition) or operating on the entire study area (no levee condition). The program developed for comparing water level management scenarios is presented (Appendix D). A similar program was developed for the aquatic areas classification.

The statistics we reported for the study were the total acreage for each class for each scenario and a summary of change for each scenario. In the summary of change, we compared each of the water level Plans 2, 3, 4, and 5 to the present plan for each discharge regime and included the loss of each class, the inundation of terrestrial habitat types, and exposure of aquatic habitat types.

Results and Discussion

Discharge–Elevation Relation

The discharge elevation relation developed for the tailwater of Lock and Dam 25 is presented in Figure 3. Predicted elevations are about 0.2 to 0.8 ft lower than the relation given in the Water Regulation Manual for Pool 25 (USACOE 1980). This difference is not surprising, especially considering possible errors associated with estimating discharges. The USGS reports much of their discharge data as being "fair," which they define as "95% of the daily discharges are within 15% of the true value" (Reed et al. 1993). A 15% error in estimating discharge, at 100,000 cfs at the Lock and Dam 25 tailwater, is equivalent to an elevation difference of about 1.1 ft.

Discharge exceedence curves for 1939 through 1993 were presented by Wlosinski (1996). Discharges were below 19,000 at Pool 25 less than 1% of the time. They were between 19,000 and 56,000 cfs 37% of the time and between 56,000 and 95,000 cfs 27% of the time. Discharges were between 95,000 and 135,000 cfs 16% of the time and above 135,000 cfs 20% of the time.

Water Level Estimates

Water level predictions from HEC-2 are listed by river mile for management Plans 1 through 5 in Tables 6 through 10, respectively. The predicted difference in water levels from one end of the pool to the other for the various scenarios varies from a low of 0.3 ft to a high of 14.4 ft (Table 11). Water levels as a function of discharge are shown for three locations in the pool for Plans 1 through 5 in Figures 5 through 9, respectively.

It should be noted that water levels can only be controlled at Lock and Dam 25 but can be managed at any other location in the pool. "Management" is defined here as the maintenance of a target water level at a specific location in the pool (control point) over a range of discharges. Also, if one specific plan is used to manage water levels in a pool, water level fluctuations anywhere else in the pool would be strictly a function of discharge. To have flexibility to manage water levels over a range of discharges, two different plans must be feasible. Water level management "flexibility" would then be the vertical distance of water levels between various management plan alternatives. Flexibility values change as a function of discharge and as a function of distance from Lock and Dam 25. The amount of water level flexibility, in feet, among the various plans is shown in Table 12 for locations at the headwater of Pool 25, near Mosier Landing, and at the tailwater of Pool 24. When water levels are managed at the dam, water level management flexibility is inversely related to distance from Lock and Dam 25.

Water Level Coverage

Graphs depicting water level elevations by river mile, for each water level management plan, are presented for each of the four discharge regimes (Figs. 10 through 13). As previously stated, levee presence or absence is not a variable in water level conditions. An example of the water elevation template is provided in Figure 14. The template is overlaid on the land water boundary for illustrative purposes.

Floodplain Elevation Coverage

The elevation coverage for the northern portion of the pool is presented in Figure 15 and the southern portion in Figure 16. The elevation coverage did not include the entire floodplain because of the absence of high elevation data, as described previously. The total area of the floodplain, obtained from the original land cover/land use map, is about 85,700 acres. The study area for this report was about 84,100 acres. The mean elevation of the entire study area is 438 ft above msl with a standard deviation of 8 ft. Sixteen percent of the area is higher than 445 ft, 47% is higher than 440 ft, 71% is higher than 435 ft, and 86% is higher than 430 ft. As expected of a floodplain, there is a longitudinal trend of decreasing elevation moving downriver. The study area that was not protected by levees had a mean elevation of 434 ft with a standard deviation of 10 ft. The study area protected by levees had a mean elevation of 440 ft with a standard deviation of 5 ft.

Levee Coverage

The area protected by levees was about 49,200 acres (59% of the floodplain). About 83% of the land on the Missouri side, including islands, is protected by Federal levees for a total of about 39,500 acres. About 43% on the Illinois side is protected by levees. A Federal levee on the northern portion of the Illinois side protects about 8,500 acres, and a non-Federal levee in the southern portion of the Illinois side protects about 1,200 acres.

Habitat Coverages

Land cover/land use classes for the northern portion of Pool 25 are presented in Figure 17 and for the southern portion in Figure 18. Similarly, the aquatic areas coverage is presented in Figures 19 and 20. A small percentage of the area along the periphery of the habitat coverages was excluded so that the area coincided more closely to the area of the elevation coverage. Acreages of land cover/land use, by class, for the two levee options are presented in Table 13. The column on the left only includes habitat acreages that were present between the levees. The column on the right includes habitat acreages for the entire floodplain. The submergents rooted floating aquatics emergents class did not occur anywhere

and was excluded from the analysis. Similarly, acreage figures for aquatic areas are presented in Table 14. A number of classes shown in Figure 4 were not found in Pool 25 and were therefore not included in the analysis.

Acreages for each land cover class, for each of the four discharges under the present water level management plan, are provided in Table 15 for the management option with levees in place and Table 16 for the option with levees removed. Tables 17 and 18 contain similar information for the aquatic areas. Acreages for a specific class do not necessarily increase or decrease as a function of discharge, because water levels in Pool 25 are presently managed by a midpool control method. As discharges increase with this method, water levels may be increasing in the upriver part of the pool, while at the same time decreasing in the downriver part of the pool.

Comparison of Scenarios

Predicted acreages for each land cover class at each water level management plan, with levees in place, are provided in Tables 19 (19,000 cfs), 20 (56,000 cfs), 21 (95,000 cfs), and 22 (135,000 cfs). Tables 23 through 26 contain similar information for the option with levees removed. An equivalent set of tables (27 through 34) include acreages for aquatic area classes.

Because habitat classes change as a function of discharge and of water level management plans, viewing total acreage figures may be confusing. We have attempted to show changes only as a function of management alternatives by comparing Plans 2 through 5 to the present plan for each level of discharge. The effects of water level management Plans 2 through 5 on land cover classes, when compared with the present plan with levees in place, are presented in Tables 35 (19,000 cfs), 36 (56,000 cfs), 37 (95,000 cfs), and 38 (135,000 cfs). Similar information is presented in Tables 39 through 42 when levees are removed. The effects on aquatic areas are presented in Tables 43 through 46 when levees remain in place and Tables 47 through 50 when levees are removed. These tables show both the number of acres changed when each plan is compared with the present plan and the percent change. It should be noted that the maximum loss is 100%, but that increases can be greater than 100%.

Maps showing the comparisons for land cover, between Plan 2 and Plan 1, are provided in Figures 21 through 28. As can be seen in these figures, the greatest area of change is in the southern portion of the floodplain. Relatively minor changes occur in the northern portion of the pool as a result of any plan.

Changes for all classes in the model are strictly a function of elevation. If an elevation anywhere in the floodplain is lower than the predicted water elevation for that river mile, that area would remain aquatic or would become an inundated terrestrial area, even if the area was surrounded by land that was higher than the water surface elevation. Similarly, any area can drain as waters recede, even if the area is effectively cut off from the river. This is especially important in the southern portion of the floodplain on the Missouri side of the river. Most of this area now drains into Pool 26. Lock and Dam 25 would have to be extended to the bluff and channels might have to be constructed to manage water levels and habitats as shown in Figures 21 through 28 and Tables 19 through 50.

The vast amount of data generated because we investigated 40 scenarios and more than 30 habitat types makes it extremely difficult to succinctly discuss results. However, as stated previously, habitat classes change both as a function of discharge and water level management plans. Viewing Figures 10 through 13, which show water levels as a function of discharge and water level management plans, may help the reader to better understand the results listed in Tables 35 through 50 and Figures 21 through 28. For example, little difference in water levels occurs anywhere in the pool when comparing Plans 1 and

2 at 19,000 cfs (Fig. 10), helping to explain why most acreage values under management Plan 2 are less than those of other management plans.

References

Hydrologic Engineering Center. 1990. HEC-2 Water surface profiles user's manual. U.S. Army Corps of Engineers, Davis, California. 308 pp.

Reed, H. L., T. J. Perkins, and G. L. Gray, Jr. 1993. Water resources data, Missouri water year 1992. U.S. Geological Survey Waterdata Report MO-92-1, Rolla, Missouri. 236 pp.

U.S. Army Corps of Engineers (USACOE). 1980. Mississippi River, Nine Foot Channel Navigation Project. Pages 1-1 through 6-2 *in* Appendix 25, Master Water Control Manual. Lock and Dam No. 25. St. Louis District, St. Louis, Missouri.

USACOE. 1991. Identification of constraints on regulation of Upper Mississippi River System Lock and Dam 18. Report by the U.S. Army Corps of Engineers, Rock Island, Illinois, for the U.S. Fish and Wildlife Service, Environmental Management Technical Center, Onalaska, Wisconsin, September 1991. EMTC 91-07. 54 pp. (NTIS #PB92-104728)

U.S. Fish and Wildlife Service. 1993. Operating Plan for the Upper Mississippi River System Long Term Resource Monitoring Program. Environmental Management Technical Center, Onalaska, Wisconsin, Revised September 1993. EMTC 91-P002R. 179 pp. (NTIS #PB94-160199)

Wilcox, D. B. 1993. An aquatic habitat classification system for the Upper Mississippi River System. U.S. Fish and Wildlife Service, Environmental Management Technical Center, Onalaska, Wisconsin, May 1993. EMTC 93-T003. 9 pp. + Appendix A. (NTIS #PB93-208981)

Wilcox, D. B., and K. W. Willis. 1993. Identification of constraints on river regulation. Lock and Dam 9 near Lynxville, Wisconsin, Upper Mississippi River 9-Foot Channel Project. Report by the U.S. Army Corps of Engineers, St. Paul District Minnesota, for the U.S. Fish and Wildlife Service, Environmental Management Technical Center, Onalaska, Wisconsin, August 1993. EMTC 93-S012. 91 pp. (NTIS #PB94-103603)

Wlosinski, J. H. 1996. Pool 25: Analysis of water levels and discharge. National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, March 1996. LTRMP 96-T001. 88 pp.

Wlosinski, J. H., and E. R. Koljord. 1996. An annotated bibliography on the effects of water levels on ecosystem components. National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin. (In press)

Table 1. Definitions of terms used in this report.

Term	Definition
Control point	A specific location in a pool where the U.S. Army Corps of Engineers maintains a target water level over a range of discharges.
Coverage	A geographical dataset containing attributes for discrete point, line, or polygon features in a vector dataset or cell values for raster datasets.
Geographic information system (GIS)	An organized collection of computer hardware, software, geographic data, and personnel adapted to efficiently capture, store, update, analyze, and display all forms of geographic information.
Grid	A geographic dataset used by ARC/INFO's raster GRID software.
Headwater	That part of a pool located immediately upriver of the dam.
Mask	Those cells within an analysis area that will not be considered when performing an operation or function. The area can be designated by a coverage with null data in masked areas.
Maximum drawdown	The maximum drop in water levels at the headwater, below the project pool elevation, that would still allow a 9-ft navigation channel.
Open river	The condition when all of the movable gates at a dam are raised out of the water and the headwater and tailwater elevations are nearly equal.
Overlay	A GIS process that operates on two or more datasets based on their geographic location. Types of operations include combining attributes of different coverages and performing mathematical functions based on attributes of multiple coverages.
Polygon	Discrete areas within closed arcs that represent areas on maps. Within a polygon is an identification label used to link the geographical location of the polygon to data tables containing information about the area.
Pool	The body of water created upriver of a dam.
Project pool elevation	The water level elevation needed to maintain a 9-ft channel at zero discharge, and for which each dam was designed.
Raster	A type of database that stores information as regularly spaced square cells.
Tailwater	That part of a pool located immediately downriver of the dam.
Vector	A GIS data structure that represents map features as a list of ordered x,y coordinates.

Table 2. Management scenarios tested for Pool 25.

Plan number	Alternative
Levees	
1	Present levees
2	No levees
Water level management plans	
1	Present plan
2	Control at the dam with present project pool elevation (434.0 ft)
3	Control at the dam with a 3-ft raise (437.0 ft)
4	Control at the dam with present drawdown elevation (429.7 ft)
5	Control at Dam 26 (gates at Lock and Dam 25 always in raised position)
Discharge regimes	
1	19,000 cfs
2	56,000 cfs
3	95,000 cfs
4	135,000 cfs

Table 3. Average water levels (in feet) at five stations in Pool 25 at various discharges. Values are based on average data collected from 1952 to 1993.

	River mile				
Discharge	**241.5**	**250.8**	**260.3**	**265.0**	**273.2**
19,000	433.8	434.0	434.1	434.2	434.6
56,000	433.8	434.1	434.9	435.6	437.3
95,000	431.7	433.0	435.7	437.1	439.9
135,000	429.9	433.7	437.9	439.8	443.0

Table 4. Long Term Resource Monitoring Program's 13-class generalized land cover/land use classification system for the Upper Mississippi River System.

Open water: Areas classified as Open Water have <10% vegetation cover and are classified as either water or duckweed. Note: Duckweed is treated as Open Water because of its mobile tendencies.

Submergents: Land cover types grouped into this class are areas classified as having either submergent vegetation or submergent vegetation mixed with duckweed.

Submergents–rooted floating aquatics: Land cover types grouped into this class contain mixtures of submergents combined with American lotus, watershields, and white water lily.

Submergents–rooted floating aquatics–emergents: Land cover types grouped into this class mixtures of submergents combined with American lotus or white water lily or both, along with arrowhead, bulrush, burreed, pickerelweed, or wild rice.

Rooted floating aquatics: Land cover types grouped into this class contain either pure stands or mixtures of American lotus, watershields, water primrose, white water lily, or yellow water lily.

Rooted floating aquatics–emergents: Land cover types grouped into this class contain mixtures of American lotus or white water lily or both mixed with arrowhead or bulrush or both.

Emergents: Land cover types grouped into this class contain either pure stands or mixtures of arrowhead, bulrush, burheads, bur-reed, cattail, flat sedge, horsetail, pickerel weed, purple loosestrife, sedges, sedge meadow, spike rush, sweetflag grass, water willow, or wild rice.

Emergents–grasses–forbs: Land cover types grouped into this class contain mixtures or arrowhead, bulrush, cattail, or purple loosestrife mixed with common reed, cutgrass, reed canary grass, sedges, or smartweed.

Grasses–forbs: Land cover types grouped into this class contain either pure stands or mixtures of cord grass, common reed, cutgrass, lowland hay meadow, grass, live stem vines, mixed forbs or grasses, nettles, pasture, ragweed, reed canary grass, roadsides–levees, sand–prairie, smartweed, or upland meadows.

Woody terrestrial: Land cover types grouped into this class contain either pure stands or mixtures of ash, bald cypress, birch, button bush, conifers, cottonwood, Eastern red cedar, elm, false indigo, hickory, maple, mesic forests, oaks, plantations, shrubs, sour gum, upland forests, or willow.

Agriculture: Agriculture is used to define any area where the ground is turned with a plow or worked with a disk.

Urban–developed: Land cover types grouped into this class area are areas that have been developed into campgrounds, picnic areas, industrial developments, urban developments, or are covered with riprap.

Sand–mud: Land cover types classified as Sand–Mud have <10% vegetation cover and are classified as either sand or mud.

Table 5. Alternative management scenarios for Pool 25. The first digit of the scenario number represents levee options, the second digit represents management plans, and the last digit represents discharge regimes.

Scenario number	Levees	Management plan	Discharge (cfs)
111	yes	present plan	19,000
112	yes	present plan	56,000
113	yes	present plan	95,000
114	yes	present plan	135,000
121	yes	dam control 434.0 ft	19,000
122	yes	dam control 434.0 ft	56,000
123	yes	dam control 434.0 ft	95,000
124	yes	dam control 434.0 ft	135,000
131	yes	dam control 437.0 ft	19,000
132	yes	dam control 437.0 ft	56,000
133	yes	dam control 437.0 ft	95,000
134	yes	dam control 437.0 ft	135,000
141	yes	dam control 429.7 ft	19,000
142	yes	dam control 429.7 ft	56,000
143	yes	dam control 429.7 ft	95,000
144	yes	dam control 429.7 ft	135,000
151	yes	no dam 25 control	19,000
152	yes	no dam 25 control	56,000
153	yes	no dam 25 control	95,000
154	yes	no dam 25 control	135,000
211	no	present plan	19,000
212	no	present plan	56,000
213	no	present plan	95,000
214	no	present plan	135,000
221	no	dam control 434.0 ft	19,000
222	no	dam control 434.0 ft	56,000
223	no	dam control 434.0 ft	95,000
224	no	dam control 434.0 ft	135,000
231	no	dam control 437.0 ft	19,000
232	no	dam control 437.0 ft	56,000
233	no	dam control 437.0 ft	95,000
234	no	dam control 437.0 ft	135,000
241	no	dam control 429.7 ft	19,000
242	no	dam control 429.7 ft	56,000
243	no	dam control 429.7 ft	95,000
244	no	dam control 429.7 ft	135,000
251	no	no dam 25 control	19,000
252	no	no dam 25 control	56,000
253	no	no dam 25 control	95,000
254	no	no dam 25 control	135,000

Table 6. Predicted water elevations for each river mile using water level management (Plan 1).

River mile	Discharge regime (cfs)			
	19,000	56,000	95,000	135,000
242	433.8	433.8	431.7	430.0
243	433.8	433.8	431.9	430.6
244	433.8	433.9	432.1	430.9
245	433.8	433.9	432.2	431.3
246	433.8	433.9	432.3	431.5
247	433.8	434.0	432.5	432.0
248	433.8	434.1	432.8	432.6
249	433.8	434.1	433.0	433.0
250	433.8	434.2	433.2	433.4
251	433.9	434.2	433.4	433.8
252	433.9	434.3	433.5	434.0
253	433.9	434.3	433.7	434.3
254	433.9	434.4	434.0	434.9
255	433.9	434.5	434.2	435.6
256	433.9	434.6	434.5	436.1
257	433.9	434.7	434.8	436.9
258	433.9	434.8	435.2	437.5
259	433.9	434.9	435.3	437.7
260	434.0	435.0	435.7	438.1
261	434.0	435.1	435.9	438.4
262	434.0	435.2	436.1	438.7
263	434.0	435.3	436.4	439.0
264	434.0	435.5	436.8	439.5
265	434.1	435.6	437.1	440.0
266	434.1	435.8	437.4	440.3
267	434.1	436.0	438.0	440.8
268	434.2	436.1	438.3	441.0
269	434.2	436.2	438.5	441.2
270	434.2	436.5	438.9	441.7
271	434.3	436.7	439.3	442.1
272	434.3	436.8	439.7	442.5
273	434.3	436.9	440.2	442.8

Table 7. Predicted water elevations for each river mile using water level management (Plan 2).

River mile	Discharge regime (cfs)			
	19,000	56,000	95,000	135,000
242	434.0	434.0	434.0	434.0
243	434.0	434.0	434.1	434.2
244	434.0	434.1	434.2	434.4
245	434.0	434.1	434.3	434.7
246	434.0	434.1	434.4	434.8
247	434.0	434.2	434.5	435.0
248	434.0	434.3	434.7	435.3
249	434.0	434.3	434.8	435.6
250	434.0	434.4	435.0	435.8
251	434.1	434.4	435.1	436.0
252	434.1	434.5	435.2	436.2
253	434.1	434.5	435.4	436.4
254	434.1	434.6	435.6	436.8
255	434.1	434.7	435.9	437.2
256	434.1	434.8	436.1	437.5
257	434.1	434.9	436.6	438.0
258	434.1	435.0	436.9	438.4
259	434.1	435.1	437.0	438.6
260	434.1	435.2	437.3	438.9
261	434.2	435.3	437.5	439.2
262	434.2	435.3	437.7	439.4
263	434.2	435.5	437.9	439.7
264	434.2	435.7	438.2	440.1
265	434.3	435.8	438.7	440.5
266	434.3	435.9	438.9	440.7
267	434.3	436.1	439.3	441.2
268	434.3	436.3	439.5	441.3
269	434.4	436.4	439.7	441.5
270	434.4	436.6	440.0	442.0
271	434.5	436.8	440.4	442.4
272	434.5	436.9	440.7	442.7
273	434.5	437.1	441.0	443.0

Table 8. Predicted water elevations for each river mile using water level management (Plan 3).

River mile	Discharge regime (cfs)			
	19,000	56,000	95,000	135,000
242	437.0	437.0	437.0	437.0
243	437.0	437.0	437.1	437.1
244	437.0	437.0	437.1	437.2
245	437.0	437.1	437.2	437.4
246	437.0	437.1	437.2	437.4
247	437.0	437.1	437.3	437.6
248	437.0	437.1	437.4	437.8
249	437.0	437.2	437.5	437.9
250	437.0	437.2	437.5	438.1
251	437.0	437.2	437.6	438.2
252	437.0	437.3	437.7	438.3
253	437.0	437.3	437.8	438.4
254	437.0	437.3	437.9	438.7
255	437.1	437.4	438.0	438.9
256	437.1	437.5	438.2	439.2
257	437.1	437.5	438.4	439.4
258	437.1	437.6	438.6	439.7
259	437.1	437.7	438.7	439.8
260	437.1	437.7	438.8	440.1
261	437.1	437.8	438.9	440.3
262	437.1	437.9	439.1	440.5
263	437.1	437.9	439.2	440.7
264	437.1	438.0	439.4	441.0
265	437.1	438.3	439.7	441.3
266	437.2	438.4	439.9	441.5
267	437.2	438.5	440.2	441.8
268	437.2	438.6	440.3	442.0
269	437.2	438.7	440.4	442.1
270	437.2	438.8	440.7	442.5
271	437.2	438.9	441.0	442.9
272	437.3	439.1	441.2	443.2
273	437.3	439.3	441.5	443.4

Table 9. Predicted water elevations for each river mile using water level management (Plan 4).

River mile	Discharge regime (cfs)			
	19,000	56,000	95,000	135,000
242	429.7	429.7	429.8	429.8
243	429.7	429.8	430.1	430.4
244	429.7	429.9	430.3	430.8
245	429.7	430.0	430.5	431.2
246	429.7	430.0	430.6	431.4
247	429.7	430.2	430.9	431.9
248	429.8	430.3	431.3	432.5
249	429.8	430.4	431.5	432.9
250	429.8	430.6	431.9	433.3
251	429.8	430.7	432.1	433.7
252	429.8	430.8	432.3	433.9
253	429.9	430.9	432.6	434.3
254	429.9	431.1	432.9	434.9
255	429.9	431.3	433.3	435.5
256	430.0	431.5	433.6	436.1
257	430.0	431.8	434.0	436.9
258	430.1	432.1	434.5	437.5
259	430.1	432.2	434.6	437.6
260	430.1	432.4	434.9	438.1
261	430.2	432.6	435.2	438.4
262	430.3	432.8	435.5	438.7
263	430.3	433.1	435.8	439.0
264	430.4	433.5	436.3	439.5
265	430.5	433.8	436.6	440.0
266	430.6	434.0	436.9	440.3
267	430.8	434.4	437.4	440.8
268	430.9	434.6	437.7	441.0
269	430.9	434.7	437.9	441.2
270	431.1	435.1	438.4	441.7
271	431.3	435.5	438.9	442.1
272	431.3	435.6	439.4	442.5
273	431.4	435.8	439.9	442.8

Table 10. Predicted water elevations for each river mile using water level management (Plan 5).

River mile	Discharge regime (cfs)			
	19,000	56,000	95,000	135,000
242	419.2	422.0	425.1	428.3
243	419.9	423.4	426.3	429.2
244	420.1	423.8	426.7	429.7
245	420.1	423.9	427.1	430.1
246	420.1	424.0	427.2	430.3
247	420.3	424.5	427.9	431.0
248	420.4	424.8	428.4	431.7
249	420.7	425.2	428.9	432.2
250	421.0	425.7	429.5	432.7
251	421.1	426.2	429.9	433.2
252	421.3	426.4	430.2	433.4
253	421.4	426.8	430.7	433.8
254	422.0	427.5	431.3	434.4
255	423.3	428.2	431.8	434.8
256	424.0	428.8	432.3	435.3
257	425.3	429.6	432.9	436.2
258	426.0	430.3	433.5	436.9
259	426.0	430.3	433.7	437.1
260	426.1	430.6	434.0	437.6
261	426.2	431.0	434.4	438.0
262	426.3	431.3	434.7	438.3
263	426.5	431.8	435.2	438.7
264	426.8	432.4	435.7	439.2
265	427.0	432.8	436.1	439.8
266	427.3	433.1	436.5	440.1
267	428.3	433.6	437.0	440.6
268	428.6	433.9	437.3	440.8
269	428.8	434.1	437.5	441.1
270	429.4	434.5	438.0	441.6
271	429.7	434.9	438.4	442.0
272	429.7	435.1	438.6	442.4
273	429.8	435.3	438.9	442.7

Table 11. The predicted difference in water levels (in feet) from one end of Pool 25 to the other with various water level management alternatives and discharge regimes.

Management plan	Discharge regime (cfs)			
	19,000	56,000	95,000	135,000
1	0.5	3.1	8.5	12.8
2	0.5	3.1	7.0	9.0
3	0.3	2.3	4.5	6.4
4	1.7	6.1	10.1	13.0
5	10.6	13.3	13.8	14.4

Table 12. The amount of water level flexibility (in feet) among the various water level management plans and discharge regimes is given for locations at the headwater of Pool 25, near Mosier Landing, and at the tailwater of Pool 24.

Plans compared	River mile	Discharge regime (cfs)			
		19,000	56,000	95,000	135,000
1–2	241.5	0.2	0.2	2.7	4.0
	260.3	0.1	0.2	1.6	0.8
	273.2	0.2	0.2	0.8	0.2
1–3	241.5	3.2	3.2	6.3	7.0
	260.3	3.1	2.7	3.1	2.0
	273.2	3.0	2.4	1.3	0.6
1–4	241.5	4.1	4.1	1.9	0.2
	260.3	3.9	2.6	0.8	0.0
	273.2	2.9	1.1	0.3	0.0
1–5	241.5	14.6	11.8	6.6	1.7
	260.3	7.9	4.4	1.7	0.5
	273.2	4.5	1.6	1.3	0.1
2–3	241.5	3.0	3.0	3.0	3.0
	260.3	3.0	2.5	1.5	1.2
	273.2	2.8	2.2	0.5	0.4
2–4	241.5	4.3	4.3	4.2	4.2
	260.3	4.0	2.6	2.4	0.8
	273.2	3.1	1.3	1.2	0.2
2–5	241.5	14.8	12.0	8.9	5.7
	260.3	8.0	4.6	3.3	1.3
	273.2	4.7	1.8	2.1	0.3
3–4	241.5	7.3	7.3	7.2	7.2
	260.3	7.0	5.3	3.9	2.0
	273.2	5.9	3.5	1.6	0.6
3–5	241.5	17.8	15.0	11.9	8.7
	260.3	11.0	7.1	4.8	2.5
	273.2	7.5	4.0	2.6	0.7
4–5	241.5	10.5	7.7	4.7	1.5
	260.3	5.0	1.8	0.9	0.5
	273.2	1.6	0.5	1.0	0.1

Table 13. Acreages from the original land cover/land use classification for Pool 25 for the two levee options.

	Levees	
Class	**In place**	**Removed**
Open water	13,784	14,953
Submergents	762	868
Submergents–rooted floating aquatics	85	91
Rooted floating aquatics	45	65
Rooted floating aquatics–emergents	10	79
Emergents	337	556
Emergents–grasses–forbs	29	134
Grasses–forbs	792	4,448
Woody terrestrial	11,941	18,828
Agriculture	6,496	42,887
Urban–developed	415	970
Sand–mud	154	180
Dewatered aquatics	0	0
Inundated terrestrial	0	0
Total	34,851	84,060

Table 14. Acreages from the original aquatic areas classification for Pool 25 for the two levee options.

	Levees	
Class[a]	**In place**	**Removed**
Main channel	7,903	7,903
Secondary channel	3,974	3,974
Tertiary channel	78	78
Tributary channel	39	102
CFL-abandoned channel lake	1,092	1,352
CFL-borrow pit	3	3
CFL-floodplain depression lake	0	9
CF shallow aquatic area	811	811
Contiguous impounded area	412	412
CFL-humanmade lake	16	16
IFL-abandoned channel lake	590	1451
IFL-borrow pit	26	117
IF shallow aquatic area	28	99
IFL-humanmade lake	10	174
Nonaquatic/terrestrial area	19,861	67,547
Dewatered aquatics	0	0
Inundated terrestrial	0	0
Total	34,842	84,048

[a]CF = contiguous floodplain
CFL = contiguous floodplain lake
IF = isolated floodplain
IFL = isolated floodplain lake

Table 15. Land cover acreages for Pool 25 for various discharges using the present water level management plan with levees in place.

	Discharge (cfs)			
Class	**19,000**	**56,000**	**95,000**	**135,000**
Open water	13,124	13,249	12,812	12,878
Submergents	652	664	292	133
Submergents–rooted floating aquatics	57	62	35	22
Rooted floating aquatics	41	41	39	33
Rooted floating aquatics–emergents	6	7	1	2
Emergents	119	146	26	40
Emergents–grasses–forbs	28	27	26	23
Grasses–forbs	774	758	764	644
Woody terrestrial	11,551	11,075	11,271	9,973
Agriculture	6,495	6,482	6,463	6,236
Urban–developed	407	363	359	266
Sand–mud	112	84	92	52
Dewatered aquatics	1,024	853	1,818	1,915
Inundated terrestrial	461	1,038	853	2,633
Total	34,851	34,851	34,851	34,851

Table 16. Land cover acreages for the floodplain of Pool 25 for various discharges using the present water level management plan with levees removed.

	Discharge (cfs)			
Class	**19,000**	**56,000**	**95,000**	**135,000**
Open water	13,872	14,067	13,268	13,388
Submergents	673	688	303	161
Submergents–rooted floating aquatics	57	62	35	25
Rooted floating aquatics	44	45	39	36
Rooted floating aquatics–emergents	13	17	3	5
Emergents	161	220	47	83
Emergents–grasses–forbs	90	81	115	107
Grasses–forbs	4,134	4,102	4,141	3,873
Woody terrestrial	16,825	16,013	17,139	15,208
Agriculture	40,750	40,323	41,156	38,579
Urban–developed	882	832	850	762
Sand–mud	121	92	104	59
Dewatered aquatics	1,793	1,513	2,918	2,916
Inundated terrestrial	4,645	6,003	3,942	8,858
Total	84,060	84,060	84,060	84,060

Table 17. Aquatic area acreages for the floodplain of Pool 25 for various discharges using the present water level management plan with levees in place.

	Discharge (cfs)			
Class[a]	**19,000**	**56,000**	**95,000**	**135,000**
Main channel	7,876	7,891	7,832	7,775
Secondary channel	3,902	3,948	3,780	3,827
Tertiary channel	64	73	40	38
Tributary channel	20	22	23	34
CFL-abandoned channel lake	989	1,050	670	588
CFL-borrow pit	3	3	0	0
CFL-floodplain depression lake	0	0	0	0
CF shallow aquatic area	663	677	432	268
Contiguous impounded area	405	405	390	358
CFL-humanmade lake	14	16	15	10
IFL-abandoned channel lake	57	62	38	217
IFL-borrow pit	11	14	5	5
IF shallow aquatic area	0	0	0	0
IFL-humanmade lake	0	0	0	0
Nonaquatic/terrestrial area	19,355	18,789	18,944	17,174
Dewatered aquatics	979	820	1,756	1,861
Inundated terrestrial	506	1,072	917	2,687
Total	34,842	34,842	34,842	34,842

[a]CF = Contiguous floodplain
CFL = Contiguous floodplain lake
IF = Isolated floodplain
IFL = Isolated floodplain lake

Table 18. Aquatic area acreages for the floodplain of Pool 25 for various discharges using the present water level management plan with levees removed.

	Discharge (cfs)			
Class[a]	**19,000**	**56,000**	**95,000**	**135,000**
Main channel	7,876	7,891	7,832	7,775
Secondary channel	3,902	3,949	3,780	3,827
Tertiary channel	64	73	40	38
Tributary channel	44	46	46	62
CFL-abandoned channel lake	1,203	1,283	700	618
CFL-borrow pit	3	3	0	0
CFL-floodplain depression lake	8	8	8	8
CF shallow aquatic area	663	677	432	268
Contiguous impounded area	405	405	390	358
CFL-humanmade lake	14	16	15	10
IFL-abandoned channel lake	608	668	484	696
IFL-borrow pit	44	50	37	42
IF shallow aquatic area	0	0	0	0
IFL-humanmade lake	6	7	12	52
Nonaquatic/terrestrial area	62,770	61,455	63,410	58,525
Dewatered aquatics	1,662	1,424	2,724	2,747
Inundated terrestrial	4,777	6,092	4,136	9,022
Total	84,048	84,048	84,048	84,048

[a]CF = Contiguous floodplain
CFL = Contiguous floodplain lake
IF = Isolated floodplain
IFL = Isolated floodplain lake

Table 19. Acreages for land cover classes in Pool 25, with levees in place, at 19,000 cfs.

	Management plan				
Class	**1**	**2**	**3**	**4**	**5**
Open water	13,124	13,199	13,360	9,726	6,409
Submergents	652	691	730	42	0
Submergents–rooted floating aquatics	57	69	85	8	0
Rooted floating aquatics	41	41	43	23	0
Rooted floating aquatics–emergents	6	6	8	0	0
Emergents	119	175	247	0	0
Emergents–grasses–forbs	28	27	26	29	29
Grasses–forbs	774	770	718	791	792
Woody terrestrial	11,551	11,282	8,801	11,928	11,940
Agriculture	6,495	6,492	6,178	6,496	6,496
Urban–developed	407	394	229	414	414
Sand–mud	112	104	61	154	154
Dewatered aquatics	1,024	841	550	5,224	8,614
Inundated terrestrial	461	758	3,814	15	2
Total	34,851	34,851	34,851	34,851	34,851

Table 20. Acreages for land cover classes in Pool 25, with levees in place, at 56,000 cfs.

	Management plan				
Class	**1**	**2**	**3**	**4**	**5**
Open water	13,249	13,272	13,387	11,052	9,142
Submergents	664	698	734	44	2
Submergents–rooted floating aquatics	62	74	85	8	0
Rooted floating aquatics	41	41	43	23	0
Rooted floating aquatics–emergents	7	7	9	0	0
Emergents	146	188	254	0	0
Emergents–grasses–forbs	27	27	24	29	29
Grasses–forbs	758	756	705	783	786
Woody terrestrial	11,075	10,863	8,510	11,844	11,900
Agriculture	6,482	6,474	6,133	6,496	6,496
Urban–developed	363	355	219	412	413
Sand–mud	84	82	51	129	138
Dewatered aquatics	853	745	511	3,895	5,878
Inundated terrestrial	1,038	1,271	4,186	133	64
Total	34,851	34,851	34,851	34,851	34,851

Table 21. Acreages for land cover classes in Pool 25, with levees in place, at 95,000 cfs.

	Management plan				
Class	**1**	**2**	**3**	**4**	**5**
Open water	12,812	13,405	13,532	11,929	10,579
Submergents	292	717	743	73	8
Submergents–rooted floating aquatics	35	84	85	20	0
Rooted floating aquatics	39	41	43	31	0
Rooted floating aquatics–emergents	1	8	9	0	0
Emergents	26	227	275	7	2
Emergents–grasses–forbs	26	22	22	27	28
Grasses–forbs	764	677	611	768	772
Woody terrestrial	11,271	9,632	7,547	11,440	11,557
Agriculture	6,463	6,364	5,927	6,475	6,487
Urban–developed	359	260	200	388	405
Sand–mud	92	53	32	103	108
Dewatered aquatics	1,818	542	336	2,963	4,434
Inundated terrestrial	853	2,819	5,489	626	471
Total	34,851	34,851	34,851	34,851	34,851

Table 22. Acreages for land cover classes in Pool 25, with levees in place, at 135,000 cfs.

	Management plan				
Class	**1**	**2**	**3**	**4**	**5**
Open water	12,878	13,536	13,613	12,789	12,217
Submergents	133	732	752	104	39
Submergents–rooted floating aquatics	22	85	85	22	1
Rooted floating aquatics	33	43	43	32	11
Rooted floating aquatics–emergents	2	9	10	2	2
Emergents	40	252	309	39	24
Emergents–grasses–forbs	23	22	21	23	24
Grasses–forbs	644	600	533	645	663
Woody terrestrial	9,973	7,995	6,142	9,988	10,272
Agriculture	6,236	5,971	5,421	6,237	6,303
Urban–developed	266	203	164	266	304
Sand–mud	52	35	26	52	66
Dewatered aquatics	1,915	366	211	2,035	2,730
Inundated terrestrial	2,633	5,002	7,520	2,617	2,195
Total	34,851	34,851	34,851	34,851	34,851

Table 23. Acreages for land cover classes in Pool 25, with levees removed, at 19,000 cfs.

	Management plan				
Class	**1**	**2**	**3**	**4**	**5**
Open water	13,872	14,011	14,309	9,928	6,409
Submergents	673	715	765	48	0
Submergents–rooted floating aquatics	57	69	85	8	0
Rooted floating aquatics	44	45	61	23	0
Rooted floating aquatics–emergents	13	16	24	0	0
Emergents	161	255	363	7	0
Emergents–grasses–forbs	90	83	71	122	134
Grasses–forbs	4,134	4,110	3,854	4,307	4,448
Woody terrestrial	16,825	16,227	11,702	18,516	18,827
Agriculture	40,750	40,427	32,885	42,820	42,885
Urban–developed	882	863	497	957	969
Sand–mud	121	112	68	168	180
Dewatered aquatics	1,793	1,501	1,006	6,600	10,204
Inundated terrestrial	4,645	5,624	18,371	557	4
Total	84,060	84,060	84,060	84,060	84,060

Table 24. Acreages for land cover classes in Pool 25, with levees removed, at 56,000 cfs.

	Management plan				
Class	**1**	**2**	**3**	**4**	**5**
Open water	14,067	14,106	14,358	11,462	9,153
Submergents	688	723	773	51	2
Submergents–rooted floating aquatics	62	74	85	8	0
Rooted floating aquatics	45	46	61	23	0
Rooted floating aquatics–emergents	17	18	25	0	0
Emergents	220	278	378	8	0
Emergents–grasses–forbs	81	79	68	120	134
Grasses–forbs	4,102	4,084	3,786	4,267	4,435
Woody terrestrial	16,013	15,606	11,292	18,260	18,781
Agriculture	40,323	40,056	32,335	42,588	42,884
Urban–developed	832	820	484	944	967
Sand–mud	92	90	57	144	164
Dewatered aquatics	1,513	1,369	933	5,061	7,458
Inundated terrestrial	6,003	6,712	19,424	1,125	81
Total	84,060	84,060	84,060	84,060	84,060

Table 25. Acreages for land cover classes in Pool 25, with levees removed, at 95,000 cfs.

	Management plan				
Class	**1**	**2**	**3**	**4**	**5**
Open water	13,268	14,352	14,541	12,355	10,643
Submergents	303	755	801	83	9
Submergents–rooted floating aquatics	35	84	90	20	0
Rooted floating aquatics	39	49	63	31	0
Rooted floating aquatics–emergents	3	22	26	0	0
Emergents	47	349	419	19	7
Emergents–grasses–forbs	115	67	59	116	131
Grasses–forbs	4,141	3,849	3,547	4,210	4,314
Woody terrestrial	17,139	13,501	9,795	17,669	18,244
Agriculture	41,156	37,557	30,681	42,013	42,616
Urban–developed	850	694	461	910	958
Sand–mud	104	59	34	117	132
Dewatered aquatics	2,918	1,003	674	4,105	5,955
Inundated terrestrial	3,942	11,719	22,868	2,412	1,051
Total	84,060	84,060	84,060	84,060	84,060

Table 26. Acreages for land cover classes in Pool 25, with levees removed, at 135,000 cfs.

	Management plan				
Class	**1**	**2**	**3**	**4**	**5**
Open water	13,388	14,545	14,669	13,295	12,700
Submergents	161	794	836	132	64
Submergents–rooted floating aquatics	25	90	91	24	2
Rooted floating aquatics	36	55	63	34	13
Rooted floating aquatics–emergents	5	25	78	4	3
Emergents	83	397	499	82	60
Emergents–grasses–forbs	107	57	48	107	109
Grasses–forbs	3,873	3,528	2,495	3,879	3,960
Woody terrestrial	15,208	10,720	7,880	15,267	15,851
Agriculture	38,579	33,681	25,924	38,647	39,717
Urban–developed	762	590	417	764	825
Sand–mud	59	36	27	59	78
Dewatered aquatics	2,916	707	378	3,042	3,772
Inundated terrestrial	8,858	18,834	30,656	8,723	6,907
Total	84,060	84,060	84,060	84,060	84,060

Table 27. Acreages for aquatic area classes in Pool 25, with levees in place, at 19,000 cfs.

	Management plan				
Class[a]	**1**	**2**	**3**	**4**	**5**
Main channel	7,876	7,887	7,901	7,118	5,469
Secondary channel	3,902	3,928	3,967	2,113	843
Tertiary channel	64	71	77	0	0
Tributary channel	20	21	23	1	0
CFL-abandoned channel lake	989	1,032	1,089	54	0
CFL-borrow pit	3	3	3	0	0
CFL-floodplain depression lake	0	0	0	0	0
CF shallow aquatic area	663	736	810	165	2
Contiguous impounded area	405	407	412	344	98
CFL-humanmade lake	14	15	16	5	0
IFL-abandoned channel lake	57	59	121	18	18
IFL-borrow pit	11	13	20	4	4
IF shallow aquatic area	0	0	0	0	0
IFL-humanmade lake	0	0	0	0	0
Nonaquatic/terrestrial area	19,355	19,072	16,039	19,780	19,793
Dewatered aquatics	979	810	543	5,157	8,547
Inundated terrestrial	506	789	3,822	81	68
Total	34,842	34,842	34,842	34,842	34,842

[a]CF = continuous floodplain
CFL = continuous floodplain lake
IF = isolated floodplain
IFL = isolated floodplain lake

Table 28. Acreages for aquatic area classes in Pool 25, with levees in place, at 56,000 cfs.

	Management plan				
Class[a]	**1**	**2**	**3**	**4**	**5**
Main channel	7,891	7,895	7,902	7,460	6,742
Secondary channel	3,948	3,955	3,969	2,997	2,211
Tertiary channel	73	75	77	11	8
Tributary channel	22	22	23	15	15
CFL-abandoned channel lake	1,050	1,064	1,089	130	13
CFL-borrow pit	3	3	3	0	0
CFL-floodplain depression lake	0	0	0	0	0
CF shallow aquatic area	677	747	810	165	4
Contiguous impounded area	405	407	412	344	150
CFL-humanmade lake	16	16	16	7	2
IFL-abandoned channel lake	62	64	153	18	18
IFL-borrow pit	14	14	20	4	4
IF shallow aquatic area	0	0	0	0	0
IFL-humanmade lake	0	0	0	0	0
Nonaquatic/terrestrial area	18,789	18,565	15,668	19,661	19,730
Dewatered aquatics	820	720	507	3,829	5,812
Inundated terrestrial	1,072	1,296	4,193	199	131
Total	34,842	34,842	34,842	34,842	34,842

[a]CF = continuous floodplain
CFL = continuous floodplain lake
IF = isolated floodplain
IFL = isolated floodplain lake

Table 29. Acreages for aquatic area classes in Pool 25, with levees in place, at 95,000 cfs.

	Management plan				
Class[a]	**1**	**2**	**3**	**4**	**5**
Main channel	7,832	7,899	7,902	7,664	7,289
Secondary channel	3,780	3,966	3,970	3,443	2,991
Tertiary channel	40	77	77	15	11
Tributary channel	23	31	33	22	22
CFL-abandoned channel lake	670	1,084	1,090	342	80
CFL-borrow pit	0	3	3	0	0
CFL-floodplain depression lake	0	0	0	0	0
CF shallow aquatic area	432	789	810	213	6
Contiguous impounded area	390	407	412	344	182
CFL-humanmade lake	15	16	16	9	5
IFL-abandoned channel lake	38	160	307	27	22
IFL-borrow pit	5	18	20	5	4
IF shallow aquatic area	0	0	0	0	0
IFL-humanmade lake	0	0	0	0	0
Nonaquatic/terrestrial area	18,944	17,034	14,378	19,170	19,325
Dewatered aquatics	1,756	530	341	2,898	4,369
Inundated terrestrial	917	2,827	5,483	691	536
Total	34,842	34,842	34,842	34,842	34,842

[a]CF = continuous floodplain
CFL = continuous floodplain lake
IF = isolated floodplain
IFL = isolated floodplain lake

Table 30. Acreages for aquatic area classes in Pool 25, with levees in place, at 135,000 cfs.

	Management plan				
Class[a]	**1**	**2**	**3**	**4**	**5**
Main channel	7,775	7,900	7,902	7,762	7,683
Secondary channel	3,827	3,969	3,971	3,800	3,597
Tertiary channel	38	77	78	29	24
Tributary channel	34	34	36	34	33
CFL-abandoned channel lake	588	1,088	1,090	572	409
CFL-borrow pit	0	3	3	0	0
CFL-floodplain depression lake	0	0	0	0	0
CF shallow aquatic area	268	807	810	229	106
Contiguous impounded area	358	409	412	344	278
CFL-humanmade lake	10	16	16	10	9
IFL-abandoned channel lake	217	296	416	214	164
IFL-borrow pit	5	20	22	5	5
IF shallow aquatic area	0	0	0	0	0
IFL-humanmade lake	0	0	0	0	0
Nonaquatic/terrestrial area	17,174	14,855	12,352	17,191	17,612
Dewatered aquatics	1,861	362	225	1,982	2,675
Inundated terrestrial	2,687	5,006	7,509	2,670	2,249
Total	34,842	34,842	34,842	34,842	34,842

[a]CF = continuous floodplain
CFL = continuous floodplain lake
IF = isolated floodplain
IFL = isolated floodplain lake

Table 31. Acreages for aquatic area classes in Pool 25, with levees removed, at 19,000 cfs.

	Management plan				
Class[a]	**1**	**2**	**3**	**4**	**5**
Main channel	7,876	7,887	7,901	7,118	5,469
Secondary channel	3,902	3,929	3,968	2,113	843
Tertiary channel	64	71	77	0	0
Tributary channel	44	45	47	17	0
CFL-abandoned channel lake	1,203	1,265	1,322	84	27
CFL-borrow pit	3	3	3	0	0
CFL-floodplain depression lake	8	8	9	8	0
CF shallow aquatic area	663	736	810	165	2
Contiguous impounded area	405	407	412	344	98
CFL-humanmade lake	14	15	16	5	0
IFL-abandoned channel lake	608	658	872	216	47
IFL-borrow pit	44	48	62	30	30
IF shallow aquatic area	0	0	0	0	0
IFL-humanmade lake	6	6	23	4	2
Nonaquatic/terrestrial area	62,770	61,845	49,149	66,786	67,322
Dewatered aquatics	1,662	1,424	979	6,397	9,984
Inundated terrestrial	4,777	5,701	18,398	761	225
Total	84,048	84,048	84,048	84,048	84,048

[a]CF = continuous floodplain
CFL = continuous floodplain lake
IF = isolated floodplain
IFL = isolated floodplain lake

Table 32. Acreages for aquatic area classes in Pool 25, with levees removed, at 56,000 cfs.

	Management plan				
Class[a]	**1**	**2**	**3**	**4**	**5**
Main channel	7,891	7,895	7,902	7,460	6,742
Secondary channel	3,949	3,956	3,970	2,997	2,211
Tertiary channel	73	75	77	11	8
Tributary channel	46	46	48	37	15
CFL-abandoned channel lake	1,283	1,297	1,322	160	40
CFL-borrow pit	3	3	3	0	0
CFL-floodplain depression lake	8	8	9	8	0
CF shallow aquatic area	677	747	810	165	4
Contiguous impounded area	405	407	412	344	150
CFL-humanmade lake	16	16	16	7	2
IFL-abandoned channel lake	668	689	928	418	57
IFL-borrow pit	50	52	62	31	30
IF shallow aquatic area	0	0	0	0	0
IFL-humanmade lake	7	7	32	4	2
Nonaquatic/terrestrial area	61,455	60,770	48,099	66,221	67,245
Dewatered aquatics	1,424	1,304	911	4,860	7,238
Inundated terrestrial	6,092	6,777	19,448	1,325	301
Total	84,048	84,048	84,048	84,048	84,048

[a]CF = continuous floodplain
CFL = continuous floodplain lake
IF = isolated floodplain
IFL = isolated floodplain lake

Table 33. Acreages for aquatic area classes in Pool 25, with levees removed, at 95,000 cfs.

	Management plan				
Class[a]	**1**	**2**	**3**	**4**	**5**
Main channel	7,832	7,899	7,902	7,664	7,289
Secondary channel	3,780	3,967	3,971	3,443	2,991
Tertiary channel	40	77	78	15	11
Tributary channel	46	55	58	45	41
CFL-abandoned channel lake	700	1,317	1,323	372	107
CFL-borrow pit	0	3	3	0	0
CFL-floodplain depression lake	8	8	9	8	2
CF shallow aquatic area	432	789	810	213	6
Contiguous impounded area	390	407	412	344	182
CFL-humanmade lake	15	16	16	9	5
IFL-abandoned channel lake	484	898	1,117	445	95
IFL-borrow pit	37	60	66	33	31
IF shallow aquatic area	0	0	0	0	0
IFL-humanmade lake	12	37	59	6	3
Nonaquatic/terrestrial area	63,410	55,799	44,684	64,935	66,280
Dewatered aquatics	2,724	967	678	3,906	5,739
Inundated terrestrial	4,136	11,748	22,862	2,612	1,267
Total	84,048	84,048	84,048	84,048	84,048

[a]CF = continuous floodplain
CFL = continuous floodplain lake
IF = isolated floodplain
IFL = isolated floodplain lake

Table 34. Acreages for aquatic area classes in Pool 25, with levees removed, at 135,000 cfs.

	Management plan				
Class[a]	**1**	**2**	**3**	**4**	**5**
Main channel	7,775	7,900	7,903	7,762	7,683
Secondary channel	3,827	3,970	3,972	3,800	3,597
Tertiary channel	38	77	78	29	24
Tributary channel	62	63	66	62	58
CFL-abandoned channel lake	618	1,321	1,324	601	438
CFL-borrow pit	0	3	3	0	0
CFL-floodplain depression lake	8	8	9	8	5
CF shallow aquatic area	268	807	810	229	106
Contiguous impounded area	358	409	412	344	278
CFL-humanmade lake	10	16	16	10	9
IFL-abandoned channel lake	696	1,088	1,234	690	627
IFL-borrow pit	42	67	87	42	38
IF shallow aquatic area	0	0	0	0	0
IFL-humanmade lake	52	67	90	52	44
Nonaquatic/terrestrial area	58,525	48,711	36,949	58,659	60,469
Dewatered aquatics	2,747	704	500	2,873	3,595
Inundated terrestrial	9,022	18,836	30,597	8,887	7,078
Total	84,048	84,048	84,048	84,048	84,048

[a]CF = continuous floodplain
CFL = continuous floodplain lake
IF = isolated floodplain
IFL = isolated floodplain lake

Table 35. The effect of various management alternatives on land cover classes in Pool 25, with levees in place, at 19,000 cfs. Values are reported as acres or percentages and are calculated as the difference between an alternative plan and the present plan (Plan 1). Parentheses signify that the alternative plan has fewer acres.

	Management plan							
	2		3		4		5	
Class	Acres	%	Acres	%	Acres	%	Acres	%
Open water	75	1	236	2	(3,398)	(26)	(6,715)	(51)
Submergents	39	6	78	12	(610)	(94)	(652)	(100)
Submergents–rooted floating aquatics	12	21	28	49	(49)	(86)	(57)	(100)
Rooted floating aquatics	0	0	2	5	(18)	(44)	(41)	(100)
Rooted floating aquatics–emergents	0	0	2	33	(6)	(100)	(6)	(100)
Emergents	56	47	128	108	(119)	(100)	(119)	(100)
Emergents–grasses–forbs	(1)	(4)	(2)	(7)	1	4	1	4
Grasses–forbs	(4)	(1)	(56)	(7)	17	2	18	2
Woody terrestrial	(269)	(2)	(2,750)	(24)	377	3	389	3
Agriculture	(3)	0	(317)	(5)	1	0	1	0
Urban–developed	(13)	(3)	(178)	(44)	7	2	7	2
Sand–mud	(8)	(7)	(51)	(46)	42	38	42	38
Dewatered aquatics	(183)	(18)	(474)	(46)	4,200	410	7,590	741
Inundated terrestrial	297	64	3,353	727	(446)	(97)	(459)	(100)

Table 36. The effect of various management alternatives on land cover classes in Pool 25, with levees in place, at 56,000 cfs. Values are reported as acres or percentages and are calculated as the difference between an alternative plan and the present plan (Plan 1). Parentheses signify that the alternative plan has fewer acres.

	Management plan							
	2		3		4		5	
Class	Acres	%	Acres	%	Acres	%	Acres	%
Open water	23	0	138	1	(2,197)	(17)	(4,107)	(31)
Submergents	34	5	70	11	(620)	(93)	(662)	(100)
Submergents–rooted floating aquatics	12	19	23	37	(54)	(87)	(62)	(100)
Rooted floating aquatics	0	0	2	5	(18)	(44)	(41)	(100)
Rooted floating aquatics–emergents	0	0	2	29	(7)	(100)	(7)	(100)
Emergents	42	29	108	74	(146)	(100)	(146)	(100)
Emergents–grasses–forbs	0	0	(3)	(11)	2	7	2	7
Grasses–forbs	(2)	0	(53)	(7)	25	3	28	4
Woody terrestrial	(212)	(2)	(2,565)	(23)	769	7	825	7
Agriculture	(8)	0	(349)	(5)	14	0	14	0
Urban–developed	(8)	(2)	(144)	(40)	49	13	50	14
Sand–mud	(2)	(2)	(33)	(39)	45	54	54	64
Dewatered aquatics	(108)	(13)	(342)	(40)	3,042	357	5,025	589
Inundated terrestrial	233	22	3,148	303	(905)	(87)	(974)	(94)

Table 37. The effect of various management alternatives on land cover classes in Pool 25, with levees in place, at 95,000 cfs. Values are reported as acres or percentages and are calculated as the difference between an alternative plan and the present plan (Plan 1). Parentheses signify that the alternative plan has fewer acres.

	Management plan							
	2		3		4		5	
Class	Acres	%	Acres	%	Acres	%	Acres	%
Open water	593	5	720	6	(883)	(7)	(2,233)	(17)
Submergents	425	146	451	154	(219)	(75)	(284)	(97)
Submergents–rooted floating aquatics	49	140	50	143	(15)	(43)	(35)	(100)
Rooted floating aquatics	2	5	4	10	(8)	(21)	(39)	(100)
Rooted floating aquatics–emergents	7	700	8	800	(1)	(100)	(1)	(100)
Emergents	201	773	249	958	(19)	(73)	(24)	(92)
Emergents–grasses–forbs	(4)	(15)	(4)	(15)	1	4	2	8
Grasses–forbs	(87)	(11)	(153)	(20)	4	1	8	1
Woody terrestrial	(1,639)	(15)	(3,724)	(33)	169	1	286	3
Agriculture	(99)	(2)	(536)	(8)	12	0	24	0
Urban–developed	(99)	(28)	(159)	(44)	29	8	46	13
Sand–mud	(39)	(42)	(60)	(65)	11	12	16	17
Dewatered aquatics	(1,276)	(70)	(1,482)	(82)	1,145	63	2,616	144
Inundated terrestrial	1,966	230	4,636	543	(227)	(27)	(382)	(45)

Table 38. The effect of various management alternatives on land cover classes in Pool 25, with levees in place, at 135,000 cfs. Values are reported as acres or percentages and are calculated as the difference between an alternative plan and the present plan (Plan 1). Parentheses signify that the alternative plan has fewer acres.

	Management plan							
	2		3		4		5	
Class	Acres	%	Acres	%	Acres	%	Acres	%
Open water	658	5	735	6	(89)	(1)	(661)	(5)
Submergents	599	450	619	465	(29)	(22)	(94)	(71)
Submergents–rooted floating aquatics	63	286	63	286	0	0	(21)	(95)
Rooted floating aquatics	10	30	10	30	(1)	(3)	(22)	(67)
Rooted floating aquatics–emergents	7	350	8	400	0	0	0	0
Emergents	212	530	269	673	(1)	(3)	(16)	(40)
Emergents–grasses–forbs	(1)	(4)	(2)	(9)	0	0	1	4
Grasses–forbs	(44)	(7)	(111)	(17)	1	0	19	3
Woody terrestrial	(1,978)	(20)	(3,831)	(38)	15	0	299	3
Agriculture	(265)	(4)	(815)	(13)	1	0	67	1
Urban–developed	(63)	(24)	(102)	(38)	0	0	38	14
Sand–mud	(17)	(33)	(26)	(50)	0	0	14	27
Dewatered aquatics	(1,549)	(81)	(1,704)	(89)	120	6	815	43
Inundated terrestrial	2,369	90	4,887	186	(16)	(1)	(438)	(17)

Table 39. The effect of various management alternatives on land cover classes in Pool 25, with levees removed, at 19,000 cfs. Values are reported as acres or percentages and are calculated as the difference between an alternative plan and the present plan (Plan 1). Parentheses signify that the alternative plan has fewer acres.

	Management plan							
	2		3		4		5	
Class	Acres	%	Acres	%	Acres	%	Acres	%
Open water	139	1	437	3	(3,944)	(28)	(7,463)	(54)
Submergents	42	6	92	14	(625)	(93)	(673)	(100)
Submergents–rooted floating aquatics	12	21	28	49	(49)	(86)	(57)	(100)
Rooted floating aquatics	1	2	17	39	(21)	(48)	(44)	(100)
Rooted floating aquatics–emergents	3	23	11	85	(13)	(100)	(13)	(100)
Emergents	94	58	202	125	(154)	(96)	(161)	(100)
Emergents–grasses–forbs	(7)	(8)	(19)	(21)	32	36	44	49
Grasses–forbs	(24)	(1)	(280)	(7)	173	4	314	8
Woody terrestrial	(598)	(4)	(5,123)	(30)	1,691	10	2,002	12
Agriculture	(323)	(1)	(7,865)	(19)	2,070	5	2,135	5
Urban–developed	(19)	(2)	(385)	(44)	75	9	87	10
Sand–mud	(9)	(7)	(53)	(44)	47	39	59	49
Dewatered aquatics	(292)	(16)	(787)	(44)	4,807	268	8,411	469
Inundated terrestrial	979	21	13,726	296	(4,088)	(88)	(4,641)	(100)

Table 40. The effect of various management alternatives on land cover classes in Pool 25, with levees removed, at 56,000 cfs. Values are reported as acres or percentages and are calculated as the difference between an alternative plan and the present plan (Plan 1). Parentheses signify that the alternative plan has fewer acres.

	Management plan							
	2		3		4		5	
Class	Acres	%	Acres	%	Acres	%	Acres	%
Open water	39	0	291	2	(2,605)	(19)	(4,914)	(35)
Submergents	35	5	85	12	(637)	(93)	(686)	(100)
Submergents–rooted floating aquatics	12	19	23	37	(54)	(87)	(62)	(100)
Rooted floating aquatics	1	2	16	36	(22)	(49)	(45)	(100)
Rooted floating aquatics–emergents	1	6	8	47	(17)	(100)	(17)	(100)
Emergents	58	26	158	72	(212)	(96)	(220)	(100)
Emergent–grasses–forbs	(2)	(2)	(13)	(16)	39	48	53	65
Grasses–forbs	(18)	0	(316)	(8)	165	4	333	8
Woody terrestrial	(407)	(3)	(4,721)	(29)	2,247	14	2,768	17
Agriculture	(267)	(1)	(7,988)	(20)	2,265	6	2,561	6
Urban–developed	(12)	(1)	(348)	(42)	112	13	135	16
Sand–mud	(2)	(2)	(35)	(38)	52	57	72	78
Dewatered aquatics	(144)	(10)	(580)	(38)	3,548	235	5,945	393
Inundated terrestrial	709	12	13,421	224	(4,878)	(81)	(5,922)	(99)

Table 41. The effect of various management alternatives on land cover classes in Pool 25, with levees removed, at 95,000 cfs. Values are reported as acres or percentages and are calculated as the difference between an alternative plan and the present plan (Plan 1). Parentheses signify that the alternative plan has fewer acres.

	Management plan							
	2		3		4		5	
Class	Acres	%	Acres	%	Acres	%	Acres	%
Open water	1,084	8	1,273	10	(913)	(7)	(2,625)	(20)
Submergents	452	149	498	164	(220)	(73)	(294)	(97)
Submergents–rooted floating aquatics	49	140	55	157	(15)	(43)	(35)	(100)
Rooted floating aquatics	10	26	24	62	(8)	(21)	(39)	(100)
Rooted floating aquatics–emergents	19	633	23	767	(3)	(100)	(3)	(100)
Emergents	302	643	372	791	(28)	(60)	(40)	(85)
Emergents–grasses–forbs	(48)	(42)	(56)	(49)	1	1	16	14
Grasses–forbs	(292)	(7)	(594)	(14)	69	2	173	4
Woody terrestrial	(3,638)	(21)	(7,344)	(43)	530	3	1,105	6
Agriculture	(3,599)	(9)	(10,475)	(25)	857	2	1,460	4
Urban–developed	(156)	(18)	(389)	(46)	60	7	108	13
Sand–mud	(45)	(43)	(70)	(67)	13	13	28	27
Dewatered aquatics	(1,915)	(66)	(2,244)	(77)	1,187	41	3,037	104
Inundated terrestrial	7,777	197	18,926	480	(1,530)	(39)	(2,891)	(73)

Table 42. The effect of various management alternatives on land cover classes in Pool 25, with levees removed, at 135,000 cfs. Values are reported as acres or percentages and are calculated as the difference between an alternative plan and the present plan (Plan 1). Parentheses signify that the alternative plan has fewer acres.

	Management plan							
	2		3		4		5	
Class	Acres	%	Acres	%	Acres	%	Acres	%
Open water	1,157	9	1,281	10	(93)	(1)	(688)	(5)
Submergents	633	393	675	419	(29)	(18)	(97)	(60)
Submergents–rooted floating aquatics	65	260	66	264	(1)	(4)	(23)	(92)
Rooted floating aquatics	19	53	27	75	(2)	(6)	(23)	(64)
Rooted floating aquatics–emergents	20	400	73	1,460	(1)	(20)	(2)	(40)
Emergents	314	378	416	501	(1)	(1)	(23)	(28)
Emergents–grasses–forbs	(50)	(47)	(59)	(55)	0	0	2	2
Grasses–forbs	(345)	(9)	(1,378)	(36)	6	0	87	2
Woody terrestrial	(4,488)	(30)	(7,328)	(48)	59	0	643	4
Agriculture	(4,898)	(13)	(12,655)	(33)	68	0	1,138	3
Urban–developed	(172)	(23)	(345)	(45)	2	0	63	8
Sand–mud	(23)	(39)	(32)	(54)	0	0	19	32
Dewatered aquatics	(2,209)	(76)	(2,538)	(87)	126	4	856	29
Inundated terrestrial	9,976	113	21,798	246	(135)	(2)	(1,951)	(22)

Table 43. The effect of various management alternatives on aquatic area classes in Pool 25, with levees in place, at 19,000 cfs. Values are reported as acres or percentages and are calculated as the difference between an alternative plan and the present plan (Plan 1). Parentheses signify that the alternative plan has fewer acres. A blank field signifies that the acreage for Plan 1 was zero.

	Management plan							
	2		3		4		5	
Class[a]	Acres	%	Acres	%	Acres	%	Acres	%
Main channel	11	0	25	0	(758)	(10)	(2,407)	(31)
Secondary channel	26	1	65	2	(1,789)	(46)	(3,059)	(78)
Tertiary channel	7	11	13	20	(64)	(100)	(64)	(100)
Tributary channel	1	5	3	15	(19)	(95)	(20)	(100)
CFL-abandoned channel lake	43	4	100	10	(935)	(95)	(989)	(100)
CFL-borrow pit	0	0	0	0	(3)	(100)	(3)	(100)
CFL-floodplain depression lake	0		0		0		0	
CF shallow aquatic area	73	11	147	22	(498)	(75)	(661)	(100)
Contiguous impounded area	2	0	7	2	(61)	(15)	(307)	(76)
CFL-humanmade lake	1	7	2	14	(9)	(64)	(14)	(100)
IFL-abandoned channel lake	2	4	64	112	(39)	(68)	(39)	(68)
IFL-borrow pit	2	18	9	82	(7)	(64)	(7)	(64)
IF shallow aquatic area	0		0		0		0	
IFL-humanmade lake	0		0		0		0	
Nonaquatic/terrestrial area	(283)	(1)	(3,316)	(17)	425	2	438	2
Dewatered aquatics	(169)	(17)	(436)	(45)	4,178	427	7,568	773
Inundated terrestrial	283	56	3,316	655	(425)	(84)	(438)	(87)

[a]CF = continuous floodplain
CFL = continuous floodplain lake
IF = isolated floodplain
IFL = isolated floodplain lake

Table 44. The effect of various management alternatives on aquatic area classes in Pool 25, with levees in place, at 56,000 cfs. Values are reported as acres or percentages and are calculated as the difference between an alternative plan and the present plan (Plan 1). Parentheses signify that the alternative plan has fewer acres. A blank field signifies that the acreage for Plan 1 was zero.

	Management plan							
	2		3		4		5	
Class[a]	Acres	%	Acres	%	Acres	%	Acres	%
Main channel	4	0	11	0	(431)	(5)	(1,149)	(15)
Secondary channel	7	0	21	1	(951)	(24)	(1,737)	(44)
Tertiary channel	2	3	4	5	(62)	(85)	(65)	(89)
Tributary channel	0	0	1	5	(7)	(32)	(7)	(32)
CFL-abandoned channel lake	14	1	39	4	(920)	(88)	(1,037)	(99)
CFL-borrow pit	0	0	0	0	(3)	(100)	(3)	(100)
CFL-floodplain depression lake	0		0		0		0	
CF shallow aquatic area	70	10	133	20	(512)	(76)	(673)	(99)
Contiguous impounded area	2	0	7	2	(61)	(15)	(255)	(63)
CFL-humanmade lake	0	0	0	0	(9)	(56)	(14)	(88)
IFL-abandoned channel lake	2	3	91	147	(44)	(71)	(44)	(71)
IFL-borrow pit	0	0	6	43	(10)	(71)	(10)	(71)
IF shallow aquatic area	0		0		0		0	
IFL-humanmade lake	0		0		0		0	
Nonaquatic/terrestrial area	(224)	(1)	(3,121)	(17)	872	5	941	5
Dewatered aquatics	(100)	(12)	(313)	(38)	3,009	367	4,992	609
Inundated terrestrial	224	21	3,121	291	(873)	(81)	(941)	(88)

[a]CF = continuous floodplain
CFL = continuous floodplain lake
IF = isolated floodplain
IFL = isolated floodplain lake

Table 45. The effect of various management alternatives on aquatic area classes in Pool 25, with levees in place, at 95,000 cfs. Values are reported as acres or percentages and are calculated as the difference between an alternative plan and the present plan (Plan 1). Parentheses signify that the alternative plan has fewer acres. A blank field signifies that the acreage for Plan 1 was zero.

	Management plan							
	2		3		4		5	
Class[a]	Acres	%	Acres	%	Acres	%	Acres	%
Main channel	67	1	70	1	(168)	(2)	(543)	(7)
Secondary channel	186	5	190	5	(337)	(9)	(789)	(21)
Tertiary channel	37	93	37	93	(25)	(63)	(29)	(73)
Tributary channel	8	35	10	43	(1)	(4)	(1)	(4)
CFL-abandoned channel lake	414	62	420	63	(328)	(49)	(590)	(88)
CFL-borrow pit	3		3		0		0	
CFL-floodplain depression lake	0		0		0		0	
CF shallow aquatic area	357	83	378	88	(219)	(51)	(426)	(99)
Contiguous impounded area	17	4	22	6	(46)	(12)	(208)	(53)
CFL-humanmade lake	1	7	1	7	(6)	(40)	(10)	(67)
IFL-abandoned channel lake	122	321	269	708	(11)	(29)	(16)	(42)
IFL-borrow pit	13	260	15	300	0	0	(1)	(20)
IF shallow aquatic area	0		0		0		0	
IFL-humanmade lake	0		0		0		0	
Nonaquatic/terrestrial area	(1,910)	(10)	(4,566)	(24)	226	1	381	2
Dewatered aquatics	(1,226)	(70)	(1,415)	(81)	1,142	65	2,613	149
Inundated terrestrial	1,910	208	4,566	498	(226)	(25)	(381)	(42)

[a]CF = continuous floodplain
CFL = continuous floodplain lake
IF = isolated floodplain
IFL = isolated floodplain lake

Table 46. The effect of various management alternatives on aquatic area classes in Pool 25, with levees in place, at 135,000 cfs. Values are reported as acres or percentages and are calculated as the difference between an alternative plan and the present plan (Plan 1). Parentheses signify that the alternative plan has fewer acres. A blank field signifies that the acreage for Plan 1 was zero.

	Management plan							
	2		3		4		5	
Class[a]	Acres	%	Acres	%	Acres	%	Acres	%
Main channel	125	2	127	2	(13)	0	(92)	(1)
Secondary channel	142	4	144	4	(27)	(1)	(230)	(6)
Tertiary channel	39	103	40	105	(9)	(24)	(14)	(37)
Tributary channel	0	0	2	6	0	0	(1)	(3)
CFL-abandoned channel lake	500	85	502	85	(16)	(3)	(179)	(30)
CFL-borrow pit	3		3		0		0	
CFL-floodplain depression lake	0		0		0		0	
CF shallow aquatic area	539	201	542	202	(39)	(15)	(162)	(60)
Contiguous impounded area	51	14	54	15	(14)	(4)	(80)	(22)
CFL-humanmade lake	6	60	6	60	0	0	(1)	(10)
IFL-abandoned channel lake	79	36	199	92	(3)	(1)	(53)	(24)
IFL-borrow pit	15	300	17	340	0	0	0	0
IF shallow aquatic area	0		0		0		0	
IFL-humanmade lake	0		0		0		0	
Nonaquatic/terrestrial area	(2,319)	(14)	(4,822)	(28)	17	0	438	3
Dewatered aquatics	(1,499)	(81)	(1,636)	(88)	121	7	814	44
Inundated terrestrial	2,319	86	4,822	179	(17)	(1)	(438)	(16)

[a]CF = continuous floodplain
CFL = continuous floodplain lake
IF = isolated floodplain
IFL = isolated floodplain lake

Table 47. The effect of various management alternatives on aquatic area classes in Pool 25, with levees removed, at 19,000 cfs. Values are reported as acres or percentages and are calculated as the difference between an alternative plan and the present plan (Plan 1). Parentheses signify that the alternative plan has fewer acres. A blank field signifies that the acreage for Plan 1 was zero.

	Management plan							
	2		3		4		5	
Class[a]	Acres	%	Acres	%	Acres	%	Acres	%
Main channel	11	0	25	0	(758)	(10)	(2,407)	(31)
Secondary channel	27	1	66	2	(1,789)	(46)	(3,059)	(78)
Tertiary channel	7	11	13	20	(64)	(100)	(64)	(100)
Tributary channel	1	2	3	7	(27)	(61)	(44)	(100)
CFL-abandoned channel lake	62	5	119	10	(1,119)	(93)	(1,176)	(98)
CFL-borrow pit	0	0	0	0	(3)	(100)	(3)	(100)
CFL-floodplain depression lake	0	0	1	13	0	0	(8)	(100)
CF shallow aquatic area	73	11	147	22	(498)	(75)	(661)	(100)
Contiguous impounded area	2	0	7	2	(61)	(15)	(307)	(76)
CFL-humanmade lake	1	7	2	14	(9)	(64)	(14)	(100)
IFL-abandoned channel lake	50	8	264	43	(392)	(64)	(561)	(92)
IFL-borrow pit	4	9	18	41	(14)	(32)	(14)	(32)
IF shallow aquatic area	0		0		0		0	
IFL-humanmade lake	0	0	17	283	(2)	(33)	(4)	(67)
Nonaquatic/terrestrial area	(925)	(1)	(13,621)	(22)	4,016	6	4,552	7
Dewatered aquatics	(238)	(14)	(683)	(41)	4,735	285	8,322	501
Inundated terrestrial	924	19	13,621	285	(4,016)	(84)	(4,552)	(95)

[a]CF = continuous floodplain
CFL = continuous floodplain lake
IF = isolated floodplain
IFL = isolated floodplain lake

Table 48. The effect of various management alternatives on aquatic area classes in Pool 25, with levees removed, at 56,000 cfs. Values are reported as acres or percentages and are calculated as the difference between an alternative plan and the present plan (Plan 1). Parentheses signify that the alternative plan has fewer acres. A blank field signifies that the acreage for Plan 1 was zero.

	Management plan							
	2		3		4		5	
Class[a]	Acres	%	Acres	%	Acres	%	Acres	%
Main channel	4	0	11	0	(431)	(5)	(1,149)	(15)
Secondary channel	7	0	21	1	(952)	(24)	(1,738)	(44)
Tertiary channel	2	3	4	5	(62)	(85)	(65)	(89)
Tributary channel	0	0	2	4	(9)	(20)	(31)	(67)
CFL-abandoned channel lake	14	1	39	3	(1,123)	(88)	(1,243)	(97)
CFL-borrow pit	0	0	0	0	(3)	(100)	(3)	(100)
CFL-floodplain depression lake	0	0	1	13	0	0	(8)	(100)
CF shallow aquatic area	70	10	133	20	(512)	(76)	(673)	(99)
Contiguous impounded area	2	0	7	2	(61)	(15)	(255)	(63)
CFL-humanmade lake	0	0	0	0	(9)	(56)	(14)	(88)
IFL-abandoned channel lake	21	3	260	39	(250)	(37)	(611)	(91)
IFL-borrow pit	2	4	12	24	(19)	(38)	(20)	(40)
IF shallow aquatic area	0		0		0		0	
IFL-humanmade lake	0	0	25	357	(3)	(43)	(5)	(71)
Nonaquatic/terrestrial area	(685)	(1)	(13,356)	(22)	4,766	8	5,790	9
Dewatered aquatics	(120)	(8)	(513)	(36)	3,436	241	5,814	408
Inundated terrestrial	685	11	13,356	219	(4,767)	(78)	(5,791)	(95)

[a]CF = continuous floodplain
CFL = continuous floodplain lake
IF = isolated floodplain
IFL = isolated floodplain lake

Table 49. The effect of various management alternatives on aquatic area classes in Pool 25, with levees removed, at 95,000 cfs. Values are reported as acres or percentages and are calculated as the difference between an alternative plan and the present plan (Plan 1). Parentheses signify that the alternative plan has fewer acres. A blank field signifies that the acreage for Plan 1 was zero.

	Management plan							
	2		3		4		5	
Class[a]	Acres	%	Acres	%	Acres	%	Acres	%
Main channel	67	1	70	1	(168)	(2)	(543)	(7)
Secondary channel	187	5	191	5	(337)	(9)	(789)	(21)
Tertiary channel	37	93	38	95	(25)	(63)	(29)	(73)
Tributary channel	9	20	12	26	(1)	(2)	(5)	(11)
CFL-abandoned channel lake	617	88	623	89	(328)	(47)	(593)	(85)
CFL-borrow pit	3		3		0		0	
CFL-floodplain depression lake	0	0	1	13	0	0	(6)	(75)
CF shallow aquatic area	357	83	378	88	(219)	(51)	(426)	(99)
Contiguous impounded area	17	4	22	6	(46)	(12)	(208)	(53)
CFL-humanmade lake	1	7	1	7	(6)	(40)	(10)	(67)
IFL-abandoned channel lake	414	86	633	131	(39)	(8)	(389)	(80)
IFL-borrow pit	23	62	29	78	(4)	(11)	(6)	(16)
IF shallow aquatic area	0		0		0		0	
IFL-humanmade lake	25	208	47	392	(6)	(50)	(9)	(75)
Nonaquatic/terrestrial area	(7,611)	(12)	(18,726)	(30)	1,525	2	2,870	5
Dewatered aquatics	(1,757)	(65)	(2,046)	(75)	1,182	43	3,015	111
Inundated terrestrial	7,612	184	18,726	453	(1,524)	(37)	(2,869)	(69)

[a]CF = continuous floodplain
CFL = continuous floodplain lake
IF = isolated floodplain
IFL = isolated floodplain lake

Table 50. The effect of various management alternatives on aquatic area classes in Pool 25, with levees removed, at 135,000 cfs. Values are reported as acres or percentages and are calculated as the difference between an alternative plan and the present plan (Plan 1). Parentheses signify that the alternative plan has fewer acres. A blank field signifies that the acreage for Plan 1 was zero.

	Management plan							
	2		3		4		5	
Class[a]	Acres	%	Acres	%	Acres	%	Acres	%
Main channel	125	2	128	2	(13)	0	(92)	(1)
Secondary channel	143	4	145	4	(27)	(1)	(230)	(6)
Tertiary channel	39	103	40	105	(9)	(24)	(14)	(37)
Tributary channel	1	2	4	6	0	0	(4)	(6)
CFL-abandoned channel lake	703	114	706	114	(17)	(3)	(180)	(29)
CFL-borrow pit	3		3		0		0	
CFL-floodplain depression lake	0	0	1	13	0	0	(3)	(38)
CF shallow aquatic area	539	201	542	202	(39)	(15)	(162)	(60)
Contiguous impounded area	51	14	54	15	(14)	(4)	(80)	(22)
CFL-humanmade lake	6	60	6	60	0	0	(1)	(10)
IFL-abandoned channel lake	392	56	538	77	(6)	(1)	(69)	(10)
IFL-borrow pit	25	60	45	107	0	0	(4)	(10)
IF shallow aquatic area	0		0		0		0	
IFL-humanmade lake	15	29	38	73	0	0	(8)	(15)
Nonaquatic/terrestrial area	(9,814)	(17)	(21,576)	(37)	134	0	1,944	3
Dewatered aquatics	(2,043)	(74)	(2,247)	(82)	126	5	848	31
Inundated terrestrial	9,814	109	21,575	239	(135)	(1)	(1,944)	(22)

[a]CF = continuous floodplain
CFL = continuous floodplain lake
IF = isolated floodplain
IFL = isolated floodplain lake

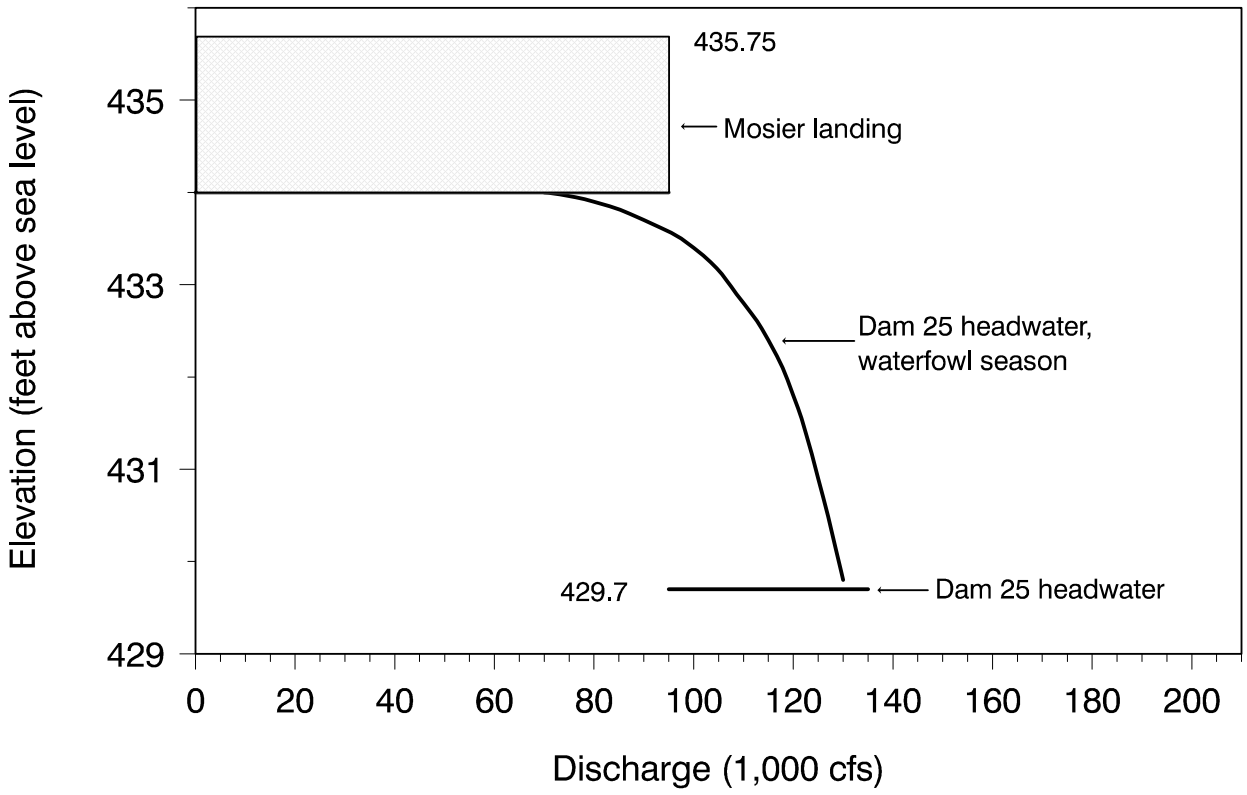


Figure 1. The present water level management plan for Pool 25. Water levels are allowed anywhere within the hatched areas at Mosier Landing (River Mile 260.3) when discharges are under 95,000 cfs.

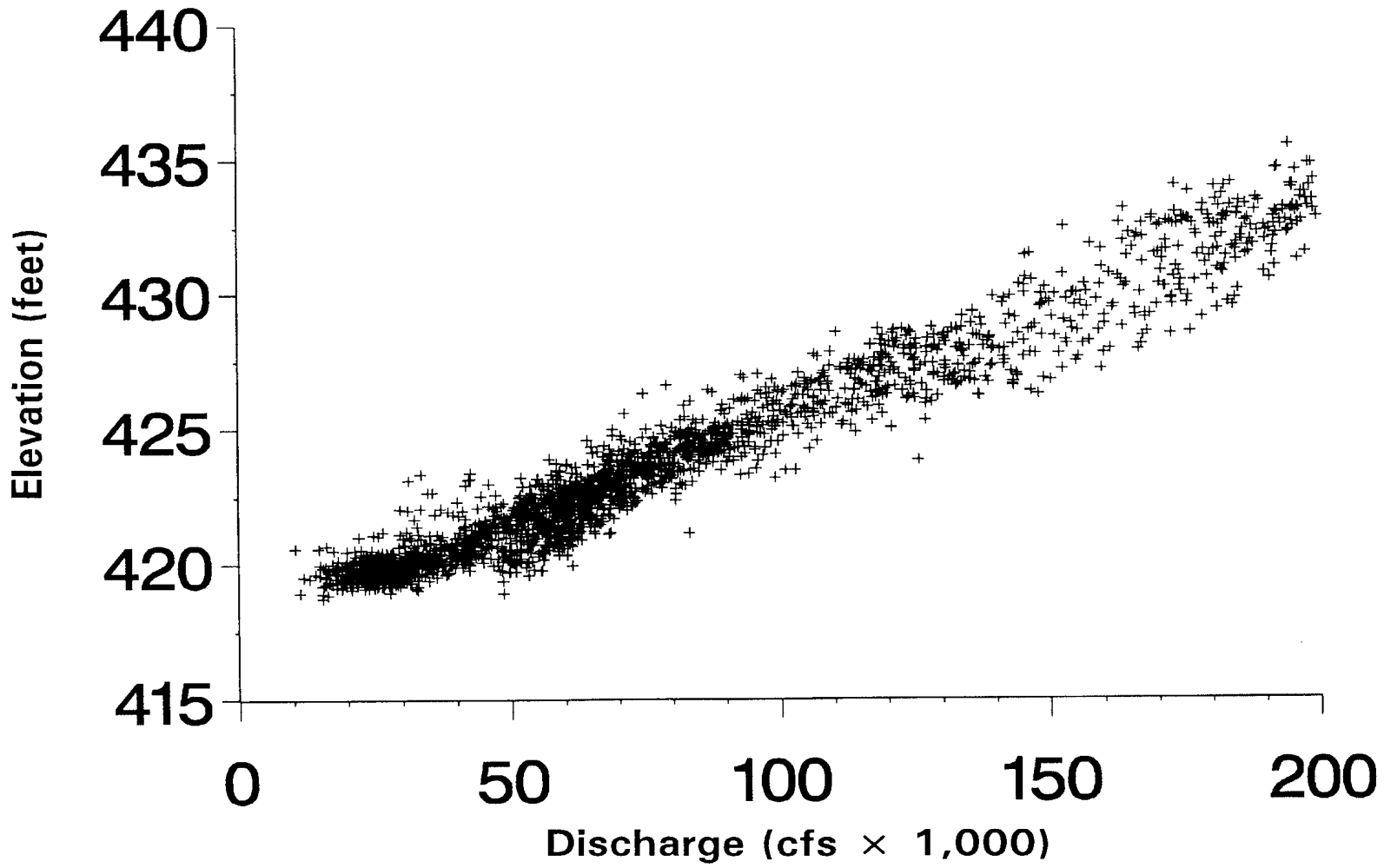


Figure 2. Water levels as a function of discharge for the tailwater at Lock and Dam 25, 1986 to 1993.

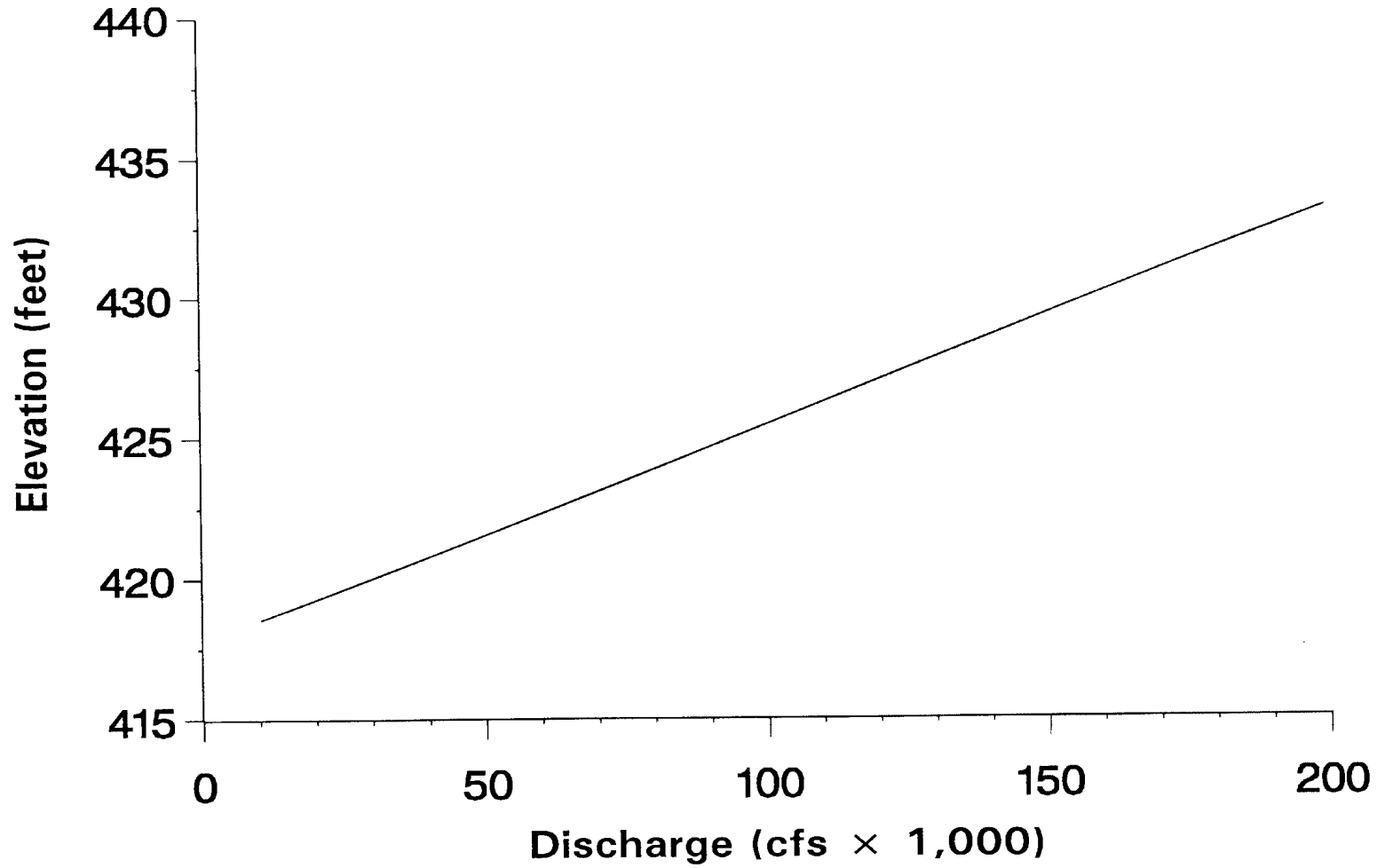


Figure 3. The discharge elevation relation developed for the tailwater of Lock and Dam 25.

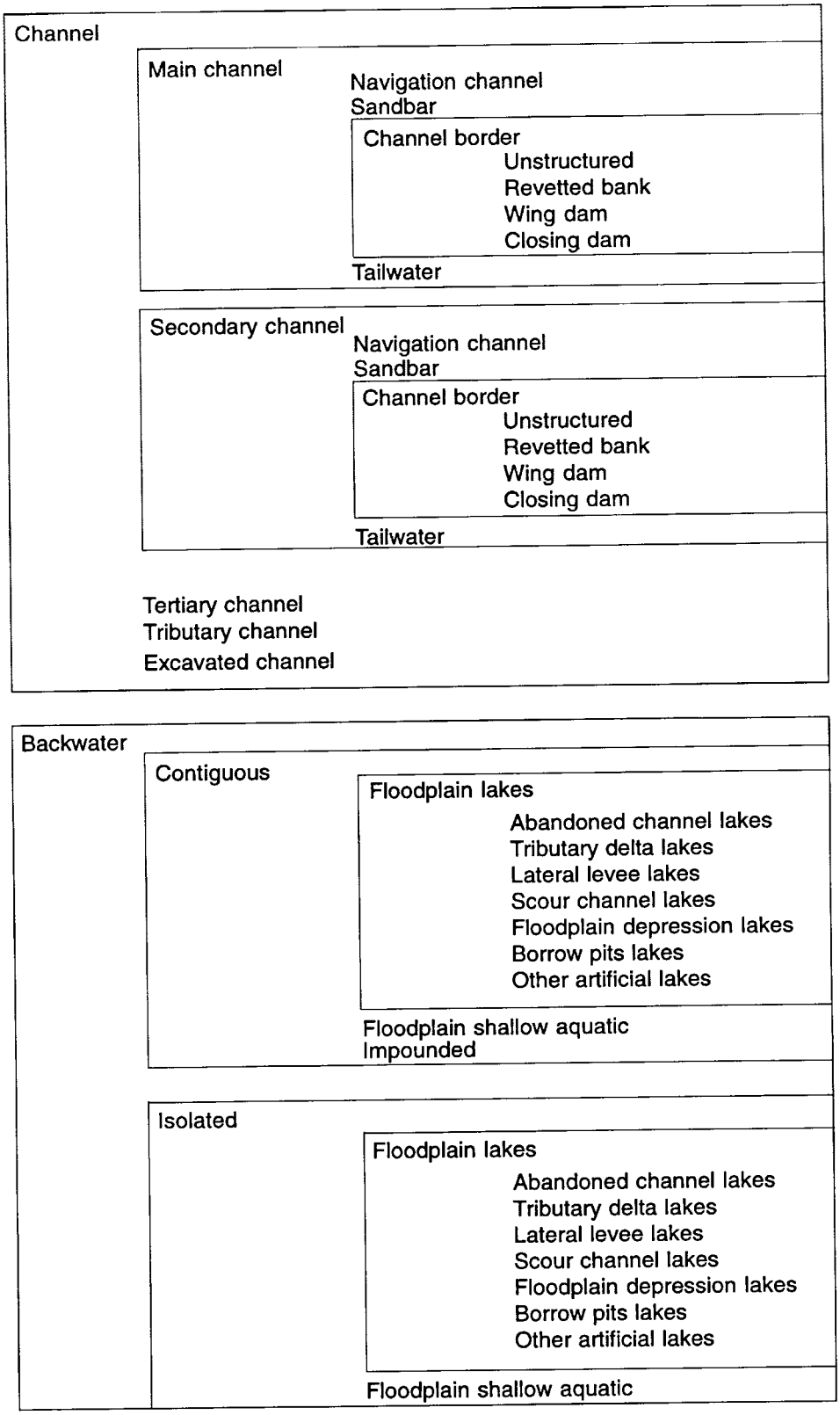


Figure 4. The aquatic areas classification scheme developed for the Upper Mississippi River System (from Wilcox 1993).

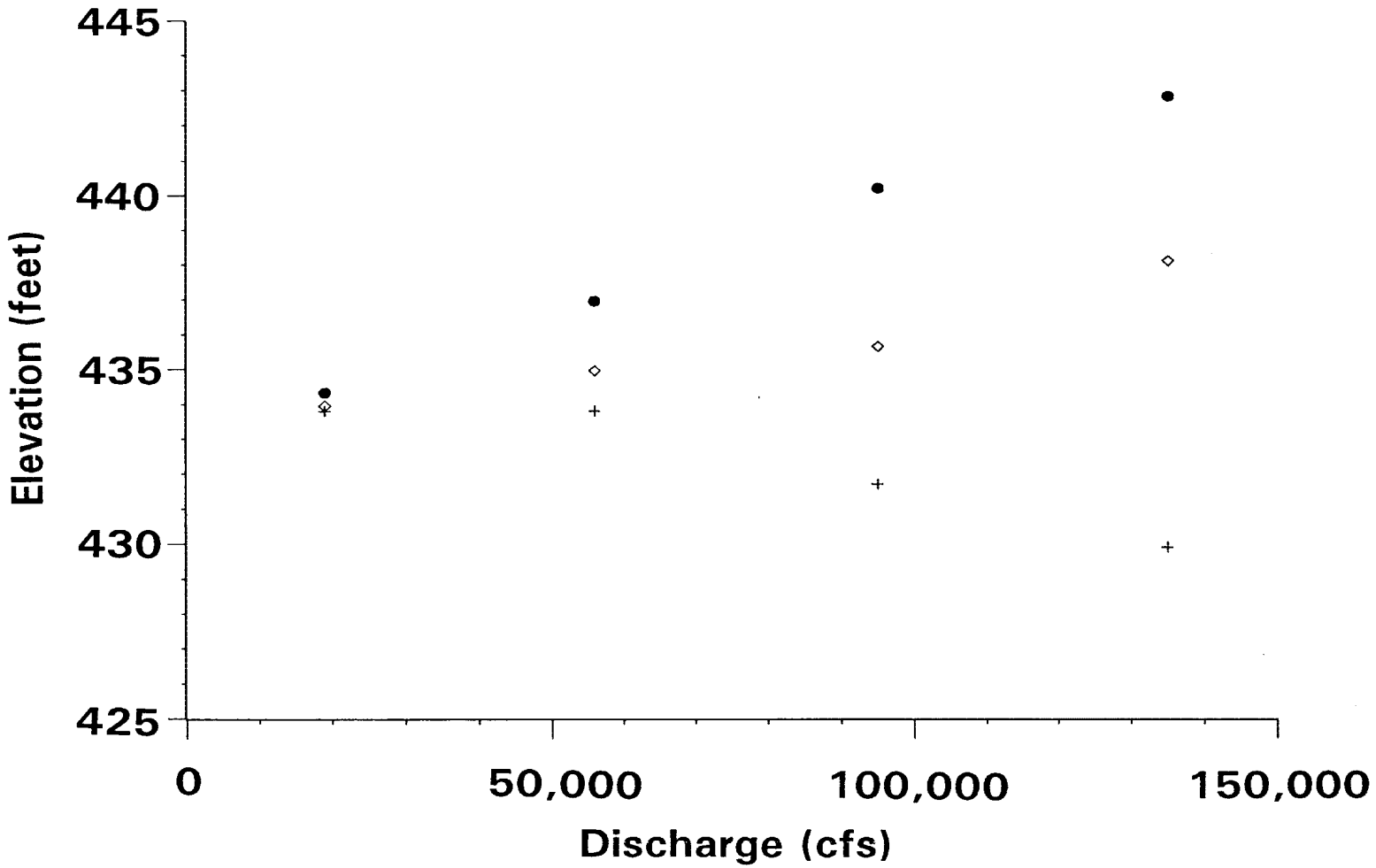


Figure 5. Predicted water level elevations (in feet) at three locations in Pool 25 using Plan 1. The Lock and Dam 25 headwater area is represented by a plus sign, Mosier Landing by a diamond, and the tailwater of Lock and Dam 24 by a black circle.

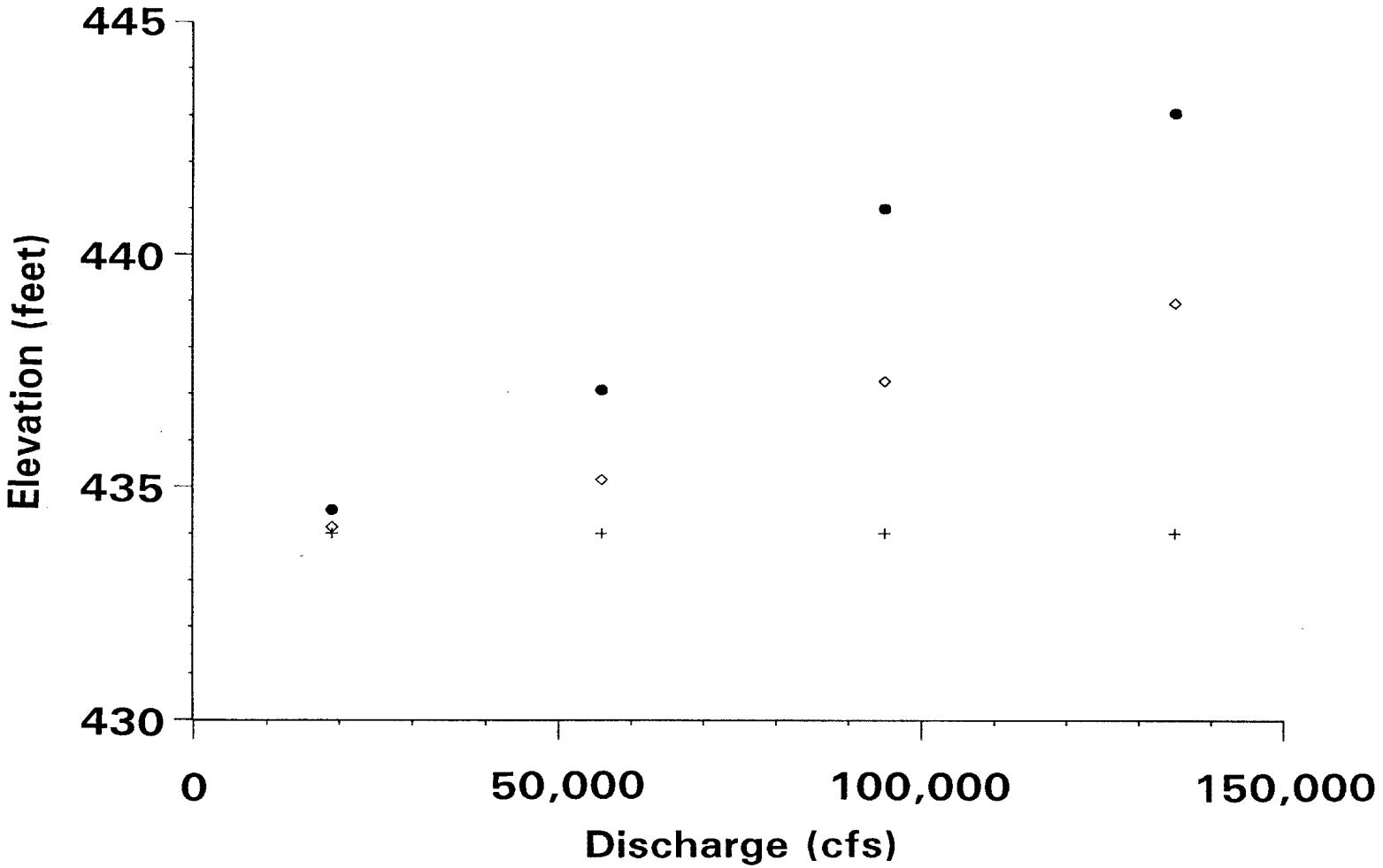


Figure 6. Predicted water level elevations (in feet) at three locations in Pool 25 using Plan 2. The Lock and Dam 25 headwater area is represented by a plus sign, Mosier Landing by a diamond, and the tailwater of Lock and Dam 24 by a black circle.

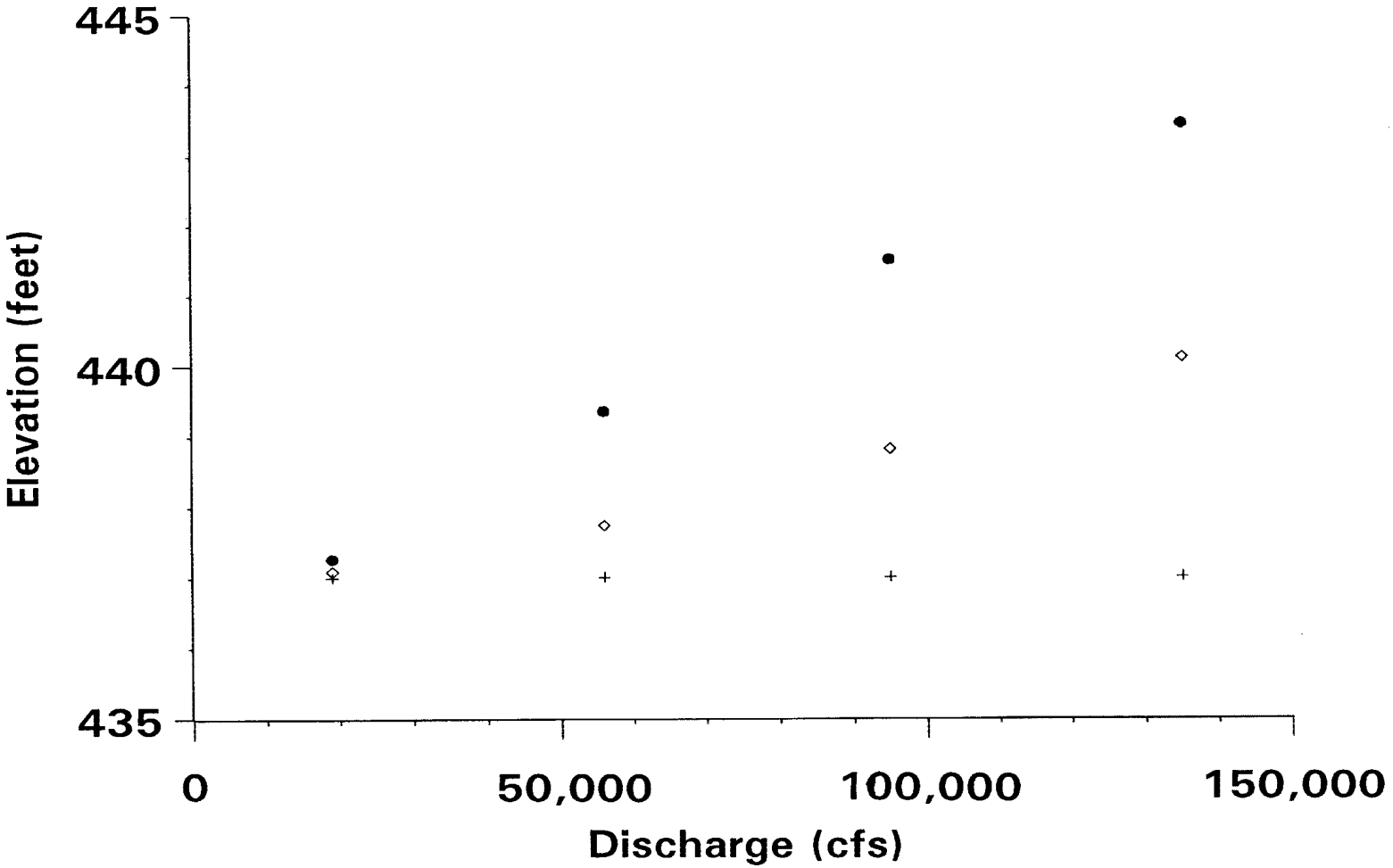


Figure 7. Predicted water level elevations (in feet) at three locations in Pool 25 using Plan 3. The Lock and Dam 25 headwater area is represented by a plus sign, Mosier Landing by a diamond, and the tailwater of Lock and Dam 24 by a black circle.

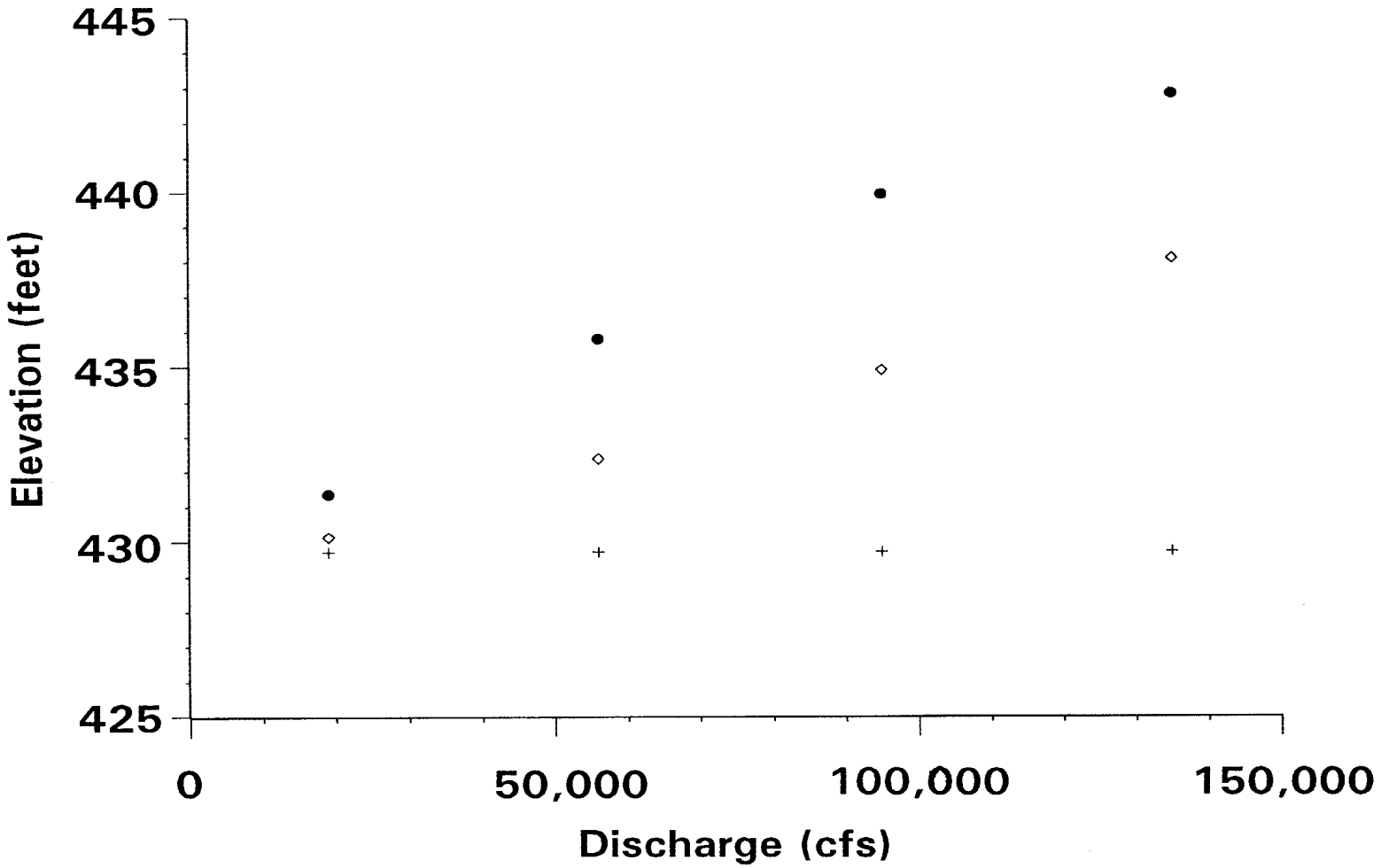


Figure 8. Predicted water level elevations (in feet) at three locations in Pool 25 using Plan 4. The Lock and Dam 25 headwater area is represented by a plus sign, Mosier Landing by a diamond, and the tailwater of Lock and Dam 24 by a black circle.

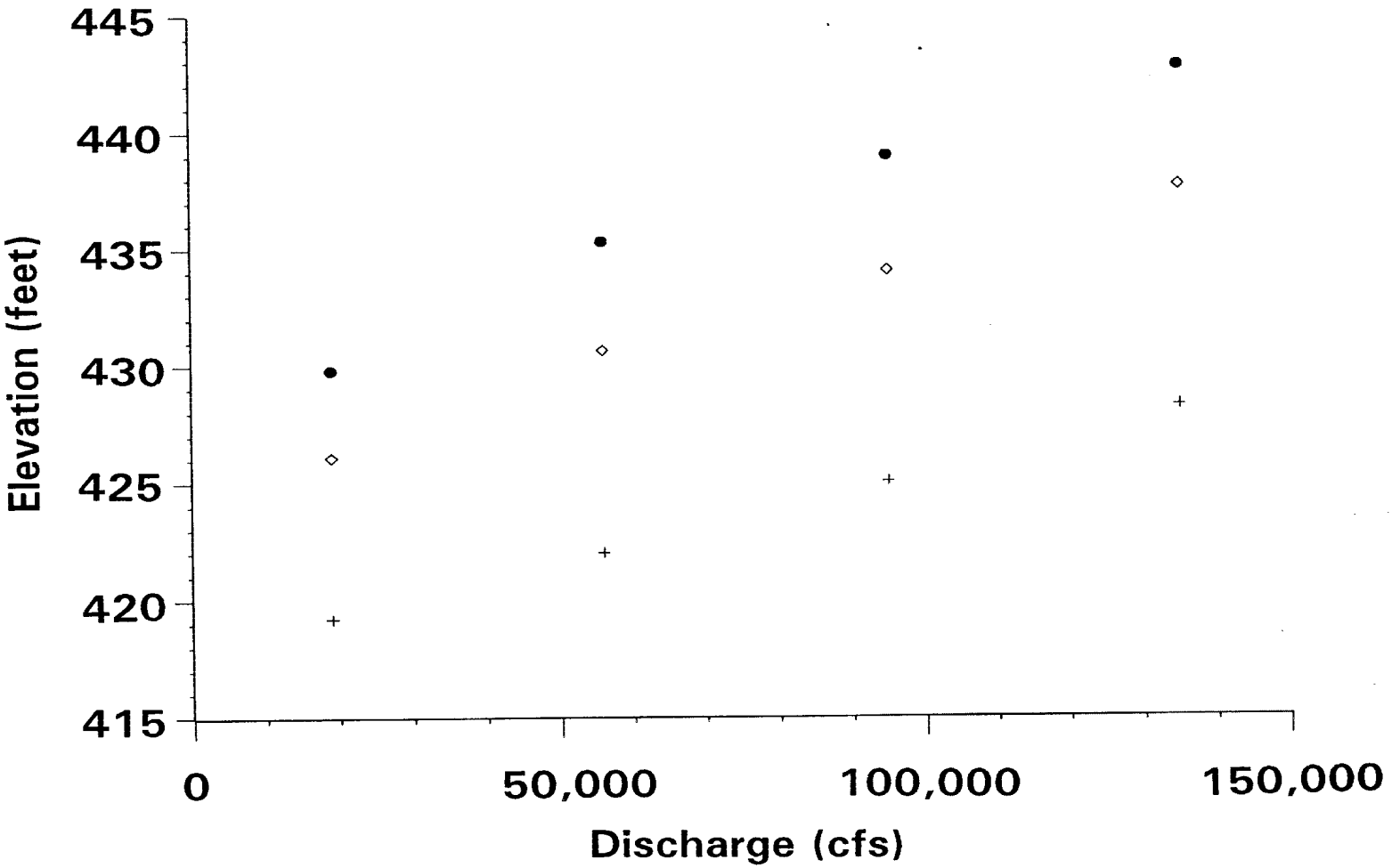


Figure 9. Predicted water level elevations (in feet) at three locations in Pool 25 using Plan 5. The Lock and Dam 25 headwater area is represented by a plus sign, Mosier Landing by a diamond, and the tailwater of Lock and Dam 24 by a black circle.

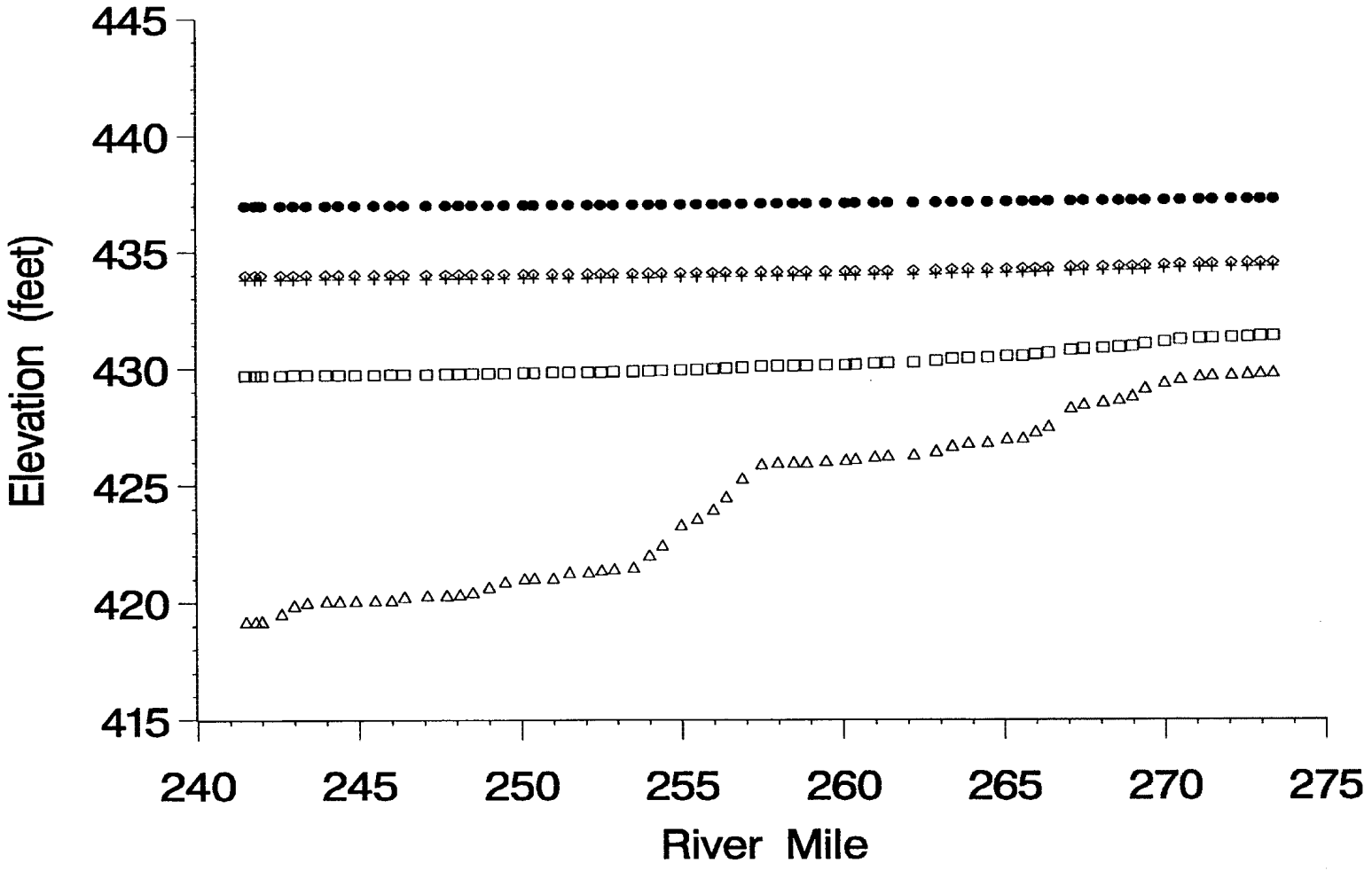


Figure 10. Predicted water level elevations (in feet) in Pool 25 at 19,000 cfs. Plan 1 is represented by a plus sign, Plan 2 by a diamond, Plan 3 by a black circle, Plan 4 by a square, and Plan 5 by a triangle.

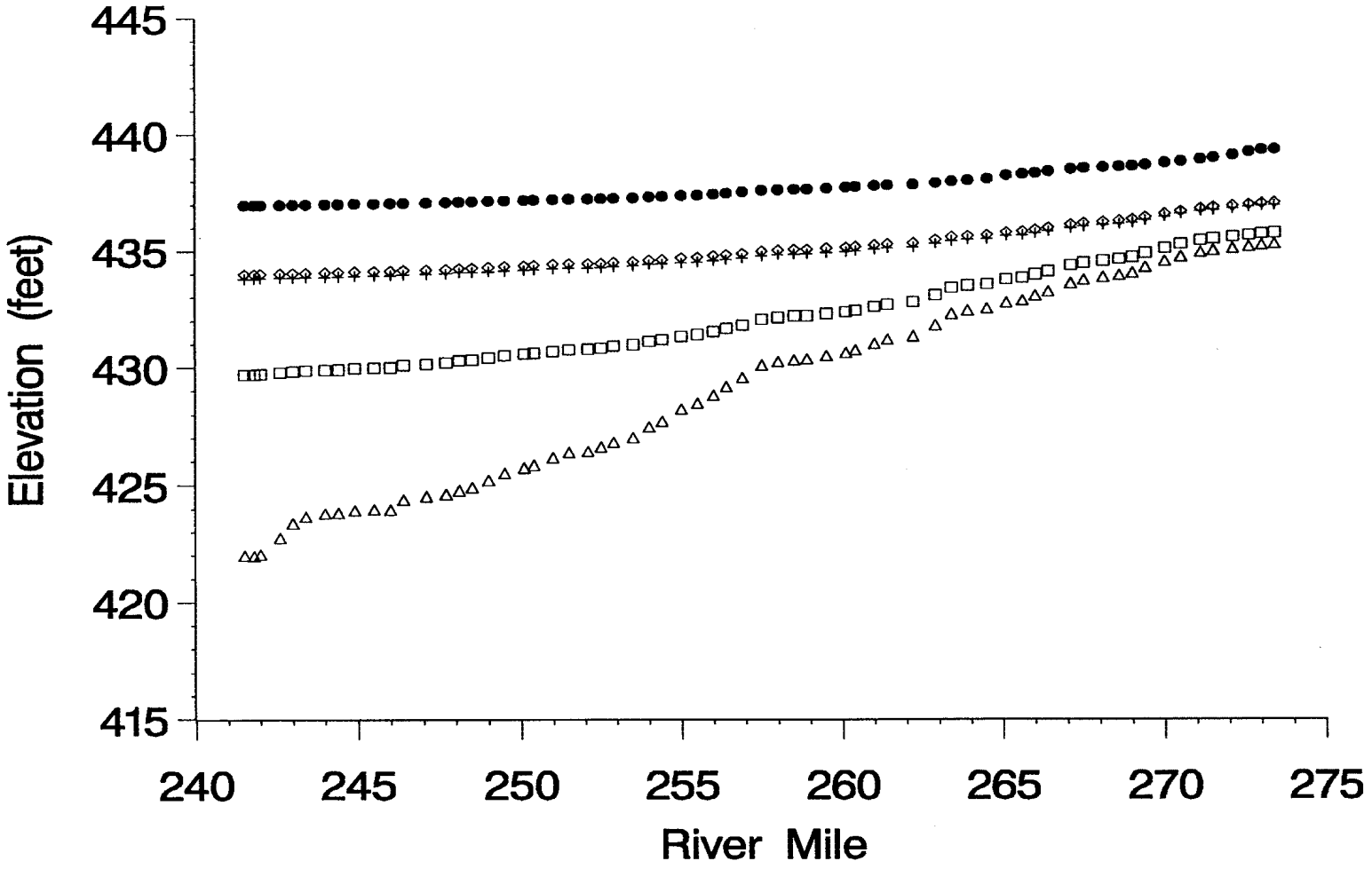


Figure 11. Predicted water level elevations (in feet) in Pool 25 at 56,000 cfs. Plan 1 is represented by a plus sign, Plan 2 by a diamond, Plan 3 by a black circle, Plan 4 by a square, and Plan 5 by a triangle.

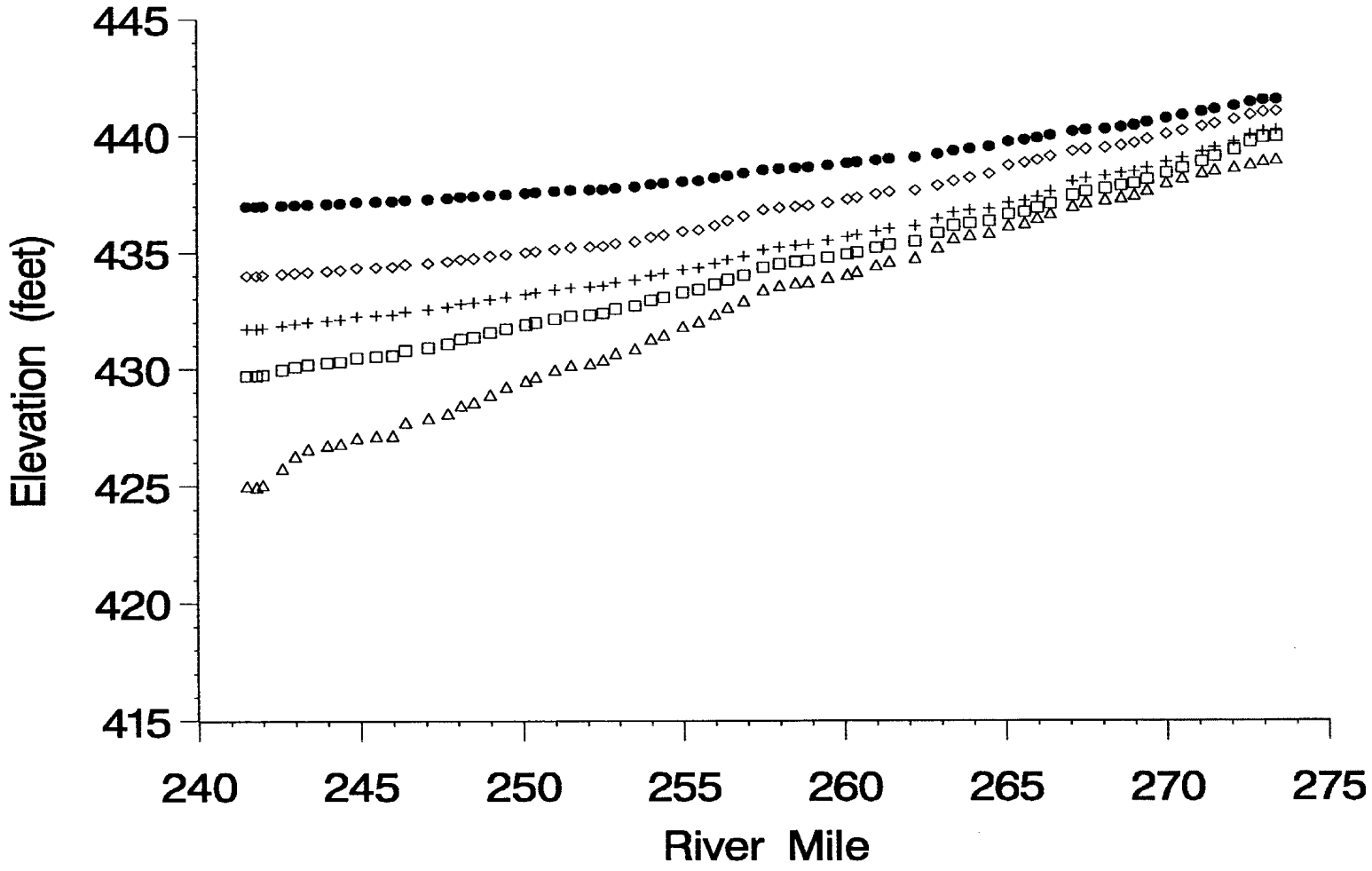


Figure 12. Predicted water level elevations (in feet) in Pool 25 at 95,000 cfs. Plan 1 is represented by a plus sign, Plan 2 by a diamond, Plan 3 by a black circle, Plan 4 by a square, and Plan 5 by a triangle.

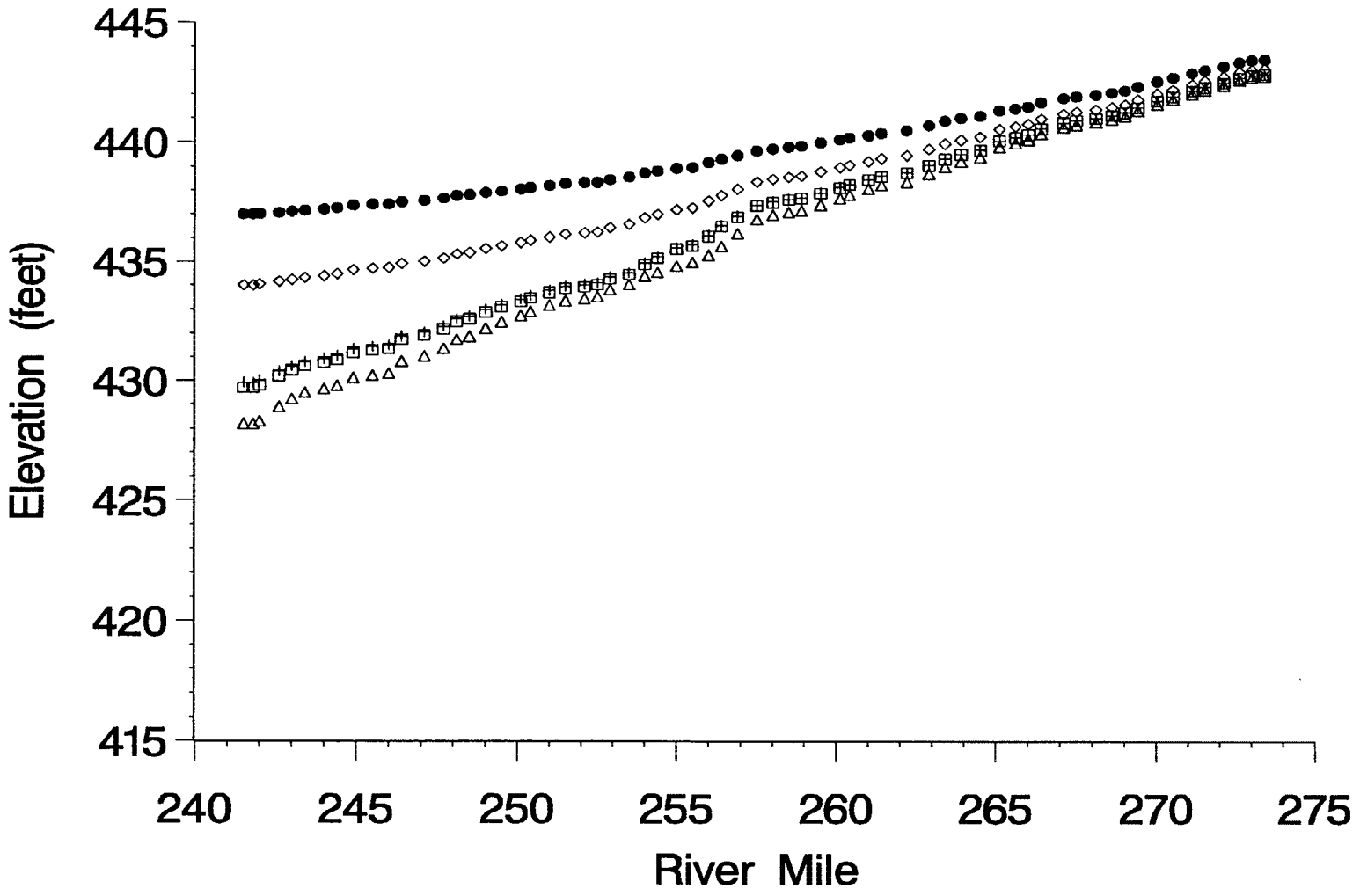


Figure 13. Predicted water level elevations (in feet) in Pool 25 at 135,000 cfs. Plan 1 is represented by a plus sign, Plan 2 by a diamond, Plan 3 by a black circle, Plan 4 by a square, and Plan 5 by a triangle.

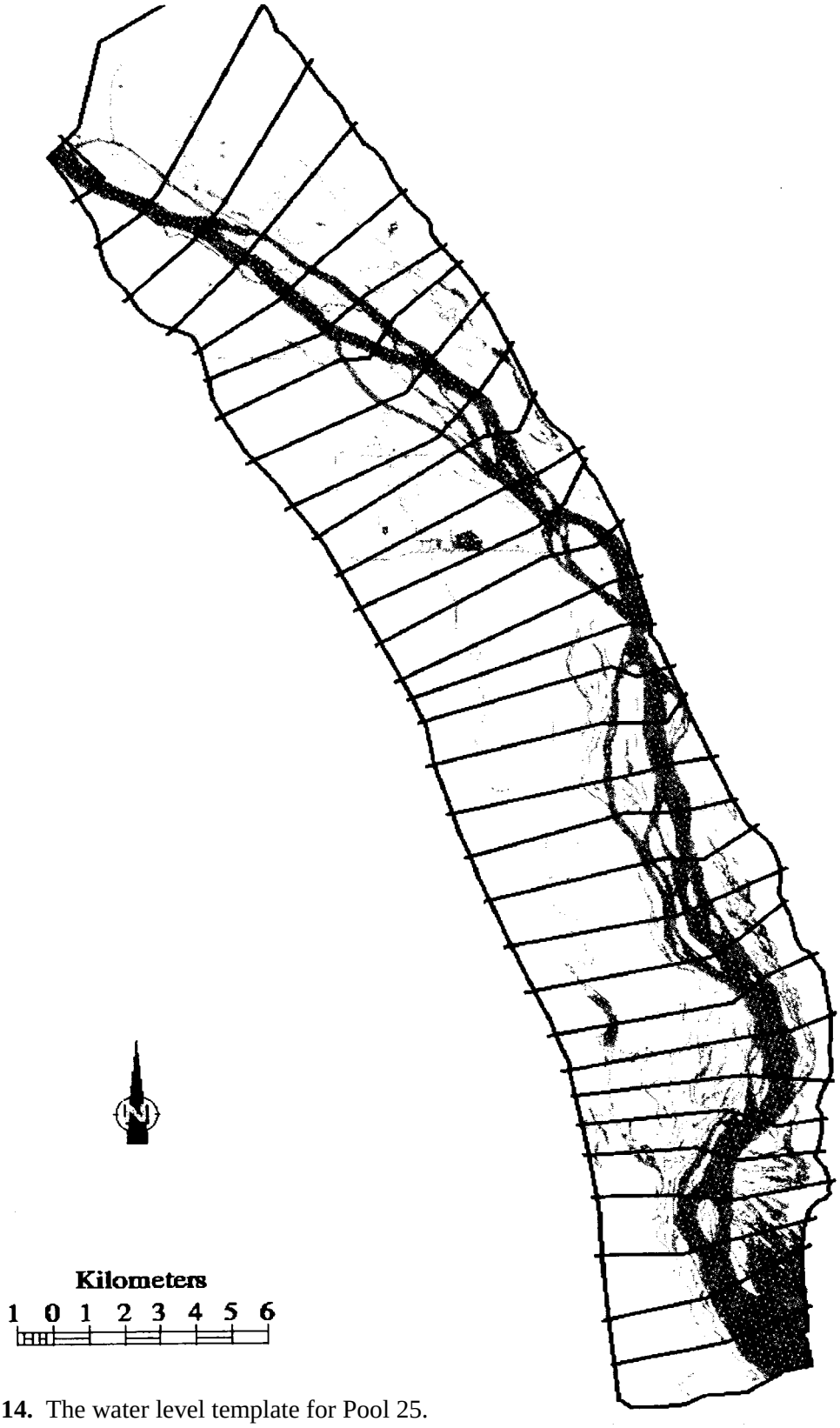


Figure 14. The water level template for Pool 25.

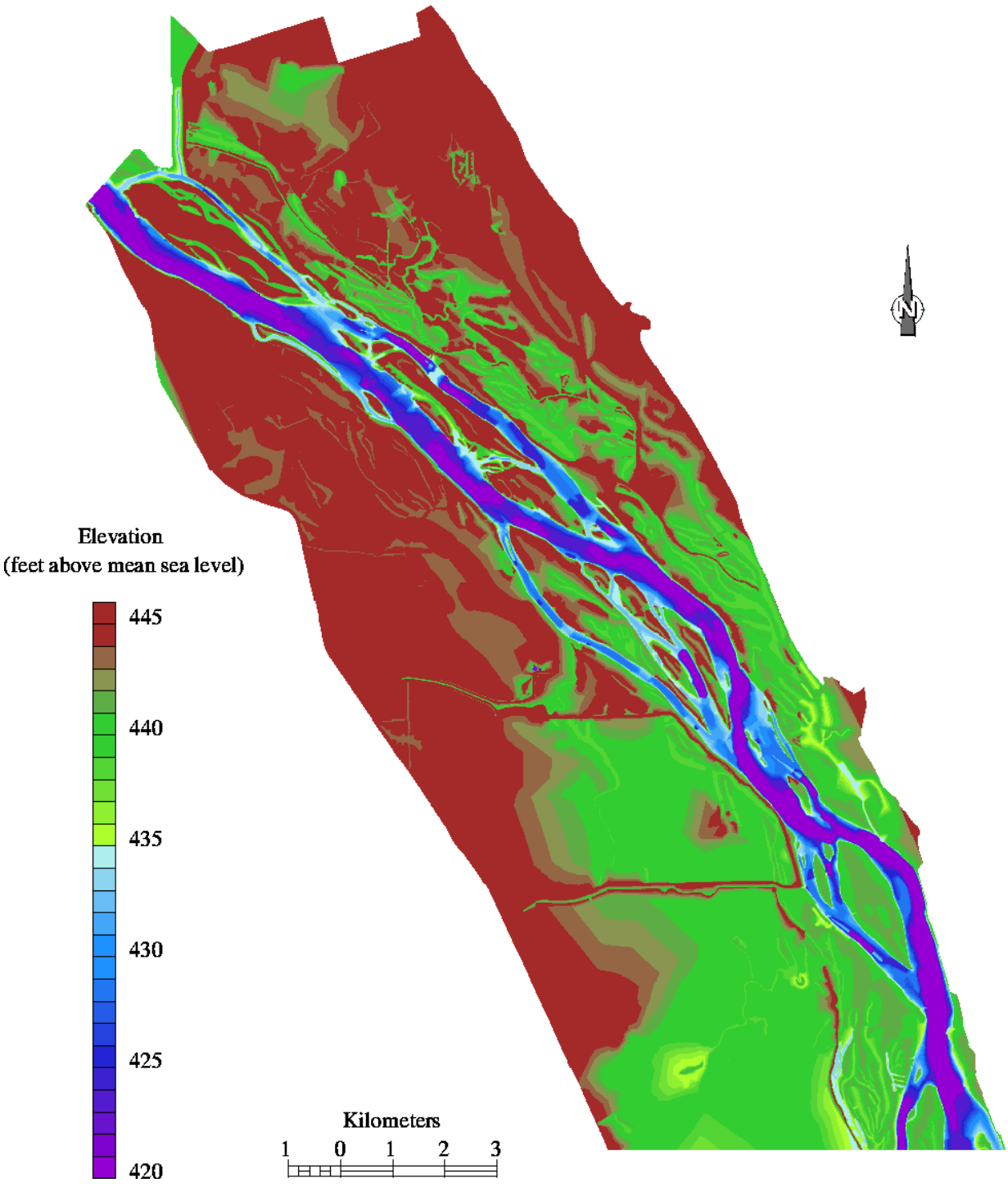


Figure 15. The elevation coverage for the northern portion of Pool 25.

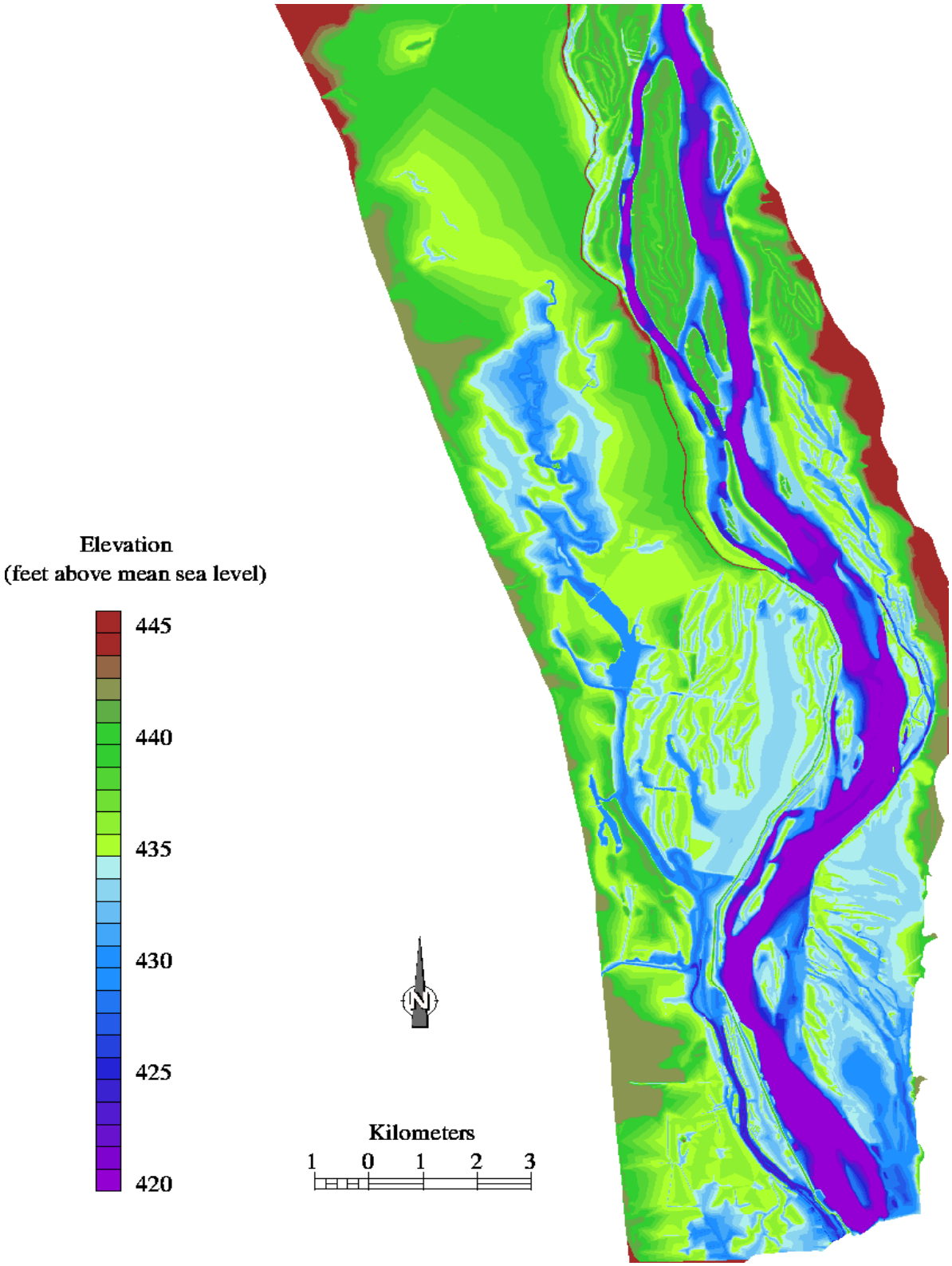


Figure 16. The elevation coverage for the southern portion of Pool 25.

Figure 17. Land cover/land use classes in the northern portion of the floodplain of Pool 25.

Figure 18. Land cover/land use classes in the southern portion of the floodplain of Pool 25.

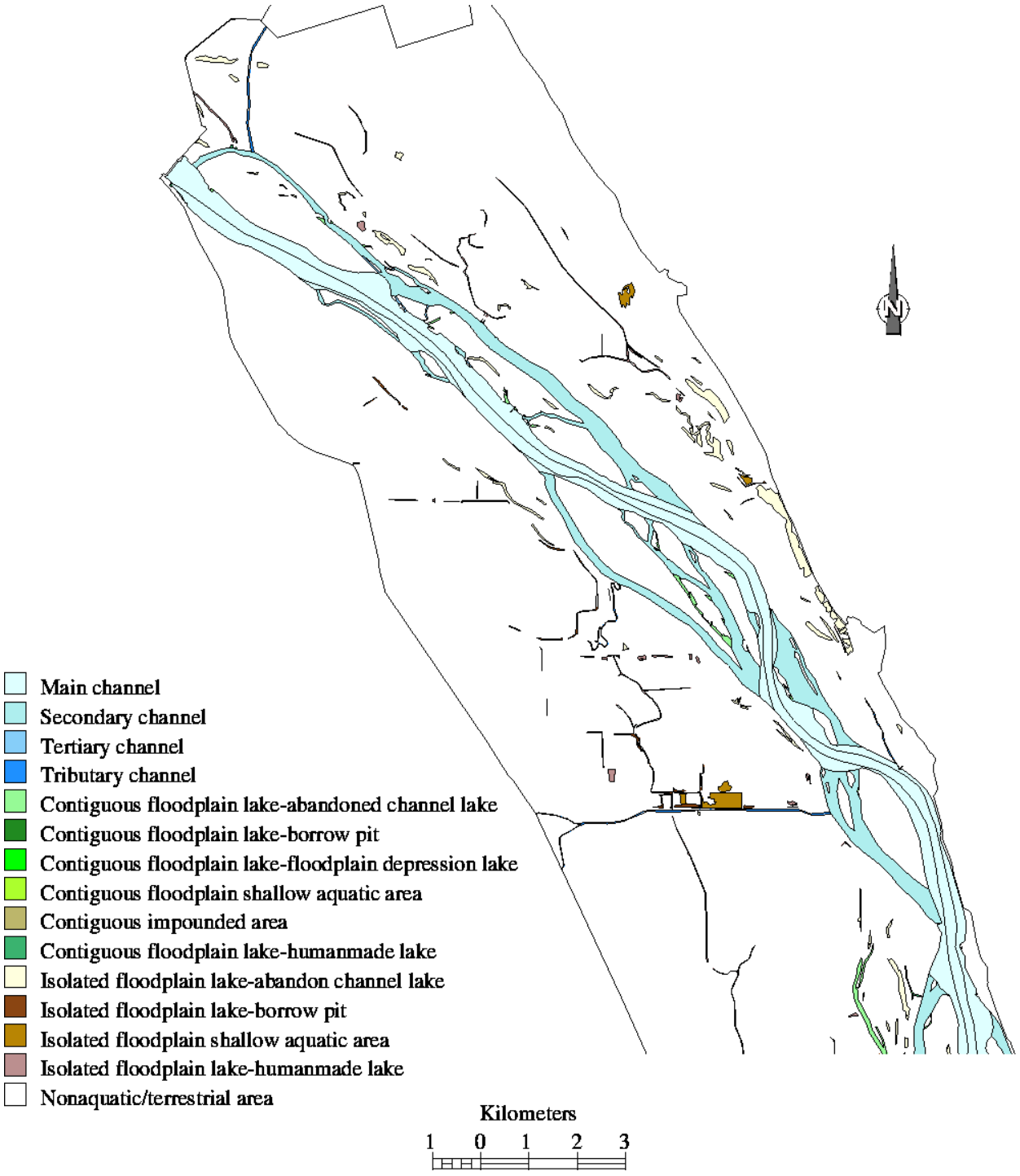


Figure 19. Aquatic areas in the northern portion of the floodplain of Pool 25.

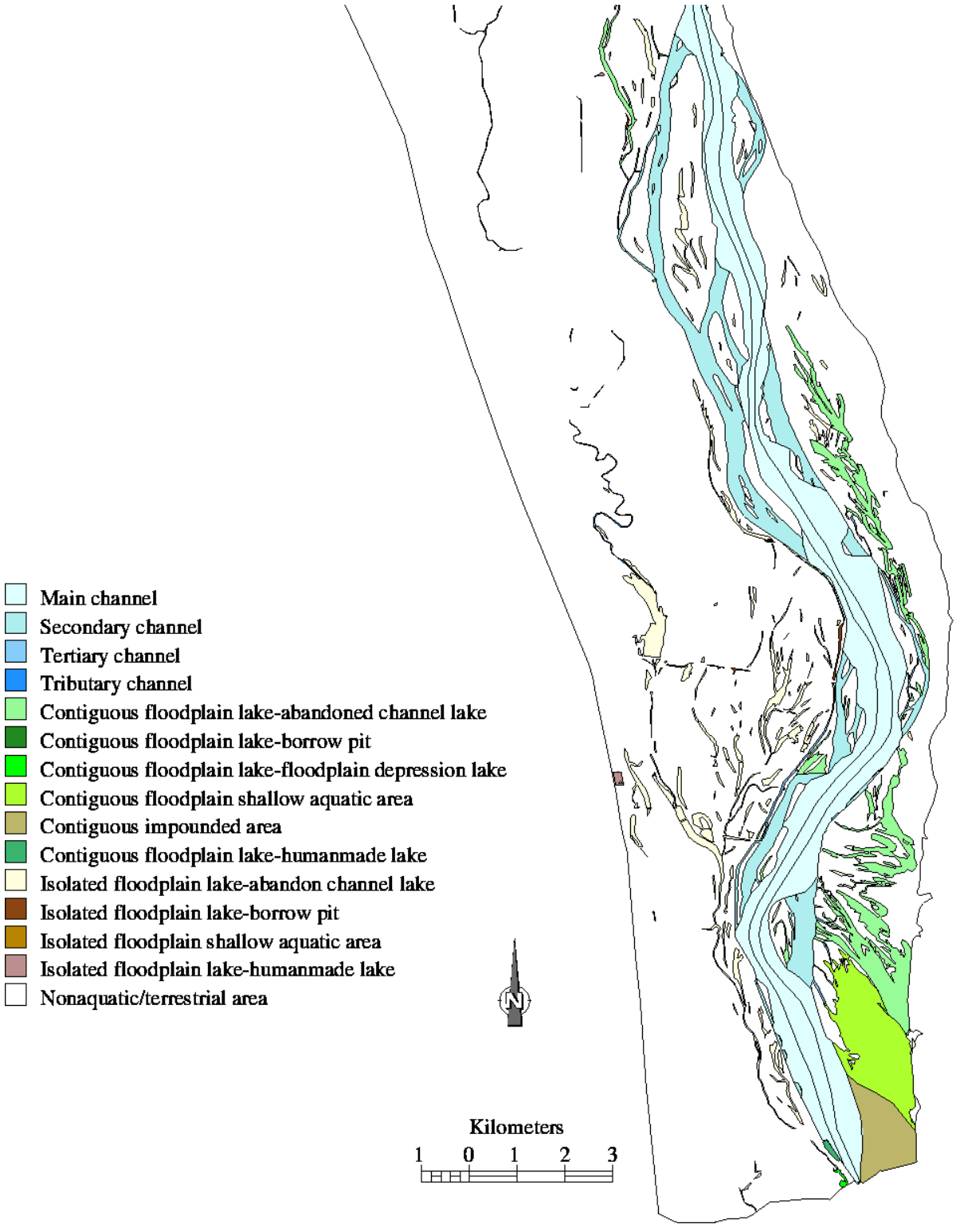


Figure 20. Aquatic areas in the southern portion of the floodplain of Pool 25.

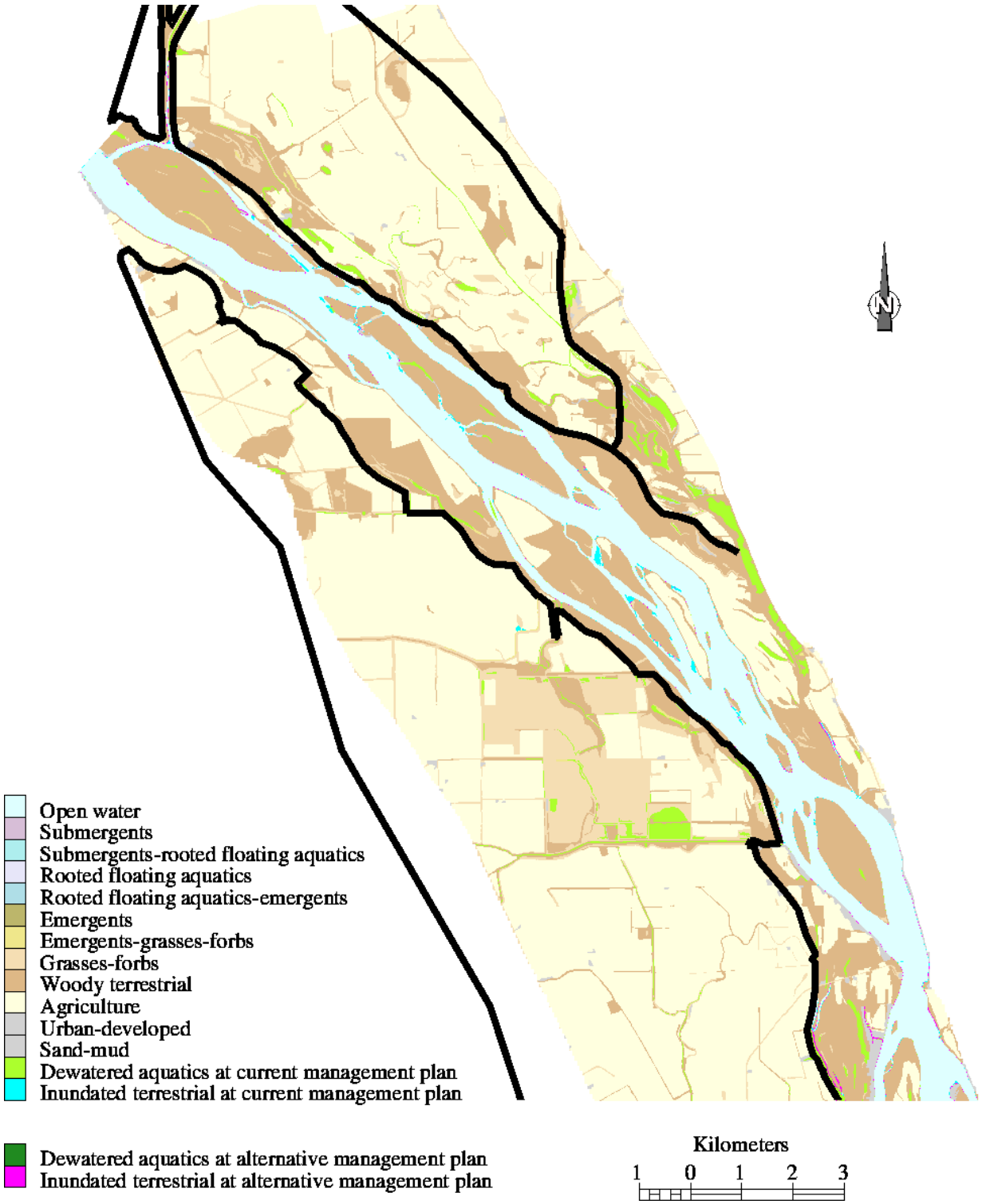


Figure 21. Comparison between water level management plan (Plan 2) and the present plan (Plan 1) at 19,000 cfs for land cover classes in the northern portion of Pool 25.

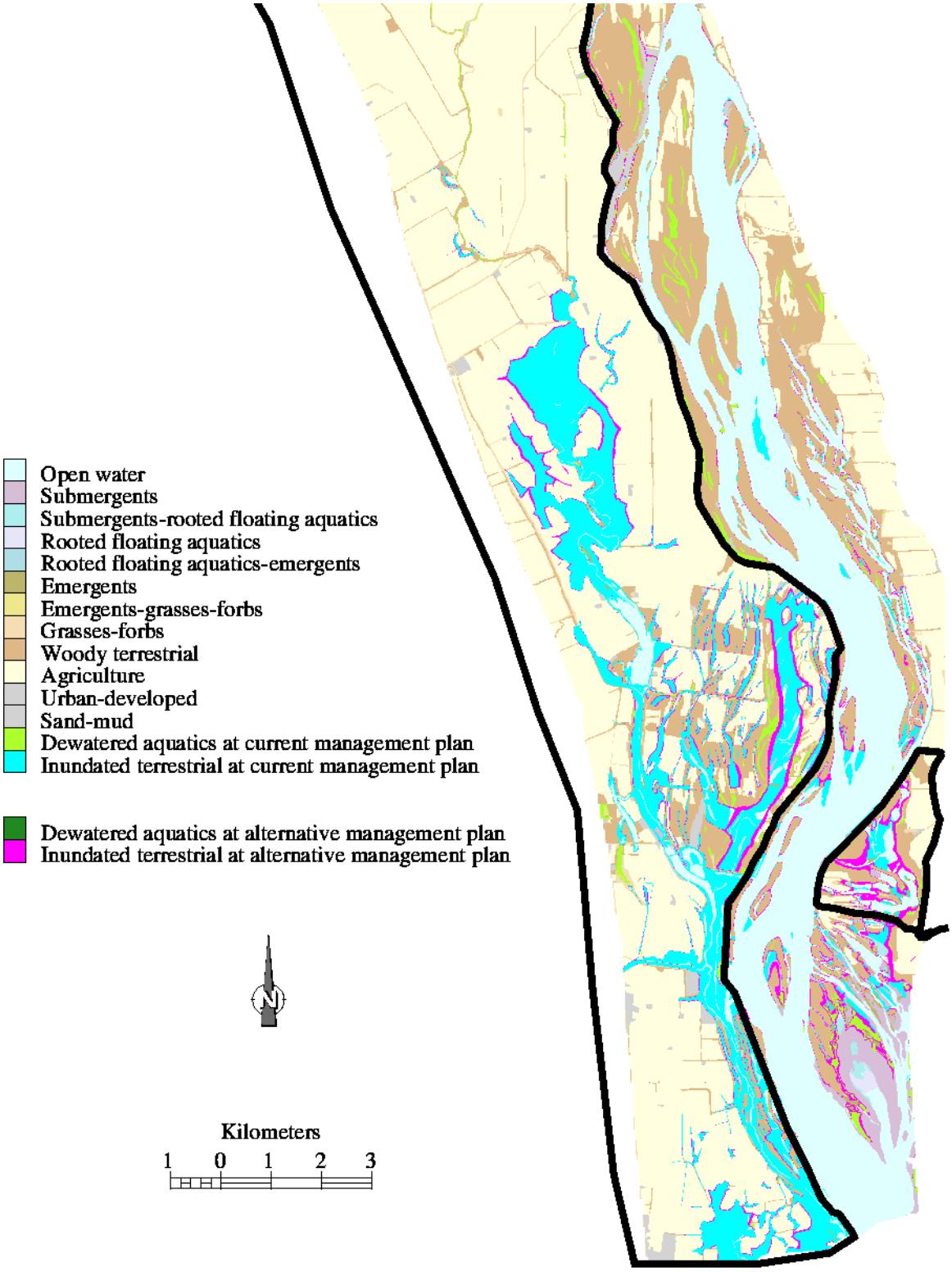


Figure 22. Comparison between water level management plan (Plan 2) and the present plan (Plan 1) at 19,000 cfs for land cover classes in the southern portion of Pool 25.

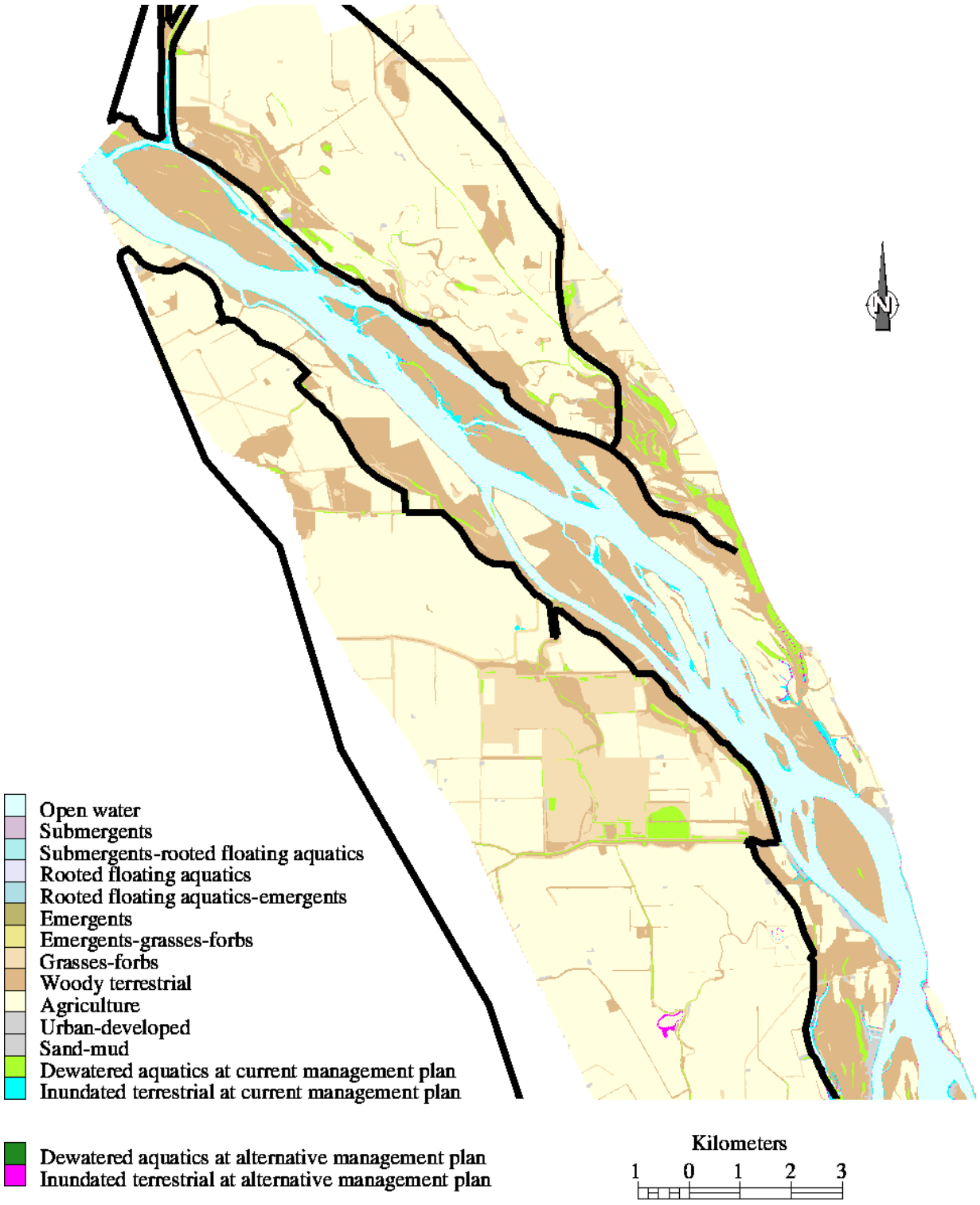


Figure 23. Comparison between water level management plan (Plan 2) and the present plan (Plan 1) at 56,000 cfs for land cover classes in the northern portion of Pool 25.

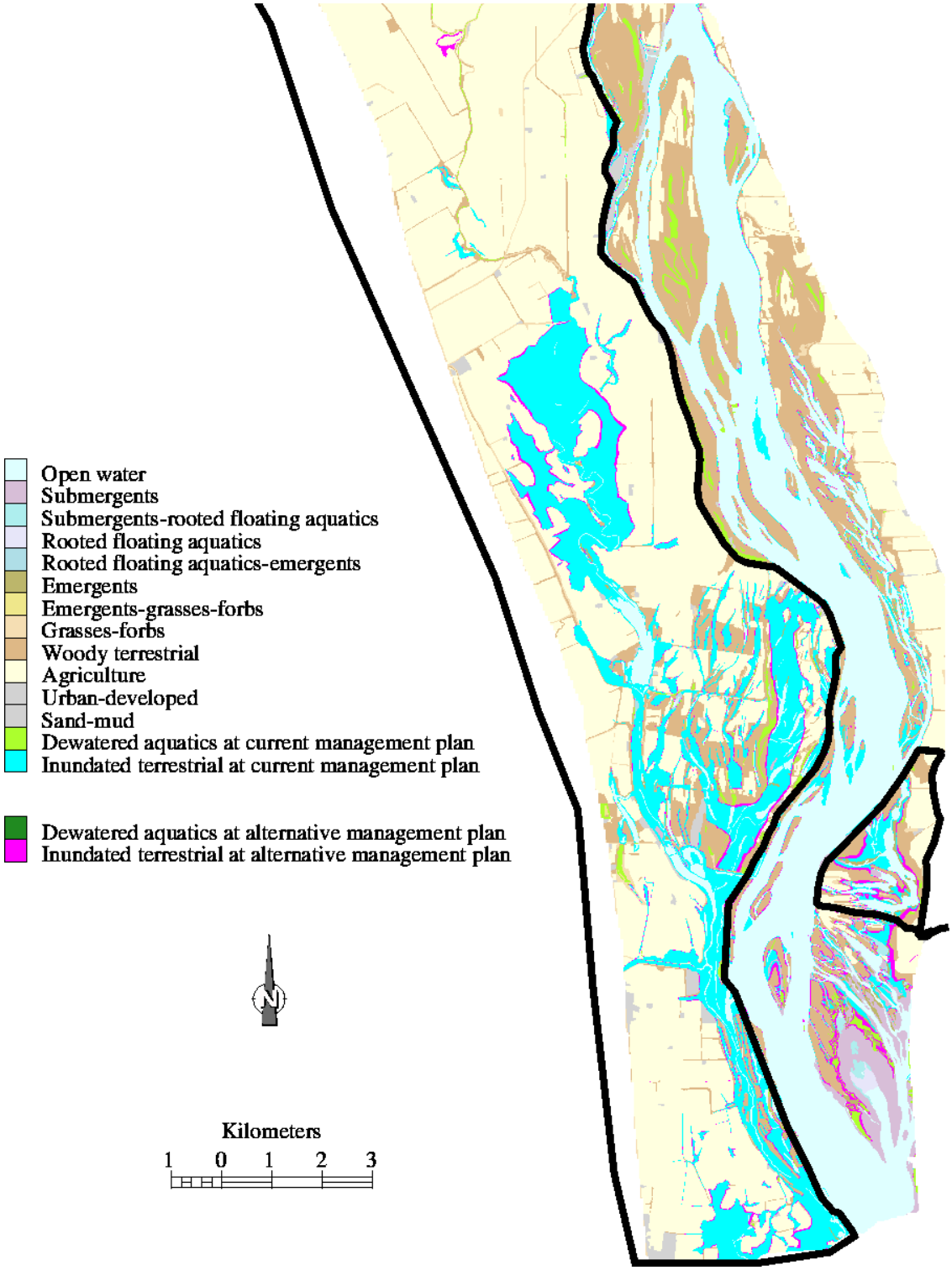


Figure 24. Comparison between water level management plan (Plan 2) and the present plan (Plan 1) at 56,000 cfs for land cover classes in the southern portion of Pool 25.

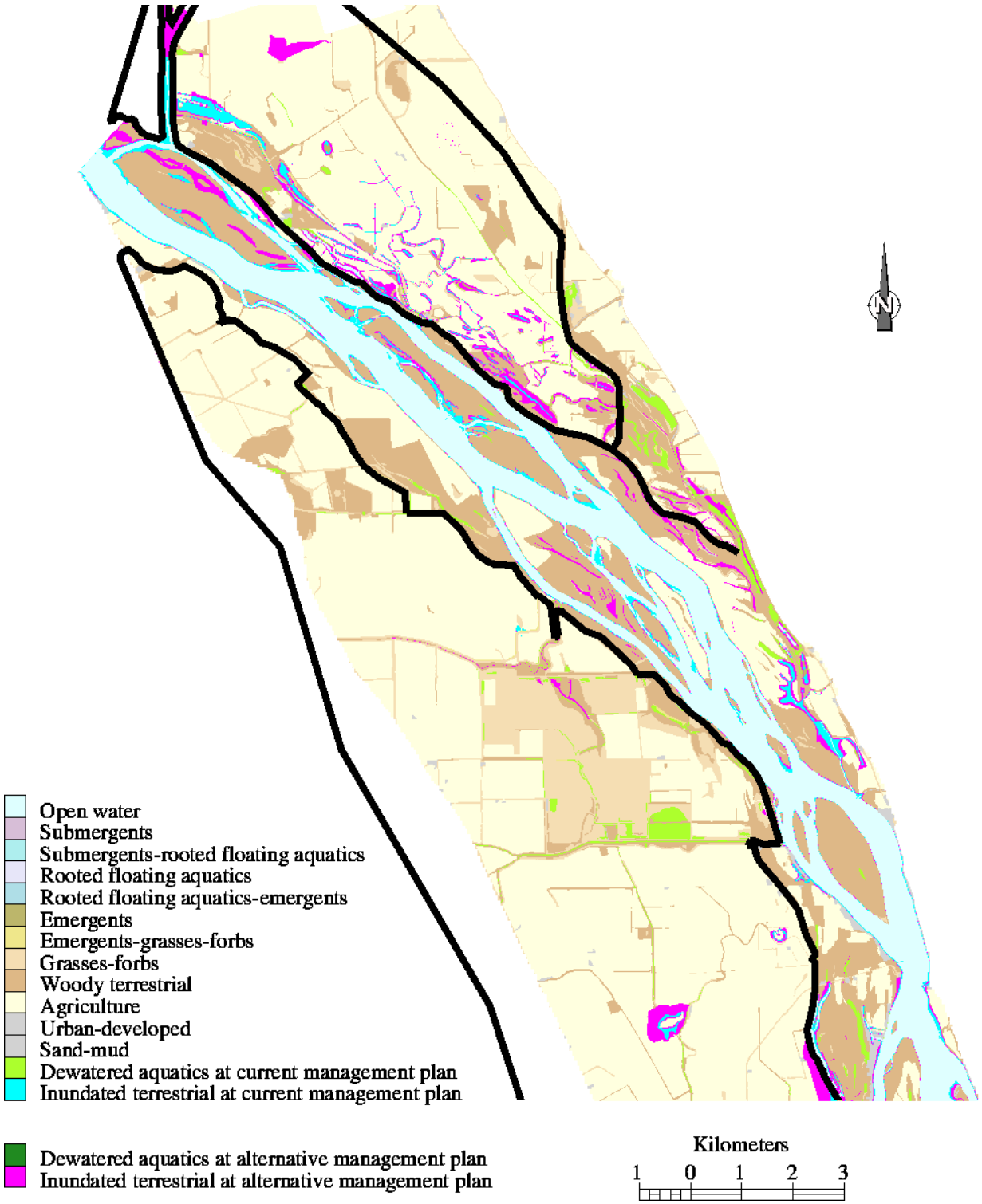


Figure 25. Comparison between water level management plan (Plan 2) and the present plan (Plan 1) at 95,000 cfs for land cover classes in the northern portion of Pool 25.

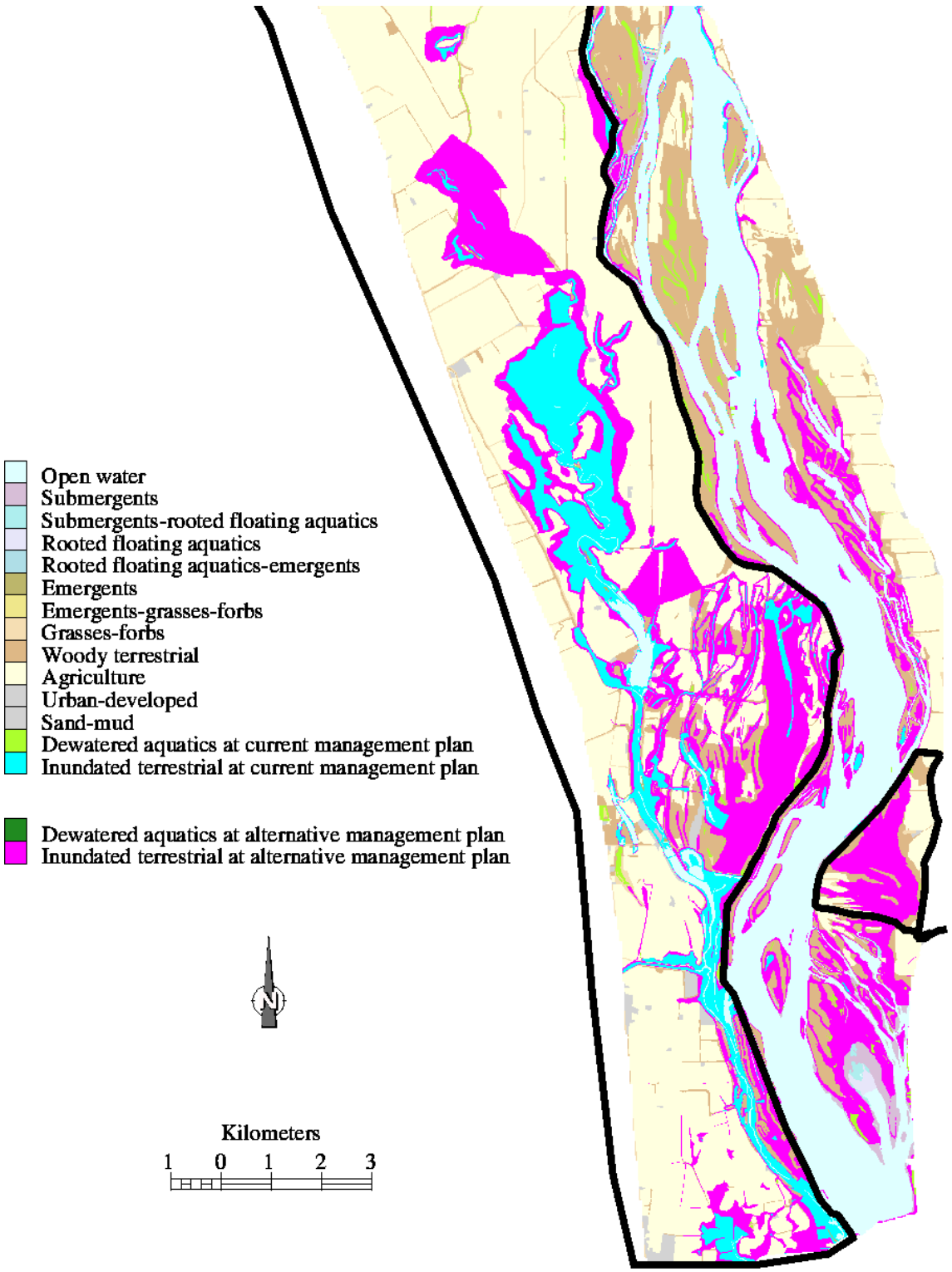


Figure 26. Comparison between water level management plan (Plan 2) and the present plan (Plan 1) at 95,000 cfs for land cover classes in the southern portion of Pool 25.

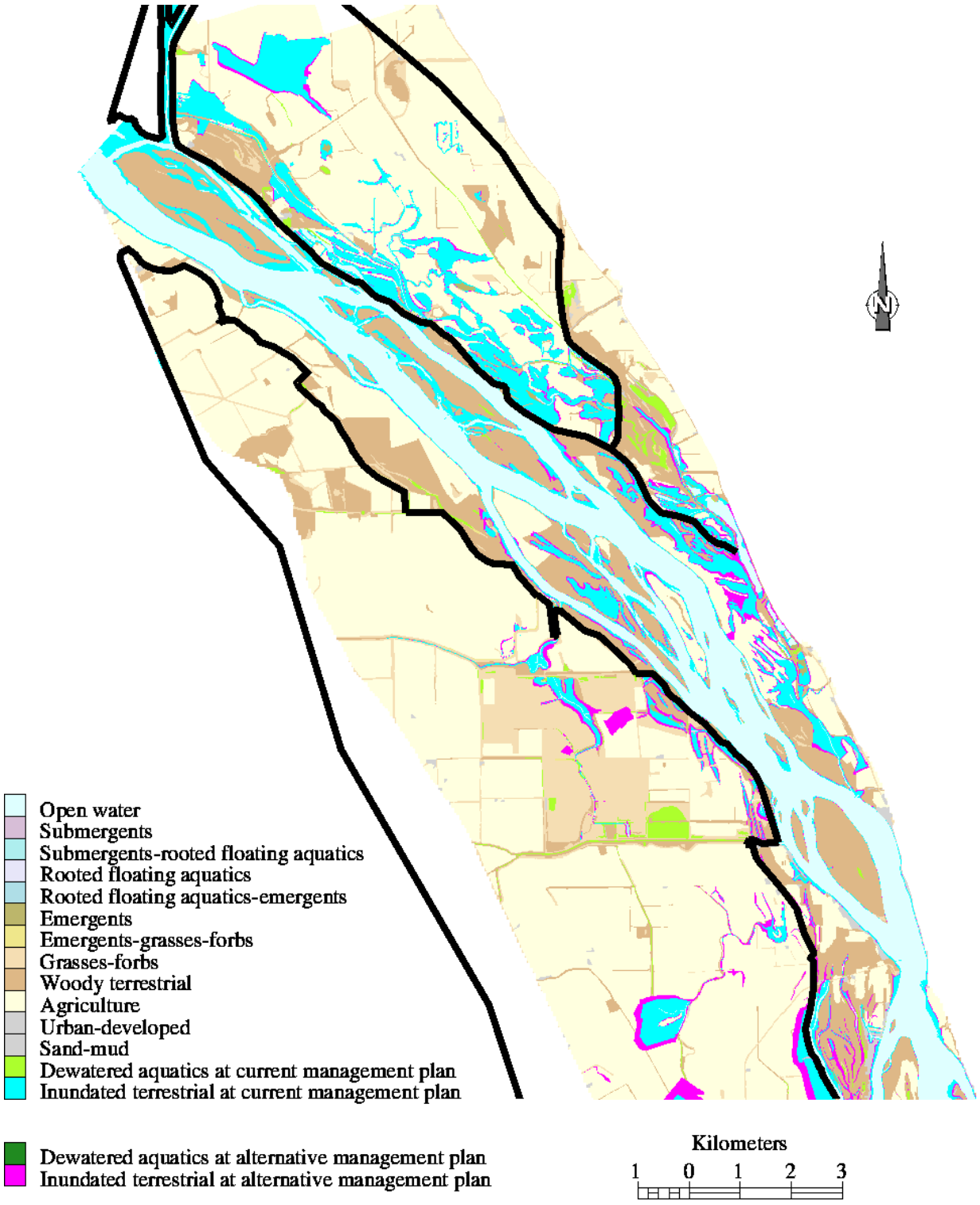


Figure 27. Comparison between water level management plan (Plan 2) and the present plan (Plan 1) at 135,000 cfs for land cover classes in the northern portion of Pool 25.

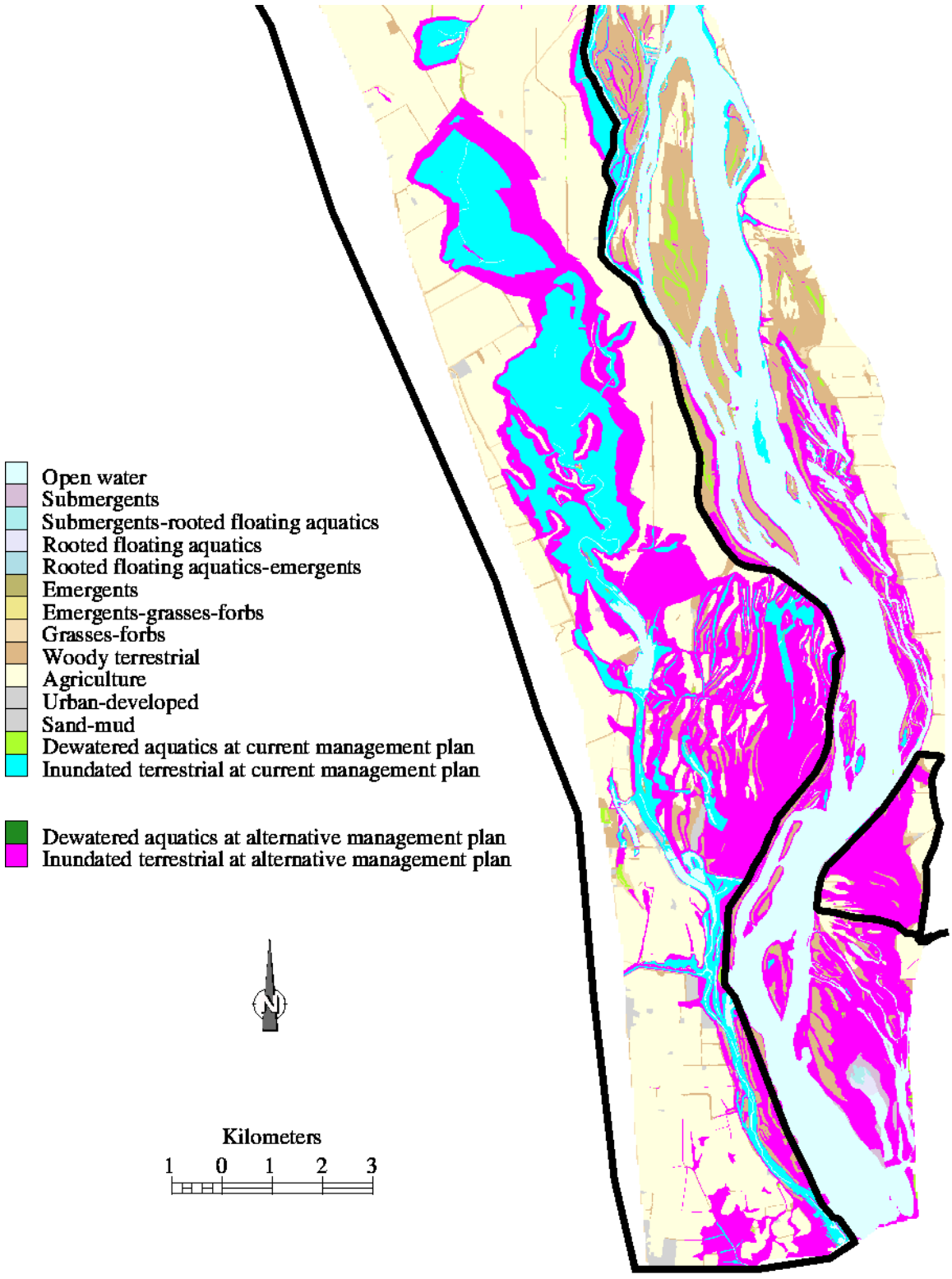


Figure 28. Comparison between water level management plan (Plan 2) and the present plan (Plan 1) at 135,000 cfs for land cover classes in the southern portion of Pool 25.

Appendix A. The HEC-2 Model Representing 1993–1994 Conditions in Pool 25

```
T1      Pool 25
T2      Data entered by Paul Page 6/1994 - 8/1994
T3      POOL 25  P2594N7 - FINAL CALIBRATION RUN  Joe Wlosinski
T4      Pool 25 Profiles from Nov. 1993 transects and 1994 bathymetry
T5      Transects not accurate for flows greater than 200000 cfs
J1   -10       2                                    433.8
J2     1
J3    38      17       1      43      26       8       7
J5   -10     -10
QT     4   19000   56000   95000  135000
NC  .025    .025    .025     .1      .3
X1241.50      36   20000   25440       0       0       0
X3    10
GR 437.0   20000   434.1   20080   431.1   20160   430.5   20320   429.9   20480
GR 428.4   20640   428.0   20800   426.8   20960   428.7   21120   429.5   21280
GR 429.4   21440   427.5   21600   425.9   21760   428.0   21920   428.2   22080
GR 428.4   22240   413.0   22400   410.6   22560   419.4   22720   420.2   22880
GR 418.3   23040   414.7   23200   413.4   23360   415.7   23520   412.1   23680
GR 405.3   23840   405.6   24000   407.4   24160   400.7   24320   399.8   24480
GR 385.9   24640   386.5   24820   391.3   24960   391.3   25120   399.3   25280
GR 437.0   25440
NC  .025    .025    .025     .1      .3
X1241.80      43   19520   25320    1300    1250    1200
X2       431.745
X3    10
GR 437.0   19520   437.0   19521   437.0   19522   437.0   19523   434.1   19600
GR 430.7   20000   430.4   20080   428.8   20160   428.6   20320   427.7   20480
GR 426.7   20640   429.1   20800   428.9   20960   429.2   21120   428.7   21280
GR 429.2   21440   429.8   21600   430.1   21760   420.8   21920   417.9   22080
GR 415.8   22240   414.6   22400   416.9   22560   418.4   22720   422.7   22880
GR 426.0   23040   427.0   23200   428.1   23360   427.9    2352   420.6   23680
GR 405.9   23840   404.3   24000   404.9   24160   407.3   24320   412.4   24480
GR 410.7   24640   407.7   24820   405.1   24960   401.8   25040   410.9   25120
GR 434.1   25200   434.1   25280   437.0   25320
NC  .025    .025    .025     .1      .3
X1 242.0      40   20000   25840    1100     950    1000
X3    10
GR 437.0   20000   431.2   20080   431.1   20160   430.5   20320   429.1   20480
GR 428.3   20640   427.6   20800   428.1   20960   428.8   21120   429.2   21280
GR 429.2   21440   425.2   21600   428.0   21760   426.9   21920   416.4   22080
GR 416.1   22240   417.1   22400   419.1   22560   422.1   22720   423.4   22880
GR 424.3   23040   426.6   23200   426.7   23360   427.3   23520   429.3   23680
GR 429.4   23840   420.1   24000   416.8   24160   416.6   24320   409.2   24480
GR 409.4   24640   409.5   24820   413.0   24960   409.2   25120   410.8   25280
```

GR 410.5 25440 413.5 25600 427.3 25680 434.1 25760 437.0 25840
NC .025 .025 .025 .1 .3
X1242.60 31 20000 24320 3400 3200 3100
X3 10
GR 437.0 20000 431.6 20080 430.2 20160 413.5 20320 411.9 20480
GR 415.0 20640 419.5 20800 418.1 20960 417.8 21120 417.7 21280
GR 422.7 21440 422.2 21600 423.8 21760 421.7 21920 421.0 22080
GR 419.3 22240 418.2 22400 416.2 22560 413.8 22720 410.9 22880
GR 414.0 23040 423.1 23200 425.5 23360 426.2 23520 423.8 23680
GR 430.3 23840 421.1 24000 419.5 24080 421.2 24160 434.1 24240
GR 437.0 24320
NC .025 .025 .025 .1 .3
X1243.00 28 20000 23920 1800 1800 1900
X3 10
GR 437.0 20000 432.0 20080 431.0 20160 428.9 20320 425.5 20480
GR 408.3 20640 405.5 20800 408.4 20960 413.5 21120 416.7 21280
GR 415.5 21440 415.2 21600 413.3 21760 414.7 21920 418.3 22080
GR 418.7 22240 422.3 22400 421.8 22560 424.4 22720 423.3 22880
GR 425.4 23040 421.2 23200 422.2 23360 420.0 23520 421.7 23680
GR 425.1 23760 427.0 23840 437.0 23920
NC .025 .025 .025 .1 .3
X1243.40 24 20000 23280 1900 2000 2000
X3 10
GR 440.0 20000 420.2 20080 418.6 20160 412.5 20320 408.1 20480
GR 408.6 20640 407.1 20800 409.4 20960 408.8 21120 410.3 21280
GR 413.4 21440 415.2 21600 417.8 21760 417.1 21920 418.7 22080
GR 420.4 22240 418.6 22400 417.6 22560 419.6 22720 417.3 22880
GR 417.4 23040 424.2 23120 425.8 23200 440.0 23280
NC .025 .025 .025 .1 .3
X1244.00 22 19200 22240 3200 3100 3000
X3 10
GR 437.0 19200 431.7 19280 431.7 19360 431.7 19440 431.7 19520
GR 431.7 20000 429.9 20080 429.2 20160 420.7 20320 416.6 20480
GR 410.4 20640 399.2 20800 393.6 20960 403.6 21120 399.6 21280
GR 406.0 21440 406.9 21600 408.2 21760 413.9 21920 430.7 22080
GR 432.8 22160 437.0 22240
NC .025 .025 .025 .1 .3
X1244.40 26 20000 23600 2400 2000 1800
X3 10
GR 437.0 20000 428.0 20080 428.9 20160 429.2 20320 430.9 20480
GR 429.9 20640 430.5 20800 429.4 20960 428.1 21120 425.5 21280
GR 426.1 21440 424.6 21600 419.4 21760 420.0 21920 427.6 22080
GR 427.5 22240 422.2 22400 420.9 22560 407.8 22720 405.0 22880
GR 391.0 23040 386.8 23200 379.0 23360 412.4 23440 434.1 23520
GR 437.0 23600
NC .026 .026 .026 .1 .3
X1244.90 37 11200 23080 3200 3000 3000
X3 10
GR 439.0 11200 430.0 17320 430.0 17360 429.0 17400 430.0 17440

GR 429.0 17520 428.0 17600 426.0 17680 426.0 17760 424.0 17840
GR 425.0 17920 424.0 18000 423.0 18080 426.0 18160 425.0 18240
GR 426.0 18320 426.0 18360 426.0 18400 426.0 18400 426.0 18400
GR 434.1 20000 424.2 20080 423.7 20160 420.9 20320 420.8 20480
GR 419.1 20640 417.7 20800 417.6 20960 414.0 21120 411.7 21280
GR 406.9 21440 397.8 21600 393.5 21760 394.1 21840 401.2 22920
GR 434.1 23000 437.0 23080
NC .026 .026 .026 .1 .3
X1245.50 38 11200 23160 900 2700 3000
X3 10
GR 439.0 11200 428.0 17160 428.0 17200 427.0 17240 426.0 17320
GR 427.0 17400 425.0 17480 425.0 17560 425.0 17640 427.0 17720
GR 428.0 17800 425.0 17880 426.0 17960 424.0 18040 422.0 18120
GR 421.0 18160 420.0 18200 420.0 18200 420.0 18200 420.0 18200
GR 434.1 20000 418.4 20080 409.6 20160 410.7 20320 411.5 20480
GR 413.6 20640 413.1 20800 412.8 20960 413.1 21120 413.7 21280
GR 411.7 21440 407.3 21600 405.1 21760 405.1 21840 402.6 22920
GR 427.2 23000 434.1 23080 437.0 23160
NC .026 .026 .026 .1 .3
X1246.00 34 20000 25120 2200 2900 3000
X3 10
GR 437.0 20000 426.1 20080 426.2 20160 427.0 20320 428.4 20480
GR 428.2 20640 429.1 20800 429.4 20960 429.6 21120 429.0 21280
GR 427.5 21440 427.5 21600 426.2 21760 425.7 21920 424.8 22080
GR 422.5 22240 409.7 22400 407.7 22560 440.7 22720 401.0 22880
GR 401.5 23040 401.2 23120 419.8 23200 434.1 23280 434.1 24240
GR 415.0 24280 414.0 24320 416.0 24360 416.0 24440 416.0 24520
GR 416.0 24600 417.0 24680 417.0 24720 439.0 25120
NC .026 .026 .026 .1 .3
X1246.40 31 20000 24200 700 2000 2400
X3 10
GR 437.0 20000 422.1 20080 423.8 20160 422.9 20320 424.7 20480
GR 422.9 20640 421.1 20800 418.9 20960 417.4 21120 415.9 21280
GR 413.8 21440 411.8 21600 412.0 21760 412.0 21920 414.0 22080
GR 411.6 22240 414.4 22400 412.6 22480 434.1 22560 418.0 23160
GR 417.0 23200 414.0 23240 413.0 23320 413.0 23400 410.0 23480
GR 411.0 23560 413.0 23640 415.0 23720 418.0 23760 418.0 23800
GR 439.0 24200
NC .026 .026 .026 .1 .3
X1247.10 29 20000 24240 2400 2700 2800
X3 10
GR 437.0 20000 398.9 20080 396.9 20160 398.1 20320 396.1 20480
GR 400.3 20640 400.3 20800 404.4 20960 409.2 21120 424.5 21280
GR 424.8 21440 426.2 21600 428.0 21760 428.6 21920 430.0 22080
GR 429.5 22240 429.6 22400 428.9 22560 428.7 22720 429.2 22880
GR 422.4 23040 420.6 23200 420.1 23360 415.7 23440 426.6 23520
GR 431.8 23680 431.8 23760 434.2 23840 439.0 24240
NC .027 .027 .027 .1 .3
X1247.70 25 20000 24560 2900 3000 3100

X3 10
GR 437.0 20000 384.7 20080 385.1 20160 390.9 20320 398.2 20480
GR 411.9 20640 430.5 20800 429.4 20960 428.1 21120 425.5 21280
GR 416.1 21440 418.2 21600 414.2 21760 424.2 21920 430.1 22080
GR 427.9 22240 426.6 22400 425.4 22560 425.1 22720 428.5 22880
GR 428.8 23040 431.0 23200 431.0 23280 434.2 23360 439.0 24560
NC .027 .027 .027 .1 .3
X1248.10 31 20000 25280 4600 3000 2400
X3 10
GR 440.0 20000 419.2 20080 414.8 20160 431.1 20320 404.5 20480
GR 393.9 20640 416.3 20800 418.1 20960 420.7 21120 419.0 21280
GR 417.0 21440 419.3 21600 416.5 21760 414.7 21920 410.4 22080
GR 421.2 22240 423.0 22400 427.9 22480 434.2 22560 426.0 23760
GR 426.0 23800 422.0 23840 423.0 23920 423.0 24000 425.0 24080
GR 429.0 24240 430.0 24320 431.0 24400 431.0 24440 430.0 24480
GR 440.0 25280
NC .027 .027 .027 .1 .3
X1248.50 42 18840 24360 2200 1800 1000
X3 10
GR 440.0 18840 423.0 19040 422.0 19080 424.0 19120 426.0 19160
GR 428.0 19200 434.1 19300 434.1 19300 434.1 19300 434.1 19300
GR 434.3 20000 414.2 20080 413.9 20160 409.7 20320 411.3 20480
GR 414.7 20640 417.0 20800 413.8 20960 415.1 21120 414.6 21280
GR 414.9 21440 417.8 21600 419.9 21760 423.9 21920 423.3 22080
GR 427.0 22240 429.6 22400 430.3 22560 429.0 22720 428.4 22800
GR 431.2 22880 434.3 22960 434.3 23960 426.0 24000 422.0 24040
GR 415.0 24080 416.0 24120 414.0 24160 415.0 24200 410.0 24240
GR 419.0 24280 440.0 24360
NC .027 .027 .027 .1 .3
X1249.00 47 18400 24770 3200 2600 2000
X3 10
GR 440.0 18400 428.0 18480 428.0 18520 430.0 18560 430.0 18600
GR 428.0 18640 429.0 18720 429.0 18760 428.0 18800 434.3 19800
GR 434.3 20000 425.1 20080 420.8 20160 417.7 20320 415.9 20480
GR 415.0 20640 411.3 20800 412.8 20960 412.8 21120 412.5 21280
GR 415.1 21440 418.3 21600 419.2 21760 425.9 21920 427.0 22080
GR 427.9 22240 428.7 22400 428.5 22560 429.9 22720 430.4 22880
GR 430.4 23040 429.7 23200 428.6 23360 430.7 23440 431.2 23520
GR 434.3 23680 430.0 24080 431.0 24120 431.0 24160 431.0 24200
GR 431.0 24240 431.0 24540 421.0 24620 419.0 24660 418.0 24700
GR 418.0 24740 440.0 24770
NC .027 .027 .027 .1 .3
X1249.50 35 18680 23360 2600 2000 1600
X3 10
GR 440.0 18680 429.0 19080 429.0 19120 424.0 19160 426.0 19200
GR 427.0 19240 427.0 19280 434.3 19320 434.3 19321 434.3 19322
GR 434.3 20000 429.9 20080 409.0 20160 407.6 20320 405.2 20480
GR 412.7 20640 417.3 20800 418.0 20960 416.6 21120 418.1 21280
GR 418.2 21440 418.3 21600 420.4 21760 419.1 21920 420.0 22080

GR 417.3 22240 419.1 22400 419.8 22560 421.9 22720 423.0 22880
GR 424.0 23040 431.0 23120 431.0 23200 434.2 23280 440.0 23360
NC .027 .027 .027 .1 .3
X1250.10 33 19600 23120 2600 2800 3200
X3 10
GR 440.0 19600 423.0 19640 424.0 19680 424.0 19720 425.0 19760
GR 434.7 19800 434.7 19800 434.7 19800 434.7 19800 434.7 19800
GR 434.7 20000 419.1 20080 417.1 20160 422.7 20320 428.7 20480
GR 429.8 20640 431.0 20800 430.4 20960 428.9 21120 427.8 21280
GR 424.1 21440 421.2 21600 419.5 21760 417.8 21920 412.2 22080
GR 405.3 22240 403.0 22400 399.3 22560 399.1 22720 402.4 22880
GR 402.8 22960 434.7 23040 440.0 23120
NC .024 .024 .024 .1 .3
X1250.40 28 19840 23120 1300 1700 2200
X3 10
GR 440.0 19840 440.0 19840 440.0 19840 440.0 19840 440.0 19840
GR 434.7 20000 429.1 20080 426.4 20160 423.6 20320 423.6 20480
GR 427.7 20640 424.1 20800 427.8 20960 429.7 21120 426.3 21280
GR 423.3 21440 424.6 21600 424.8 21760 422.3 21920 419.8 22080
GR 415.1 22240 414.8 22400 406.7 22560 392.0 22720 392.5 22880
GR 394.1 22960 403.5 23040 440.0 23120
NC .024 .024 .024 .1 .3
X1251.00 34 19840 24080 3000 3000 3000
X3 10
GR 440.0 19840 440.0 19840 440.0 19840 440.0 19840 440.0 19840
GR 434.7 20000 432.2 20080 422.0 20160 421.8 20320 419.3 20480
GR 427.0 20640 424.5 20800 423.2 20960 418.3 21120 427.1 21280
GR 420.7 21440 421.8 21600 422.1 21760 420.1 21920 417.6 22080
GR 419.3 22240 418.0 22400 418.9 22560 423.6 22720 425.2 22880
GR 425.1 23040 425.2 23200 416.3 23360 412.0 23520 412.9 23680
GR 415.5 23840 424.5 23920 434.7 24000 440.0 24080
NC .024 .024 .024 .1 .3
X1251.50 32 20000 25280 3400 2800 3100
X3 10
GR 440.0 20000 433.0 20080 429.6 20160 422.6 20320 416.2 20480
GR 418.9 20640 419.7 20800 419.3 20960 414.4 21120 412.7 21280
GR 412.8 21440 406.8 21600 409.2 21760 409.7 21840 407.9 22920
GR 408.8 23000 434.7 23080 434.7 24080 431.0 24320 430.0 24360
GR 430.0 24400 429.0 24480 430.0 24560 428.0 24640 426.0 24720
GR 418.0 24800 417.0 24880 414.0 24960 414.0 25040 414.0 25120
GR 415.0 25200 440.0 25280
NC .024 .024 .024 .1 .3
X1252.10 40 20000 24860 3400 3200 3000
X3 10
GR 440.0 20000 430.4 20080 428.7 20160 428.3 20320 425.8 20480
GR 428.6 20640 423.3 20800 421.4 20960 418.2 21120 414.7 21280
GR 414.5 21440 410.0 21600 410.3 21760 413.8 21920 414.1 22080
GR 414.2 22240 422.0 22400 434.7 22480 427.0 23380 427.0 23420
GR 426.0 23460 425.0 23540 424.0 23620 423.0 23700 422.0 23780

```
GR 424.0  23860  423.0  23940  423.0  24020  425.0  24100  425.0  24180
GR 426.0  24260  427.0  24340  425.0  24420  425.0  24500  424.0  24580
GR 425.0  24660  427.0  24740  429.0  24780  431.0  24820  440.0  24860
NC  .024   .024   .024    .1    .3
X1252.50    28  20000  22920   2000   2000   1900
X3   10
GR 440.0  20000  427.7  20080  421.0  20160  415.6  20320  407.1  20480
GR 403.8  20640  400.6  20800  397.8  20960  434.7  21040  434.7  21640
GR 424.0  21680  425.0  21720  425.0  21800  424.0  21880  423.0  21960
GR 424.0  22040  425.0  22120  425.0  22200  428.0  22280  428.0  22360
GR 430.0  22440  430.0  22520  431.0  22600  431.0  22680  431.0  22760
GR 430.0  22840  429.0  22880  440.0  22920
NC  .024   .024   .024    .1    .3
X1252.90    19  20000  22560   2400   1800   1600
X3   10
GR 440.0  20000  418.7  20080  416.0  20160  415.2  20320  416.4  20480
GR 409.8  20640  401.6  20800  394.5  20960  413.4  21120  423.7  21280
GR 424.5  21440  423.5  21600  424.2  21760  428.7  21920  426.1  22080
GR 425.3  22240  426.4  22400  431.7  22480  440.0  22560
NC  .024   .024   .024    .1    .3
X1253.50    33  20000  24100   2800   2400   2000
X3   10
GR 440.0  20000  426.6  20080  429.6  20160  428.3  20320  420.7  20480
GR 413.6  20640  408.8  20800  418.5  20960  418.1  21120  417.5  21280
GR 416.8  21440  420.7  21600  421.5  21680  434.7  21760  434.7  22760
GR 415.0  22800  413.0  22840  412.0  22880  416.0  22960  418.0  23040
GR 419.0  23120  419.0  23200  421.0  23280  425.0  23360  426.0  23440
GR 427.0  23520  428.0  23600  429.0  23680  430.0  23760  430.0  23840
GR 430.0  23920  430.0  24000  440.0  24100
NC  .024   .024   .024    .1    .3
X1254.00    38  20000  25600   2800   3000   3200
X3   10
GR 440.0  20000  425.8  20080  414.3  20160  414.3  20320  414.0  20480
GR 417.9  20640  418.7  20800  420.0  20960  416.0  21120  416.8  21280
GR 419.1  21440  421.3  21520  434.6  21600  434.6  22600  425.0  22640
GR 424.0  22680  424.0  22720  423.0  22800  424.0  22880  425.0  22960
GR 426.0  23040  425.0  23080  434.6  23120  434.6  24220  429.0  24260
GR 427.0  24300  427.0  24340  422.0  24420  418.0  24500  416.0  24580
GR 417.0  24820  422.0  24940  425.0  25060  426.0  25460  425.0  25500
GR 426.0  25540  426.0  25580  440.0  25600
NC  .024   .024   .024    .1    .3
X1254.40    34  20000  27100   1400   1900   2100
X3   10
GR 440.0  20000  434.6  20080  421.1  20160  419.2  20320  424.5  20480
GR 419.2  20640  416.0  20800  415.8  20960  422.4  21120  422.5  21280
GR 420.7  21440  418.3  21600  416.8  21760  434.6  21840  434.6  23040
GR 430.0  23080  428.0  23200  428.0  23360  426.0  23560  427.0  23800
GR 425.0  24000  434.6  24100  434.6  26100  422.0  26140  423.0  26180
GR 421.0  26260  423.0  26340  421.0  26420  420.0  26620  419.0  26660
```

GR 418.0 26780 416.0 26860 417.0 27060 442.0 27100
NC .024 .024 .024 .1 .3
X1255.00 35 20000 24680 2200 3000 3400
X3 10
GR 442.0 20000 435.0 20080 430.0 20160 427.6 20320 424.3 20480
GR 421.5 20640 419.9 20800 416.4 20960 418.1 21120 418.4 21280
GR 418.7 21440 421.2 21600 425.1 21760 425.1 21920 426.4 22080
GR 428.0 22240 430.0 22400 430.0 22560 426.2 22720 427.1 22880
GR 427.0 22960 435.1 23040 435.1 23920 420.0 24000 420.0 24040
GR 418.0 24080 421.0 24120 418.0 24160 417.0 24200 416.0 24240
GR 415.0 24380 415.0 24420 416.0 24520 419.0 24600 442.0 24680
NC .024 .024 .024 .1 .3
X1255.50 17 20000 22320 2200 2100 2000
X3 10
GR 442.0 20000 425.1 20080 423.8 20160 422.3 20320 420.9 20480
GR 418.7 20640 422.7 20800 424.2 20960 422.9 21120 421.3 21280
GR 417.6 21440 416.2 21600 413.7 21760 415.5 21920 412.5 22080
GR 407.8 22240 435.4 22320
NC .024 .024 .024 .1 .3
X1256.00 28 20000 26060 2000 2600 2800
X3 10
GR 442.0 20000 430.9 20080 427.8 20160 427.1 20320 429.3 20480
GR 428.2 20640 424.7 20800 424.3 20960 421.3 21120 418.5 21280
GR 418.4 21440 419.5 21600 419.0 21760 417.8 21920 418.0 22080
GR 417.0 22160 435.4 22240 435.4 25240 411.0 25300 410.0 25340
GR 417.0 25380 423.0 25420 424.0 25460 425.0 25500 423.0 25700
GR 423.0 25820 424.0 25900 442.0 26060
NC .022 .022 .022 .1 .3
X1256.40 34 17600 25360 2800 2100 2200
X3 10
GR 442.0 17600 442.0 17600 442.0 17600 442.0 17600 442.0 17600
GR 435.4 20000 431.9 20080 429.7 20160 422.4 20320 422.5 20480
GR 420.2 20640 419.7 20800 419.0 20960 419.8 21120 418.5 21280
GR 420.7 21440 421.5 21600 420.8 21760 421.7 21920 422.4 22000
GR 435.4 22080 435.4 24480 419.0 24560 420.0 24600 420.0 24640
GR 421.0 24680 423.0 24880 423.0 25000 425.0 25040 426.0 25120
GR 424.0 25240 423.0 25280 426.0 25320 442.0 25360
NC .022 .022 .022 .1 .3
X1256.90 34 18400 25320 3400 2800 2600
X3 10
GR 442.0 18400 442.0 18400 442.0 18400 442.0 18400 442.0 18400
GR 435.4 20000 432.0 20080 432.1 20160 426.3 20320 424.4 20480
GR 421.3 20640 426.1 20800 427.3 20960 426.8 21120 422.9 21280
GR 420.7 21440 420.1 21600 424.8 21760 425.3 21920 426.7 22080
GR 426.4 22160 435.4 22240 435.5 24640 411.0 24680 410.0 24720
GR 411.0 24760 417.0 24800 423.0 24880 424.0 24920 423.0 25040
GR 423.0 25160 424.0 25200 422.0 25240 442.0 25320
NC .022 .022 .022 .1 .3
X1257.50 38 20000 24960 2000 2800 3200

```
X3   10
GR 442.0  20000  435.5  20080  423.5  20160  421.3  20320  421.9  20480
GR 422.9  20640  423.5  20800  424.0  20960  421.2  21120  420.2  21280
GR 418.5  21440  415.0  21600  414.5  21760  415.9  21920  419.3  22000
GR 435.4  22080  435.4  24080  424.0  24120  424.0  24160  423.0  24200
GR 424.0  24240  421.0  24280  422.0  24320  424.0  24360  424.0  24440
GR 426.0  24480  427.0  24520  429.0  24560  425.0  24600  425.0  24640
GR 428.0  24680  425.0  24720  424.0  24760  423.0  24800  422.0  24840
GR 424.0  24880  425.0  24920  440.0  24960
NC  .022   .022   .022    .1    .3
X1258.00    20  20000  22640   3800   3000   2800
X3   10
GR 442.0  20000  435.4  20080  431.4  20160  409.0  20320  404.1  20480
GR 404.2  20640  406.3  20800  408.0  20960  409.1  21120  413.9  21280
GR 416.2  21440  422.1  21600  425.9  21760  428.3  21920  429.0  22080
GR 427.4  22240  427.3  22400  426.7  22480  427.9  22560  442.0  22640
NC  .022   .022   .022    .1    .3
X1258.50    16  20000  23000   2400   2800   3000
X3   10
GR 442.0  20000  435.4  20080  421.3  20160  420.5  20320  419.9  20480
GR 417.7  20640  408.8  20800  405.0  20960  402.3  21120  401.0  21280
GR 402.6  21440  412.0  21600  422.5  21760  428.8  21840  435.4  22920
GR 442.0  23000
NC  .023   .023   .023    .1    .3
X1258.90    21  20000  22880   2300   2000   1800
X3   10
GR 442.0  20000  435.4  20080  427.9  20160  415.4  20320  414.5  20480
GR 413.7  20640  415.7  20800  415.3  20960  414.5  21120  414.5  21280
GR 408.0  21440  407.3  21600  426.3  21760  427.7  21920  429.1  22080
GR 427.4  22240  428.3  22400  427.9  22560  430.0  22720  435.4  22800
GR 442.0  22880
NC  .023   .023   .023    .1    .3
X1259.50    27  20000  24360   3000   3200   3600
X3   10
GR 442.0  20000  435.4  20080  421.6  20160  414.1  20320  413.1  20480
GR 409.0  20640  412.9  20800  410.8  20960  413.7  21120  416.7  21280
GR 424.2  21440  425.6  21600  427.6  21680  435.4  21760  435.4  23360
GR 427.0  23400  426.0  23600  425.0  23640  423.0  23760  422.0  23960
GR 421.0  24000  423.0  24120  424.0  24200  425.0  24240  425.0  24280
GR 429.0  24320  444.0  24360
NC  .023   .023   .023    .1    .3
X1260.10    30  20000  25940   3100   2900   2800
X3   10
GR 444.0  20000  436.8  20080  425.0  20160  408.2  20320  410.5  20480
GR 417.9  20640  418.1  20800  428.2  20960  430.1  21120  429.7  21280
GR 428.8  21440  426.9  21600  425.7  21760  436.8  21840  436.8  24840
GR 430.0  24880  431.0  24920  430.0  25080  431.0  25120  429.0  25160
GR 429.0  25320  427.0  25360  425.0  25440  422.0  25480  420.0  25560
GR 421.0  25640  422.0  25720  423.0  25760  424.0  25840  444.0  25940
```

```
NC .023 .023 .023 .1 .3
X1260.40 31 20000 27720 2400 1800 400
X3 10
GR 444.0 20000 436.8 20080 432.5 20160 416.5 20320 406.0 20480
GR 412.1 20640 415.2 20800 416.5 20960 420.5 21120 421.4 21280
GR 423.8 21440 425.4 21600 424.8 21760 430.0 21840 436.5 22920
GR 435.8 26320 432.0 26360 430.0 26440 428.0 26640 428.0 26880
GR 429.0 27080 427.0 27120 428.0 27160 430.0 27200 430.0 27400
GR 428.0 27440 426.0 27560 425.0 27600 423.0 27640 421.0 27680
GR 444.0 27720
NC .023 .023 .023 .1 .3
X1261.00 35 20000 24960 2700 2900 3200
X3 10
GR 444.0 20000 436.8 20080 428.0 20160 429.8 20320 428.2 20480
GR 419.6 20640 404.8 20800 387.3 20960 389.6 21120 436.8 21200
GR 436.0 22400 422.0 22440 425.0 22480 424.0 22520 428.0 22560
GR 430.0 22600 427.0 23200 423.0 23240 423.0 23280 422.0 23320
GR 423.0 23360 426.0 23400 430.0 23440 430.0 23480 427.0 23520
GR 428.0 23560 428.0 24360 426.0 24400 425.0 24560 426.0 24600
GR 427.0 24680 428.0 24720 426.0 24840 429.0 24880 444.0 24960
NC .023 .023 .023 .1 .3
X1261.40 22 20000 23960 2900 2800 3400
X3 10
GR 444.0 20000 436.8 20080 428.8 20160 424.5 20320 422.0 20480
GR 417.9 20640 419.5 20800 430.9 20960 429.2 21120 422.3 21280
GR 419.9 21440 415.3 21600 412.6 21760 408.8 21920 405.5 22080
GR 412.8 22240 429.8 22400 426.2 22560 427.5 22720 427.9 22800
GR 436.8 22880 444.0 23960
NC .023 .023 .023 .1 .3
X1262.20 19 20000 23280 3000 3000 3000
X3 10
GR 444.0 20000 436.9 20080 427.8 20160 427.5 20320 436.5 20480
GR 427.7 21440 425.6 21600 426.4 21760 426.7 21920 425.0 22080
GR 419.7 22240 418.1 22400 419.2 22560 412.5 22720 407.2 22880
GR 407.0 23040 415.9 23120 436.9 23200 444.0 23280
NC .023 .023 .023 .1 .3
X1262.90 33 17920 22400 3500 3600 3700
X3 10
GR 444.0 17920 431.0 17960 432.0 18000 431.0 18040 430.0 18080
GR 433.0 18680 432.0 18880 431.0 19080 430.0 19280 431.0 19680
GR 431.0 19720 432.0 19760 429.0 19800 429.0 19800 429.0 19800
GR 436.0 20000 413.9 20080 417.6 20160 418.1 20320 416.8 20480
GR 414.9 20640 411.2 20800 428.8 20960 433.6 21120 433.0 21280
GR 429.7 21440 426.9 21600 429.6 21760 430.8 21920 430.7 22080
GR 431.2 22240 436.9 22320 444.0 22400
NC .023 .023 .023 .1 .3
X1263.40 31 20000 25240 1400 2600 3800
X3 10
GR 444.0 20000 433.4 20080 432.8 20160 432.4 20320 432.0 20480
```

```
GR 426.2  20640  423.5  20800  421.7  20960  421.5  21120  420.1  21280
GR 422.3  21440  413.4  21600  411.8  21760  412.7  21840  436.9  22920
GR 436.9  23720  433.0  23760  429.0  23800  427.0  23840  427.0  23900
GR 428.0  24140  427.0  24180  429.0  24340  433.0  24380  425.0  24780
GR 429.0  24820  427.0  24900  425.0  24980  425.0  25160  426.0  25200
GR 444.0  25240
NC  .023   .023   .023    .1     .3
X1263.90    22  20000  25720   3600   2800   3500
X3   10
GR 444.0  20000  436.9  20080  410.6  20160  404.5  20320  405.4  20480
GR 417.5  20640  421.6  20800  425.1  20960  421.5  21120  425.0  21280
GR 425.5  21440  429.3  21520  430.5  21600  436.9  21680  436.9  25280
GR 430.0  25320  428.0  25360  428.0  25400  429.0  25440  429.0  25640
GR 427.0  25680  447.0  25720
NC  .023   .023   .023    .1     .3
X1264.50    20  20000  26400   3400   3000   1200
X3   10
GR 447.0  20000  437.3  20080  419.0  20160  419.2  20320  423.0  20480
GR 424.2  20640  421.3  20800  419.4  20960  418.5  21120  421.7  21280
GR 422.8  21440  424.2  21600  421.4  21680  437.3  21760  437.3  25760
GR 430.0  25800  429.0  25880  430.0  26240  431.0  26360  447.0  26400
NC  .023   .023   .023    .1     .3
X1265.10    23  20000  26720   2800   2800   2800
X3   10
GR 447.0  20000  437.3  20080  411.5  20160  409.6  20320  410.2  20480
GR 411.8  20640  416.5  20800  418.2  20960  421.9  21120  427.5  21280
GR 430.2  21440  431.6  21600  433.8  21760  434.3  21920  432.9  22000
GR 433.7  22080  437.3  22160  437.3  26160  426.0  26200  428.0  26240
GR 428.0  26640  428.0  26680  447.0  26720
NC  .024   .024   .024    .1     .3
X1265.60    27  20000  27840   3300   2600   1200
X3   10
GR 447.0  20000  437.3  20080  429.3  20160  430.5  20320  428.4  20480
GR 427.8  20640  428.6  20800  427.2  20960  421.4  21120  417.4  21280
GR 419.0  21440  420.4  21600  420.7  21760  425.2  21920  422.3  22080
GR 425.8  22240  425.0  22400  426.0  22480  437.3  22560  437.3  27360
GR 433.0  27400  431.0  27440  432.0  27480  431.0  27560  429.0  27640
GR 428.0  27800  447.0  27840
NC  .024   .024   .024    .1     .3
X1266.00    27  18460  21440   2000   2000   2000
X3   10
GR 447.0  18460  429.0  18540  430.0  18620  428.0  18700  425.0  18780
GR 424.0  18860  421.0  18940  419.0  19020  419.0  19100  416.0  19140
GR 416.0  19220  420.0  19260  425.0  19300  425.0  19300  425.0  19300
GR 437.3  20000  435.4  20080  428.4  20160  417.9  20320  420.2  20480
GR 421.6  20640  419.5  20800  421.0  20960  421.3  21120  419.4  21280
GR 417.9  21360  437.3  21440
NC  .024   .024   .024    .1     .3
X1266.40    32  17600  24680   2100   2100   2500
```

```
X3   10
GR 447.0  17600  434.0  17680  432.0  17760  428.0  18080  427.0  18160
GR 425.0  18560  425.0  18680  432.0  18960  437.3  19000  437.3  19000
GR 437.3  20000  430.7  20080  427.6  20160  426.6  20320  425.2  20480
GR 423.4  20640  420.2  20800  419.6  20960  419.2  21120  422.2  21280
GR 424.1  21360  425.4  21440  437.3  21520  437.3  24160  427.0  24200
GR 426.0  24240  425.0  24280  425.0  24440  427.0  24480  428.0  24560
GR 429.0  24600  447.0  24680
NC  .024   .024   .024    .1    .3
X1267.10    31  16540  23000   4000   3700   3600
X3   10
GR 447.0  16540  431.0  16620  429.0  16700  430.0  16820  428.0  16940
GR 428.0  17060  427.0  17100  426.0  17180  425.0  17260  426.0  17660
GR 428.0  17740  432.0  17820  434.0  17860  437.3  17900  437.3  17900
GR 437.3  20000  427.7  20080  427.0  20160  423.1  20320  423.1  20480
GR 420.3  20640  422.8  20800  420.6  20960  425.0  21120  423.9  21280
GR 424.8  21440  420.8  21600  425.8  21760  430.6  21840  437.3  22920
GR 447.0  23000
NC  .024   .024   .024    .1    .3
X1267.50    29  15800  21600   1800   1900   2000
X3   10
GR 448.0  15800  420.0  15840  420.0  15880  422.0  15920  426.0  16120
GR 427.0  16320  429.0  16480  427.0  16560  427.0  16640  425.0  17440
GR 434.0  17480  432.0  17520  434.0  17560  430.0  17600  430.0  17600
GR 437.4  20000  421.2  20080  420.2  20160  416.1  20320  416.7  20480
GR 418.1  20640  420.6  20800  420.1  20960  418.8  21120  419.2  21280
GR 419.8  21360  421.4  21440  437.4  21520  447.0  21600
NC  .024   .024   .024    .1    .3
X1268.10    31  17000  23000   2500   3100   3200
X3   10
GR 448.0  17000  429.0  17040  424.0  17120  423.0  17160  423.0  17280
GR 426.0  17360  427.0  17440  426.0  17560  425.0  17700  423.0  17820
GR 437.4  17900  437.4  17900  437.4  17900  437.4  17900  437.4  17900
GR 437.4  20000  425.5  20080  423.9  20160  432.1  20320  426.7  20480
GR 421.9  20640  425.5  20800  425.5  20960  419.5  21120  419.3  21280
GR 418.7  21440  417.1  21600  419.0  21760  417.3  21840  437.4  22920
GR 447.0  23000
NC  .024   .024   .024    .1    .3
X1268.60    34  17100  21760   3500   2900   2900
X3   10
GR 449.0  17100  425.0  17180  424.0  17260  425.0  17340  423.0  17420
GR 422.0  17500  423.0  17580  422.0  17660  421.0  17740  423.0  17820
GR 423.0  17900  422.0  17980  420.0  18060  418.0  18140  422.0  18220
GR 438.8  18300  438.8  18300  438.8  18300  438.8  18300  438.8  18300
GR 438.8  20000  428.3  20080  427.1  20160  422.9  20320  422.9  20480
GR 421.9  20640  425.0  20800  424.4  20960  424.4  21120  421.4  21280
GR 423.6  21440  424.4  21600  438.8  21680  447.0  21760
NC  .024   .024   .024    .1    .3
X1269.00    27  18620  22160   1900   1900   2000
```

```
X3   10
GR 449.0  18620  424.0  18700  423.0  18740  423.0  18820  426.0  18900
GR 425.0  19060  424.0  19260  425.0  19340  432.0  19420  438.8  19440
GR 438.8  20000  433.7  20080  433.1  20160  431.2  20320  430.7  20480
GR 429.1  20640  426.7  20800  424.1  20960  424.4  21120  424.1  21280
GR 423.5  21440  422.3  21600  425.1  21760  426.9  21920  427.9  22000
GR 438.8  22080  447.0  22160
NC  .024   .024   .024    .1    .3
X1269.40    31  17720  22000   2200   2000   2000
X3   10
GR 449.0  17720  421.0  17800  415.0  17840  416.0  17880  419.0  17920
GR 418.0  18060  422.0  18100  422.0  18300  421.0  18340  430.0  18360
GR 438.8  18400  438.8  18400  438.8  18400  438.8  18400  438.8  18400
GR 438.8  20000  435.2  20080  433.3  20160  431.2  20320  428.6  20480
GR 428.0  20640  426.7  20800  423.8  20960  424.4  21120  425.1  21280
GR 424.9  21440  426.5  21600  424.3  21760  427.2  21840  438.8  21920
GR 447.0  22000
NC  .024   .024   .024    .1    .3
X1270.00    30  18340  22920   3000   2900   2900
X3   10
GR 449.0  18340  423.0  18940  421.0  18980  419.0  19020  420.0  19160
GR 427.0  19200  429.0  19240  430.0  19280  431.0  19360  433.0  19480
GR 432.0  19520  433.0  19600  433.0  19600  433.0  19600  433.0  19600
GR 438.7  20000  424.5  20080  424.2  20160  425.0  20320  424.5  20480
GR 422.4  20640  422.3  20800  422.7  20960  423.8  21120  422.2  21280
GR 423.1  21440  423.7  21600  424.7  21760  438.7  21840  447.0  22920
NC  .024   .024   .024    .1    .3
X1270.50    29  18460  22560   3100   3000   2800
X3   10
GR 449.0  18460  434.0  19260  433.0  19420  436.0  19560  434.0  19580
GR 435.0  19620  436.0  19740  435.0  19860  438.1  19900  438.1  19920
GR 438.7  20000  434.1  20080  433.8  20160  432.2  20320  430.0  20480
GR 429.0  20640  428.4  20800  425.3  20960  429.2  21120  425.6  21280
GR 422.0  21440  422.6  21600  421.0  21760  421.2  21920  419.7  22080
GR 416.6  22240  417.4  22400  438.7  22480  449.0  22560
NC  .024   .024   .024    .1    .3
X1271.10    27  17480  22160   3300   3200   3100
X3   10
GR 449.0  17480  436.0  17520  435.0  17560  434.0  17600  433.0  17640
GR 432.0  17720  430.0  17840  429.0  17880  429.0  17960  438.7  18000
GR 438.7  20000  414.6  20080  416.1  20160  413.2  20320  416.3  20480
GR 416.9  20640  418.9  20800  418.8  20960  419.8  21120  419.6  21280
GR 424.2  21440  426.8  21600  427.2  21760  423.8  21920  428.0  22000
GR 438.7  22080  449.0  22160
NC  .024   .024   .024    .1    .3
X1271.50    26  17280  22000   2400   2600   2700
X3   10
GR 449.0  17280  436.0  17360  435.0  17440  435.0  17520  436.0  17600
GR 436.0  17680  433.0  17760  434.0  17840  432.0  17920  438.7  18000
```

```
GR 438.7  20000  434.8  20080  432.4  20160  428.2  20320  426.0  20480
GR 423.9  20640  417.8  20800  416.8  20960  413.2  21120  412.2  21280
GR 412.4  21440  414.3  21600  416.2  21760  415.0  21840  427.5  21920
GR 449.0  22000
NC  .024   .024   .024    .1    .3
X1272.10    19  15920  21680   4200   3200   3000
X3   10
GR 449.0  15920  432.0  16000  429.0  16080  429.0  16160  428.0  16240
GR 430.0  16320  439.1  16400  439.1  16400  439.1  16400  439.1  16400
GR 439.1  20000  427.1  20080  425.8  20160  427.0  20320  423.6  20480
GR 402.0  21440  420.7  21520  439.1  21600  449.0  21680
NC  .024   .024   .024    .1    .3
X1272.60    28  15200  22320   2300   2700   2800
X3   10
GR 449.0  15200  432.0  15280  425.0  15360  426.0  15440  433.0  15520
GR 439.2  15600  439.2  15600  439.2  15600  439.2  15600  439.2  15600
GR 439.2  20000  426.8  20080  428.3  20160  429.7  20320  427.1  20480
GR 424.9  20640  423.6  20800  421.5  20960  421.5  21120  420.5  21280
GR 419.0  21440  419.2  21600  419.1  21760  418.2  21920  417.8  22080
GR 422.2  22160  439.2  22240  449.0  22320
NC  .024   .024   .024    .1    .3
X1273.00    26  17120  22080    800   1600   2200
X3   10
GR 449.0  17120  432.0  17200  434.0  17280  436.0  17360  436.0  17440
GR 438.0  17520  438.5  17600  438.5  17600  438.5  17600  438.5  17600
GR 438.5  20000  428.2  20080  401.2  20160  410.3  20320  422.7  20480
GR 416.1  20640  410.5  20800  418.9  20960  420.5  21120  419.7  21280
GR 418.3  21440  421.5  21600  422.1  21760  431.5  21920  434.7  22000
GR 449.0  22080
NC  .024   .024   .024    .1    .3
X1273.40    15  20000  21840   4000   2000   1800
X3   10
GR 451.0  20000  436.0  20080  428.6  20160  399.6  20320  382.2  20480
GR 400.0  20640  404.9  20800  406.8  20960  406.6  21120  406.8  21280
GR 417.2  21440  427.8  21600  422.8  21680  420.8  21760  449.0  21840
EJ
T1     LOCK AND DAM 25
T2     RUN BY JOE WLOSINSKI
T3     56000 CFS
J1    0      3                                  433.8
J2    2

T1     LOCK AND DAM 25
T2     RUN BY JOE WLOSINSKI
T3     95000 CFS
J1    0      4                                  431.7
J2    3

T1     LOCK AND DAM 25
```

```
T2     RUN BY JOE WLOSINSKI
T3     135000 CFS
J1    0      5                              429.9
J2    4

ER
```

Appendix B. The Arc Macro Language Program for Creating Water Level Elevation Templates

```
/* Arc Macro Language program for assigning water elevations by river mile
/* use files generated from HEC model
/* template coverage of river miles must exist

/* set variables
&sv .pool = pool25
&work /usr4/arc_work/jtr0/bath/%.pool%
&sv .pl = p25
&sv .wlm = 1
&sv .dr = 1

/* add data to info tables
&do &until %.wlm% = 6
 tables
  define temp
  VALUE
  4
  10
  b
  WSE-%.wlm%-%.dr%
  4
  5
  f
  1
  ~
  add from /net/sun04/home/jtr0/wse/pool25/%.pl%-%.wlm%-%.dr%
  q stop
 joinitem wse%.pl%.vat temp wse%.pl%.vat value count ordered
 tables
  kill temp
  q stop
 &sv .dr = %.dr% + 1
 &if %.dr% = 5 &then
  &do
  &sv .wlm = %.wlm% + 1
  &sv .dr = 1
  &end
&end

&return
```

Appendix C. The Long Term Resource Monitoring Program's Land Cover/Land Use Classification System for the Upper Mississippi River System

Long Term Resource Monitoring Program
Land Cover/Land Use Classification List

Version 2.06
July 1, 1994

The Long Term Resource Monitoring Program (LTRMP) was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U.S. Army Corps of Engineers' Environmental Management Program. The LTRMP is being implemented by the Environmental Management Technical Center (EMTC), an office of the National Biological Survey, in cooperation with the five Upper Mississippi River System States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, with guidance and Program responsibility provided by the U.S. Army Corps of Engineers.

The mission of the LTRMP is to provide decision makers with information for maintaining the Upper Mississippi River System (UMRS) as a viable large river ecosystem given its multiple-use character. The long-term goals of the Program are to understand the system, determine resource trends and impacts, develop management alternatives, manage information, and develop useful products.

In 1989, the LTRMP began collecting aerial photography, photographing the entire UMRS floodplain in both true color and color infrared (scale, 1:15,000). In the years since, color infrared photography has been collected for selected regions of the river.

The LTRMP has field stations collecting data within six study reaches of the UMRS. The former National Ecology Research Center (NERC; Fort Collins, Colorado) was contracted to interpret and computerize 1989 photography of LTRMP study reaches and four other project areas. In 1991, LTRMP personnel began interpreting aerial photography. Interpreters from NERC used a minimum mapping unit of <1 acre and a minimum of 10% vegetation cover; LTRMP interpreters use a minimum mapping unit of 1 acre and a minimum of 10% vegetation cover.

Photography is interpreted to delineate three feature types: land cover/land use, percent vegetation cover, and tree height. Examples of how photographs are interpreted follow:

1. **An area of forested islands with no aquatic vegetation.** The interpreter first locates, then marks, the land–water interface. Each island is studied to see if more than one land cover/land use type is present. If multiple types are present, the interpreter analyzes the area to see if the trees are growing in a mixture or if unique stands of trees are present. Each polygon is then labeled with the appropriate vegetation code followed by a character describing the percentage of the island covered by the trees (i.e., canopy closure). The average tree height is then calculated and recorded.

2. **A sand bar–dredge spoil island sparsely vegetated with grass.** Like the previous example, the interpreter first marks the outer boundary of the sand bar. If all of the vegetation is localized within one region of the sand bar and the area is large enough to be mapped, a boundary line is drawn around the vegetation. If the vegetation is so sparse that it does not cover at least 10% of the

sand surface, the grasses are ignored and the area is mapped as sand. If the grasses cover more than 10% of the sand surface, the area is mapped as grass and the percent vegetation cover is noted. Vegetation height is recorded only when trees are present.

3. **A transition zone containing a mixture of various rooted and floating vegetation, emergents, and submergents.** The area containing the mixture is first separated from its surrounding features. The mixture is then analyzed to see if the region contains a uniform mixture of plants or several distinct regions of different plant mixtures. Each polygon is labeled with the appropriate vegetation code, then the percent vegetation cover is noted. LTRMP interpreters do not analyze plant mixtures to determine plant dominance. Therefore, the sequence in which mixed vegetation types are listed is arbitrary and does not represent plant dominance.

The average size and size ranges of the mixed plant beds vary within the UMRS, and are site-specific. It should be noted that although LTRMP interpreters use a small, minimum mapping unit, sometimes the mixed vegetation beds are large. For example, within UMRS Pools 7 and 8, the mean size of a mixed vegetation polygon is 2–5 acres, but they range in size from 0.1 acre to 178 acres. Single polygons >50 acres have been created for

Nelumbo/Nymphaea/Sagittaria
Nelumbo/Nymphaea/submerg/Lemn
Nymphaea/submergents/Lemnaceae

and polygons >150 acres have been created for

Nymphaea/Nelumbo/submergents
Nymphaea/submergents

Photointerpreters from the LTRMP use a genus-level classification scheme. A 13-class generalized classification scheme was also developed for regrouping the data. A numeric classification scheme is then used to relate the two classification schemes. An explanation of LTRMP vegetation codes follows:

Each LTRMP generalized vegetation group has been assigned a number that is a multiple of 100. For example, Open Water is 100, Submergents is 200.

Each vegetation type was then assigned a numeric value that related it to the 13 vegetation groups. For example, the submergent *Myriophyllum* (water milfoil) is 202.

Vegetation types unique to historical coverages have been assigned values of 50 or above. Example: *Sagittaria latifolia* (broad arrowhead) is 751. The 700 portion of the number signifies that *Sagittaria latifolia* is an Emergent, while the 51 signifies that this vegetation class is not in use by LTRMP photointerpreters.

****

100 Open Water - Any unvegetated body of water. Includes rivers, streams, lakes, and ponds. All 100-numbered water types within the 13-class land cover/land use coverages are grouped into Open Water. Note: Industrial ponds are classified under Urban/Developed (1200's).

101 Lemnaceae - Duckweed (floating) - Duckweed has been assigned an Open Water classification because of its mobile tendencies; Duckweed goes wherever the wind takes it.

****

200 Submergents - Used to classify any area with submergent vegetation whose species composition is unknown. All 200-numbered submergents within the 13-class land cover/land use coverages are grouped into Submergents. Note: Species classification of submergents within LTRMP coverages began in 1992, only for plant beds that had been groundtruthed. The order in which plant combinations are listed does not reflect plant dominance.

201 Lemnaceae/submergents - Duckweed/submergent vegetation mixture

202 Myriophyllum - Water Milfoil

203 Zosterella - Water Star Grass

204 Vallisneria/Zosterella - Wild Celery/Water Star Grass mixture

205 Myriophyllum/Zosterella - Water Milfoil/Water Star Grass mixture

206 Vallisneria/Potamogeton - Wild Celery/Pondweed mixture

207 Myrioph/Potamoget/Vallis - Water Milfoil/Pondweed/Wild Celery mixture

208 Potamoget/Vallis/Zost/Cerat - Pondweed/Wild Celery/Water Star Grass/Coontail mixture

209 Elodea - Waterweed

250* Vallisneria/Potamoget/Heteran - Wild Celery/Pondweed/Water Stargrass mixture. Note: The name of this class was established by the classification of the GREAT data. Since then, the genus *Heterantha* has been changed to *Zosterella*.

251* Ceratophyllum - Coontail

252* Lemnaceae/Ceratophyllum - Duckweed/Coontail mixture

253* Lemna/Ceratophyll/Potamogeton - Duckweed/Coontail/Pondweed mixture

254* Potamogeton - Pondweed

255* Vallisneria - Wild Celery

***** This class was assigned a historical classification number (50's) because at the time it was assigned its number, this class was only utilized within the GREAT river study coverages (1970's).

****

300 Submerg–Rooted Floating Aqua - This class is used only to regroup 300-numbered Submergent-Rooted Floating Aquatics for use in the 13-class generalized land cover/land use coverages. This class should not appear on any interpreted photographs. Note: Species classification of submergents within LTRMP coverages first began in 1992, only for plant beds that had been groundtruthed. The order in which plant combinations are listed does not reflect plant dominance.

301 Brasenia/submergents - Watershield/submergent vegetation mixture

302 Nelumbo/Nymphaea/submerg/Lemn - American Lotus/White Water Lily/submergent vegetation/Duckweed mixture

303 Nelumbo/submergents - American Lotus/submergent vegetation

304 Nelumbo/submergents/Lemnaceae - American Lotus/submergent vegetation/Duckweed mixture

305 Nymphaea/Nelumbo/submergents - White Water Lily/American Lotus/submergent vegetation mixture

306 Nymphaea/submergents - White Water Lily/submergent vegetation mixture

307 Nymphaea/submergents/Lemnaceae - White Water Lily/submergent vegetation/Duckweed mixture

308 Nymphaea/Myriophyllum - White Water Lily/Water Milfoil mixture

309 Nelumbo/Myriophyllum - American Lotus/Water Milfoil mixture

310 Nelumbo/Nymphaea/Myriophyllum - American Lotus/White Water Lily/Water Milfoil mixture

311 Nymph/Ceratoph/Myriophyl/Lemna - White Water Lily/ Coontail/Water Milfoil/Duckweed mixture

312 Nymphaea/Ceratophyllum/Lemna - White Water Lily/Coontail/Duckweed mixture

****

400 Submerg–Rooted Floating–Emerg - This class is used only to regroup all 400-numbered Submergent-Rooted Floating Aquatic-Emergents for use in the 13-class generalized land cover/land use coverages. This class should not appear on any interpreted photographs. Note: Species classification of submergents within LTRMP coverages began in 1992, only for plant beds that had been groundtruthed. The order in which plant combinations are listed does not reflect plant dominance.

401 Nelum/Nymph/Sag/Sparg/sub/Lemn - American Lotus/White Water Lily/Arrowhead/Bur-reed/submergents/Duckweed mixture

402 Nelum/Nymph/Ponted/sub/Lemn - American Lotus/White Water Lily/Pickerelweed/submergents/Duckweed mixture

403 Scirpus/Nelumbo/submergents - Bulrush/American Lotus/submergents mixture

404 Scirpus/Nymphaea/submergents - Bulrush/White Water Lily/submergents mixture

405 Zizania/Nymphaea/Nelumbo/sub - Wild Rice/White Water Lily/American Lotus/submergents mixture

406 Pontederia/Nymph/Nelumbo/sub - Pickerelweed/White Water Lily/American Lotus/submergents mixture

407 Sagit/Ceratophyllum/Lemnaceae - Arrowhead/Coontail/Duckweed mixture

****

500 Rooted Floating Aquatics - This class is used only to regroup all 500-numbered Rooted/Floating Aquatics for use in the 13-class generalized land cover/land use coverages. This class should not appear on any interpreted photographs. Note: The order in which plant combinations are listed does not reflect plant dominance.

501 Brasenia - Watershields

502 Jussiaea - Water Primrose

503 Nelumbo - American Lotus

504 Nelumbo/Lemnaceae - American Lotus/Duckweed mixture

505 Nelumbo/Nymphaea - American Lotus/White Water Lily mixture

506 Nuphar - Yellow Water Lily - Note: *Nuphar* and *Nymphaea* cannot be differentiated on aerial photography. *Nuphar* is used in areas where it is known to occur; otherwise, *Nymphaea* is the default water lily genus.

507 Nymphaea - White Water Lily

508 Nelumbo/Nymphaea/Lemnaceae - American Lotus/White Water Lilly/Duckweed mixture

509 Nymphaea/Lemnaceae - White Water Lily/Duckweed mixture

****

600 Rooted Floating Aqua–Emergents - This class is used only to regroup all 600-numbered Rooted Floating Aquatic-Emergents for use in the 13-class generalized land cover/land use coverages. This class should not appear on any interpreted photographs. Note: The order in which plant combinations are listed does not reflect plant dominance.

601 Nelumbo/Nymphaea/Sagittaria - American Lotus/White Water Lily/Arrowhead mixture

602 Nymphaea/Sagittaria - White Water Lily/Arrowhead mixture

603 Nymphaea/Scirpus - White Water Lily/Bulrush mixture

604 Sagittaria/Nelumbo - Arrowhead/American Lotus mixture

****

700 Emergents - This class is used only to regroup all 700-numbered Emergents for use in the 13-class generalized land cover/land use coverages. This class should not appear on any interpreted photographs. Note: The order in which plant combinations are listed does not reflect plant dominance.

701 Acorus - Sweetflag Grass

702 Carex - Sedges

703 Cyperus - Flat Sedge

704 Decodon - Water Willow

705 Echinodorus - Burheads

706 Eleocharis - Spike Rush

707 Lythrum salicaria - Purple Loosestrife

708 Pontederia - Pickerel Weed

709 Sagittaria - Arrowhead

710 Sagittaria/Lemnaceae - Arrowhead/Duckweed mixture

712 Sagittaria/Scirpus/Sparganium - Arrowhead/Bulrush/Bur-reed mixture

713 Sagittaria/Sparganium - Arrowhead/Bur-reed mixture

714 Scirpus - Bulrush

715 Scirpus/Sagittaria - Bulrush/Arrowhead mixture

716 Scirpus/Sparganium - Bulrush/Bur-reed mixture

717 Sedge meadow - A very wet meadow dominated by sedges. Other emergents may be mixed within.

718 Sparganium - Bur-reed

719 Typha - Cattail

720 Typha/Sagittaria - Cattail/Arrowhead mixture

721 Typha/Scirpus - Cattail/Bulrush mixture

722 Typha/Scirpus/Sparganium - Cattail/Bullrush/Bur-reed mixture

723 Typha/Sparganium - Cattail/Bur-reed mixture

724 Zizania - Wild Rice

725 Equisetum - Horsetail - To date, only a handful of polygons have been recognizable on aerial photos. All were located within UMRS Pools 5a and 6.

726 Dead Emergents - Added in 1993 to map emergent vegetation beds containing standing crop killed by the 1993 flood.

****

800 Emergents–Grasses–Forbs - This class is used only to regroup all 800-numbered Emergents-Grasses/Forbs for use in the 13-class generalized land cover/land use coverages. This class should not appear on any interpreted photographs. Note: The order in which plant combinations are listed does not reflect plant dominance.

801 Leersia/Carex/Polygonum - Cutgrass/Sedges/Smartweed mixture

802 Leersia/Carex/Sagit/Polygonum - Cutgrass/Sedges/Arrowhead/Smartweed mixture

803 Leer/Phalar/Scirp/Lythr/Phrag - Cutgrass/Reed Canary Grass/Bulrush/Purple Loosestrife/Common Reed mixture

804 Leersia/Sagittaria - Cutgrass/Arrowhead mixture

805 Sagittaria/Phalaris - Arrowhead/Reed Canary Grass mixture

806 Sagittaria/Polygonum - Arrowhead/Smartweed mixture

807 Sag/Sparg/Typ/Scirp/Leer/Phrag - Arrowhead/Bur-reed/Cattail/Bulrush/Cutgrass/Common Reed mixture

808 Scirpus/Leersia - Bulrush/Cutgrass mixture

809 Scirpus/Carex/Leersia/Polygon - Bulrush/Sedges/Cutgrass/Smartweed mixture

810 Scirpus/Phalaris - Bulrush/Reed Canary Grass mixture

811 Scirpus/Phragmites - Bulrush/Common Reed mixture

812 Scirpus/Polygonum - Bulrush/Smartweed mixture

813 Scirpus/Typha/Phalaris - Bulrush/Cattail/Reed Canary Grass mixture

814 Sparganium/Leersia - Bur-reed/Cutgrass mixture

****

900 Grasses–Forbs - Non-woody plants. This class is used only to regroup all 900-numbered Grasses/Forbs for use in the 13-class generalized land cover/land use coverages. This class should not appear on any interpreted photographs. Note: The order in which plant combinations are listed does not reflect plant dominance.

901 Ambrosia - Ragweed

902 Grass - Used to delineate areas of mixed grasses. Abandoned/set aside fields are also placed within this class.

903 Hay meadow - Lowland (temporarily wet) areas, regularly cut and baled for hay.

904 Pasture (heavily grazed areas) - "Hay fields" regularly pastured with cattle or similar livestock.

905 Leersia - Cutgrass

906 Leersia/Polygonum - Cutgrass/Smartweed mixture

907 Meadow - Upland areas regularly cut and baled for hay.

908 Mixed forbs and/or grasses - Class used to describe a mixture of many different Grasses and Forbs. Note: Photointerpreters should not intermix the use of this class and class 900. Class 900 is to be used only for regrouping purposes.

909 Nettles - any nettles

910 Phalaris - Reed Canary Grass

911 Phalaris/Polygonum - Reed Canary Grass/Smartweed mixture

912 Phragmites - Common Reed

913 Phragmites/Phalaris - Common Reed/Reed Canary Grass mixture

914 Polygonum - Smartweed

915 Polygonum/Nelumbo - Smartweed/American Lotus mixture

916 Rdside-levee/grass/forbs/shrub - Any roadside ditch or levee. Example of a roadside: Delineation of a north/south roadway would begin on the far west side of the western ditch and go to the far eastern side of the eastern ditch. Both ditches and the road are included within the same polygon.

917 Sand–prairie - A very sandy area covered with very dry-soil grasses.

918 Spartina - Cord Grass

919 Vines as dense overgrowth - Any live stem vine growing as a dense covering.

920 Polygonum/Eupatorium - Smartweed/*Eupatorium* mixture

921 Dead Grass - Added in 1993 to map vegetation beds of standing crop killed by the 1993 flood.

****

1000 Woody Terrestrial - All trees and shrubs. This class was intended to be used only for regrouping all 1000-numbered classes, but photointerpreters for Pools 4, 8, and 13 used this class on 1991 and 1992 aerial photos as a time-saving measure. When Woody Terrestrial is used on a photograph, it signifies that any or all of the 1000-group plants can be found in those areas. The use of Woody Terrestrial ended in 1993 with the introduction of Forest Mesic. Pool 26, Open River, and La Grange have concentrated their efforts on classifying the floodplain forest to the genus level since their study areas do not contain as much aquatic vegetation as the upper pools. Woody Terrestrial was not used in the 1989 coverages prepared by NERC and should no longer appear on any interpreted photographs. Note: The order in which plant combinations are listed does not reflect plant dominance.

1001 Acer - Maples

1002 Acer/Populus and/or Salix - Maples/Cottonwood or Willow mixture

1003 Amorpha - False Indigo

1004 Betula - Birches

1005 Brush - Any small shrubby species

1006 Carya/Nyssa - Hickory/Sour Gums

1007 Cephalanthus - Button Bush

1008 Forest-mesic (moist soil sp.) - Plant communities occurring at low elevations. Forest-mesic can contain any combination of the following: *Acer, Acer/Populus* and/or *Salix, Carya/Nyssa, Fraxinus, Betula,* Brush, *Cephalanthus,* Conifers, *Populus, Salix, Salix* and/or *Populus, Salix* and/or *Populus* - grass, *Quercus, Taxodium, Taxodium/Nyssa,* and *Ulmus.*

1009 Forest-upland (dry soil sp.) - Plant communities occurring above the floodplain. Forest-upland can contain any combination of the following: *Acer, Betula,* Brush, Conifers, *Fraxinus, Juniperus,* Plantation, *Populus,* and *Quercus.*

1010 Fraxinus - Ash

1011 Plantation - Any group of planted, cultivated trees. Examples include apple orchards, Christmas tree farms, and stands of planted pines.

1012 Populus - Cottonwood

1013 Quercus - Oaks

1014 Salix - Willows

1015 Salix and/or Populus - Willows and/or Cottonwood

1016 Salix and/or Populus - grass - Willows and/or Cottonwood mixed with grasses

1017 Shrub/grass/forbs - Shrub/grass/forbs mixture

1018 Shrub/Scirpus - Shrub/Bulrush mixture

1019 Taxodium - Bald Cypress

1020 Taxodium/Nyssa - Bald Cypress/Sour Gum

1021 Ulmus - Elm

1022 Conifers - Naturally occurring cone-bearing trees (unplanted)

1023 Juniperus - Eastern Red Cedar

****

1100 Agriculture - Any cultivated field that is either turned with a plow or worked with a disk. Crops include corn, soybeans, and oats.

****

1200 Urban–Developed - Any area "developed" by humans. This class is used only to regroup all 1200-numbered Urban classes for use in the 13-class generalized land cover/land use coverages. This class should not appear on any interpreted photographs.

1201 Developed - Shopping malls, industrial parks, military depots, farmsteads, storage facilities, and isolated industrial sites (built in the middle of a rural area) are considered developed.

1202 Developed parks - City and state parks are included in this category but only those areas actively used by humans. Examples are picnic areas, campgrounds, administrative buildings, and interpretive complexes.

1203 Industrial pond - Examples of industrial ponds are water coolant ponds and fish ponds actively managed for industrial or research use (i.e., fish farms and hatcheries).

1204 Urban - Residential areas, including schools.

1205 Revetted Bank - Riprap used to control bank erosion.

****

1300 Sand–Mud - This class is used only to regroup all 1300-numbered Sand/Mud classes for use in the 13-class generalized land cover/land use coverages. This class should not appear on any interpreted photographs.

1301 Mud - Mud

1303 Sand - Sand

****

1400 No Coverage - Used to label areas within the floodplain study area (a) not covered by aerial photography or (b) with no aerial photography available.

Modifiers:

The first group of modifiers is used to describe the average height of polygons containing Woody Terrestrial vegetation.

1 0–20 ft tall
2 21–50 ft tall
3 >50 ft tall

The second group of modifiers is used to describe vegetation density within an interpreted polygon. No attempts have been made to utilize these modifiers to describe plant dominance within mixed species polygons.

A 10%–33% vegetation cover
B 34%–67% vegetation cover
C 68%–90% vegetation cover
D >90% vegetation cover

Appendix D. The Arc Macro Language Program for Comparing Water Level Management Scenarios

```
/* Arc Macro Language code for change detection

/* set variables
&sv datapath = /usr4/arc_work/jtr0/projects/pool25/data/
&sv .lw = %datapath%lw-1-1
&sv .elv = %datapath%p25elv
&sv .lcu = %datapath%lcu89
&sv .wlm = 1
&sv .dr = 1

/* create land-water and lcu grid
grid
 setmask off
 &do &until %.dr% = 5
  setcell minof
    temp = %datapath%wsep25.wse-%.wlm%-%.dr% * 10 - %.elv%
    if (temp lt 0)lw-%.wlm%-%.dr% = 1
     else lw-%.wlm%-%.dr% = 2
     endif
   kill temp
  /* land = 1  water = 2

   lcu-b-%.wlm%-%.dr% = setnull (%.lw% ne lw-%.wlm%-%.dr%, %.lcu%)
   setmask %datapath%p25lev
   lcu-a-%.wlm%-%.dr% = lcu-b-%.wlm%-%.dr%
   setmask off

    &if %.wlm% = 1 &then
     &do
      if (%.lw% ne lw-1-%.dr%) lcu-%.dr% = 16 - %.lw%
      else lcu-%.dr% = %.lcu%
     &end
    &else
      &do
       lcuc-b-%.wlm%-%.dr% = setnull (lw-1-%.dr% eq lw-%.wlm%-%.dr%, lcu-%.dr%)
       setmask %datapath%p25lev
       lcuc-a-%.wlm%-%.dr% = lcuc-b-%.wlm%-%.dr%
       setmask off
      &end

  &sv .wlm = %.wlm% + 1
  &if %.wlm% = 6 &then
   &do
    &sv .dr = %.dr% + 1
    &sv .wlm = 1
   &end
 &end
```

```
q

/* create tables of frequency

&sv .dr = 1
&sv .wlm = 1
&if %.dr% ne 6 &then
&do
 &sv .lev = a
 &do &until %.lev% eq c
  &do &until %.dr% = 5
   copyinfo lcu-%.lev%-%.wlm%-%.dr%.vat lcu-%.lev%-%.wlm%-%.dr%.dat
   kill lcu-%.lev%-%.wlm%-%.dr%
   tables
    sel lcu-%.lev%-%.wlm%-%.dr%.dat
     alter count
     %.lev%%.wlm%%.dr%
     ~
     ~
     ~
    q stop
   &if %.wlm% eq 1 and %.dr% eq 1 &then
   &else
   &do
    joinitem lcu-%.lev%-1-1.dat lcu-%.lev%-%.wlm%-%.dr%.dat lcu-%.lev%-1-1.dat value %.lev%11
    tables
     kill lcu-%.lev%-%.wlm%-%.dr%.dat
    q stop
   &end

   &sv .wlm = %.wlm% + 1
   &if %.wlm% = 6 &then
    &do
     &sv .dr = %.dr% + 1
     &sv .wlm = 1
    &end
  &end

   &if %.lev% = b &then
    &sv .lev = c
   &if %.lev% = a &then
   &do
    &sv .lev = b
    &sv .dr = 1
    &sv .wlm = 1
   &end
 &end

/* export to ascii file
&data ARC INFO
 ARC
  sel LCU-A-1-1.DAT
```

```
   export /usr4/arc_work/jtr0/projects/pool25/output/lcu-a.dat sdf
VALUE,A11,A21,A31,A41,A51,A12,A22,A32,A42,A52,A13,A23,A33,A43,A53,A14,A24,A34,A44,A5
4
  sel LCU-B-1-1.DAT
   export /usr4/arc_work/jtr0/projects/pool25/output/lcu-b.dat sdf
VALUE,B11,B21,B31,B41,B51,B12,B22,B32,B42,B52,B13,B23,B33,B43,B53,B14,B24,B34,B44,B54
 q stop
&end
&end
```

REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, D.C. 20503

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	October 1996	

4. TITLE AND SUBTITLE	5. FUNDING NUMBERS
Pool 25: Water level management alternatives and their effects on habitat	
6. AUTHOR(S)	
Joseph H. Wlosinski and James T. Rogala	

7. PERFORMING ORGANIZATION NAME AND ADDRESS	8. PERFORMING ORGANIZATION REPORT NUMBER
U.S. Geological Survey Upper Midwest Environmental Sciences Center 2630 Fanta Reed Road La Crosse, Wisconsin 54603	

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSORING/MONITORING AGENCY REPORT NUMBER
U.S. Geological Survey Upper Midwest Environmental Sciences Center 2630 Fanta Reed Road La Crosse, Wisconsin 54603	96-T004

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT	12b. DISTRIBUTION CODE
Release unlimited. Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161 (1-800-553-6847 or 703-487-4650	

13. ABSTRACT (Maximum 200 words)

The effects of changing levee and water level management practices on present habitat types and amounts on the Upper Mississippi River floodplain at Pool 25 were predicted. The intent of the study was to investigate a broad range of plans that would provide course resolution information and the tools needed to study specific plans in the future. Two conditions were investigated for levees: the present levee system and all levees removed. Five water level management plans were studied: the present plan, two plans that would increase water levels, and two plans that would decrease water levels. The two management variables--levee and water level management plans--resulted in a total of ten unique management alternatives. Each was studied at four discharge regimes for a total of 40 scenarios. A geographic information system (GIS) was used to investigate the amounts and types of habitat that would be affected for each scenario. Tools developed for the study were a discharge elevation relation for the tailwater of Pool 25; estimates of water levels throughout Pool 25 for each scenario; GIS coverages of water levels, floodplain elevations, levees, and habitat types; and a technique to compare alternative scenarios. All GIS analyses were performed in a raster environment.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Discharge, GIS, habitat, habitat changes, land cover, levee, Mississippi River, Upper Mississippi River, water level	85 pp. + Appendixes A–D
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	

The Long Term Resource Monitoring Program (LTRMP) for the Upper Mississippi River System was authorized under the Water Resources Development Act of 1986 as an element of the Environmental Management Program. The mission of the LTRMP is to provide river managers with information for maintaining the Upper Mississippi River System as a sustainable large river ecosystem given its multiple-use character. The LTRMP is a cooperative effort by the U.S. Geological Survey, the U.S. Army Corps of Engineers, and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin.